

# **ELECTRICAL SYSTEM**

## **Volume VI**

**Operations & Maintenance Manual**

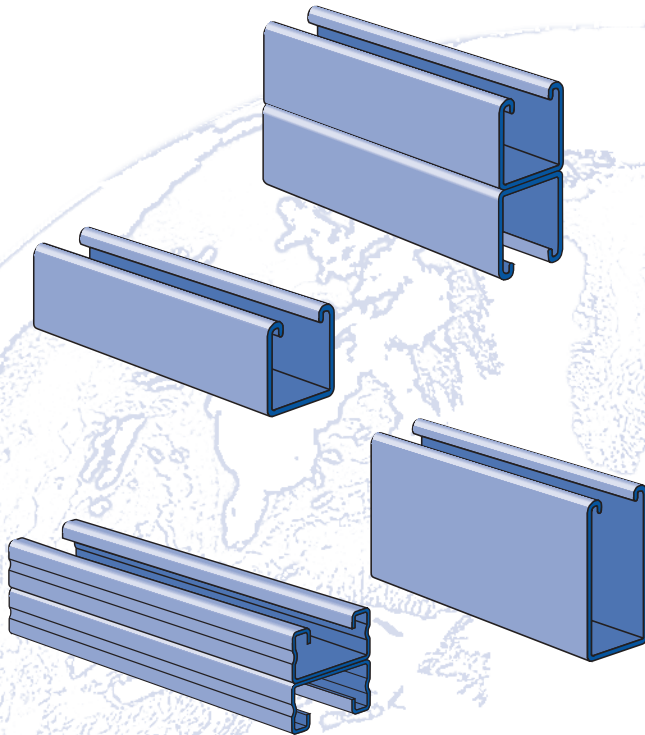
# **FCP-RCP MOUNTING** **SUPPORTS**

**Operations & Maintenance Manual**  
**December 2015**





# 1<sup>5</sup>/<sub>8</sub>" CHANNEL



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## MATERIAL

Unistrut channels are accurately and carefully cold formed to size from low-carbon strip steel.

All spot-welded combination members, except P1001T, are welded 3" (76 mm) maximum on center.

### STEEL: PLAIN

12 Ga. (2.7 mm), 14 Ga.(1.9 mm) and  
16 Ga. (1.5 mm) ASTM A1011 SS GR 33.

### STEEL: PRE-GALVANIZED

12 Ga. (2.7 mm), 14 Ga. (1.9 mm) and  
16 Ga. (1.5mm) ASTM A653 GR 33.

For other materials, see Special Metals or Fiberglass sections.

## FINISHES

All channels are available in:

- Perma Green III (GR).
- Pre-galvanized (PG), conforming to ASTM A653 G90.
- Hot-dipped galvanized (HG), conforming to ASTM A123.
- Plain (PL).

## DIMENSIONS

Imperial dimensions are illustrated in inches. Metric dimensions are shown in millimeters and rounded to one decimal place.

## STANDARD LENGTHS

Standard lengths are 10 feet (3.05m) and 20 feet (6.10m). Tolerances are +<sup>1</sup>/<sub>8</sub>" (3 mm) to +<sup>1</sup>/<sub>2</sub>" (13 mm) to allow for cutting. Special lengths are available for a small cutting charge with a tolerance of ±<sup>1</sup>/<sub>8</sub>" (3 mm).

## CURVED CHANNEL

Contact your local Unistrut Service Center or Unistrut Corporation for more information.

## LOAD DATA

All beam and column load data pertains to carbon steel and stainless steel channels. Load tables and charts are constructed to be in accordance with the SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS 2001 EDITION published by the AMERICAN IRON AND STEEL INSTITUTE USING ASD METHOD.

Type of Load	Safety Factor to Yield Strength	Safety Factor to Ultimate Strength
Beam Loads	1.67	2.0
Column Load	1.80	2.2

CHANNEL SELECTION CHART

Channel	Channel Dimensions		Material & Thickness			Hole Pattern Styles					
			Steel	Stainless Steel	Alum.						
	Width In (mm)	Height In (mm)	gauge	gauge	In (mm)	HS	T	KO	SL	DS	H3
P1000	1½ (41)	1½ (41)	12 ga	12 ga	0.109 (2.8)	■	■	■	■	■	■
P1100	1½ (41)	1½ (41)	14 ga	14 ga	—	■	■	■	■	—	—
P2000	1½ (41)	1½ (41)	16 ga	—	—	■	■	■	■	—	—
P3000	1½ (41)	1¾ (35)	12 ga	—	—	■	■	■	■	—	—
P3300	1½ (41)	7⁄8 (22)	12 ga	12 ga	—	■	■	—	■	—	—
P4000	1½ (41)	1⅜ (21)	16 ga	16 ga	0.078 (2.0)	■	■	—	■	—	—
P4100	1½ (41)	1⅜ (21)	14 ga	—	—	■	■	—	■	—	—
P5000	1½ (41)	3¼ (83)	12 ga	12 ga	—	■	■	■	■	—	—
P5500	1½ (41)	2⅞ (62)	12 ga	—	0.109 (2.8)	■	■	■	■	—	—

CHANNELS & COMBINATIONS IN DESCENDING ORDER OF STRENGTH

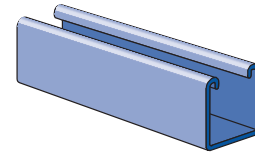
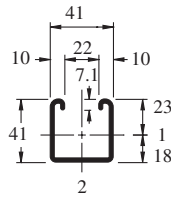
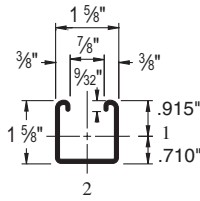
Channel	Area In <sup>2</sup> (cm <sup>2</sup> )	Weight lbs/ft (kg/m)	I In <sup>4</sup> (cm <sup>4</sup> )	s In <sup>3</sup> (cm <sup>3</sup> )	Allow. Moment In-lbs (N*m)
P5001	1.793 11.57	6.10 9.1	6.227 259.2	1.916 31.4	48,180 5,440
P1004A	1.965 12.68	6.68 9.9	4.068 169.3	1.669 27.4	41,980 4,740
P5501	1.452 9.37	4.94 7.3	2.805 116.8	1.151 18.9	28,940 3,270
P1001C41	2.221 14.33	7.55 11.2	1.856 77.2	1.142 18.7	28,720 3,250
P5000	0.897 5.78	3.05 4.5	1.098 45.7	0.627 10.3	15,770 1,780
P1001	1.111 7.16	3.78 5.6	0.928 38.6	0.571 9.4	14,360 1,620
P1101	0.835 5.39	2.84 4.2	0.733 30.5	0.451 7.4	11,340 1,280
P3001	1.000 6.45	3.40 5.1	0.591 24.6	0.430 7.0	10,810 1,220
P5500	0.726 4.68	2.47 3.7	0.522 21.7	0.390 6.4	9,820 1,110
P2001	0.684 4.41	2.32 3.5	0.618 25.7	0.381 6.2	9,570 1,080
P9200	0.489 3.16	2.23 3.3	0.279 11.6	0.297 4.9	7,480 850
A5000	0.492 3.17	1.67 2.5	0.358 14.9	0.265 4.3	6,670 750
A1001	0.609 3.93	2.07 3.1	0.302 12.6	0.242 4.0	6,070 690
P9000	0.387 2.50	1.88 2.8	0.166 6.9	0.205 3.4	5,150 580
P1000	0.555 3.58	1.89 2.8	0.185 7.7	0.202 3.3	5,070 570
P3301	0.790 5.10	2.69 4.0	0.176 7.3	0.201 3.3	5,060 570

Combinations not shown in catalog are available on special order. Consult factory for more details.

Channel	Area In <sup>2</sup> (cm <sup>2</sup> )	Weight lbs/ft (kg/m)	I In <sup>4</sup> (cm <sup>4</sup> )	s In <sup>3</sup> (cm <sup>3</sup> )	Allow. Moment In-lbs (N*m)
P1100	0.418 2.69	1.42 2.1	0.145 6.0	0.162 2.6	4,060 460
P3000	0.500 3.23	1.70 2.5	0.120 5.0	0.153 2.5	3,850 430
P4101	0.579 3.74	1.97 2.9	0.117 4.9	0.143 2.4	3,610 410
P2000	0.342 2.21	1.16 1.7	0.125 5.2	0.140 2.3	3,520 400
P4001	0.478 3.14	1.66 2.5	0.104 4.3	0.128 2.1	3,210 360
A3301	0.459 2.96	1.56 2.3	0.077 3.2	0.103 1.7	2,590 290
A1000	0.305 1.96	1.04 1.5	0.061 2.5	0.086 1.4	2,170 250
P3300	0.395 2.55	1.34 2.0	0.037 1.5	0.072 1.2	1,800 200
A4001	0.264 1.70	0.90 1.3	0.037 1.5	0.058 1.0	1,470 170
P6001	0.213 1.38	0.73 1.1	0.045 1.9	0.055 0.9	1,400 160
P4100	0.290 1.87	0.98 1.5	0.026 1.1	0.054 0.9	1,360 150
P4000	0.244 1.57	0.83 1.2	0.023 0.9	0.049 0.8	1,230 140
A3300	0.230 1.48	0.78 1.2	0.017 0.7	0.038 0.6	950 110
A4000	0.132 0.85	0.45 0.7	0.008 0.3	0.022 0.4	560 60
P6000	0.107 0.69	0.36 0.5	0.009 0.4	0.020 0.3	510 60
P7001	0.148 0.96	0.50 0.8	0.007 0.3	0.018 0.3	460 50
P7000	0.074 0.48	0.25 0.4	0.002 0.1	0.007 0.1	170 20

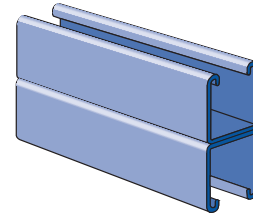
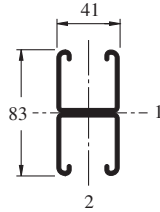
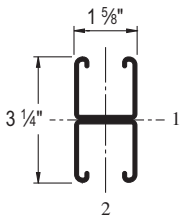


### P1000®



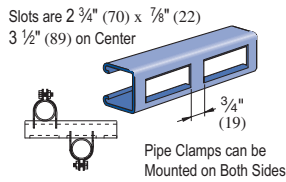
Wt/100 Ft: 189 Lbs (281 kg/100 m)  
 Allowable Moment 5,070 In-Lbs (570 N\*m)  
 12 Gauge Nominal Thickness .105" (2.7mm)

### P1001



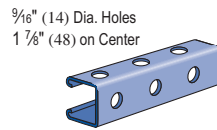
Wt/100 Ft: 378 Lbs (562 kg/100 m)  
 Allowable Moment 14,360 In-Lbs (1,620 N\*m)  
 12 Gauge Nominal Thickness .105" (2.7mm)

### P1000 DS



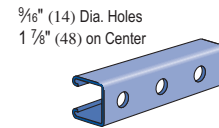
Wt/100 Ft: 173 Lbs (257 kg/100 m)

### P1000 H3



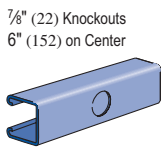
Wt/100 Ft: 175 Lbs (260 kg/100 m)

### P1000 HS



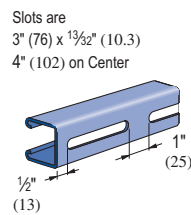
Wt/100 Ft: 185 Lbs (275 kg/100 m)

### P1000 KO



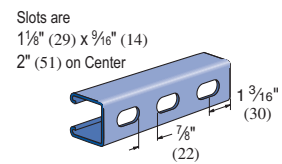
Wt/100 Ft: 190 Lbs (283 kg/100 m)

### P1000 SL



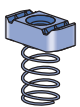
Wt/100 Ft: 185 Lbs (275 kg/100 m)

### P1000 T



Wt/100 Ft: 185 Lbs (275 kg/100 m)

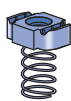
### CHANNEL NUTS (REFER TO HARDWARE SECTION FOR DETAILS)



**P1006-0832**  
**P1006-1024**  
**P1006-1420**  
**P1007**  
**P1008**  
**P1009**  
**P1010**



**P1008T**  
**P1006T1420**  
**P1010T**



**P1024**  
**P1012S**  
**P1023S**



**P1012**  
**P1023**  
**P1024S**



**P3006-0832**  
**P3006-1024**  
**P3006-1420**  
**P3007**  
**P3008**  
**P3009**  
**P3010**



**P3016-0632**  
**P3016-0832**  
**P3016-1024**  
**P3016-1420**

Channel Finishes: PL, GR, HG, PG; Standard Lengths: 10' & 20'

1 5/8" Channel  
 Telestrut System  
 Nuts & Hardware  
 General Fittings  
 Pipe/Conduit Supports  
 Electrical Fittings  
 Concrete Inserts  
 1 1/4" Framing System  
 1 3/4" Framing System  
 Fiberglass System  
 Special Metals  
 PrimeAngle System  
 Product Index

**P1000 - BEAM LOADING**

Span In	Max. Allowable Uniform Load Lbs	Defl. at Uniform Load In	Uniform Loading at Deflection		
			Span/180 Lbs	Span/240 Lbs	Span/360 Lbs
24	1,690	0.06	1,690	1,690	1,690
36	1,130	0.13	1,130	1,130	900
48	850	0.22	850	760	500
60	680	0.35	650	480	320
72	560	0.50	450	340	220
84	480	0.68	330	250	160
96	420	0.89	250	190	130
108	380	1.14	200	150	100
120	340	1.40	160	120	80
144	280	2.00	110	80	60
168	240	2.72	80	60	40
192	210	3.55	60	50	NR
216	190	4.58	50	40	NR
240	170	5.62	40	NR	NR

**P1001 - BEAM LOADING**

Span In	Max. Allowable Uniform Load Lbs	Defl. at Uniform Load In	Uniform Loading at Deflection		
			Span/180 Lbs	Span/240 Lbs	Span/360 Lbs
24	3,500*	0.02	3,500*	3,500*	3,500*
36	3,190	0.07	3,190	3,190	3,190
48	2,390	0.13	2,390	2,390	2,390
60	1,910	0.20	1,910	1,910	1,620
72	1,600	0.28	1,600	1,600	1,130
84	1,370	0.39	1,370	1,240	830
96	1,200	0.51	1,200	950	630
108	1,060	0.64	1,000	750	500
120	960	0.79	810	610	410
144	800	1.14	560	420	280
168	680	1.53	410	310	210
192	600	2.02	320	240	160
216	530	2.54	250	190	130
240	480	3.16	200	150	100

**P1000 - COLUMN LOADING**

Unbraced Height In	Max. Allowable Load at Slot Face Lbs	Maximum Column Load Applied at C.G.			
		K = 0.65 Lbs	K = 0.80 Lbs	K = 1.0 Lbs	K = 1.2 Lbs
24	3,550	10,740	9,890	8,770	7,740
36	3,190	8,910	7,740	6,390	5,310
48	2,770	7,260	6,010	4,690	3,800
60	2,380	5,910	4,690	3,630	2,960
72	2,080	4,840	3,800	2,960	2,400
84	1,860	4,040	3,200	2,480	1,980
96	1,670	3,480	2,750	2,110	1,660
108	1,510	3,050	2,400	1,810	**
120	1,380	2,700	2,110	**	**
144	1,150	2,180	1,660	**	**

**P1001 - COLUMN LOADING**

Unbraced Height In	Max. Allowable Load at Slot Face Lbs	Maximum Column Load Applied at C.G.			
		K = 0.65 Lbs	K = 0.80 Lbs	K = 1.0 Lbs	K = 1.2 Lbs
24	6,430	24,280	23,610	22,700	21,820
36	6,290	22,810	21,820	20,650	19,670
48	6,160	21,410	20,300	18,670	16,160
60	6,000	20,210	18,670	15,520	12,390
72	5,620	18,970	16,160	12,390	8,950
84	5,170	16,950	13,630	9,470	6,580
96	4,690	14,890	11,190	7,250	5,040
108	4,170	12,850	8,950	5,730	3,980
120	3,690	10,900	7,250	4,640	**
144	2,930	7,630	5,040	**	**

**P1000/P1001 - ELEMENTS OF SECTION**

Parameter	P1000		P1001	
Area of Section	0.555	In <sup>2</sup>	1.111	In <sup>2</sup>
Axis 1-1				
Moment of Inertia (I)	0.185	In <sup>4</sup>	0.928	In <sup>4</sup>
Section Modulus (S)	0.202	In <sup>3</sup>	0.571	In <sup>3</sup>
Radius of Gyration (r)	0.577	In	0.914	In
Axis 2-2				
Moment of Inertia (I)	0.236	In <sup>4</sup>	0.471	In <sup>4</sup>
Section Modulus (S)	0.290	In <sup>3</sup>	0.580	In <sup>3</sup>
Radius of Gyration (r)	0.651	In	0.651	In

Notes:

\* Load limited by spot weld shear.

\*\* KL/r > 200

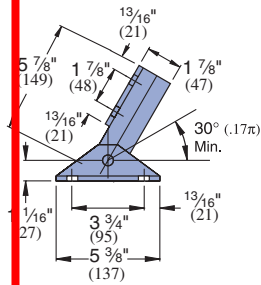
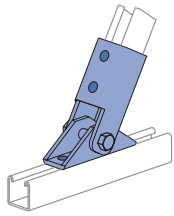
NR = Not Recommended.

- Above loads include the weight of the member. This weight must be deducted to arrive at the net allowable load the beam will support.
- Long span beams should be supported in such a manner as to prevent rotation and twist.
- Allowable uniformly distributed loads are listed for various simple spans, that is, a beam on two supports. If load is concentrated at the center of the span, multiply load from the table by 0.5 and corresponding deflection by 0.8.
- See page 56 for lateral bracing reduction charts.
- For Pierced Channel, Beam Load Values in the tables are multiplied by the following factor:

"DS" Series	70%	"T" Series	85%
"KO" Series	95%	"H3" Series	90%
"SL" Series	85%	"HS" Series	90%

### P2815

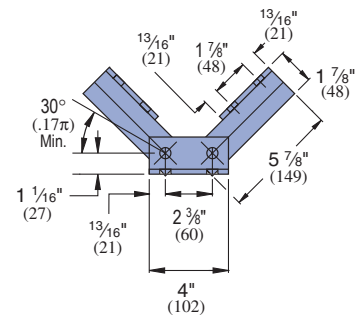
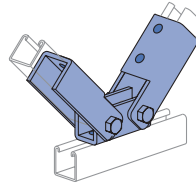
### ADJUSTABLE BRACE FITTING



Wt/100 pcs: 307 Lbs (139.3 kg)

### P2815D

### ADJUSTABLE BRACE FITTING



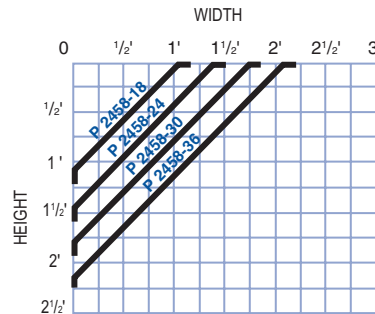
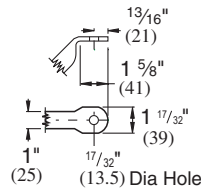
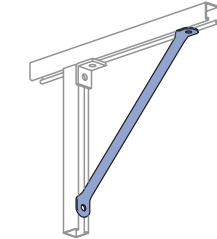
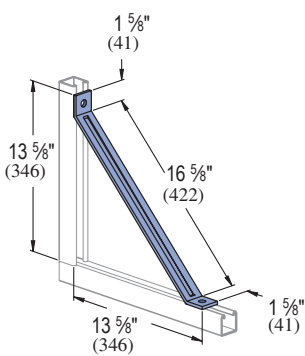
Wt/100 pcs: 497 Lbs (225.4 kg)

### P2452

### KNEE BRACE

### P2458-18 THRU P2458-36

### TUBULAR KNEE BRACES



Part Number	"A" In (mm)	Wt/100 pcs Lbs (kg)
P2458-18	18	146
P2458-24	24	186
P2458-30	30	227
P2458-36	36	267
	914	121.1

Design Axial Load  
1200 Lbs (5.34 kN)

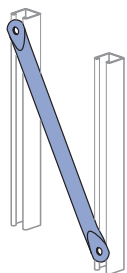
Material: 1/4" (6.4) thick steel.

Wt/100 pcs: 277 Lbs (125.6 kg)

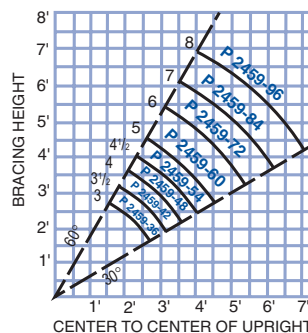
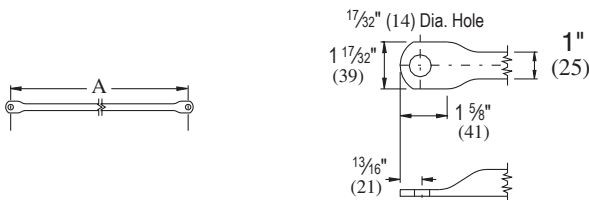
Design Loads  
Compression = 1500 Lbs (6.67 kN)  
Tension = 300 Lbs (1.33 kN)

### P2459-36 THRU P2459-96

### TUBULAR BACK BRACES



1. The vertical lines of the graph correspond to the center to center line dimension of the uprights.
2. Along this vertical line locate the (maximum usable) horizontal bracing height line.
3. The arc line that intersects the point formed by the intersection of the two lines, indicates the brace required.
4. 60° - 30° maximum, minimum brace angles are indicated for maximum effect.



Part Number	"A" In (mm)	Wt/100 pcs Lbs (kg)
P2459-36	36	255
	914	115.7
P2459-42	42	296
	1,067	134.3
P2459-48	48	336
	1,219	152.4
P2459-54	54	377
	1,372	171.0
P2459-60	60	418
	1,524	189.6
P2459-72	72	499
	1,829	226.3
P2459-84	84	580
	2,134	263.1
P2459-96	96	661
	2,438	299.8

Standard Dimensions for 1 1/8" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)

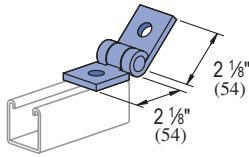
Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 13/16" (21mm); Hole Spacing - On Center: 1 1/8" (48mm); Width: 1 1/8" (41mm); Thickness: 1/4" (6mm)

Note : When used for mechanical supports, load capacities of brackets and fittings should be in compliance with the American Standard Code for Pressure Piping.



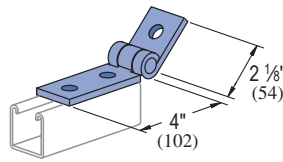


### P1843 ADJ. HINGE CONNECTION



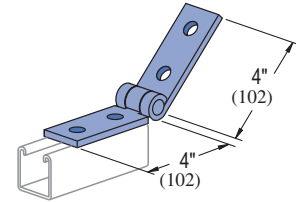
Wt/100 pcs: 68 Lbs (30.8 kg)

### P1354A ADJ. HINGE CONNECTION



Wt/100 pcs: 89 Lbs (40.4 kg)

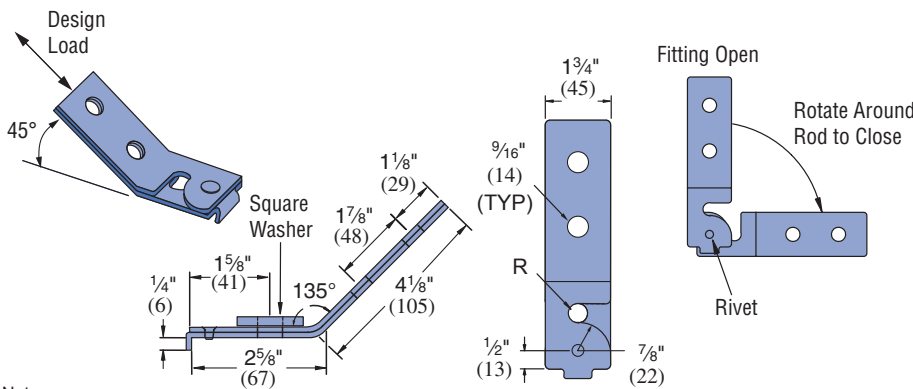
### P1354 ADJ. HINGE CONNECTION



Wt/100 pcs: 109 Lbs (49.4 kg)

### SEISMIC PIVOT FITTINGS

### SPF® 100



#### Notes:

1. Design load is limited to slip capacity of a channel nut at hole "R".
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specifications.
3. For retrofit application, engineer of record must verify.
4. Patented.
5. Square washer provided with fitting.
6. When a hanger rod is thru-bolted (in lieu of channel nut installation), higher transverse loads may be transmitted due to the higher allowed rod shear loads compared to channel nut slip values. This higher load may be used with verification through engineering calculations.

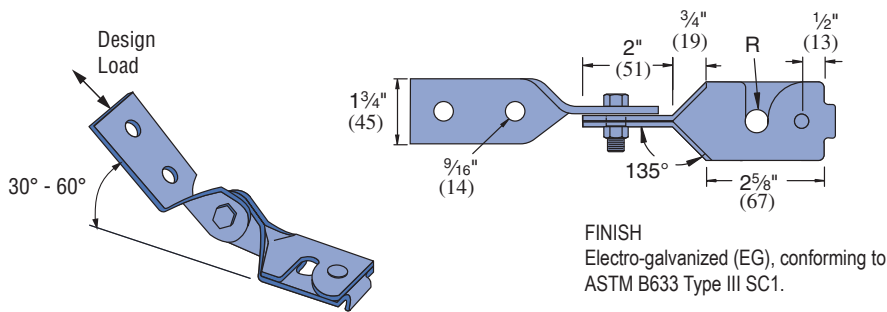
Part Number	Rod Size In (mm)	"R" - Hole Diameter In (mm)	Design Load Lbs (KN)
SPF 100-037	3/8 10	7/16 11	1,400 6.23
SPF 100-050	1/2 13	9/16 14	2,100 9.34
SPF 100-062	5/8 16	11/16 18	2,100 9.34
SPF 100-075	3/4 19	13/16 21	2,400 10.68

Safety Factor = 3.0

FINISH

Electro-galvanized (EG), conforming to ASTM B633 Type III SC1.

### SPF® 200



FINISH

Electro-galvanized (EG), conforming to ASTM B633 Type III SC1.

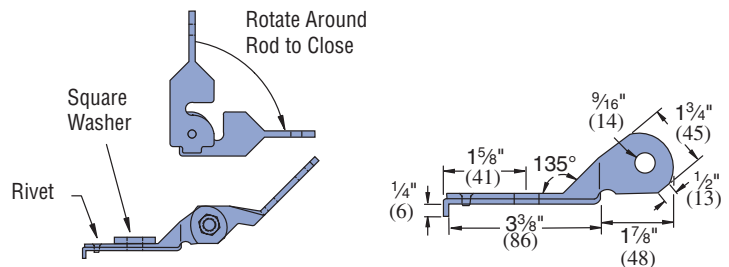
### ADJUSTABLE SEISMIC PIVOT FITTINGS

Part Number	Rod Size In (mm)	"R" - Hole Diameter In (mm)	Design Load Lbs (KN)
SPF 200-037	3/8 10	7/16 11	1,400 6.23
SPF 200-050	1/2 13	9/16 14	2,100 9.34
SPF 200-062	5/8 16	11/16 18	2,100 9.34
SPF 200-075	3/4 19	13/16 21	2,400 10.68

Safety Factor = 3.0

#### Notes:

1. Design load is limited to slip capacity of a channel nut at hole "R".
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specifications at 45° from horizontal.
3. For retrofit application, engineer of record must verify.
4. Patented.
5. Square washer provided with fitting.
6. When a hanger rod is thru-bolted (in lieu of channel nut installation), higher transverse loads may be transmitted due to the higher allowed rod shear loads compared to channel nut slip values. This higher load may be used with verification through engineering calculations.



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# **ELECTRICAL BOXES AND** **ENCLOSURES**

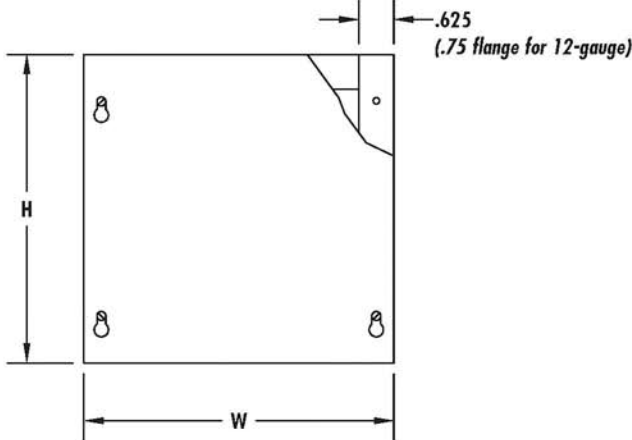
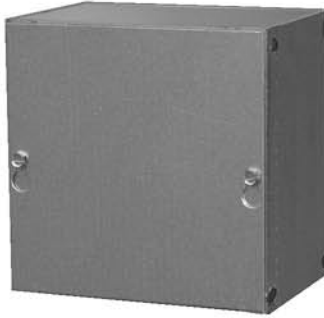
**Operations & Maintenance Manual**  
**December 2015**



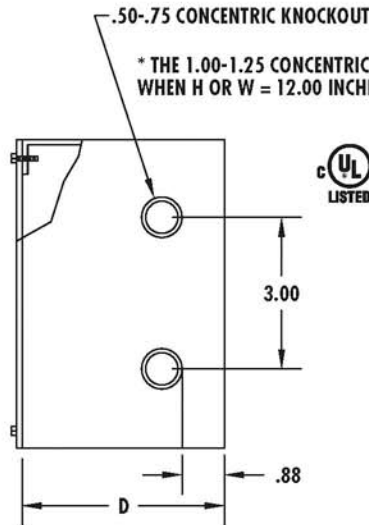
# GALVANIZED AND PAINTED TYPE 1 BOXES

Screw Cover, Screw Cover w/KO's, Hinge Cover, Hinge Cover w/KO's

TYPE 1



**TYPE 1 SCREW COVER**



**TYPE 1 SCREW COVER WITH KNOCKOUTS**

\* THE 1.00-1.25 CONCENTRIC KNOCKOUT IS USED WHEN H OR W = 12.00 INCHES OR MORE.\*

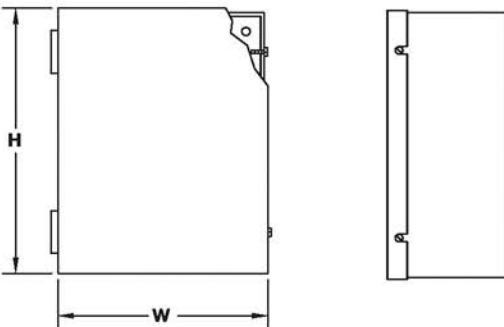


**CONSTRUCTION:**

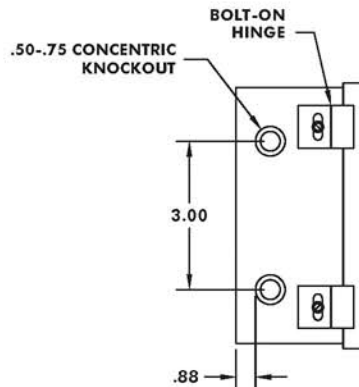
- CODE GAUGE G-90U GALVANIZED STEEL
- REMOVABLE COVER FASTENED WITH PLATED STEEL SCREWS
- KEYHOLE SCREW SLOTS IN THE COVER PERMIT THE REMOVAL OF THE COVER WITHOUT EXTRACTING THE SCREWS

**FINISH:**

- E-BOX TYPE 1 SCREW COVER BOXES ARE PROVIDED IN GALVANIZED G-90U OR ANSI 61 GRAY POLYESTER POWDER COATING INSIDE AND OUT OVER PAINT GRIP GALVANIZED STEEL



**TYPE 1 HINGE SCREW COVER**



\* THE 1.00-1.25 CONCENTRIC KNOCKOUT IS USED WHEN H OR W = 12.00 INCHES OR MORE. \*



**CONSTRUCTION:**

- CODE GAUGE G-90U GRADE GALVANIZED STEEL
- HINGE COVERS ARE FASTENED WITH STEEL PLATED SCREWS
- BOLT-ON HINGE COVERS HAVE A FORMED STEEL ON SMALLER BOXES AND A BUTT HINGE ON LARGER HINGE BOXES

**FINISH:**

- E-BOX TYPE 1 SCREW COVER BOXES ARE PROVIDED IN GALVANIZED G-90U OR ANSI 61 GRAY POLYESTER POWDER COATING INSIDE AND OUT OVER PAINT GRIP GALVANIZED STEEL

# GALVANIZED AND PAINTED TYPE 1 BOXES

Screw Cover, Screw Cover w/KO's, Hinge Cover, Hinge Cover w/KO's



TYPE I

## GALVANIZED

**SC Suffix** = Galvanized Screw Cover

**NOTE:** Replace "SC" suffix with:

**SCKO** ..... Galvanized Screw cover w/KO's

**HC** ..... Galvanized Hinge cover

**HCKO** ..... Galvanized Hinge cover w/KO's

## PAINTED

**SC Suffix** = Galvanized Screw Cover

**NOTE:** Replace "SC" suffix with:

**SCP** ..... Painted Screw Cover

**SCPKO** ..... Painted Screw cover w/KO's

**HCP** ..... Painted Hinge cover

**HCPKO** ..... Painted Hinge cover w/KO's

Enclosure Size HxWxD	Catalog Number	Weight
4x4x4	444SC	2
6x4x4	644SC	2
6x6x4	664SC	3
8x6x4	864SC	4
8x8x4	884SC	5
10x6x4	1064SC	5
10x8x4	1084SC	5
10x10x4	10104SC	7
12x6x4	1264SC	6
12x8x4	1284SC	6
12x10x4	12104SC	7
12x12x4	12124SC	9
15x12x4	15124SC	11
15x15x4	15154SC	14
16x16x4	16164SC	16
18x12x4	18124SC	13
18x15x4	18154SC	16
18x18x4	18184SC	17
24x12x4	24124SC	15
24x18x4	24184SC	23
24x24x4	24244SC	35
30x24x4	30244SC	43
36x24x4	36244SC	51
6x6x6	666SC	4
8x6x6	866SC	5
8x8x6	886SC	6
10x8x6	1086SC	7
10x10x6	10106SC	9
12x8x6	1286SC	9
12x10x6	12106SC	10
12x12x6	12126SC	11
15x12x6	15126SC	13
15x15x6	15156SC	16
16x16x6	16166SC	18
18x12x6	18126SC	16
18x15x6	18156SC	17
18x18x6	18186SC	20
24x12x6	24126SC	21
24x18x6	24186SC	26
24x24x6	24246SC	39
30x24x6	30246SC	48
30x30x6	30306SC	56
36x24x6	36246SC	81
36x30x6	36306SC	94
* 36x36x6	36366SC	110
* 48x24x6	48246SC	101
* 48x36x6	48366SC	128
* 48x48x6	48486SC	234

**NOTE:** \* Size **not** available with KO'S

**FOR LARGE QUANTITIES CALL FACTORY**

*Continue on next Page*



# GALVANIZED AND PAINTED TYPE 1 BOXES

Screw Cover, Screw Cover w/KO's, Hinge Cover, Hinge Cover w/KO's

TYPE  
1

## GALVANIZED

**SC Suffix** = Galvanized Screw Cover

**NOTE:** Replace "SC" suffix with:

**SKCO** ..... Galvanized Screw cover w/KO's

**HC** ..... Galvanized Hinge cover

**HCKO** ..... Galvanized Hinge cover w/KO's

## PAINTED

**SC Suffix** = Galvanized Screw Cover

**NOTE:** Replace "SC" suffix with:

**SCP** ..... Painted Screw Cover

**SCPKO** ..... Painted Screw cover w/KO's

**HCP** ..... Painted Hinge cover

**HCPKO** ..... Painted Hinge cover w/KO's

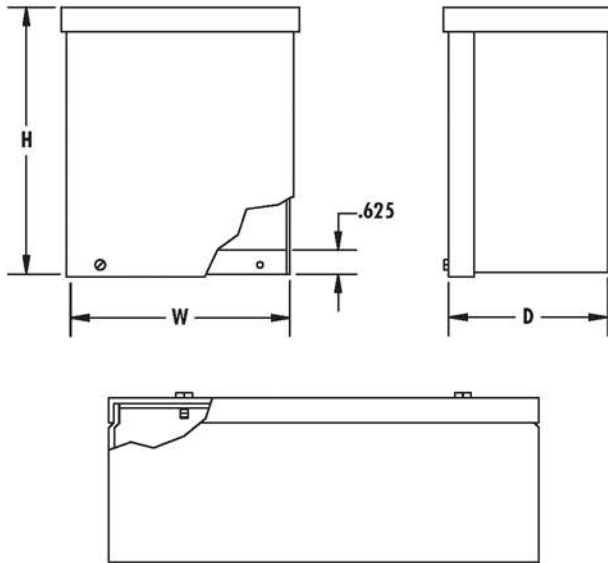
Enclosure Size HxWxD	Catalog Number	Weight
8x8x8	888SC	7
10x10x8	10108SC	10
12x12x8	12128SC	12
15x12x8	15128SC	15
15x15x8	15158SC	17
18x12x8	18128SC	17
18x15x8	18158SC	20
18x18x8	18188SC	23
24x12x8	24128SC	23
24x18x8	24188SC	29
24x24x8	24248SC	42
30x24x8	30248SC	51
30x30x8	30308SC	88
36x24x8	36248SC	60
36x30x8	36308SC	102
* 36x36x8	36368SC	119
48x24x8	48248SC	110
* 48x36x8	48368SC	159
* 48x48x8	48488SC	249
12x12x10	121210SC	14
18x12x10	181210SC	19
18x18x10	181810SC	25
24x18x10	241810SC	31
24x24x10	242410SC	48
30x30x10	303010SC	96
30x24x10	302410SC	56
36x24x10	362410SC	67
36x30x10	363010SC	111
* 36x36x10	363610SC	128
* 48x36x10	483610SC	171
* 48x48x10	484810SC	265
12x12x12	121212SC	16
18x12x12	181212SC	21
18x18x12	181812SC	28
24x12x12	241212SC	27
24x18x12	241812SC	34
24x24x12	242412SC	53
30x30x12	303012SC	103
36x24x12	362412SC	70
* 36x36x12	363612SC	137
* 48x36x12	483612SC	179
* 48x48x12	484812SC	280

**NOTE:** \* Size **not** available with KO'S

**FOR LARGE QUANTITIES CALL FACTORY**

**E**

**GALVANIZED AND PAINTED TYPE 3R RAINPROOF BOXES**



**CONSTRUCTION:**

- CODE GAUGE G-90U GALVANIZED STEEL
- DRIP SHIELD TOP, FRONT, SIDES, AND BACK PROTECT FROM FALLING RAIN, SNOW, OR SLEET
- SLIDE-ON REMOVABLE COVER FASTENED WITH PLATED STEEL SCREWS ALONG BOTTOM EDGE

**FINISH:**

- E-BOX TYPE 3R SCREW COVER BOXES ARE PROVIDED GALVANIZED STEEL OR ANSI-61 GRAY POLYESTER POWDER COATING INSIDE AND OUT OVER PAINT GRIP GALVANIZED STEEL

**NOTE:** For painted replace "RB" suffix with RBP

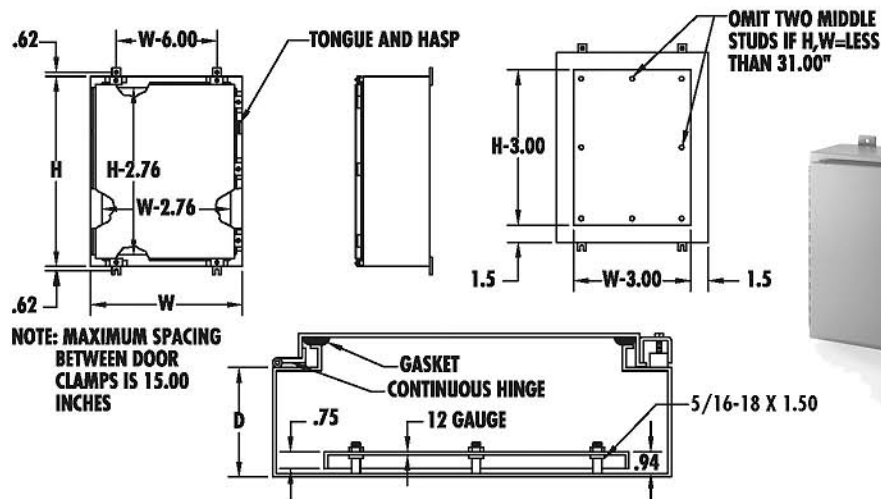
**NOTE:** For KO'S, replace suffix with "RBKO" or "RBPKO"

**TYPE 3R**

Enclosure Size HxWxD	Catalog Number	Weight
6x6x4	664RB	4
8x6x4	864RB	4
8x8x4	884RB	5
10x8x4	1084RB	66
12x8x4	1284RB	77
10x10x4	10104RB	77
12x12x4	12124RB	10
6x6x6	666RB	4
8x8x6	886RB	6
10x8x6	1086RB	8
10x10x6	10106RB	9
12x10x6	12106RB	11
12x12x6	12126RB	12
15x12x6	15126RB	13
18x12x6	18126RB	16
18x15x6	18156RB	19
18x18x6	18186RB	21
24x18x6	24186RB	33
24x24x6	24246RB	40
12x12x8	12128RB	13
18x15x8	18158RB	20
18x18x8	18188RB	23
24x18x8	24188RB	35
24x24x8	24248RB	44
30x24x8	30248RB	56
24x24x10	242410RB	48
18x18x12	181812RB	37
24x18x12	241812RB	48
24x24x12	242412RB	56
36x24x12	362412RB	72
36x30x12	363012RB	101
36x36x12	363612RB	183

**FOR LARGE QUANTITIES CALL FACTORY**

# SINGLE DOOR TYPE 4-PAINTED-ENCLOSURE - LESS PANEL



## CONSTRUCTION:

- CODE GAUGE PAINT GRIP GALVANIZED STEEL
- SEAMS CONTINUOUSLY WELDED AND GROUND SMOOTH
- DOOR CLAMPS ON THREE SIDES OF DOOR
- HEAVY GAUGE CONTINUOUS HINGE
- TONGUE AND HASP FOR PADLOCKING
- OIL RESISTANT GASKET
- STUDS PROVIDED FOR MOUNTING OPTIONAL PANEL
- ALSO MEETS INDUSTRY STANDARDS FOR TYPE 12 USE

## FINISH:

- ANSI 61 GRAY POLYESTER POWDER COATING INSIDE AND OUT



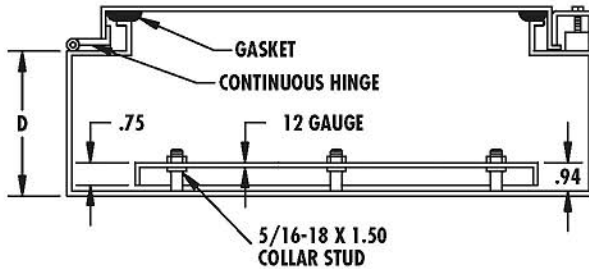
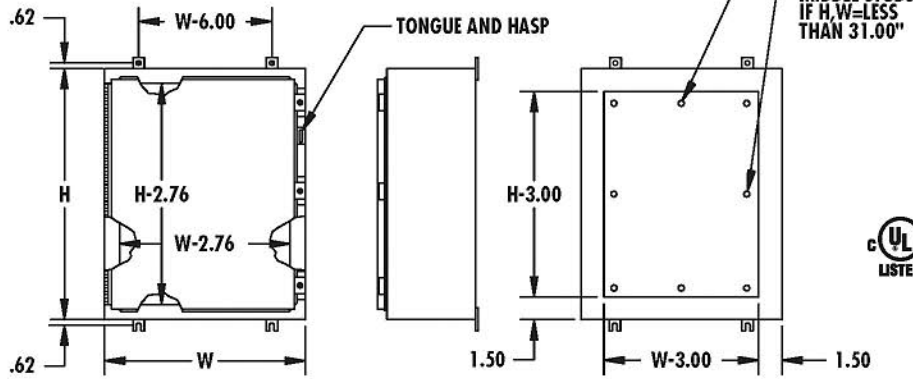
SINGLE DOOR TYPE 4				STEEL PANEL (WHITE)	
Enclosure Size HxWxD	Catalog Number	Weight	Number of Clamps	Catalog Number	Weight
16x12x6	16126N4	23	4	1612P	4
16x16x6	16166N4	28	4	1616P	6
20x16x6	20166N4	32	4	2016P	9
16x20x6	16206N4	32	4	1620P	9
20x20x6	20206N4	38	4	2020P	10
24x12x6	24126N4	31	5	2412P	7
24x16x6	24166N4	37	5	2416P	9
24x20x6	24206N4	43	5	2420P	13
24x24x6	24246N4	49	5	2424P	15
30x24x6	30246N4	60	5	3024P	19
30x20x6	30206N4	53	5	3020P	16
36x24x6	36246N4	69	5	3624P	24
16x12x8	16128N4	25	4	1612P	4
20x16x8	20168N4	35	4	2016P	9
20x20x8	20208N4	42	4	2020P	10
24x20x8	24208N4	47	5	2420P	13
24x24x8	24248N4	54	5	2424P	15
30x20x8	30208N4	57	5	3020P	16
30x24x8	30248N4	65	5	3024P	19
30x30x8	30308N4	78	7	3030P	19
36x24x8	36248N4	74	5	3624P	24
36x30x8	36308N4	92	7	3630P	30
42x30x8	42308N4	106	8	4230P	35
42x36x8	42368N4	125	8	4236P	43
48x36x8	48368N4	139	8	4836P	49
60x36x8	60368N4	167	9	6036P	61
20x16x10	201610N4	39	4	2016P	9
24x20x10	242010N4	52	5	2420P	13
30x24x10	302410N4	70	5	3024P	19
36x30x10	363010N4	98	7	3630P	30
48x30x10	483010N4	125	8	4830P	40
48x36x10	483610N4	147	8	4836P	49
60x36x10	603610N4	176	9	6036P	61
36x36x12	363612N4	119	7	3636P	37
30x24x12	302412N4	75	5	3024P	19
36x30x12	363012N4	104	7	3630P	30
48x36x12	483612N4	154	8	4836P	49

NOTE: FOR QUICK RELEASE LATCHES SEE ACCESSORIES PAGE  
FOR LARGE QUANTITIES CALL FACTORY

TYPE 4



NOTE: MAXIMUM SPACING BETWEEN DOOR CLAMPS IS 24.00 INCHES



**CONSTRUCTION:**

- CODE GAUGE PAINT GRIP GALVANIZED STEEL
- SEAMS CONTINUOUSLY WELDED AND GROUND SMOOTH
- DOOR CLAMPS ARE QUICK AND EASY TO OPERATE
- HEAVY GAUGE CONTINUOUS HINGE
- TONGUE AND HASP FOR PAD LOCKING
- OIL RESISTANT GASKET
- STUDS PROVIDED FOR MOUNTING OPTIONAL PANEL

**FINISH:**

- ANSI 61 GRAY POLYESTER POWDER COATING INSIDE AND OUT

## SINGLE DOOR TYPE 12

## STEEL PANEL (WHITE)

Enclosure Size HxWxD	Catalog Number	Weight	Number of Clamps	Catalog Number	Weight
16x12x6	16126N12	22	2	1612P	4
16x16x6	16166N12	27	2	1616P	6
16x20x6	16206N12	31	2	1620P	9
20x12x6	20126N12	22	2	2012P	5
20x16x6	20166N12	31	2	2016P	9
20x20x6	20206N12	36	2	2020P	10
24x12x6	24126N12	30	2	2412P	7
24x16x6	24166N12	37	2	2416P	9
24x20x6	24206N12	42	2	2420P	13
24x24x6	24246N12	48	2	2424P	15
30x20x6	30206N12	51	2	3020P	16
30x24x6	30246N12	58	2	3024P	19
36x24x6	36246N12	69	3	3624P	24
36x30x6	36306N12	84	3	3630P	30

NOTE: FOR QUICK RELEASE LATCH SEE ACCESSORIES SECTION  
FOR LARGE QUANTITIES CALL FACTORY

Continue on next Page

# SINGLE DOOR TYPE 12 ENCLOSURES - LESS PANEL



SINGLE DOOR TYPE 12				STEEL PANEL (WHITE)	
Enclosure Size HxWxD	Catalog Number	Weight	Number of Clamps	Catalog Number	Weight
16x12x8	16128N12	24	2	1612P	4
16x16x8	16168N12	31	2	1616P	6
20x16x8	20168N12	34	2	2016P	9
20x20x8	20208N12	40	2	2020P	10
24x12x8	24128N12	27	2	2412P	7
24x16x8	24168N12	40	2	2416P	9
24x20x8	24208N12	46	2	2420P	13
24x24x8	24248N12	52	2	2424P	15
30x20x8	30208N12	55	2	3020P	16
30x24x8	30248N12	63	2	3024P	19
30x30x8	30308N12	75	2	3030P	19
36x24x8	36248N12	72	2	3624P	24
36x30x8	36308N12	90	3	3630P	30
36x36x8	36368N12	102	3	3636P	37
42x24x8	42248N12	76	3	4224P	25
42x30x8	42308N12	101	3	4230P	35
42x36x8	42368N12	119	3	4236P	43
48x30x8	48308N12	113	3	4830P	40
48x36x8	48368N12	113	3	4836P	49
60x36x8	60368N12	160	3	6036P	61
16x12x10	161210N12	25	2	1612P	4
20x16x10	201610N12	38	2	2016P	9
20x20x10	202010N12	44	2	2020P	10
24x20x10	242010N12	50	2	2420P	13
24x24x10	242410N12	56	2	2424P	15
30x24x10	302410N12	68	2	3024P	19
36x24x10	362410N12	78	3	3624P	24
36x30x10	363010N12	96	3	3630P	30
42x30x10	423010N12	108	3	4230P	35
42x36x10	423610N12	126	3	4236P	43
48x30x10	483010N12	120	3	4830P	40
48x36x10	483610N12	141	3	4836P	49
60x36x10	603610N12	169	3	6036P	61
20x16x12	201612N12	40	2	2016P	9
24x20x12	242012N12	54	2	2420P	13
24x24x12	242412N12	61	2	2424P	15
30x24x12	302412N12	73	2	3024P	19
30x30x12	303012N12	89	2	3030P	19
36x24x12	362412N12	83	3	3624P	24
36x30x12	363012N12	102	3	3630P	30
36x36x12	363612N12	117	3	3636P	37
42x30x12	423012N12	115	3	4230P	35
42x36x12	423612N12	132	3	4236P	43
48x36x12	483612N12	148	3	4836P	49
60x36x12	603612N12	178	3	6036P	61
72x36x12	723612N12	221	3	7236P	74
24x20x16	242016N12	60	2	2420P	13
30x24x16	302416N12	82	2	3024P	19
36x30x16	363016N12	106	3	3630P	30
48x36x16	483616N12	164	3	4836P	49
60x36x16	603616N12	121	3	6036P	61
36x30x20	363020N12	121	3	3630P	30
48x36x20	483620N12	172	3	4836P	49
60x36x20	603620N12	208	3	6036P	61

NOTE: FOR QUICK RELEASE LATCH SEE ACCESSORIES SECTION

FOR LARGE QUANTITIES CALL FACTORY

TYPE  
12

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# **ANCHORS & HARDWARE**

**Operations & Maintenance Manual  
December 2015**

## **Powers Fasteners® Power-Stud+(tm) SD4 & SD6 Submittal Section:**

### **Competitive Comparisons:**

- Powers Fasteners® Power-Stud+(tm) SD4 & SD6 vs. HILTI\* Kwik Bolt TZ Stainless

### **Product Pages:**

- General Information
- Design Tables

### **Code Reports & Agency Listings:**

- ICC-ES Approval: ESR-2502 (Cracked & Uncracked Concrete)



**Offline version available for download at [www.powersdesignassist.com](http://www.powersdesignassist.com).**

Powers Fasteners developed the Powers Design Assist (PDA) anchor software to enable users to input technical data into a dynamic model environment-to visualize, consider, and specify anchors in today's changing engineering climate.

For a demonstration of the latest version of PDA, contact us at [www.powers.com](http://www.powers.com) or call **(800) 524-3244**.

## POWER-STUD+® SD4/SD6 VS. HILTI\* KWIK BOLT TZ STAINLESS

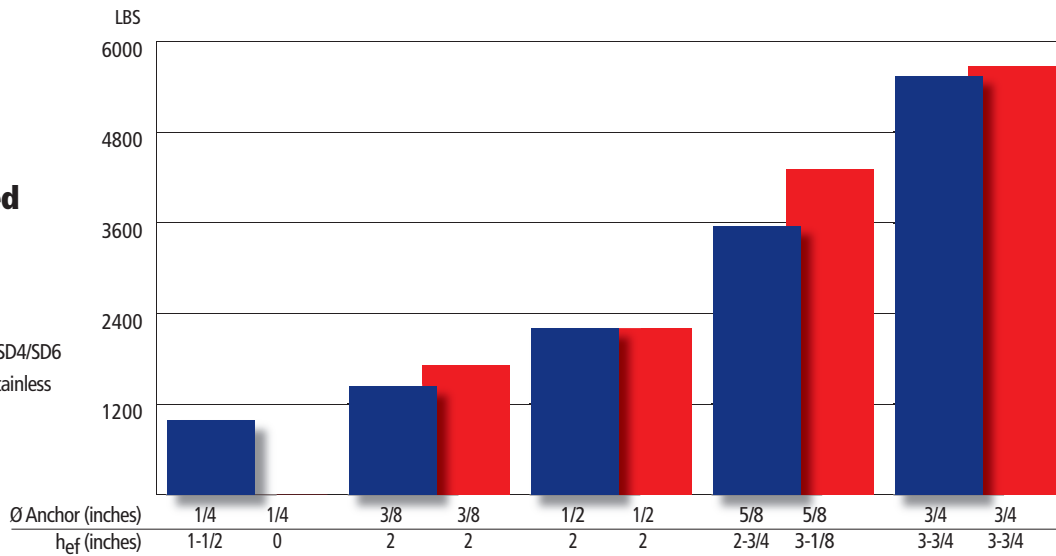
Product Comparison		
Product Name	Power-Stud+ SD4/6	Kwik Bolt TZ Stainless
Company	Powers Fasteners	Hilti*
Description	Stainless steel wedge anchor with stainless steel clip	Stainless steel wedge anchor with stainless steel clip
Size Range (inch)	1/4, 3/8, 1/2, 5/8, 3/4	3/8, 1/2, 5/8, 3/4
ICC-ES ESR (concrete)	ESR-2502	ESR-1917
Cracked Concrete	Yes	Yes
Seismic Approval in Concrete	Yes	Yes
LEED	Yes	Yes

\* Hilti is a registered trademark of Hilti Corporation

### Factored Loads Tension (lbs)

### Uncracked Concrete 2500 psi

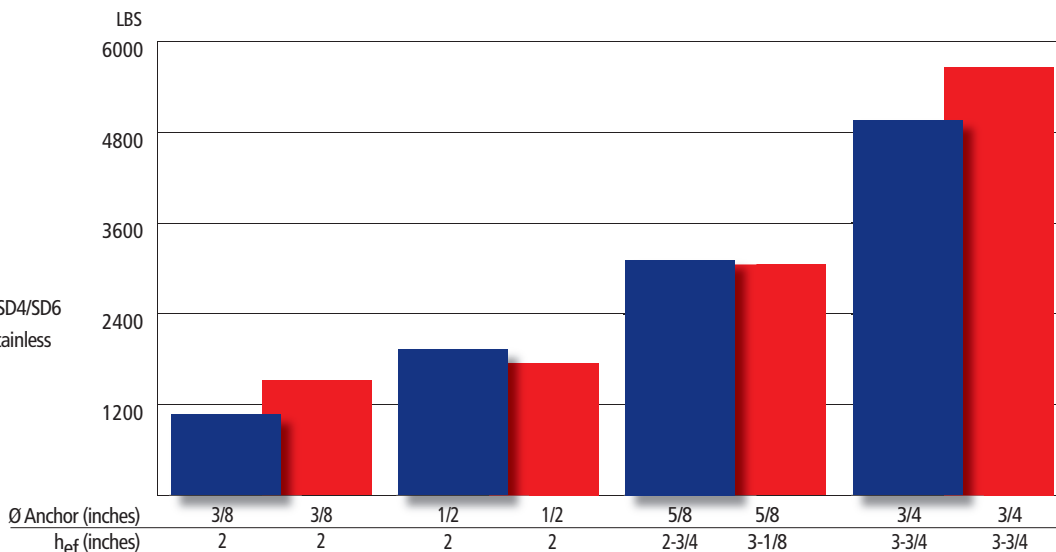
■ Power-Stud+ SD4/SD6  
■ KwikBolt TZ Stainless



### Factored Loads Tension (lbs)

### Cracked Concrete 2500 psi

■ Power-Stud+ SD4/SD6  
■ KwikBolt TZ Stainless



Source: ESR-2502 (Revised: 2014 September), ESR-1917 (Revised: 2014 August)

**GENERAL INFORMATION**

**POWER-STUD+™ SD4/SD6**

*Stainless Steel Wedge Expansion Anchors*

**PRODUCT DESCRIPTION**

The Power-Stud+ SD4 and Power-Stud+ SD6 anchors are fully threaded, torque-controlled, stainless steel wedge expansion anchors which are designed for consistent performance in cracked and uncracked concrete. Suitable base materials are normal-weight, sand-lightweight concrete, and grouted concrete masonry (CMU). The anchor is manufactured with a stainless steel body and expansion clip. Nut and washer are included.

**GENERAL APPLICATIONS AND USES**

- Structural connections, i.e., beam and column anchorage
- Safety-related and common attachments
- Interior and exterior applications
- Tension zone applications, i.e., cable trays and strut, pipe supports, fire sprinklers

**FEATURES AND BENEFITS**

- + Knurled mandrel design provides consistent performance in cracked concrete and helps prevent galling during service life.
- + Nominal drill bit size is the same as the anchor diameter
- + Anchor can be installed through standard clearance fixture holes
- + Length ID code and identifying marking stamped on head of each anchor
- + Anchor design allows for follow-up expansion after setting under tensile loading
- + Corrosion resistant stainless steel anchors
- + Domestically manufactured by request, call for details

**APPROVALS AND LISTINGS**

- International Code Council Evaluation Service (ICC-ES), ESR-2502 for cracked and uncracked concrete [2012 IBC & IRC, 2009 IBC & IRC, and 2006 IBC & IRC]
- Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI 318 (Strength Design method using Appendix D)
- Evaluated and qualified by an accredited independent testing laboratory for recognition in cracked and uncracked concrete including seismic and wind loading (Category 1 anchors)

**GUIDE SPECIFICATIONS**

CSI Divisions: 031600-Concrete Anchors, 04 05 19.16 - Masonry Anchors and 050519 Post-installed Concrete Anchors. Expansion anchors shall be Power-Stud+ SD4 and Power-Stud+ SD6 as supplied by Powers Fasteners, Inc., Brewster, NY. Anchors shall be installed in accordance with published instructions and the Authority Having Jurisdiction.

**MATERIAL SPECIFICATIONS**

Anchor component	Specification	
	SD4 <sup>1</sup>	SD6 <sup>1</sup>
Anchor body	Type 304 Stainless Steel	Type 316 Stainless Steel
Washer	300 Series Stainless Steel	Type 316 Stainless Steel
Hex Nut	Type 316 Stainless Steel	
Expansion wedge (clip)	Type 316 Stainless Steel	

1. Domestically manufactured anchors are available upon request (see ordering information for details).

**SECTION CONTENTS**

General Information..... 1  
 Material Specifications..... 1  
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 Reference Data (ASD)..... 2  
 Performance Data..... 6  
 Strength Design (SD)..... 7  
 Strength Design Performance Data..... 10  
 Ordering Information..... 11



POWER-STUD+ STAINLESS STEEL ASSEMBLY

**THREAD VERSION**

- UNC threaded stud

**ANCHOR MATERIALS**

- Stainless steel body and expansion clip, nut and washer

**ANCHOR SIZE RANGE (TYP.)**

- 1/4" diameter through 3/4" diameter

**SUITABLE BASE MATERIALS**

- Normal-weight concrete
- Structural sand-lightweight
- Grouted Concrete Masonry (CMU)



This Product Available In



Powers Design Assist  
 Real Time Anchor Design Software  
[www.powersdesignassist.com](http://www.powersdesignassist.com)



**Ultimate Load Capacities for Power-Stud+ SD4 and Power-Stud+ SD6 in Normal-Weight Concrete<sup>1,2</sup>**

Nominal Anchor Diameter in.	Minimum Embedment Depth $h_{nom}$ in. (mm)	Minimum Concrete Compressive Strength									
		$f'c = 2,500$ psi (17.3 MPa)		$f'c = 3,000$ psi (20.7 MPa)		$f'c = 4,000$ psi (27.6 MPa)		$f'c = 6,000$ psi (41.4 MPa)		$f'c = 8,000$ psi (55.2 MPa)	
		Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)
1/4	1-1/8 (29)	1,095 (4.9)	2,135 (9.5)	1,200 (5.3)	2,135 (9.5)	1,390 (6.2)	2,135 (9.5)	1,455 (6.5)	2,135 (9.5)	1,680 (7.5)	2,135 (9.5)
	1-3/4 (44)	1,890 (8.4)	2,135 (9.5)	2,070 (9.2)	2,135 (9.5)	2,390 (10.6)	2,135 (9.5)	2,480 (11.0)	2,135 (9.5)	2,480 (11.0)	2,135 (9.5)
3/8	1-3/8 (41)	1,530 (6.8)	2,745 (12.2)	1,680 (7.5)	2,745 (12.2)	1,940 (8.6)	2,745 (12.2)	2,520 (11.2)	2,745 (12.2)	2,910 (12.9)	2,745 (12.2)
	1-7/8 (48)	2,790 (12.4)	2,745 (12.2)	3,060 (13.6)	2,745 (12.2)	3,530 (15.7)	2,745 (12.2)	4,195 (18.7)	2,745 (12.2)	4,840 (21.5)	2,745 (12.2)
	3 (76)	4,700 (20.9)	2,745 (12.2)	4,895 (21.8)	2,745 (12.2)	4,895 (21.8)	2,745 (12.2)	4,895 (21.8)	2,745 (12.2)	4,895 (21.8)	2,745 (12.2)
1/2	1-7/8 (48)	2,745 (12.2)	5,090 (22.6)	3,010 (13.4)	5,090 (22.6)	3,475 (15.5)	5,090 (22.6)	4,525 (20.1)	5,090 (22.6)	5,230 (23.3)	5,090 (22.6)
	2-3/8 (60)	5,370 (23.9)	5,090 (22.6)	5,880 (26.2)	5,090 (22.6)	6,790 (30.2)	5,090 (22.6)	6,790 (30.2)	5,090 (22.6)	7,845 (34.9)	5,090 (22.6)
	3-3/4 (95)	8,840 (39.3)	5,090 (22.6)	9,300 (41.4)	5,090 (22.6)	9,300 (41.4)	5,090 (22.6)	9,300 (41.4)	5,090 (22.6)	9,300 (41.4)	5,090 (22.6)
5/8	2-1/2 (64)	5,015 (22.3)	9,230 (41.1)	5,495 (24.4)	9,230 (41.1)	6,345 (28.2)	9,230 (41.1)	7,250 (32.2)	9,230 (41.1)	8,370 (37.2)	9,230 (41.1)
	3-1/4 (83)	6,760 (30.1)	9,230 (41.1)	7,405 (32.9)	9,230 (41.1)	8,560 (38.1)	9,230 (41.1)	9,615 (42.8)	9,230 (41.1)	11,105 (49.4)	9,230 (41.1)
	4-3/4 (121)	10,550 (46.9)	9,230 (41.1)	11,555 (51.4)	9,230 (41.1)	13,345 (59.4)	9,230 (41.1)	14,560 (64.8)	9,230 (41.1)	14,560 (64.8)	9,230 (41.1)
3/4	3-3/8 (86)	6,695 (29.8)	11,255 (50.1)	7,330 (32.6)	12,625 (56.2)	8,465 (37.7)	14,580 (64.9)	9,705 (43.2)	15,440 (68.7)	11,210 (49.9)	15,440 (68.7)
	4-1/2 (114)	10,800 (48.0)	15,440 (68.7)	11,830 (52.6)	15,440 (68.7)	13,575 (60.4)	15,440 (68.7)	17,110 (76.1)	15,440 (68.7)	19,760 (87.9)	15,440 (68.7)
	5-5/8 (143)	11,730 (52.2)	15,440 (68.7)	12,850 (57.2)	15,440 (68.7)	13,575 (60.4)	15,440 (68.7)	19,710 (87.7)	15,440 (68.7)	21,705 (96.5)	15,440 (68.7)

1. Tabulated load values are for anchors installed in uncracked concrete with no edge or spacing considerations. Concrete compressive strength must be at the specified minimum at the time of installation.  
 2. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working loads.

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**

Stainless Steel Wedge Expansion Anchors



**Allowable Load Capacities for Power-Stud+ SD4 and Power-Stud+ SD6 in Normal-Weight Concrete<sup>1,2,3,4</sup>**

Nominal Anchor Diameter in.	Minimum Embedment Depth $h_{nom}$ in. (mm)	Minimum Concrete Compressive Strength									
		$f'c = 2,500$ psi (17.3 MPa)		$f'c = 3,000$ psi (20.7 MPa)		$f'c = 4,000$ psi (27.6 MPa)		$f'c = 6,000$ psi (41.4 MPa)		$f'c = 8,000$ psi (55.2 MPa)	
		Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)
1/4	1-1/8 (28)	275 (1.2)	535 (2.4)	300 (1.3)	535 (2.4)	350 (1.6)	535 (2.4)	365 (1.6)	535 (2.4)	420 (1.9)	535 (2.4)
	1-3/4 (44)	475 (2.1)	535 (2.4)	520 (2.3)	535 (2.4)	600 (2.7)	535 (2.4)	620 (2.8)	535 (2.4)	620 (2.8)	535 (2.4)
3/8	1-3/8 (41)	385 (1.7)	685 (3.0)	420 (1.9)	685 (3.0)	485 (2.2)	685 (3.0)	630 (2.8)	685 (3.0)	730 (3.2)	685 (3.0)
	1-7/8 (60)	700 (3.1)	685 (3.0)	765 (3.4)	685 (3.0)	885 (3.9)	685 (3.0)	1,050 (4.7)	685 (3.0)	1,210 (5.4)	685 (3.0)
	3 (60)	1,175 (5.2)	685 (3.0)	1,225 (5.4)	685 (3.0)	1,225 (5.4)	685 (3.0)	1,225 (5.4)	685 (3.0)	1,225 (5.4)	685 (3.0)
1/2	1-7/8 (57)	685 (3.0)	1,275 (5.7)	755 (3.4)	1,275 (5.7)	870 (3.9)	1,275 (5.7)	1,130 (5.0)	1,275 (5.7)	1,310 (5.8)	1,275 (5.7)
	2-3/8 (64)	1,345 (6.0)	1,275 (5.7)	1,470 (6.5)	1,275 (5.7)	1,700 (7.6)	1,275 (5.7)	1,700 (7.6)	1,275 (5.7)	1,960 (8.7)	1,275 (5.7)
	3-3/4 (95)	2,210 (9.8)	1,275 (5.7)	2,325 (10.3)	1,275 (5.7)	2,325 (10.3)	1,275 (5.7)	2,325 (10.3)	1,275 (5.7)	2,325 (10.3)	1,275 (5.7)
5/8	2-1/2 (70)	1,255 (5.6)	2,310 (10.3)	1,375 (6.1)	2,310 (10.3)	1,585 (7.1)	2,310 (10.3)	1,815 (8.1)	2,310 (10.3)	2,095 (9.3)	2,310 (10.3)
	3-1/4 (86)	1,690 (7.5)	2,310 (10.3)	1,850 (8.2)	2,310 (10.3)	2,140 (9.5)	2,310 (10.3)	2,405 (10.7)	2,310 (10.3)	2,775 (12.3)	2,310 (10.3)
	4-3/4 (117)	2,640 (11.7)	2,310 (10.3)	2,890 (12.9)	2,310 (10.3)	3,335 (14.8)	2,310 (10.3)	3,640 (16.2)	2,310 (10.3)	3,640 (16.2)	2,310 (10.3)
3/4	3-3/8 (86)	1,675 (7.5)	2,815 (12.5)	1,835 (8.2)	3,155 (14.0)	2,115 (9.4)	3,645 (16.2)	2,425 (10.8)	3,860 (17.2)	2,805 (12.5)	3,860 (17.2)
	4-1/2 (114)	2,700 (12.0)	3,860 (17.2)	2,960 (13.2)	3,860 (17.2)	3,395 (15.1)	3,860 (17.2)	4,280 (19.0)	3,860 (17.2)	4,940 (22.0)	3,860 (17.2)
	5-5/8 (143)	2,935 (13.1)	3,860 (17.2)	3,215 (14.3)	3,860 (17.2)	3,395 (15.1)	3,860 (17.2)	4,930 (21.9)	3,860 (17.2)	5,425 (24.1)	3,860 (17.2)

1. Tabulated load values are for anchors installed in uncracked concrete. Concrete compressive strength must be at the specified minimum at the time of installation.
2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.
3. Allowable load capacities must be multiplied by reduction factors when anchor spacing or edge distances are less than critical distances.
4. Linear interpolation may be used to determine allowable loads for intermediate embedments and compressive strengths.

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**  
Stainless Steel/Wedge Expansion Anchors

**SPACING DISTANCE AND EDGE DISTANCE ADJUSTMENT FACTORS FOR NORMAL WEIGHT CONCRETE - TENSION ( $F_{NS}$ ,  $F_{NC}$ )**

**Spacing Reduction Factors - Tension ( $F_{NS}$ )**

Diameter (in)	1/4	3/8	1/2	5/8	3/4	
Nominal Embed. $h_{nom}$ (in)	1-3/4	1-7/8	2-1/2	3-1/4	4-1/2	
Minimum Spacing, $S_{min}$ (in)	2	3	3	5	5	
Spacing Distance (inches)	1-3/4	-	-	-	-	
	2	0.79	-	-	-	
	2-1/4	0.81	-	-	-	
	2-1/2	0.83	-	-	-	
	2-3/4	0.85	-	-	-	
	3	0.87	0.87	0.82	-	-
	3-1/2	0.91	0.91	0.85	-	-
	4	0.96	0.96	0.88	-	-
	4-1/2	1.00	1.00	0.91	-	-
	5	1.00	1.00	0.94	0.85	0.76
	5-1/2	1.00	1.00	0.97	0.87	0.78
	6	1.00	1.00	1.00	0.90	0.80
	6-1/2	1.00	1.00	1.00	0.92	0.82
	7	1.00	1.00	1.00	0.94	0.84
	7-1/2	1.00	1.00	1.00	0.97	0.86
	8	1.00	1.00	1.00	0.99	0.87
	8-1/4	1.00	1.00	1.00	1.00	0.88
8-1/2	1.00	1.00	1.00	1.00	0.89	
9	1.00	1.00	1.00	1.00	0.91	
9-1/2	1.00	1.00	1.00	1.00	0.93	
10	1.00	1.00	1.00	1.00	0.95	
10-1/2	1.00	1.00	1.00	1.00	0.97	
11	1.00	1.00	1.00	1.00	0.99	
11-1/4	1.00	1.00	1.00	1.00	1.00	

**Edge Distance Reduction Factors- Tension ( $F_{NC}$ )**

Diameter (in)	1/4	3/8	1/2	5/8	3/4	
Nominal Embed. $h_{nom}$ (in)	1-3/4	1-7/8	2-1/2	3-1/4	4-1/2	
Critical Edge Distance, $c_{cr}$ (in)	5	5	7-1/2	9-1/2	9	
Min. Edge Distance, $c_{min}$ (in)	1-3/4	3	3	4-1/2	5	
Edge Distance (inches)	1-1/2	-	-	-	-	
	1-3/4	0.35	-	-	-	
	2	0.40	-	-	-	
	2-1/4	0.45	-	-	-	
	2-1/2	0.50	-	-	-	
	2-3/4	0.55	-	-	-	
	3	0.60	0.60	0.40	-	-
	3-1/2	0.70	0.70	0.47	-	-
	4	0.80	0.80	0.53	-	-
	4-1/2	0.90	0.90	0.60	0.47	-
	5	1.00	1.00	0.67	0.53	0.56
	5-1/2	1.00	1.00	0.73	0.58	0.61
	6	1.00	1.00	0.80	0.63	0.67
	6-1/2	1.00	1.00	0.87	0.68	0.72
	7	1.00	1.00	0.93	0.74	0.78
	7-1/2	1.00	1.00	1.00	0.79	0.83
	8	1.00	1.00	1.00	0.84	0.89
8-1/2	1.00	1.00	1.00	0.89	0.94	
9	1.00	1.00	1.00	0.95	1.00	
9-1/2	1.00	1.00	1.00	1.00	1.00	

**SPACING DISTANCE AND EDGE DISTANCE ADJUSTMENT FACTORS FOR NORMAL WEIGHT CONCRETE - SHEAR ( $F_{VS}$ ,  $F_{VC}$ )**

**Spacing Reduction Factors - Shear ( $F_{VS}$ )**

Diameter (in)	1/4	3/8	1/2	5/8	3/4	
Nominal Embed. $h_{nom}$ (in)	1-3/4	1-7/8	2-1/2	3-1/4	4-1/2	
Minimum Spacing, $S_{min}$ (in)	2	3	3	5	5	
Spacing Distance (inches)	1-3/4	-	-	-	-	
	2	0.87	-	-	-	
	2-1/4	0.88	-	-	-	
	2-1/2	0.90	-	-	-	
	2-3/4	0.91	-	-	-	
	3	0.92	0.92	0.89	-	-
	3-1/2	0.95	0.95	0.91	-	-
	4	0.97	0.97	0.93	-	-
	4-1/2	1.00	1.00	0.95	-	-
	5	1.00	1.00	0.96	0.91	0.84
	5-1/2	1.00	1.00	0.98	0.93	0.85
	6	1.00	1.00	1.00	0.94	0.86
	6-1/2	1.00	1.00	1.00	0.95	0.88
	7	1.00	1.00	1.00	0.97	0.89
	7-1/2	1.00	1.00	1.00	0.98	0.90
	8	1.00	1.00	1.00	0.99	0.92
	8-1/4	1.00	1.00	1.00	1.00	0.92
8-1/2	1.00	1.00	1.00	1.00	0.93	
9	1.00	1.00	1.00	1.00	0.94	
9-1/2	1.00	1.00	1.00	1.00	0.95	
10	1.00	1.00	1.00	1.00	0.97	
10-1/2	1.00	1.00	1.00	1.00	0.98	
11	1.00	1.00	1.00	1.00	0.99	
11-1/4	1.00	1.00	1.00	1.00	1.00	

**Edge Distance Reduction Factors - Shear ( $F_{VC}$ )**

Diameter (in)	1/4	3/8	1/2	5/8	3/4	
Nominal Embed. $h_{nom}$ (in)	1-3/4	1-7/8	2-1/2	3-1/4	4-1/2	
Min. Edge Distance, $c_{min}$ (in)	1-3/4	3	3	4-1/2	5	
Edge Distance (inches)	1-1/2	-	-	-	-	
	1-3/4	0.39	-	-	-	
	2	0.44	-	-	-	
	2-1/4	0.50	-	-	-	
	2-1/2	0.56	-	-	-	
	2-3/4	0.61	-	-	-	
	3	0.67	0.67	-	-	-
	3-1/2	0.78	0.78	-	-	-
	4	0.89	0.89	-	-	-
	4-1/2	1.00	1.00	-	0.55	-
	5	1.00	1.00	-	0.61	0.44
	5-1/2	1.00	1.00	-	0.67	0.49
	6	1.00	1.00	1.00	0.73	0.53
	6-1/2	1.00	1.00	1.00	0.79	0.58
	7	1.00	1.00	1.00	0.85	0.62
	7-1/2	1.00	1.00	1.00	0.91	0.67
	8	1.00	1.00	1.00	0.97	0.71
8-1/4	1.00	1.00	1.00	1.00	0.73	
8-1/2	1.00	1.00	1.00	1.00	0.76	
9	1.00	1.00	1.00	1.00	0.80	
9-1/2	1.00	1.00	1.00	1.00	0.84	
10	1.00	1.00	1.00	1.00	0.89	
10-1/2	1.00	1.00	1.00	1.00	0.93	
11	1.00	1.00	1.00	1.00	0.98	
11-1/4	1.00	1.00	1.00	1.00	1.00	

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**

Stainless Steel Wedge Expansion Anchors

**PERFORMANCE DATA**

**Ultimate Load Capacities for Power-Stud+ SD4 and Power-Stud+ SD6 installed into the Face of Grout Filled Concrete Masonry<sup>1,2</sup>**

Nominal Anchor Diameter in.	Minimum Embedment $h_{nom}$ in. (mm)	Minimum Edge Distance in. (mm)	Minimum End Distance in. (mm)	Ultimate Tension Load lb (kN)	Direction of Shear Loading	Ultimate Shear Load lb (kN)
1/2	2-3/8 (60)	3 (76.2)	3 (76.2)	1,695 (7.5)	Any	2,080 (9.3)
		12 (304.8)	12 (304.8)	2,425 (10.8)	Any	4,905 (21.8)
5/8	3-1/4 (83)	12 (304.8)	12 (304.8)	5,565 (24.8)	Any	7,944 (35.3)

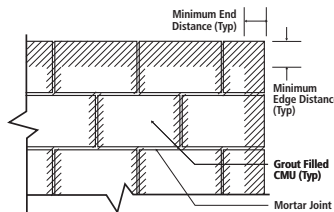
1. Tabulated load values are for anchors installed in minimum 8 inch wide, minimum Grade N, Type II, normal-weight concrete masonry units conforming to ASTM C 90. Mortar must be minimum Type N. Masonry compressive strength must be at the specified minimum at the time of installation.
2. Ultimate load capacities must be reduced by a minimum safety factor of 5.0 or greater to determine allowable working loads.

**Allowable Load Capacities for Power-Stud+ SD4 and Power-Stud+ SD6 installed into the Face of Grout Filled Concrete Masonry<sup>1,2,3,4,5</sup>**



Nominal Anchor Diameter in.	Minimum Embedment $h_{nom}$ in. (mm)	Minimum Edge Distance in. (mm)	Minimum End Distance in. (mm)	Allowable Tension Load lb (kN)	Direction of Shear Loading	Allowable Shear Load lb (kN)
1/2	2-3/8 (60)	3 (76.2)	3 (76.2)	340 (1.5)	Any	415 (1.8)
		12 (304.8)	12 (304.8)	485 (2.2)	Any	980 (4.4)
5/8	3-1/4 (83)	12 (304.8)	12 (304.8)	1,115 (5.0)	Any	1,590 (7.1)

1. Tabulated load values are for anchors installed in minimum 8 inch wide, minimum Grade N, Type II, normal-weight concrete masonry units conforming to ASTM C 90. Mortar must be minimum Type N. Masonry compressive strength must be at the specified minimum at the time of installation.
2. Allowable load capacities listed are calculated using an applied safety factor of 5.0. Consideration of safety factors of 10 or higher may be necessary depending upon the application such as life safety.
3. The tabulated values are applicable for anchors installed in grouted masonry wall faces at a critical spacing distance,  $s_{cr}$ , between anchors of 16 times the anchor diameter. The spacing distance between two anchors may be reduced to a minimum distance,  $s_{min}$ , of 8 times the anchor diameter provided the allowable tension loads are multiplied a reduction factor of 0.80 and allowable shear loads are multiplied by a reduction factor of 0.90. Linear interpolation for calculation of allowable loads may be used for intermediate anchor spacing distances.
4. Anchors may be installed in the grouted cells and in cell webs and bed joints not closer than 1-3/8" from head joints. The minimum edge and end distances must also be maintained.
5. Allowable tension values for anchors installed into bed joints of grouted masonry wall faces with a minimum of 12" edge and end distance may be increased by 20 percent for the 1/2-inch diameter and 10 percent for the 5/8-inch diameter.



**Wall Face Permissible Anchor Locations (Un-hatched Area)**

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**  
Stainless Steel Wedge Expansion Anchors



**STRENGTH DESIGN (SD)**

**Strength Design Installation Table for Power-Stud+ SD4 and Power-Stud+ SD6<sup>1,4</sup>**

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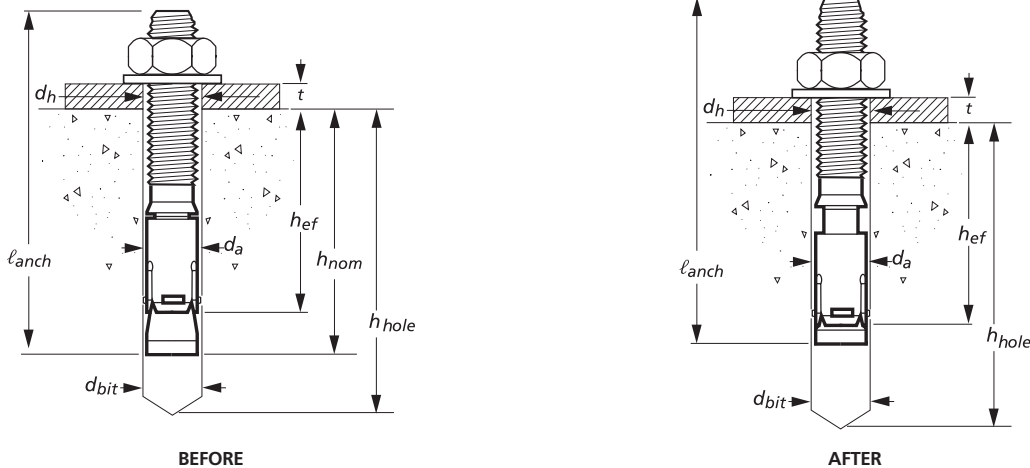


Anchor Property/Setting Information	Notation	Units	Nominal Anchor Diameter								
			1/4	3/8		1/2	5/8		3/4		
Anchor outside diameter	$d_a$ [ $d_o$ ] <sup>5</sup>	in. (mm)	0.250 (6.4)	0.375 (9.5)		0.500 (12.7)	0.625 (15.9)		0.750 (19.1)		
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)		9/16 (14.3)	11/16 (17.5)		13/16 (20.6)		
Nominal drill bit diameter	$d_{bit}$	in. ANSI	1/4 ANSI	3/8 ANSI		1/2 ANSI	5/8 ANSI		3/4 ANSI		
Minimum nominal embedment depth <sup>2</sup>	$h_{nom}$	in. (mm)	1-3/4 (44)	1-7/8 (48)		2-1/2 (64)	3-1/4 (83)		4-1/2 (114)		
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)		2.00 (51)	2.75 (70)		3-3/4 (95)		
Minimum hole depth	$h_{hole}$	in. (mm)	1-7/8 (48)	2 (51)		2-5/8 (67)	3-1/2 (89)		4-3/4 (121)		
Minimum member thickness	$h_{min}$	in. (mm)	3-1/4 (83)	3-1/4 (83)	4 (102)	4 (102)	5 (127)		6 (152)		
Minimum overall anchor length <sup>2</sup>	$\ell_{anch}$	in. (mm)	2-1/4 (57)	2-3/4 (70)		3-3/4 (95)	4-1/2 (114)		5-1/2 (140)		
Minimum edge distance	$c_{min}$	in. (mm)	1-3/4 (44)	3 (76)	3-1/2 (89)	6 (152)	3 (76)	4-1/2 (114)	8-1/2 (216)	5 (127)	9 (229)
Minimum spacing distance	$s_{min}$	in. (mm)	2 (51)	5-1/2 (140)	3 (76)	3 (76)	6 (152)	8-1/2 (216)	5 (127)	9 (229)	5 (127)
Critical edge distance	$c_{ac}$	in. (mm)	5 (127)	5 (127)		7-1/2 (191)	9-1/2 (241)		9 (229)		
Installation torque	$T_{inst}$	ft.-lbf. (N-m)	6 (8)	25 (34)		40 (54)	60 (81)		110 (149)		
Torque wrench/socket size	-	in.	7/16	9/16		3/4	15/16		1-1/8		
Nut height	-	in.	7/32	21/64		7/16	35/64		41/64		

For SI: 1 inch = 25.4 mm; 1 ft-lbf = 1.356 N-m.

- The information presented in this table is to be used in conjunction with ACI 318 Appendix D.
- The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.
- The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment.
- The anchors may be installed in the topside of concrete-filled steel deck floor and roof assemblies in accordance with the following: the 1/4-inch diameter anchors must be installed in uncracked normal-weight or sand-lightweight concrete; 3/8-inch to 3/4-inch diameter anchors must be installed in cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa) provided the concrete thickness above the upper flute meets the minimum thickness specified in this table.
- The notation in brackets is for the 2006 IBC.

**Power-Stud+ SD4 and Power-Stud+ SD6 Anchor Detail**



Application of Installation Torque

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**

Stainless Steel Wedge Expansion Anchors

**Tension Design Information for Power-Stud+ SD4 and Power-Stud+ SD6 Anchors in Concrete**  
(For use with load combinations taken from ACI 318, Section 9.2)<sup>1,7</sup>

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Design Characteristic	Notation	Units	Nominal Anchor Diameter				
			1/4	3/8	1/2	5/8	3/4
Anchor category	1,2 or 3	-	1	1	1	1	1
Nominal embedment depth	$h_{nom}$	in.	1-3/4	1-7/8	2-3/8	3-1/4	4-1/2
<b>STEEL STRENGTH IN TENSION<sup>4</sup></b>							
Minimum specified yield strength (neck)	$f_y$	ksi (N/mm <sup>2</sup> )	60 (414)	60 (414)	60 (414)	60 (414)	60 (414)
Minimum specified ultimate tensile strength (neck)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	90 (621)	90 (621)	90 (621)	90 (621)	90 (621)
Effective tensile stress area (neck)	$A_{se,N}$ [ $A_{sa}$ ] <sup>9</sup>	in <sup>2</sup> (mm <sup>2</sup> )	0.0249 (16.1)	0.0530 (34.2)	0.1020 (65.8)	0.1630 (105.2)	0.2380 (151)
Steel strength in tension	$N_{sa}$	lb (kN)	2,240 (10.0)	4,780 (21.3)	9,160 (40.8)	14,635 (65.1)	21,380 (95.1)
Reduction factor for steel strength <sup>2</sup>	$\phi$	-	0.75				
<b>CONCRETE BREAKOUT STRENGTH IN TENSION</b>							
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75 (95)
Effectiveness factor for uncracked concrete	$k_{uncr}$	-	24	24	24	24	24
Effectiveness factor for cracked concrete	$k_{cr}$	-	Not Applicable	17	21	21	21
Modification factor for cracked and uncracked concrete	$\psi_{c,N}$	-	1.0 See Note 4	1.0 See Note 4	1.0 See Note 4	1.0 See Note 4	1.0 See Note 4
Critical edge distance (uncracked concrete only)	$c_{ec}$	in. (mm)	5 (127)	5 (127)	7-1/2 (191)	9-1/2 (241)	9 (229)
Reduction factor for concrete breakout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)				
<b>PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)</b>							
Characteristic pullout strength, uncracked concrete (2,500 psi) <sup>5</sup>	$N_{p,uncr}$	lb (kN)	1,510 (6.7)	See Note 6	See Note 6	See Note 6	8,520 (37.8)
Characteristic pullout strength, cracked concrete (2,500 psi) <sup>5</sup>	$N_{p,cr}$	lb (kN)	Not Applicable	See Note 6	See Note 6	See Note 6	See Note 6
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)				
<b>PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS<sup>6</sup></b>							
Characteristic pullout strength, seismic (2,500 psi) <sup>5,8</sup>	$N_{p,eq}$	lb (kN)	Not Applicable	1,645 (7.3)	See Note 6	See Note 6	See Note 6
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)				

For SI: 1 inch = 25.4 mm; 1 ft-lbf = 1.356 N-m; 1 ksi = 6.894 N/mm<sup>2</sup>; 1 lb = 0.0044 kN.

- The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.
- The tabulated value of  $\phi$  for steel strength applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for steel strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5). The anchors are ductile steel elements as defined in ACI 318 D.1.
- The tabulated value of  $\phi$  for concrete breakout strength and pullout strength applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition B are satisfied. If the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are satisfied, the appropriate value of  $\phi$  for concrete breakout strength and pullout strength must be determined in accordance with ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for concrete breakout strength and pullout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 or -05 D.4.5).
- For all design cases  $\psi_{c,N} = 1.0$ . The appropriate effectiveness factor for cracked concrete ( $k_{cr}$ ) or uncracked concrete ( $k_{uncr}$ ) must be used.
- For all design cases  $\psi_{c,p} = 1.0$ . For concrete compressive strength greater than 2,500psi,  $N_{pn} = (\text{pullout strength value from table})^2 (\text{specified concrete strength}/2500)^{0.5}$ .
- Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.
- Anchors are permitted to be used in sand-lightweight concrete provided that the modification factor  $\lambda_a$  (ACI 318-11) or  $\lambda$  (ACI 318-08) for concrete breakout strength is taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC). In addition, the pullout strength  $N_{p,cr}$ ,  $N_{p,eq}$ ,  $N_{p,uncr}$  must be multiplied by 0.6, as applicable. For ACI 318-05, the values  $N_b$ ,  $N_{p,eq}$ ,  $N_{p,cr}$ ,  $N_{p,uncr}$  and  $V_b$  must be multiplied by 0.6.
- Tabulated values for characteristic pullout strength in tension are for seismic applications and based on test results per ACI 355.2 Section 9.5.
- The notation in brackets is for the 2006 IBC.

**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**  
Stainless Steel Wedge Expansion Anchors

**Shear Design Information for Power-Stud+ SD4 and Power-Stud+ SD6 Anchors in Concrete**  
(For use with load combinations taken from ACI 318, Section 9.2)<sup>1,6</sup>

**CODE LISTED**  
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Design Characteristic	Notation	Units	Nominal Anchor Diameter				
			1/4	3/8	1/2	5/8	3/4
Anchor category	1, 2 or 3	-	1	1	1	1	1
Nominal embedment depth	$h_{nom}$	in.	1-3/4	1-7/8	2-3/8	3-1/4	4-1/2
<b>STEEL STRENGTH IN SHEAR</b>							
Minimum specified yield strength (threads)	$f_y$	ksi (N/mm <sup>2</sup> )	60 (414)	60 (414)	60 (414)	60 (414)	60 (414)
Minimum specified ultimate strength (threads)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	90 (621)	90 (621)	90 (621)	90 (621)	90 (621)
Effective tensile stress area (threads)	$A_{se, v}$ [ $A_{se}$ ] <sup>8</sup>	in <sup>2</sup> (mm <sup>2</sup> )	0.0318 (20.5)	0.078 (50.3)	0.142 (91.6)	0.226 (145.8)	0.334 (212)
Steel strength in shear <sup>5</sup>	$V_{sa}$	lb (kN)	1,115 (5.0)	1,470 (6.6)	3,170 (14.3)	7,455 (33.6)	11,955 (53.2)
Reduction factor for steel strength <sup>2</sup>	$\phi$	-			0.65		
<b>CONCRETE BREAKOUT STRENGTH IN SHEAR<sup>6</sup></b>							
Load bearing length of anchor ( $h_{ef}$ or $8d_a$ , whichever is less)	$\ell_e$	in. (mm)	1.50 (38.1)	1.50 (38.1)	2.00 (50.8)	2.75 (69.9)	3.75 (95)
Nominal anchor diameter	$d_a$ [ $d_n$ ] <sup>8</sup>	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)
Reduction factor for concrete breakout <sup>3</sup>	$\phi$	-			0.70 (Condition B)		
<b>CONCRETE PRYOUT STRENGTH IN SHEAR<sup>6</sup></b>							
Coefficient for prout strength (1.0 for $h_{ef} < 2.5$ in., 2.0 for $h_{ef} \geq 2.5$ in.)	$k_{cp}$	-	1.0	1.0	1.0	2.0	2.0
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38.1)	1.50 (38.1)	2.00 (50.8)	2.75 (69.9)	3.75 (95)
Reduction factor for prout strength <sup>4</sup>	$\phi$	-			0.70 (Condition B)		
<b>STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS</b>							
Steel strength in shear, seismic <sup>7</sup>	$V_{sa, eq}$	lb (kN)	Not Applicable	1,305 (5.9)	2,765 (12.3)	5,240 (23.3)	7,745 (34.5)
Reduction factor for steel strength in shear for seismic <sup>2</sup>	$\phi$	-			0.65		

For SI: 1 inch = 25.4 mm; 1 ft-lbf = 1.356 N-m; 1 ksi = 6.894 N/mm<sup>2</sup>; 1 lb = 0.0044 kN.

- The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.
- The tabulated value of  $\phi$  for steel strength applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for steel strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5). The anchors are ductile steel elements as defined in ACI 318 D.1.
- The tabulated value of  $\phi$  for concrete breakout strength applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition B are satisfied. If the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are satisfied, the appropriate value of  $\phi$  for concrete breakout strength and pullout strength must be determined in accordance with ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for concrete breakout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 or -05 D.4.5).
- The tabulated value for prout strength applies if the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for prout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5), Condition B.
- Tabulated values for steel strength in shear must be used for design
- Anchors are permitted to be used in sand-lightweight concrete provided that the modification factor  $\lambda_s$  (ACI 318-11) or  $\lambda$  (ACI 318-08) for concrete breakout strength is taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC). In addition, the pullout strength  $N_{p, cr}$ ,  $N_{p, eq}$ ,  $N_{p, unc}$  must be multiplied by 0.6, as applicable. For ACI 318-05, the values  $N_b$ ,  $N_{p, eq}$ ,  $N_{p, cr}$ ,  $N_{p, unc}$  and  $V_b$  must be multiplied by 0.6.
- Tabulated values for steel strength in shear are for seismic applications and based on test results per ACI 355.2, Section 9.6.
- The notation in brackets is for the 2006 IBC.

**STRENGTH DESIGN PERFORMANCE DATA**

Factored design strength  $\phi N_n$  and  $\phi V_n$   
Calculated in accordance with ACI 318 Appendix D  
Compliant with the International Building Code



**MECHANICAL ANCHORS**

**POWER-STUD+™ SD4/SD6**  
Stainless Steel Wedge Expansion Anchors

**Tension and Shear Design Strengths Installed in Cracked Concrete<sup>1-6</sup>**

Nominal Anchor Diameter (in.)	Nominal Embed. $h_{nom}$ (in.)	Minimum Concrete Compressive Strength									
		f'c = 2,500 psi		f'c = 3,000 psi		f'c = 4,000 psi		f'c = 6,000 psi		f'c = 8,000 psi	
		$\phi N_{sa}, \phi N_{cp}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)
1/4	-	-	-	-	-	-	-	-	-	-	-
3/8	1-7/8	1,015	955	1,110	955	1,285	955	1,570	955	1,815	955
1/2	2-1/2	1,930	2,060	2,115	2,060	2,440	2,060	2,990	2,060	3,455	2,060
5/8	3-1/4	3,110	4,520	3,410	4,845	3,935	4,845	4,820	4,845	5,570	4,845
3/4	4-1/2	4,955	5,270	5,430	5,770	6,270	6,665	7,680	7,770	8,865	7,770

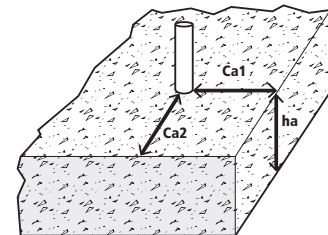
■ - Anchor Pullout/Pryout Strength Controls 
 ■ - Concrete Breakout Strength Controls 
 ■ - Steel Strength Controls

**Tension and Shear Design Strengths Installed in Uncracked Concrete<sup>1-6</sup>**

Nominal Anchor Diameter (in.)	Nominal Embed. $h_{nom}$ (in.)	Minimum Concrete Compressive Strength									
		f'c = 2,500 psi		f'c = 3,000 psi		f'c = 4,000 psi		f'c = 6,000 psi		f'c = 8,000 psi	
		$\phi N_{sa}, \phi N_{cp}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)	$\phi N_{sa}, \phi N_{cb}$ or $\phi N_{cp}$ Tension (lbs.)	$\phi V_{sa}, \phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.)
1/4	1-3/4	980	725	1,075	725	1,240	725	1,520	725	1,680	725
3/8	1-7/8	1,435	955	1,570	955	1,815	955	2,220	955	2,565	955
1/2	2-1/2	2,205	2,060	2,415	2,060	2,790	2,060	3,420	2,060	3,945	2,060
5/8	3-1/4	3,555	4,845	3,895	4,845	4,500	4,845	5,510	4,845	6,365	4,845
3/4	4-1/2	5,540	7,375	6,065	7,770	7,005	7,770	8,580	7,770	9,905	7,770

■ - Anchor Pullout/Pryout Strength Controls 
 ■ - Concrete Breakout Strength Controls 
 ■ - Steel Strength Controls

- 1- Tabular values are provided for illustration and are applicable for single anchors installed in normal-weight concrete with minimum slab thickness,  $h_a = h_{min}$ , and with the following conditions:
  - $C_{a1}$  is greater than or equal to the critical edge distance,  $C_{ac}$  (table values based on  $C_{a1} = C_{ac}$ ).
  - $C_{a2}$  is greater than or equal to 1.5 times  $C_{a1}$ .
- 2- Calculations were performed according to ACI 318-11 Appendix D. The load level corresponding to the controlling failure mode is listed. (e.g. For tension: steel, concrete breakout and pullout; For shear: steel, concrete breakout and pryout). Furthermore, the capacities for concrete breakout strength in tension and pryout strength in shear are calculated using the effective embedment values,  $h_{ef}$ , for the selected anchors as noted in the design information tables. Please also reference the installation specifications for more information.
- 3- Strength reduction factors ( $\phi$ ) were based on ACI 318 Section 9.2 for load combinations. Condition B is assumed.
- 4- Tabular values are permitted for static loads only, seismic loading is not considered with these tables.
- 5- For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 Appendix D.
- 6- Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths please see ACI 318 Appendix D. For other design conditions including seismic considerations please see ACI 318 Appendix D.



# ICC-ES Evaluation Report

**ESR-2502\***

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**EVALUATION SUBJECT:**
**POWERS POWER-STUD+ SD2 CARBON STEEL ANCHORS, POWER-STUD+ SD4 STAINLESS STEEL ANCHORS AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE**
**1.0 EVALUATION SCOPE**
**Compliance with the following codes:**

- 2012, 2009, and 2006 *International Building Code*® (IBC)
- 2012, 2009, and 2006 *International Residential Code*® (IRC)

**Property evaluated:**

Structural

**2.0 USES**

The Powers Power-Stud+ SD2 carbon steel anchors and SD4 and SD6 stainless steel anchors are used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight and sand-lightweight concrete having a specified compressive strength,  $f'_c$ , of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). The Powers Power-Stud+ SD2 carbon steel anchor are also used in cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having

a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa).

The anchors comply with Section 1909 of the 2012 IBC, and Section 1912 of the 2009 and 2006 IBC. The anchors are an alternative to cast-in-place anchors described in Section 1908 of the 2012 IBC, and Section 1911 of the 2009 and 2006 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

**3.0 DESCRIPTION**
**3.1 General:**

The anchors are torque-controlled, mechanical expansion anchors comprised of an anchor body, expansion wedge (clip), washer and hex nut.

Product names for the report holder and the additional listee are presented in Table A of this report. The anchor body is comprised of a high-strength carbon or stainless steel rod threaded at one end and having a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion clip which freely moves around the mandrel. The expansion clip movement is restrained by the mandrel taper and by a collar. On the stainless steel anchors, the mandrel taper has a knurling with the exception of the 1/4-inch-diameter (6.4 mm) anchors.

The anchors are installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor on the threaded end of the anchor body, the mandrel at the other end of the anchor is drawn into the expansion clip, forcing it outward into the sides of the predrilled hole in the base material. Installation instructions and related information are set forth in Section 4.3, Table 1 and Figures 1, 3, 4A and 4B.

**3.2 Power-Stud+ SD2 Carbon Steel Anchors:**

The anchor body is manufactured from medium carbon steel and has minimum 0.0002-inch (5  $\mu$ m) zinc plating in accordance with ASTM B633. The expansion clip is manufactured from AISI Type 316 stainless steel. The washer conforms to ASTM F844. The hex nuts conform to ASTM A563, Grade A. The Power-Stud+ SD2 anchor is illustrated in Figure 2 Installation instructions and related information are set forth in Section 4.3, Table 1 and Figures 1, 3, 4A and 4B.

**3.3 Power-Stud+ SD4 and Power-Stud+ SD6 Stainless Steel Anchors:**

The Power-Stud+ SD4 anchor body is manufactured from Type 304 stainless steel and the Power-Stud+ SD6 is

\*Revised September 2014



manufactured from Type 316 stainless steel. The expansion clips and hex nuts are manufactured from Type 316 stainless steel. Washers are manufactured from 300 series stainless steel for the Power-Stud+ SD4 and Type 316 stainless steel for the Power-Stud+ SD6. The Power-Stud+ SD4 and Power-Stud+ SD6 anchors are illustrated in Figure 2. Installation instructions and related information are set forth in Section 4.3, Table 2 and Figures 1 and 3

### 3.4 Concrete:

Normal-weight and sand-lightweight concrete must conform to Sections 1903 and 1905 of the IBC.

### 3.5 Steel Deck Panels (For SD2 anchors only):

Steel deck panels must comply with the configurations in Figure 4 and have a minimum base-metal thickness of 0.035 inch (0.899 mm) [20 gage]. Steel deck must comply with the requirements of ASTM A653/A653M SS Grade 33, and have a minimum yield strength of 33 ksi (228 MPa).

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design:

**4.1.1 General:** Design strength of anchors complying with the 2012 IBC, as well as Section 301.1.3 of the 2012 IRC, must be determined in accordance with ACI 318-11 Appendix D and this report.

Design strength of anchors complying with the 2009 IBC, as well as Section R301.1.3 of the 2009 IRC, must be determined in accordance with ACI 318-08 Appendix D and this report.

Design strength of anchors complying with the 2006 IBC and Section 301.1.3 of 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.

Design examples according to the 2012 IBC are given in Figures 5–9 of this report.

Design parameters are based on the 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12 of this report. The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors,  $\phi$ , as given in ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) and noted in Tables 3, 4, 5 and 6 of this report, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC and Section 9.2 of ACI 318. Strength reduction factors,  $\phi$ , as given in ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5) must be used for load combinations calculated in accordance with Appendix C of ACI 318. The value of  $f'_c$  used in the calculation must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318-11 D.3.7.

**4.1.2 Requirements for Static Steel Strength in Tension,  $N_{sa}$ :** The nominal steel strength of a single anchor in tension,  $N_{sa}$ , is given in Tables 3 and 5 of this report. The values of  $N_{sa}$  for single anchors given in Tables 3 and 5 must be used and not be derived by calculation.

The mean anchor stiffness value  $\beta$  is given in Tables B and C.

**4.1.3 Requirements for Static Concrete Breakout Strength in Tension,  $N_{cb}$  or  $N_{cbg}$ :** The nominal concrete breakout strength of a single anchor or group of anchors in tension,  $N_{cb}$  and  $N_{cbg}$ , respectively, must be calculated in accordance with ACI 318 D.5.2, with modifications as described in this section. The basic concrete breakout strength of a single anchor in tension,  $N_b$ , must be calculated according to ACI 318 D.5.2.2, using the values of  $h_{ef}$  and  $k_{cr}$  as given in Tables 3 and 5 of this report. The nominal concrete breakout strength in tension in regions

where analysis indicates no cracking in accordance with ACI 318 D.5.2.6 must be calculated, with  $\psi_{c,N} = 1.0$  and using the value of  $k_{uncr}$  as given in Tables 3 and 5.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figures 4A and 4B, calculation of the concrete breakout strength in accordance with ACI 318 D.5.2 is not required.

**4.1.4 Requirements for Static Pullout Strength in Tension,  $N_{pn}$ :** The nominal pullout strength of a single anchor in tension in accordance with ACI 318 D.5.3 in cracked and uncracked concrete,  $N_{p,cr}$  and  $N_{p,uncr}$ , respectively, is given in Tables 3 and 5 of this report. For all design cases,  $\psi_{c,P} = 1.0$ . In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be adjusted by calculation according to Eq-1:

$$N_{pn,f'_c} = N_{p,cr} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-1})$$

$$N_{pn,f'_c} = N_{p,cr} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchor diameters with the exception of the  $3/8$ -inch-diameter (9.5 mm) Power-Stud+ SD2 anchor size, where  $n = 1/3$ .

In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension must be adjusted by calculation according to Eq-2:

$$N_{pn,f'_c} = N_{p,uncr} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-2})$$

$$N_{pn,f'_c} = N_{p,uncr} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchors.

Where values for  $N_{p,cr}$  or  $N_{p,uncr}$  are not provided in Table 3 or 5, the pullout strength in tension need not be evaluated.

The nominal pullout strength in tension of the anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figures 4A and 4B, is provided in Table 3. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be calculated according to Eq-1, whereby the value of  $N_{p,deck,cr}$  must be substituted for  $N_{p,cr}$  and the values of 3,000 psi or 20.7 MPa must substitute for 2,500 psi or 17.2 MPa in the denominator. In regions where analysis indicates no cracking in accordance with ACI 318 5.3.6, the nominal strength in uncracked concrete must be calculated according to Eq-2, whereby the value of  $N_{p,deck,uncr}$  must be substituted for  $N_{p,uncr}$  and the values of 3,000 psi or 20.7 MPa must substitute for 2,500 psi or 17.2 MPa in the denominator.

**4.1.5 Requirements for Static Steel Shear Capacity,  $V_{sa}$ :** The nominal steel strength in shear,  $V_{sa}$ , of a single anchor in accordance with ACI 318 D.6.1.2 is given in Tables 4 and 6 of this report and must be used in lieu of the values derived by calculation from ACI 318-11, Eq. D-29. The shear strength  $V_{sa,deck}$  of anchors installed in the soffit of sand-lightweight or normal weight concrete filled steel deck floor and roof assemblies, as shown in Figures 4A and 4B, is given in Table 4.

**4.1.6 Requirements for Static Concrete Breakout Strength in Shear,  $V_{cb}$  or  $V_{cbg}$ :** The nominal concrete breakout strength of a single anchor or group of anchors in shear,  $V_{cb}$  or  $V_{cbg}$ , respectively, must be calculated in

accordance with ACI 318 D.6.2, with modifications as described in this section. The basic concrete breakout strength of a single anchor in shear,  $V_b$ , must be calculated in accordance with ACI 318 D.6.2.2 using the value of  $\ell_e$  and  $d_a$  ( $d_o$ ) given in Tables 4 and 6.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 4A and 4B, calculation of the concrete breakout strength in accordance with ACI 318 D.6.2 is not required.

**4.1.7 Requirements for Static Concrete Pryout Strength in Shear,  $V_{cp}$  or  $V_{cpg}$ :** The nominal concrete pryout strength,  $V_{cp}$  or  $V_{cpg}$ , must be calculated in accordance with ACI 318 D.6.3, modified by using the value of  $k_{cp}$  provided in Tables 4 and 6 and the value of  $N_{cb}$  or  $N_{cbg}$  as calculated in accordance with Section 4.1.3 of this report.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 4A and 4B, calculation of the concrete pryout strength in accordance with ACI 318 D.6.3 is not required.

**4.1.8 Requirements for Seismic Design:**

**4.1.8.1 General:** For load combinations including seismic loads, the design must be performed in accordance with ACI 318 D.3.3. For the 2012 IBC, Section 1905.1.9 is omitted. Modifications to ACI 318 D.3.3 must be applied under Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as applicable.

The nominal steel strength and nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated according to ACI 318 D.5 and D.6, respectively, taking into account the corresponding values in Tables 3, 4, 5 and 6 of this report. The anchors comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-11 D.3.3.4, D.3.3.5 D.3.3.6 or D.3.3.7; ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6; or ACI 318-05 D.3.3.4 or D.3.3.5, as applicable. Strength reduction factors,  $\phi$ , are given in Tables 3, 4, 5 and 6. The anchors, except for the 1/4-inch-diameter (6.4 mm) stainless steel anchors, may be installed in regions designed as IBC Seismic Design Category A through F.

**4.1.8.2 Seismic Tension:** The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated according to ACI 318 D.5.1 and D.5.2, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318 D.5.3.2, the appropriate value for pullout strength in tension for seismic loads,  $N_{p,eq}$  or  $N_{p,deck,cr}$ , described in Tables 3 and 5 of this report, must be used in lieu of  $N_p$ . The values of  $N_{p,eq}$  or  $N_{p,deck,cr}$  can be adjusted for concrete strength as follows:

$$N_{eq,f'_c} = N_{eq} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-3})$$

$$N_{eq,f'_c} = N_{eq} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchor diameters with the exception of the 3/8-inch-diameter (9.5 mm) Power-Stud+ SD2 anchor size where  $n = 1/3$ . In addition, for sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, the value of 3,000 psi or 20.7 MPa must be substituted for the value of 2,500 psi or 17.2 MPa in the denominator.

Where values of  $N_{p,eq}$  are not provided in Tables 3 and 5 of this report, the pullout strength in tension for seismic loads does not govern and need not be evaluated.

**4.1.8.3 Seismic Shear:** The nominal concrete breakout strength and pryout strength for anchors in shear must be calculated according to ACI 318 D.6.2 and D.6.3, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318 D.6.1.2, the appropriate value for nominal steel strength in shear for seismic loads,  $V_{sa,eq}$  or  $V_{sa,deck,eq}$ , described in Tables 4 and 6 of this report must be used in lieu of  $V_{sa}$ .

**4.1.9 Interaction of Tensile and Shear Forces:** For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design must be performed in accordance with ACI 318 D.7.

**4.1.10 Requirements for Critical Edge Distance:** In applications where  $c < c_{ac}$  and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated according to ACI 318 D.5.2, must be further multiplied by the factor  $\psi_{cp,N}$  given by the following equation:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \quad (\text{Eq-4})$$

whereby the factor  $\psi_{cp,N}$  need not be taken as less than  $\frac{1.5h_{ef}}{c_{ac}}$ . For all other cases  $\psi_{cp,N} = 1.0$ . In lieu of ACI 318 D.8.6, values of  $c_{ac}$  provided in Table 1 of this report must be used.

**4.1.11 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance:** In lieu of ACI 318 D.8.1 and D.8.3, values of  $c_{min}$  and  $s_{min}$  as given in Tables 1 and 2 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thicknesses,  $h_{min}$  as given in Tables 1 and 2 must be used.

For anchors installed through the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 4A or 4B, as applicable, and shall have an axial spacing along the flute equal to the greater of  $3h_{ef}$  or 1.5 times the flute width.

**4.1.12 Sand-lightweight Concrete:** For ACI 318-11 and ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor  $\lambda_a$  or  $\lambda$ , respectively, for concrete breakout strength must be taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC). In addition, the pullout strength  $N_{p,cr}$ ,  $N_{p,eq}$ , and  $N_{puncr}$  must be multiplied by 0.6, as applicable.

For ACI 318-05, the values  $N_b$ ,  $N_{p,eq}$ ,  $N_{p,cr}$ ,  $N_{puncr}$  and  $V_b$  determined in accordance with this report must be multiplied by 0.6, in lieu of ACI 318 D.3.4.

For anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction is not required.

**4.2 Allowable Stress Design (ASD):**

**4.2.1 General:** Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC, shall be established using the following equations:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad (\text{Eq-5})$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \quad (\text{Eq-6})$$

where:

$$T_{allowable,ASD} = \text{Allowable tension load (lbf or kN)}$$

$$V_{allowable,ASD} = \text{Allowable shear load (lbf or kN)}$$

- $\phi N_n$  = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, or 2009 IBC Section 1908.1.9, or 2006 IBC Section 1908.1.16, as applicable (lbf or N).
- $\phi V_n$  = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, or 2009 IBC Section 1908.1.9, or 2006 IBC Section 1908.1.16, as applicable (lbf or N).
- $\alpha$  = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition,  $\alpha$  shall include all applicable factors to account for non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, as described in this report, must apply. An example of allowable stress design values for illustrative purposes is shown in Table 7 and Figure 5 of this report.

**4.2.2 Interaction of Tensile and Shear Forces:** The interaction shall be calculated and consistent with ACI 318 D.7 as follows:

For shear loads  $V \leq 0.2V_{allowable,ASD}$ , the full allowable load in tension shall be permitted.

For tension loads  $T \leq 0.2T_{allowable,ASD}$ , the full allowable load in shear shall be permitted.

$$\text{For all other cases: } \frac{T}{T_{allowable}} + \frac{V}{V_{allowable}} \leq 1.2 \quad (\text{Eq-7})$$

#### 4.3 Installation:

Installation parameters are provided in Table 1, Table 2, and Figures 1, 3, 4A, and 4B. Anchor locations must comply with this report and the plans and specifications approved by the code official. The Power-Stud+ SD2 carbon steel anchors and Power-Stud+ SD4 and Power-Stud+ SD6 stainless steel anchors must be installed according to manufacturer's published installation instructions and this report. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor size. The minimum drilled hole depth is given in Table 1. The predrilled hole must be cleaned free of dust and debris. The anchor must be hammered into the predrilled hole until the proper nominal embedment depth is achieved. The nut must be tightened against the washer until the torque values specified in Tables 1 and 2 are achieved.

For installation of SD2 anchors in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck must not exceed the diameter of the hole in the concrete by more than  $\frac{1}{8}$  inch (3.2 mm). For member thickness and edge distance requirements for installations into the soffit of concrete on steel deck assemblies, see Figure 4A and 4B.

#### 4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1705.1.1 and Table 1705.3 of the 2012 IBC; Section 1704.15 and Table 1704.4 of the 2009 IBC; or Section 1704.13 of the 2006. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedure, anchor spacing, edge distances,

concrete member thickness, anchor embedment, tightening torque and adherence to the Powers Fasteners' printed installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection".

#### 5.0 CONDITIONS OF USE

The Powers anchors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 The anchors must be installed in accordance with the manufacturer's published installation instructions and this report. In case of a conflict, this report governs.
- 5.2 Anchor sizes, dimensions, and minimum embedment depths are as set forth in this report.
- 5.3 The  $\frac{1}{4}$ -inch-diameter (6.4 mm) anchors must be installed in uncracked normal-weight or sand-lightweight concrete;  $\frac{3}{8}$ -inch- to  $\frac{3}{4}$ -inch-diameter (9.5 mm to 19.1 mm) anchors must be installed in cracked and uncracked normal-weight concrete and sand-lightweight concrete having a specified compressive strength,  $f'_c$ , of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked normal weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa).
- 5.4 The values of  $f'_c$  used for calculation purposes must not exceed 8,000 psi (55.2 MPa).
- 5.5 Strength Design values must be established in accordance with Section 4.1 of this report.
- 5.6 Allowable Stress Design values must be established in accordance with Section 4.2 of this report.
- 5.7 Anchor spacing(s) and edge distance(s), as well as minimum member thickness, must comply with Tables 1 and 2 and Figure 4A and 4B.
- 5.8 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.
- 5.10 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ( $f_t > f_r$ ), subject to the conditions of this report.
- 5.11 The  $\frac{3}{8}$ -inch-diameter to  $\frac{3}{4}$ -inch-diameter (9.5 mm to 19.1 mm) anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F under the IBC, subject to the conditions of this report. The  $\frac{1}{4}$ -inch-diameter (6.4 mm) anchors may be used to resist short-term loading due to wind forces, and for seismic load combinations limited to structures assigned to Seismic Design Categories A and B under the IBC, subject to the conditions of this report.
- 5.12 Where not otherwise prohibited in the code, the anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:



- Anchors are used to resist wind or seismic forces only.
- Anchors that support a fire-resistance-rated envelope or a fire-resistance-rated membrane are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

**5.13** Use of zinc-coated carbon steel anchors is limited to dry, interior locations.

**5.14** Use of anchors made of stainless steel as specified in this report are permitted for exterior exposure or damp environments.

**5.15** Use of anchors made of stainless steel as specified in this report are permitted for contact with preservative-treated and fire-retardant-treated wood

**5.16** Special inspection must be provided in accordance with Section 4.4 of this report.

**5.17** Anchors are manufactured under an approved quality control program with inspections by ICC-ES.

**6.0 EVIDENCE SUBMITTED**

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193),

dated June 2012, which incorporates requirements in ACI 355.2-07 / ACI 355.2-04, for use in cracked and uncracked concrete; including optional service-condition Test 18 and Test 19 (AC193, Annex 1, Table 4.2) for seismic tension and shear; and quality control documentation.

**7.0 IDENTIFICATION**

The anchors are identified by dimensional characteristics and packaging. A length letter code head marking is stamped on each anchor on the exposed threaded stud end which is visible after installation. Table D shows the length code identification system. For the Power-Stud+ SD2 anchors, a plus sign “+” and the number “2” are also visible after installation. For the Power-Stud+ SD4 and Power-Stud+ SD6 anchors, a plus sign “+” is also marked with a number on all anchors with the exception of the 1/4-inch-diameter (6.4 mm) anchors. The number “4” designates the Power-Stud+ SD4 and the number “6” designates the Power-Stud+ SD6. Packages are identified with the anchor name, type and size, the company name as set forth in Table A, and the evaluation report number (ESR-2502).

**TABLE A—PRODUCT NAMES BY COMPANY AND DESIGN INDEX**

Company Name	Product Name	Installation Specifications	Tension Design Data	Shear Design Data
Powers Fasteners	Power-Stud+ SD2	Table 1	Table 3	Table 4
	Power-Stud+ SD4 and Power-Stud+ SD6	Table 2	Table 5	Table 6
DEWALT (Stanley Black & Decker)	Power-Stud+ SD2	Table 1	Table 3	Table 4
	Power-Stud+ SD4 and Power-Stud+ SD6	Table 2	Table 5	Table 6

**TABLE B—MEAN AXIAL STIFFNESS VALUES, β, FOR POWER-STUD+ SD2 EXPANSION ANCHORS IN NORMAL-WEIGHT CONCRETE<sup>1</sup>**

Concrete State	Units x10 <sup>2</sup>	Nominal Anchor Size (inch)			
		3/8	1/2	5/8	3/4
Uncracked concrete	lbf/in. (kN/mm)	8,650 (1,517)	7,170 (1,258)	5,690 (998)	4,200 (737)
Cracked concrete	lbf/in. (kN/mm)	495 (87)	570 (100)	645 (113)	720 (126)

<sup>1</sup>Mean values shown; actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

**TABLE C—MEAN AXIAL STIFFNESS VALUES, β, FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN NORMAL-WEIGHT CONCRETE<sup>1</sup>**

Concrete State	Units	Nominal Anchor Size (inch)				
		1/4	3/8	1/2	5/8	3/4
Uncracked concrete	lbf/in. (kN/mm)	171,400 (30,060)	490,000 (86,000)	459,000 (80,500)	234,000 (41,000)	395,000 (69,300)
Cracked concrete	lbf/in. (kN/mm)	Not applicable	228,000 (40,000)	392,000 (68,800)	193,000 (33,800)	76,600 (13,400)

<sup>1</sup>Mean values shown; actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

**TABLE D—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 LENGTH CODE IDENTIFICATION SYSTEM**

Length ID marking on threaded stud head	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
Overall anchor length, <i>l<sub>anch</sub></i> , (inches)	From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10
	Up to but not including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11

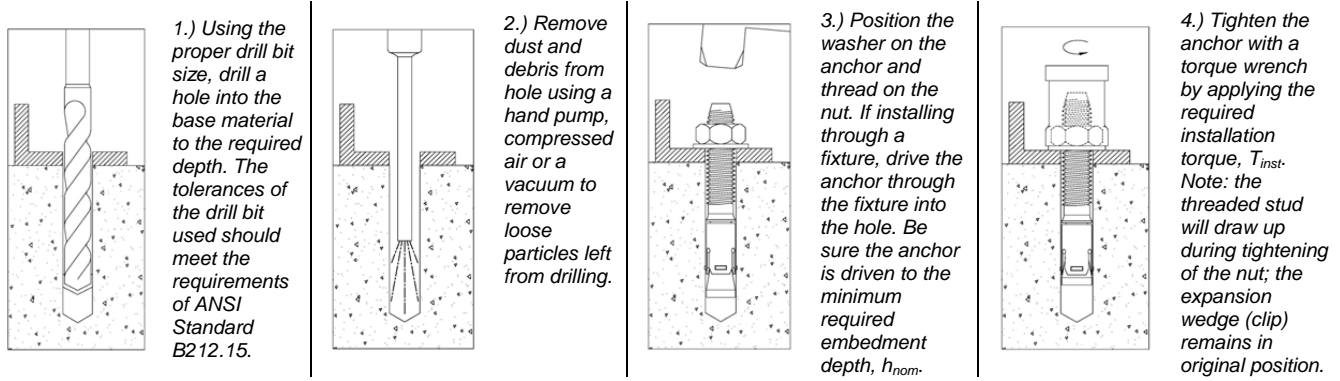


FIGURE 3— POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 INSTALLATION INSTRUCTIONS

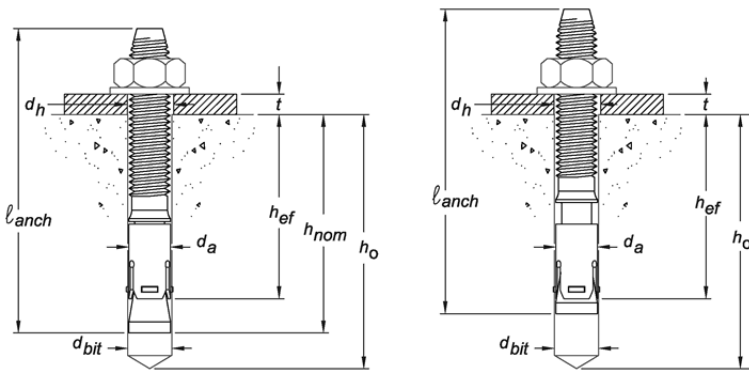


FIGURE 1—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR DETAIL

Before (Left Picture) and After (Right Picture) Application of Installation Torque

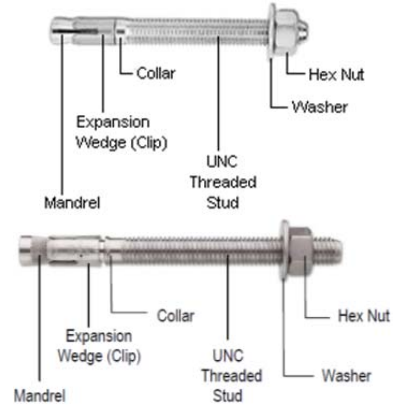


FIGURE 2—POWER-STUD+ SD2 (Top Picture), POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR ASSEMBLY (Bottom Picture)

TABLE 1—POWER-STUD+ SD2 ANCHOR INSTALLATION SPECIFICATIONS

ANCHOR PROPERTY AND SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE <sup>4</sup> (inch)									
			<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>		<sup>5</sup> / <sub>8</sub>		<sup>3</sup> / <sub>4</sub>				
Outside diameter of anchor	$d_a$ [ $d_o$ ] <sup>5</sup>	in. (mm)	0.375 (9.5)	0.500 (12.7)		0.625 (15.9)		0.750 (19.1)				
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	<sup>7</sup> / <sub>16</sub> (11.1)	<sup>9</sup> / <sub>16</sub> (14.3)		<sup>11</sup> / <sub>16</sub> (17.5)		<sup>13</sup> / <sub>16</sub> (20.6)				
Nominal drill bit diameter	$d_{bit}$	in.	<sup>3</sup> / <sub>8</sub> ANSI	<sup>1</sup> / <sub>2</sub> ANSI		<sup>5</sup> / <sub>8</sub> ANSI		<sup>3</sup> / <sub>4</sub> ANSI				
Minimum nominal embedment depth <sup>1</sup>	$h_{nom}$	in. (mm)	2 <sup>3</sup> / <sub>8</sub> (60)	2 <sup>1</sup> / <sub>2</sub> (64)	3 <sup>3</sup> / <sub>4</sub> (83)	3 <sup>7</sup> / <sub>8</sub> (98)	4 <sup>1</sup> / <sub>8</sub> (124)	4 <sup>1</sup> / <sub>2</sub> (114)	5 <sup>3</sup> / <sub>4</sub> (146)			
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)			
Minimum concrete member thickness	$h_{min}$	in. (mm)	4 (102)	4 <sup>1</sup> / <sub>2</sub> (114)	6 (152)	5 <sup>3</sup> / <sub>4</sub> (146)	5 <sup>3</sup> / <sub>4</sub> (146)	5 <sup>3</sup> / <sub>4</sub> (146)	6 <sup>1</sup> / <sub>2</sub> (165)	8 (203)	7 (178)	10 (254)
Critical edge distance <sup>2</sup>	$c_{ac}$	in. (mm)	6 <sup>1</sup> / <sub>2</sub> (165)	8 (203)		10 (254)		8 (203)	15 <sup>3</sup> / <sub>4</sub> (400)	10 (254)	12 (305)	12 (305)
Minimum edge distance <sup>2</sup>	$c_{min}$	in. (mm)	2 <sup>1</sup> / <sub>2</sub> (64)	4 (102)	2 <sup>3</sup> / <sub>4</sub> (70)	4 (102)	2 <sup>3</sup> / <sub>4</sub> (70)	4 <sup>1</sup> / <sub>4</sub> (108)	4 <sup>1</sup> / <sub>4</sub> (108)	5 (127)	4 <sup>1</sup> / <sub>2</sub> (114)	
Minimum spacing distance <sup>2</sup>	$s_{min}$	in. (mm)	3 <sup>1</sup> / <sub>2</sub> (89)	6 (152)	6 (152)	4 (102)	6 (152)	4 <sup>1</sup> / <sub>4</sub> (108)	4 <sup>1</sup> / <sub>4</sub> (108)	6 (152)	6 (152)	
Minimum hole depth <sup>2</sup>	$h_o$	in. (mm)	2 <sup>5</sup> / <sub>8</sub> (67)	2 <sup>3</sup> / <sub>4</sub> (70)		4 (102)		4 <sup>1</sup> / <sub>4</sub> (108)	5 <sup>1</sup> / <sub>4</sub> (133)	5 (127)	6 <sup>1</sup> / <sub>4</sub> (159)	
Minimum overall anchor length <sup>3</sup>	$l_{anch}$	in. (mm)	3 (76)	3 <sup>3</sup> / <sub>4</sub> (95)		4 <sup>1</sup> / <sub>2</sub> (114)		4 <sup>3</sup> / <sub>4</sub> (121)	6 (152)	5 <sup>1</sup> / <sub>2</sub> (159)	7 (178)	
Installation torque	$T_{inst}$	ft.-lb. (N-m)	20 (27)	40 (54)		60 (81)		110 (149)				
Torque wrench / socket size	-	in.	<sup>9</sup> / <sub>16</sub>	<sup>3</sup> / <sub>4</sub>		<sup>15</sup> / <sub>16</sub>		1 <sup>1</sup> / <sub>8</sub>				
Nut height	-	In.	<sup>21</sup> / <sub>64</sub>	<sup>7</sup> / <sub>16</sub>		<sup>35</sup> / <sub>64</sub>		<sup>41</sup> / <sub>64</sub>				

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

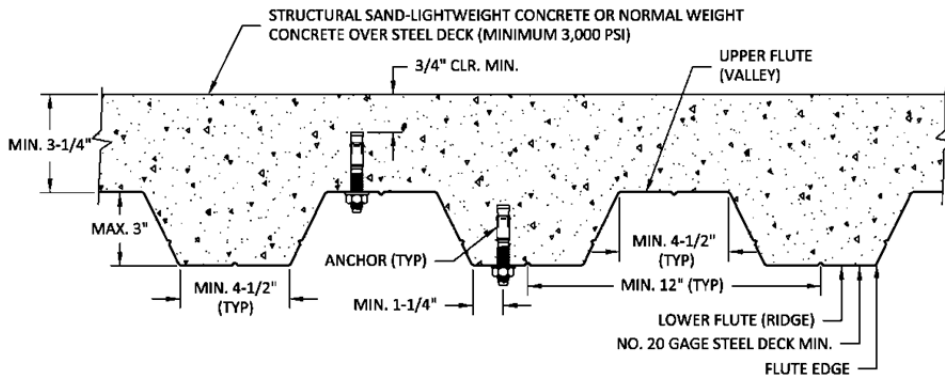
<sup>1</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>2</sup>For installations through the soffit of steel deck into concrete see the installation details in Figure 4A and 4B of this report. In addition, anchors shall have an axial spacing along the flute equal to the greater of  $3h_{ef}$  or 1.5 times the flute width.

<sup>3</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment.

<sup>4</sup>The anchors may be installed in the topside of concrete-filled steel deck floor and roof assemblies in accordance with Section 5.3 of this report, provided the concrete thickness above the upper flute meets the minimum thicknesses specified in this table.

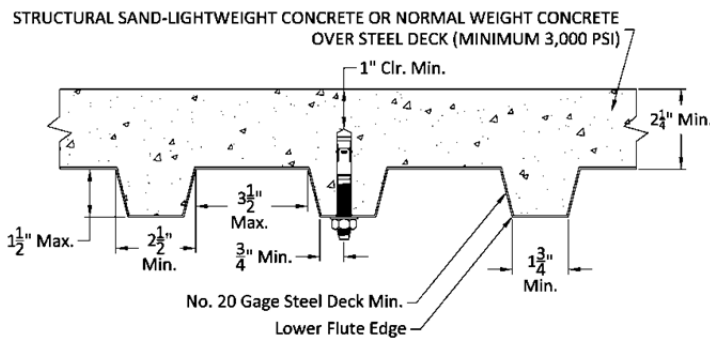
<sup>5</sup>The notation in brackets is for the 2006 IRC.



**FIGURE 4A—POWER-STUD+ SD2 INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1</sup>**

<sup>1</sup> SD2 anchors may be placed in the upper flute or lower flute of the steel deck profiles in accordance with Figure 4A provided the minimum hole clearance is satisfied.

Anchors in the lower flute of Figure 4A profiles may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.



**FIGURE 4B—POWER-STUD+ SD2 INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1,2</sup>**

<sup>1</sup> SD2 anchors may be placed in the lower flute of the steel deck profiles in accordance with Figure 4B provided the minimum hole clearance is satisfied.

Anchors in the lower flute of Figure 4B profiles may be installed with a maximum 1/8-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

<sup>2</sup> Anchors may be placed in the upper flute of the steel deck profiles in accordance with Figure 4B provided the concrete thickness above the upper flute is minimum 3 1/4-inch and a minimum hole clearance of 3/4-inch is satisfied.

**TABLE 2—POWER-STUD+ SD4 AND POWER-STUD+ SD6 INSTALLATION SPECIFICATIONS**

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size <sup>3</sup> (inch)								
			1/4	3/8		1/2	5/8		3/4		
Outside diameter of anchor	$d_a$ [ $d_o$ ] <sup>4</sup>	in. (mm)	0.250 (6.4)	0.375 (9.5)		0.500 (12.7)	0.625 (15.9)		0.750 (19.1)		
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)		9/16 (14.3)	11/16 (17.5)		13/16 (20.6)		
Nominal drill bit diameter	$d_{bit}$	in.	1/4 ANSI	3/8 ANSI		1/2 ANSI	5/8 ANSI		3/4 ANSI		
Minimum nominal embedment depth <sup>1</sup>	$h_{nom}$	in. (mm)	1 3/4 (44)	1 7/8 (48)		2 1/2 (64)	3 1/4 (83)		4 1/2 (114)		
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)		2.00 (51)	2.75 (70)		3.75 (95)		
Minimum concrete member thickness	$h_{min}$	in. (mm)	3 1/4 (83)	3 1/4 (83)	4 (102)	4 (102)	5 (127)		6 (152)		
Critical edge distance	$c_{ac}$	in. (mm)	5 (127)	5 (127)		7 1/2 (191)	9 1/2 (241)		9 (229)		
Minimum edge distance	$c_{min}$	in. (mm)	1 3/4 (45)	3 (76)	3 1/2 (89)	6 (8)	3 (76)	4 1/2 (114)	8 1/2 (216)	5 (127)	9 (229)
Minimum spacing distance	$s_{min}$	in. (mm)	2 (51)	5 1/2 (140)	3 (76)	3 (76)	6 (8)	8 1/2 (216)	5 (127)	9 (229)	5 (127)
Minimum hole depth	$h_o$	in. (mm)	1 1/8 (48)	2 (51)		2 5/8 (67)	3 1/2 (89)		4 3/4 (121)		
Minimum overall anchor length <sup>2</sup>	$l_{anch}$	in. (mm)	2 1/4 (57)	2 3/4 (70)		3 3/4 (95)	4 1/2 (114)		5 1/2 (140)		
Installation torque	$T_{inst}$	ft.-lb. (N-m)	6 (8)	25 (34)		40 (54)	60 (81)		110 (149)		
Torque wrench / socket size	-	in.	7/16	9/16		3/4	15/16		1 1/8		
Nut height	-	in.	7/32	21/64		7/16	35/64		41/64		

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

<sup>1</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>2</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment.

<sup>3</sup>The anchors may be installed in the topside of concrete-filled steel deck floor and roof assemblies in accordance with Section 5.3 of this report, provided the concrete thickness above the upper flute meets the minimum thicknesses specified in this table.

<sup>4</sup>The notation in brackets is for the 2006 IBC.

**TABLE 3—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHOR IN CONCRETE**  
(For use with load combinations taken from ACI 318, Section 9.2)<sup>1,2</sup>

Design Characteristic	Notation	Units	Nominal Anchor Size (inch)						
			<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub>			
Anchor category	1, 2 or 3	-	1	1	1	1			
<b>STEEL STRENGTH IN TENSION<sup>4</sup></b>									
Minimum specified yield strength (neck)	$f_y$	ksi (N/mm <sup>2</sup> )	96.0 (662)	85.0 (586)	85.0 (586)	85.0 (586)	70.0 (483)		
Minimum specified ultimate strength (neck)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	120.0 (827)	106.0 (731)	106.0 (731)	106.0 (731)	90.0 (620)		
Effective tensile stress area (neck)	$A_{se,N}$ [ $A_{se}$ ] <sup>11</sup>	in <sup>2</sup> (mm <sup>2</sup> )	0.0552 (35.6)	0.1007 (65.0)	0.1619 (104.5)	0.2359 (153.2)			
Steel strength in tension	$N_{sa}$	lbf (kN)	6,625 (29.5)	10,445 (46.5)	13,080 (58.2)	21,230 (94.4)			
Reduction factor for steel strength <sup>3</sup>	$\phi$	-	0.75						
<b>CONCRETE BREAKOUT STRENGTH IN TENSION<sup>8</sup></b>									
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Effectiveness factor for uncracked concrete	$k_{uncr}$	-	24	24	24	24	24	24	24
Effectiveness factor for cracked concrete	$k_{cr}$	-	17	17	17	17	17	17	17
Modification factor for cracked and uncracked concrete <sup>5</sup>	$\psi_{c,N}$	-	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5
Critical edge distance	$c_{ac}$	in. (mm)	See Table 1						
Reduction factor for concrete breakout strength in tension <sup>3</sup>	$\phi$	-	0.65 (Condition B)						
<b>PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)<sup>8</sup></b>									
Characteristic pullout strength, uncracked concrete (2,500 psi) <sup>6</sup>	$N_{p,uncr}$	lbf (kN)	2,775 (12.3)	See note 7	6,615 (29.4)	See note 7	See note 7	See note 7	See note 7
Characteristic pullout strength, cracked concrete (2,500 psi) <sup>6</sup>	$N_{p,cr}$	lbf (kN)	2,165 (9.6)	See note 7	4,375 (19.5)	See note 7	See note 7	See note 7	7,795 (35.1)
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)						
<b>PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS<sup>8</sup></b>									
Characteristic pullout strength, seismic (2,500 psi) <sup>6,9</sup>	$N_{p,eq}$	lbf (kN)	2,165 (9.6)	See note 7	4,375 (19.5)	See note 7	See note 7	See note 7	7,795 (35.1)
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)						
<b>PULLOUT STRENGTH IN TENSION FOR ANCHORS IN SOFFIT OF SAND LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK</b>									
Characteristic pullout strength, uncracked concrete over steel deck, according to Figure 4A <sup>6,10</sup>	$N_{p,deck,uncr}$	lbf (kN)	1,855 (8.3)	2,065 (9.2)	3,930 (17.5)	4,665 (20.8)	7,365 (32.8)	4,900 (21.8)	
Characteristic pullout strength, cracked concrete over steel deck, according to Figure 4A <sup>6,10</sup>	$N_{p,deck,cr}$	lbf (kN)	1,445 (6.4)	1,465 (6.5)	2,600 (11.6)	3,305 (14.7)	5,215 (23.2)	3,470 (15.4)	
Characteristic pullout strength, uncracked concrete over steel deck, according to Figure 4B <sup>6,10</sup>	$N_{p,deck,uncr}$	lbf (kN)	1,600 (7.1)	2,025 (9.0)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Characteristic pullout strength, cracked concrete over steel deck, according to Figure 4B <sup>6,10</sup>	$N_{p,deck,cr}$	lbf (kN)	1,250 (5.6)	1,435 (6.4)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)						

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of  $\phi$  were determined from the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2. If the load combinations of ACI 318 Appendix C are used, then the appropriate value of  $\phi$  must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5). For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for the appropriate  $\phi$  factor when the load combinations of IBC Section 1605.2 or AC 318 Section 9.2 are used.

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element in tension as defined by ACI 318 D.1. Tabulated values for steel strength in tension are based on test results per ACI 355.2 and must be used for design.

<sup>5</sup>For all design cases  $\psi_{c,N}=1.0$ . The appropriate effectiveness factor for cracked concrete ( $k_{cr}$ ) or uncracked concrete ( $k_{uncr}$ ) must be used.

<sup>6</sup>For all design cases  $\psi_{c,P}=1.0$ . For the calculation of  $N_{pn}$ , see Section 4.1.4 of this report.

<sup>7</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>8</sup>Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>9</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2, Section 9.5.

<sup>10</sup>Values for  $N_{p,deck}$  are for sand-lightweight concrete ( $f'_{c,min} = 3,000$  psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.5.2 is not required for anchors installed in the deck soffit (flute).

<sup>11</sup>The notation in brackets is for the 2006 IBC.

**TABLE 4—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHOR IN CONCRETE**  
(For use with load combinations taken from ACI 318, Section 9.2)<sup>1,2</sup>

Design Characteristic	Notation	Units	Nominal Anchor Diameter						
			<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub>			
Anchor category	1, 2 or 3	-	1	1	1	1			
<b>STEEL STRENGTH IN SHEAR<sup>4</sup></b>									
Minimum specified yield strength (threads)	$f_y$	ksi (N/mm <sup>2</sup> )	76.8 (530)	68.0 (469)	68.0 (469)	68.0 (469)	56.0 (386)		
Minimum specified ultimate strength (threads)	$f_{uta}^{10}$	ksi (N/mm <sup>2</sup> )	100.0 (690)	88.0 (607)	88.0 (607)	88.0 (607)	80.0 (551)		
Effective tensile stress area (threads)	$A_{se, v} [A_{se}]^{10}$	in <sup>2</sup> (mm <sup>2</sup> )	0.0775 (50.0)	0.1419 (65.7)	0.2260 (104.9)	0.2260 (104.9)	0.3345 (215.8)		
Steel strength in shear <sup>5</sup>	$V_{sa}$	lbf (kN)	3,115 (13.9)	4,815 (21.4)	10,170 (45.2)	10,170 (45.2)	12,610 (56.1)		
Reduction factor for steel strength <sup>3</sup>	$\phi$	-	0.65						
<b>CONCRETE BREAKOUT STRENGTH IN SHEAR<sup>6</sup></b>									
Load-bearing length of anchor ( $h_{ef}$ or $8d_o$ , whichever is less)	$\ell_e$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Nominal anchor diameter	$d_a [d_o]^{10}$	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.625 (15.9)	0.750 (19.1)		
Reduction factor for concrete breakout strength in shear <sup>3</sup>	$\phi$	-	0.70 (Condition B)						
<b>PRYOUT STRENGTH IN SHEAR<sup>6</sup></b>									
Coefficient for prout strength (1.0 for $h_{ef} < 2.5$ in., 2.0 for $h_{ef} \geq 2.5$ in.)	$k_{cp}$	-	1.0	1.0	2.0	2.0	2.0	2.0	2.0
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Reduction factor for prout strength <sup>3</sup>	$\phi$	-	0.70 (Condition B)						
<b>STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS</b>									
Steel strength in shear, seismic <sup>7</sup>	$V_{sa, eq}$	lbf (kN)	2,460 (11.0)	4,815 (21.4)	6,770 (30.1)	6,770 (30.1)	8,060 (35.9)		
Reduction factor for steel strength in shear, seismic <sup>3</sup>	$\phi$	-	0.65						
<b>STEEL STRENGTH IN SHEAR FOR SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK<sup>9</sup></b>									
Steel strength in shear, concrete over steel deck, according to Figure 4A <sup>8</sup>	$V_{sa, deck}$	lbf (kN)	2,170 (9.7)	3,815 (17.0)	5,040 (22.4)	4,015 (17.9)	6,670 (29.7)	4,325 (19.2)	
Steel strength in shear, seismic, concrete over steel deck, according to Figure 4A <sup>8</sup>	$V_{sa, deck, eq}$	lbf (kN)	1,940 (8.6)	3,815 (17.0)	5,040 (22.4)	2,675 (11.9)	4,445 (19.8)	2,820 (12.5)	
Steel strength in shear, concrete over steel deck, according to Figure 4B <sup>8</sup>	$V_{sa, deck}$	lbf (kN)	2,170 (9.7)	2,880 (12.8)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Steel strength in shear, seismic, concrete over steel deck, according to Figure 4B <sup>8</sup>	$V_{sa, deck, eq}$	lbf (kN)	1,940 (8.6)	2,880 (12.8)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Reduction factor for steel strength in shear, concrete over steel deck <sup>3</sup>	$\phi$	-	0.65						

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of  $\phi$  were determined from the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2. If the load combinations of ACI 318 Appendix C are used, then the appropriate value of  $\phi$  must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.4). For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for the appropriate  $\phi$  factor when the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2 are used.

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element as defined by ACI 318 D.1.

<sup>5</sup>Tabulated values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design.

<sup>6</sup>Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>7</sup>Tabulated values for steel strength in shear are for seismic applications are based on test results per ACI 355.2, Section 9.6.

<sup>8</sup>Values for  $V_{sa, deck}$  and  $V_{sa, deck, eq}$  are for sand-lightweight concrete ( $f'_{c, min} = 3,000$  psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.6.2 and the prout capacity in accordance with Section D.6.3 is not required for anchors installed in the deck soffit (flute).

<sup>9</sup>Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

<sup>10</sup>The notation in brackets is for the 2006 IBC.



**TABLE 5—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN CONCRETE (For use with load combinations taken from ACI 318, Section 9.2)<sup>1,7</sup>**

Design Characteristic	Notation	Units	Nominal Anchor Size (inch)				
			1/4	3/8	1/2	5/8	3/4
Anchor category	1, 2 or 3	-	1	1	1	1	1
<b>STEEL STRENGTH IN TENSION</b>							
Minimum specified yield strength (neck)	$f_y$	ksi (N/mm <sup>2</sup> )	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)
Minimum specified ultimate strength (neck)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)
Effective tensile stress area (neck)	$A_{se,N}$ [ $A_{se}$ ] <sup>9</sup>	in <sup>2</sup> (mm <sup>2</sup> )	0.0249 (16.1)	0.0530 (34.2)	0.1020 (65.8)	0.1630 (105.2)	0.238 (151)
Steel strength in tension	$N_{sa}$	lbf (kN)	2,240 (10.0)	4,780 (21.3)	9,160 (40.8)	14,635 (65.1)	21,380 (95.1)
Reduction factor for steel strength <sup>2</sup>	$\phi$	-	0.75				
<b>CONCRETE BREAKOUT STRENGTH IN TENSION<sup>6</sup></b>							
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75 (95)
Effectiveness factor for uncracked concrete	$k_{uncr}$	-	24	24	24	24	24
Effectiveness factor for cracked concrete	$k_{cr}$	-	Not applicable	17	21	21	21
Modification factor for cracked and uncracked concrete	$\Psi_{c,N}$	-	1.0 See note 4	1.0 See note 4	1.0 See note 4	1.0 See note 4	1.0 See note 4
Critical edge distance	$c_{ac}$	in. (mm)	See Table 2				
Reduction factor for concrete breakout strength in tension <sup>3</sup>	$\phi$	-	0.65 (Condition B)				
<b>PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)</b>							
Characteristic pullout strength, uncracked concrete (2,500 psi) <sup>5</sup>	$N_{p,uncr}$	lbf (kN)	1,510 (6.7)	See note	See note 6	See note 6	8,520 (37.8)
Characteristic pullout strength, cracked concrete (2,500 psi) <sup>5</sup>	$N_{p,cr}$	lbf (kN)	Not applicable	1,645 (7.3)	See note 6	See note 6	See note 6
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)				
<b>PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS</b>							
Characteristic pullout strength, seismic (2,500 psi) <sup>5,8</sup>	$N_{p,eq}$	lbf (kN)	Not applicable	1,645 (7.3)	See note 6	See note 6	See note 6
Reduction factor for pullout strength <sup>3</sup>	$\phi$	-	0.65 (Condition B)				

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.

<sup>2</sup>The tabulated value of  $\phi$  for steel strength applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for steel strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5). The anchors are ductile steel elements as defined in ACI 318 D.1.

<sup>3</sup>The tabulated value of  $\phi$  for concrete breakout strength and pullout strength applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition B are satisfied. If the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are satisfied, the appropriate value of  $\phi$  for concrete breakout strength and pullout strength must be determined in accordance with ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for concrete breakout strength and pullout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5).

<sup>4</sup>For all design cases  $\Psi_{c,N}=1.0$ . The appropriate effectiveness factor for cracked concrete ( $k_{cr}$ ) or uncracked concrete ( $k_{uncr}$ ) must be used.

<sup>5</sup>For all design cases  $\Psi_{c,P}=1.0$ . For the calculation of  $N_{pn}$ , see Section 4.1.4 of this report.

<sup>6</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>7</sup>Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>8</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2, Section 9.5.

<sup>9</sup>The notation in brackets is for the 2006 IBC.

**TABLE 6—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN CONCRETE (For use with load combinations taken from ACI 318, Section 9.2)<sup>1,6</sup>**

Design Characteristic	Notation	Units	Nominal Anchor Diameter				
			1/4	3/8	1/2	5/8	3/4
Anchor category	1, 2 or 3	-	1	1	1	1	1
<b>STEEL STRENGTH IN SHEAR<sup>3</sup></b>							
Minimum specified yield strength (threads)	$f_y$	ksi (N/mm <sup>2</sup> )	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)
Minimum specified ultimate strength (threads)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)
Effective shear stress area (threads)	$A_{se,v}[A_{se}]^8$	in <sup>2</sup> (mm <sup>2</sup> )	0.0318 (20.5)	0.0780 (50.3)	0.142 (91.6)	0.226 (145.8)	0.334 (212)
Steel strength in shear <sup>5</sup>	$V_{sa}$	lbf (kN)	1,115 (5.0)	1,470 (6.6)	3,170 (14.1)	7,455 (33.2)	11,955 (53.2)
Reduction factor for steel strength <sup>2</sup>	$\phi$	-	0.65				
<b>CONCRETE BREAKOUT STRENGTH IN SHEAR</b>							
Load-bearing length of anchor ( $h_{ef}$ or $8d_n$ , whichever is less)	$\ell_e$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75
Nominal anchor diameter	$d_n [d_n]^8$	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)
Reduction factor for concrete breakout strength in shear <sup>3</sup>	$\phi$	-	0.70 (Condition B)				
<b>PRYOUT STRENGTH IN SHEAR</b>							
Coefficient for prout strength	$k_{cp}$	-	1.0	1.0	1.0	2.0	2.0
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3 <sup>3</sup> / <sub>4</sub> (95)
Reduction factor for prout strength <sup>4</sup>	$\phi$	-	0.70 (Condition B)				
<b>STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS</b>							
Steel strength in shear, seismic <sup>7</sup>	$V_{sa,eq}$	lbf (kN)	Not applicable	1,305 (5.8)	2,765 (12.3)	5,240 (23.3)	7,745 (34.45)
Reduction factor for steel strength in shear, seismic <sup>2</sup>	$\phi$	-	0.65				

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.

<sup>2</sup>The tabulated value of  $\phi$  for steel strength applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for steel strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5). The anchors are ductile steel elements as defined in ACI 318 D.1.

<sup>3</sup>The tabulated value of  $\phi$  for concrete breakout strength applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition B are satisfied. If the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are satisfied, the appropriate value of  $\phi$  for concrete breakout strength must be determined in accordance with ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for concrete breakout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5).

<sup>4</sup>The tabulated value of  $\phi$  for prout strength applies if the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  for prout strength must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5), Condition B.

<sup>5</sup>Tabulated values for steel strength in shear must be used for design.

<sup>6</sup>Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>7</sup>Tabulated values for steel strength in shear are for seismic applications are based on test results per ACI 355.2, Section 9.6.

<sup>8</sup>The notation in brackets is for the 2006 IBC.

TABLE 7—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7,8,9</sup>

Nominal Anchor Diameter (in.)	Product	Nominal Embedment Depth (in.)	Effective Embedment (in.)	Allowable Tension Load (pounds)
1/4	Power-Stud+ SD4 and Power-Stud+ SD6	1 3/4	1.50	665
3/8	Power-Stud+ SD2	2 3/8	2.00	1,220
	Power-Stud+ SD4 and Power-Stud+ SD6	1 7/8	1.50	970
1/2	Power-Stud+ SD2	2 1/2	2.00	1,490
	Power-Stud+ SD4 and Power-Stud+ SD6	2 1/2	2.00	1,865
	Power-Stud+ SD2	3 3/4	3.25	2,905
5/8	Power-Stud+ SD4 and Power-Stud+ SD6	3 1/4	2.75	2,405
	Power-Stud+ SD2	3 7/8	3.25	3,090
	Power-Stud+ SD2	4 7/8	4.25	4,615
3/4	Power-Stud+ SD4 and Power-Stud+ SD6	4 1/2	3.75	3,740
	Power-Stud+ SD2	4 1/2	3.75	3,825
	Power-Stud+ SD2	5 3/4	5.00	5,890

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

<sup>1</sup> Single anchor with static tension load only.

<sup>2</sup> Concrete determined to remain uncracked for the life of the anchorage.

<sup>3</sup> Load combinations from ACI 318 Section 9.2 (no seismic loading considered).

<sup>4</sup> 30% dead load and 70% live load, controlling load combination 1.2D + 1.6L.

<sup>5</sup> Calculation of weighted average for  $\alpha = 1.2(0.3) + 1.6(0.7) = 1.48$ .

<sup>6</sup>  $f'_c = 2,500$  psi (normal weight concrete).

<sup>7</sup>  $c_{a1} = c_{a2} \geq c_{ac}$ .

<sup>8</sup>  $h \geq h_{min}$ .

<sup>9</sup> Values are for Condition B where supplementary reinforcement in accordance with ACI 318-11 D.4.3 is not provided.

<b>Given:</b> Calculate the factored strength design resistance in tension, $\phi N_n$ , and the allowable stress design value, $T_{allowable,ASD}$ , for a 3/8-inch diameter Power-Stud+ SD2 anchor assuming the given conditions in Table 5.		
Calculation in accordance with ACI 318-11 Appendix D and this report:	Code Ref.	Report Ref.
Step 1. Calculate steel strength of a single anchor in tension: $\phi N_{sa} = (0.75)(6,625) = 4,969 \text{ lbs.}$	D.5.1.2	Table 3
Step 2. Calculate concrete breakout strength of a single anchor in tension: $\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nco}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ $N_b = k_c \lambda_a \sqrt{f'_c} (h_{ef})^{1.5}$ $N_b = (24)(1.0) \sqrt{2,500} (2.0)^{1.5} = 3,394 \text{ lbs.}$ $\phi N_{cb} = (0.65) \frac{(36.0)}{(36.0)} (1.0)(1.0)(1.0)(3,394) = 2,206 \text{ lbs.}$	D.5.2.1	Table 3
Step 3. Calculate pullout strength of a single anchor: $\phi N_{pn} = \phi N_{p,uncr} \psi_{c,p} \left( \frac{f'_c}{2,500} \right)^n$ $\phi N_{pn} = (0.65)(2,775)(1.0)(1.0)^{0.5} = 1,804 \text{ lbs.}$	D.5.2.2	Table 3
Step 4. Determine controlling factored resistance strength in tension: $\phi N_n = \min[\phi N_{sa}, \phi N_{cb}, \phi N_{pn}] = \phi N_{pn} = 1,804 \text{ lbs.}$	D.4.1.1	
Step 5. Calculate allowable stress design conversion factor for loading condition: Controlling load combination: 1.2D + 1.6L $\alpha = 1.2(30\%) + 1.6(70\%) = 1.48$	9.2	
Step 6. Calculate allowable stress design value: $T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{1,804}{1.48} = 1,219 \text{ lbs.}$		§ 4.2

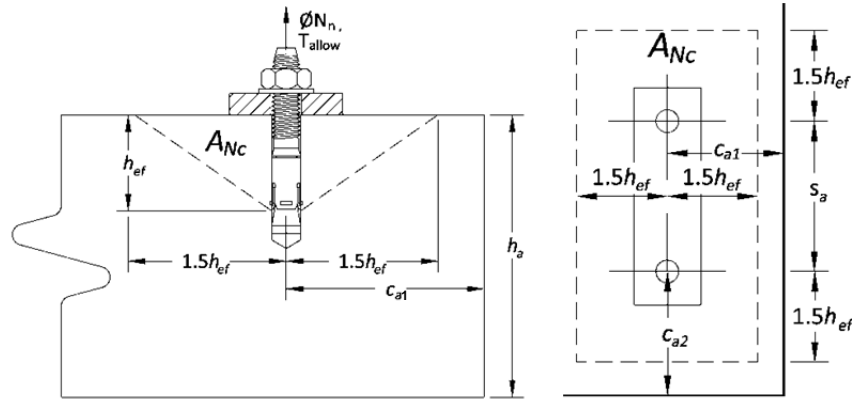
FIGURE 5—EXAMPLE STRENGTH DESIGN CALCULATION INCLUDING ASD CONVERSION FOR ILLUSTRATIVE PURPOSES E - 42



**Given:**

Two  $\frac{3}{8}$ " Power-Stud+ SD2 anchors  
 Concrete compressive strength:  
 $(f'_c) = 4,000$  psi  
 No supplemental reinforcement:  
 (Condition B per ACI 318-11 D.4.3 c)  
 Assume cracked concrete, no seismic,  
 no loading eccentricity and a rigid plate

$h_a = 5.0$  in.  
 $h_{ef} = 2.0$  in.  
 $s_a = 4.5$  in.  
 $c_{a1} = c_{a,min} = 6.0$  in.  
 $c_{a2} \geq 1.5c_{a1}$



**Calculate the factored resistance design strength in tension and equivalent allowable stress design load for the configuration.**

Calculation in accordance with ACI 318-11 and this report:	Code Ref.	Report Ref.
<b>Step 1.</b> Verify minimum member thickness, spacing and edge distance: $h_a = 5.0$ in. $\geq h_{min} = 4.0$ in. $\therefore$ OK $s_a = 4.5$ in. $\geq s_{min} = 3.5$ in. $\therefore$ OK $c_{a,min} = 6.0$ in. $\geq c_{min} = 2.5$ in. $\therefore$ OK	D.8	Table 1
<b>Step 2.</b> Calculate steel strength of anchor group in tension: $N_{sag} = n \cdot N_{sa} = 2 \cdot 6,625$ lbs. = 13,250 lbs. Calculate steel capacity: $\phi N_{sag} = 0.75 \cdot 13,250$ lbs. = <b>9,937 lbs.</b>	D.5.1.2	§4.1.2 Table 3
<b>Step 3.</b> Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = \frac{A_{Nc}}{A_{Nc0}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$	D.5.2.1 (b)	§4.1.3
<b>Step 3a.</b> Calculate $A_{Nc0}$ and $A_{Nc}$ $A_{Nc0} = 9h_{ef}^2 = 9 \cdot (2.0)^2 = \mathbf{36.0}$ in. <sup>2</sup> $A_{Nc} = (3.0 h_{ef}) \cdot (3.0 h_{ef} + s_a) = (3.0 \cdot 2.0) \cdot ((3.0 \cdot 2.0) + 4.5) = \mathbf{63.0}$ in. <sup>2</sup> $\therefore A_{Nc} = \mathbf{63.0}$ in. <sup>2</sup>	D.5.2.1 (b)	Table 1
<b>Step 3b.</b> Calculate $\psi_{ec,N} = \frac{1}{(1 + \frac{2e'_N}{3h_{ef}})} \leq 1.0$ ; $e'_N = 0 \therefore \psi_{ec,N} = \mathbf{1.0}$	D.5.2.4	-
<b>Step 3c.</b> Calculate $\psi_{ed,N} = 1.0$ if $c_{a,min} \geq 1.5h_{ef}$ ; $\psi_{ed,N} = 0.7 + 0.3 \frac{c_{a,min}}{1.5h_{ef}}$ if $c_{a,min} < 1.5h_{ef}$ $c_{a,min} = 6.0$ in. $\geq 1.5h_{ef} = 3.0$ in. $\therefore \psi_{ed,N} = \mathbf{1.0}$	D.5.2.5	Table 1
<b>Step 3d.</b> Calculate $\psi_{c,N} = \mathbf{1.0}$	D.5.2.6	Table 3
<b>Step 3e.</b> Calculate $\psi_{cp,N} = \mathbf{1.0}$ (cracked concrete)	D.5.2.7	-
<b>Step 3f.</b> Calculate $N_b = k_{cr} \lambda_\alpha \sqrt{f'_c} h_{ef}^{1.5} = 17 (1.0) \sqrt{4,000} \cdot 2.0^{1.5} = \mathbf{3,041}$ lbs.	D.5.2.2	Table 3
<b>Step 3g.</b> Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = (63.0/36.0) \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 3,041 = 5,321$ lbs. Calculate concrete breakout capacity = $\phi N_{cbg} = 0.65 \cdot 5,321 = \mathbf{3,459}$ lbs.	D.5.2.1 (b)	§4.1.3
<b>Step 4.</b> Calculate nominal pullout strength of a single anchor in tension: $N_{pn} = \psi_{c,p} \cdot N_{pn,f'c}$	D.5.3.1	§4.1.4 Table 3
<b>Step 4a.</b> Calculate $\psi_{c,p} = \mathbf{1.0}$ (cracked concrete)	D.5.3.6	§4.1.10 Table 3
<b>Step 4b.</b> Calculate $N_{pn,f'c} = N_{p,cr} \left(\frac{f'_c}{2500}\right)^{0.33} = 2,165 \left(\frac{4000}{2500}\right)^{0.33} = 2,528$ lbs. Calculate pullout capacity: $\phi N_{pn} = 0.65 \cdot 2,528 \cdot 1.0 = \mathbf{1,643}$ lbs.	D.5.3.2	§4.1.4 Table 3
<b>Step 5.</b> Determine controlling resistance strength of the anchor group in tension: $\phi N_n = \min[\phi N_{sag}, \phi N_{cbg}, n \phi N_{pn}] = n \phi N_{pn} = \mathbf{3,287}$ lbs.	D.4.1.1	§4.1.1
<b>Step 6.</b> Calculate allowable stress design conversion factor for loading condition: Assume controlling load combination: 1.2D + 1.6L ; 50% Dead Load, 50% Live Load $\alpha = 1.2(50\%) + 1.6(50\%) = \mathbf{1.40}$	9.2	§4.2.1
<b>Step 7.</b> Calculate allowable stress design value: $T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{3,287}{1.40} = \mathbf{2,347}$ lbs.	9.2	§4.2.1

**FIGURE 6—EXAMPLE STRENGTH DESIGN CALCULATION FOR TENSION CAPACITY FOR POWER-STUD+ SD2**

<p><b>Given:</b>                  Two <math>\frac{3}{8}</math>" Power-Stud+ SD2 anchors                  Concrete compressive strength:  <math>(f'_c) = 4,000</math> psi                  No supplemental reinforcement:                  (Condition B per ACI 318-11 D.4.3 c)                  Assume cracked concrete, no seismic,                  no loading eccentricity and a rigid plate</p> <p><math>h_a = 5.0</math> in.  <math>h_{ef} = 2.0</math> in.  <math>s_a = 4.5</math> in.  <math>c_{a1} = c_{a,min} = 6.0</math> in.  <math>c_{a2} \geq 1.5c_{a1}</math></p>		
<p><b>Calculate the factored resistance design strength in shear and equivalent allowable stress design load for the configuration.</b></p>		
<p><b>Calculation in accordance with ACI 318-11 and this report:</b></p>	<p><b>Code Ref.</b></p>	<p><b>Report Ref.</b></p>
<p><b>Step 1.</b> Verify minimum member thickness, spacing and edge distance:  <math>h_a = 5.0</math> in. <math>\geq h_{min} = 4.0</math> in. <math>\therefore</math> OK  <math>s_a = 4.5</math> in. <math>\geq s_{min} = 3.5</math> in. <math>\therefore</math> OK  <math>c_{a,min} = 6.0</math> in. <math>\geq c_{min} = 2.5</math> in. <math>\therefore</math> OK</p>	<p>D.8</p> <p>Table 1</p>	
<p><b>Step 2.</b> Calculate steel strength of anchor group in shear: <math>V_{sag} = n \cdot V_{sa} = 2 \cdot 3,115</math> lbs. = 6,230 lbs.                  Calculate steel capacity: <math>\phi V_{sag} = 0.65 \cdot 6,230</math> lbs. = <b>4,050 lbs.</b></p>	<p>D.6.1.2</p> <p>§4.1.5 Table 4</p>	
<p><b>Step 3.</b> Calculate concrete breakout strength of anchor group in shear:  <math>V_{cbg} = \frac{A_{Vc}}{A_{Vc0}} \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_b</math></p>	<p>D.6.2.1 (b)</p> <p>§4.1.6</p>	
<p><b>Step 3a.</b> Calculate <math>A_{Vc0}</math> and <math>A_{Vc}</math>  <math>A_{Vc0} = 4.5 (c_{a1})^2 = 4.5 \cdot (6.0)^2 = \mathbf{162.0}</math> in.<sup>2</sup>  <math>A_{Vc} = (h_a) \cdot (3 c_{a1} + s_a) = (5.0)((3 \cdot 6.0) + 4.5) = \mathbf{112.5}</math> in.<sup>2</sup></p>	<p>D.6.2.1</p> <p>Table 1</p>	
<p><b>Step 3b.</b> Calculate <math>\psi_{ec,v} = \frac{1}{(1 + \frac{2e'_v}{3c_{a1}})} \leq 1.0</math>; <math>e'_v = 0 \therefore \psi_{ec,v} = \mathbf{1.0}</math></p>	<p>D.6.2.5</p> <p>-</p>	
<p><b>Step 3c.</b> Calculate <math>\psi_{ed,v} = 1.0</math> if <math>c_{a2} \geq 1.5c_{a1}</math>; <math>\psi_{ed,v} = 0.7 + 0.3 \frac{c_{a2}}{1.5c_{a1}}</math> if <math>c_{a2} &lt; 1.5c_{a1}</math>  <math>c_{a2} \geq 1.5 c_{a1} \therefore \psi_{ed,v} = \mathbf{1.0}</math></p>	<p>D.6.2.6</p> <p>Table 1</p>	
<p><b>Step 3d.</b> Calculate <math>\psi_{c,v} = \mathbf{1.0}</math> (cracked concrete, no supplemental or edge reinforcement)</p>	<p>D.6.2.7</p> <p>-</p>	
<p><b>Step 3e.</b> Calculate <math>\psi_{h,v} = \sqrt{\frac{1.5c_{a1}}{h_a}}</math>; for members where <math>h_a &lt; 1.5c_{a1}</math>  <math>h_a = 5.0 &lt; 1.5c_{a1} = 9.0 \therefore \psi_{h,v} = \sqrt{\frac{9.0}{5.0}} = \mathbf{1.34}</math></p>	<p>D.6.2.8</p> <p>-</p>	
<p><b>Step 3f.</b> Calculate <math>V_b = \left(7 \left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda \alpha \sqrt{f'_c} (c_{a1})^{1.5} = 7 \left(\frac{2.0}{0.375}\right)^{0.2} \sqrt{0.375} (1.0) \sqrt{4000} (6.0)^{1.5}</math>  <math>= \mathbf{5,569}</math> lbs.</p>	<p>D.6.2.2</p> <p>Table 4</p>	
<p><b>Step 3g.</b> Calculate concrete breakout strength of anchor group in shear:  <math>V_{cbg} = (112.5/162.0) \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 1.34 \cdot 5,569 = 5,182</math> lbs.                  Calculate concrete breakout capacity = <math>\phi V_{cbg} = 0.70 \cdot 5,182 = \mathbf{3,627}</math> lbs.</p>	<p>D.6.2.1 (b)</p> <p>§4.1.6</p>	
<p><b>Step 4.</b> Calculate nominal pryout strength of an anchor group in shear:  <math>V_{cpg} = k_{cp} N_{cbg} = 1.0 \cdot 5,321</math> lbs = 5,321 lbs.                  Calculate pryout capacity: <math>\phi V_{cpg} = 0.70 \cdot 5,321</math> lbs. = <b>3,724 lbs.</b></p>	<p>D.6.3.1 (b)</p> <p>§4.1.7 Table 4</p>	
<p><b>Step 5.</b> Determine controlling resistance strength in shear:  <math>\phi V_n = \min\{\phi V_{sag}, \phi V_{cbg}, \phi V_{cpg}\} = \phi V_{sag} = \mathbf{3,627}</math> lbs.</p>	<p>D.4.1.1</p> <p>§4.1.1</p>	
<p><b>Step 6.</b> Calculate allowable stress design conversion factor for loading condition:                  Assume controlling load combination: 1.2D + 1.6L ; 50% Dead Load, 50% Live Load  <math>\alpha = 1.2(30\%) + 1.6(70\%) = \mathbf{1.48}</math></p>	<p>9.2</p> <p>§4.2.1</p>	
<p><b>Step 7.</b> Calculate allowable stress design value:  <math>V_{allowable, ASD} = \frac{\phi V_n}{\alpha} = \frac{3,627}{1.48} = \mathbf{2,451}</math> lbs.</p>	<p>9.2</p> <p>§4.2.1</p>	

FIGURE 7—EXAMPLE STRENGTH DESIGN CALCULATION FOR SHEAR CAPACITY FOR POWER-STUD+ SD2

**Given:**

Two 1/2" Power-Stud+ SD4 anchors

Concrete compressive strength:

$(f'_c) = 4,000 \text{ psi}$

No supplemental reinforcement:

(Condition B per ACI 318-11 D.4.3 c)

Assume cracked concrete, no seismic, no loading eccentricity and a rigid plate

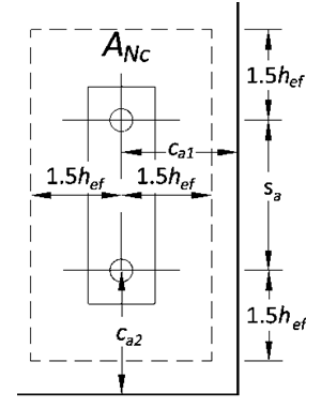
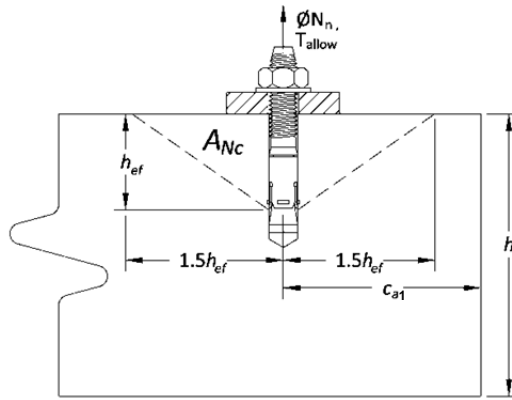
$h_a = 5.0 \text{ in.}$

$h_{ef} = 2.0 \text{ in.}$

$s_a = 4.5 \text{ in.}$

$c_{a1} = c_{a,min} = 6.0 \text{ in.}$

$c_{a2} \geq 1.5c_{a1}$



Calculate the factored resistance design strength in tension and equivalent allowable stress design load for the configuration.

Calculation in accordance with ACI 318-11 and this report:	Code Ref.	Report Ref.
<b>Step 1.</b> Verify minimum member thickness, spacing and edge distance: $h_a = 5.0 \text{ in.} \geq h_{min} = 4.0 \text{ in.} \therefore \text{OK}$ $s_a = 4.5 \text{ in.} \geq s_{min} = 4.5 \text{ in.} \therefore \text{OK}$ $c_{a,min} = 6.0 \text{ in.} \geq c_{min} = 6.0 \text{ in.} \therefore \text{OK}$	D.8	Table 1
<b>Step 2.</b> Calculate steel strength of anchor group in tension: $N_{sag} = n \cdot N_{sa} = 2 \cdot 9,160 \text{ lbs.} = 18,320 \text{ lbs.}$ Calculate steel capacity: $\phi N_{sag} = 0.75 \cdot 18,320 \text{ lbs.} = \mathbf{13,740 \text{ lbs.}}$	D.5.1.2	§4.1.2 Table 3
<b>Step 3.</b> Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = \frac{A_{Nc}}{A_{Nc0}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$	D.5.2.1 (b)	§4.1.3
<b>Step 3a.</b> Calculate $A_{Nc0}$ and $A_{Nc}$ $A_{Nc0} = 9h_{ef}^2 = 9 \cdot (2.0)^2 = \mathbf{36.0 \text{ in.}^2}$ $A_{Nc} = (3.0 h_{ef}) \cdot (3.0 h_{ef} + s_a) = (3.0 \cdot 2.0) \cdot ((3.0 \cdot 2.0) + 4.5) = \mathbf{63.0 \text{ in.}^2} \therefore A_{Nc} = \mathbf{63.0 \text{ in.}^2}$	D.5.2.1 (b)	Table 1
<b>Step 3b.</b> Calculate $\psi_{ec,N} = \frac{1}{(1 + \frac{2e'_N}{3h_{ef}})} \leq 1.0$ ; $e'_N = 0 \therefore \psi_{ec,N} = \mathbf{1.0}$	D.5.2.4	-
<b>Step 3c.</b> Calculate $\psi_{ed,N} = 1.0$ if $c_{a,min} \geq 1.5h_{ef}$ ; $\psi_{ed,N} = 0.7 + 0.3 \frac{c_{a,min}}{1.5h_{ef}}$ if $c_{a,min} < 1.5h_{ef}$ $c_{a,min} = 6.0 \text{ in.} \geq 1.5h_{ef} = 3.0 \text{ in.} \therefore \psi_{ed,N} = \mathbf{1.0}$	D.5.2.5	Table 1
<b>Step 3d.</b> Calculate $\psi_{c,N} = \mathbf{1.0}$	D.5.2.6	Table 3
<b>Step 3e.</b> Calculate $\psi_{cp,N} = \mathbf{1.0}$ (cracked concrete)	D.5.2.7	-
<b>Step 3f.</b> Calculate $N_b = k_c \lambda_{\alpha} \sqrt{f'_c} h_{ef}^{1.5} = 21 (1.0) \sqrt{4,000} \cdot 2.0^{1.5} = \mathbf{3,755 \text{ lbs.}}$	D.5.2.2	Table 3
<b>Step 3g.</b> Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = (63.0/36.0) \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 3,755 = 6571 \text{ lbs.}$ Calculate concrete breakout capacity = $\phi N_{cbg} = 0.65 \cdot 6571 = \mathbf{4,270 \text{ lbs.}}$	D.5.2.1 (b)	§4.1.3
<b>Step 4.</b> Calculate nominal pullout strength of a single anchor in tension: $N_{pn} = \psi_{c,p} \cdot N_{pn,f'c}$	D.5.3.1	§4.1.4 Table 3
<b>Step 4a.</b> Calculate $\psi_{c,p} = \mathbf{1.0}$ (cracked concrete)	D.5.3.6	§4.1.10 Table 3
<b>Step 4b.</b> Calculate $N_{pn,f'c} = N_{p,cr} \left( \frac{f'_c}{2500} \right)^{0.5}$ Per Table 3, pullout does not control $\therefore$ do not calculate pullout capacity	D.5.3.2	§4.1.4 Table 3
<b>Step 5.</b> Determine controlling resistance strength of the anchor group in tension: $\phi N_n = \min \{ \phi N_{sag}, \phi N_{cbg}, n \phi N_{pn} \} = \phi N_{cbg} = \mathbf{4,270 \text{ lbs.}}$	D.4.1.1 D.4.1.2	§4.1.1
<b>Step 6.</b> Calculate allowable stress design conversion factor for loading condition: Assume controlling load combination: 1.2D + 1.6L ; 50% Dead Load, 50% Live Load $\alpha = 1.2(50\%) + 1.6(50\%) = \mathbf{1.40}$	9.2	§4.2.1
<b>Step 7.</b> Calculate allowable stress design value: $T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{4,270}{1.40} = \mathbf{3,050 \text{ lbs.}}$	9.2	§4.2.1

FIGURE 8—EXAMPLE STRENGTH DESIGN CALCULATION FOR TENSION CAPACITY FOR POWER-STUD+ SD4

**Given:**

Two 1/2" Power-Stud+ SD4 anchors

Concrete compressive strength:

$$(f'_c) = 4,000 \text{ psi}$$

No supplemental reinforcement:

(Condition B per ACI 318-11 D.4.3 c)

Assume cracked concrete, no seismic, no loading eccentricity and a rigid plate

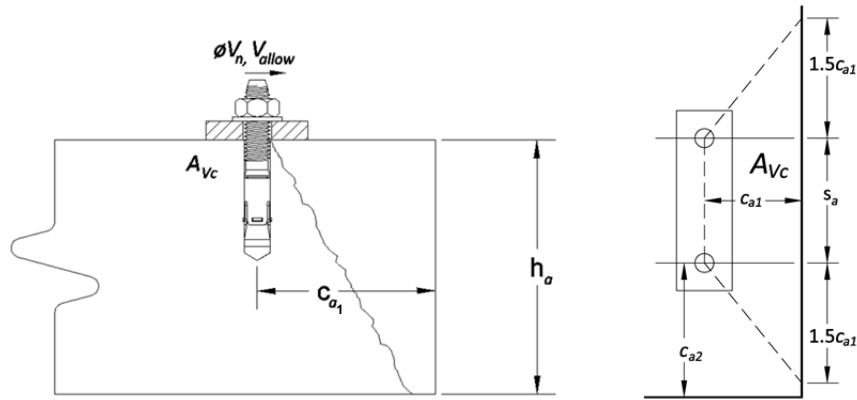
$$h_a = 5.0 \text{ in.}$$

$$h_{ef} = 2.0 \text{ in.}$$

$$s_a = 4.5 \text{ in.}$$

$$c_{a1} = c_{a,min} = 6.0 \text{ in.}$$

$$c_{a2} \geq 1.5c_{a1}$$



Calculate the factored resistance design strength in shear and equivalent allowable stress design load for the configuration.

Calculation in accordance with ACI 318-11 and this report:	Code Ref.	Report Ref.
<b>Step 1.</b> Verify minimum member thickness, spacing and edge distance: $h_a = 5.0 \text{ in.} \geq h_{min} = 4.0 \text{ in.} \therefore \text{OK}$ $s_a = 4.5 \text{ in.} \geq s_{min} = 4.5 \text{ in.} \therefore \text{OK}$ $c_{a,min} = 6.0 \text{ in.} \geq c_{min} = 6.0 \text{ in.} \therefore \text{OK}$	D.8	Table 1
<b>Step 2.</b> Calculate steel strength of anchor group in shear: $V_{sag} = n \cdot V_{sa} = 2 \cdot 3,170 \text{ lbs.} = 6,340 \text{ lbs.}$ Calculate steel capacity: $\phi V_{sag} = 0.65 \cdot 6,340 \text{ lbs.} = \mathbf{4,120 \text{ lbs.}}$	D.6.1.2	§4.1.5 Table 4
<b>Step 3.</b> Calculate concrete breakout strength of anchor group in shear: $V_{cbg} = \frac{A_{vc}}{A_{vc0}} \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_b$	D.6.2.1 (b)	§4.1.6
<b>Step 3a.</b> Calculate $A_{vc0}$ and $A_{vc}$ $A_{vc0} = 4.5 (c_{a1})^2 = 4.5 \cdot (6.0)^2 = \mathbf{162.0 \text{ in.}^2}$ $A_{vc} = (h_a) \cdot (3 c_{a1} + s_a) = (5.0)((3 \cdot 6.0) + 4.5) = \mathbf{112.5 \text{ in.}^2}$	D.6.2.1	Table 1
<b>Step 3b.</b> Calculate $\psi_{ec,v} = \frac{1}{(1 + \frac{2e'_v}{3c_{a1}})} \leq 1.0$ ; $e'_v = 0 \therefore \psi_{ec,v} = \mathbf{1.0}$	D.6.2.5	-
<b>Step 3c.</b> Calculate $\psi_{ed,v} = 1.0$ if $c_{a2} \geq 1.5c_{a1}$ ; $\psi_{ed,v} = 0.7 + 0.3 \frac{c_{a2}}{1.5c_{a1}}$ if $c_{a2} < 1.5c_{a1}$ $c_{a2} \geq 1.5 c_{a1} \therefore \psi_{ed,v} = \mathbf{1.0}$	D.6.2.6	Table 1
<b>Step 3d.</b> Calculate $\psi_{c,v} = \mathbf{1.0}$ (cracked concrete, no supplemental or edge reinforcement)	D.6.2.7	-
<b>Step 3e.</b> Calculate $\psi_{h,v} = \sqrt{\frac{1.5c_{a1}}{h_a}}$ ; for members where $h_a < 1.5c_{a1}$ $h_a = 5.0 < 1.5c_{a1} = 9.0 \therefore \psi_{h,v} = \sqrt{\frac{9.0}{5.0}} = \mathbf{1.34}$	D.6.2.8	-
<b>Step 3f.</b> Calculate $V_b = (7 (\frac{l_e}{d_a})^{0.2} \sqrt{d_a}) \lambda_\alpha \sqrt{f'_c} (c_{a1})^{1.5} = 7 (\frac{2.0}{0.5})^{0.2} \sqrt{0.5} (1.0) \sqrt{4000} (6.0)^{1.5}$ $= \mathbf{6,071 \text{ lbs.}}$	D.6.2.2	Table 4
<b>Step 3g.</b> Calculate concrete breakout strength of anchor group in shear: $V_{cbg} = (112.5/162.0) \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 1.34 \cdot 6,070 = 5,649 \text{ lbs.}$ Calculate concrete breakout capacity = $\phi V_{cbg} = 0.70 \cdot 5,649 = \mathbf{3,955 \text{ lbs.}}$	D.6.2.1 (b)	§4.1.6
<b>Step 4.</b> Calculate nominal pryout strength of an anchor group in shear: $V_{cpg} = k_{cp} N_{cbg} = 1.0 \cdot 7,510 \text{ lbs} = 7,510 \text{ lbs.}$ Calculate pryout capacity: $\phi V_{cpg} = 0.70 \cdot 7,510 \text{ lbs.} = \mathbf{5,257 \text{ lbs.}}$	D.6.3.1 (b)	§4.1.7 Table 4
<b>Step 5.</b> Determine controlling resistance strength in shear: $\phi V_n = \min \{ \phi V_{sag}, \phi V_{cbg}, \phi V_{cpg} \} = \phi V_{cbg} = \mathbf{3,955 \text{ lbs.}}$	D.4.1.1 D.4.1.2	§4.1.1
<b>Step 6.</b> Calculate allowable stress design conversion factor for loading condition: Assume controlling load combination: 1.2D + 1.6L; 50% Dead Load, 50% Live Load $\alpha = 1.2(50\%) + 1.6(50\%) = \mathbf{1.40}$	9.2	§4.2.1
<b>Step 7.</b> Calculate allowable stress design value: $V_{allowable,ASD} = \frac{\phi V_n}{\alpha} = \frac{3,955}{1.40} = \mathbf{2,825}$	9.2	§4.2.1

FIGURE 9—EXAMPLE STRENGTH DESIGN CALCULATION FOR SHEAR CAPACITY FOR POWER-STUD+ SD4

**ICC-ES Evaluation Report****ESR-2502 Supplement\***

Reissued May 2014

This report is subject to renewal May 2015.

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**DIVISION: 03 00 00—CONCRETE****Section: 03 16 00—Concrete Anchors****DIVISION: 05 00 00—METALS****Section: 05 05 19—Post-Installed Concrete Anchors****REPORT HOLDER:**

**POWERS FASTENERS, INC.**  
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(800) 524-3244  
[www.powers.com](http://www.powers.com)  
[engineering@powers.com](mailto:engineering@powers.com)

**EVALUATION SUBJECT:**

**POWERS POWER-STUD™ + SD2 CARBON STEEL ANCHORS, POWER-STUD+ SD4 STAINLESS STEEL ANCHORS AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE**

**1.0 REPORT PURPOSE AND SCOPE****Purpose:**

The purpose of this evaluation report supplement is to indicate that Powers Power-Stud+ SD2 Anchors, Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in Cracked and Uncracked Concrete, recognized in ICC-ES master evaluation report ESR-2502, have also been evaluated for compliance with the codes noted below:

**Compliance with the following codes:**

- 2010 *Florida Building Code—Building*
- 2010 *Florida Building Code—Residential*

**2.0 PURPOSE OF THIS SUPPLEMENT**

The Powers Power-Stud+ SD2 Carbon Steel Anchors, Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the master evaluation report ESR-2502, comply with the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, provided the design and installation are in accordance with the *International Building Code*® (IBC) provisions noted in the master evaluation report and the following conditions apply:

- Design wind loads must be based on Section 1609 of the 2010 *Florida Building Code—Building* or Section 301.2.1.1 of the 2010 *Florida Building Code—Residential*, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the 2010 *Florida Building Code—Building*, as applicable.
- The modifications to ACI 318 as shown in the 2009 IBC Sections 1908.1.9 and 1908.1.10, as noted in 2009 IBC Section 1912.1, do not apply to the 2010 *Florida Building Code*.

Use of the Powers Power-Stud+ SD2 Anchors in cracked and uncracked concrete for compliance with the High-Velocity Hurricane Zone provisions of the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, has not been evaluated, and is outside the scope of this supplemental report.

Use of the Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in cracked and uncracked concrete has also been found to be in compliance with the High-Velocity Hurricane Zone (HVHZ) provisions of the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, provided that the design wind loads for use of the anchors in the HVHZ are based on Section 1620 of the *Florida Building Code—Building*.

For products falling under Florida Rule 9N-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the master report reissued May 2014, revised September 2014.

**\*Revised September 2014**

## Domestic Wedge Anchor

Anchor made in the U.S.A., nut and washer made in Taiwan or China\*  
Carbon Steel and Stainless Steel Wedge Expansion Anchors

### PRODUCT DESCRIPTION

The Domestic Wedge Anchor is a threaded, torque-controlled, carbon steel or stainless steel wedge expansion anchor which is designed for consistent performance in concrete. Suitable base materials are normal-weight and sand-lightweight concrete. The anchor is manufactured with carbon steel body and expansion clip or a stainless steel body and expansion clip. Nut and washer are included.

### GENERAL APPLICATIONS AND USES

- Steel fixtures
- Support connections
- Equipment and railing

### FEATURES AND BENEFITS

- + Anchors made in the U.S.A., nut and washer made in Taiwan or China. (Domestic nut and washer available upon request.)
- + Nominal drill bit size is the same as the anchor diameter
- + Anchor can be installed through standard fixture holes
- + Length ID code and identifying marking stamped on head of each anchor
- + Anchor design allows for follow-up expansion after setting under tensile loading
- + Corrosion resistant stainless steel anchors

### APPROVALS AND LISTINGS

Tested to ASTM E 488

### GUIDE SPECIFICATIONS

**CSI Divisions:** 031600-Concrete Anchors, 05090-Metal Fastenings and 050519 Post-installed concrete anchors. Expansion anchors shall be Domestic Wedge Anchor as supplied by Powers Fasteners, Inc., Brewster, NY. Anchors shall be installed in accordance with published instructions and the Authority Having Jurisdiction.

### MATERIAL SPECIFICATIONS

Anchor component	Specification		
	Carbon Steel <sup>1</sup>	Type 303	Type 316
Anchor body	AISI C12L14	Type 303 Stainless Steel	Type 316 Stainless Steel
Washer	AISI C1010-1018	300 Series Stainless Steel	Type 316 Stainless Steel
Hex Nut	Low Carbon Steel, ASTM A563, Grade A	Type 18-8	Type 316 Stainless Steel
Expansion wedge (clip)	AISI C1010-1018 1037	Type 18-8	Type 316 Stainless Steel

1. Plated with Commercial Bright Zinc and supplementary chromate treatment in accordance with ASTM B 633, SC1 Type III.  
\* Domestic nut and washer available upon request.

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Installation Specifications.....	2
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Ordering Information .....	5



Domestic Wedge Anchor Assembly

### THREAD VERSION

UNC threaded stud

### ANCHOR MATERIALS

Carbon Steel, Type 303 Stainless Steel, or Type 316 Stainless Steel

### ANCHOR SIZE RANGE (TYP.)

1/4" diameter through 1-1/4" diameter

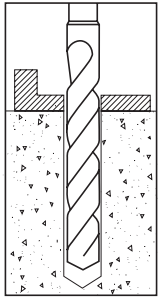
### SUITABLE BASE MATERIALS

Normal-weight concrete  
Sand-lightweight concrete

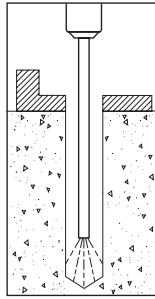


**INSTALLATION INSTRUCTIONS**

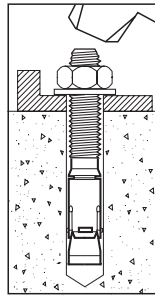
**Installation Instructions for Domestic Wedge Anchor**



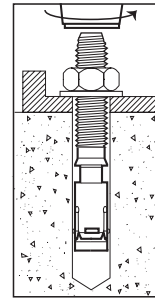
1.) Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.



2.) Remove dust and debris from the hole using a hand pump, compressed air or a vacuum to remove loose particles left from drilling.



3.) Position the supplied washer on the anchor and thread on the supplied nut. If installing through a fixture, drive the anchor through the fixture into the hole. Be sure the anchor is driven to the minimum required embedment depth.



4.) Tighten the anchor with a torque wrench by applying the required installation torque,  $T_{inst}$ .

**Installation Table for Domestic Wedge Anchor**

Anchor Property/ Setting Information	Notation	Units	Nominal Anchor Diameter (inch)							
			1/4	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Anchor outside diameter	$d$	in. (mm)	0.25 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Nominal drill bit diameter	$d_{bit}$	in.	1/4 ANSI	3/8 ANSI	1/2 ANSI	5/8 ANSI	3/4 ANSI	7/8 ANSI	1 ANSI	1-1/4 ANSI
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)	9/16 (14.3)	11/16 (17.5)	13/16 (20.6)	15/16 (23.8)	1-1/8 (28.6)	1-3/8 (34.9)
Minimum nominal embedment depth	$h_{nom}$	in. (mm)	1-1/8 (28.6)	1-1/2 (38.1)	2-1/4 (57.2)	2-3/4 (69.9)	3-1/4 (82.6)	3-7/8 (98.4)	4-1/2 (114.3)	5-1/2 (139.7)
Minimum hole depth	$h_o$	in. (mm)	1-3/8 (34.9)	1-7/8 (47.6)	2-3/4 (69.9)	3-1/4 (82.6)	3-3/4 (95.3)	4-3/8 (111.1)	5 (127.0)	6 (152.4)
Minimum member thickness	$h_{min}$	in. (mm)	3 (76.2)	3 (76.2)	3-3/8 (85.7)	4-1/8 (104.8)	4-7/8 (123.8)	5-13/16 (147.6)	6-3/4 (171.5)	8-1/4 (209.6)
Installation torque	$T_{inst}$	ft.-lbf. (N-m)	5-10 (6.8-13.6)	25-30 (33.9-40.7)	50-60 (67.8-81.4)	75-90 (102-122)	150-175 (203-237)	200-250 (271-339)	250-300 (339-407)	400-450 (542-610)
Torque wrench/socket size	-	in.	7/16	9/16	3/4	15/16	1-1/8	1-5/16	1-1/2	1-7/8
Nut height	-	in.	7/32	21/64	7/16	35/64	41/64	3/4	55/64	1-1/16

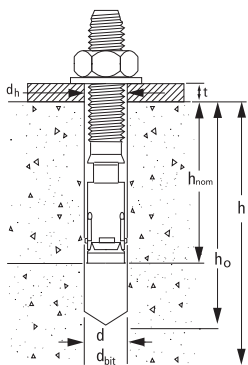
For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

**Length Identification**

Mark	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
From	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"
Up to but not including	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"	12"

Length identification mark indicates overall length of anchor.

**Installation Detail**



**Nomenclature**

- $d$  = Diameter of anchor
- $d_{bit}$  = Diameter of drill bit
- $d_h$  = Diameter of fixture clearance hole
- $h$  = Base material thickness  
The minimum value of  $h$  should be  $1.5h_{nom}$  or 3" whichever is greater
- $h_{nom}$  = Minimum nominal embedment
- $t$  = Fixture thickness
- $h_o$  = Minimum hole depth



**REFERENCE PERFORMANCE DATA**

**Ultimate Load Capacities for Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2</sup>**

Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)
1/4	1-1/8	1,170	1,445	1,770	1,815	2,775	2,635
	1-3/4	1,840		2,410		2,775	
	2-3/4	1,975		2,750		2,830	
3/8	1-1/2	1,630	4,320	3,640	5,120	4,450	6,235
	3	3,230		5,655		5,975	
	5	4,075		6,330		6,360	
1/2	2-1/4	4,000	7,420	6,715	9,380	9,615	9,890
	4	6,335		8,945		10,190	
	6	6,900		10,175		12,065	
5/8	2-3/4	5,000	8,265	8,750	12,930	9,760	16,375
	5	8,855		15,590		16,800	
	7	9,380		16,710		17,735	
3/4	3-1/4	6,640	12,505	11,315	17,050	16,230	22,965
	6	10,085		18,410		21,095	
	8	11,170		19,805		22,525	
7/8	3-7/8	8,395	18,250	16,355	20,235	16,800	23,980
	5-3/4	12,065		18,250		23,405	
1	4-1/2	9,775	23,620	18,250	27,605	27,460	28,910
	7-1/2	11,890		26,725		34,960	
	10	15,590		30,490		37,840	
1-1/4	5-1/2	17,550	32,275	22,970	42,690	32,370	55,565
	7	21,050		27,845		48,365	
	10	27,895		34,790		61,270	

1. Tabulated load values are for anchors installed in uncracked concrete with no edge or spacing considerations. Concrete compressive strength must be at the specified minimum at the time of installation.

2. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working loads.

**REFERENCE PERFORMANCE DATA**

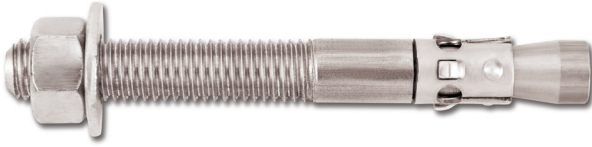
**Allowable Load Capacities for Carbon Steel and Stainless Steel Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2,3</sup>**



Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)
1/4	1-1/8	295	360	445	455	695	660
	1-3/4	460		600		695	
	2-3/4	495		690		710	
3/8	1-1/2	410	1,080	910	1,280	1,115	1,560
	3	810		1,415		1,495	
	5	1,020		1,580		1,590	
1/2	2-1/4	1,000	1,855	1,680	2,345	2,405	2,475
	4	1,585		2,235		2,550	
	6	1,725		2,545		3,015	
5/8	2-3/4	1,250	2,065	2,190	3,235	2,440	4,095
	5	2,215		3,900		4,200	
	7	2,345		4,180		4,435	
3/4	3-1/4	1,660	3,125	2,830	4,265	4,060	5,740
	6	2,520		4,600		5,275	
	8	2,795		4,950		5,630	
7/8	3-7/8	2,100	4,565	4,090	5,060	4,200	5,995
	5-3/4	3,015		4,565		5,850	
1	4-1/2	2,445	5,905	4,565	6,900	6,865	7,230
	7-1/2	2,975		6,685		8,740	
	10	3,900		7,625		9,460	
1-1/4	5-1/2	4,390	8,070	5,745	10,675	8,095	13,890
	7	5,265		6,960		12,095	
	10	6,975		8,700		15,320	

1. Tabulated load values are for anchors installed in uncracked concrete. Concrete compressive strength must be at the specified minimum at the time of installation.  
 2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.

**ORDERING INFORMATION**



**Domestic Wedge Anchor (Carbon Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7400USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7402USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7404USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7410USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7412USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7413USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7414USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7415USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7416USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7417USA	3/8" x 6-1/2"	1-1/2"	1-1/8"	50	200
7420USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7422USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7423USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7424USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7426USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7427USA	1/2" x 8-1/2"	2-1/4"	1-1/4"	25	100
7428USA	1/2" x 10"	2-1/4"	1-1/4"	25	100
7429USA	1/2" x 12"	2-1/4"	1-1/4"	25	100
7430USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7432USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7433USA	5/8" x 5"	2-3/4"	2"	25	100
7434USA	5/8" x 6"	2-3/4"	2"	25	75
7436USA	5/8" x 7"	2-3/4"	2"	25	75
7438USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7439USA	5/8" x 10"	2-3/4"	2"	25	75
7437USA	5/8" x 12"	2-3/4"	2"	25	75
7440USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7441USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7442USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7444USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7446USA	3/4" x 7"	3-1/4"	2"	20	60
7448USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7449USA	3/4" x 10"	3-1/4"	2"	10	30
7451USA	3/4" x 12"	3-1/4"	2"	10	30
7461USA	1" x 6"	4-1/2"	2-1/4"	10	40
7463USA	1" x 9"	4-1/2"	2-1/4"	10	30
7465USA	1" x 12"	4-1/2"	2-1/4"	5	15
7475USA	1-1/4" x 12"	5-1/2"	3-1/4"	5	15

**Installation Accessories**

Cat. No.	Description	Box Qty
08466	Adjustable torque wrench with 1/2" square drive (25 to 250 ft.-lbs.)	1
08280	Hand pump / dust blower	1

The published size includes the diameter and the overall length of the anchor. All anchors are packaged with nuts and washers.

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**Domestic Wedge Anchor (Type 303 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7300USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7302USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7304USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7310USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7312USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7313USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7314USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7315USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7316USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7320USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7323USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7324USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7326USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7330USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7332USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7333USA	5/8" x 5"	2-3/4"	2"	25	100
7334USA	5/8" x 6"	2-3/4"	2"	25	75
7336USA	5/8" x 7"	2-3/4"	2"	25	75
7338USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7340USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7341USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7342USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7344USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7346USA	3/4" x 7"	3-1/4"	2"	20	60
7348USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7349USA	3/4" x 10"	3-1/4"	2"	10	30

**Domestic Wedge Anchor (Type 316 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7600USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7602USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7604USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7610USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7612USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7613USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7614USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7615USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7616USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7620USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7622USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7623USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7624USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7626USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7630USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7632USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7633USA	5/8" x 5"	2-3/4"	2"	25	100
7634USA	5/8" x 6"	2-3/4"	2"	25	75
7636USA	5/8" x 7"	2-3/4"	2"	25	75
7638USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7640USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7641USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7642USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7644USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7646USA	3/4" x 7"	3-1/4"	2"	20	60
7648USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7652USA	7/8" x 8"	3-7/8"	2-1/4"	10	40
7663USA	1" x 9"	4-1/2"	2-1/4"	10	30

## Smart DI+ Internally Threaded Expansion Anchor

### PRODUCT DESCRIPTION

The Smart DI+ is an all-steel, machine bolt anchor available in carbon steel. It can be used in solid concrete, hard stone, and solid block base materials. The Smart DI+ is specifically designed to be easier to fully set during installation as a benefit to the user.

### GENERAL APPLICATIONS AND USES

- Suspending Conduit
- Cable Trays and Strut
- Pipe Supports
- Fire Sprinkler
- Concrete Formwork
- Suspended Lighting

### FEATURES AND BENEFITS

- + Installs with reduced effort compared to traditional drop in style anchors.
- + Can be installed using the Powers manual setting tool or Powers Smart DI+ System with a hammer-drill
- + Setting indicator makes identification of properly set anchors easy (when installed using the Smart Tool and Smart Bit).
- + Internally threaded anchor for easy bolt removability and service work

### TESTING, APPROVALS AND LISTINGS

FM Global (Factory Mutual) - Report No. 3040746 (see ordering information)  
Underwriters Laboratory (UL Listed) – File No. EX1289 (N) (see ordering information)

### GUIDE SPECIFICATIONS

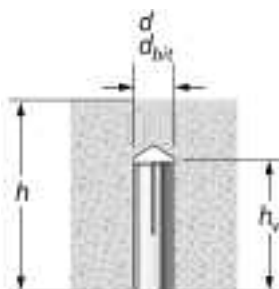
**CSI Divisions: 03151-Concrete Anchoring and 05090-Metal Fastenings.** Dropin anchors shall be Smart DI+ as supplied by Powers Fasteners, Inc., Brewster, NY.

### MATERIAL SPECIFICATIONS

Anchor Component	Carbon Steel
Anchor Body	AISI 1008
Plug	AISI 1008
Zinc Plating	ASTM B633,SC1, Type III (Fe/Zn 5)

### INSTALLATION SPECIFICATIONS

Anchor (Rod) Size	Rod/Anchor Diameter				
	1/4"	3/8"	1/2"	5/8"	3/4"
Nominal Outside Diameter $d$ (in.)	0.375	0.500	0.625	0.875	1.000
ANSI Drill Bit Size, $d_{bit}$ (in.)	3/8	1/2	5/8	7/8	1
Maximum Tightening Torque, $T_{max}$ (ft.-lbs.)	5	10	20	40	80
Thread Size (UNC)	1/4-20	3/8-16	1/2-13	5/8-11	3/4-10
Thread Depth (in.)	7/16	5/8	13/16	1 3/16	1 3/8
Anchor Length $l$ , $h_v$ (in.)	1	1 9/16	2	2 1/2	3 3/16



#### Nomenclature

- $d$  = Diameter of anchor
- $d_{bit}$  = Diameter of drill bit
- $h$  = Base material thickness.  
The minimum value of  $h$  should be  $1.5h_v$  or 3" min. (whichever is greater)
- $h_v$  = Minimum embedment depth
- $l$  = Overall length of anchor

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Smart DI+

### THREAD VERSION

Coarse (UNC)

### ANCHOR MATERIALS

Zinc Plated Carbon Steel

### ROD/ANCHOR SIZE RANGE (TYP.)

1/4" to 3/4" diameter  
(UNC)

### SUITABLE BASE MATERIALS

Normal-weight Concrete

### STANDARD DROP-IN



### SMART DI+ DROP-IN



Anchor prior to installation



When properly set, anchor indicator will leave blue paint in recessed cavities.  
**Note:** Blue does not have to be removed from all four top surfaces to be fully set.

- Easier to Set
- More Expansion
- Expansion Indicator with a Smart DI+ System

**PERFORMANCE DATA**
**Ultimate Load Capacities for Smart DI+™ Anchor (Drop-In) in Normal-Weight Concrete<sup>1,2</sup>**

Nominal Anchor Diameter d in.	Minimum Embedment Depth in.	Minimum Concrete Compressive Strength - f'c (psi)							
		2,500		3,000		4,000		6,000	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
1/4	1	1,300	2,495	1,390	2,510	1,565	2,550	1,910	2,620
3/8	1 9/16	1,985	4,160	2,275	4,360	2,850	4,755	4,000	5,550
1/2	2	3,630	7,170	3,815	7,280	4,190	7,505	4,935	7,955
5/8	2 1/2	5,765	9,850	6,290	10,805	7,335	12,710	9,430	16,525
3/4	3 3/16	6,200	16,110	7,320	16,730	9,565	17,975	14,045	20,460

1. Tabulated load values are for anchors installed in concrete. Concrete compressive strength must be at the specified minimum at the time of installation.
2. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working load.

**Allowable Load Capacities for Smart DI+™ Anchor (Drop-In) in Normal-Weight Concrete<sup>1,2,3</sup>**

Nominal Anchor Diameter d in.	Minimum Embedment Depth in.	Minimum Concrete Compressive Strength - f'c (psi)							
		2,500		3,000		4,000		6,000	
		Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)	Tension (lbs.)	Shear (lbs.)
1/4	1	325	623	347	627	391	637	477	655
3/8	1 9/16	496	1,040	568	1,090	712	1,188	1,000	1,387
1/2	2	907	1,792	953	1,820	1,047	1,876	1,233	1,988
5/8	2 1/2	1,441	2,462	1,572	2,701	1,833	3,177	2,357	4,131
3/4	3 3/16	1,550	4,027	1,830	4,182	2,391	4,493	3,511	5,115

1. Allowable load capacities listed are calculated using and applied safety factor of 4.0.
2. Linear interpolation may be used to determine allowable loads for intermediate compressive strengths.
3. Allowable load capacities are multiplied by reduction factors found in the Design Criteria section when anchor spacing or edge distances are less than critical distances.

**DESIGN CRITERIA (ALLOWABLE STRESS DESIGN)**
**Combined Loading**

For anchors loaded in both shear and tension, the combination of loads should be proportioned as follows:

$$\left(\frac{N_u}{N_n}\right)^{\frac{5}{3}} + \left(\frac{V_u}{V_n}\right)^{\frac{5}{3}} \leq 1 \quad \text{or} \quad \left(\frac{N_u}{N_n}\right) + \left(\frac{V_u}{V_n}\right) \leq 1$$

Where:  $N_u$  = Applied Service Tension Load  
 $N_n$  = Allowable Tension Load  
 $V_u$  = Applied Service Shear Load  
 $V_n$  = Allowable Shear Load

**Load Adjustment Factors for Spacing and Edge Distances<sup>1</sup>**

NOTE: Allowable load values found in the performance data tables are multiplied by reduction factors when anchor spacing or edge distances are less than critical distances. Linear interpolation is allowed for intermediate anchor spacing and edge distances between critical and minimum distances. When an anchor is affected by both reduced spacing and edge distance, the spacing and edge reduction factors must be combined (multiplied). Multiple reduction factors for anchor spacing and edge distance may be required depending on the anchor group configuration.

**Steel Dropin™** Internally Threaded Expansion Anchor

**PRODUCT DESCRIPTION**

The Steel Dropin is an all-steel, machine bolt anchor available in carbon steel and two types of stainless steel. It can be used in solid concrete, hard stone, and solid block base materials. A coil thread version for forming applications is also available.

**GENERAL APPLICATIONS AND USES**

- Suspending Conduit
- Cable Trays and Strut
- Pipe Supports
- Fire Sprinkler
- Concrete Formwork
- Suspended Lighting

**FEATURES AND BENEFITS**

- + Internally threaded anchor for easy bolt removability and service work
- + Flanged (lipped) version installs flush for easy inspection and standard embedment
- + Smooth wall dropin can be installed flush mounted or below the base material surface
- + Optionally available with a knurled body
- + Coil thread version accepts coil rod and typically used for concrete formwork applications

**TESTING, APPROVALS AND LISTINGS**

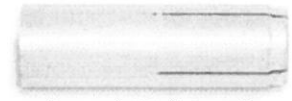
Tested in accordance with ASTM 488 and AC01 criteria  
 FM Global (Factory Mutual) - File No. J.I. OK4A9.AH (see ordering information)  
 Underwriters Laboratory (UL Listed) – File No. EX1289 (N) (see ordering information)  
 CalTrans listing for “Shell Mechanical Expansion Anchors”

**GUIDE SPECIFICATIONS**

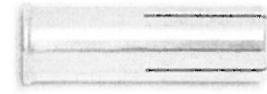
**CSI Divisions:** 03151-Concrete Anchoring and 05090-Metal Fastenings. Dropin anchors shall be Steel Dropin as supplied by Powers Fasteners, Inc., Brewster, NY.

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Smooth Wall Dropin



Flange (Lipped) Dropin

**THREAD VERSION**

- UNC Coarse Thread
- Coil Thread

**ANCHOR MATERIALS**

- Zinc Plated Carbon Steel
- 303 Stainless Steel
- 316 Stainless Steel

**ROD/ANCHOR SIZE RANGE (TYP.)**

- 1/4" to 3/4" diameter UNC Coarse Thread
- 1/2" and 3/4" diameter Coil Thread

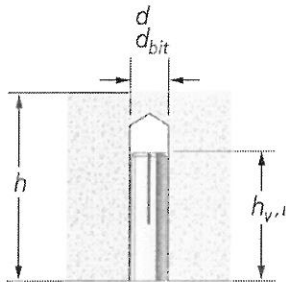
**SUITABLE BASE MATERIALS**

- Normal-weight Concrete
- Structural Lightweight Concrete



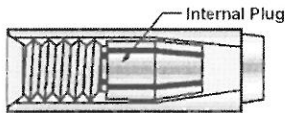
**INSTALLATION SPECIFICATIONS**

Anchor (Rod) Size	Rod/Anchor Diameter, <i>d</i>						
	1/4"	3/8"	1/2"	1/2" Coil Thread	5/8"	3/4"	3/4" Coil Thread
ANSI Drill Bit Size, <i>d<sub>bit</sub></i> (in.)	3/8	1/2	5/8	5/8	7/8	1	1
Maximum Tightening Torque, <i>T<sub>max</sub></i> (ft.-lbs.)	5	10	20	20	40	80	80
Thread Size (UNC)	1/4-20	3/8-16	1/2-13	1/2-6	5/8-11	3/4-10	3/4-4 1/2
Thread Depth (in.)	7/16	5/8	13/16	13/16	1 3/16	1 3/8	1 3/8
Flange Size (in.)	7/16	9/16	45/64	—	—	—	—
Anchor Length <i>l</i> , <i>h<sub>v</sub></i> (in.)	1	1 9/16	2	2	2 1/2	3 3/16	3 3/16



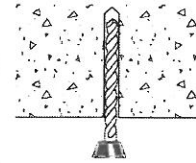
**Nomenclature**

- d* = Diameter of anchor
- d<sub>bit</sub>* = Diameter of drill bit
- h* = Base material thickness.  
The minimum value of *h* should be 1.5*h<sub>v</sub>* or 3" min. (whichever is greater)
- h<sub>v</sub>* = Minimum embedment depth
- l* = Overall length of anchor
- T<sub>max</sub>* = Maximum tightening torque

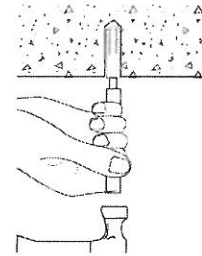


**Installation Procedure**

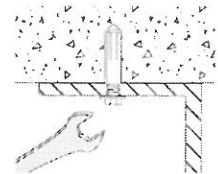
Drill a hole into the base material to the depth of embedment required. The tolerances of the drill bit used must meet the requirements of ANSI Standard B212.15. Do not over drill the hole unless the application calls for a subset anchor.



Blow the hole clean of dust and other materials. Insert the anchor into the hole and tap flush with surface. *Using a Powers setting tool specifically, set the anchor by driving the tool with a sufficient number of hammer blows until the shoulder of the tool is seated against the anchor.* Anchor will not hold allowable loads required if shoulder of Powers setting tool does not seat against anchor.



If using a fixture, position it, insert bolt and tighten. Most overhead applications utilize threaded rod. Minimum thread engagement should be at least one anchor diameter.



**MATERIAL SPECIFICATIONS**

Anchor Component	Carbon Steel	Type 303 Stainless Steel	Type 316 Stainless Steel
Anchor Body	AISI 1008	Type 303 Stainless Steel	Type 316 Stainless Steel
Plug	AISI 1018	Type 303 Stainless Steel	Type 316 Stainless Steel
Zinc Plating	ASTM B633, SC1, Type III (Fe/Zn 5)		N/A

Stainless steel anchor components are passivated.

**PERFORMANCE DATA**

**Ultimate Load Capacities for Steel Dropin in Normal-Weight Concrete<sup>1,2,3</sup>**

Rod/Anchor Diameter <i>d</i> in. (mm)	Minimum Embedment Depth <i>h<sub>v</sub></i> in. (mm)	Minimum Concrete Compressive Strength ( <i>f<sub>c</sub></i> )					
		2,000 psi (13.8 MPa)		4,000 psi (27.6 MPa)		6,000 psi (41.4 MPa)	
		Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)
1/4 (6.4)	1 (25.4)	1,140 (5.1)	2,120 (9.5)	1,985 (8.9)	2,120 (9.5)	2,080 (9.4)	2,120 (9.5)
3/8 (9.5)	1 9/16 (39.7)	2,180 (9.8)	4,585 (20.6)	4,180 (18.8)	4,585 (20.6)	4,950 (22.3)	4,585 (20.6)
1/2 (12.7)	2 (50.8)	4,105 (18.5)	6,400 (28.8)	5,760 (25.9)	6,400 (28.8)	6,585 (29.6)	6,400 (28.8)
5/8 (15.9)	2 1/2 (63.5)	4,665 (21.0)	12,380 (55.7)	7,440 (33.5)	12,380 (55.7)	10,920 (49.1)	12,380 (55.7)
3/4 (19.1)	3 3/16 (81.0)	8,580 (38.6)	15,680 (70.6)	9,405 (41.8)	15,680 (70.6)	11,300 (50.3)	15,680 (70.6)

1. Tabulated load values are applicable to carbon and stainless steel anchors.
2. Tabulated load values are for anchors installed in concrete. Concrete compressive strength must be at the specified minimum at the time of installation.
3. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working load.

**Allowable Load Capacities for Steel Dropin in Normal-Weight Concrete<sup>1,2,3,4</sup>**

Rod/Anchor Diameter <i>d</i> in. (mm)	Minimum Embedment Depth <i>h<sub>v</sub></i> in. (mm)	Minimum Concrete Compressive Strength ( <i>f<sub>c</sub></i> )					
		2,000 psi (13.8 MPa)		4,000 psi (27.6 MPa)		6,000 psi (41.4 MPa)	
		Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)
1/4 (6.4)	1 (25.4)	285 (1.3)	530 (2.4)	495 (2.2)	530 (2.4)	520 (2.3)	530 (2.4)
3/8 (9.5)	1 9/16 (39.7)	545 (2.5)	1,145 (5.2)	1,045 (4.7)	1,145 (5.2)	1,240 (5.6)	1,145 (5.2)
1/2 (12.7)	2 (50.8)	1,025 (4.6)	1,600 (7.2)	1,440 (6.5)	1,600 (7.2)	1,645 (7.4)	1,600 (7.2)
5/8 (15.9)	2 1/2 (63.5)	1,165 (5.2)	3,095 (13.9)	1,860 (8.4)	3,095 (13.9)	2,730 (12.3)	3,095 (13.9)
3/4 (19.1)	3 3/16 (81.0)	2,145 (9.7)	3,920 (17.6)	2,350 (10.5)	3,920 (17.6)	2,825 (12.6)	3,920 (17.6)

1. Tabulated load values are applicable to carbon and stainless steel anchors.
2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.
3. Linear interpolation may be used to determine allowable loads for intermediate compressive strengths.
4. Allowable load capacities are multiplied by reduction factors found in the Design Criteria section when anchor spacing or edge distances are less than critical distances.

**Ultimate Load Capacities for Steel Dropin in Structural Lightweight Concrete<sup>1,2,3</sup>**

Rod/Anchor Diameter <i>d</i> in. (mm)	Minimum Embedment Depth <i>h<sub>v</sub></i> in. (mm)	Minimum Concrete Compressive Strength ( <i>f<sub>c</sub></i> )					
		2,000 psi (13.8 MPa)		4,000 psi (27.6 MPa)		6,000 psi (41.4 MPa)	
		Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)
1/4 (6.4)	1 (25.4)	1,060 (4.8)	1,920 (8.6)	1,360 (6.1)	1,920 (8.6)	1,660 (7.5)	1,920 (8.6)
3/8 (9.5)	1 9/16 (39.7)	3,040 (13.7)	4,120 (18.5)	3,780 (17.0)	4,120 (18.5)	4,520 (20.3)	4,120 (18.5)
1/2 (12.7)	2 (50.8)	4,240 (19.1)	5,680 (25.6)	4,840 (21.8)	5,680 (25.6)	5,460 (24.6)	5,680 (25.6)
5/8 (15.9)	2 1/2 (63.5)	6,860 (30.9)	9,640 (43.4)	7,840 (35.3)	9,640 (43.4)	8,840 (39.8)	9,640 (43.4)
3/4 (19.1)	3 3/16 (81.0)	10,280 (46.3)	15,680 (70.6)	11,700 (52.7)	15,680 (70.6)	13,120 (59.0)	15,680 (70.6)

1. Tabulated load values are applicable to carbon and stainless steel anchors.
2. Tabulated load values are for anchors installed in sand-lightweight concrete. Concrete compressive strength must be at the specified minimum at the time of installation.
3. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working load.



**PERFORMANCE DATA**

**Allowable Load Capacities for Steel Dropin in Structural Lightweight Concrete<sup>1,2,3,4</sup>**

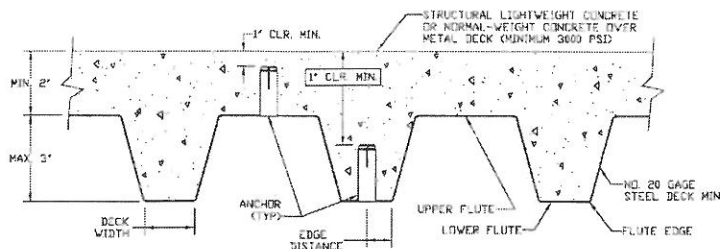
Rod/Anchor Diameter <i>d</i> in. (mm)	Minimum Embedment Depth <i>h<sub>v</sub></i> in. (mm)	Minimum Concrete Compressive Strength ( <i>f'<sub>c</sub></i> )					
		3,000 psi (20.7 MPa)		4,000 psi (27.6 MPa)		5,000 psi (34.5 MPa)	
		Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)
1/4 (6.4)	1 (25.4)	265 (1.2)	480 (2.2)	340 (1.5)	480 (2.2)	415 (1.9)	480 (2.2)
3/8 (9.5)	1 9/16 (39.7)	760 (3.4)	1,030 (4.6)	945 (4.3)	1,030 (4.6)	1,130 (5.1)	1,030 (4.6)
1/2 (12.7)	2 (50.8)	1,060 (4.8)	1,420 (6.4)	1,210 (5.4)	1,420 (6.4)	1,365 (6.1)	1,420 (6.4)
5/8 (15.9)	2 1/2 (63.5)	1,715 (7.7)	2,410 (10.8)	1,960 (8.8)	2,410 (10.8)	2,210 (9.9)	2,410 (10.8)
3/4 (19.1)	3 3/16 (81.0)	2,145 (9.7)	3,920 (17.6)	2,350 (10.5)	3,920 (17.6)	2,825 (12.6)	3,920 (17.6)

1. Tabulated load values are applicable to carbon and stainless steel anchors.
2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.
3. Linear interpolation may be used to determine allowable loads for intermediate compressive strengths.
4. Allowable load capacities are multiplied by reduction factors found in the Design Criteria section when anchor spacing or edge distances are less than critical distances.

**Ultimate and Allowable Load Capacities for Steel Dropin Installed Through Metal Deck into Structural Lightweight Concrete<sup>1,2,3,4,5</sup>**

Rod/Anchor Diameter <i>d</i> in. (mm)	Minimum Embedment Depth <i>h<sub>v</sub></i> in. (mm)	Lightweight Concrete over Metal Deck, <i>f'<sub>c</sub></i> ≥ 3,000 (20.7 MPa)							
		Minimum 1-1/2" Wide Deck				Minimum 4-1/2" Wide Deck			
		Ultimate Load		Allowable Load		Ultimate Load		Allowable Load	
		Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)	Tension lbs. (kN)	Shear lbs. (kN)
1/4 (6.4)	1 (25.4)	400 (1.8)	2,040 (9.2)	100 (0.4)	510 (2.3)	760 (3.4)	2,040 (9.2)	190 (0.8)	510 (2.3)
3/8 (9.5)	1 9/16 (39.7)	600 (2.7)	2,760 (12.3)	150 (0.7)	690 (3.1)	960 (4.3)	2,760 (12.3)	240 (1.1)	690 (3.1)
1/2 (12.7)	2 (50.8)	-	-	-	-	2,740 (12.3)	5,560 (25.0)	685 (3.1)	1,390 (6.3)

1. Tabulated load values are for carbon steel and stainless steel anchors installed in sand-lightweight concrete over steel deck. Concrete compressive strength must be at the specified minimum at the time of installation.
2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.
3. Tabulated load values are for anchors installed in the center of the flute. Spacing distances shall be in accordance with the spacing table for lightweight concrete listed in the Design Criteria.
4. Flute edge distance equals one-half the minimum deck width.
5. Anchors are permitted to be installed in the lower or upper flute of the metal deck provided the proper installation procedures are maintained.



**DESIGN CRITERIA (ALLOWABLE STRESS DESIGN)**

**Combined Loading**

For anchors loaded in both shear and tension, the combination of loads should be proportioned as follows:

$$\left(\frac{N_u}{N_n}\right)^{\frac{5}{3}} + \left(\frac{V_u}{V_n}\right)^{\frac{5}{3}} \leq 1 \quad \text{or} \quad \left(\frac{N_u}{N_n}\right) + \left(\frac{V_u}{V_n}\right) \leq 1$$

Where:  $N_u$  = Applied Service Tension Load  
 $N_n$  = Allowable Tension Load  
 $V_u$  = Applied Service Shear Load  
 $V_n$  = Allowable Shear Load

**Load Adjustment Factors for Spacing and Edge Distances<sup>1</sup>**

Anchor Installed in Normal-Weight Concrete					
Anchor Dimension	Load Type	Critical Distance (Full Anchor Capacity)	Critical Load Factor	Minimum Distance (Reduced Capacity)	Minimum Load Factor
Spacing ( <i>s</i> )	Tension and Shear	$s_{cr} = 3.0h_v$	$F_{N_S} = F_{V_S} = 1.0$	$s_{min} = 1.5h_v$	$F_{N_S} = F_{V_S} = 0.50$
Edge Distance ( <i>c</i> )	Tension	$c_{cr} = 14d$	$F_{N_C} = 1.0$	$c_{min} = 7d$	$F_{N_C} = 0.90$
	Shear	$c_{cr} = 14d$	$F_{V_C} = 1.0$	$c_{min} = 7d$	$F_{V_C} = 0.50$

Anchor Installed in Lightweight Concrete					
Anchor Dimension	Load Type	Critical Distance (Full Anchor Capacity)	Critical Load Factor	Minimum Distance (Reduced Capacity)	Minimum Load Factor
Spacing ( <i>s</i> )	Tension and Shear	$s_{cr} = 3.0h_v$	$F_{N_S} = F_{V_S} = 1.0$	$s_{min} = 1.5h_v$	$F_{N_S} = F_{V_S} = 0.50$
Edge Distance ( <i>c</i> )	Tension	$c_{cr} = 14d$	$F_{N_C} = 1.0$	$c_{min} = 7d$	$F_{N_C} = 0.80$
	Shear	$c_{cr} = 14d$	$F_{V_C} = 1.0$	$c_{min} = 7d$	$F_{V_C} = 0.50$

1. Allowable load values found in the performance data tables are multiplied by reduction factors when anchor spacing or edge distances are less than critical distances. Linear interpolation is allowed for intermediate anchor spacing and edge distances between critical and minimum distances. When an anchor is affected by both reduced spacing and edge distance, the spacing and edge reduction factors must be combined (multiplied). Multiple reduction factors for anchor spacing and edge distance may be required depending on the anchor group configuration.

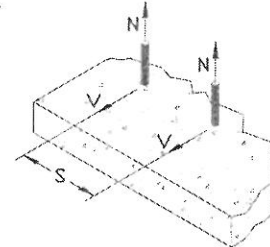


**DESIGN CRITERIA (ALLOWABLE STRESS DESIGN)**

**Load Adjustment Factors for Normal-Weight and Lightweight Concrete**

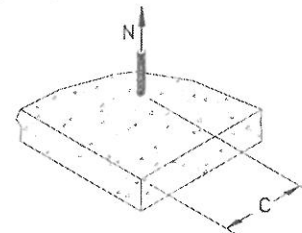
Spacing, Tension ( $F_{NS}$ ) & Shear ( $F_{VS}$ )					
Dia. (in.)	1/4	3/8	1/2	5/8	3/4
$h_v$ (in.)	1	1 1/2	2	2 1/2	3
$S_{cr}$ (in.)	3	4 1/2	6	7 1/2	9
$S_{min}$ (in.)	1 1/2	2 1/4	3	3 3/4	4 1/2
Spacing, $s$ (inches)	1 1/2	0.50			
	2 1/4	0.75	0.50		
	3	1.00	0.67	0.50	
	3 3/4		0.83	0.63	0.50
	4		0.89	0.67	0.53
	4 1/2		1.000	0.75	0.60
	5			0.83	0.67
	6			1.00	0.80
	7 1/2				1.00
9					1.00

Notes: For anchors loaded in tension and shear, the critical spacing ( $S_{cr}$ ) is equal to 3 embedment depths ( $3h_v$ ) at which the anchor achieves 100% of load. Minimum spacing ( $S_{min}$ ) is equal to 1.5 embedment depths ( $1.5h_v$ ) at which the anchor achieves 50% of load.



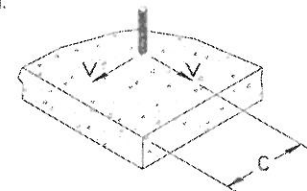
Edge Distance, Tension ( $F_{NC}$ ) (Normal-Weight concrete only)					
Dia. (in.)	1/4	3/8	1/2	5/8	3/4
$C_{cr}$ (in.)	3 1/2	5 1/4	7	8 3/4	10 1/2
$C_{min}$ (in.)	1 3/4	2 5/8	3 1/2	4 3/8	5 1/4
Edge Distance, $c$ (inches)	1 3/4	0.90			
	2	0.91			
	2 5/8	0.95	0.90		
	3	0.97	0.91		
	3 1/2	1.00	0.93	0.90	
	4 3/8		0.97	0.93	0.90
	5 1/4		1.00	0.95	0.92
	6			0.97	0.94
	7			1.00	0.96
	8				0.98
	8 3/4				1.00
10 1/2					1.00

Notes: For anchors loaded in tension, the critical edge distance ( $C_{cr}$ ) is equal to 14 anchor diameters ( $14d$ ) at which the anchor achieves 100% of load. Minimum edge distance ( $C_{min}$ ) is equal to 7 anchor diameters ( $7d$ ) at which the anchor achieves 90% of load for normal-weight concrete and 80% of load for lightweight concrete.



Edge Distance, Tension ( $F_{NC}$ ) (Lightweight concrete only)					
Dia. (in.)	1/4	3/8	1/2	5/8	3/4
$C_{cr}$ (in.)	3 1/2	5 1/4	7	8 3/4	10 1/2
$C_{min}$ (in.)	1 3/4	2 5/8	3 1/2	4 3/8	5 1/4
Edge Distance, $c$ (inches)	1 3/4	0.80			
	2	0.83			
	2 5/8	0.90	0.80		
	3	0.94	0.83		
	3 1/2	1.00	0.87	0.80	
	4 3/8		0.93	0.85	0.80
	5 1/4		1.00	0.90	0.84
	6			0.94	0.87
	7			1.00	0.92
	8				0.97
	8 3/4				1.00
10 1/2					1.00

Notes: For anchors loaded in shear, the critical edge distance ( $C_{cr}$ ) is equal to 14 anchor diameters ( $14d$ ) at which the anchor achieves 100% of load. Minimum edge distance ( $C_{min}$ ) is equal to 7 anchor diameters ( $7d$ ) at which the anchor achieves 50% of load.



Edge Distance, Shear ( $F_{VC}$ )					
Dia. (in.)	1/4	3/8	1/2	5/8	3/4
$C_{cr}$ (in.)	3 1/2	5 1/4	7	8 3/4	10 1/2
$C_{min}$ (in.)	1 3/4	2 5/8	3 1/2	4 3/8	5 1/4
Edge Distance, $c$ (inches)	1 3/4	0.50			
	2	0.57			
	2 5/8	0.75	0.50		
	3	0.86	0.57		
	3 1/2	1.00	0.67	0.50	
	4 3/8		0.83	0.63	0.50
	5		0.95	0.71	0.57
	5 1/4		1.00	0.75	0.60
	6			0.86	0.69
	7			1.00	0.80
	8				0.91
8 3/4				1.00	
10					0.95
10 1/2					1.00

## Domestic Wedge Anchor

Anchor made in the U.S.A., nut and washer made in Taiwan or China\*  
Carbon Steel and Stainless Steel Wedge Expansion Anchors

### PRODUCT DESCRIPTION

The Domestic Wedge Anchor is a threaded, torque-controlled, carbon steel or stainless steel wedge expansion anchor which is designed for consistent performance in concrete. Suitable base materials are normal-weight and sand-lightweight concrete. The anchor is manufactured with carbon steel body and expansion clip or a stainless steel body and expansion clip. Nut and washer are included.

### GENERAL APPLICATIONS AND USES

- Steel fixtures
- Support connections
- Equipment and railing

### FEATURES AND BENEFITS

- + Anchors made in the U.S.A., nut and washer made in Taiwan or China. (Domestic nut and washer available upon request.)
- + Nominal drill bit size is the same as the anchor diameter
- + Anchor can be installed through standard fixture holes
- + Length ID code and identifying marking stamped on head of each anchor
- + Anchor design allows for follow-up expansion after setting under tensile loading
- + Corrosion resistant stainless steel anchors

### APPROVALS AND LISTINGS

Tested to ASTM E 488

### GUIDE SPECIFICATIONS

**CSI Divisions:** 031600-Concrete Anchors, 05090-Metal Fastenings and 050519 Post-installed concrete anchors. Expansion anchors shall be Domestic Wedge Anchor as supplied by Powers Fasteners, Inc., Brewster, NY. Anchors shall be installed in accordance with published instructions and the Authority Having Jurisdiction.

### MATERIAL SPECIFICATIONS

Anchor component	Specification		
	Carbon Steel <sup>1</sup>	Type 303	Type 316
Anchor body	AISI C12L14	Type 303 Stainless Steel	Type 316 Stainless Steel
Washer	AISI C1010-1018	300 Series Stainless Steel	Type 316 Stainless Steel
Hex Nut	Low Carbon Steel, ASTM A563, Grade A	Type 18-8	Type 316 Stainless Steel
Expansion wedge (clip)	AISI C1010-1018 1037	Type 18-8	Type 316 Stainless Steel

1. Plated with Commercial Bright Zinc and supplementary chromate treatment in accordance with ASTM B 633, SC1 Type III.  
\* Domestic nut and washer available upon request.

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Domestic Wedge Anchor Assembly

### THREAD VERSION

UNC threaded stud

### ANCHOR MATERIALS

Carbon Steel, Type 303 Stainless Steel, or Type 316 Stainless Steel

### ANCHOR SIZE RANGE (TYP.)

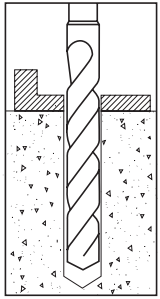
1/4" diameter through 1-1/4" diameter

### SUITABLE BASE MATERIALS

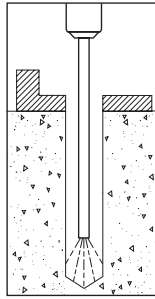
Normal-weight concrete  
Sand-lightweight concrete

**INSTALLATION INSTRUCTIONS**

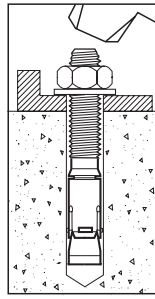
**Installation Instructions for Domestic Wedge Anchor**



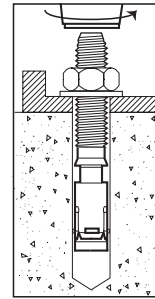
1.) Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.



2.) Remove dust and debris from the hole using a hand pump, compressed air or a vacuum to remove loose particles left from drilling.



3.) Position the supplied washer on the anchor and thread on the supplied nut. If installing through a fixture, drive the anchor through the fixture into the hole. Be sure the anchor is driven to the minimum required embedment depth.



4.) Tighten the anchor with a torque wrench by applying the required installation torque,  $T_{inst}$ .

**Installation Table for Domestic Wedge Anchor**

Anchor Property/ Setting Information	Notation	Units	Nominal Anchor Diameter (inch)							
			1/4	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Anchor outside diameter	$d$	in. (mm)	0.25 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Nominal drill bit diameter	$d_{bit}$	in.	1/4 ANSI	3/8 ANSI	1/2 ANSI	5/8 ANSI	3/4 ANSI	7/8 ANSI	1 ANSI	1-1/4 ANSI
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)	9/16 (14.3)	11/16 (17.5)	13/16 (20.6)	15/16 (23.8)	1-1/8 (28.6)	1-3/8 (34.9)
Minimum nominal embedment depth	$h_{nom}$	in. (mm)	1-1/8 (28.6)	1-1/2 (38.1)	2-1/4 (57.2)	2-3/4 (69.9)	3-1/4 (82.6)	3-7/8 (98.4)	4-1/2 (114.3)	5-1/2 (139.7)
Minimum hole depth	$h_o$	in. (mm)	1-3/8 (34.9)	1-7/8 (47.6)	2-3/4 (69.9)	3-1/4 (82.6)	3-3/4 (95.3)	4-3/8 (111.1)	5 (127.0)	6 (152.4)
Minimum member thickness	$h_{min}$	in. (mm)	3 (76.2)	3 (76.2)	3-3/8 (85.7)	4-1/8 (104.8)	4-7/8 (123.8)	5-13/16 (147.6)	6-3/4 (171.5)	8-1/4 (209.6)
Installation torque	$T_{inst}$	ft.-lbf. (N-m)	5-10 (6.8-13.6)	25-30 (33.9-40.7)	50-60 (67.8-81.4)	75-90 (102-122)	150-175 (203-237)	200-250 (271-339)	250-300 (339-407)	400-450 (542-610)
Torque wrench/socket size	-	in.	7/16	9/16	3/4	15/16	1-1/8	1-5/16	1-1/2	1-7/8
Nut height	-	in.	7/32	21/64	7/16	35/64	41/64	3/4	55/64	1-1/16

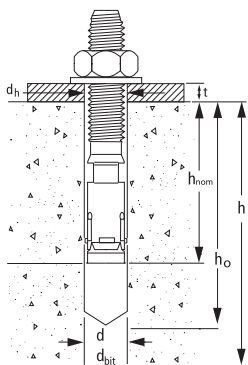
For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

**Length Identification**

Mark	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
From	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"
Up to but not including	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"	12"

Length identification mark indicates overall length of anchor.

**Installation Detail**



**Nomenclature**

- $d$  = Diameter of anchor
- $d_{bit}$  = Diameter of drill bit
- $d_h$  = Diameter of fixture clearance hole
- $h$  = Base material thickness  
The minimum value of  $h$  should be  $1.5h_{nom}$  or 3" whichever is greater
- $h_{nom}$  = Minimum nominal embedment
- $t$  = Fixture thickness
- $h_o$  = Minimum hole depth

**REFERENCE PERFORMANCE DATA**

**Ultimate Load Capacities for Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2</sup>**

Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)
1/4	1-1/8	1,170	1,445	1,770	1,815	2,775	2,635
	1-3/4	1,840		2,410		2,775	
	2-3/4	1,975		2,750		2,830	
3/8	1-1/2	1,630	4,320	3,640	5,120	4,450	6,235
	3	3,230		5,655		5,975	
	5	4,075		6,330		6,360	
1/2	2-1/4	4,000	7,420	6,715	9,380	9,615	9,890
	4	6,335		8,945		10,190	
	6	6,900		10,175		12,065	
5/8	2-3/4	5,000	8,265	8,750	12,930	9,760	16,375
	5	8,855		15,590		16,800	
	7	9,380		16,710		17,735	
3/4	3-1/4	6,640	12,505	11,315	17,050	16,230	22,965
	6	10,085		18,410		21,095	
	8	11,170		19,805		22,525	
7/8	3-7/8	8,395	18,250	16,355	20,235	16,800	23,980
	5-3/4	12,065		18,250		23,405	
1	4-1/2	9,775	23,620	18,250	27,605	27,460	28,910
	7-1/2	11,890		26,725		34,960	
	10	15,590		30,490		37,840	
1-1/4	5-1/2	17,550	32,275	22,970	42,690	32,370	55,565
	7	21,050		27,845		48,365	
	10	27,895		34,790		61,270	

1. Tabulated load values are for anchors installed in uncracked concrete with no edge or spacing considerations. Concrete compressive strength must be at the specified minimum at the time of installation.

2. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working loads.

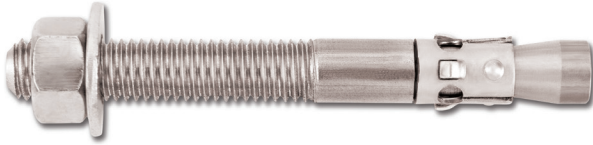
**REFERENCE PERFORMANCE DATA**
**Allowable Load Capacities for Carbon Steel and Stainless Steel Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2,3</sup>**


Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)
1/4	1-1/8	295	360	445	455	695	660
	1-3/4	460		600		695	
	2-3/4	495		690		710	
3/8	1-1/2	410	1,080	910	1,280	1,115	1,560
	3	810		1,415		1,495	
	5	1,020		1,580		1,590	
1/2	2-1/4	1,000	1,855	1,680	2,345	2,405	2,475
	4	1,585		2,235		2,550	
	6	1,725		2,545		3,015	
5/8	2-3/4	1,250	2,065	2,190	3,235	2,440	4,095
	5	2,215		3,900		4,200	
	7	2,345		4,180		4,435	
3/4	3-1/4	1,660	3,125	2,830	4,265	4,060	5,740
	6	2,520		4,600		5,275	
	8	2,795		4,950		5,630	
7/8	3-7/8	2,100	4,565	4,090	5,060	4,200	5,995
	5-3/4	3,015		4,565		5,850	
1	4-1/2	2,445	5,905	4,565	6,900	6,865	7,230
	7-1/2	2,975		6,685		8,740	
	10	3,900		7,625		9,460	
1-1/4	5-1/2	4,390	8,070	5,745	10,675	8,095	13,890
	7	5,265		6,960		12,095	
	10	6,975		8,700		15,320	

1. Tabulated load values are for anchors installed in uncracked concrete. Concrete compressive strength must be at the specified minimum at the time of installation.  
 2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.



**ORDERING INFORMATION**



**Domestic Wedge Anchor (Carbon Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7400USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7402USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7404USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7410USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7412USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7413USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7414USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7415USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7416USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7417USA	3/8" x 6-1/2"	1-1/2"	1-1/8"	50	200
7420USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7422USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7423USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7424USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7426USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7427USA	1/2" x 8-1/2"	2-1/4"	1-1/4"	25	100
7428USA	1/2" x 10"	2-1/4"	1-1/4"	25	100
7429USA	1/2" x 12"	2-1/4"	1-1/4"	25	100
7430USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7432USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7433USA	5/8" x 5"	2-3/4"	2"	25	100
7434USA	5/8" x 6"	2-3/4"	2"	25	75
7436USA	5/8" x 7"	2-3/4"	2"	25	75
7438USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7439USA	5/8" x 10"	2-3/4"	2"	25	75
7437USA	5/8" x 12"	2-3/4"	2"	25	75
7440USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7441USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7442USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7444USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7446USA	3/4" x 7"	3-1/4"	2"	20	60
7448USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7449USA	3/4" x 10"	3-1/4"	2"	10	30
7451USA	3/4" x 12"	3-1/4"	2"	10	30
7461USA	1" x 6"	4-1/2"	2-1/4"	10	40
7463USA	1" x 9"	4-1/2"	2-1/4"	10	30
7465USA	1" x 12"	4-1/2"	2-1/4"	5	15
7475USA	1-1/4" x 12"	5-1/2"	3-1/4"	5	15

**Installation Accessories**

Cat. No.	Description	Box Qty
08466	Adjustable torque wrench with 1/2" square drive (25 to 250 ft.-lbs.)	1
08280	Hand pump / dust blower	1

The published size includes the diameter and the overall length of the anchor. All anchors are packaged with nuts and washers.

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**Domestic Wedge Anchor (Type 303 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7300USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7302USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7304USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7310USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7312USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7313USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7314USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7315USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7316USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7320USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7323USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7324USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7326USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7330USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7332USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7333USA	5/8" x 5"	2-3/4"	2"	25	100
7334USA	5/8" x 6"	2-3/4"	2"	25	75
7336USA	5/8" x 7"	2-3/4"	2"	25	75
7338USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7340USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7341USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7342USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7344USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7346USA	3/4" x 7"	3-1/4"	2"	20	60
7348USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7349USA	3/4" x 10"	3-1/4"	2"	10	30

**Domestic Wedge Anchor (Type 316 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7600USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7602USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7604USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7610USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7612USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7613USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7614USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7615USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7616USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7620USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7622USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7623USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7624USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7626USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7630USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7632USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7633USA	5/8" x 5"	2-3/4"	2"	25	100
7634USA	5/8" x 6"	2-3/4"	2"	25	75
7636USA	5/8" x 7"	2-3/4"	2"	25	75
7638USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7640USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7641USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7642USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7644USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7646USA	3/4" x 7"	3-1/4"	2"	20	60
7648USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7652USA	7/8" x 8"	3-7/8"	2-1/4"	10	40
7663USA	1" x 9"	4-1/2"	2-1/4"	10	30

# DROP-IN Internally-Threaded Expansion Shell Anchor



Drop-in anchors are internally-threaded, deformation-controlled expansion anchors with a preassembled expander plug, suitable for flush mount applications in solid base materials. The anchor is set by driving the expansion plug towards the bottom of the anchor using the setting tool. Drop-in anchors are also available in coil-threaded versions for 1/2" and 3/4" coil threaded rod.

The Lipped Drop-In (DIAL) features a lip at the top of the anchor body that keeps the top of the anchor flush with the concrete. This eliminates the need for precisely drilled hole depths and allows for easier flush installation, consistent embedment and uniform rod lengths.

The 3/8" Short Drop-In Anchor (DIA37S) is for use in solid and hollow concrete. The short length permits shallow embedment, thus avoiding drilling into rebar or prestressing strands. The wide surface flange allows the DIA37S to be installed in deep or bottomless holes.

**MATERIAL:** Carbon and stainless steel  
(DIA37S available in zinc plated carbon steel only)

**FINISH:** Carbon steel: Zinc plated

**INSTALLATION:**

- Drill a hole in the base material using the appropriate diameter carbide drill bit as specified in the table. Drill the hole to the specified embedment depth plus 1/8" for flush mounting. Blow the hole clean using compressed air. Overhead installations need not be blown clean.

**Caution:** Oversized holes will make it difficult to set the anchor and will reduce the anchor's load capacity.

- Insert anchor into hole. Tap with hammer until flush against surface.
- Using the Drop-in setting tool, drive expander plug towards the bottom of the anchor until shoulder of setting tool makes contact with the top of the anchor.

**CODES:** Drop-In: City of L.A. RR24682; Factory Mutual 3017082; Underwriters Laboratories File Ex3605. Meets requirements of Federal Specifications A-A-55614, Type I. Short Drop-In: Factory Mutual 3017082 & Underwriters Laboratories File Ex3605.

The load tables list values based upon results from the most recent testing and may not reflect those in current code reports. Where code jurisdictions apply, consult the current reports for applicable load values.

**TEST CRITERIA:** The Drop-In anchor has been tested in accordance with ICC-ES's Acceptance Criteria for Expansion Anchors (AC01) for the following:

- Seismic/wind loading
- Combination tension and shear loads
- Critical and minimum edge distance and spacing

**SUGGESTED SPECIFICATIONS:** Drop-In anchors shall be internally threaded, expanding shell anchors. The anchor shell shall be zinc plated carbon steel with a minimum 70,000 psi tensile strength, type 303 or 316 stainless steel, as called for on the drawings. Drop-In anchors shall meet Federal Specification A-A-55614, Type I. Anchors shall be Drop-In anchors from Simpson Strong-Tie, Pleasanton, CA. Anchors shall be installed following the Simpson Strong-Tie instructions for Drop-In internally threaded expansion shell anchors.



Drop-In



Lipped Drop-In



Short Drop-In



Coil-Thread Drop-In



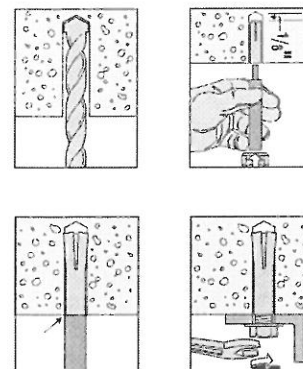
Mechanical Anchors

**Material Specifications**

Anchor Component	Component Material		
	Zinc Plated Carbon Steel	Type 303 Stainless Steel	Type 316 Stainless Steel
Anchor Body	Meets minimum 70,000 psi tensile	AISI 303. Meets chemical requirements of ASTM A-582	Type 316
Expander Plug	Meets minimum 50,000 psi tensile	AISI 303	Type 316
Thread	UNC 2B/Coil-thread	UNC 2B	UNC 2B

Note: DIA37S, DIA50C and DIA75C are not available in stainless steel.

**Installation Sequence (Short Drop-In anchor similar)**



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# DROP-IN Internally Threaded Expansion Shell Anchor



## Drop-In Anchor Product Data - Carbon and Stainless Steel

Rod Size (in.)	Carbon Steel Model No.	303 Stainless Model No.	316 Stainless Model No.	Drill Bit Diameter (in.)	Bolt Threads (per in.)	Body Length (in.)	Quantity	
							Box	Ctn.
1/4	DIA25	DIA25SS	DIA256SS	3/8	20	1	100	500
3/8	DIA37	DIA37SS	DIA376SS	1/2	16	1 1/2	50	250
1/2	DIA50	DIA50SS	DIA506SS	5/8	13	2	50	200
5/8	DIA62	DIA62SS	•	7/8	11	2 1/2	25	100
3/4	DIA75	DIA75SS	•	1	10	3 1/2	20	80



Drop-In Anchor

## Lipped Drop-In Anchor Product Data

Rod Size (in.)	Carbon Steel Model No.	Drill Bit Diameter (in.)	Bolt Threads (per in.)	Body Length (in.)	Quantity	
					Box	Ctn.
1/4	DIAL25	3/8	20	1	100	500
3/8	DIAL37	1/2	16	1 1/2	50	250
1/2	DIAL50	5/8	13	2	50	200



Lipped Drop-In Anchor

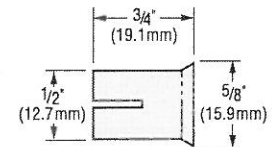
## Short Drop-In Anchor Product Data

Rod Size (in.)	Carbon Steel Model No.	Drill Bit Diameter (in.)	Bolt Threads (per in.)	Body Length (in.)	Quantity	
					Box	Ctn.
3/8	DIA37S <sup>1</sup>	1/2	16	3/4	100	500

1. A dedicated setting tool is included with each box of the DIA37S.



Short Drop-In Anchor



Short Drop-In Anchor Dimensions

## Coil-Thread Drop-In Anchor Product Data

Rod Size (in.)	Carbon Steel Model No.	Drill Bit Diameter (in.)	Bolt Threads (per in.)	Body Length (in.)	Quantity	
					Box	Ctn.
1/2	DIA50C <sup>1</sup>	5/8	6	2	50	200
3/4	DIA75C <sup>1</sup>	1	5	3 1/2	20	80

1. DIA50C and DIA75C accept 1/2" and 3/4" coil-thread rod, respectively.



Coil-Thread Drop-In Anchor

## Drop-In Anchor Setting Tool Product Data

Model No.	For use With	Box Qty.
DIAS25	DIA25, DIAL25	10
DIAS37	DIA37, DIAL37	10
DIAS50	DIA50, DIA50C, DIAL50	10
DIAS62	DIA62	5
DIAS75	DIA75, DIA75C	5

1. Setting Tools sold separately except for DIA37S.  
2. Setting Tools for use with carbon and stainless steel Drop-In anchors.



Standard Setting Tool

Mechanical Anchors

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# DROP-IN Internally Threaded Expansion Shell Anchor



## Tension Loads for Drop-In (Carbon and Stainless Steel) and Lipped Drop-In (Carbon Steel) Anchors in Normal-Weight Concrete



Rod Size in. (mm)	Drill Bit Dia. in.	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load							
					f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete		f'c ≥ 4000 psi (27.6 MPa) Concrete		
					Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	
1/4 (6.4)	3/8	1 (25)	3 (76)	4 (102)	1,400 (6.2)	201 (0.9)	350 (1.6)	405 (1.8)	1,840 (8.2)	451 (2.0)	460 (2.0)	
3/8 (9.5)	1/2	1 1/2 (38)	4 1/2 (114)	6 (152)	2,400 (10.7)	251 (1.1)	600 (2.7)	795 (3.5)	3,960 (17.6)	367 (1.6)	990 (4.4)	
1/2 (12.7)	5/8	2 (51)	6 (152)	8 (203)	3,320 (14.8)	372 (1.7)	830 (3.7)	1,178 (5.2)	6,100 (27.1)	422 (1.9)	1,525 (6.8)	
5/8 (15.9)	7/8	2 1/2 (64)	7 1/2 (191)	10 (254)	5,040 (22.4)	689 (3.1)	1,260 (5.6)	1,715 (7.6)	8,680 (38.6)	971 (4.3)	2,170 (9.7)	
3/4 (19.1)	1	3 (76)	9 (229)	12 (305)	8,160 (36.3)	961 (4.3)	2,040 (9.1)	2,365 (10.5)	10,760 (47.9)	1,696 (7.5)	2,690 (12.0)	

1. The allowable loads listed are based on a safety factor of 4.0.
2. Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
3. Refer to allowable load-adjustment factors for edge distance and spacing on page 157.
4. Allowable loads may be linearly interpolated between concrete strengths listed.
5. The minimum concrete thickness is 1 1/2 times the embedment depth.

\* See page 10 for an explanation of the load table icons

## Shear Loads for Drop-In (Carbon and Stainless Steel) and Lipped Drop-In (Carbon Steel) Anchors in Normal-Weight Concrete



Rod Size in. (mm)	Drill Bit Dia. in.	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Shear Load					
					f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete		f'c ≥ 4000 psi (27.6 MPa) Concrete
					Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	
1/4 (6.4)	3/8	1 (25)	3 1/2 (89)	4 (102)	1,960 (8.7)	178 (0.8)	490 (2.2)	490 (2.2)	490 (2.2)	
3/8 (9.5)	1/2	1 1/2 (38)	5 1/4 (133)	6 (152)	3,240 (14.4)	351 (1.6)	810 (3.6)	925 (4.1)	1,040 (4.6)	
1/2 (12.7)	5/8	2 (51)	7 (178)	8 (203)	7,000 (31.1)	562 (2.5)	1,750 (7.8)	1,750 (7.8)	1,750 (7.8)	
5/8 (15.9)	7/8	2 1/2 (64)	8 3/4 (222)	10 (254)	11,080 (49.3)	923 (4.1)	2,770 (12.3)	2,770 (12.3)	2,770 (12.3)	
3/4 (19.1)	1	3 (76)	10 1/2 (267)	12 (305)	13,800 (61.4)	1,781 (7.9)	3,450 (15.3)	3,725 (16.6)	4,000 (17.8)	

1. The allowable loads listed are based on a safety factor of 4.0.
2. Allowable loads may be increased by 16% for short-term loading due to wind or seismic forces where permitted by code.
3. Refer to allowable load-adjustment factors for edge distance and spacing on page 157.
4. Allowable loads may be linearly interpolated between concrete strengths listed.
5. The minimum concrete thickness is 1 1/2 times the embedment depth.

## Tension Loads for Coil-Thread Drop-In Anchors in Normal-Weight Concrete



Model No.	Drill Bit Dia. in.	Embed. Depth in. (mm)	Tension Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load					
					f'c ≥ 2500 psi (13.8 MPa) Concrete			f'c ≥ 4000 psi (13.8 MPa) Concrete		
					Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)
DIA75C	1	3 (76)	9 (229)	12 (305)	10,520 (46.8)	1,100 (4.9)	2,630 (11.7)	12,980 (57.7)	1,548 (6.9)	3,245 (14.4)

1. The allowable loads listed are based on a safety factor of 4.0.
2. Allowable loads may not be increased for short-term loading due to wind or seismic forces.
3. Refer to allowable load-adjustment factors for edge distance and spacing on page 157.
4. The minimum concrete thickness is 1 1/2 times the embedment depth.

Mechanical Anchors

# DROP-IN Internally Threaded Expansion Shell Anchor



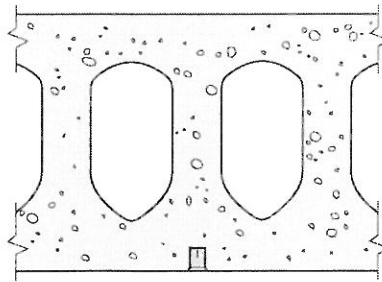
## Tension and Shear Loads for 3/8" Short Drop-In Anchor in Normal-Weight Concrete and Hollow Core Concrete Panel



Model No.	Rod Size in. (mm)	Drill Bit Dia. in.	Embed. Depth in. (mm)	Tension Critical Edge Dist. in. (mm)	Shear Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load			Shear Load		
							Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)
Normal-Weight Concrete, f'c ≥ 2000 psi (13.8 MPa)												
DIA37S	3/8 (9.5)	1/2	3/4 (19)	4 1/2 (114)	5 1/4 (133)	3 (76)	1,500 (6.7)	220 (1.0)	375 (1.7)	2,274 (10.1)	374 (1.7)	570 (2.5)
Hollow Core Concrete Panel, f'c ≥ 4000 psi (27.6 MPa)												
DIA37S	3/8 (9.5)	1/2	3/4 (19)	4 1/2 (114)	5 1/4 (133)	3 (76)	1,860 (8.3)	119 (0.5)	465 (2.1)	3,308 (14.7)	210 (0.9)	825 (3.7)

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may not be increased for short-term loading due to wind or seismic forces.
- Refer to allowable load-adjustment factors for edge distance and spacing on page 157.

\*See page 10 for an explanation of the load table icons



Hollow Core Concrete Panel  
(Anchor can be installed below web or hollow core)

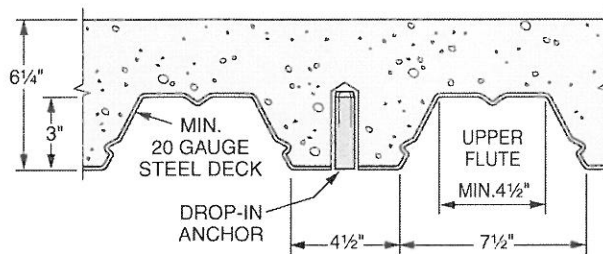
Mechanical Anchors

## Tension and Shear Loads for Drop-In (Carbon Steel) and Lipped Drop-In (Carbon Steel) Anchors in Sand-Lightweight Concrete over Metal Deck



Model No.	Rod Size in. (mm)	Drill Bit Dia. in.	Embed. Depth in. (mm)	Tension Critical Edge Dist. in. (mm)	Shear Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load (Install through Metal Deck)			Shear Load (Install through Metal Deck)		
							f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete		
							Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)
DIA37	3/8 (9.5)	1/2	1 1/2 (38)	6 (152)	7 (178)	8 (203)	3,000 (13.3)	367 (1.6)	750 (3.3)	2,400 (10.7)	187 (0.8)	600 (2.7)
DIA50	1/2 (12.7)	5/8	2 (51)	8 (203)	9 3/8 (238)	10 5/8 (270)	3,580 (15.9)	861 (3.8)	895 (4.0)	5,600 (24.9)	200 (0.9)	1,400 (6.2)

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may not be increased for short-term loading due to wind or seismic forces.
- Refer to allowable load-adjustment factors for edge distance and spacing on page 157.



Lightweight Concrete over Metal Deck

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## Load-Adjustment Factors for Drop-In (Carbon and Stainless Steel) and Lipped Drop-In (Carbon Steel) Anchors in Normal-Weight Concrete: Edge Distance and Spacing, Tension and Shear Loads

### How to use these charts:

- The following tables are for reduced edge distance and spacing.
- Locate the anchor size to be used for either a tension and/or shear load application.
- Locate the edge distance ( $C_{act}$ ) or spacing ( $S_{act}$ ) at which the anchor is to be installed.
- The load adjustment factor ( $f_c$  or  $f_s$ ) is the intersection of the row and column.
- Multiply the allowable load by the applicable load adjustment factor.
- Reduction factors for multiple edges or spacing are multiplied together.

### Edge Distance Tension ( $f_c$ )



Edge Dist. ( $C_{act}$ ) (in.)	Size	1/4	3/8	1/2	5/8	3/4
	$C_{cr}$	3	4 1/2	6	7 1/2	9
	$C_{min}$	1 1/4	2 5/8	3 1/2	4 3/8	5 1/4
	$f_{cmin}$	0.65	0.65	0.65	0.65	0.65
1 1/4		0.65				
2		0.72				
2 1/2		0.86				
2 5/8		0.90	0.65			
3		1.00	0.72			
3 1/2			0.81	0.65		
4			0.91	0.72		
4 3/8			0.98	0.77	0.65	
4 1/2			1.00	0.79	0.66	
5				0.86	0.72	
5 1/4				0.90	0.75	0.65
5 1/2				0.93	0.78	0.67
6				1.00	0.83	0.72
6 1/2					0.89	0.77
7					0.94	0.81
7 1/2					1.00	0.86
8						0.91
8 1/2						0.95
9						1.00

\* See page 10 for an explanation of the load table icons

### Spacing Tension and Shear ( $f_s$ )



$S_{act}$ (in.)	Size	1/4	3/8 <sup>9</sup>	3/8	1/2	5/8	3/4
	E	1	3/4	1 1/2	2	2 1/2	3
	$S_{cr}$	4	3	6	8	10	12
	$S_{min}$	2	1 1/2	3	4	5	6
	$f_{smin}$	0.50	0.50	0.50	0.50	0.50	0.50
1 1/2			0.50				
2			0.50	0.67			
2 1/2			0.63	0.83			
3			0.75	1.00	0.50		
3 1/2			0.88		0.58		
4			1.00		0.67	0.50	
4 1/2					0.75	0.56	
5					0.83	0.63	0.50
5 1/2					0.92	0.69	0.55
6					1.00	0.75	0.60
7						0.88	0.70
8						1.00	0.80
9							0.90
10							1.00
11							
12							1.00

- E = Embedment depth (inches).
- $S_{act}$  = actual spacing distance at which anchors are installed (inches).
- $S_{cr}$  = critical spacing distance for 100% load (inches).
- $S_{min}$  = minimum spacing distance for reduced load (inches).
- $f_s$  = adjustment factor for allowable load at actual spacing distance.
- $f_{scr}$  = adjustment factor for allowable load at critical spacing distance.  $f_{scr}$  is always = 1.00.
- $f_{smin}$  = adjustment factor for allowable load at minimum spacing distance.
- $f_c = f_{smin} + [(1 - f_{smin}) (S_{act} - S_{min}) / (S_{cr} - S_{min})]$ .
- 3/8" Short Drop-In (DIA37S).

See Notes Below

### Edge Distance Shear ( $f_c$ )



Edge Dist. ( $C_{act}$ ) (in.)	Size	1/4	3/8	1/2	5/8	3/4
	$C_{cr}$	3 1/2	5 1/4	7	8 3/4	10 1/2
	$C_{min}$	1 1/4	2 5/8	3 1/2	4 3/8	5 1/4
	$f_{cmin}$	0.45	0.45	0.45	0.45	0.45
1 1/4		0.45				
2		0.53				
2 1/2		0.69				
2 5/8		0.73	0.45			
3		0.84	0.53			
3 1/2		1.00	0.63	0.45		
4			0.74	0.53		
4 3/8			0.82	0.59	0.45	
4 1/2			0.84	0.61	0.47	
5			0.95	0.69	0.53	
5 1/4			1.00	0.73	0.56	0.45
5 1/2				0.76	0.59	0.48
6				0.84	0.65	0.53
6 1/2				0.92	0.72	0.58
7				1.00	0.78	0.63
7 1/2					0.84	0.69
8					0.91	0.74
8 1/2					0.97	0.79
8 3/4					1.00	0.82
9						0.84
9 1/2						0.90
10						0.95
10 1/2						1.00

- $C_{act}$  = actual edge distance at which anchor is installed (inches).
- $C_{cr}$  = critical edge distance for 100% load (inches).
- $C_{min}$  = minimum edge distance for reduced load (inches).
- $f_c$  = adjustment factor for allowable load at actual edge distance.
- $f_{scr}$  = adjustment factor for allowable load at critical edge distance.  $f_{scr}$  is always = 1.00.
- $f_{cmin}$  = adjustment factor for allowable load at minimum edge distance.
- $f_c = f_{cmin} + [(1 - f_{cmin}) (C_{act} - C_{min}) / (C_{cr} - C_{min})]$ .



## Load-Adjustment Factors for Drop-In (Carbon and Stainless Steel) and Lipped Drop-In (Carbon Steel) Anchors in Sand-Lightweight Concrete over Metal Deck: Edge Distance and Spacing, Tension and Shear Loads

### How to use these charts:

1. The following tables are for reduced edge distance and spacing.
2. Locate the anchor size to be used for either a tension and/or shear load application.
3. Locate the edge distance ( $C_{act}$ ) or spacing ( $S_{act}$ ) at which the anchor is to be installed.
4. The load adjustment factor ( $f_c$  or  $f_s$ ) is the intersection of the row and column.
5. Multiply the allowable load by the applicable load adjustment factor.
6. Reduction factors for multiple edges or spacing are multiplied together.

### Edge Distance Tension ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2
	$C_{cr}$	6	8
	$C_{min}$	3 1/2	4 3/4
	$f_{cmin}$	0.65	0.65
3 1/2		0.65	
4		0.72	
4 1/2		0.79	
4 3/4		0.83	0.65
5		0.86	0.68
5 1/2		0.93	0.73
6		1.00	0.78
6 1/2			0.84
7			0.89
7 1/2			0.95
8			1.00



\*See page 10 for an explanation of the load table icons

### Spacing Tension and Shear ( $f_s$ )

$S_{act}$ (in.)	Size	3/8	1/2
	$S_{cr}$	8	10 5/8
	$S_{min}$	4	5 1/4
	$f_{smin}$	0.50	0.50
4		0.50	
4 1/2		0.56	
5		0.63	
5 1/4		0.66	0.50
6		0.75	0.57
6 1/2		0.81	0.62
7		0.88	0.66
7 1/2		0.94	0.71
8		1.00	0.76
8 1/2			0.80
9			0.85
9 1/2			0.90
10			0.94
10 5/8			1.00



See Notes Below

### Edge Distance Shear ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2
	$C_{cr}$	7	9 5/8
	$C_{min}$	3 1/2	4 3/4
	$f_{cmin}$	0.45	0.45
3 1/2		0.45	
4		0.53	
4 1/2		0.61	
4 3/4		0.65	0.45
5		0.69	0.48
5 1/2		0.76	0.54
6		0.84	0.60
6 1/2		0.92	0.66
7		1.00	0.72
7 1/2			0.78
8			0.84
8 1/2			0.90
9			0.96
9 5/8			1.00



1.  $S_{act}$  = actual spacing distance at which anchors are installed (inches).
2.  $S_{cr}$  = critical spacing distance for 100% load (inches).
3.  $S_{min}$  = minimum spacing distance for reduced load (inches).
4.  $f_s$  = adjustment factor for allowable load at actual spacing distance.
5.  $f_{scr}$  = adjustment factor for allowable load at critical spacing distance.  $f_{scr}$  is always = 1.00.
6.  $f_{smin}$  = adjustment factor for allowable load at minimum spacing distance.
7.  $f_s = f_{smin} + [(1 - f_{smin}) (S_{act} - S_{min}) / (S_{cr} - S_{min})]$ .

1.  $C_{act}$  = actual edge distance at which anchor is installed (inches).
2.  $C_{cr}$  = critical edge distance for 100% load (inches).
3.  $C_{min}$  = minimum edge distance for reduced load (inches).
4.  $f_c$  = adjustment factor for allowable load at actual edge distance.
5.  $f_{scr}$  = adjustment factor for allowable load at critical edge distance.  $f_{scr}$  is always = 1.00.
6.  $f_{cmin}$  = adjustment factor for allowable load at minimum edge distance.
7.  $f_c = f_{cmin} + [(1 - f_{cmin}) (C_{act} - C_{min}) / (C_{cr} - C_{min})]$ .



# WEDGE-ALL® Wedge Anchors



The Wedge-All® wedge anchors are a non-bottom bearing, wedge-style expansion anchor for use in solid concrete or grout-filled masonry. A one-piece clip ensures uniform holding capacity that increases as tension is applied. The threaded stud version is available in eight diameters and multiple lengths. A single size tie-wire version is available for wire supported fixtures. Threaded studs are set by tightening the nut. Tie-wire anchors are set with the claw end of a hammer.

### WEDGE-ALL SPECIAL FEATURES:

- One piece wrap around clip
- Threaded end is chamfered for ease of starting nut
- Most sizes feature full thread for added versatility

**MATERIAL:** Carbon and stainless steel

**FINISH:** Carbon steel anchors are available zinc plated or mechanically galvanized.

**CODES:** ICC-ES ESR-1396 (CMU); City of L.A. RR24682; Factory Mutual 3017082 and 3031136; Florida FL 11506.8; Underwriters Laboratories File Ex3605; Meets requirements of Federal Specifications A-A-1923A, Type 4. The Tie-Wire anchor is not code listed.

**!** The load tables list values based upon results from the most recent testing and may not reflect those in current code reports. Where code jurisdictions apply, consult the current reports for applicable load values.

**TEST CRITERIA:** The Wedge-All anchor has been tested in accordance with ICC-ES's Acceptance Criteria for Expansion Anchors (AC01) for the following:

- Static tension and shear loading
- Seismic and wind loading
- Combination tension and shear loading
- Critical and minimum edge distance

### INSTALLATION:

- Holes in metal fixtures to be mounted should exceed nominal anchor diameter by 1/16" for 1/4" thru 5/8" diameter anchors, and by 1/8" for all other diameters.
- Do not use an impact wrench to set or tighten the Wedge-All.

**!** Caution: Oversized holes in the base material will make it difficult to set the anchor and will reduce the anchor's load capacity.

### Threaded studs:

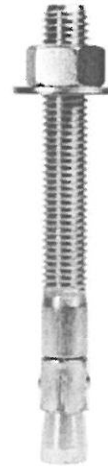
- Drill a hole in the base material using a carbide drill bit the same diameter as the nominal diameter of the anchor to be installed. Drill the hole to the specified embedment depth and blow it clean using compressed air. Overhead installations need not be blown clean. Alternatively, drill the hole deep enough to accommodate embedment depth and dust from drilling.
- Assemble the anchor with nut and washer so the top of the nut is flush with the top of the anchor. Place the anchor in the fixture and drive into the hole until washer and nut are tight against fixture.
- Tighten to the required installation torque.

### Tie-Wire:

- Drill a hole at least 1 1/2" deep using a 1/4" diameter carbide tipped bit.
- Drive the anchor into the hole until the head is seated against the base material.
- Set the anchor by prying/pulling the head with the claw end of the hammer.

### SUGGESTED SPECIFICATIONS:

Wedge anchors shall be a threaded stud with an integral cone expander and a single piece expansion clip. The stud shall be carbon steel with a minimum 70,000 psi tensile strength, or type 303, 304 or 316 stainless steel, as called for on the drawings. Anchors shall meet Federal Specification A-A-1923A, Type 4. Anchors shall be Wedge-All® anchors from Simpson Strong-Tie, Pleasanton, CA. Anchors shall be installed following the Simpson Strong-Tie instructions for Wedge-All anchors.

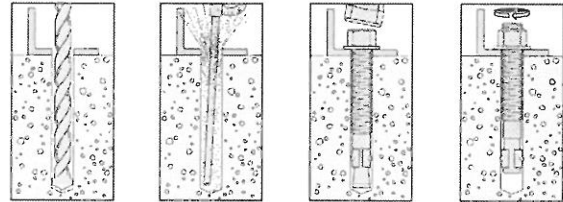


Wedge-All® Anchor

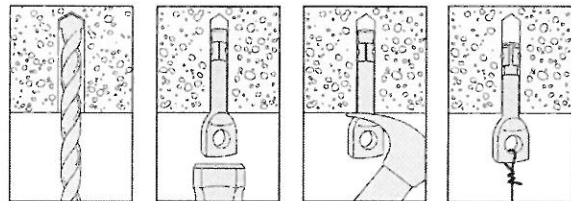


Tie-Wire Anchor (Zinc plate only)

### Wedge-All® Anchor Installation Sequence



### Tie-Wire Anchor Installation Sequence



### Wedge-All® Anchor Installation Data

Wedge-All Dia. (in.)	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
Bit Size (in.)	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
Min. Fixture Hole (in.)	5/16	7/16	9/16	1 1/16	7/8	1	1 1/8	1 3/8
Wrench Size (in.)	7/16	9/16	3/4	15/16	1 1/8	1 1/16	1 1/2	1 7/8

### Length Identification Head Marks on Wedge-All® Anchors (corresponds to length of anchor – inches).

Mark	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16	17	18
Up To But Not Including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16	17	18	19

Mechanical Anchors

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# WEDGE-ALL® Carbon-Steel Wedge Anchors



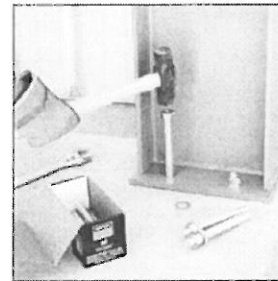
## Wedge-All® Anchor Product Data Carbon Steel: Zinc Plated and Mechanically Galvanized

Size (in.)	Carbon Steel Model No.	Mechanically Galvanized Model No.	Drill Bit Dia. (in.)	Thread Length (in.)	Quantity	
					Box	Carton
1/4 x 1 1/2 <sup>3</sup>	TWD25112 <sup>4</sup>	*	1/4	Hole dia. is 9/32	100	500
1/4 x 1 3/4	WA25134	WA25134MG		15/16	100	500
1/4 x 2 1/4	WA25214	WA25214MG		1 7/16	100	500
1/4 x 3 1/4	WA25314	WA25314MG		2 7/16	100	500
3/8 x 2 1/4	WA37214	WA37214MG	3/8	1 1/8	50	250
3/8 x 2 3/4	WA37234	WA37234MG		1 5/8	50	250
3/8 x 3	WA37300	WA37300MG		1 7/8	50	250
3/8 x 3 1/2	WA37312	WA37312MG		2 1/2	50	250
3/8 x 3 3/4	WA37334	WA37334MG		2 5/8	50	250
3/8 x 5	WA37500	WA37500MG		3 7/8	50	200
3/8 x 7	WA37700	WA37700MG		5 7/8	50	200
1/2 x 2 3/4	WA50234	WA50234MG	1/2	1 1/16	25	125
1/2 x 3 3/4	WA50334	WA50334MG		2 1/16	25	125
1/2 x 4 1/4	WA50414	WA50414MG		2 13/16	25	100
1/2 x 5 1/2	WA50512	WA50512MG		4 1/16	25	100
1/2 x 7	WA50700	WA50700MG		4 9/16	25	100
1/2 x 8 1/2	WA50812	WA50812MG		6	25	50
1/2 x 10	WA50100	WA50100MG		6	25	50
1/2 x 12	WA50120	WA50120MG	6	25	50	
5/8 x 3 1/2	WA62312	WA62312MG	5/8	1 7/8	20	80
5/8 x 4 1/2	WA62412	WA62412MG		2 1/8	20	80
5/8 x 5	WA62500	WA62500MG		3 3/8	20	80
5/8 x 6	WA62600	WA62600MG		4 3/8	20	80
5/8 x 7	WA62700	WA62700MG		5 3/8	20	80
5/8 x 8 1/2	WA62812	WA62812MG		6	20	40
5/8 x 10	WA62100	WA62100MG		6	10	20
5/8 x 12	WA62120	WA62120MG	6	10	20	
3/4 x 4 1/4	WA75414	WA75414MG	3/4	2 3/8	10	40
3/4 x 4 3/4	WA75434	WA75434MG		2 7/8	10	40
3/4 x 5 1/2	WA75512	WA75512MG		3 3/8	10	40
3/4 x 6 1/4	WA75614	WA75614MG		4 3/8	10	40
3/4 x 7	WA75700	WA75700MG		5 3/8	10	40
3/4 x 8 1/2	WA75812	WA75812MG		6	10	20
3/4 x 10	WA75100	WA75100MG		6	10	20
3/4 x 12	WA75120	WA75120MG	6	5	10	
7/8 x 6	WA87600	WA87600MG	7/8	2 1/8	5	20
7/8 x 8	WA87800	WA87800MG		2 1 3/8	5	10
7/8 x 10	WA87100	WA87100MG		2 1 5/8	5	10
7/8 x 12	WA87120	WA87120MG		2 1 7/8	5	10
1 x 6	WA16000	WA16000MG	1	2 1/4	5	20
1 x 9	WA19000	WA19000MG		2 1/4	5	10
1 x 12	WA11200	WA11200MG		2 1/4	5	10
1 1/4 x 9	WA12590	WA12590MG	1 1/4	2 3/4	5	10
1 1/4 x 12	WA12512	WA12512MG		2 3/4	5	10

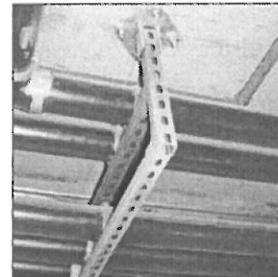
1. The published length is the overall length of the anchor. Allow one anchor diameter for the nut and washer thickness plus the fixture thickness when selecting the minimum length.
2. Special lengths are available on request. Load values are valid as long as minimum embedment depths are satisfied.
3. Tie-Wire Wedge-All® anchor, overall length is 2".
4. Tie-Wire Wedge-All® anchor also available in bulk quantity of 2,000, model TWD25112B.
5. Bulk packaged Wedge-All® anchors available, call Simpson Strong-Tie® for details.

## Material Specifications

Carbon Steel - Zinc Plated			
Component Materials			
Anchor Body	Nut	Washer	Clip
Material Meets minimum 70,000 psi tensile strength	Carbon Steel ASTM A 563, Grade A	Carbon Steel	Carbon Steel



**Application:** Interior environment, low level of corrosion resistance. See page 16 for more corrosion information.



Mechanical Anchors

## Material Specifications

Carbon Steel - Mechanically Galvanized <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Material Meets minimum 70,000 psi tensile strength	Carbon Steel ASTM A 563, Grade A	Carbon Steel	Carbon Steel

1. Mechanical Galvanizing meets ASTM B695, Class 55, Type 1.



**Application:** Exterior unpolluted environment, medium level of corrosion resistance. Well suited to humid environments. See page 16 for more corrosion information.



# WEDGE-ALL® Stainless-Steel Wedge Anchors



## Wedge-All® Anchor Product Data - Stainless Steel

Size (in.)	304/303 Stainless Model No. <sup>1</sup>	316 Stainless Model No. <sup>2</sup>	Drill Bit Dia. (in.)	Thread Length (in.)	Standard Quantity		Mini-Pack Quantity -R" Suffix in Model No. (see note below)	
					Box	Carton	Box	Carton
1/4 x 1 1/4	WA251344SS	WA251346SS	1/4	1 5/16	100	500	20	200
1/4 x 2 1/4	WA252144SS	WA252146SS		1 7/16	100	500	20	200
1/4 x 3 1/4	WA253144SS	WA253146SS		2 1/16	100	500	20	200
3/8 x 2 1/4	WA372144SS	WA372146SS	3/8	1 1/8	50	250	20	200
3/8 x 2 3/4	WA372344SS	WA372346SS		1 3/8	50	250	20	200
3/8 x 3	WA373004SS	WA373006SS		1 7/8	50	250	20	200
3/8 x 3 1/2	WA373124SS	WA373126SS		2 1/2	50	250	20	200
3/8 x 3 3/4	WA373344SS	WA373346SS		2 5/8	50	250	20	200
3/8 x 5	WA375004SS	WA375006SS		3 7/8	50	200	10	100
3/8 x 7	WA377004SS	WA377006SS		5 7/8	50	200	18	80
1/2 x 2 3/4	WA502344SS	WA502346SS	1/2	1 5/16	25	125	10	100
1/2 x 3 3/4	WA503344SS	WA503346SS		2 5/16	25	125	10	100
1/2 x 4 1/4	WA504144SS	WA504146SS		2 13/16	25	100	-	-
1/2 x 5 1/2	WA505124SS	WA505126SS		4 1/16	25	100	10	80
1/2 x 7	WA507004SS	WA507006SS		5 7/16	25	100	4	32
1/2 x 8 1/2	WA50812SS	WA508123SS	2	25	50	4	16	
1/2 x 10	WA50100SS	WA501003SS	2	25	50	4	16	
1/2 x 12	WA50120SS	WA501203SS	2	25	50	4	16	
5/8 x 3 1/2	WA623124SS	WA623126SS	5/8	1 7/8	20	80	10	100
5/8 x 4 1/2	WA624124SS	WA624126SS		2 7/8	20	80	10	80
5/8 x 5	WA625004SS	WA625006SS		3 3/8	20	80	10	80
5/8 x 6	WA626004SS	WA626006SS		4 3/8	20	80	10	80
5/8 x 7	WA627004SS	WA627006SS		5 3/8	20	80	4	16
5/8 x 8 1/2	WA62812SS	WA628123SS		2	20	40	4	16
5/8 x 10	WA62100SS	WA621003SS		2	10	20	4	16
5/8 x 12	WA62120SS	WA621203SS	2	10	20	4	16	
3/4 x 4 1/4	WA754144SS	WA754146SS	3/4	2 3/8	10	40	4	40
3/4 x 4 3/4	WA754344SS	WA754346SS		2 7/8	10	40	4	40
3/4 x 5 1/2	WA755124SS	WA755126SS		3 3/8	10	40	4	32
3/4 x 6 1/4	WA756144SS	WA756146SS		4 3/8	10	40	4	32
3/4 x 7	WA757004SS	WA757006SS		5 1/8	10	40	4	32
3/4 x 8 1/2	WA75812SS	WA758123SS		2 1/4	10	20	4	16
3/4 x 10	WA75100SS	WA751003SS		2 1/4	10	20	4	16
3/4 x 12	WA75120SS	WA751203SS	2 1/4	5	10	4	16	
7/8 x 6	WA87600SS	WA876003SS	7/8	2 1/8	5	20	4	8
7/8 x 8	WA87800SS	WA878003SS		2 1/8	5	10	4	8
7/8 x 10	WA87100SS	WA871003SS		2 1/8	5	10	4	8
7/8 x 12	WA87120SS	WA871203SS		2 1/8	5	10	-	-
1 x 6	WA16000SS	WA160003SS	1	2 1/4	5	20	4	8
1 x 9	WA19000SS	WA190003SS		2 1/4	5	10	4	8
1 x 12	WA11200SS	WA112003SS		2 1/4	5	10	4	8
1 1/4 x 9	WA12590SS	WA125903SS	1 1/4	2 3/4	5	10	4 <sup>3</sup>	8
1 1/4 x 12	WA12512SS	WA125123SS		2 3/4	5	10	4 <sup>3</sup>	8

Mechanical Anchors

1. Anchors with the "SS" suffix in the model number are manufactured from type 303 stainless steel, the remaining anchors (with the "4SS" suffix) are manufactured from type 304 stainless steel. 303 stainless anchors may require extra lead time, call factory for details. Types 303 and 304 stainless steel perform equally well in certain corrosive environments.
2. Anchors with the "3SS" suffix in the model number may require extra lead time. Call Simpson Strong-Tie for details.
3. These package quantities available in type 303 stainless steel only.
4. The published length is the overall length of the anchor. Allow one anchor diameter for the nut and washer thickness plus the fixture thickness when selecting a length.

5. Special lengths are available on request. Load values are valid as long as minimum embedment depths are satisfied.

**Mini Pack:** These package quantities must be ordered with a "-R" suffix on the end of the standard model number. (example: WA505124SS-R).

### Material Specifications

304/303 Stainless Steel <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Type 303 and 304 Stainless Steel	Type 18-8 Stainless Steel	Type 18-8 Stainless Steel	Type 304 or 316 Stainless Steel

1. Type 303 and 304 stainless steels perform equally well in certain corrosive environments. Larger sizes are manufactured from type 303.

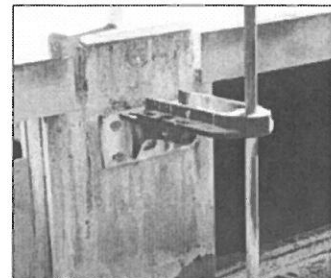
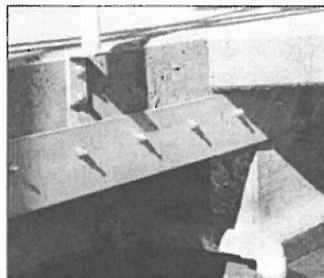
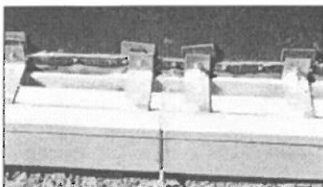
**Application:** Exterior environment, high level of corrosion resistance. Resistant to organic chemicals, many inorganic chemicals, mild atmospheric pollution and mild marine environments (not in direct contact with salt water). See page 16 for more corrosion information.

### Material Specifications

316 Stainless Steel <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Type 316 Stainless Steel	Type 316 Stainless Steel	Type 316 Stainless Steel	Type 304 or 316 Stainless Steel

1. Type 316 stainless steel provides the greatest degree of corrosion resistance offered by Simpson Strong-Tie®.

**Application:** Exterior environment, high level of corrosion resistance. Resistant to chlorides, sulfuric acid compounds and direct contact with salt water. See page 16 for more corrosion information.





**Tension Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Normal-Weight Concrete**



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load							Instal. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete		f'c ≥ 4000 psi (27.6 MPa) Concrete		
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	
1/4" (6.4)	1 1/8" (29)	2 1/2" (64)	1 3/8" (41)	680 (3.0)	167 (0.7)	170 (0.8)	205 (0.9)	960 (4.3)	233 (1.0)	240 (1.1)	8 (10.8)
	2 1/4" (57)	2 1/2" (64)	3 1/8" (79)	1,920 (8.5)	286 (1.3)	480 (2.1)	530 (2.4)	2,320 (10.3)	105 (0.5)	580 (2.6)	
3/8" (9.5)	1 3/4" (44)	3 3/4" (95)	2 3/8" (60)	1,560 (6.9)	261 (1.2)	390 (1.7)	555 (2.5)	2,880 (12.8)	588 (2.6)	720 (3.2)	30 (40.7)
	2 3/8" (67)	3 3/4" (95)	3 3/8" (92)	3,360 (14.9)	464 (2.1)	840 (3.7)	1,100 (4.9)	5,440 (24.2)	553 (2.5)	1,360 (6.0)	
	3 3/8" (86)	3 3/4" (95)	4 3/4" (121)	3,680 (16.4)	585 (2.6)	920 (4.1)	1,140 (5.1)	5,440 (24.2)	318 (1.4)	1,360 (6.0)	
1/2" (12.7)	2 1/4" (57)	5" (127)	3 1/8" (79)	3,280 (14.6)	871 (3.9)	820 (3.6)	1,070 (4.8)	5,280 (23.5)	849 (3.8)	1,320 (5.9)	60 (81.3)
	3 3/8" (86)	5" (127)	4 3/4" (121)	6,040 (26.9)	654 (2.9)	1,510 (6.7)	1,985 (8.8)	9,840 (43.8)	1,303 (5.8)	2,460 (10.9)	
	4 1/2" (114)	5" (127)	6 1/4" (159)	6,960 (31.0)	839 (3.7)	1,740 (7.7)	2,350 (10.5)	11,840 (52.7)	2,462 (11.0)	2,960 (13.2)	
5/8" (15.9)	2 3/4" (70)	6 1/4" (159)	3 3/8" (98)	4,520 (20.1)	120 (0.5)	1,130 (5.0)	1,640 (7.3)	8,600 (38.3)	729 (3.2)	2,150 (9.6)	90 (122.0)
	4 1/2" (114)	6 1/4" (159)	6 1/4" (159)	8,200 (36.5)	612 (2.7)	2,050 (9.1)	2,990 (13.3)	15,720 (69.9)	1,224 (5.4)	3,930 (17.5)	
	5 1/2" (140)	6 1/4" (159)	7 3/4" (197)	8,200 (36.5)	639 (2.8)	2,050 (9.1)	2,990 (13.3)	15,720 (69.9)	1,116 (5.0)	3,930 (17.5)	
3/4" (19.1)	3 3/8" (86)	7 1/2" (191)	4 3/4" (121)	6,760 (30.1)	1,452 (6.5)	1,690 (7.5)	2,090 (9.3)	9,960 (44.3)	1,324 (5.9)	2,490 (11.1)	150 (203.4)
	5" (127)	7 1/2" (191)	7" (178)	10,040 (44.7)	544 (2.4)	2,510 (11.2)	3,225 (14.3)	15,760 (70.1)	1,550 (6.9)	3,940 (17.5)	
	6 3/4" (171)	7 1/2" (191)	9 1/2" (241)	10,040 (44.7)	1,588 (7.1)	2,510 (11.2)	3,380 (15.0)	17,000 (75.6)	1,668 (7.4)	4,250 (18.9)	
7/8" (22.2)	3 3/8" (98)	8 3/4" (222)	5 3/8" (137)	7,480 (33.3)	821 (3.7)	1,870 (8.3)	2,275 (10.1)	10,720 (47.7)	1,253 (5.6)	2,680 (11.9)	200 (271.2)
	7 7/8" (200)	8 3/4" (222)	11" (279)	17,040 (75.8)	1,566 (7.0)	4,260 (18.9)	4,670 (20.8)	20,320 (90.4)	2,401 (10.7)	5,080 (22.6)	
1" (25.4)	4 1/2" (114)	10" (254)	6 1/4" (159)	15,400 (68.5)	2,440 (10.9)	3,850 (17.1)	3,885 (17.3)	15,680 (69.7)	1,876 (8.3)	3,920 (17.4)	300 (406.7)
	9" (229)	10" (254)	12 3/8" (321)	20,760 (92.3)	3,116 (13.9)	5,190 (23.1)	6,355 (28.3)	30,080 (133.8)	1,612 (7.2)	7,520 (33.5)	
1 1/4" (31.8)	5 3/8" (143)	12 1/2" (318)	7 3/8" (200)	15,160 (67.4)	1,346 (6.0)	3,790 (16.9)	4,990 (22.2)	24,760 (110.1)	625 (2.8)	6,190 (27.5)	400 (542.3)
	9 1/2" (241)	12 1/2" (318)	13 1/4" (337)	20,160 (89.7)	3,250 (14.5)	5,040 (22.4)	8,635 (38.4)	48,920 (217.6)	1,693 (7.5)	12,230 (54.4)	

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for edge distance and spacing on pages 144 and 146.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- Allowable loads for 1/4-inch size at 1 1/8-inch embedment apply to both the Wedge-All® and Tie-Wire anchors. Installation torque does not apply to the Tie-Wire anchor.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

\* See page 10 for an explanation of the load table icons



**Shear Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Normal-Weight Concrete**



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Shear Load					Install. Torque ft-lbs (N-m)	
				f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 4000 psi (27.6 MPa) Concrete
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)		
1/4 <sup>6</sup> (6.4)	1 1/8 (29)	2 1/2 (64)	1 3/8 (41)	920 (4.1)	47 (0.2)	230 (1.0)	230 (1.0)	230 (1.0)	8 (10.8)	
	2 1/4 (57)	2 1/2 (64)	3 1/8 (79)	•	•	230 (1.0)	230 (1.0)	230 (1.0)		
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	2,280 (10.1)	96 (0.4)	570 (2.5)	570 (2.5)	570 (2.5)	30 (40.7)	
	2 5/8 (67)	3 3/4 (95)	3 5/8 (92)	4,220 (18.8)	384 (1.7)	1,055 (4.7)	1,055 (4.7)	1,055 (4.7)		
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	•	•	1,055 (4.7)	1,055 (4.7)	1,055 (4.7)		
1/2 (12.7)	2 1/4 (57)	5 (127)	3 1/8 (79)	6,560 (29.2)	850 (3.8)	1,345 (6.0)	1,485 (6.6)	1,625 (7.2)	60 (81.3)	
	3 3/8 (86)	5 (127)	4 3/4 (121)	8,160 (36.3)	880 (3.9)	1,675 (7.5)	1,850 (8.2)	2,020 (9.0)		
	4 1/2 (114)	5 (127)	6 1/4 (159)	•	•	1,675 (7.5)	1,850 (8.2)	2,020 (9.0)		
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 7/8 (98)	8,720 (38.8)	1,699 (7.6)	1,620 (7.2)	1,900 (8.5)	2,180 (9.7)	90 (122.0)	
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	12,570 (55.9)	396 (1.8)	2,330 (10.4)	2,740 (12.2)	3,145 (14.0)		
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	•	•	2,330 (10.4)	2,740 (12.2)	3,145 (14.0)		
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	11,360 (50.5)	792 (3.5)	2,840 (12.6)	2,840 (12.6)	2,840 (12.6)	150 (203.4)	
	5 (127)	7 1/2 (191)	7 (178)	18,430 (82.0)	1,921 (8.5)	4,610 (20.5)	4,610 (20.5)	4,610 (20.5)		
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	•	•	4,610 (20.5)	4,610 (20.5)	4,610 (20.5)		
7/8 (22.2)	3 7/8 (98)	8 3/4 (222)	5 3/8 (137)	13,760 (61.2)	2,059 (9.2)	3,440 (15.3)	3,440 (15.3)	3,440 (15.3)	200 (271.2)	
	7 7/8 (200)	8 3/4 (222)	11 (279)	22,300 (99.2)	477 (2.1)	5,575 (24.8)	5,575 (24.8)	5,575 (24.8)		
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	22,519 (100.2)	1,156 (5.1)	5,730 (25.5)	5,730 (25.5)	5,730 (25.5)	300 (406.7)	
	9 (229)	10 (254)	12 5/8 (321)	25,380 (112.9)	729 (3.2)	6,345 (28.2)	6,345 (28.2)	6,345 (28.2)		
1 1/4 (31.8)	5 5/8 (143)	12 1/2 (318)	7 7/8 (200)	29,320 (130.4)	2,099 (9.3)	7,330 (32.6)	7,330 (32.6)	7,330 (32.6)	400 (542.3)	
	9 1/2 (241)	12 1/2 (318)	13 1/4 (337)	•	•	7,330 (32.6)	7,330 (32.6)	7,330 (32.6)		

Mechanical Anchors

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for spacing and edge distance on pages 144, 145 and 147.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- Allowable loads for 1/4-inch size at 1 1/8-inch embedment apply to both the Wedge-All® and Tie-Wire anchors. Installation torque does not apply to the Tie-Wire anchor.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

\*See page 10 for an explanation of the load table icons

Tension Loads for Stainless-Steel Wedge-All® Anchors  
in Normal-Weight Concrete



\* See page 10 for an explanation of the load table icons

Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Allowable Tension Load lbs. (kN)			Install. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete	f'c ≥ 3000 psi (20.7 MPa) Concrete	f'c ≥ 4000 psi (27.6 MPa) Concrete	
1/4 (6.4)	1 1/8 (29)	2 1/2 (64)	1 5/8 (41)	155 (0.7)	185 (0.8)	215 (1.0)	8 (10.8)
	2 1/4 (57)	2 1/2 (64)	3 3/8 (79)	430 (1.9)	475 (2.1)	520 (2.3)	
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	350 (1.6)	500 (2.2)	650 (2.9)	30 (40.7)
	2 5/8 (67)	3 3/4 (95)	3 3/8 (92)	755 (3.4)	990 (4.4)	1,225 (5.4)	
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	830 (3.7)	1,025 (4.6)	1,225 (5.4)	
1/2 (12.7)	2 1/4 (57)	5 (127)	3 3/8 (79)	740 (3.3)	965 (4.3)	1,190 (5.3)	60 (81.3)
	3 3/8 (86)	5 (127)	4 3/4 (121)	1,360 (6.0)	1,785 (7.9)	2,215 (9.9)	
	4 1/2 (114)	5 (127)	6 1/4 (159)	1,565 (7.0)	2,115 (9.4)	2,665 (11.9)	
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 7/8 (98)	1,015 (4.5)	1,475 (6.6)	1,935 (8.6)	90 (122.0)
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	1,845 (8.2)	2,690 (12.0)	3,535 (15.7)	
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	1,845 (8.2)	2,690 (12.0)	3,535 (15.7)	
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	1,520 (6.8)	1,880 (8.4)	2,240 (10.0)	150 (203.4)
	5 (127)	7 1/2 (191)	7 (178)	2,260 (10.1)	2,905 (12.9)	3,545 (15.8)	
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	2,260 (10.1)	3,040 (13.5)	3,825 (17.0)	
7/8 (22.2)	3 7/8 (98)	8 3/4 (222)	5 3/8 (137)	1,685 (7.5)	2,050 (9.1)	2,410 (10.7)	200 (271.2)
	7 7/8 (200)	8 3/4 (222)	11 (279)	3,835 (17.1)	4,205 (18.7)	4,570 (20.3)	
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	3,465 (15.4)	3,495 (15.5)	3,530 (15.7)	300 (406.7)
	9 (229)	10 (254)	12 5/8 (321)	4,670 (20.8)	5,720 (25.4)	6,770 (30.1)	
1 1/4 (31.8)	5 5/8 (143)	12 1/2 (318)	7 7/8 (200)	3,410 (15.2)	4,490 (20.0)	5,570 (24.8)	400 (542.3)
	9 1/2 (241)	12 1/2 (318)	13 1/4 (337)	4,535 (20.2)	7,770 (34.6)	11,005 (49.0)	

1. The allowable loads listed are based on a safety factor of 4.0.
2. Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
3. Refer to allowable load-adjustment factors for edge distance and spacing on pages 144 and 146.
4. Drill bit diameter used in base material corresponds to nominal anchor diameter.
5. Allowable loads may be linearly interpolated between concrete strengths listed.
6. The minimum concrete thickness is 1 1/2 times the embedment depth.

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Mechanical Anchors



## Shear Loads for Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete



\* See page 10 for an explanation of the load table icons

Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Allowable Shear Load lbs. (kN)			Install. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete	f'c ≥ 3000 psi (20.7 MPa) Concrete	f'c ≥ 4000 psi (27.6 MPa) Concrete	
1/4 (6.4)	1 1/8 (29)	2 1/2 (64)	1 3/8 (41)	265 (1.2)	265 (1.2)	265 (1.2)	8 (10.8)
	2 1/4 (57)	2 1/2 (64)	3 3/8 (79)	265 (1.2)	265 (1.2)	265 (1.2)	
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	655 (2.9)	655 (2.9)	655 (2.9)	30 (40.7)
	2 3/8 (67)	3 3/4 (95)	3 3/8 (92)	1,215 (5.4)	1,215 (5.4)	1,215 (5.4)	
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	1,215 (5.4)	1,215 (5.4)	1,215 (5.4)	
1/2 (12.7)	2 1/4 (57)	5 (127)	3 3/8 (79)	1,545 (6.9)	1,710 (7.6)	1,870 (8.3)	60 (81.3)
	3 3/8 (86)	5 (127)	4 3/4 (121)	1,925 (8.6)	2,130 (9.5)	2,325 (10.3)	
	4 1/2 (114)	5 (127)	6 1/4 (159)	1,925 (8.6)	2,130 (9.5)	2,325 (10.3)	
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 3/8 (98)	1,865 (8.3)	2,185 (9.7)	2,505 (11.1)	90 (122.0)
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	2,680 (11.9)	3,150 (14.0)	3,615 (16.1)	
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	2,680 (11.9)	3,150 (14.0)	3,615 (16.1)	
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	3,265 (14.5)	3,265 (14.5)	3,265 (14.5)	150 (203.4)
	5 (127)	7 1/2 (191)	7 (178)	5,300 (23.6)	5,300 (23.6)	5,300 (23.6)	
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	5,300 (23.6)	5,300 (23.6)	5,300 (23.6)	
7/8 (22.2)	3 7/8 (98)	8 3/4 (222)	5 3/8 (137)	3,955 (17.6)	3,955 (17.6)	3,955 (17.6)	200 (271.2)
	7 7/8 (200)	8 3/4 (222)	11 (279)	6,410 (28.5)	6,410 (28.5)	6,410 (28.5)	
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	6,590 (29.3)	6,590 (29.3)	6,590 (29.3)	300 (406.7)
	9 (229)	10 (254)	12 3/8 (321)	7,295 (32.4)	7,295 (32.4)	7,295 (32.4)	
1 1/4 (31.8)	5 3/8 (143)	12 1/2 (318)	7 7/8 (200)	8,430 (37.5)	8,430 (37.5)	8,430 (37.5)	400 (542.3)
	9 1/2 (241)	12 1/2 (318)	13 3/4 (337)	8,430 (37.5)	8,430 (37.5)	8,430 (37.5)	

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 16% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for spacing and edge distance on pages 144, 145 and 147.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

Mechanical Anchors



# WEDGE-ALL® Wedge Anchors



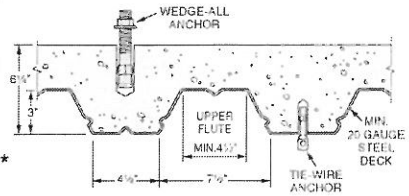
## Tension Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Sand-Lightweight Concrete over Metal Deck



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load (Install in Concrete)			Tension Load (Install through Metal Deck)			Install. Torque ft-lbs (N-m)
				f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
1/4 (TWD) (6.4)	1 1/2 (38)	3 3/8 (86)	2 3/4 (70)	.	.	.	1,440 (6.4)	167 (0.7)	360 (1.6)	.
1/2 (12.7)	2 1/4 (57)	6 3/4 (171)	4 1/8 (105)	3,880 (17.3)	228 (1.0)	970 (4.3)	3,860 (17.2)	564 (2.5)	965 (4.3)	60 (81.3)
5/8 (15.9)	2 3/4 (70)	8 3/8 (213)	5 (127)	5,920 (26.3)	239 (1.1)	1,480 (6.6)	5,220 (23.2)	370 (1.6)	1,305 (5.8)	90 (122.0)
3/4 (19.1)	3 3/8 (86)	10 (254)	6 1/8 (156)	7,140 (31.8)	537 (2.4)	1,785 (7.9)	6,600 (29.4)	903 (4.0)	1,650 (7.3)	150 (203.4)

\* See page 10 for an explanation of the load table icons

See Notes 1-8 Below



## Shear Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Sand-Lightweight Concrete over Metal Deck



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Shear Load (Install in Concrete)			Shear Load (Install through Metal Deck)			Install. Torque ft-lbs (N-m)
				f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
1/4 (TWD) (6.4)	1 1/2 (38)	3 3/8 (86)	2 3/4 (70)	.	.	.	1,660 (7.4)	627 (2.8)	415 (1.8)	.
1/2 (12.7)	2 1/4 (57)	6 3/4 (171)	4 1/8 (105)	5,575 (24.8)	377 (1.7)	1,395 (6.2)	7,260 (32.3)	607 (2.7)	1,815 (8.1)	60 (81.3)
5/8 (15.9)	2 3/4 (70)	8 3/8 (213)	5 (127)	8,900 (39.6)	742 (3.3)	2,225 (9.9)	8,560 (38.1)	114 (0.5)	2,140 (9.5)	90 (122.0)
3/4 (19.1)	3 3/8 (86)	10 (254)	6 1/8 (156)	10,400 (46.3)	495 (2.2)	2,600 (11.6)	11,040 (49.1)	321 (1.4)	2,760 (12.3)	150 (203.4)

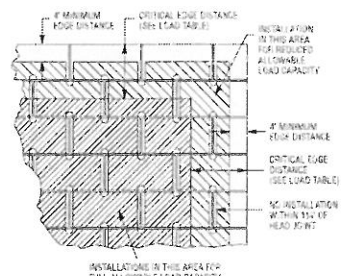
Lightweight Concrete On Metal Deck

- The allowable loads listed are based on a safety factor of 4.0.
- For installations in concrete (not through metal deck), allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces.
- For installations through metal deck, allowable tension loads must be decreased 23% and allowable shear loads may be increased 33 1/3% for short-term loading due to wind or seismic forces.
- Refer to allowable load-adjustment factors for edge distance on page 148.
- 100% of the allowable load is permitted at critical spacing. Loads at reduced spacing have not been determined.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- The minimum concrete thickness is 1 1/2 times the embedment depth.
- Metal deck must be minimum 20 gauge.
- Anchors installed in the steel bottom flute of the steel deck must have a minimum allowable edge distance of 1 1/2" from the inclined edge of the bottom flute.

## Tension and Shear Loads for Carbon-Steel Wedge-All® Anchors in Grout-Filled CMU



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical End Dist. in. (mm)	Critical Spacing in. (mm)	8" Grout-Filled CMU Allowable Load Based on CMU Strength						Install. Torque ft-lbs (N-m)
					Tension Load			Shear Load			
					Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
<b>Anchor Installed on the Face of the CMU Wall at Least 1 1/4 inch Away from Head Joint (See Figure)</b>											
3/8 (9.5)	2 5/8 (67)	12 (305)	10 1/2 (267)	10 1/2 (267)	1,700 (7.6)	129 (0.6)	340 (1.5)	3,360 (14.9)	223 (1.0)	670 (3.0)	30 (40.7)
1/2 (12.7)	3 1/2 (89)	12 (305)	14 (356)	14 (356)	2,120 (9.4)	129 (0.6)	425 (1.9)	5,360 (23.8)	617 (2.7)	1,070 (4.8)	35 (47.4)
5/8 (15.9)	4 3/8 (111)	20 (508)	17 1/2 (445)	17 1/2 (445)	3,120 (13.9)	342 (1.5)	625 (2.8)	8,180 (36.4)	513 (2.3)	1,635 (7.3)	55 (74.5)
3/4 (19.1)	5 1/4 (133)	20 (508)	21 (533)	21 (533)	4,320 (19.2)	248 (1.1)	865 (3.8)	10,160 (45.2)	801 (3.6)	2,030 (9.0)	120 (162.6)



Shaded Area = Placement for Full and Reduced Allowable Load Capacity in Grout-Filled CMU

- The tabulated allowable loads are based on a safety factor of 5.0 for installations under the IBC and IRC. For installations under the UBC use a safety factor of 4.0 (multiply the tabulated allowable loads by 1.25).
- Listed loads may be applied to installations on the face of the CMU wall at least 1 1/4 inch away from headjoints.
- Values are for 8-inch-wide CMU Grade N, Type II, lightweight, medium-weight and normal-weight concrete masonry units conforming to UBC standard 21-4 or ASTM C90. The masonry units must be fully grouted with grout complying with UBC section 2103.4 or IBC section 2103.12. Mortar must be Type M or S prepared in accordance with section 2103.3 of the UBC and UBC standard 21-15, or IBC section 2103.8. The specified compressive strength of masonry, f'm, at 28 days must be a minimum of 1,500 psi.
- Embedment depth is measured from the outside face of the concrete masonry unit.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be increased by 33 1/3 percent for short-term loading due to wind and seismic forces.
- Tension and shear loads for the Wedge-All® anchor may be combined using the parabolic interaction equation (n=5).
- Refer to allowable load-adjustment factors for edge distance on page 148.

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Mechanical Anchors



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Edge Distance, Tension and Shear Loads

How to use these charts:

- The following tables are for reduced edge distance.
- Locate the anchor size to be used for either a tension and/or shear load application.
- Locate the edge distance ( $C_{act}$ ) at which the anchor is to be installed.
- The load adjustment factor ( $f_c$ ) is the intersection of the row and column.
- Multiply the allowable load by the applicable load adjustment factor.
- Reduction factors for multiple edges are multiplied together.

### Edge Distance Tension ( $f_c$ )



Edge Dist. $C_{act}$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
		$C_{cr}$	2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10
	$C_{min}$	1	1 1/2	2	2 1/2	3	3 1/2	4	5
	$f_{cmin}$	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
1		0.70							
1 1/2		0.80	0.70						
2		0.90	0.77	0.70					
2 1/2		1.00	0.83	0.75	0.70				
3			0.90	0.80	0.74	0.70			
3 1/2			0.97	0.85	0.78	0.73	0.70		
3 3/4			1.00	0.88	0.80	0.75	0.71		
4				0.90	0.82	0.77	0.73	0.70	
4 1/2				0.95	0.86	0.80	0.76	0.73	
5				1.00	0.90	0.83	0.79	0.75	0.70
5 1/2					0.94	0.87	0.81	0.78	0.72
6					0.98	0.90	0.84	0.80	0.74
6 1/4					1.00	0.92	0.86	0.81	0.75
6 1/2						0.93	0.87	0.83	0.76
7						0.97	0.90	0.85	0.78
7 1/2						1.00	0.93	0.88	0.80
8							0.96	0.90	0.82
8 1/2							0.99	0.93	0.84
8 3/4							1.00	0.94	0.85
10								1.00	0.90
12 1/2									1.00
15									

\* See page 10 for an explanation of the load table icons

See Notes Below

### Edge Distance Shear ( $f_c$ ) (Shear Applied Perpendicular to Edge)



Edge Dist. $C_{act}$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
		$C_{cr}$	2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10
	$C_{min}$	1	1 1/2	2	2 1/2	3	3 1/2	4	5
	$f_{cmin}$	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
1		0.30							
1 1/2		0.53	0.30						
2		0.77	0.46	0.30					
2 1/2		1.00	0.61	0.42	0.30				
3			0.77	0.53	0.39	0.30			
3 1/2			0.92	0.65	0.49	0.38	0.30		
3 3/4			1.00	0.71	0.53	0.42	0.33		
4				0.77	0.58	0.46	0.37	0.30	
4 1/2				0.88	0.67	0.53	0.43	0.36	
5				1.00	0.77	0.61	0.50	0.42	0.30
5 1/2					0.86	0.69	0.57	0.48	0.35
6					0.95	0.77	0.63	0.53	0.39
6 1/4					1.00	0.81	0.67	0.56	0.42
6 1/2						0.84	0.70	0.59	0.44
7						0.92	0.77	0.65	0.49
7 1/2						1.00	0.83	0.71	0.53
8							0.90	0.77	0.58
8 1/2							0.97	0.83	0.63
8 3/4							1.00	0.85	0.65
10								1.00	0.77
12 1/2									1.00
15									

- $C_{act}$  = actual edge distance at which anchor is installed (inches).
- $C_{cr}$  = critical edge distance for 100% load (inches).
- $C_{min}$  = minimum edge distance for reduced load (inches).
- $f_c$  = adjustment factor for allowable load at actual edge distance.
- $f_{cor}$  = adjustment factor for allowable load at critical edge distance.  $f_{cor}$  is always = 1.00.
- $f_{cmin}$  = adjustment factor for allowable load at minimum edge distance.
- $f_c = f_{cmin} + [(1 - f_{cmin}) (C_{act} - C_{min}) / (C_{cr} - C_{min})]$ .

### Load-Adjustment Factors for Reduced Spacing:

Critical spacing is listed in the load tables. No adjustment in load is required when the anchors are spaced at critical spacing. No additional testing has been performed to determine the adjustment factors for spacing dimensions less than those listed in the load tables.

Mechanical Anchors

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## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Edge Distance and Shear Load Applied Parallel to Edge

### How to use these charts:

1. The following tables are for reduced edge distance.
2. Locate the anchor size to be used for a shear load application.
3. Locate the edge distance ( $C_{act||}$ ) at which the anchor is to be installed.
4. The load adjustment factor ( $f_{c||}$ ) is the intersection of the row and column.
5. Multiply the allowable load by the applicable load adjustment factor.
6. Reduction factors for multiple edges are multiplied together.

### Edge Distance Shear ( $f_{c||}$ ) (Shear Applied Parallel to Edge with End Distance $\geq ED_{min}$ )



Edge Dist. $C_{act  }$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
	E		2 1/4	3 3/8	4 1/2	5 1/2	6 3/4	7 7/8	9
$ED_{min}$		9	13 1/2	18	22	27	31 1/2	36	38
$C_{crit  }$		2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10	12 1/2
$C_{min  }$		1	1 1/2	2	2 1/2	3	3 1/2	4	5
$f_{cmin  }$		1.00	0.93	0.70	0.62	0.62	0.62	0.62	0.62
1		1.00							
1 1/2		1.00	0.93						
2		1.00	0.95	0.70					
2 1/2		1.00	0.96	0.75	0.62				
3			0.98	0.80	0.67	0.62			
3 1/2			0.99	0.85	0.72	0.66	0.62		
4			1.00	0.90	0.77	0.70	0.66	0.62	
5				1.00	0.87	0.79	0.73	0.68	0.62
6					0.97	0.87	0.80	0.75	0.67
7					1.00	0.96	0.87	0.81	0.72
8						1.00	0.95	0.87	0.77
9							1.00	0.94	0.82
10								1.00	0.87
11									0.92
12									0.97
13									1.00

\*See page 10 for an explanation of the load table icons

1. Table is not applicable to anchors with  $ED < ED_{min}$ . Factors from this table may not be combined with load-adjustment factors for shear loads applied perpendicular to edge.
2.  $C_{act||}$  = actual edge distance (measured perpendicular to direction of shear load) at which anchor is installed (inches).
3.  $C_{crit||}$  = critical edge distance (measured perpendicular to direction of shear load) for 100% load (inches).
4.  $C_{min||}$  = minimum edge distance (measured perpendicular to direction of shear load) for reduced load (inches).
5.  $ED$  = actual end distance (measured parallel to direction of shear load) at which anchor is installed (inches).
6.  $ED_{min}$  = minimum edge distance (measured parallel to direction of shear load).
7.  $f_{c||}$  = adjustment factor for allowable load at actual edge distance.
8.  $f_{c||}$  = adjustment factor for allowable load at critical edge distance.  $f_{c||}$  is always = 1.00.
9.  $f_{cmin||}$  = adjustment factor for allowable load at minimum edge distance.
10.  $f_{c||}$  =  $f_{cmin||} + [(1 - f_{cmin||}) (C_{act||} - C_{min||}) / (C_{crit||} - C_{min||})]$ .



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Spacing, Tension Loads

### How to use these charts:

1. The following tables are for reduced spacing.
2. Locate the anchor size to be used for a tension load application.
3. Locate the anchor embedment (E) used for a tension load application.
4. Locate the spacing ( $S_{act}$ ) at which the anchor is to be installed.
5. The load adjustment factor ( $f_s$ ) is the intersection of the row and column.
6. Multiply the allowable load by the applicable load adjustment factor.
7. Reduction factors for multiple spacings are multiplied together.

### Spacing Tension ( $f_s$ )



$S_{act}$ (in.)	Dia.	1/4			3/8			1/2			5/8		
	E	1 1/8	2 1/4	1 3/4	2 5/8	3 3/8	2 1/4	3 3/8	4 1/2	2 3/4	4 1/2	5 1/2	
	$S_{cr}$	1 5/8	3 1/8	2 3/8	3 5/8	4 3/4	3 1/8	4 3/4	6 1/4	3 3/8	6 1/4	7 3/4	
	$S_{min}$	5/8	1 1/8	7/8	1 3/8	1 3/4	1 1/8	1 3/4	2 1/4	1 3/8	2 1/4	2 3/4	
	$f_{smin}$	0.43	0.70	0.43	0.43	0.70	0.43	0.43	0.70	0.43	0.43	0.70	
3/4		0.50											
1		0.64		0.48									
1 1/4		0.79	0.72	0.57			0.47						
1 1/2		0.93	0.76	0.67	0.46		0.54			0.46			
1 3/4		1.00	0.79	0.76	0.53	0.70	0.61	0.43		0.52			
2			0.83	0.86	0.59	0.73	0.68	0.48		0.57			
2 1/4			0.87	0.95	0.65	0.75	0.75	0.53	0.70	0.63	0.43		
2 1/2			0.91	1.00	0.72	0.78	0.82	0.57	0.72	0.69	0.47		
2 3/4			0.94		0.78	0.80	0.89	0.62	0.74	0.74	0.50	0.70	
3			0.98		0.84	0.83	0.96	0.67	0.76	0.80	0.54	0.72	
3 1/2			1.00		0.97	0.88	1.00	0.76	0.79	0.91	0.61	0.75	
4					1.00	0.93		0.86	0.83	1.00	0.68	0.78	
4 1/2						0.98		0.95	0.87		0.75	0.81	
5						1.00		1.00	0.91		0.82	0.84	
6									0.98		0.96	0.90	
7									1.00		1.00	0.96	
8												1.00	

\*See page 10 for an explanation of the load table icons

See Notes Below

### Spacing Tension ( $f_s$ )



$S_{act}$ (in.)	Dia.	3/4		7/8		1		1 1/4		
	E	3 3/8	5	6 1/4	3 7/8	7 7/8	4 1/2	9	5 5/8	9 1/2
	$S_{cr}$	4 3/4	7	9 1/2	5 5/8	11	6 1/4	12 5/8	7 7/8	13 1/4
	$S_{min}$	1 3/4	2 1/2	3 3/8	2	4	2 1/4	4 1/2	2 7/8	4 3/4
	$f_{smin}$	0.43	0.43	0.70	0.43	0.70	0.43	0.70	0.43	0.70
2		0.48			0.43					
3		0.67	0.49		0.60		0.54		0.46	
4		0.86	0.62	0.73	0.77	0.70	0.68		0.57	
5		1.00	0.75	0.78	0.94	0.74	0.82	0.72	0.68	0.71
6			0.87	0.83	1.00	0.79	0.96	0.76	0.79	0.74
7			1.00	0.88		0.83	1.00	0.79	0.90	0.78
8				0.93		0.87		0.83	1.00	0.81
9				0.98		0.91		0.87		0.85
10				1.00		0.96		0.90		0.89
11						1.00		0.94		0.92
12								0.98		0.96
13								1.00		0.99
14										1.00

1. E = Embedment depth (inches).
2.  $S_{act}$  = actual spacing distance at which anchors are installed (inches).
3.  $S_{cr}$  = critical spacing distance for 100% load (inches).
4.  $S_{min}$  = minimum spacing distance for reduced load (inches).
5.  $f_s$  = adjustment factor for allowable load at actual spacing distance.
6.  $f_{sct}$  = adjustment factor for allowable load at critical spacing distance.  $f_{sct}$  is always = 1.00.
7.  $f_{smin}$  = adjustment factor for allowable load at minimum spacing distance.
8.  $f_s = f_{smin} + [(1 - f_{smin})(S_{act} - S_{min}) / (S_{cr} - S_{min})]$ .

Mechanical Anchors

# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Spacing, Shear Loads

### How to use these charts:

1. The following tables are for reduced spacing.
2. Locate the anchor size to be used for a shear load application.
3. Locate the anchor embedment (E) used for a shear load application.
4. Locate the spacing ( $S_{act}$ ) at which the anchor is to be installed.
5. The load adjustment factor ( $f_s$ ) is the intersection of the row and column.
6. Multiply the allowable load by the applicable load adjustment factor.
7. Reduction factors for multiple spacings are multiplied together.

### Spacing Shear ( $f_s$ )



$S_{act}$ (in.)	Dia.	1/4			3/8			1/2			5/8		
	E	1 1/8	2 1/4	1 3/4	2 5/8	3 3/8	2 1/4	3 3/8	4 1/2	2 3/4	4 1/2	5 1/2	
	$S_{cr}$	1 5/8	3 1/8	2 3/8	3 5/8	4 3/4	3 1/8	4 3/4	6 1/4	3 7/8	6 1/4	7 3/4	
	$S_{min}$	5/8	1 1/8	7/8	1 3/8	1 3/4	1 1/8	1 3/4	2 1/4	1 3/8	2 1/4	2 3/4	
	$f_{smin}$	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	
3/4		0.82											
1		0.87		0.81									
1 1/4		0.92	0.80	0.84			0.80						
1 1/2		0.97	0.83	0.88	0.80		0.83			0.80			
1 3/4		1.00	0.86	0.91	0.83	0.79	0.86	0.79		0.82			
2			0.88	0.95	0.85	0.81	0.88	0.81		0.84			
2 1/4			0.91	0.98	0.87	0.83	0.91	0.83	0.79	0.86	0.79		
2 1/2			0.93	1.00	0.90	0.84	0.93	0.84	0.80	0.88	0.80		
2 3/4			0.96		0.92	0.86	0.96	0.86	0.82	0.91	0.82	0.79	
3			0.99		0.94	0.88	0.99	0.88	0.83	0.93	0.83	0.80	
3 1/2			1.00		0.99	0.91	1.00	0.91	0.86	0.97	0.86	0.82	
4					1.00	0.95		0.95	0.88	1.00	0.88	0.84	
4 1/2						0.98		0.98	0.91		0.91	0.86	
5						1.00		1.00	0.93		0.93	0.88	
6									0.99		0.99	0.93	
7									1.00		1.00	0.97	
8												1.00	

\* See page 10 for an explanation of the load table icons

See Notes Below

### Spacing Shear ( $f_s$ )



$S_{act}$ (in.)	Dia.	3/4			7/8		1		1 1/4	
	E	3 3/8	5	6 3/4	3 7/8	7 7/8	4 1/2	9	5 5/8	9 1/2
	$S_{cr}$	4 3/4	7	9 1/2	5 5/8	11	6 1/4	12 5/8	7 7/8	13 1/4
	$S_{min}$	1 3/4	2 1/2	3 3/8	2	4	2 1/4	4 1/2	2 7/8	4 3/4
	$f_{smin}$	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
2		0.81			0.79					
3		0.88	0.81		0.85		0.83		0.80	
4		0.95	0.86	0.81	0.91	0.79	0.88		0.84	
5		1.00	0.91	0.85	0.98	0.82	0.93	0.80	0.88	0.80
6			0.95	0.88	1.00	0.85	0.99	0.83	0.92	0.82
7			1.00	0.91		0.88	1.00	0.85	0.96	0.85
8				0.95		0.91		0.88	1.00	0.87
9				0.98		0.94		0.91		0.90
10				1.00		0.97		0.93		0.92
11						1.00		0.96		0.94
12								0.98		0.97
13								1.00		0.99
14										1.00

1. E = Embedment depth (inches).
2.  $S_{act}$  = actual spacing distance at which anchors are installed (inches).
3.  $S_{cr}$  = critical spacing distance for 100% load (inches).
4.  $S_{min}$  = minimum spacing distance for reduced load (inches).
5.  $f_s$  = adjustment factor for allowable load at actual spacing distance.
6.  $f_{s,cr}$  = adjustment factor for allowable load at critical spacing distance.  
 $f_{s,cr}$  is always = 1.00.
7.  $f_{s,min}$  = adjustment factor for allowable load at minimum spacing distance.
8.  $f_s = f_{s,min} + [(1 - f_{s,min}) (S_{act} - S_{min}) / (S_{cr} - S_{min})]$ .



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel Wedge-All® Anchors in Sand-Lightweight Concrete: Edge Distance, Tension and Shear Loads

How to use these charts:

- The following tables are for reduced edge distance.
- Locate the anchor size to be used for either a tension and/or shear load application.
- Locate the edge distance ( $C_{act}$ ) at which the anchor is to be installed.
- The load adjustment factor ( $f_c$ ) is the intersection of the row and column.
- Multiply the allowable load by the applicable load adjustment factor.
- Reduction factors for multiple edges are multiplied together.

Edge Distance Tension ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	1/4	1/2	5/8	3/4	
		$C_{cr}$	3/8	6/4	8/8	10
		$C_{min}$	1/8	2/4	3/8	4
		$f_{cmin}$	0.70	0.70	0.70	0.70
1 3/8			0.70			
1 1/2			0.72			
2			0.79			
2 1/2			0.87			
2 3/4			0.91	0.70		
3			0.94	0.72		
3 3/8			1.00	0.75	0.70	
3 1/2				0.76	0.71	
4				0.79	0.74	0.70
4 1/2				0.83	0.77	0.73
5				0.87	0.80	0.75
5 1/2				0.91	0.83	0.78
6				0.94	0.86	0.80
6 1/2				0.98	0.89	0.83
6 3/4				1.00	0.90	0.84
7					0.92	0.85
7 1/2					0.95	0.88
8					0.98	0.90
8 3/8					1.00	0.92
8 1/2						0.93
9						0.95
9 1/2						0.98
10						1.00

See Notes Below

Edge Distance Shear ( $f_c$ ) (Shear Applied Perpendicular to Edge)

Edge Dist. $C_{act}$ (in.)	Size	1/4	1/2	5/8	3/4	
		$C_{cr}$	3/8	6/4	8/8	10
		$C_{min}$	1/8	2/4	3/8	4
		$f_{cmin}$	0.30	0.30	0.30	0.30
1 3/8			0.30			
1 1/2			0.34			
2			0.52			
2 1/2			0.69			
2 3/4			0.78	0.30		
3			0.87	0.34		
3 3/8			1.00	0.41	0.30	
3 1/2				0.43	0.32	
4				0.52	0.39	0.30
4 1/2				0.61	0.46	0.36
5				0.69	0.53	0.42
5 1/2				0.78	0.60	0.48
6				0.87	0.67	0.53
6 1/2				0.96	0.74	0.59
6 3/4				1.00	0.77	0.62
7					0.81	0.65
7 1/2					0.88	0.71
8					0.95	0.77
8 3/8					1.00	0.81
8 1/2						0.83
9						0.88
9 1/2						0.94
10						1.00

See Notes Below

\* See page 10 for an explanation of the load table icons

Mechanical Anchors

## Load-Adjustment Factors for Carbon-Steel Wedge-All® Anchors in Face of Wall Installation in 8" Grout-Filled CMU: Edge Distance, Tension and Shear Loads

Edge Distance Tension ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2	5/8	3/4	
		$C_{cr}$	12	12	20	20
		$C_{min}$	4	4	4	4
		$f_{cmin}$	1.00	1.00	0.80	0.80
4			1.00	1.00	0.80	0.80
6			1.00	1.00	0.83	0.83
8			1.00	1.00	0.85	0.85
10			1.00	1.00	0.88	0.88
12			1.00	1.00	0.90	0.90
14					0.93	0.93
16					0.95	0.95
18					0.98	0.98
20					1.00	1.00

Edge Distance Shear ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2	5/8	3/4	
		$C_{cr}$	12	12	20	20
		$C_{min}$	4	4	4	4
		$f_{cmin}$	0.79	0.52	0.32	0.32
4			0.79	0.52	0.32	0.32
5			0.82	0.58	0.36	0.36
6			0.84	0.64	0.41	0.41
7			0.87	0.70	0.45	0.45
8			0.90	0.76	0.49	0.49
9			0.92	0.82	0.53	0.53
10			0.95	0.88	0.58	0.58
11			0.97	0.94	0.62	0.62
12			1.00	1.00	0.66	0.66
13					0.70	0.70
14					0.75	0.75
15					0.79	0.79
16					0.83	0.83
17					0.87	0.87
18					0.92	0.92
19					0.96	0.96
20					1.00	1.00

- $C_{act}$  = actual edge distance at which anchor is installed (inches).
- $C_{cr}$  = critical edge distance for 100% load (inches).
- $C_{min}$  = minimum edge distance for reduced load (inches).
- $f_c$  = adjustment factor for allowable load at actual edge distance.
- $f_{c,c}$  = adjustment factor for allowable load at critical edge distance.  $f_{c,c}$  is always = 1.00.
- $f_{c,min}$  = adjustment factor for allowable load at minimum edge distance.
- $f_c = f_{c,min} + \frac{(1 - f_{c,min})(C_{act} - C_{min})}{(C_{cr} - C_{min})}$ .

**Load-Adjustment Factors for Reduced Spacing:**  
Critical spacing is listed in the load tables. No adjustment in load is required when the anchors are spaced at critical spacing. No additional testing has been performed to determine the adjustment factors for spacing dimensions less than those listed in the load tables.



**QUIK DRIVE®** Auto-Feed Screw Driving Systems

Quik Drive Fasteners: Minimum Coating or Material Recommendation						
Environment	Untreated	SBX/DOT & Zinc Borate	MCQ	ACQ-C, ACQ-D, CA-B, CBA-A		
				w/o Ammonia	w/ Ammonia	Higher Chemical Content
Interior Dry	Low	Low	Low	Med	Med	High
Exterior	Med	N/A	Med	Med	High	High
Higher Exposure	High	N/A	High	High	High	High

**Low** – Heavy zinc electroplate, yellow zinc dichromate, gray phosphate, C-3 mechanically galvanized, Climaseal®, TufCote®, clear zinc, 410 stainless steel

**Med** – N2000®, Quik Guard®

**High** – 305/316 stainless steel

- Use 305/316 stainless steel with any treatment chemical not listed above or in uncertain environmental exposure conditions.
- For wood with actual retention levels higher than 0.10 pcf (above ground) for CA-B and 0.20 pcf for CBA-A, or 0.25 pcf (above ground) for ACQ-D, ACQ-C and MCQ 305/316 stainless steel fasteners are recommended. Verify actual retention level with wood treater.
- Borate treated woods are not appropriate for outdoor use.
- Test results indicate that N2000 and Quik Guard will perform adequately, subject to regular maintenance and periodic inspection. However, the test protocol followed was a modified version of the nationally recognized test method AWPA E12-94. This test method is an accelerated test, so data over an extended period of time is not available. Also noteworthy is that tests run in a laboratory may not correlate to service conditions. If uncertain, use 305/316 stainless steel.
- Some treated wood may have excess surface chemicals making it potentially more corrosive. If you suspect this or are uncertain, use 305/316 stainless steel.
- Ammonia is typically used as a chemical carrier for difficult to treat wood species, such as, but not exclusive to, Douglas Fir and Hem Fir, which are usually found in the Western United States. Amine carriers are used in some of the Eastern species, such as Southern Yellow Pine. If uncertain, verify chemical chemical with wood treater.

For the latest Simpson Strong-Tie® Quik Drive coating information and additional technical information on this topic, visit our website at [www.strongtie.com/info](http://www.strongtie.com/info).

**SCREWS** Self-Drilling Fasteners

To achieve the loads shown in this catalog, the Designer must verify that the self-tapping screws used have an allowable load capacity equal to or greater than those shown in the table below.

Hex head screw sizes shown are required for connectors in this catalog. Where sheathing or finishes will be applied over the screws and low profile heads are needed, such as with bracing connectors, hurricane ties, and stud-plate ties, the Designer is to ensure that the minimum screw head diameter complies with ASME B18.6.4.

#8 x 3/4"



#10 x 3/4"



#14 x 1"

Shown  
Actual Size**Minimum ASD Loads for C-CFS10 Connector Screws**

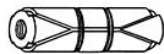
Screw No. Designation	Nominal Diameter d <sup>s</sup>	Washer Diameter d <sub>w</sub>	P <sub>ss</sub> /Ω	Shear (P <sub>ns</sub> /Ω, P <sub>ss</sub> /Ω)					P <sub>ts</sub> /Ω	Tension (Tension: Pull-Out (P <sub>not</sub> /Ω, P <sub>ts</sub> /Ω))				
				Steel Thickness: mil (ga)						Steel Thickness: mil (ga)				
				33-33 (20-20)	43-43 (18-18)	54-54 (16-16)	68-68 (14-14)	97-97 (12-12)		33 (20)	43 (18)	54 (16)	68 (14)	97 (12)
#8	0.164	0.318	335	165	245	335	335	—	655	70	95	145	150	—
#10	0.190	0.375	555	175	265	535	555	555	880	85	110	180	220	355
#14 <sup>7</sup>	0.242	0.500	810	200	295	605	810	810	1225	80	140	185	200	320

- The tabulated loads may be multiplied by a Factor of Safety (Ω) of 3 to determine the screw nominal strength. The LRFD load may be determined by multiplying the nominal screw load by a Resistance Factor (Φ) of 0.50.
- Self-tapping screw fasteners for steel-to-steel connections used for connectors in this catalog shall be in compliance with ASTM C1513.
- Values are based on cold-formed steel (CFS) members with a minimum yield strength, F<sub>y</sub>, of 33 ksi and tensile strength, F<sub>u</sub> of 45 ksi for 43 mils (18 ga) and thinner and a minimum yield strength of 50 ksi and tension strength of 65 ksi for 54 mils (16 ga) and thicker.
- Minimum base metal thickness is based on AISI General Provisions Standard Table A5.1-1. Design thickness shall be the minimum base metal thickness divided by 0.95. Design thickness for the steel sheets are: 33 mil=0.0346", 43 mil=0.0451", 54 mil=0.0566", 68 mil = 0.0713", and 97 mil = 0.1017".
- Minimum required screw length is the greater of 3/4" and the minimum length required for the screw to extend through the steel connection a minimum of (3) exposed threads per AISI General Provisions Standard Section D1.3.
- Screw diameters per 2001 AISI NAS Commentary Table C-E4-1.
- 1/4" self-tapping screws may be substituted for #14 screws.



### Drop-In Anchor

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R14DI	78630019777	Drop-In Anchor Zinc Plated	1/4	100PK	DIA14	DA25
R38DI	78630019778	Drop-In Anchor Zinc Plated	3/8	100PK	DIA38	DA38
R12DI	78630019641	Drop-In Anchor Zinc Plated	1/2	50PK	DIA12	DA50
6362	78630043008	Drop-In Anchor Zinc Plated	5/8	25PK	DIA58	D58
6375	78630043010	Drop-In Anchor Zinc Plated	3/4	10PK		DA75
R14DIT	78630063260	Drop-In Anchor Setting Tool Steel	1/4	1PK	DIA14T	AT25
R38DIT	78630063261	Drop-In Anchor Setting Tool Steel	3/8	1PK	DIA38T	AT38
R12DIT	78630063262	Drop-In Anchor Setting Tool Steel	1/2	1PK	DIA12T	AT50



### Double Expansion Anchor

Part #	NAED	Description	Size	UOM	Metallics
R14DMB	78630019879	Double Expansion Anchor Zinc Plated	1/4 x 1	10PK	DEA14
R38DMB	78630019880	Double Expansion Anchor Zinc Plated	3/8 x 1-1/2	10PK	DEA38



### Hex Nut Sleeve Anchor

Part #	NAED	Description	Size	UOM	Metallics	Dottie
1458SA	78630011935	Sleeve Anchor Hex Head Zinc Plated	1/4 x 5/8	100PK		
5205	786300X0018	Sleeve Anchor Hex Head Zinc Plated	1/4 x 1-1/8	100PK		
R14138SA	78630019651	Sleeve Anchor Hex Head Zinc Plated	1/4 x 1-3/8	100PK	2513	SA14138
R14214SA	78630019652	Sleeve Anchor Hex Head Zinc Plated	1/4 x 2-1/4	100PK	2522	SA14214
R38178SA	78630047009	Sleeve Anchor Hex Head Zinc Plated	3/8 x 1-7/8	50PK	3717	SA38178
R383SA	78630019693	Sleeve Anchor Hex Head Zinc Plated	3/8 x 3	25PK	3730	SA38300
5022SJ	78630047011	Sleeve Anchor Hex Head Zinc Plated	1/2 x 2-1/4	25PK		SA12214
5030SJ	78630047027	Sleeve Anchor Hex Head Zinc Plated	1/2 x 2-3/4	25PK	5026	



### Metal Hammer Drive Anchor

Part #	NAED	Description	Screw Size	UOM	Metallics	Dottie
R78HD	78630019841	Hammer Drive Anchor Nail-In	3/16 x 7/8	100PK	NA316	ZA78
R34HD	78630019857	Hammer Drive Anchor Nail-In	1/4 x 3/4	100PK	NA140	
R1HD	78630019858	Hammer Drive Anchor Nail-In	1/4 x 1	100PK	NA141	ZA100
R114HD	78630019859	Hammer Drive Anchor Nail-In	1/4 x 1-1/4	100PK	NA1414	ZA125
R112HD	78630019860	Hammer Drive Anchor Nail-In	1/4 x 1-1/2	100PK	NA1415	ZA150
R2HD	78630019861	Hammer Drive Anchor Nail-In	1/4 x 2	100PK	NA142	ZA200
R34HS	78630019629	Hammer Drive Anchor Screw-In	1/4 x 3/4	100PK		
R1HS	78630019630	Hammer Drive Anchor Screw-In	1/4 x 1	100PK		
R114HS	78630019631	Hammer Drive Anchor Screw-In	1/4 x 1-1/4	100PK		
R112HS	78630019632	Hammer Drive Anchor Screw-In	1/4 x 1-1/2	100PK		
R2HS	78630019633	Hammer Drive Anchor Screw-In	1/4 x 2	100PK		



### Wedge Anchor (Stud Anchor)

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R14134WA	78630019645	Wedge Anchor Zinc Plated	14 x 1-3/4	100PK	TS1124	W14134
R14214WA	78630019646	Wedge Anchor Zinc Plated	1/4 x 2-1/4	100PK	TS1214	W14214
R14314WA	78630019706	Wedge Anchor Zinc Plated	1/4 x 3-1/4	100PK	TS103	W14314
R38214WA	78630019647	Wedge Anchor Zinc Plated	3/8 x 2-1/4	50PK	TS3218	W38214
R38234WA	78630019648	Wedge Anchor Zinc Plated	3/8 x 2-3/4	50PK	TS3234	T38234
R383WA	78630019705	Wedge Anchor Zinc Plated	3/8 x 3	50PK	TS303	W38300
R38334WA	78630019649	Wedge Anchor Zinc Plated	3/8 x 3-3/4	25PK	TS312	W38334
R385WA	78630019851	Wedge Anchor Zinc Plated	3/8 x 5	15PK	TS385	W38500
R12234WA	78630019700	wedge Anchor Zinc Plated	1/2 x 2-3/4	25PK	TS4234	W12234
R12334WA	78630019717	Wedge Anchor Zinc Plated	1/2 x 3-3/4	25PK	TS4334	W12334
R12414WA	78630019852	Wedge Anchor Zinc Plated	1/2 x 4-1/4	10PK	TS4414	W12400
R12512WA	78630019853	Wedge Anchor Zinc Plated	1/2 x 5-1/2	10PK	TS4512	W12512
6426	78630044026	Wedge Anchor Zinc Plated	1/2 x 7	25PK	TS407	
6430	78630044028	Wedge Anchor Zinc Plated	5/8 x 3-1/2	25PK	TS5312	
R7300	78630044200	Wedge Anchor Stainless Steel	1/4 x 1-3/4	100PK	TS1134SS	WS14134
R7304	78630044204	Wedge Anchor Stainless Steel	1/4 x 3-1/4	100PK	TS103SS	WS14314
R7313	78630044210	Wedge Anchor Stainless Steel	3/8 x 3	50PK	TS303SS	WS38300
R7320	78630044216	Wedge Anchor Stainless Steel	1/2 x 3-3/4	50PK	TS4334SS	WS12334



### Hammer Drive Wedge Anchor

Part #	NAED	Description	Size	UOM	Metallics
DFS14134AS	78630080200	Hammer Drive Wedge Anchor Zinc Plated	1/4 x 1-3/4	100PK	HW14134
DFS12234AS	78630080207	Hammer Drive Wedge Anchor Zinc Plated	1/2 x 2-3/4	100PK	HW12234
DFS12312AS	78630080208	Hammer Drive Wedge Anchor Zinc Plated	1/2 x 3-1/2	50PK	HW12312



### Rod Hanger Wedge Anchor

Part #	NAED	Description	Size	UOM	Metallics
5810J	78630047032	Rod Hanger Wedge Anchor	5/16 Dia.	50PK	
5815	78630005815	Rod Hanger Wedge Anchor	3/8 Dia.	50PK	RCA38
5825	78630047034	Rod Hanger Wedge Anchor	1/2 Dia.	25PK	RCA12



### Hand Drive Pin

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R34DP	78630019634	Drive Pin Zinc Plated	1/4 x 3/4 Long	100PK	DP2	HD220
R1DP	78630019635	Drive Pin Zinc Plated	1/4 x 1 Long	100PK	DP3	HD230
R114DP	78630019636	Drive Pin Zinc Plated	1/4 x 1-1/4 Long	100PK	DP4	HD240
1405J	78630096458	Drive Pin Zinc Plated	1/4 x 1-1/2 Long	100PK	DP5	HD255
143	78630039014	Drive Pin Installation Tool		1PK	HDT2	



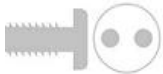
### Machine Screw > Flat Head > Phillips

Part #	NAED	Description	Size	UOM	Metallics (Slot)	Dottie (Slot)
R612FHP	78630019440	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1/2	100PK	FM80	FM63212
R634FHP	78630019441	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 3/4	100PK	FM81	FM63234
R61FHP	78630019442	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1	100PK	FM63	FM6321
R6114FHP	78630019443	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/4	100PK	FM68	FM632114
R6112FHP	78630019444	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/2	100PK	FM82	FM632112
6112FHP2C	78630034039	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/2	200PK		
R62FHP	78630019445	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 2	100PK	FM83	FM6322
R6212FHP	78630019446	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1/2	100PK	FM140	FM63212
R63FHP	78630019447	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 3	100PK	FM142	FM6323
R81FHP	78630096119	Flat Head Phillips Mach. Screw Zinc Plated	8-32 x 1	100PK	FM86	FM8321
R82FHP	78630096121	Flat Head Phillips Mach. Screw Zinc Plated	8-32 x 2	100PK	FM89	FM8322



### Machine Screw > Flat Head > Slotted

Part #	NAED	Description	Size	UOM	Metallics	Dottie
832X12FHSMZJ	78630002283	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1/2	100PK	FM84	FM83212
832X34FHSMZJ	78630002287	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 3/4	100PK	FM85	FM83234
832X114FHSMZJ	78630002289	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1-1/4	100PK	FM87	FM832114
832X112FHSMZJ	78630002293	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1-1/2	100PK	FM88	FM832112
832X212FHSMZJ	78630002299	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 2-1/2	100PK	FM90	FM832212
832X3FHSMZJ	78630002301	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 3	100PK	FM91	FM8323
1032X2FHSMZJ	78630002339	Flat Head Slotted Mach. Screw Zinc Plated	10-32 x 2	100PK	FM93	FM10322
1420X12FHSMZJ	78630002357	Flat Head Slotted Mach. Screw Zinc Plated	1/4-20 x 1/2	100PK	FM99	FM1412
1420X2FHSMZJ	78630002369	Flat Head Slotted Mach. Screw Zinc Plated	1/4-20 x 2	100PK	FM104	FM142
R632FHSSKIT	78630019994	Flat Head Slotted Mach. Screw KIT	Assorted 6-32	1PK	FMK632	632



### Tamper Proof Machine Screw > Pan Head > Spanner

Part #	NAED	Description	Size	UOM	Metallics	Dottie
632X12PHSPMSSS	78630012530	Tamp. Resist Mach. Screw- Pan-Spanner	6-32 x 1/2	50PK	TP300SPC	T63212SP



### Self-Drilling Screw > Pan Head > Phillips

Part #	NAED	Description	Size	UOM	Metallics	Dottie
6X34PHPTJ	78630003087	Pan Head Phillips Self Drill Screw Zinc Plated	6 x 3/4	100PK	TEK11P	TEKPH634
6X1PHPTJ	78630003089	Pan Head Phillips Self Drill Screw Zinc Plated	6 x 1	100PK	TEK12P	TEKPH61
R812PHPT	78630019727	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1/2	100PK	TEK1P	TEKPH812
R834PHPT	78630019728	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 3/4	100PK	TEK2P	TEKPH834
R81PHPT	78630019735	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1	100PK	TEK14P	TEKPH81
8X112PHPTJ	78630003101	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1-1/2	100PK	TEK15P	TEKPH8112
R1012PHPT	78630019729	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1/2	100PK	TEK4P	TEKPH1012
R1034PHPT	78630019730	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 3/4	100PK	TEK3P	TEKPH1034
R101PHPT	78630019731	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1	100PK	TEK7P	TEKPH101
R10112PHPT	78630019756	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1-1/2	100PK	TEK19P	TEKPH10112

### Self-Drilling Screw > Pan Head > Square Drive

Part #	NAED	Description	Size	UOM	Dottie
10X114PHPT	786300X0034	Pan Head Square Drive Self Drill Screw Zinc Plated	10 x 1-1/4	100PK	TEKDD10114



### Self-Drilling Screw > Hex Washer Head

Part #	NAED	Description	Size	UOM	Metallics	Dottie
612HTJ	78630003045	Hex Washer Head Self Drill Screw Zinc Plated	6 x 1/2	100PK		TEKHW612
6X34HT	78630017460	Hex Washer Head Self Drill Screw Zinc Plated	6 x 3/4	100PK		
6X1HT	78630017465	Hex Washer Head Self Drill Screw Zinc Plated	6 x 1	100PK		
R812HT	78630019495	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1/2	100PK	TEKD1	TEKHW812
R834HT	78630019496	Hex Washer Head Self Drill Screw Zinc Plated	8 x 3/4	100PK	TEDK2	TEKHW834
R81HT	78630019497	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1	100PK	TEKD14	TEKHW81
8X114HTJ	78630096182	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1-1/4	100PK		TEKHW8114
8X112HTJ	78630096184	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1-1/2	100PK	TEKD15	TEKHW8112
8X2HTJ	78630096186	Hex Washer Head Self Drill Screw Zinc Plated	8 x 2	100PK		TEKHW82
R1012HT	78630019501	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1/2	100PK	TEKD5	TEKHW1012
10X58HTJ	78630003059	Hex Washer Head Self Drill Screw Zinc Plated	10 x 5/8	100PK	TEKD17	
R1034HT	78630019502	Hex Washer Head Self Drill Screw Zinc Plated	10 x 3/4	100PK	TEKD6	TEKHW1034
R101HT	78630019503	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1	100PK	TEKD7	TEKHW101
R10114HT	78630019504	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1-1/4	100PK	TEKD18	TEKHW10114
R10112HT	78630019505	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1-1/2	100PK	TEKD19	TEKHW10112
R102HT	78630019506	Hex Washer Head Self Drill Screw Zinc Plated	10 x 2	100PK	TEKD22	TEKHW102
R1234HT	78630019507	Hex Washer Head Self Drill Screw Zinc Plated	12 x 3/4	100PK	TEKD20	TEKHW1234
R121HT	78630019508	Hex Washer Head Self Drill Screw Zinc Plated	12 x 1	100PK	TEKD8	TEKHW121
R12112HT	78630019510	Hex Washer Head Self Drill Screw Zinc Plated	12 x 1-1/2	100PK	TEKD21	TEKHW12112
R122HT	78630019511	Hex Washer Head Self Drill Screw Zinc Plated	12 x 2	100PK	TEKD32	TEKHW122
R1434HT	78630019765	Hex Washer Head Self Drill Screw Zinc Plated	14 x 3/4	100PK	TEKD9	TEKHW1434
R141HT	78630019748	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1	100PK	TEKD10	TEKHW141
14X114HTJ	78630003079	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1-1/4	100PK		TEKHW14114
R14112HT	78630019750	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1-1/2	100PK	TEKD11	TEKHW14112
R142HT	78630019751	Hex Washer Head Self Drill Screw Zinc Plated	14 x 2	100PK	TEKD34	TEKHW142
RTEKKIT	78630020030	Hex Washer Head Self Drill Screw KIT	Assorted	1PK	TEKDK1	



### Self-Drilling Screw > Heavy Duty Tek Screw

Part #	NAED	Description	Size	UOM	Metallics
1224X114HTJ	78630003377	Heavy Duty Steel-to-Steel Applications	12-24 x 1-1/4	100PK	TXV12114

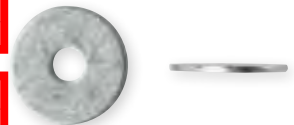


BizLine Part #	UPC	Size	Description	Unit Size	Lid Colors	*Commonly sold products
<b>SCREWS, WASHERS, NUTS AND BOLTS</b>						
R61DSYZ	19736	6 x 1	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R61DSYZ5	19739	6 x 1	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6118DSYZ	19744	6 x 1-1/8	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6118DSYZ5	19740	6 x 1-1/8	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6114DSYZ	19732	6 x 1-1/4	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6114DSYZ5	19741	6 x 1-1/4	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6158DSYZ	19733	6 x 1-5/8	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6158DSYZ5	19742	6 x 1-5/8	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R62DSYZ	19734	6 x 2	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R62DSYZ250	19743	6 x 2	Bugle Phillip Drywall Screw Yellow Zinc	250	Red	
R8212DSYZ	19737	8 x 2½	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R83DSYZ	19738	8 x 3	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6114DSD	80004	6 x 1¼	Bugle Phillip Deck Screw Dacrotized	100	Red	
R812WT	19491	8 x ½	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R812WT5	19745	8 x ½	Wafer Head Phillip Self Drill Screw Zinc Plated	500	White	
R834WT	19492	8 x ¾	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R834WT5	19746	8 x ¾	Wafer Head Phillip Self Drill Screw Zinc Plated	500	White	
R81WT	19493	8 x 1	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R8114WT	19494	8 x 1¼	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R812HT	19495	8 x ½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R834HT	19496	8 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R81HT	19497	8 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R8112HT	19499	8 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R82HT	19500	8 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1012HT	19501	10 x ½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1058HT	19747	10 x 5/8	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1034HT	19502	10 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R101HT	19503	10 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R10114HT	19504	10 x 1¼	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R10112HT	19505	10 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R102HT	19506	10 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1234HT	19507	12 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R121HT	19508	12 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R12114HT	19509	12 x 1¼	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R12112HT	19510	12 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R122HT	19511	12 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1434HT	19765	14 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R141HT	19748	14 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R14112HT	19750	14 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R142HT	19751	14 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R612PHPT	19752	6 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R61PHPT	19754	6 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R812PHPT	19727	8 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R834PHPT	19728	8 x ¾	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R81PHPT	19735	8 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R8112PHPT	19755	8 x 1½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R1012PHPT	19729	10 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R1034PHPT	19730	10 x ¾	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R101PHPT	19731	10 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R10112PHPT	19756	10 x 1½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R6716FS	19512	6 x 7/16	Pan Head Phillip Sharp Point Framing Screw	100	Red	
R6716FT	19513	6 x 7/16	Pan Head Phillip Framing Tek	100	White	
R6716FSM	19514	6 x 7/16	Pan Head Phillip Sharp Point Framing Screw	1000	Red	
R632HN	19516	6-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R832HN	19517	8-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R1024HN	19518	10-24	Hex Machine Screw Nut Zinc Plated	100	Green	
R1032HN	19519	10-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R1420HN	19520	¼-20	Finished Hex Nut Zinc Plated	100	Green	
R51618HN	19521	5/16-18	Finished Hex Nut Zinc Plated	100	Green	
R3816HN	19522	3/8-16	Finished Hex Nut Zinc Plated	100	Green	
R1213HN	19523	½-13	Finished Hex Nut Zinc Plated	100	Green	





BizLine Part #	UPC	Size	Description	Unit Size	Lid Colors	*Commonly sold products
<b>SCREWS, WASHERS, NUTS AND BOLTS</b>						
R1420NLN	55550	¼-20	Nylon Insert Lock Nut Zinc Plated	100	Green	
R14RC	19524	¼-20	Rod Coupling Nut Zinc Plated	100	Green	
R14RC10	19532	¼-20	Rod Coupling Nut Zinc Plated	10	Green	
R38RC	19525	⅜-16	Rod Coupling Nut Zinc Plated	100	Green	
R38RC10	19547	⅜-16	Rod Coupling Nut Zinc Plated	10	Green	
R12RC	19526	½-13	Rod Coupling Nut Zinc Plated	50	Green	
R12RC10	19563	½-13	Rod Coupling Nut Zinc Plated	10	Green	
R1420HNG5	12225	¼-20	Hex Nut Grade 5 Zinc Plated	100	Green	
R3816HNG5	12226	⅜-16	Hex Nut Grade 5 Zinc Plated	100	Green	
R316FWU	19527	⅜	Flat Washer USS Zinc Plated	100	Yellow	
R14FWU	19528	¼	Flat Washer USS Zinc Plated	100	Yellow	
R516FWU	19529	⅝	Flat Washer USS Zinc Plated	100	Yellow	
R38FWU	19530	⅜	Flat Washer USS Zinc Plated	100	Yellow	
R12FWU	19531	½	Flat Washer USS Zinc Plated	100	Yellow	
R6FWS	19533	#6	Flat Washer SAE Zinc Plated	100	Yellow	
R8FWS	19534	#8	Flat Washer SAE Zinc Plated	100	Yellow	
R10FWS	19535	#10	Flat Washer SAE Zinc Plated	100	Yellow	
R14FWS	11807	¼	Flat Washer SAE Zinc Plated	100	Yellow	
R38FWS	11808	⅜	Flat Washer SAE Zinc Plated	100	Yellow	
R12FWS	11771	½	Flat Washer SAE Zinc Plated	100	Yellow	
R3161FW	19536	⅜ x 1	Fender Washer Zinc Plated	100	Yellow	
R31614FW	19537	⅜ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R141FW	19538	¼ x 1	Fender Washer Zinc Plated	100	Yellow	
R14114FW	19539	¼ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R14112FW	19540	¼ x 1½	Fender Washer Zinc Plated	100	Yellow	
R142FW	19541	¼ x 2	Fender Washer Zinc Plated	100	Yellow	
R51614FW	19692	⅝ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R381FW	19691	⅜ x 1	Fender Washer Zinc Plated	100	Yellow	
R38114FW	19542	⅜ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R38112FW	19543	⅜ x 1½	Fender Washer Zinc Plated	100	Yellow	
R382FW	19544	⅜ x 2	Fender Washer Zinc Plated	100	Yellow	
R12112FW	19545	½ x 1½	Fender Washer Zinc Plated	100	Yellow	
R122FW	19546	12 x 2	Fender Washer Zinc Plated	100	Yellow	
R6LW	19548	#6	Lock Washer Zinc Plated	100	Yellow	
R8LW	19549	#8	Lock Washer Zinc Plated	100	Yellow	
R10LW	19550	#10	Lock Washer Zinc Plated	100	Yellow	
R14LW	19551	¼	Lock Washer Zinc Plated	100	Yellow	
R516LW	19552	⅝	Lock Washer Zinc Plated	100	Yellow	
R38LW	19553	⅜	Lock Washer Zinc Plated	100	Yellow	
R12LW	19554	½	Lock Washer Zinc Plated	100	Yellow	
R14FW188	03900	1/4	Flat Washer 18-8 Stainless Steel	100	Yellow	
R38FW188	12228	3/8	Flat Washer 18-8 Stainless Steel	100	Yellow	
R12FW188	12229	1/2	Flat Washer 18-8 Stainless Steel	50	Yellow	
R14114FW188	12233	1/4 x 1-1/4	Fender Washer 18-8 Stainless Steel	100	Yellow	
R14LW188	03918	1/4	Lock Washer 18-8 Stainless Steel	100	Yellow	
R38LW188	12234	3/8	Lock Washer 18-8 Stainless Steel	100	Yellow	
R12LW188	12235	1/2	Lock Washer 18-8 Stainless Steel	50	Yellow	
R1412HBG5	19830	¼ x ½	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R1434HBG5	19831	¼ x ¾	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R141HBG5	19832	¼ x 1	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R381HBG5	19836	⅜ x 1	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R38114HBG5	19837	⅜ x 1¼	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R38112HBG5	19838	⅜ x 1½	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R1412HB	19555	¼ x ½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R1434HB	19556	¼ x ¾	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R141HB	19557	¼ x 1	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R14114HB	19558	¼ x 1¼	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R14112HB	19559	¼ x 1½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R142HB	19560	¼ x 2	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R143HB	19562	¼ x 3	Hex Tap Bolt Grade 2 Zinc Plated	50	Orange	
R3812HB	19565	⅜ x ½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R3834HB	19566	⅜ x ¾	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R381HB	19567	⅜ x 1	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	



# Bolts



## Hex Head Tap Bolt > Grade 2 > Full Thread

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R1412HB	78630019555	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1/2	100PK	HTB11	MB1412
1412HB2C	78630034004	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1/2	200PK		
R1434HB	78630019556	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3/4	100PK	HTB1	MB1434
1434HB2C	78630034035	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3/4	200PK		
R141HB	78630019557	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1	100PK	HTB2	MB141
141HB2C	78630034032	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1	200PK		
R14114HB	78630019558	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/4	100PK	HTB49	MB14114
14114HB2C	78630034043	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/4	200PK		
R14112HB	78630019559	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/2	100PK	HTB3	MB14112
14112HB2C	78630034042	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/2	200PK		
R142HB	78630019560	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 2	100PK	HTB4	MB142
R143HB	78630019562	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3	50PK	HTB6	MB143
14X4HBG2ZJ	78630096314	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 4	50PK		MB144
14X5HBG2ZJ	78630009038	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 5	100PK		MB145
516X12HBG2GZJ	78630009053	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 1/2	100PK		MB51612
516X212HBG2Z	78630009072	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 2-1/2	100PK		MB516212
516X3HBG2Z	78630009076	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 3	100PK		MB5163
R3812HB	78630019565	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1/2	100PK	HTB88	MB3812
R3834HB	78630019566	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 3/4	100PK	HTB44	MB3834
R381HB	78630019567	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1	100PK	HTB45	MB381
R38114HB	78630019568	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1-1/4	100PK	HTB59	MB38114
R38112HB	78630019569	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1-1/2	100PK	HTB23	MB38112
R382HB	78630019570	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 2	50PK	HTB24	MB382
R38212HB	78630019571	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 2-1/2	50PK	HTB25	MB38212
R383HB	78630019572	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 3	50PK	HTB26	MB383
38X5HBG2Z	78630009138	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 5	50PK		MB385
R1234HB	78630019575	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3/4	50PK		MB1234
1234HB1C	78630034011	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3/4	100PK		
R121HB	78630019576	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1	50PK	HTB46	MB121
R12114HB	78630019577	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1-1/4	50PK	HTB64	MB12114
R12112HB	78630019578	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1-1/2	50PK	HTB47	MB12112
R122HB	78630019579	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 2	50PK	HTB33	MB122
R12212HB	78630019580	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 2-1/2	25PK	HTB34	MB12212
R123HB	78630019581	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3	25PK	HTB35	MB123
12X5HBG2Z	78630009216	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 5	25PK		MB125
58X1HBG2Z	78630009238	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/8 x 1	25PK		MB581
34X1HBG2Z	78630009288	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 1	25PK		MB341
34X112HBG2Z	78630009292	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 1-1/2	25PK		MB34112
34X6HBG2Z	78630009320	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 6	25PK		MB346

# Nuts



## Machine Screw Hex Nuts

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R632HN	78630019516	Machine Screw Hex Nut Zinc Plated	6-32	100PK	N159	HN632
632HN2C	78630034012	Machine Screw Hex Nut Zinc Plated	6-32	200PK		
R832HN	78630019517	Machine Screw Hex Nut Zinc Plated	8-32	100PK	N160	HN832
832HN2C	78630034016	Machine Screw Hex Nut Zinc Plated	8-32	200PK		
R1024HN	78630019518	Machine Screw Hex Nut Zinc Plated	10-24	100PK	N161	HN1024
1024HN2C	78630034023	Machine Screw Hex Nut Zinc Plated	10-24	200PK		
R1032HN	78630019519	Machine Screw Hex Nut Zinc Plated	10-32	100PK	N162	HN1032
1032HN2C	78630034022	Machine Screw Hex Nut Zinc Plated	10-32	200PK		
632HNSS	78630070002	Machine Screw Hex Nut Stainless Steel	6-32	100PK	SN10	HNS632
832HNSS	78630070004	Machine Screw Hex Nut Stainless Steel	8-32	100PK	SN11	HNS832
1024HNSS	78630070006	Machine Screw Hex Nut Stainless Steel	10-24	100PK	SN12	HNS1024
1032HNSS	78630070008	Machine Screw Hex Nut Stainless Steel	10-32	100PK	SN13	HNS1032



## Finished Hex Nuts

Part #	NAED	Description	Size	UOM	Metallics	Dottie
1420HN	78630011803	Grade 2 Finished Hex Nut Zinc Pltd	1/4-20	100PK	N163	HN14
1420HN2C	78630034020	Grade 2 Finished Hex Nut Zinc Pltd	1/4-20	200PK		
R51618HN	78630019521	Grade 2 Finished Hex Nut Zinc Pltd	5/16-18	100PK	N164	HN516
51618HN2C	78630034009	Grade 2 Finished Hex Nut Zinc Pltd	5/16-18	200PK		
R3816HN	78630019522	Grade 2 Finished Hex Nut Zinc Pltd	3/8-16	100PK	N165	HN38
1213HN	78630011806	Grade 2 Finished Hex Nut Zinc Pltd	1/2-13	100PK	N166	HN12
58FHNUSSZ	78630005030	Grade 2 Finished Hex Nut Zinc Pltd	5/8-11	50PK	N167	HN58
34FHNUSSZ	78630005032	Grade 2 Finished Hex Nut Zinc Pltd	3/4-10	50PK	N168	HN34
12HHNZ	78630005100	Grade 2 Hvy Finished Hex Nut Zinc Pltd	1/2-13	100PK	HHN12	
14HNG5USSZ	78630005400	Grade 5 Finished Hex Nut Zinc Pltd	1/4-20	100PK	G5N163	5HN14
38HNG5USSZ	78630005404	Grade 5 Finished Hex Nut Zinc Pltd	3/8-16	100PK	G5N165	5HN38
12HNG5USSZ	78630005408	Grade 5 Finished Hex Nut Zinc Pltd	1/2-13	100PK	G5N166	5HN12
14HNG8USSYZJ	78630005340	Grade 8 Finished Hex Nut Zinc Pltd	1/4-20	100PK	G8N163	8HN14
38HNG8USSYZJ	78630005342	Grade 8 Finished Hex Nut Zinc Pltd	3/8-16	100PK	G8N165	8HN38
1213HNG8USSYZJ	78630005344	Grade 8 Finished Hex Nut Zinc Pltd	1/2-13	50PK	G8N166	8HN12
R1420HN188	78630003909	Finished Hex Nut 18-8 Stainless Steel	1/4-20	100PK	SN14	HNS14
R3816HN188	78630003919	Finished Hex Nut 18-8 Stainless Steel	3/8-16	100PK	SN16	HNS38
R1213HN188	78630003910	Finished Hex Nut 18-8 Stainless Steel	1/2-13	100PK	SN18	HNS12
51618HNSS	78630070012	Finished Hex Nut 316 Stainless Steel	5/16-18	100PK	SN15	HNS516
5811HN316SS	78630070020	Finished Hex Nut 316 Stainless Steel	5/8-11	50PK		HNS58
3410HNSS	78630070022	Finished Hex Nut 316 Stainless Steel	3/4-10	50PK		HNS34
1420HNSB	78630070036	Finished Hex Nut Silicone Bronze	1/4-20	100PK	SBN14	HNBZ14
51618HNSB	78630070038	Finished Hex Nut Silicone Bronze	5/16-18	100PK	SBN516	HNBZ516
3816HNSB	78630070040	Finished Hex Nut Silicone Bronze	3/8-16	100PK	SBN38	HNBZ38
1213HNSB	78630070042	Finished Hex Nut Silicone Bronze	1/2-13	50PK	SBN12	HNBZ12
HNKIT	78630000086	Hex Nut KIT – Zinc Plated	Various	400PK	NK1	339

## Tapered with Wings PC 4370



- Tapered with Wings
- Plastic
- Packed in Invincibox™
- Wings Secure Anchor From Spinning

Plastic anchors: Tapered with Wings. Drill a hole into drywall, concrete, brick or block and insert anchor. The screw is then installed through the fixture into the anchor. Used for light duty work.

CAT NO	UPC	SCREW SIZE	DRILL SIZE	LENGTH	COLOR	STD	SLEEVE	MSTR	WT/STD	UNIT
121	31430	4-6-8	3/16"	1"	White	100	500	4000	0.11#	C
122	31432	8-10-12	1/4"	1-1/4"	Yellow	100	500	3000	0.20#	C
123	31434	12-14-16	5/16"	1-1/2"	Green	50	250	1500	0.15#	C

## Tapered with Collar PC 4370



- Tapered with Collar
- Plastic
- Packed in Invincibox™

Plastic anchors: Tapered w/Collar. Drill a hole into drywall, concrete, brick or block and insert anchor. The screw is then installed through the fixture into the anchor. Used for light duty work.

CAT NO	UPC	SCREW SIZE	DRILL SIZE	LENGTH	COLOR	STD	SLEEVE	MSTR	WT/STD	UNIT
20	15080	4-6-8	3/16"	3/4"	Red	100	500	4000	0.08#	C
21	15085	6-8-10	3/16"	7/8"	Red	100	500	4000	0.08#	C
22	15090	8-10-12	1/4"	1"	Red	100	500	3000	0.15#	C
23	15095	12-14-16	5/16"	1-1/2"	Red	50	250	1500	0.14#	C

## Straight PC 4370



- Straight
- Ribbed Body
- Plastic
- Packed in Invincibox™

Plastic anchors: Straight. Drill a hole into drywall, concrete, brick or block and insert anchor. The screw is then installed through the fixture into the anchor. Used for light duty work.

CAT NO	UPC	SCREW SIZE	DRILL SIZE	LENGTH	COLOR	STD	SLEEVE	MSTR	WT/STD	UNIT
221	16085	6-8	3/16"	1"	White	100	500	4000	0.15#	C
222	16090	10-12	1/4"	1"	Green	100	500	3000	0.22#	C
223	16095	12-14	5/16"	1-1/2"	Blue	50	250	1500	0.23#	C

## Nylon Button Head with Pins PC 4370



- Straight
- Ribbed Body
- Nylon
- Steel Pin

Nylon button head anchors with pins. Fast and easy to install. Position the fixture, drill a hole into concrete, brick or block and insert anchor through the fixture into the hole. Hammer the nail to spread and secure anchor. Used for light duty work.

CAT NO	UPC	SIZE	LENGTH	COLOR	STD	SLEEVE	MSTR	WT/STD	UNIT
1711	10070	3/16"	1"	White	100	500	3000	0.55#	C
1714	10075	1/4"	1"	White	100	500	3000	0.57#	C

## Triple Grip PC 4370



- Claws Grip For Strength
- Wings For Strength and Vibration Resistance
- Core Expands For additional Holding Power



CAT NO	UPC	SCREW SIZE	DRILL SIZE	LENGTH	COLOR	STD	SLEEVE	MSTR	WT/STD	UNIT
6	81643	#6	1/4"	1-1/4"	Beige	100	500	4000	0.91#	C
7	81644	#8	1/2"	1-1/2"	Grey	100	500	4000	1.07#	C
10	81645	#10	5/16"	1-1/2"	Blue	50	250	1500	0.60#	C
12	81646	#12	3/8"	1-1/2"	Green	50	250	1500	1.29#	C

See new products at [Ihdottie.com](http://Ihdottie.com)

Dottie







- 100 Sheet Metal Screws
- 100 Anchors
- Carbide Masonry Drill
- Display or Tuff Pack
- Caution! Always Wear Eye Protection

Dottie is an industry leader in Anchor Kits. We offer a comprehensive variety for almost any imaginable need.

CAT NO	UPC	D-DISPLAY PACK T-TUFF PACK	SCREW TYPE	ANCHOR TYPE	DRILL	STD	MSTR	WT/STD	UNIT
<b>6 x 1 Sheet Metal Screws</b>									
RD2	30460	D		Phillips/Slotted	#21 Red Collar	3/16"	1	10	0.59# Ea
RD2TP	30465	T		Phillips/Slotted	#21 Red Collar	3/16"	1	6	0.59# Ea
RD2HX	30463	D		Hex/Slotted	#21 Red Collar	3/16"	1	10	0.54# Ea
RD2HXTP	30461	T		Hex/Slotted	#21 Red Collar	3/16"	1	6	0.54# Ea
1AK	29630	D		Phillips/Slotted	#121 White Wing	3/16"	1	10	0.60# Ea
1AKTP	29632	T		Phillips/Slotted	#121 White Wing	3/16"	1	6	0.60# Ea
<b>8 x 1 Sheet Metal Screws</b>									
RD3	30467	D		Phillips/Slotted	#22 Red Collar	1/4"	1	10	0.83# Ea
RD3TP	30469	T		Phillips/Slotted	#22 Red Collar	1/4"	1	6	0.83# Ea
RD3HX	30471	D		Hex/Slotted	#22 Red Collar	1/4"	1	10	0.82# Ea
RD3HXTP	30473	T		Hex/Slotted	#22 Red Collar	1/4"	1	6	0.82# Ea
RD3DD	30475	D		Square Drive	#22 Red Collar	1/4"	1	10	0.84# Ea
RD3DDTP	30477	T		Square Drive	#22 Red Collar	1/4"	1	6	0.84# Ea
<b>10 x 1 Sheet Metal Screws</b>									
K6CO	29625	D		Phillips/Slotted	#22 Red Collar	1/4"	1	10	1.03# Ea
K6COTP	29627	T		Phillips/Slotted	#22 Red Collar	1/4"	1	6	1.03# Ea
K6HX	29621	D		Hex/Phil/Slotted	#22 Red Collar	1/4"	1	10	1.05# Ea
K6HXTP	29622	T		Hex/Phil/Slotted	#22 Red Collar	1/4"	1	6	1.05# Ea
K7DC	16945	D		Square Drive	#22 Red Collar	1/4"	1	10	1.01# Ea
K7DCTP	16947	T		Square Drive	#22 Red Collar	1/4"	1	6	1.01# Ea
2AK	59200	D		Phillips/Slotted	#122 Yellow Wing	1/4"	1	10	1.11# Ea
2AKTP	59202	T		Phillips/Slotted	#122 Yellow Wing	1/4"	1	6	1.11# Ea
2AKHX	59203	D		Hex/Phil/Slotted	#122 Yellow Wing	1/4"	1	10	1.04# Ea
2AKHXTP	59204	T		Hex/Phil/Slotted	#122 Yellow Wing	1/4"	1	6	1.04# Ea
2AKDD	59207	D		Square Drive	#122 Yellow Wing	1/4"	1	10	1.06# Ea
2AKDDTP	59206	T		Square Drive	#122 Yellow Wing	1/4"	1	6	1.06# Ea
K6D	29600	D		Phillips/Slotted	#222 Green Str.	1/4"	1	10	1.02# Ea
K6DTP	29602	T		Phillips/Slotted	#222 Green Str.	1/4"	1	6	1.02# Ea
<b>12 x 1-1/2 Sheet Metal Screws ( 50 Screws, 50 Anchors )</b>									
K14C	29615	D		Phillips/Slotted	#23 Red Collar	5/16"	1	10	0.95# Ea
K14CTP	29617	T		Phillips/Slotted	#23 Red Collar	5/16"	1	6	0.95# Ea
K14CHX	29550	D		Hex/Slotted	#23 Red Collar	5/16"	1	10	0.99# Ea
K14CHXTP	29552	T		Hex/Slotted	#23 Red Collar	5/16"	1	6	0.99# Ea
K14CDD	29554	D		Square Drive	#23 Red Collar	5/16"	1	10	0.99# Ea
K14CDDTP	29556	T		Square Drive	#23 Red Collar	5/16"	1	6	0.99# Ea
3AK	29635	D		Phillips/Slotted	#123 Yellow Wing	5/16"	1	10	0.95# Ea
3AKTP	29637	T		Phillips/Slotted	#123 Yellow Wing	5/16"	1	6	0.95# Ea
<b>Triple Grip Kits Contain: 100 6 x 1-1/4" Screws, 100 #6 Anchors</b>									
TG6KTP	81647			#6 Phillips/Slotted	#6 Beige	1/4"	1	6	0.80# Ea
TG6KSQTP	81649			#6 Square Drive	#6 Beige	1/4"	1	6	0.80# Ea
TG6KHXTTP	81651			#6 Hex/Slotted	#6 Beige	1/4"	1	6	0.80# Ea
<b>Triple Grip Kits Contain: 100 8 x 1-1/4" Screws, 100 #8 Anchors</b>									
TG8KTP	81653			#8 Phillips/Slotted	#8 Gray	1/4"	1	6	0.90# Ea
TG8KSQTP	81655			#8 Square Drive	#8 Gray	1/4"	1	6	0.90# Ea
TG8KHXTTP	81657			#8 Hex/Slotted	#8 Gray	1/4"	1	6	0.90# Ea
<b>Triple Grip Kits Contain: 100 10 x 1-1/2" Screws, 100 #10 Anchors</b>									
TG10KTP	81659			#10 Phillips/Slotted	#10 Blue	5/16"	1	6	1.30# Ea
TG10KSQTP	81661			#10 Square Drive	#10 Blue	5/16"	1	6	1.30# Ea
TG10KHXTTP	81663			#10 Hex/Slotted	#10 Blue	5/16"	1	6	1.30# Ea
<b>Triple Grip Kits Contain: 50 12 x 1-1/2" Screws, 50 #12 Anchors</b>									
TG12KTP	81665			#12 Phillips/Slotted	#12 Green	3/8"	1	6	1.30# Ea
TG12KSQTP	81667			#12 Square Drive	#12 Green	3/8"	1	6	1.30# Ea
TG12KHXTTP	81669			#12 Hex/Slotted	#12 Green	3/8"	1	6	1.30# Ea





## Drop In Anchors PC 4500, 4310

Drop In Anchors: This steel anchor performs well in a variety of concrete strengths. Can be used in brick. Any head style screw can be used. The screw can easily be removed or loosened and retightened. Drill hole in concrete and drop anchor into hole. Place setting tool over anchor and hammer until set.

- Drop In
- Zinc Plated Steel
- Stainless Steel
- Caution! Always Wear Eye Protection

CAT NO	UPC	ANCHOR SIZE	DRILL SIZE	REQUIRED TOOL	STD	MSTR	WT/STD	UNIT
<b>Steel Zinc Plated - PC 4500</b>								
DA25	27600	1/4-20	3/8"	AT25	100	1000	2.00#	C
DA38	27605	3/8-16	1/2"	AT38	50	500	3.00#	C
DA50	27610	1/2-13	5/8"	AT50	50	250	6.00#	C
DA58	27615	5/8-11	7/8"	AT58	25	125	6.00#	C
DA75	27620	3/4-10	1"	AT75	10	50	4.80#	C
<b>Stainless Steel - PC 4310</b>								
DAS25	70260	1/4-20	3/8"	AT25	100	1000	2.00#	C
DAS38	70262	3/8-16	1/2"	AT38	50	500	3.00#	C
DAS50	70264	1/2-13	5/8"	AT50	50	250	6.00#	C
DAS58	70266	5/8-11	7/8"	AT58	25	125	6.00#	C
DAS75	70268	3/4-10	1"	AT75	10	50	4.80#	C

("AT" Tool - SOLD SEPARATELY - Must Be Used For Proper Installation )



## "AT" Tool For DA Anchors PC 4510

"AT" tool must be used for proper installation. Sold separately from DA/DAS anchors

CAT NO	UPC	SIZE	ANCHOR TYPE	STD	MSTR	WT/STD	UNIT
AT25	27630	1/4"	DA25/DAS25	1	10	0.14#	Ea
AT38	27635	3/8"	DA38/DAS38	1	10	0.25#	Ea
AT50	27570	1/2"	DA50/DAS50	1	10	0.41#	Ea
AT58	27575	5/8"	DA58/DAS58	1	10	0.55#	Ea
AT75	27580	3/4"	DA75/DAS75	1	10	0.77#	Ea



## Sleeve Anchors - Zinc Plated PC 4550

Sleeve Anchors: Similar to the wedge anchor. It can be used in the same materials as the wedge anchor, but can also be used in soft concretes because the compression load can be distributed over a longer length. Can be installed through the fixture. Assemble nut and washer on stud and insert into predrilled hole. Anchor is hammered into hole until the nut is seated.

- Sleeve
- Hex or Acorn Nut
- Zinc Plated
- Available In Larger Diameters & Lengths

CAT NO	UPC	SIZE	BOLT LENGTH	DRILL DIA	MIN. EMBED	STD	MSTR	WT/STD	UNIT
<b>Acorn Nut</b>									
SA14138	59330	1/4 x 1-3/8"	1-21/32"	1/4"	1-1/8"	100	600	2.75#	C
SA14214	59332	1/4 x 2-1/4"	2-9/16"	1/4"	1-1/8"	100	600	3.25#	C
<b>Hex Nut</b>									
SA516112	59334	5/16 x 1-1/2"	1-13/16"	5/16"	1-3/8"	100	600	4.25#	C
SA516212	59336	5/16 x 2-1/2"	2-11/16"	5/16"	1-1/2"	100	500	5.75#	C
SA38178	59338	3/8 x 1-7/8"	2-3/16"	3/8"	1-5/8"	50	300	3.50#	C
SA38300	59340	3/8 x 3"	3-5/16"	3/8"	1-5/8"	50	250	5.00#	C
SA12214	59342	1/2 x 2-1/4"	2-7/8"	1/2"	2-1/8"	25	150	3.50#	C
SA12300	59344	1/2 x 3"	3-3/8"	1/2"	2-1/4"	25	150	4.30#	C
SA12400	59346	1/2 x 4"	4-3/8"	1/2"	2-1/4"	25	150	5.50#	C





# Wedge Anchors Full Thread Zinc Plated - PC 4540



- Wedge
- Full Thread
- Zinc Plated
- Available In Larger Diameters & Lengths
- Caution! Always Wear Eye Protection

Wedge anchors can be installed through the fixture. Assemble nut and washer until the nut is flush with the top of the anchor, insert into predrilled hole. Hammer anchor into hole until the washer is flush with surface of the fixture. Expand the anchor

CAT NO	UPC	ANCHOR HOLE DIA	OVERALL LENGTH	THREAD LENGTH	STD	MSTR	WT/STD	UNIT
W14134	59300	1/4-20	1-3/4"	3/4"	100	600	3.00#	C
W14214	59302	1/4-20	2-1/4"	1-1/4"	100	600	3.50#	C
W14314	59304	1/4-20	3-1/4"	2-1/4"	100	600	4.75#	C
W38214	59306	3/8-16	2-1/4"	1-1/4"	50	300	4.37#	C
W38234	59307	3/8-16	2-3/4"	1-5/8"	50	300	4.75#	C
W38300	59308	3/8-16	3"	1-7/8"	50	300	5.37#	C
W38334	59310	3/8-16	3-3/4"	2-5/8"	50	300	6.37#	C
W38500	59311	3/8-16	5"	3-7/8"	50	300	7.75#	C

The published length is the overall length of the anchor. Allow for fixture thickness plus one anchor diameter for the nut and washer thickness when selecting a length.

# Wedge Anchors Full Thread Stainless Steel PC 4310



- Wedge
- Full Thread
- Stainless Steel
- Available In Larger Diameters & Lengths

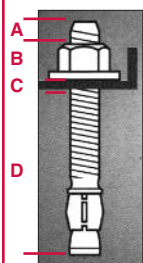
Stainless Steel Wedge Anchors resist corrosion and are ideal for applications where chemical resistance is required. Stainless can be mildly magnetic. ICC Approval (Pending).

CAT NO	UPC	ANCHOR HOLE DIA	OVERALL LENGTH	THREAD LENGTH	STD	MSTR	WT/STD	UNIT
WS14134	70310	1/4-20	1-3/4"	3/4"	100	600	3.00#	C
WS14214	70312	1/4-20	2-1/4"	1-1/4"	100	600	3.50#	C
WS14314	70314	1/4-20	3-1/4"	2-1/4"	100	600	4.75#	C
WS38214	70320	3/8-16	2-1/4"	1-1/4"	50	300	4.37#	C
WS38234	70322	3/8-16	2-3/4"	1-5/8"	50	300	4.75#	C
WS38300	70324	3/8-16	3"	1-7/8"	50	300	5.37#	C
WS38334	70326	3/8-16	3-3/4"	2-5/8"	50	300	6.37#	C
WS38500	70328	3/8-16	5"	3-7/8"	50	300	7.75#	C

The published length is the overall length of the anchor. Allow for fixture thickness plus one anchor diameter for the nut and washer thickness when selecting a length.

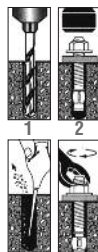
# TECH TALK

## Selection



- A** 3 turns of nut (approx. 1/2 bolt dia.) +
  - B** Nut & washer thickness (approx. 1 bolt dia.) +
  - C** Fixture thickness +
  - D** Minimum embedment (min. 4112 bolt dia.) =
- Minimum Anchor Length**  
If minimum anchor length falls between 2 sizes, use longer size. The maximum recommended anchor embedment should be 80% of the base material thickness. If a concrete slab is 10" thick, an 8" depth would be the maximum recommended anchor embedment.

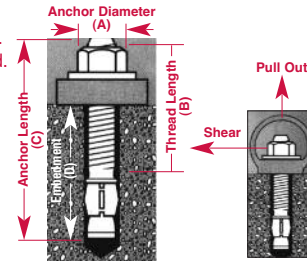
## Installation



1. Use a carbide bit (ANSI) B94 12) the same size as the bolt dia. Drill hole deeper than bolt embed. (min. 4.5 dia.) Do not use core bits. Maintain accurate hole size.
2. Clean hole debris
3. Add washer + thread nut flush with top of bolt. Drive bolt into hole through item to be fastened.
4. To set, tighten nut 3-4 full turns or consult chart for guide installation torque.

NOTE: Using in concrete cured less than 28 days will greatly reduce anchor strength.  
WARNING: WEAR SAFETY GOGGLES

## Terminology

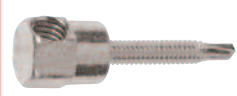




## Steel Bottom Mount Rod Hangers PC 4600

CAT NO	UPC	ROD SIZE	SCREW SHANK SIZE/LENGTH	POINT STYLE	SELF DRILLING RANGE	STD	MSTR	WT/STD UNIT	
<b>#3 For Purlins</b>									
SSM14B <b>B</b>	17591	1/4"	1/4"-20 x 1"	#3	0.036" – 0.188"	100	600	7.50#	C
SSM38BR <b>B N</b>	17592	3/8"	1/4"-20 x 1-1/2"	#3	0.036" – 0.188"	100	500	8.01#	C
<b>#5 For Beams</b>									
SSM12BR <b>B N</b>	17597	1/2"	12-24 x 1-1/2"	#5	0.188" – 0.500"	100	500	8.01#	C

Mount Direction: **B** = Bottom Mount    **B N** = Bottom Mount With Nut



## Steel Side Mount Rod Hangers PC 4600

CAT NO	UPC	ROD SIZE	SCREW SHANK SIZE/LENGTH	POINT STYLE	SELF DRILLING RANGE	STD	MSTR	WT/STD UNIT	
<b>#3 For Purlins</b>									
SSM14S <b>S</b>	17593	1/4"	1/4"-20 x 1"	#3	0.036" – 0.188"	100	600	7.30#	C
SSM38SR <b>S N</b>	17594	3/8"	1/4"-20 x 1-1/2"	#3	0.188" – 0.520"	100	500	7.00#	C

Mount Direction: **S** = Side Mount    **S N** = Side Mount With Nut

### ULTIMATE LOAD CAPACITIES INSTALLED IN MINIMUM ASTM A 36 STEEL (PURLINS AND BEAMS)

ROD DIA		SCREW SHANK	STEEL GAUGE (THICKNESS)					3/16"	1/4"
			20	18	16	14	12		
1/4"	<b>B</b>	1/4"-20 x 1"	1,550	1,550	1,775	1,775	2,050	3,850	5,040
1/4"	<b>S</b>	1/4"-20 x 1"	1,550	1,550	1,775	1,775	2,050	3,850	2,050
3/8"	<b>B N</b>	1/4"-20 x 1-1/2"	1,550	1,550	1,775	1,775	2,050	3,850	5,040
3/8"	<b>S N</b>	1/4"-20 x 1-1/2"	1,550	1,550	1,775	1,775	2,050	3,850	2,050
1/2"	<b>B N</b>	12-24 x 1-1/2"	-	-	920	1,560	2,050	3,280	5,040

Mount Direction: **B** = Bottom Mount    **B N** = Bottom Mount With Nut    **S** = Side Mount    **S N** = Side Mount With Nut

Dottie Steel Rod Hangers loaded perpendicular to the threaded rod (shear) the ultimate load capacity for the anchor is 1,965 lbs in nominal 20 gauge steel (0.036"). Steel Dottie Rod Hangers are recommended to be installed with the Universal Steel & Wood Nut Driver UNIB.



Steel Rod Hanger



Wood Rod Hanger



Concrete Rod Hanger





CAT NO	UPC	SOCKET DESCRIPTION	SUGGESTED GUIDELINES	USAGE COLOR	**SCP Series		WT/STD	UNIT
					STD	MSTR		
<b>Nut Drivers</b>								
UNIB*	17595	*Steel & Wood Universal Side & Bottom Installation Tool	500 – 1500 RPM drill speed	Red	1	5	0.25#	Ea
SCP14**	81217	1/4" Concrete Installation Tool		Blue	1	5	0.25#	Ea
SCP38**	81218	3/8" Concrete Installation Tool		Blue	1	5	0.25#	Ea
SCP50**	81248	1/2" Concrete Installation Tool		Blue	1	5	0.25#	Ea
SS3009	11209	Installation Tool Kit for Concrete Anchors			1	10	2.92#	Ea
<b>Pole Tool</b>								
PT612	81220	6' - 12' Pole Tool (includes three Jaw Chuck)			1	1	7.30#	Ea

**Save in Installation Costs**

STEEL BASE MATERIAL	SPEED OF INSTALLATION	INSTALLED COST	INSTALLATION	TYPICAL COST INSTALLED (3/8" SIZE)				
				LABOR/MIN	TIME	LABOR	MATERIAL	TOTAL
Steel Dottie Rod Hanger	Fast	Low	Very Easy	\$0.77	1	\$0.77	\$1.73	\$2.50
Beam Clamp	Slow	High	Average	\$0.77	4	\$3.08	\$2.22	\$5.30

**Save \$2.80 Save 53%**

WOOD BASE MATERIAL	SPEED OF INSTALLATION	INSTALLED COST	INSTALLATION	TYPICAL COST INSTALLED (3/8" SIZE)				
				LABOR/MIN	TIME	LABOR	MATERIAL	TOTAL
Wood Dottie Rod Hanger	Fast	Low	Easy	\$0.77	1	\$0.77	\$1.42	\$2.19
Hanger Bolt Rod/Coupler	Medium	High	Medium	\$0.77	5	\$3.85	\$0.73	\$6.54

**Save \$4.35 Save 67%**

CONCRETE BASE MATERIAL	SPEED OF INSTALLATION	INSTALLED COST	INSTALLATION	TYPICAL COST INSTALLED (3/8" SIZE)				
				LABOR/MIN	TIME	LABOR	MATERIAL	TOTAL
Concrete Dottie Rod Hanger	Medium	Low	Easy	\$0.77	5	\$3.85	\$1.42	\$5.27
Steel Dropin	Slow	High	Hard	\$0.77	11	\$8.47	\$1.02	\$9.49

**Save \$4.22 Save 44%**

\*Labor rates based on ENR 20-City average of hourly pay scales for Electricians, Plumbers and Steamfitters, report dated June 2002.

**TECH TALK**

**Installation Procedure**

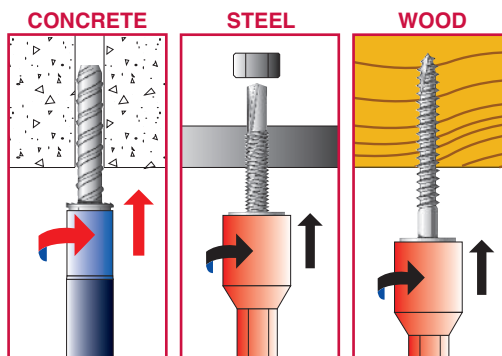
Always wear eye protection. If pre-drilling is required, select the recommended drill bit type and diameter. Drill to the appropriate embedment depth, adding at least one diameter (1/4" to 1/2") to the drilling depth to prevent the tip of the fastener from running into a dead end at the rear of the anchor hole. Select the appropriate socket driver for the anchor size and type to be installed and mount into chuck of installation tool. Insert the Dottie Rod

Hanging System fastener into the socket driver, and install perpendicular to the base material surface. Drive the

fastener with a smooth steady motion until the coupling is firmly seated against the surface of the base material.

Thread the appropriate diameter steel threaded rod or threaded bolt into the coupling. The threaded rod or bolt should fully engage the thread length of the coupling on a vertical mount fastener.

Please visit the Dottie website at [Ihdottie.com](http://Ihdottie.com) for approvals.







## Concrete Anchoring System Hi-Low Thread - PC 4560

Faster to install than most steel anchors, yet has significant load capacities. One tool drills the hole and sets the anchor without the need to remove from the drill chuck. Has the added advantage of close to edge fastening without potential breakout. Works in poured concrete, prestressed concrete, cinder block, brick, and mortar, and can be loosened for adjustment or removed. ICC Approval (Pending).

- Concrete Anchor System
- Hex Head Slotted or Flat Head Phillips
- Hi-Low Thread
- Ceramic Coated Blue Finish
- Includes Drill
- Caution! Always Wear Eye Protection

CAT NO	UPC		ANCHOR SIZE	HEX/PHILLIPS BIT SIZE	DRILL SIZE	STD	MSTR	WT/STD	UNIT
36H114	11208		3/16 x 1-1/4"	1/4"	5/32 x 3-1/2"	100	500	0.89#	C
36H134	11288	<b>Hex Head</b>	3/16 x 1-3/4"	1/4"	5/32 x 3-1/2"	100	500	1.07#	C
36H214	11368	<b>Slotted</b>	3/16 x 2-1/4"	1/4"	5/32 x 4-1/2"	100	500	1.30#	C
36H234	11448	<b>3/16"</b>	3/16 x 2-3/4"	1/4"	5/32 x 4-1/2"	100	500	1.51#	C
36H314	11528		3/16 x 3-1/4"	1/4"	5/32 x 5-1/2"	100	500	1.87#	C
14H114	25208		1/4 x 1-1/4"	5/16"	3/16 x 3-1/2"	100	500	1.44#	C
14H134	25288		1/4 x 1-3/4"	5/16"	3/16 x 3-1/2"	100	500	1.83#	C
14H214	25368	<b>Hex Head</b>	1/4 x 2-1/4"	5/16"	3/16 x 4-1/2"	100	500	2.26#	C
14H234	25448	<b>Slotted</b>	1/4 x 2-3/4"	5/16"	3/16 x 4-1/2"	100	500	2.96#	C
14H314	25528	<b>1/4"</b>	1/4 x 3-1/4"	5/16"	3/16 x 5-1/2"	100	500	3.02#	C
14H334	25608		1/4 x 3-3/4"	5/16"	3/16 x 5-1/2"	100	500	3.41#	C
14H400	25648		1/4 x 4"	5/16"	3/16 x 5-1/2"	100	500	3.62#	C
36P114	11201		3/16 x 1-1/4"	#2	5/32 x 3-1/2"	100	500	0.84#	C
36P134	11281		3/16 x 1-3/4"	#2	5/32 x 3-1/2"	100	500	1.04#	C
36P214	11361	<b>Flat Head</b>	3/16 x 2-1/4"	#2	5/32 x 4-1/2"	100	500	1.28#	C
36P234	11441	<b>Phillips</b>	3/16 x 2-3/4"	#2	5/32 x 4-1/2"	100	500	1.45#	C
36P314	11521	<b>3/16"</b>	3/16 x 3-1/4"	#2	5/32 x 5-1/2"	100	500	1.77#	C
14P114	25201		1/4 x 1-1/4"	#2	3/16 x 3-1/2"	100	500	1.39#	C
14P134	25281		1/4 x 1-3/4"	#2	3/16 x 3-1/2"	100	500	1.85#	C
14P214	25361	<b>Flat Head</b>	1/4 x 2-1/4"	#2	3/16 x 4-1/2"	100	500	2.05#	C
14P234	25441	<b>Phillips</b>	1/4 x 2-3/4"	#2	3/16 x 4-1/2"	100	500	2.53#	C
14P314	25521	<b>1/4"</b>	1/4 x 3-1/4"	#2	3/16 x 5-1/2"	100	500	2.96#	C
14P334	25601		1/4 x 3-3/4"	#2	3/16 x 5-1/2"	100	500	3.38#	C
14P400	25641		1/4 x 4"	#2	3/16 x 5-1/2"	100	500	3.61#	C



### Installation Tool - Phillips & Hex Head PC 4590

Installation tool installs all lengths of both phillips & hex head concrete screws. Consists of one each: Masonry drill bit holder; Phillips socket driver with one #2 & one #3 Phillips bit; 1/4" Hex socket driver; 5/16" Hex socket driver & Allen wrench.

- Phillips or Hex Head
- Accommodates All Lengths
- Storage Box

CAT NO	UPC	DESCRIPTION	STD	MSTR	WT/STD	UNIT
IT1000	14495	Installation Tool	1	1	1.50#	Ea



### Hammer Drill Carbide Tipped Masonry Drill Bits PC 4570

Hammer Drills (CD Series) made specifically for Concrete Screw Anchoring System and are manufactured with closer tolerances.

- Carbide Tipped
- Close Tolerances
- Caution! Always Wear Eye Protection

CAT NO	UPC		ANCHOR SIZE	DRILL SIZE	STD	MSTR	WT/STD	UNIT
CD5323	14500		3/16"	5/32 x 3-1/2"	10	10	0.22#	Ea
CD5324	14502	<b>5/32"</b>	3/16"	5/32 x 4-1/2"	10	10	0.22#	Ea
CD5325	14504		3/16"	5/32 x 5-1/2"	10	10	0.24#	Ea
CD3163	14506		1/4"	3/16 x 3-1/2"	10	10	0.25#	Ea
CD3164	14508	<b>3/16"</b>	1/4"	3/16 x 4-1/2"	10	10	0.27#	Ea
CD3165	14510		1/4"	3/16 x 5-1/2"	10	10	0.29#	Ea

SDS Rotohammer Bits See Page E4

























## Self Drilling Screw Kits - Zinc Plated PC 4810




Dottie introduced assorted screw kits over 40 years ago and has a comprehensive variety for almost any imaginable need.

- Installation Tool
- Reusable Six Compartment Box

CAT NO	UPC	DESCRIPTION	STD	MSTR	WT/STD	UNIT
<b>#8</b>						
TK800	17705	240 Assorted Self Drilling Hex Head Screws: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 30 - 8 x 1-1/4", 25 - 8 x 1-1/2", 20 - 8 x 2", + 1 - MT8 Magnetic Driver	1	6	1.50#	Ea
						
TK800DD	17706	240 Assorted Self Drilling Square Drive Screws: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 30 - 8 x 1-1/4", 25 - 8 x 1-1/2", 20 - 8 x 2", + 1 - IB2 Insert Bit	1	6	1.41#	Ea
						
TK800PH	17707	240 Assorted Self Drilling Phillips Head Screw: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 30 - 8 x 1-1/4", 25 - 8 x 1-1/2", 20 - 8 x 2", + 1 - IB2P Insert Bit	1	6	1.84#	Ea
						
<b>#10</b>						
TK100	17770	240 Assorted Self Drilling Hex Head Screws: 75 - 10 x 1/2", 50 - 10 x 3/4", 40 - 10 x 1", 30 - 10 x 1-1/4", 25 - 10 x 1-1/2", 20 - 10 x 2", + 1 - MT10 Magnetic Driver	1	6	1.85#	Ea
						
TK100DD	17701	240 Assorted Self Drilling Square Drive Screws: 75 - 10 x 1/2", 50 - 10 x 3/4", 40 - 10 x 1", 30 - 10 x 1-1/4", 25 - 10 x 1-1/2", 20 - 10 x 2", + 1 - IB2 Insert Bit	1	6	1.85#	Ea
						
TK100PH	17702	240 Assorted Self Drilling Phillips Head Screws: 75 - 10 x 1/2", 50 - 10 x 3/4", 40 - 10 x 1", 30 - 10 x 1-1/4", 25 - 10 x 1-1/2", 20 - 10 x 2", + 1 - IB2P Insert Bit	1	6	1.84#	Ea
						
<b>#8 and #10</b>						
TK810	17710	295 Assorted Self Drilling Hex Head Screws: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 50 - 10 x 1/2", 50 - 10 x 3/4", 30 - 10 x 1", + 1 Each; MT8 & MT10 Magnetic Drivers	1	6	1.92#	Ea
						
TK810DD	17711	330 Assorted Self Drilling Square Drive Screws: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 75 - 10 x 1/2", 50 - 10 x 3/4", 40 - 10 x 1", + 1 - IB2 Insert Bit	1	6	1.90#	Ea
						
TK810PH	17712	330 Assorted Self Drilling Phillips Head Screws: 75 - 8 x 1/2", 50 - 8 x 3/4", 40 - 8 x 1", 75 - 10 x 1/2", 50 - 10 x 3/4", 40 - 10 x 1", + 1 - IB2P Insert Bit	1	6	1.86#	Ea
						



## Washer Kits PC 4760

CAT NO	UPC	DESCRIPTION	STD	MSTR	WT/STD	UNIT
<b>Flat Washer Kit</b>						
FW2	15050	Flat Washer Kit (2 pounds) #8 120 pcs, #10 120 pcs, 1/4" 60 pcs, 5/16" 30 pcs, 3/8" 85 pcs, 1/2" 6 pcs	1	6	2.00#	Ea
						
<b>Fender Washer Kit</b>						
FENWK	15539	120 Assorted Zinc Plated Fender Washers 3 Sizes: 3/16 x 1-1/4", 1/4 x 1-1/4", 3/8 x 1-1/4" 40 Each Size	1	6	2.54#	Ea
						
<b>Lock Washer Kit</b>						
LWK	31005	415 Assorted Zinc Plated Lock Washers 6 Sizes: #8, #10, 1/4", 5/16", 3/8", 1/2" 100 - #8, 100 - #10, 100- 1/4", 50 - 5/16", 40 - 3/8", 25 - 1/2"	1	6	1.38#	Ea
						



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# **CONDUIT FITTINGS**

**Operations & Maintenance Manual  
December 2015**



Made in the USA Since 1946

## Rigid Couplings Three Piece Construction

- Industrial specification grade, screw machined steel, zinc plated
- 1/2" & 3/4" Steel UL Rated Liquid Tight & Concrete Tight
- 1" - 4" UL Rated Concrete Tight

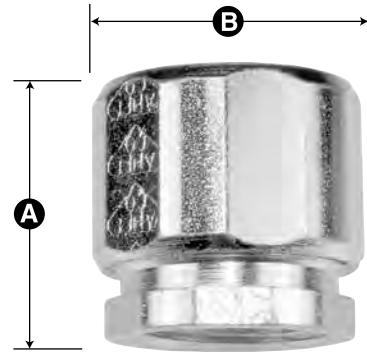


E93605



LR61799

## SPEC-grade



Featuring:  
EZ-Torque Compression Nut

### Steel - 3 Piece Couplings

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
ER50	1/2"	20	200	15
ER75	3/4"	20	100	17
ER100	1"	5	50	36
ER125	1-1/4"	5	25	52
ER150	1-1/2"	5	25	68
ER200	2"	5	25	90

### Dimensional Table

Cat. #	A Length	B Diameter
ER50	1.43	1.31
ER75	1.52	1.61
ER100	1.70	2.13
ER125	2.13	2.40
ER150	2.18	2.89
ER200	2.36	3.40

### Malleable Iron - 3 Piece Couplings

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
ER50M	1/2"	20	200	36
ER75M	3/4"	20	100	32
ER100M	1"	5	50	55
ER125M	1-1/4"	5	25	119
ER150M	1-1/2"	5	25	140
ER200M	2"	5	25	199
ER250M*	2-1/2"	-	5	361
ER300M*	3"	-	5	454
ER350M*	3-1/2"	-	4	637
ER400M*	4"	-	2	811

### Dimensional Table

Cat. #	A Length	B Diameter
ER50M	1.43	1.31
ER75M	1.52	1.61
ER100M	1.70	2.13
ER125M	2.13	2.40
ER150M	2.18	2.89
ER200M	2.36	3.40
ER250M	2.52	4.03
ER300M	2.58	4.62
ER350M	2.65	5.35
ER400M	3.42	5.87

Rigid IMC Conduit Fittings

\*malleable iron





# AMERICAN FITTINGS Corporation

Made in the USA Since 1946

Industrial **SPEC-grade**<sup>TM</sup>  
Rigid / IMC Ground Bushings  
1/2" to 4"  
Steel

Full Product Options Shown on Reverse Side

## GB Series Industrial **SPEC-grade** GROUNDING Bushings<sup>TM</sup> Set Screw, Threaded or Threadless with Insulated Throat \* With and Without Optional Ground Lug \*

Furnished with 3 Pre-Drilled Holes and Set Screws

Unique Design Allows Ease of Installation and Orientation of Set Screw & Ground Lugs

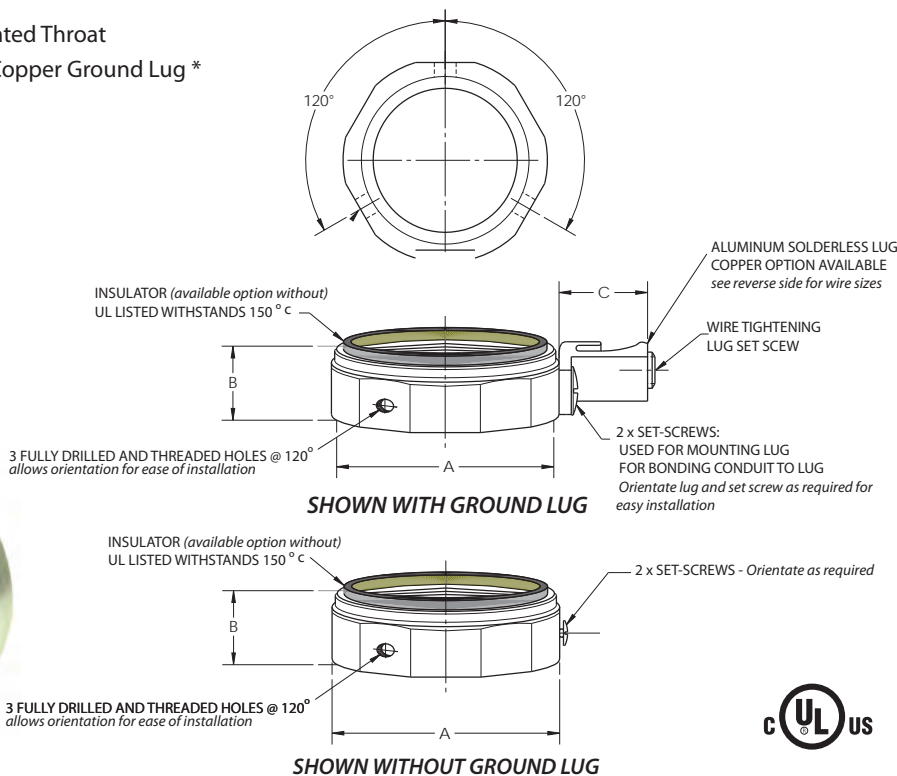
Solid Steel with Hex Nut Design Permits Industrial Grade Torque without Damage to Pipe

Solid Machined Steel Option of Zinc Plated or Galvanized Plated

Superior Life & Performance Over Zinc Die Cast Products

Furnished with UL Component Temperature Rated 150°C Insulated Throat

Available with Option of Aluminum (Standard) Ground Lug or Copper Ground Lug \*



Galvanized Plating Available

Mechanically Galvanized Plating Equivalent To ASTM A-153

Hot-Dip Performance Criteria in Harsh Environments such as Below Grade Work

Superior Plated Product, Will Not Flake Off When Installed

GB Product Series WITH Grounding Lugs				<b>SPEC-grade</b> <sup>TM</sup>		GB Product Series WITHOUT Grounding Lug		
Product Series	TRADE SIZE	A Outside Diameter "	B Overall Length "	C Length of Lug "	Product Series	TRADE SIZE	A Outside Diameter "	B Overall Length "
GB 50BGL	1/2"	1.06	.63	.75	GB 50B	1/2"	1.06	.63
GB 75BGL	3/4"	1.22	.63	.75	GB 75B	3/4"	1.22	.63
GB 100BGL	1"	1.50	.75	.75	GB100B	1"	1.50	.75
GB 125BGL	1-1/4"	1.88	.78	.75	GB125B	1-1/4"	1.88	.78
GB 150BGL	1-1/2"	2.16	.78	.75	GB150B	1-1/2"	2.16	.78
GB 200BGL	2"	2.16	.78	.75	GB 200B	2"	2.16	.78
GB 250BGL**	2-1/2"	3.21	1.05	1.10	GB 250B**	2-1/2"	3.21	1.05
GB 300BGL**	3"	3.96	1.08	1.10	GB 300B**	3"	3.96	1.08
GB 350BGL**	3-1/2"	4.47	1.08	1.10	GB 350B**	3-1/2"	4.47	1.08
GB 400BGL**	4"	5.15	1.18	1.70	GB 400B**	4"	5.15	1.18

\* Full Product Series with Available Options Shown on Reverse Side

\*\* 2 1/2" and larger are malleable iron construction

GB01113.1

amftgs.com

t: 800.221.5268

e: info@amftgs.com



# AMERICAN FITTINGS Corporation

Made in the USA Since 1946

Industrial SPEC- grade™  
Rigid / IMC Grounding Bushings  
1/2" to 4"  
Steel

## GB Series Industrial SPEC-grade GROUNDING Bushings™

Set Screw, Threaded or Threadless with Insulated Throat \*

Available With or Without Optional Ground Lug \*

Furnished with 3 Pre-Drilled Holes and Set Screws

Unique Design Allows Ease of Installation and Orientation of Set Screw & Ground Lugs

Solid Steel with Hex Nut Design Permits Industrial Grade Torque without Damage to Pipe

Solid Machined Steel Zinc Plated or Galvanized Plated Product

Superior Life & Performance Over Zinc Die Cast Products

Furnished with UL Component Temperature Rated 150°C Insulated Throat

Available with Aluminum (Standard) Ground Lug or Copper Ground Lug



### \* Product Options for AMFICO SPEC-grade GROUNDING Bushings™

Trade Size	Material	Plating Options 1	Configurations 2	Insulated Throat Option 3	Lug Options 4	Lug Material Options 5	Ground Lug Wire Range
1/2"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4
3/4"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4
1"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4
1 1/4"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4 or 8-10
1 1/2"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4 or 8-10
2"	Solid Steel	Z or G	T - NT	Y	Y	AL - CU	14-4 or 8-10
2 1/2"	MI	Z	T - NT	Y	Y	AL - CU	6-250 m cm
3"	MI	Z	T - NT	Y	Y	AL - CU	6-250 m cm
3 1/2"	MI	Z	T - NT	Y	Y	AL - CU	6-250 m cm
4"	MI	Z	T - NT	Y	Y	AL - CU	6-250 m cm

#### Keys for Product Options Offered

- 1 Z = Zinc or G = Galvanized
- 2 T = Threaded NT = No Threads (Threadless with Set Screw)
- 3 Insulated Throat Option Available (B)
- 4 Available With and Without Ground Lug (GL)
- 5 AL = Aluminum Lug or CU = Copper Lug
- MI Malleable Iron Construction ( 2 1/2" and larger)



Larger sizes are available, please consult factory for details.

For Full Catalog Numbers Go online: to [amtgs.com/gbpn](http://amtgs.com/gbpn)  
Or Call Factory

GB1013.1

[amtgs.com](http://amtgs.com)

t: 800.221.5268

e: [info@amtgs.com](mailto:info@amtgs.com)



"The Diamond of the Industry"

## Reducing Bushings

- Industrial specification grade, screw machined steel, zinc plated
- (N.P.S.) Straight Thread
- For reducing the threaded opening in conduit bodies or any female threaded fitting

## Steel, Zinc Plated

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
RB5038	1/2" x 3/8"	100	1000	2
RB7550	3/4" x 1/2"	100	500	14
RB10050	1" x 1/2"	50	250	12
RB10075	1" x 3/4"	50	250	12
RB12550	1-1/4" x 1/2"	20	200	28
RB12575	1-1/4" x 3/4"	20	200	22
RB125100	1-1/4" x 1"	20	200	14
RB15050	1-1/2" x 1/2"	10	100	42
RB15075	1-1/2" x 3/4"	10	100	36
RB150100	1-1/2" x 1"	10	100	28
RB150125	1-1/2" x 1-1/4"	10	100	12
RB20050	2" x 1/2"	5	50	84
RB20075	2" x 3/4"	5	50	76
RB200100	2" x 1"	5	50	68
RB200125	2" x 1-1/4"	5	50	48
RB200150	2" x 1-1/2"	5	50	32

## Dimensional Table

Cat. #	A Length	B Diameter
RB5038	.563	.750
RB7550	.650	.920
RB10050	.715	1.125
RB10075	.715	1.125
RB12550	.820	1.470
RB12575	.820	1.470
RB125100	.820	1.470
RB15050	.850	1.700
RB15075	.850	1.700
RB150100	.850	1.700
RB150125	.850	1.700
RB20050	.970	2.230
RB20075	.970	2.230
RB200100	.970	2.230
RB200125	.970	2.230
RB200150	.970	2.230





"The Diamond of the Industry"

## Plastic Insulating Bushings

- Polypropylene - Impact Resistant
- Temperature Rated at 105°
- Flame Retardant
- Threaded and used with locknut to terminate rigid or IMC conduit to box
- Smooth rounded surface prevents damage to wire insulation at raceway entrance

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
PIB50	1/2"	100	1000	1
PIB75	3/4"	100	500	2
PIB100	1"	50	250	2
PIB125	1-1/4"	-	100	2
PIB150	1-1/2"	-	100	2
PIB200	2"	-	50	3
PIB250	2-1/2"	-	25	4
PIB300	3"	-	25	5
PIB350	3-1/2"	-	25	7
PIB400	4"	-	20	8
PIB500	5"	-	5	10
PIB600	6"	-	5	11



Cat. #	A	B
PIB50	1.05	.36
PIB75	1.29	.40
PIB100	1.63	.49
PIB125	1.93	.48
PIB150	2.18	.48
PIB200	2.64	.54
PIB250	3.25	.63
PIB300	3.90	.68
PIB350	4.41	.68
PIB400	4.93	.68
PIB500	5.98	.77
PIB600	7.06	.77





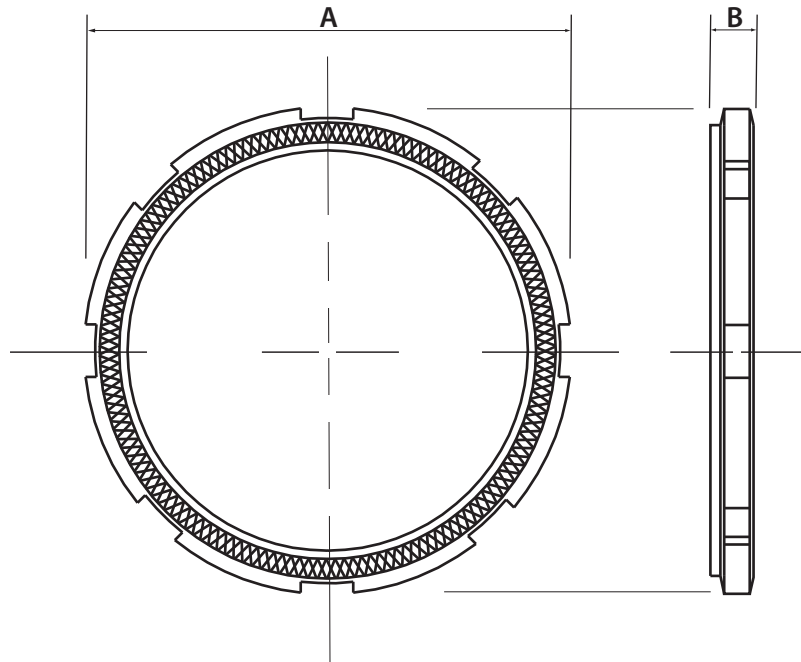
## "TURN ON" with AMFICO's Next Generation SPEC-grade LOCKnuts™

Heavy Duty Industrial  
Specification Grade Locknuts

Solid Steel Construction  
Machined from Bar Stock  
Electro Plated Zinc, Will Not Flake When Installed  
Made in the USA



Patent Pending



*The Most Severe Vibrations Will NOT Loosen This Locknut's "Cutting Edge" Grip*

### SPEC-grade LOCKnuts™

Our solid steel industrial grade locknuts feature AMFICO's uniformed and uniquely designed machine cut serrations. This assures you the capability of cutting through protective coatings on boxes or enclosures to guarantee a positive lock for bonding and grounding.

Unique beveled tangs provide the easiest means to tighten the locknut.

Fully machined ID threads provide the fastest and an ultra-secure threading to pipe or AMIFCO fittings.

Patent Pending

Solid Steel Fully Machined Industrial Specification Grade Locknuts

Cat. #	Trade Size	A	B Thickness
LN 50US	1/2"	1.13"	.13"
LN 75US	3/4"	1.39"	.13"
LN100US	1"	1.69"	.17"
LN125US	1-1/4"	2.06"	.17"
LN150US	1-1/2"	2.28"	.17"
LN200US	2"	2.78"	.17"

Better Ideas, Better Products, Made in the USA



Made in the USA Since 1946

## Conduit Locknuts (UL & CSA listed)

- Industrial specification grade steel
- Heavier steel construction
- Electro zinc plated for corrosion protection
- Fastens threaded conduit to unthreaded opening in a box or enclosure
- Superior clean threads for tightening without distortion
- Rugged tangs for extensive reach and ensured bonding

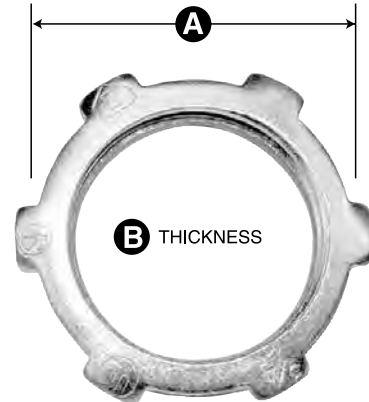


E93605



LR61799

## SPEC-grade



### Dimensional Table

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
LN25	1/4"	200	2000	1
LN38	3/8"	200	2000	1
LN50	1/2"	200	2000	1
LN75	3/4"	100	1000	2
LN100	1"	50	500	4
LN125	1-1/4"	50	500	7
LN150	1-1/2"	25	250	8
LN200	2"	25	250	9
LN250	2 1/2"	-	30	29
LN300	3"	-	25	42
LN350	3 1/2"	-	25	48
LN400	4"	-	25	52
LN500	5"	-	10	95
LN600	6"	-	10	106

Cat. #	A Diameter	B Thickness
LN25	.80	.11
LN38	.98	.12
LN50	1.13	.13
LN75	1.38	.14
LN100	1.72	.18
LN125	2.06	.19
LN150	2.38	.18
LN200	2.89	.19
LN250	3.54	.39
LN300	4.23	.39
LN350	4.75	.39
LN400	5.29	.39
LN500	6.68	.50
LN600	7.34	.56

Rigid IMC Conduit Fittings

\* Malleable Iron



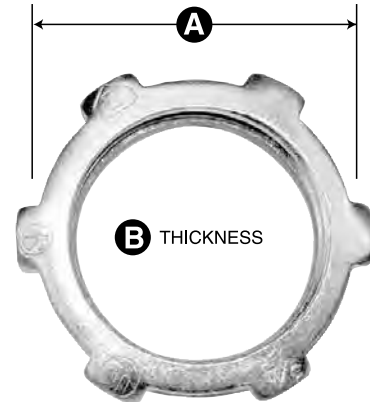
Made in the USA Since 1946

## Sealing Locknuts

- Zinc plated with PVC Molded Gasket



## SPEC-grade



## Steel - Sealing Locknuts

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
SL1*	1/2"	100	1000	2
SL2*	3/4"	100	1000	3
SL3*	1"	50	500	2
SL4*	1-1/4"	25	250	8
SL5*	1-1/2"	25	250	8
SL6*	2"	10	100	12
SL7	2-1/2"	-	25	20
SL8	3"	-	25	20
SL9	3-1/2"	-	10	24
SL10	4"	-	10	24
SL11	5"	-	5	95
SL12	6"	-	5	125

## Dimensional Table

Cat. #	A Diameter	B Thickness
SL1	1.12	.26
SL2	1.37	.27
SL3	1.75	.28
SL4	2.06	.32
SL5	2.37	.32
SL6	2.87	.32
SL7	3.43	.32
SL8	4.12	.32
SL9	4.62	.32
SL10	5.18	.32

Rigid IMC Conduit Fittings

\*UL & CSA Listed



## Grounding Locknuts

- Threaded for Rigid/IMC conduit
- Used to insure positive bonding and fastening to a box or enclosure
- Required for installations where severe vibration is encountered
- Solid steel construction
- Zinc plated for corrosion protection



## SPEC-grade



## Grounding Locknuts

Cat. #	Size	Unit Ctn	Std Pkg	WT/100
GRL50	1/2"	100	1000	3
GRL75	3/4"	100	1000	3
GRL100	1"	50	500	5
GRL125	1-1/4"	50	250	6
GRL150	1-1/2"	25	250	9
GRL200	2"	20	200	14
GRL250	2-1/2"	-	25	16
GRL300	3"	-	20	28
GRL350	3-1/2"	-	10	36
GRL400	4"	-	10	40

## Dimensional Table

Cat. #	A Diameter	B Thickness
GRL50	1.340	.170
GRL75	1.575	.170
GRL100	1.890	.170
GRL125	2.300	.170
GRL150	2.600	.170
GRL200	3.100	.187
GRL250	3.562	.375
GRL300	4.250	.375
GRL350	4.803	.375
GRL400	5.402	.375

Rigid IMC Conduit Fittings





"The Diamond of the Industry"

## Sealing Locknuts

- Zinc plated with PVC Molded Gasket

### Steel

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
SL1*	1/2"	100	1000	2
SL2*	3/4"	100	1000	3
SL3*	1"	50	500	2
SL4*	1-1/4"	25	250	8
SL5*	1-1/2"	25	250	8
SL6*	2"	10	100	12
SL7	2-1/2"	-	25	20
SL8	3"	-	25	20
SL9	3-1/2"	-	10	24
SL10	4"	-	10	24
SL11	5"	-	5	95
SL12	6"	-	5	125

\* UL & CSA Listed



### Dimensional Table

Cat. #	A Diameter	B Thickness
SL1	1.12	.26
SL2	1.37	.27
SL3	1.75	.28
SL4	2.06	.32
SL5	2.37	.32
SL6	2.87	.32
SL7	3.43	.32
SL8	4.12	.32
SL9	4.62	.32
SL10	5.18	.32



Made in the USA Since 1946

## Liquid Tight Connectors Reusable Fittings

- Industrial specification grade, screw machined steel, zinc plated
- UL Rated Liquid Tight
- Includes sealing washer
- Bonds conduit to box or enclosure
- Corrosion resistant protection from moisture & oils
- Designed to protect against excessive vibration

### Straight Connectors (STR)

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR38	3/8"	20	200	10
STR50	1/2"	20	200	13
STR75	3/4"	20	100	18
STR100	1"	5	50	32
STR125	1-1/4"	5	25	44
STR150	1-1/2"	5	25	66
STR200	2"	5	25	85
STR250**	2-1/2"	-	5	260
STR300**	3"	-	4	360
STR350**	3-1/2"	-	4	445
STR400**	4"	-	2	520
STR500**	5"	-	1	1150

6" connectors available upon request

\*\* Malleable Iron

### Dimensional Table

Cat. #	A Diameter	B Overall Length	C Length of Thread
STR38/B	1.09	1.19	.63
STR50/B	1.19	1.34	.63
STR75/B	1.43	1.43	.63
STR100/B	1.75	1.63	.66
STR125/B	2.16	1.84	.67
STR150/B	2.38	2.00	.72
STR200/B	2.88	2.13	.72
STR250/B	4.00	3.25	1.50
STR300/B	4.63	3.88	1.50
STR350/B	5.50	4.00	1.50
STR400/B	5.82	4.00	1.63
STR500/B	7.00	5.00	1.63

Liquid Tight Connectors 1

## SPEC-grade



E93605



LR61799

UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b), 505-4(a), 503-3(a)

Featuring:  
**EZ-Torque Compression Nut**

### Straight Connectors with Insulated Throat

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR38B	3/8"	20	200	10
STR50B	1/2"	20	200	13
STR75B	3/4"	20	100	18
STR100B	1"	5	50	32
STR125B	1-1/4"	5	25	44
STR150B	1-1/2"	5	25	66
STR200B	2"	5	25	85
STR250B**	2-1/2"	-	5	260
STR300B**	3"	-	4	360
STR350B**	3-1/2"	-	4	445
STR400B**	4"	-	2	520
STR500B**	5"	-	1	1150

6" connectors available upon request

\*\* Malleable Iron



Made in the USA Since 1946

## Liquid Tight Connectors 90° Reusable Fittings

- Industrial specification grade steel, zinc plated
- Malleable iron body
- UL rated Liquid Tight
- Includes sealing washer
- Bonds conduit to box or enclosure
- Corrosion resistant protection from moisture & oils
- Designed to protect against excessive vibration

### 90° Angle Connectors (STR)

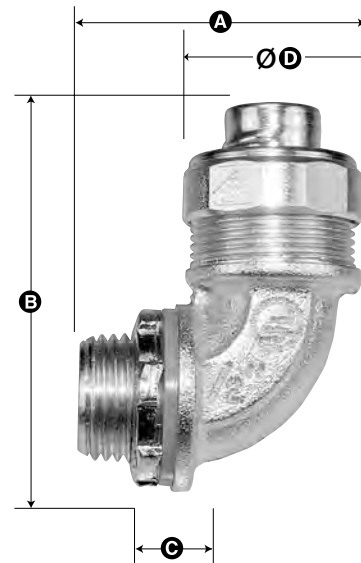
Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3890**	3/8"	10	100	24
STR5090**	1/2"	10	100	24
STR7590**	3/4"	5	50	38
STR10090**	1"	5	25	70
STR12590**	1-1/4"	2	20	88
STR15090**	1-1/2"	1	10	125
STR20090**	2"	1	5	180
STR25090	2-1/2"	-	2	625
STR30090	3"	-	1	900
STR35090	3-1/2"	-	1	1000
STR40090	4"	-	2	1500

\*\*Steel Nut

### Dimensional Table

Cat. #	A	B	C Length of Thread	D Ø
STR3890/B	1.25	1.59	.59	1.09
STR5090/B	1.25	1.66	.59	1.19
STR7590/B	1.53	1.78	.59	1.43
STR10090/B	1.84	2.19	.66	1.75
STR12590/B	1.94	2.38	.69	2.16
STR15090/B	2.09	2.63	.72	2.38
STR20090/B	2.41	3.06	.72	2.88
STR25090/B	8.00	9.25	1.50	?
STR30090/B	8.75	10.50	1.50	?
STR35090/B	10.93	11.50	1.50	?
STR40090/B	12.63	13.00	1.50	?

## SPEC-grade



E93605



LR61799

UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b), 505-4(a), 503-3(a)

Featuring:  
**EZ-Torque Compression Nut**

### 90° Angle Connectors with Insulated Throat

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3890B**	3/8"	10	100	24
STR5090B**	1/2"	10	100	24
STR7590B**	3/4"	5	50	38
STR10090B**	1"	5	25	70
STR12590B**	1-1/4"	2	20	88
STR15090B**	1-1/2"	1	10	125
STR20090B**	2"	1	5	180
STR25090B	2-1/2"	-	2	625
STR30090B	3"	-	1	900
STR35090B	3-1/2"	-	1	1000
STR40090B	4"	-	2	1500

\*\*Steel Nut



Made in the USA Since 1946

## Liquid Tight Connectors 45° Reusable Fittings

- Industrial specification grade steel, zinc plated
- Malleable iron body
- UL rated Liquid Tight
- Includes sealing washer
- Bonds conduit to box or enclosure
- Corrosion resistant protection from moisture & oils
- Designed to protect against excessive vibration

### 45° Angle Connectors (STR)

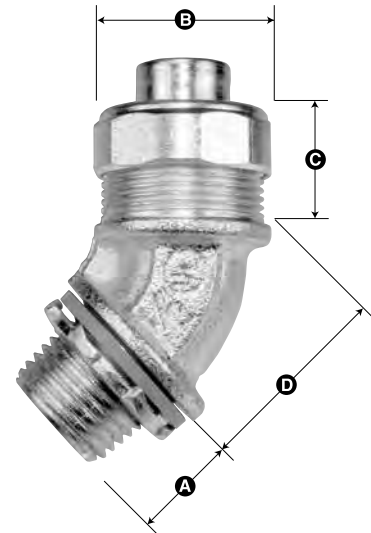
Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3845**	3/8"	10	100	21
STR5045**	1/2"	10	100	23
STR7545**	3/4"	10	50	32
STR10045**	1"	5	50	53
STR12545**	1-1/4"	5	25	69
STR15045**	1-1/2"	3	15	99
STR20045**	2"	1	10	152
STR25045	2-1/2"	-	2	478
STR30045	3"	-	2	775
STR35045	3-1/2"	-	1	880
STR40045	4"	-	1	1000

\*\* Steel Nut

### Dimensional Table

Cat. #	A	B	C	D
STR3845/B	.59	1.09	1.22	1.03
STR5045/B	.59	1.19	1.32	1.03
STR7545/B	.59	1.43	1.38	1.13
STR10045/B	.66	1.75	1.66	1.25
STR12545/B	.69	2.16	1.72	1.34
STR15045/B	.72	2.38	2.00	1.47
STR20045/B	.72	2.88	2.28	1.63
STR25045/B	1.50	4.00	2.25	4.75
STR30045/B	1.50	4.63	2.50	5.50
STR35045/B	1.56	5.25	2.50	6.50
STR40045/B	1.63	5.81	2.50	7.75

## SPEC-grade



E93605



LR61799

UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b), 502-4(a), 503-3(a)

Featuring:  
**EZ-Torque Compression Nut**

### 45° Angle Connectors with Insulated Throat

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3845B**	3/8"	10	100	21
STR5045B**	1/2"	10	100	23
STR7545B**	3/4"	10	50	32
STR10045B**	1"	5	50	53
STR12545B**	1-1/4"	5	25	69
STR15045B**	1-1/2"	3	15	99
STR20045B**	2"	1	10	152
STR25045B	2-1/2"	-	2	478
STR30045B	3"	-	2	775
STR35045B	3-1/2"	-	1	880
STR40045B	4"	-	1	1000

\*\* Steel Nut





Made in the USA Since 1946

## Liquid Tight Connectors Grounding Type with Aluminum Lugs

- A quick, effective solution to connecting liquid tight conduit while terminating a bonding connector in one action
- Sleek screw machined bodies and nuts promote easy installation
- Strong construction and long ferrule prevent pullouts
- All components are reusable
- Furnished with locknut and sealing washer

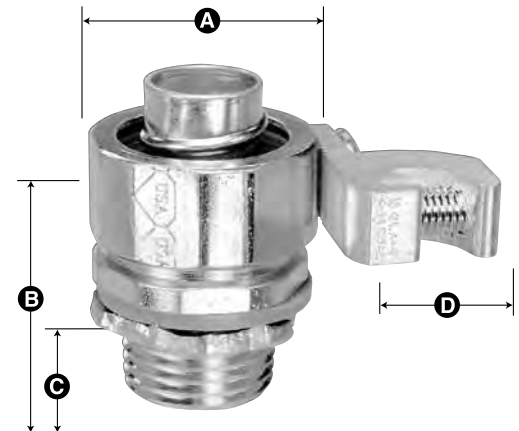
### Straight Connectors (STR)

Cat. #	Size	Unit Ctn	Std Pkg	WT/100
STR38GL	3/8"	25	125	12
STR50GL	1/2"	25	125	15
STR75GL	3/4"	25	125	20
STR100GL	1"	10	50	34
STR125GL	1-1/4"	5	25	46
STR150GL	1-1/2"	5	25	68
STR200GL	2"	2	10	87
STR250GL	2-1/2"	-	5	267
STR300GL	3"	-	4	367
STR350GL	3-1/2"	-	3	464
STR400GL	4"	-	2	539

### Dimensional Table

Cat. #	A		B		C		D		Wire Size	
	Diameter	Overall Length	Length of Thread	Length of Lug	Min	Max	Min	Max	Min	Max
STR38GL	1.09	1.19	.63	.750	14	4				
STR50GL	1.19	1.34	.63	.750	14	4				
STR75GL	1.43	1.43	.63	.750	14	4				
STR100GL	1.75	1.63	.66	.750	14	4				
STR125GL	2.16	1.84	.67	.750	14	4				
STR150GL	2.38	2.00	.72	.750	14	4				
STR200GL	2.88	2.13	.72	.750	14	4				
STR250GL	4.00	3.25	1.50	1.093	8	110				
STR300GL	4.63	3.88	1.50	1.093	8	110				
STR350GL	5.50	4.00	1.50	1.687	6	250				
STR400GL	5.82	4.00	1.63	1.687	6	250				

## SPEC-grade



UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b), 502-4(a), 503-3(a)

Featuring:  
**EZ-Torque Compression Nut**

### Straight Connectors with Insulated Throat

Cat. #	Size	Unit Ctn	Std Pkg	WT/100
STR38BGL	3/8"	25	125	12
STR50BGL	1/2"	25	125	15
STR75BGL	3/4"	25	125	20
STR100BGL	1"	10	50	34
STR125BGL	1-1/4"	5	25	46
STR150BGL	1-1/2"	5	25	68
STR200BGL	2"	2	10	87
STR250BGL	2-1/2"	-	5	267
STR300BGL	3"	-	4	367
STR350BGL	3-1/2"	-	3	464
STR400BGL	4"	-	2	539



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## Liquid Tight Connectors 90° Grounding Type with Aluminum Lugs

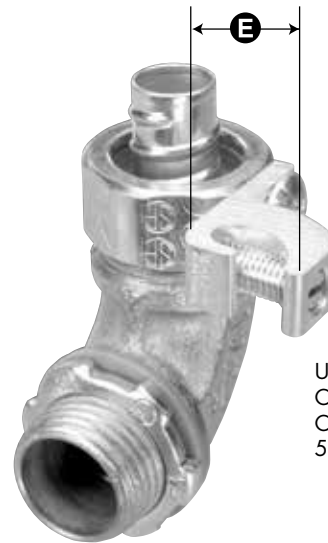
- A quick, effective solution to connecting liquid tight conduit while terminating a bonding connector in one action
- Strong construction and long ferrule prevent pullouts
- All components are reusable
- Furnished with locknut and sealing washer

### 90° Angle Connectors (STR)

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3890GL	3/8"	20	100	26
STR5090GL	1/2"	20	100	26
STR7590GL	3/4"	10	50	40
STR10090GL	1"	5	25	72
STR12590GL	1-1/4"	4	20	90
STR15090GL	1-1/2"	3	15	127
STR20090GL	2"	2	10	182
STR25090GL	2-1/2"	-	2	632
STR30090GL	3"	-	1	907
STR35090GL	3-1/2"	-	1	1019
STR40090GL	4"	-	2	1519

### 90° Angle Connectors with Insulated Throat

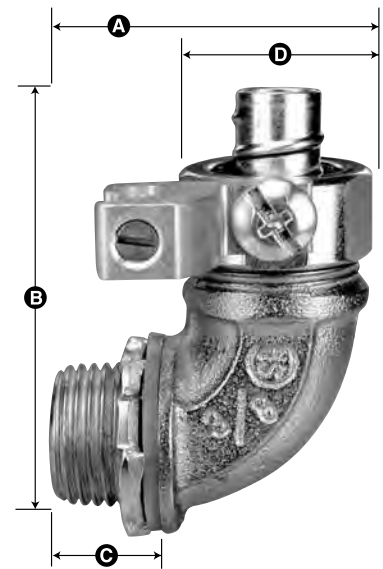
Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3890GL	3/8"	20	100	26
STR5090GL	1/2"	20	100	26
STR7590GL	3/4"	10	50	40
STR10090GL	1"	5	25	72
STR12590GL	1-1/4"	4	20	90
STR15090GL	1-1/2"	3	15	127
STR20090GL	2"	2	10	182
STR25090GL	2-1/2"	-	2	632
STR30090GL	3"	-	1	907
STR35090GL	3-1/2"	-	1	1019
STR40090GL	4"	-	2	1519



**SPEC-grade**



UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b),  
502-4(a), 503-3(a)



Featuring:  
**EZ-Torque Compression Nut**

### Dimensional Table

Cat. #	A	B	C	D	E	Wire Min	Size Max
STR3890GL	1.25	1.59	.59	1.09	.750	14	4
STR5090GL	1.25	1.66	.59	1.19	.750	14	4
STR7590GL	1.53	1.78	.59	1.43	.750	14	4
STR10090GL	1.84	2.19	.66	1.75	.750	14	4
STR12590GL	1.94	2.38	.69	2.16	.750	14	4
STR15090GL	2.09	2.63	.72	2.38	.750	14	4
STR20090GL	2.41	3.06	.72	2.88	.750	14	4
STR25090GL	8.00	9.25	1.50	4.00	1.093	8	110
STR30090GL	8.75	10.50	1.50	4.63	1.093	8	110
STR35090GL	10.93	11.50	1.50	5.50	1.687	6	250
STR40090GL	12.63	13.00	1.50	5.82	1.687	6	250



Made in the USA Since 1946

## Liquid Tight Connectors 45° Grounding Type with Aluminum Lugs

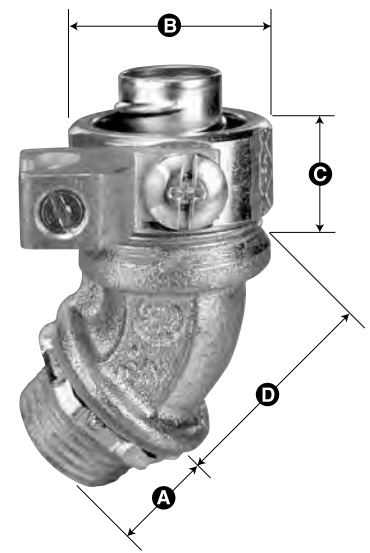
- A quick, effective solution to connecting liquid tight conduit while terminating a bonding connector in one action
- Strong construction and long ferrule prevent pullouts
- All components are reusable
- Furnished with locknut and sealing washer

### 45° Angle Connectors (STR)

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3845GL	3/8"	20	100	23
STR5045GL	1/2"	20	100	25
STR7545GL	3/4"	10	50	34
STR10045GL	1"	5	25	55
STR12545GL	1-1/4"	4	20	71
STR15045GL	1-1/2"	3	15	101
STR20045GL	2"	2	10	154
STR25045GL	2-1/2"	-	4	485
STR30045GL	3"	-	2	782
STR35045GL	3-1/2"	-	2	899
STR40045GL	4"	-	1	1019

### 45° Angle Connectors with Insulated Throat

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR3845BGL	3/8"	20	100	23
STR5045BGL	1/2"	20	100	25
STR7545BGL	3/4"	10	50	34
STR10045BGL	1"	5	25	55
STR12545BGL	1-1/4"	4	20	71
STR15045BGL	1-1/2"	3	15	101
STR20045BGL	2"	2	10	154
STR25045BGL	2-1/2"	-	4	485
STR30045BGL	3"	-	2	782
STR35045BGL	3-1/2"	-	2	899
STR40045BGL	4"	-	1	1019



Featuring:  
EZ-Torque Compression Nut

### Dimensional Table

Cat. #	A	B	C	D	E
STR3845GL	.59	1.09	1.22	1.03	.750
STR5045GL	.59	1.19	1.32	1.03	.750
STR7545GL	.59	1.43	1.38	1.13	.750
STR10045GL	.66	1.75	1.66	1.25	.750
STR12545GL	.69	2.16	1.72	1.34	.750
STR15045GL	.72	2.38	2.00	1.47	.750
STR20045GL	.72	2.88	2.28	1.63	.750
STR25045GL	1.50	4.00	2.25	4.75	1.093
STR30045GL	1.50	4.63	2.50	5.50	1.093
STR35045GL	1.56	5.25	2.50	6.50	1.687
STR40045GL	1.63	5.81	2.50	7.75	1.687



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## Raintight Combination Couplings Liquid Tight Conduit to Rigid Conduit-IMC

- Reusable ferrule
- Steel, zinc plated



UL rated suitable for hazardous locations  
Class I, Div. 2; Class II, Div. 1 and 2;  
Class III, Div. 1 and 2; NEC 501-4(b),  
502-4(a), 503-3(a)

**SPEC-grade**



Featuring:  
**EZ-Torque Compression Nut**

### Combination Coupling (STR-EMT)

Cat. #	Size	Uni Ctn	Std Pkg	WT/ 100
STREMT50RT	1/2"	25	250	15
STREMT75RT	3/4"	10	100	22
STREMT100RT	1"	5	50	40





## Liquid Tight Connectors with Female Threaded Hubs

- For Connecting Liquid Tight Conduit with Rigid/IMC Threaded Conduit
- Provides versatility in threaded hub or panelboard applications



## SPEC-grade



Featuring:  
EZ-Torque Compression Nut

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR38FR	3/8"	25	125	13
STR50FR	1/2"	25	125	14
STR75FR	3/4"	25	125	21
STR100FR	1"	5	25	31
STR125FR	1 1/4"	5	25	56
STR150FR	1 1/2"	5	25	69
STR200FR	2"	5	25	88

### Dimensional Table

Cat. #	A	B
STR38FR	1.08	1 1/8"
STR50FR	1.19	1 1/8"
STR75FR	1.43	1 3/8"
STR100FR	1.75	1 5/8"
STR125FR	2.16	2"
STR150FR	2.38	2 1/4"
STR200FR	2.88	2 3/4"

Liquid Tight Connectors 9



## Liquid Tight Connectors with Female Threaded Hubs and Chase Nipples

- For connecting liquid tight conduit into electrical box - inside low profile
- Provides versatility in threaded hub or panelboard applications
- Includes a sealing washer



### Liquid Tight Female Hub

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
STR38FRCN	3/8"	25	125	16
STR50FRCN	1/2"	25	125	17
STR75FRCN	3/4"	25	125	25
STR100FRCN	1"	5	25	40
STR125FRCN	1 1/4"	5	25	73
STR150FRCN	1 1/2"	5	25	90
STR200FRCN	2"	5	25	117

### Dimensional Table

Cat. #	A	B	C	D
STR38FRCN	1.09	1.14	.16	1"
STR50FRCN	1.19	1.21	.16	1"
STR75FRCN	1.43	1.24	.16	1 1/4"
STR100FRCN	1.75	1.57	.19	1 5/8"
STR125FRCN	2.16	1.86	.20	1 7/8"
STR150FRCN	2.38	1.97	.25	2 3/16"
STR200FRCN	2.88	2.07	.25	2 11/16"

## SPEC-grade



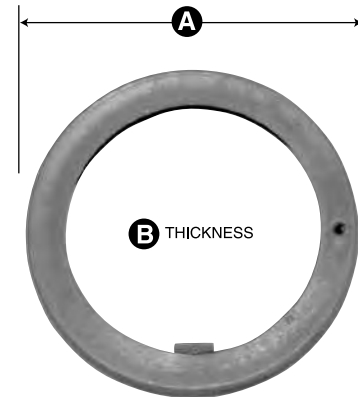
Featuring:  
EZ-Torque Compression Nut



## Sealing Washers

- Polyethylene
- Moisture resistant

## SPEC-grade



Cat. #	Size	Std Pkg	WT/ 100
SW50	1/2"	500	.5
SW75	3/4"	500	.5
SW100	1"	250	1
SW125	1-1/4"	250	1
SW150	1-1/2"	250	1
SW200	2"	250	2
SW250	2-1/2"	100	2
SW300	3"	100	2
SW350	3-1/2"	50	2
SW400	4"	50	2

## Dimensional Table

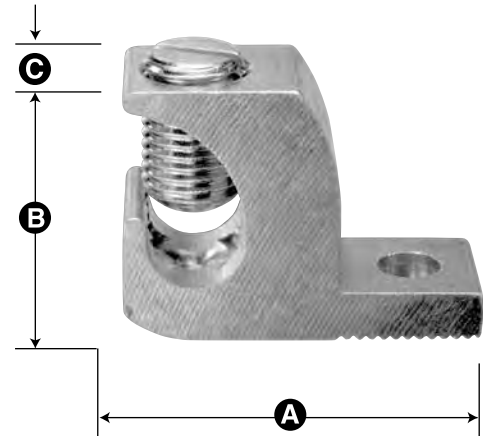
Cat. #	A Diameter	B Thickness
SW50	1.10	.075
SW75	1.34	.080
SW100	1.60	.080
SW125	1.93	.080
SW150	2.20	.080
SW200	2.57	.080
SW250	2.88	.125
SW300	3.52	.125
SW350	4.03	.125
SW400	4.52	.125



Made in the USA Since 1946

## Solderless Lugs - Copper and Aluminum

- Lay-in connectors
- High strength, high conductive



### Aluminum Alloy 6061

Cat. #	Wire Range CU-AL	Unit Ctn	Std Pkg	WT/ 100
GLA4	4-14	50	500	2
GLA0	1/0-8	25	250	7
GLA250	250 mcm-6	10	100	19

### Dimensional Table

Cat. #	A	B	C
GLA4	1.07	.75	.38
GLA0	1.50	1.10	.60
GLA250	2.20	1.70	.80

### Copper

Cat. #	Wire Range CU-AL	Unit Ctn	Std Pkg	WT/ 100
GLCU4	4-14	50	500	6
GLCU2	2-8	50	500	5

### Dimensional Table

Cat. #	A	B	C
GLCU4	1.30	.88	.40
GLCU2	1.47	.92	.48



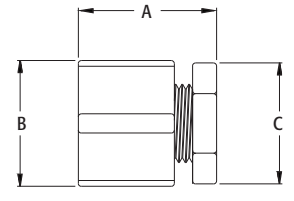
## 3-Piece Coupling Rigid • IMC

Zinc die-cast.



CATALOG NUMBER	UPC/DCI/NAED MFG #018997	TRADE SIZE	STD PKG	DIM A	DIM B	DIM C
200	00200	1/2	50	1.430	1.310	1.250
201	00201	3/4	50	1.520	1.610	1.560
202	00202	1	25	1.700	2.125	2.100
203	00203	1-1/4	25	2.125	2.400	2.415
204	00204	1-1/2	25	2.125	2.890	2.940
205	00205	2	20	2.360	3.400	3.500
206	00206	2-1/2	10	2.520	4.030	4.390
207	00207	3	5	2.580	4.620	4.930
208	00208	3-1/2	5	2.645	5.350	5.425
209	00209	4	2	3.420	5.870	5.780
210†	00210	5	1	4.375	7.000	7.000
211†	00211	6	1	4.375	8.250	8.250

† Malleable.



# RIGID • IMC FITTINGS

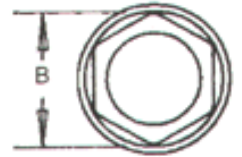
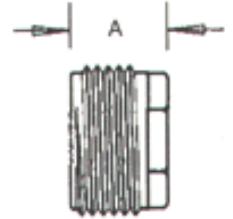
## REDUCING BUSHINGS

Zinc die-cast.

CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	UNIT PKG	STD PKG	DIM A	DIM B
522	00522	3/4x1/2	50	500	.650	.920
523	00523	1x1/2	25	100	.715	1.125
524	00524	1x3/4	25	100	.715	1.125
525	00525	1-1/4x1/2	25	25	.820	1.470
526	00526	1-1/4x3/4	25	25	.820	1.470
527	00527	1-1/4x1	25	25	.820	1.470
528	00528	1-1/2x1/2	25	25	.850	1.700
529	00529	1-1/2x3/4	25	25	.850	1.700
530	00530	1-1/2x1	25	25	.850	1.700
531	00531	1-1/2x1-1/4	25	25	.850	1.700
532	00532	2x1/2	10	10	.970	2.230
533	00533	2x3/4	10	10	.970	2.230
534	00534	2x1	10	10	.970	2.230
535	00535	2x1-1/4	10	10	.970	2.230
536	00536	2x1-1/2	10	10	.970	2.230



522



E60812 LR49636

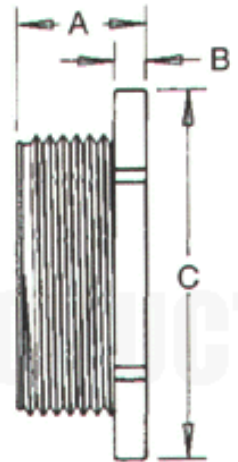
## LARGER REDUCING BUSHINGS

Zinc die-cast.

CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	UNIT PKG	STD PKG	DIM A	DIM B	DIM C
1274	01274	2-1/2x1-1/4	5	5	2.090	.430	2.845
1275	01275	2-1/2x1-1/2	5	5	1.125	.430	2.820
1276	01276	2-1/2x2	5	5	1.200	.300	3.485
1283	01283	3x1	5	5	1.785	.500	4.075
1284	01284	3x1-1/4	5	5	2.100	.410	3.445
1285	01285	3x1-1/2	5	5	2.020	.440	3.460
1286	01286	3x2	5	5	2.000	.400	3.380
1287	01287	3x2-1/2	5	5	1.390	.375	4.395
1296	01296	3-1/2x2	2	2	1.905	.565	4.575
1297	01297	3-1/2x2-1/2	2	2	2.020	.450	3.945
1298	01298	3-1/2x3	2	2	1.385	.380	4.920
1307	01307	4x2-1/2	2	2	2.070	.570	5.250
1308	01308	4x3	2	2	1.775	.500	5.250
1309	01309	4x3-1/2	2	2	1.400	.375	5.420



1274



E60812 LR49636

Reducing bushings are raintight in threaded hubs. Also, reducing bushings, unlike reducing washers, maintain grounding path and are able to pass UL high current testing.



**Combination  
Threaded Rigid  
and Set-Screw EMT  
to Box**

90° pulling elbows with cover and gasket. Zinc die-cast.

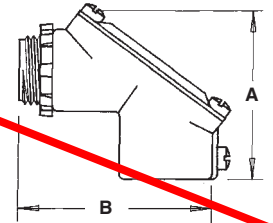


CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	UNIT PKG	STD PKG	DIM A	DIM B
9100	91005	1/2	5	50	2.030	1.945
9110	91100	3/4	5	50	2.260	2.140
9120	50165	1	5	25	2.610	2.610
9130	50167	1-1/4	2	10	3.037	3.037

See hub illustration below.



E20643 LR49636



**Combination  
Threaded Rigid  
and Set-Screw EMT  
90° Pulling Elbow**

90° pulling elbows with cover and gasket. Zinc die-cast.

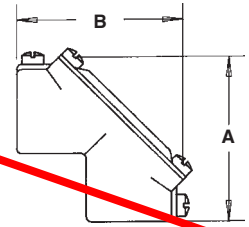


CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	UNIT PKG	STD PKG	DIM A	DIM B
HL5000	83105	1/2	10	100	2.120	2.120
HL7500	83175	3/4	5	50	2.380	2.380
HL100	50171	1	5	25	3.040	3.040
HL125	50173	1-1/4	2	10	3.900	3.900

See hub illustration above.



E20643 LR49636



**Watertight  
Conduit Hubs**

For rigid • IMC conduit. With insulated throat. Zinc die-cast.

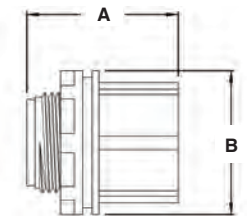


CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	STD PKG	DIM A	DIM B
WH1	58100	1/2	10	1.325	1.325
WH2	58200	3/4	10	1.450	1.512
WH3	58300	1	10	1.450	1.790
WH4	58400	1-1/4	5	1.575	2.295
WH5	58500	1-1/2	2	1.700	2.450
WH6	58600	2	2	1.700	2.875
WH7	58700	2-1/2	1	2.045	3.325
WH8	58800	3	1	2.150	4.040
WH9	58900	3-1/2	1	2.420	4.550
WH10	58101	4	1	2.420	5.030
WH11*	58103	5	1	3.000	6.750
WH12*	58105	6	1	3.085	7.600

\*Malleable.



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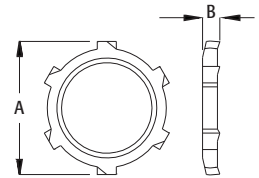


## Conduit Locknuts

Plated steel.



CATALOG NUMBER	UPC/DCI/NAED MFG #018997	TRADE SIZE	UNIT PKG	STD PKG	DIM A	DIM B
401	00401	1/2	200	2000	1.125	.130
402	00402	3/4	100	1000	1.383	.140
403	00403	1	100	1000	1.730	.160
404	00404	1-1/4	50	250	2.080	.187
405	00405	1-1/2	50	250	2.376	.187
406	00406	2	25	250	2.890	.250
407	00407	2-1/2	30	30	3.470	.250
408	00408	3	25	25	4.165	.250
409	00409	3-1/2	25	25	4.700	.275
410	00410	4	25	25	5.320	.275
411	00411	5	10	10	6.487	.450
412	00412	6	10	10	7.830	.450



# NEER Zinc Offset Nipples and Three Piece Couplings

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

## RN: 3/4" Offset

### Applications

- To provide an offset connection between two outlet boxes or enclosures.

### Material/Finish

- Zinc diecast

### Certifications and Compliances

- UL Standard: 514B
- UL Listed: E32539
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 70872
- NEMA: FB-1



RN-50

Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters	
		Body Length	Maximum Diameter
1/2	<b>RN-50</b>	2.45/62.2	0.94/23.9
3/4	<b>RN-75</b>	2.60/66.0	1.15/29.2
1	<b>RN-100</b>	2.76/70.1	1.40/35.6
1-1/4	<b>RN-125</b>	2.90/73.7	1.84/46.7
1-1/2	<b>RN-150</b>	3.05/77.5	2.06/52.3
2	<b>RN-200</b>	3.23/82.0	2.66/67.6

## TPC: Three Piece

### Applications

- Provides threaded coupling between lengths of rigid conduit and IMC conduit elbows, where neither can be rotated.

### Material/Finish

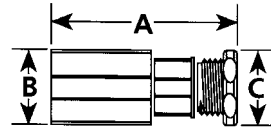
- Malleable iron/zinc plated

### Certifications and Compliances

- UL Standard: 514B
- UL Listed: E163167
- NEMA: FB-1



TPC-50



Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters		
		A	B	C
1/2	<b>TPC-50</b>	1.36/34.5	1.30/33.0	1.20/30.5
3/4	<b>TPC-75</b>	1.63/41.4	1.57/39.9	1.30/33.0
1	<b>TPC-100</b>	1.70/43.2	2.13/54.1	1.88/47.8
1-1/4	<b>TPC-125</b>	2.12/53.8	2.44/62.0	2.14/54.4
1-1/2	<b>TPC-150</b>	2.00/50.8	2.89/73.4	2.61/66.3
2	<b>TPC-200</b>	2.38/60.5	3.41/86.6	3.13/79.5
2-1/2	<b>TPC-250</b>	2.54/64.5	4.03/102.4	3.91/99.3
3	<b>TPC-300</b>	2.56/65.0	4.60/116.8	4.36/110.7
3-1/2	<b>TPC-350</b>	2.54/64.5	4.61/117.1	4.37/111.0
4	<b>TPC-400</b>	3.94/100.1	5.61/142.5	5.10/129.5



# Threaded Rigid Conduit and IMC Couplings and Connectors

## Applications

- Three piece union couples two lengths of conduit when neither can be turned.
- Gasketed pulling elbows: provides a compact wire pulling point.
- Elbows provide a 90° change of direction in a conduit run.
- Male to female: for connecting threaded rigid conduit or IMC to box or enclosure.

## Material

- Malleable iron

## Certifications and Compliances

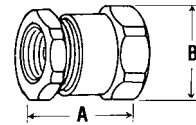
- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters			Weight Lbs./Kgs. Per 100
		A	B	C	

### Three Piece Union – Concretetight



<b>EC-50</b>	1/2	1.44/36.6	1.44/36.6	—	16.50/7.48
<b>EC-75</b>	3/4	1.56/39.6	1.56/39.6	—	24.00/10.89
<b>EC-100</b>	1	1.69/42.9	2.00/50.8	—	58.00/26.31
<b>EC-125</b>	1-1/4	2.13/54.1	2.44/62.0	—	98.00/44.45
<b>EC-150</b>	1-1/2	2.19/55.6	2.69/68.3	—	134.00/60.78
<b>EC-200</b>	2	2.44/62.0	3.25/82.6	—	198.00/89.81
<b>EC-250</b>	2-1/2	2.63/66.8	3.06/77.7	—	255.00/115.67
<b>EC-300</b>	3	2.63/66.8	4.63/117.6	—	394.00/178.72
<b>EC-350</b>	3-1/2	2.63/66.8	5.19/131.8	—	380.00/172.37
<b>EC-400</b>	4	3.44/87.4	5.69/144.5	—	700.00/317.51
<b>EC-500</b>	5	3.50/88.9	6.94/176.3	—	788.00/357.43
<b>EC-600</b>	6	3.50/88.9	8.13/206.5	—	825.00/374.21

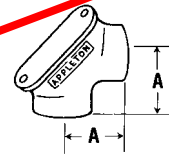


COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

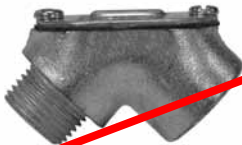
### 90° Female Gasketed Pulling Elbows – Watertight



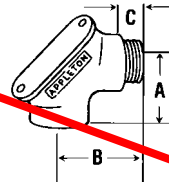
<b>FFL-50</b>	1/2	1.19/30.2	—	—	31.00/14.06
<b>FFL-75</b>	3/4	1.34/34.0	—	—	46.00/20.87
<b>FFL-100</b>	1	1.59/40.4	—	—	76.00/34.47
<b>FFL-125</b>	1-1/4	2.25/57.2	—	—	120.00/54.43
<b>FFL-150</b>	1-1/2	2.56/65.0	—	—	160.00/72.57
<b>FFL-200</b>	2	3.19/81.0	—	—	293.00/132.90



### 90° Male to Female Gasketed Pulling Elbows – Watertight



<b>MFL-50</b>	1/2	1.19/30.2	1.44/36.6	0.47/11.9	36.00/16.33
<b>MFL-75</b>	3/4	1.34/34.0	1.53/38.9	0.50/12.7	55.00/24.95
<b>MFL-100</b>	1	1.59/40.4	1.75/44.5	0.56/14.2	90.00/40.82
<b>MFL-125</b>	1-1/4	2.25/57.2	3.13/79.5	0.88/22.4	141.00/63.96
<b>MFL-150</b>	1-1/2	2.56/65.0	3.44/87.4	0.88/22.4	192.00/87.09
<b>MFL-200</b>	2	3.19/81.0	4.19/106.4	1.00/25.4	335.00/151.95



Commercial Products

# Set Screw and Non-Set Screw Insulated Grounding Bushings for Threadless/Threaded Rigid Metal Conduit/IMC

GIB-LS-AC and GIB-L-AC Series - with Aluminum Lay-In-Lug™ for Copper or Aluminum Conductors.

GIB-LS-BC and GIB-L-BC Series - with Bronze Lay-In-Lug™ for Copper Conductors Only.

## Applications

- GIB-LS Series insulated bushings fasten and ground threadless rigid metal conduit to an enclosure.
- GIB-L Series insulated bushings fasten and ground threaded rigid metal conduit to an enclosure.
- Can be used with a locknut to terminate conduit at an enclosure.
- Lug used to connect bonding jumper to a neutral bus bar.

## Features

- Temperature rating 150 °C.
- Insulating liner material is self-extinguishing.
- The plastic liner is tough. It won't chip, crack, swell or shrink. It resists corrosion, chemicals and temperature extremes. Surface friction is so low that wires can be pulled with virtually no abrasion on the cable insulation.

- GIB-LS Series is provided with a set-screw allowing fitting to lock bushing in any desired position.
- UL listed for use with copper or aluminum grounding conductors.
- Lugs not sold separately.

## Material/Finish

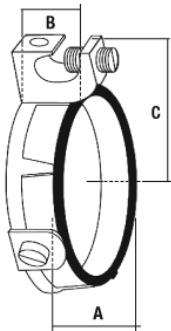
- Body: malleable iron/zinc plated
- Lug: aluminum/tin plated or bronze/bright dip
- Clamping and set screw: steel/zinc plated

## Certifications and Compliances

- UL Standard: 467
- UL Listed: E6581
- CSA Standard: C22.2 No. 41
- NEMA: FB-1

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products



Catalog Number Aluminum Lug	Catalog Number Bronze Lug	Trade Size (Inches)	Wire Size		Dimensions in Inches/Millimeters		
			Min.	Max.	A Bushing Diameter	B Bushing Height	C Turning Radius w/Lug
GIB-50LS-4AC	GIB-50LS-4BC	1/2	14 SOL	4 STR	1.19/ 30.2	0.44/ 11.2	1.19/ 30.2
GIB-75LS-4AC	GIB-75LS-4BC	3/4	14 SOL	4 STR	1.44/ 36.6	0.50/ 12.7	1.31/ 33.3
GIB-100LS-4AC	GIB-100LS-4BC	1	14 SOL	4 STR	1.75/ 44.5	0.56/ 14.2	1.44/ 36.6
GIB-100LS-20AC	GIB-100LS-20BC	1	14 SOL	2/0 STR	1.75/ 44.5	0.56/ 14.2	1.69/ 42.9
GIB-125LS-4AC	GIB-125LS-4BC	1-1/4	14 SOL	4 STR	2.13/ 54.1	0.63/ 16.0	1.63/ 41.4
GIB-125LS-20AC	GIB-125LS-20BC	1-1/4	14 SOL	2/0 STR	2.13/ 54.1	0.63/ 16.0	1.41/ 35.8
GIB-150LS-4AC	GIB-150LS-4BC	1-1/2	14 SOL	4 STR	2.31/ 58.7	0.69/ 17.5	1.75/ 44.5
GIB-150LS-20AC	GIB-150LS-20BC	1-1/2	14 SOL	2/0 STR	2.31/ 58.7	0.69/ 17.5	2.00/ 50.8
GIB-200LS-4AC	GIB-200LS-4BC	2	14 SOL	4 STR	2.81/ 71.4	0.75/ 19.1	2.00/ 50.8
GIB-200LS-20AC	GIB-200LS-20BC	2	14 SOL	2/0 STR	2.81/ 71.4	0.75/ 19.1	2.25/ 57.2
GIB-250LS-4AC	GIB-250LS-4BC	2-1/2	14 SOL	4 STR	3.38/ 85.9	0.88/ 22.4	2.25/ 57.2
GIB-250LS-20AC	GIB-250LS-20BC	2-1/2	14 SOL	2/0 STR	3.38/ 85.9	0.88/ 22.4	2.50/ 63.5
GIB-250LS-25AC	GIB-250LS-25BC	2-1/2	6 STR	250 STR	3.38/ 85.9	0.88/ 22.4	2.47/ 62.7
GIB-300LS-4AC	GIB-300LS-4BC	3	14 SOL	4 STR	4.06/ 103.1	1.31/ 33.3	2.63/ 66.8
GIB-300LS-20AC	GIB-300LS-20BC	3	14 SOL	2/0 STR	4.06/ 103.1	1.31/ 33.3	2.81/ 71.4
GIB-300LS-25AC	GIB-300LS-25BC	3	6 STR	250 STR	4.06/ 103.1	1.31/ 33.3	3.31/ 84.1

# NEER Zinc Grounding Type Insulated Bushings

For Rigid Conduit and IMC

## GBL: Grounding Insulated Bushing

### Application

- Used with a locknut to terminate rigid metal conduit or IMC conduit to a box or enclosure.

### Features

- Threaded (NPS) for rigid conduit and IMC.
- Temperature rating 150 °C.
- Low surface friction permits pulling of wires with virtually no abrasion on the cable insulation.
- Set screw provided with each fitting locks bushing in any desired position.
- For use with copper or aluminum grounding conductors.

### Material/Finish

- Body: zinc
- Lug: aluminum/tin plated
- Clamping screw: steel/zinc plated
- Set screws: steel/zinc plated

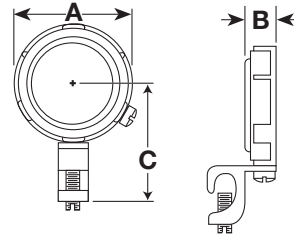
### Certifications and Compliances

- UL Standard: 467
- UL Listed: E37337
- CSA Standard: C22.2 No. 41
- CSA Certified: 208044
- NEMA: FB-1

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS



GBL



Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters			Wire Range
		A Bushing Diameter	B Bushing Height	C Turning Radius w/Lug	
1/2	GBL-100	1.04/26.4	0.49/12.4	1.36/34.5	4-14
3/4	GBL-200	1.28/32.5	0.49/12.4	1.48/37.6	4-14
1	GBL-300	1.53/38.9	0.60/15.2	1.57/39.9	4-14
1-1/4	GBL-400	1.89/48.0	0.61/15.5	2.14/54.4	1/0-14
1-1/2	GBL-500	2.16/54.9	0.60/15.2	2.26/57.4	1/0-14
2	GBL-600	2.66/67.6	0.60/15.2	2.49/63.2	1/0-14
2-1/2	GBL-700	3.23/82.0	0.83/21.1	2.76/70.1	1/0-14
3	GBL-800	3.85/97.8	0.83/21.1	3.07/78.0	1/0-14
3-1/2	GBL-900	4.35/110.5	0.83/21.1	3.33/84.6	1/0-14
4	GBL-1000	4.87/123.7	0.83/21.1	3.57/90.7	1/0-14

# NEER Reducing Washers and Bushings

## RWN: Reducing Washer

### Applications

- Reduce knockout size on sheet metal box, enclosure or cabinet.

### Material/Finish

- Galvanized steel

### Certifications and Compliances

- UL Standard: 514B
- UL Listed: E32539, E61301
- CSA Standard: C22.2 No. 18.3
- cUL Listed: E61301
- NEMA: FB-1

#### Note:

- Two reducing washers are required for each knockout.



RWN

## RB: Reducing Bushing Flush Type

### Applications

- To reduce the trade size of a tapered entry.

### Features

- Threaded for rigid conduit and IMC.

### Material/Finish

- Steel/zinc plated

### Certifications and Compliances

- UL Standard: 514B
- UL Listed: E-163167
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 70872
- NEMA: FB-1



RB

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters	
		Inside Diameter	Outside Diameter
3/4 x 1/2	<b>RWN-503</b>	0.88/22.4	1.44/36.6
1 x 1/2	<b>RWN-504</b>	0.88/22.4	1.75/44.5
1 x 3/4	<b>RWN-505</b>	1.11/28.2	1.75/44.5
1-1/4 x 1/2	<b>RWN-506</b>	0.88/22.4	2.19/55.6
1-1/4 x 3/4	<b>RWN-507</b>	1.11/28.2	2.19/55.6
1-1/4 x 1	<b>RWN-508</b>	1.37/34.8	2.19/55.6
1-1/2 x 1/2	<b>RWN-509</b>	0.88/22.4	2.50/63.5
1-1/2 x 3/4	<b>RWN-510</b>	1.11/28.2	2.50/63.5
1-1/2 x 1	<b>RWN-511</b>	1.37/34.8	2.50/63.5
1-1/2 x 1-1/4	<b>RWN-512</b>	1.73/43.9	2.50/63.5
2 x 1/4	<b>RWN-513</b>	0.88/22.4	3.00/76.2
2 x 3/4	<b>RWN-514</b>	1.11/28.2	3.00/76.2
2 x 1	<b>RWN-515</b>	1.37/34.8	3.00/76.2
2 x 1-1/4	<b>RWN-516</b>	1.73/43.9	3.00/76.2
2 x 1-1/2	<b>RWN-517</b>	1.98/50.3	3.00/76.2

Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters	
		Diameter	Height
3/4 x 1/2	<b>RB-2</b>	0.67/17.0	1.03/26.2
1 x 1/2	<b>RB-3</b>	0.71/18.0	1.28/32.5
1 x 3/4	<b>RB-4</b>	0.70/17.8	1.27/32.3
1-1/4 x 1/2	<b>RB-5</b>	0.71/18.0	1.62/41.1
1-1/4 x 3/4	<b>RB-6</b>	0.82/20.8	1.62/41.1
1-1/4 x 1	<b>RB-7</b>	0.82/20.8	1.63/41.4
1-1/2 x 1/2	<b>RB-8</b>	0.85/21.6	1.87/47.5
1-1/2 x 3/4	<b>RB-9</b>	0.85/21.6	1.88/47.8
1-1/2 x 1	<b>RB-10</b>	0.87/22.1	1.87/47.5
1-1/2 x 1-1/4	<b>RB-11</b>	0.85/21.6	1.87/47.5
2 x 1/2	<b>RB-12</b>	0.97/24.6	2.33/59.2
2 x 3/4	<b>RB-13</b>	0.98/24.9	2.34/59.4
2 x 1	<b>RB-14</b>	1.00/25.4	2.34/59.4
2 x 1-1/4	<b>RB-15</b>	0.97/24.6	2.34/59.4
2 x 1-1/2	<b>RB-16</b>	0.99/25.1	2.34/59.4

# Conduit Bushings for Rigid Metal Conduit and IMC

## Applications

- Used with a locknut to terminate rigid metal conduit or IMC conduit to a box or enclosure.

## Features



- Provides a smooth pulling surface.

## Material/Finish

- BU: malleable iron/zinc electroplated
- BBU: impact resistant plastic or thermoplastic

## Certifications and Compliances

- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

	Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100
			Diameter	Height	
<b>Threaded Bushings — Malleable Iron, Zinc Electroplated</b>					
	BU50	1/2	1.03/26.2	0.38/9.7	3.00/1.36
	BU75	3/4	1.25/31.8	0.44/11.2	4.00/1.81
	BU100	1	1.56/39.6	0.50/12.7	7.00/3.18
	BU125	1-1/4	2.00/50.8	0.63/16.0	13.00/5.90
	BU150	1-1/2	2.16/54.9	0.63/16.0	14.00/6.35
	BU200	2	2.63/66.8	0.63/16.0	19.00/8.62
	BU250	2-1/2	3.19/81.0	0.75/19.1	43.00/19.50
	BU300	3	3.81/96.8	0.94/23.9	56.00/25.40
	BU350	3-1/2	4.44/112.8	0.94/23.9	76.00/34.47
	BU400	4	4.94/125.5	1.06/26.9	109.00/49.44
	BU500	5	6.00/152.4	1.19/30.2	144.00/65.32
BU600	6	7.38/187.5	1.31/33.3	243.00/110.22	
<b>Threaded Bushings — Insulated — 150 °C Temperature Rating — Malleable Iron, Zinc Electroplated</b>					
	BU50I	1/2	1.19/30.2	0.50/12.7	4.00/1.81
	BU75I	3/4	1.44/36.6	0.56/14.2	6.00/2.72
	BU100I	1	1.75/44.5	0.63/16.0	9.00/4.08
	BU125I	1-1/4	2.13/54.1	0.75/19.1	10.00/4.54
	BU150I	1-1/2	2.31/58.7	0.88/22.4	19.00/8.62
	BU200I	2	2.81/71.4	0.94/23.9	24.00/10.89
	BU250I	2-1/2	3.38/85.9	1.00/25.4	47.00/21.32
	BU300I	3	4.06/103.1	1.13/28.7	60.00/27.22
	BU350I	3-1/2	4.50/114.3	1.19/30.2	69.00/31.30
	BU400I	4	5.19/131.8	1.31/33.3	100.00/45.36
	BU500I	5	6.06/153.9	1.31/33.3	200.00/90.72
BU600I	6	7.25/184.2	1.31/33.3	243.00/110.22	

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS



Commercial Products



# Conduit Bushings for Rigid Metal Conduit and IMC

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

	Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100
			Diameter	Height	
<b>Threadless Bushings – Insulated – 150 °C Temperature Rating – Malleable Iron, Zinc Electroplated</b>					
	BU50SI	1/2	1.19/30.2	0.50/12.7	4.00/1.81
	BU75SI	3/4	1.44/36.6	9.06/230.1	6.00/2.72
	BU100SI	1	1.75/44.5	0.63/16.0	9.00/4.08
	BU125SI	1-1/4	2.13/54.1	0.75/19.1	10.00/4.54
	BU150SI	1-1/2	2.31/58.7	0.88/22.4	18.00/8.16
	BU200SI	2	2.81/71.4	0.94/23.9	25.00/11.34
	BU250SI	2-1/2	3.38/85.9	1.00/25.4	40.00/18.14
	BU300SI	3	4.06/103.1	1.13/28.7	55.00/24.95
	BU350SI	3-1/2	4.50/114.3	1.19/30.2	59.00/26.76
	BU400SI	4	5.19/131.8	1.31/33.3	90.00/40.82
<b>Threaded Capped Bushings – Malleable Iron, Zinc Electroplated, Polyethylene Cap</b>					
	BUC50	1/2	1.03/26.2	0.38/9.7	3.00/1.36
	BUC75	3/4	1.25/31.8	0.44/11.2	5.00/2.27
	BUC100	1	1.56/39.6	0.50/12.7	8.00/3.63
	BUC125	1-1/4	2.00/50.8	0.63/16.0	12.00/5.44
	BUC150	1-1/2	2.16/54.9	0.63/16.0	17.00/7.71
	BUC200	2	2.63/66.8	0.63/16.0	20.00/9.07
	BUC250	2-1/2	3.19/81.0	0.75/19.1	40.00/18.14
	BUC300	3	3.81/96.8	0.94/23.9	52.00/23.59
	BUC350	3-1/2	4.44/112.8	0.94/23.9	76.00/34.47
	BUC400	4	4.94/125.5	1.06/26.9	114.00/51.71
	BUC500	5	6.00/152.4	1.19/30.2	149.00/67.59
BUC600	6	7.38/187.5	1.31/33.3	250.00/113.40	

# Conduit Bushings for Rigid Metal Conduit and IMC

Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100
		Diameter	Height	

## Threaded Impact Resistant Plastic Bushing – 105 °C Temperature Rating



<b>BBU50</b>	1/2	1.06/26.9	0.41/10.4	0.60/0.27
<b>BBU75</b>	3/4	1.31/33.3	0.41/10.4	0.80/0.36
<b>BBU100</b>	1	1.56/39.6	0.56/14.2	1.50/0.68
<b>BBU125</b>	1-1/4	1.91/48.5	0.56/14.2	2.30/1.04
<b>BBU150</b>	1-1/2	2.19/55.6	0.56/14.2	3.00/1.36
<b>BBU200</b>	2	2.69/68.3	0.63/16.0	4.00/1.81
<b>BBU250</b>	2-1/2	3.19/81.0	0.72/18.3	7.80/3.54
<b>BBU300</b>	3	3.84/97.5	0.75/19.1	10.00/4.54
<b>BBU350</b>	3-1/2	4.34/110.2	0.75/19.1	13.00/5.90
<b>BBU400</b>	4	4.84/122.9	0.78/19.8	11.00/4.99

## Threaded Thermoplastic Bushing – 150 °C Temperature Rating



<b>BBU50H</b>	1/2	1.06/26.9	0.41/10.4	0.80/0.36
<b>BBU75H</b>	3/4	1.31/33.3	0.41/10.4	0.90/0.41
<b>BBU100H</b>	1	1.56/39.6	0.56/14.2	1.80/0.82
<b>BBU125H</b>	1-1/4	1.91/48.5	0.56/14.2	2.80/1.27
<b>BBU150H</b>	1-1/2	2.19/55.6	0.56/14.2	3.30/1.50
<b>BBU200H</b>	2	2.69/68.3	0.63/16.0	4.40/2.00
<b>BBU250H</b>	2-1/2	3.19/81.0	0.72/18.3	14.30/6.49
<b>BBU300H</b>	3	3.84/97.5	0.75/19.1	11.00/4.99
<b>BBU350H</b>	3-1/2	4.34/110.2	0.75/19.1	14.30/6.49
<b>BBU400H</b>	4	4.84/122.9	0.78/19.8	18.70/8.48

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

# Rigid Conduit and IMC Locknuts

## Applications



- Used to secure an ordinary nut from working loose by locking itself when screwed down tight.

## Material

- Steel or aluminum

## Certifications and Compliances

- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

	Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100
			Diameter	Height	
<b>Locknuts — Steel</b>					
	BL38	3/8	0.94/23.9	0.13/3.3	1.40/0.64
	BL50	1/2	1.13/28.7	0.13/3.3	1.30/0.59
	BL75	3/4	1.38/35.1	0.13/3.3	2.40/1.09
	BL100	1	1.69/42.9	0.19/4.8	4.00/1.81
	BL125	1-1/4	2.25/57.2	0.19/4.8	5.50/2.49
	BL150	1-1/2	2.38/60.5	0.19/4.8	10.00/4.54
	BL200	2	2.88/73.2	0.19/4.8	13.90/6.30
	BL250	2-1/2	3.56/90.4	0.38/9.7	24.00/10.89
	BL300	3	4.25/108.0	0.38/9.7	32.00/14.51
	BL350	3-1/2	4.81/122.2	0.38/9.7	47.00/21.32
	BL400	4	5.44/138.2	0.38/9.7	60.00/27.22
	BL500	5	6.69/169.9	0.50/12.7	98.00/44.45
	BL600	6	7.94/201.7	0.50/12.7	160.00/72.57
<b>PVC Gasketed Sealing Locknuts — Steel — Liquidtight</b>					
	BLSG50	1/2	1.13/28.7	0.25/6.4	1.40/0.64
	BLSG75	3/4	1.88/47.8	0.25/6.4	2.60/1.18
	BLSG100	1	1.75/44.5	0.28/7.1	5.00/2.27
	BLSG125	1-1/4	2.09/53.1	0.28/7.1	6.80/3.08
	BLSG150	1-1/2	2.41/61.2	0.28/7.1	11.50/5.22
	BLSG200	2	2.94/74.7	0.31/7.9	14.70/6.67
	BLSG250	2-1/2	3.50/88.9	0.38/9.7	24.00/10.89
	BLSG300	3	4.19/106.4	0.38/9.7	32.00/14.51
	BLSG350	3-1/2	4.75/120.7	0.44/11.2	47.00/21.32
	BLSG400	4	5.34/135.6	0.44/11.2	60.00/27.22
	BLSG500	5	6.63/168.4	0.50/12.7	98.00/44.45
BLSG600	6	7.88/200.2	0.56/14.2	160.00/72.57	



COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

# Rigid Conduit and IMC Locknuts

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

	Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs. / Kgs. Per 100
			Diameter	Height	
<b>Bonding Locknuts — Steel</b>					
	GL50	1/2	1.38/35.1	0.19/4.8	3.00/1.36
	GL75	3/4	1.63/41.4	0.19/4.8	3.00/1.36
	GL100	1	1.81/46.0	0.25/6.4	5.00/2.27
	GL125	1-1/4	2.31/58.7	0.25/6.4	6.00/2.72
	GL150	1-1/2	2.63/66.8	0.25/6.4	7.00/3.18
	GL200	2	3.13/79.5	0.25/6.4	13.00/5.90
	GL250	2-1/2	3.56/90.4	0.44/11.2	18.00/8.16
	GL300	3	4.25/108.0	0.44/11.2	37.00/16.78
	GL350	3-1/2	4.81/122.2	0.50/12.7	45.00/20.41
	GL400	4	5.44/138.2	0.50/12.7	50.00/22.68
<b>Locknuts — Aluminum</b>					
	BL50A	1/2	1.13/28.7	0.19/4.8	0.50/0.23
	BL75A	3/4	1.38/35.1	0.19/4.8	0.80/0.36
	BL100A	1	1.69/42.9	0.19/4.8	1.60/0.73
	BL125A	1-1/4	2.25/57.2	0.19/4.8	2.90/1.32
	BL150A	1-1/2	2.38/60.5	0.19/4.8	2.20/1.00
	BL200A	2	2.80/73.2	0.19/4.8	4.80/2.18
	BL250A	2-1/2	3.56/90.4	0.38/9.7	7.50/3.40
	BL300A	3	4.25/108.0	0.38/9.7	10.60/4.81
	BL350A	3-1/2	4.81/122.2	0.38/9.7	14.30/6.49
	BL400A	4	5.44/138.2	0.38/9.7	18.60/8.44

# NEER Standard Conduit Locknuts

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

## L-D: Zinc Diecast

### Applications

- For securing threaded conduit or connectors with tapered or straight thread to a knockout or unthreaded slip hole.

### Features

- Single cast thread eliminates cross-threading.
- UL Listed as a fittings locknut and stand alone rigid conduit locknut.
- All locknuts are symmetrical and can be assembled from either side.
- Conical flange on either side enters the knockout creating a 360° ground path.

### Material/Finish

- Zinc die cast

### Certifications and Compliances

- UL Standard: 514B
- UL Listed: E32539
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 208044
- NEMA: FB-1



L-100-D

## L: Steel

### Applications

- For securing threaded conduit or connectors with tapered or straight thread to a knockout or unthreaded slip hole.

### Material/Finish

- Steel/zinc plated



L-100

Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters	
		Diameter	Height
1/2	L-100-D	1.10/27.9	0.16/4.1
3/4	L-200-D	1.36/34.5	0.16/4.1
1	L-300-D	1.68/42.7	0.20/5.1
1-1/4	L-400-D	2.05/52.1	0.21/5.3
1-1/2	L-500-D	2.38/60.5	0.21/5.3
2	L-600-D	2.91/73.9	0.21/5.3
2-1/2	L-700-D	3.52/89.4	0.29/7.4
3	L-800-D	4.15/105.4	0.30/7.6
3-1/2	L-900-D	4.65/118.1	0.28/7.1
4	L-1000-D	5.12/130.0	0.29/7.4

Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters	
		Diameter	Height
1/2	L-100	1.13/28.7	0.13/3.3
3/4	L-200	1.40/35.6	0.13/3.3
1	L-300	1.72/43.7	0.15/3.8
1-1/4	L-400	2.08/52.8	0.15/3.8
1-1/2	L-500	2.40/61.0	0.16/4.1
2	L-600	2.90/73.7	0.17/4.3
2-1/2	L-700	3.48/88.4	0.19/4.8
3	L-800	4.13/104.9	0.18/4.6
3-1/2	L-900	4.70/119.4	0.20/5.1
4	L-1000	5.32/135.1	0.20/5.1
5	L-1100	6.38/162.1	0.42/10.7
6	L-1200	7.75/196.9	0.43/10.9



# Threaded Rigid and IMC Conduit Hubs

Suitable for use in Class I, Division 2

## Applications

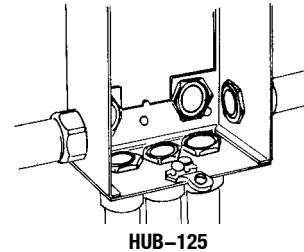
- Insulated throat form provides a more vibration resistant connection between threaded rigid conduit or IMC and enclosure.
- Provides threaded termination in sheet metal enclosures.
- Suitable for service entrance.
- General purpose fitting.

## Features

- Appleton's Uni-Seal rigid conduit hubs eliminate the need for welded hubs. Efficiency of installation is built into the superior design; single wrench installation.
- Patented hex-hub wedge adapter fits nearly flush against the interior side walls of enclosures; provides maximum wiring room.
- Simple two piece construction.
- Protective insulated throats, positive grounding and watertight sealing action.
- Flame resistant insulated throat eliminates need for end bushings.
- Locking edge of body bites into enclosure wall, makes hub self-locking, eliminates the need for locknuts, provides continuous 360° pressure on both sides of enclosure wall, forms positive grounding and vibration-resistant connection.
- Built-in recessed gasket.

## Material/Finish

- HUB50 thru HUB100: steel
- HUB125 thru HUB400 and HUB9050 thru HUB90100: malleable iron
- Gasket: neoprene



## Certifications and Compliances

- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

## Options

- PVC coating available on select hubs. Add suffix **-PVC** to catalog number.

Catalog Number	Trade Size (Inches)	Hole Diameter in Inches/Millimeters		Panel Thickness in Inches/Millimeters		Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100	
		Max.	Min.	Max.	Min.	A	B		
<b>Straight — Steel</b>									
HUB-50 †	1/2	0.88/	0.94/	0.06/	0.08/	1.08/	1.11/	16.00/	
		22.4	23.9	1.5	2.0	27.4	28.2	7.26	
HUB-75 †	3/4	1.09/	1.16/	0.06/	0.08/	1.11/	1.38/	23.00/	
		27.7	29.5	1.5	2.0	28.2	35.1	10.43	
HUB-100 †	1	1.34/	1.41/	0.06/	0.08/	1.25/	1.72/	39.00/	
		34.0	35.8	1.5	2.0	31.8	43.7	17.69	
		1.47/	1.47/	0.09/	0.25/				
		37.3	37.3	2.3	6.4				



† PVC coating available on select hubs. Add suffix **-PVC** to catalog number.

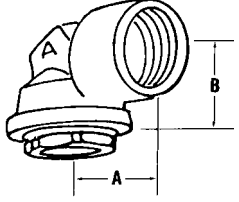
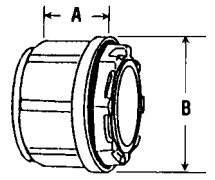
# Threaded Rigid and IMC Conduit Hubs

Suitable for use in Class I, Division 2

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

Catalog Number	Trade Size (Inches)	Hole Diameter in Inches/Millimeters		Panel Thickness in Inches/Millimeters		Dimensions in Inches/Millimeters		Weight Lbs./Kgs. Per 100
		Max.	Min.	Max.	Min.	A	B	
<b>Straight — Malleable Iron</b>								
HUB-125 †	1-1/4	1.69/	1.78/	0.06/	0.08/	1.80/	2.31/	77.00/
		42.9	45.2	1.5	2.0			34.93
HUB-150 †	1-1/2	1.94/	2.03/	0.06/	0.08/	1.83/	2.63/	92.00/
		49.3	51.6	1.5	2.0			41.73
HUB-200 †	2	2.39/	2.53/	0.06/	0.08/	1.88/	3.13/	134.00/
		60.7	64.3	1.5	2.0			60.78
HUB-250 †	2-1/2	2.89/	3.02/	0.09/	0.31/	2.39/	3.63/	236.00/
		73.4	76.7	2.3	7.9			107.05
HUB-300 †	3	3.52/	3.64/	0.09/	0.31/	2.48/	1.00/	310.00/
		89.4	92.5	2.3	7.9			140.61
HUB-350 †	3-1/2	4.02/	4.13/	0.09/	0.31/	3.19/	4.81/	400.00/
		102.1	104.9	2.3	7.9			181.44
HUB-400 †	4	4.52/	4.63/	0.09/	0.31/	2.63/	5.44/	475.00/
		114.8	117.6	2.3	7.9			215.46
<b>90° — Malleable Iron</b>								
HUB-9050	1/2	0.88/	0.94/	0.06/	0.08/	1.28/	0.88/	36.00/
		22.4	23.9	1.5	2.0			16.33
HUB-9075	3/4	1.09/	1.16/	0.06/	0.08/	1.44/	0.94/	50.00/
		27.7	29.5	1.5	2.0			22.68
HUB-90100	1	1.34/	1.41/	0.06/	0.08/	1.63/	1.13/	75.00/
		34.0	35.8	1.5	2.0			34.02
		1.47/	1.47/	0.09/	0.25/	41.4	28.7	34.02
		37.3	37.3	2.3	6.4			



† PVC coating available on select hubs. Add suffix -PVC to catalog number.

# Threaded Rigid and IMC Conduit Hubs With Bonding Screws

Suitable for use in Class I, Division 2

## Applications

- Provides threaded termination in sheet metal enclosures.
- Suitable for service entrance.
- General purpose fitting.

## Features

- Bonding locknut.
- Insulated throat.
- Recessed neoprene O-ring to assure water and dust-tight connections.

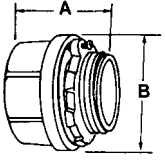

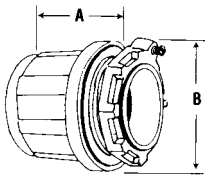
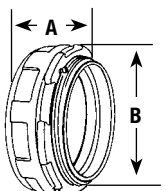
## Material/Finish

- Body: 1/2" thru 1": steel, zinc electroplate; 1-1/4" thru 6": malleable iron, zinc electroplate, chromate, epoxy powder coat
- Wedge: 1-1/4" thru 4": malleable iron, zinc electroplate, chromate, epoxy powder coat
- Locknut: 1/2" thru 1", 5" thru 6": steel, zinc electroplate
- Screw: steel, zinc electroplate

- O-ring: neoprene
- Liners: nylon

## Certifications and Compliances

- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters		Weight Lbs. /Kgs. Per 100	
		A	B		
<b>Straight</b>					
HUB-50B	1/2	0.91/23.1	1.31/33.3	12.80/5.81	
HUB-75B	3/4	0.91/23.1	1.56/39.6	18.40/8.35	
HUB-100B	1	0.97/24.6	1.81/46.0	31.20/14.15	
HUB-125B	1-1/4	1.13/28.7	2.31/58.7	59.40/26.94	 
HUB-150B	1-1/2	1.13/28.7	2.63/66.8	73.60/33.38	
HUB-200B	2	1.19/30.2	3.13/79.5	100.00/45.36	
HUB-250B	2-1/2	1.63/41.4	3.63/92.2	184.40/83.64	
HUB-300B	3	1.63/41.4	4.31/109.5	259.40/117.66	
HUB-350B	3-1/2	1.75/44.5	4.81/122.2	315.60/143.15	
HUB-400B	4	1.75/44.5	5.44/138.2	365.60/165.83	
HUB-500MB	5	2.03/51.6	6.63/168.4	700.00/317.51	
HUB-600MB	6	2.03/51.6	7.69/195.3	916.00/415.49	

COMMERCIAL PRODUCTS: RIGID AND IMC FITTINGS

Commercial Products

# Rigid Metal Conduit Expansion Couplings and Bonding Jumpers

FITTINGS: HAZARDOUS CONDUIT FITTINGS

## Applications

- "XJ" Expansion Couplings provide for movement that takes place on long runs of conduit installed in buildings of great length and between Divisions of buildings which are sectioned apart by structural expansion joints.

## Features

- Couplings have the equivalent of weather-tight joints for use with heavywall conduit.
- Metallic packing ring to insure the entire conduit system remains a continuous electrical conductor.
- Copper Bonding Jumpers are available to provide additional effective metallic bond to each conduit run.
- "XJ" Expansion Couplings have been Listed by UL for use with Bonding Jumpers in indoor and outdoor locations.

## Material/Finish

- XJ: malleable iron
- BJ: copper
- Hot-dip galvanized

## Certifications and Compliances

- UL Standard: 467
- UL Listed: E14814



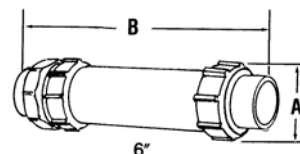
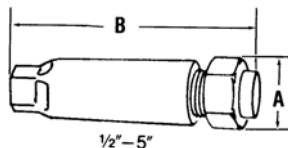
Expansion Couplings




Bonding Jumper

## Expansion Couplings

Catalog Number	Size (Inches)	Dimensions In Inches/Millimeters		Wt. Lbs./Kgs. Per 100
		A	B	
<b>4 Inch Movement XJ Expansion Couplings</b>				
XJ504	1/2	2.00/50.8	6.25/158.8	170.00/77.1
XJ754	3/4	2.25/57.2	6.38/162.1	200.00/90.7
XJ1004	1	2.63/66.8	6.63/168.4	280.00/127.0
XJ1254	1-1/4	3.13/79.5	6.63/168.4	350.00/158.8
XJ1504	1-1/2	3.50/88.9	6.63/168.4	500.00/226.8
XJ2004	2	4.00/101.6	7.13/181.1	700.00/317.5
XJ2504	2-1/2	4.50/114.3	7.50/190.5	800.00/362.9
XJ3004	3	5.38/136.7	8.13/206.5	1100.00/499.0
XJ3504	3-1/2	6.00/152.4	8.50/215.9	1450.00/657.7
XJ4004	4	6.63/168.4	8.63/219.2	1850.00/839.1
XJ5004	5	8.00/203.2	9.50/241.3	2250.00/1020.6
<b>8 Inch Movement XJ Expansion Couplings</b>				
XJ508	1/2	2.00/50.8	10.25/260.4	270.00/122.5
XJ758	3/4	2.25/57.2	10.38/263.7	320.00/145.1
XJ1008	1	2.63/66.8	10.63/270.0	440.00/199.6
XJ1258	1-1/4	3.13/79.5	10.63/270.0	520.00/235.9
XJ1508	1-1/2	3.50/88.9	10.63/270.0	720.00/326.6
XJ2008	2	4.00/101.6	11.13/282.7	1030.00/467.2
XJ2508	2-1/2	4.50/114.3	11.50/292.1	1170.00/530.7
XJ3008	3	5.38/136.7	12.13/308.1	1550.00/703.1
XJ3508	3-1/2	6.00/152.4	12.50/317.5	1950.00/884.5
XJ4008	4	6.63/168.4	12.63/320.8	2400.00/1088.6
XJ5008	5	8.00/203.2	13.50/342.9	3300.00/1496.9
XJ6008	6	9.50/241.3	15.38/390.7	5650.00/2562.8



# Rigid Metal Conduit Expansion Couplings and Bonding Jumpers

Bonding Jumpers		
	Catalog Number	Description
	<b>4 Inch Movement Copper Bonding Jumpers</b>	
	BJ45075	Used on XJ50-4 and XJ75-4
	BJ41012	Used on XJ100-4 and XJ125-4
	BJ41520	Used on XJ150-4 and XJ200-4
	BJ42530	Used on XJ250-4 and XJ300-4
	BJ43540	Used on XJ350-4 and XJ400-4
	BJ45060	Used on XJ500-4
	<b>8 Inch Movement Copper Bonding Jumpers</b>	
	BJ85075	Used on XJ50-8 and XJ75-8
	BJ81012	Used on XJ100-8 and XJ125-8
	BJ81520	Used on XJ150-8 and XJ200-8
	BJ82530	Used on XJ250-8 and XJ300-8
	BJ83540	Used on XJ350-8 and XJ400-8
	BJ85060	Used on XJ500-8 and XJ600-8

Fittings

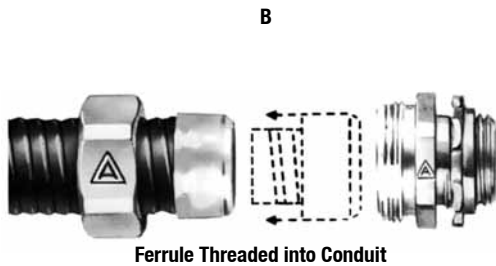
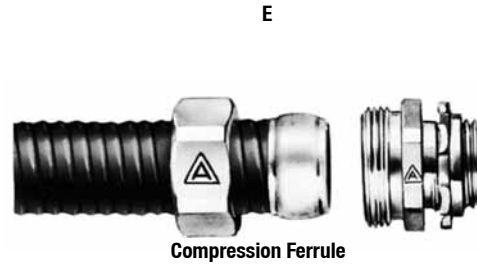
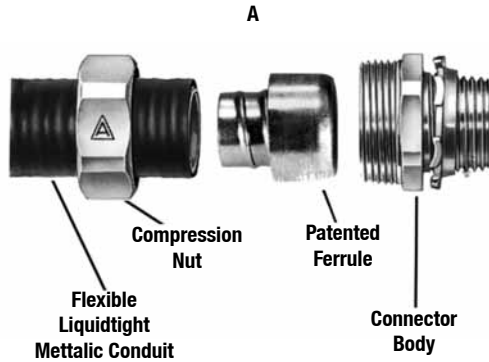
FITTINGS: HAZARDOUS CONDUIT FITTINGS



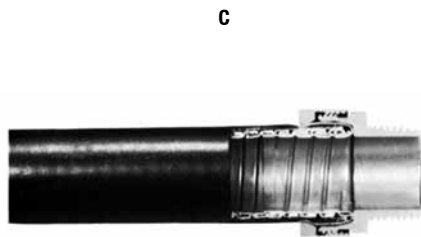
# Installation Features of ST, STB, STN and STL Connectors and Hubs

For Liquidtight Flexible Metal Conduit

Using hacksaw, cut liquidtight flexible conduit making certain that the jacket and conduit are flush. (A) Place compression nut over conduit. (B) Screw ferrule onto the spiralled steel inner wall of the conduit. The firm grip of the ferrule threading against the inner conduit wall provides a continuous, permanent, positive metal-to-metal ground. There are no sharp edges to cause injury to wire during or after installation. (C) Place the liquidtight flexible conduit with the ferrule into connector body. (D) Tighten compression nut as far as it will go. This will assure correct collaring of the conduit—the end of the metal edge of the ferrule will curve out slightly. (E) This prevents damage to the conduit jacket itself at the time of installation, and also insures against future damage from frequent flexing, jarring or vibration.

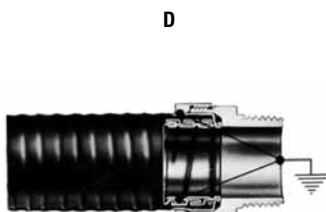


**Sealing Gasket**  
Neoprene sealing gasket eliminates common connection problems and assures a liquidtight installation. Seals against oil, water, dirt and chemicals.



**Space Saving Hex-Hub Wedge Adapter**

Male shank of unique Appleton hex-hub wedge adapter “finger tightens” into connector body. Flared surface of adapter wedges box wall against locking edge of body. Forms full 360° contact on both sides of box wall.



**Insulated Throat**

Insulating insert recessed into hex-hub wedge adapter protects against wire damage...without reduction in throat diameter. Perfect for extreme vibration conditions. Nothing to come loose, deteriorate, crack or break!

Commercial Products

COMMERCIAL PRODUCTS: LIQUIDTIGHT CONDUIT FITTINGS

1670







Visit our website at [www.appletonelec.com](http://www.appletonelec.com) or contact us at (800) 621-1506.

© January 2011

# Liquidtight ST Series Plain Throat Connectors

For Liquidtight Flexible Metal Conduit

Suitable for use in Class I, Division 2

	Catalog Number	Conduit Size (Inches)	Dimensions in Inches/Millimeters				Weight Lbs./Kgs. Per 100
			A	B	C	D	
<b>Straight</b>							
	ST-38	3/8 flex, 1/2 hub	1.44/36.6	0.63/16.0	1.13/28.7	—	16.00/7.26
	ST-50	1/2	1.44/36.6	0.63/16.0	1.25/31.8	—	15.00/6.80
	ST-75	3/4	1.50/38.1	0.63/16.0	1.50/38.1	—	22.00/9.98
	ST-100	1	1.63/41.4	0.75/19.1	1.81/45.9	—	34.00/15.42
	ST-125	1-1/4	2.00/50.8	0.63/16.0	2.31/58.7	—	84.00/38.10
	ST-150	1-1/2	2.25/57.2	0.63/16.0	2.63/66.8	—	120.00/54.43
	ST-200	2	2.50/63.5	0.69/17.5	3.19/81.0	—	165.00/74.84
	ST-250	2-1/2	3.38/85.9	1.06/26.9	3.94/100.1	—	350.00/158.76
	ST-300	3	3.69/93.7	1.19/30.2	4.38/111.3	—	450.00/204.12
	ST-350	3-1/2	3.69/93.7	1.19/30.2	5.00/127.0	—	525.00/238.13
	ST-400	4	4.00/101.6	1.25/31.8	5.50/139.7	—	664.00/301.19
	<b>45°</b>						
	ST-4538	3/8 flex, 1/2 hub	0.88/22.4	0.63/16.0	1.13/28.7	1.13/28.7	19.00/8.62
	ST-4550	1/2	0.88/22.4	0.63/16.0	1.25/31.8	1.13/28.7	19.00/8.62
	ST-4575	3/4	1.13/28.7	0.63/16.0	1.50/38.1	1.25/31.8	32.00/14.51
	ST-45100	1	1.38/35.1	0.75/19.1	1.81/45.9	1.81/45.9	46.00/20.87
	ST-45125	1-1/4	1.63/41.4	0.63/16.0	2.31/58.7	1.81/45.9	103.00/46.72
	ST-45150	1-1/2	1.81/45.9	0.63/16.0	2.63/66.8	2.13/54.1	165.00/74.84
	ST-45200	2	2.00/50.8	0.69/17.5	3.19/81.0	2.38/60.5	245.00/111.13
	ST-45250	2-1/2	3.56/90.4	1.06/26.9	3.94/100.1	5.00/127.0	760.00/344.73
	ST-45300	3	4.31/109.5	1.19/30.2	4.38/111.3	5.81/147.6	962.00/436.36
	ST-45400	4	4.63/117.6	1.25/31.8	5.50/139.7	4.00/101.6	1512.00/685.83
<b>90°</b>							
	ST-9038	3/8 flex, 1/2 hub	1.25/31.8	0.63/16.0	1.13/28.7	1.50/38.1	22.80/10.34
	ST-9050	1/2	1.25/31.8	0.63/16.0	1.25/31.8	1.50/38.1	23.00/10.43
	ST-9075	3/4	1.44/36.6	0.63/16.0	1.50/38.1	1.56/39.6	39.00/17.69
	ST-90100	1	1.38/35.1	0.75/19.1	1.81/45.9	1.88/47.8	62.00/28.12
	ST-90125	1-1/4	1.81/45.9	0.63/16.0	2.31/58.7	2.38/60.5	114.00/51.71
	ST-90150	1-1/2	2.44/61.9	0.63/16.0	2.63/66.8	3.19/81.0	195.00/88.45
	ST-90200	2	2.63/66.8	0.69/17.5	3.19/81.0	3.56/90.4	290.00/131.54
	ST-90250	2-1/2	7.19/182.6	1.06/26.9	3.94/100.1	8.44/214.4	843.00/382.38
	ST-90300	3	8.63/219.2	1.19/30.2	4.38/111.3	10.13/257.3	1100.00/498.95
	ST-90400	4	11.25/285.8	1.25/31.8	5.50/139.7	12.81/325.4	2100.00/952.54

Commercial Products

COMMERCIAL PRODUCTS: LIQUIDTIGHT CONDUIT FITTINGS

# Liquidtight STN Insulated Connectors for Liquidtight Flexible Metal Conduit

Straight and 90° for Liquidtight Flexible Metal Conduit Connections to Sheet Metal Enclosures.

Suitable for use in Class I, Division 2

## Applications

- For use with liquidtight flexible metal conduit in sheet metal enclosure installations.

## Features

- Unique long ferrule with more pronounced threads provides over four times UL pull-out requirements.
- Ferrule provides maximum surface contact for better sealing and a continuous, permanent, positive metal-to-metal ground.
- Flame resistant, insulating insert recessed into hex-head wedge adapter protects against wire damage, without reduction in throat diameter.
- Space-saving hex-hub wedge adapter fits nearly flush against inside walls of enclosures, providing maximum wiring room.
- Liquidtight/raintight/oiltight.
- Suitable for wet locations.

## Standard Material/Finish

- 3/8" thru 1" straight: steel
- 1-1/4" thru 4" straight and 3/8" thru 1" 90°: malleable iron
- 3/8" thru 1" ferrule: steel; 1-1/4" thru 4" ferrule: aluminum
- Steel: zinc electroplate
- Malleable iron: zinc electroplate, chromate and epoxy powder coat/zinc electroplate

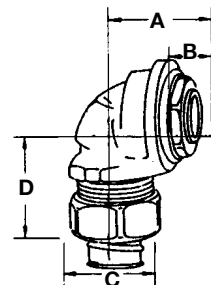
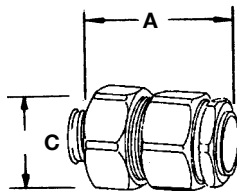
## Compliances and Certification

- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

## STD Conduit Thread Size

Flexible Conduit Size (Inches)	NPT Size
3/8	1/2
1/2	1/2
3/4	3/4
1	1
1-1/4	1-1/4
1-1/2	1-1/2
2	2
2-1/2	2-1/2
3	3
4	4



## Dimensions



# Liquidtight STN Insulated Connectors for Liquidtight Flexible Metal Conduit

Straight and 90° for Liquidtight Flexible Metal Conduit Connections to Sheet Metal Enclosures.

Suitable for use in Class I, Division 2

	Catalog Number	Size (Inches)	Inches/Millimeters								Weight Lbs./Kgs. Per 100
			Dimensions			Hole Diameter		Wall Thickness		D	
			A	B	C	Min.	Max.	Min.	Max.		
<b>Straight</b>											
	<b>STN-38</b>	3/8	1.44/35.6	—	1.13/28.7	—	0.88/22.4	0.94/23.9 0.97/24.6	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	18.00/8.16
	<b>STN-50</b>	1/2	1.44/35.6	—	1.25/31.8	—	0.88/22.4	0.94/23.9 0.97/24.6	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	20.00/9.07
	<b>STN-75</b>	3/4	1.56/39.6	—	1.50/38.1	—	1.09/27.7	1.16/29.5 1.22/31.0	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	30.00/13.61
	<b>STN-100</b>	1	1.75/44.5	—	1.81/45.9	—	1.34/34.0	1.41/35.8 1.47/37.3	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	40.80/18.51
	<b>STN-125</b>	1-1/4	2.63/66.8	—	2.31/58.7	—	1.69/42.9	1.78/45.2 1.84/46.7	0.06/1.5 0.09/2.3	0.08/2.0 0.31/7.9	125.00/56.70
	<b>STN-150</b>	1-1/2	2.63/66.8	—	2.63/66.8	—	1.94/49.3	2.03/51.6 2.09/53.1	0.06/1.5 0.09/2.3	0.08/2.0 0.31/7.9	184.00/83.46
	<b>STN-200</b>	2	2.94/74.7	—	3.19/81.0	—	2.39/60.7	2.53/64.3 2.59/65.8	0.06/1.5 0.09/2.3	0.08/2.0 0.31/7.9	280.00/127.01
	<b>STN-250</b>	2-1/2	3.63/92.2	—	3.94/100.1	—	2.89/73.4	3.02/76.7	0.09/2.3	0.31/7.9	509.00/230.88
<b>STN-300</b>	3	3.19/81.0	—	4.38/111.3	—	3.52/89.4	3.64/92.5	0.09/2.3	0.31/7.9	669.00/303.45	
<b>STN-400</b>	4	4.19/106.4	—	5.50/139.7	—	4.52/114.8	4.63/117.6	0.09/2.3	0.31/7.9	860.00/390.09	
<b>90°</b>											
	<b>STN-9038</b>	3/8	0.84/21.3	—	1.13/28.7	—	0.88/22.4	0.94/23.9 0.97/24.6	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	21.00/9.53
	<b>STN-9050</b>	1/2	0.84/21.3	—	1.25/31.8	—	0.88/22.4	0.94/23.9 0.97/24.6	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	30.00/13.61
	<b>STN-9075</b>	3/4	0.94/23.9	—	1.50/38.1	—	1.09/27.7	1.16/29.5 1.22/31.0	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	36.00/16.33
	<b>STN-90100</b>	1	1.10/27.9	—	1.81/45.9	—	1.34/34.0	1.41/35.8 1.47/37.3	0.06/1.5 0.09/2.3	0.08/2.0 0.25/6.4	80.00/36.29

Commercial Products

COMMERCIAL PRODUCTS: LIQUIDTIGHT CONDUIT FITTINGS

# Liquidtight STF Connectors with Threaded Hubs

For Liquidtight Flexible Metal Conduit. Female ST Connectors.

Suitable for use in Class I, Division 2

## Applications

- For use with liquidtight flexible metal conduit when making connection to threaded rigid conduit and IMC.

## Features

- Female ST connectors have a unique long ferrule with more pronounced threads that provide over four times UL pull-out requirements. The ferrule also provides maximum surface contact for better sealing and a continuous, permanent, positive metal-to-metal ground.
- Liquidtight/raintight/oiltight.
- Suitable for wet locations.
- Full, machined tapered threads (NPT).
- ST connectors have compact design with small turning radius.

## Standard Material/Finish

- 3/8" thru 1": steel with steel ferrule; 1-1/4" thru 4": malleable iron with aluminum ferrule
- Steel: zinc electroplate
- Malleable iron: zinc electroplate, chromate and epoxy powder coat/zinc electroplate

## Certifications and Compliances

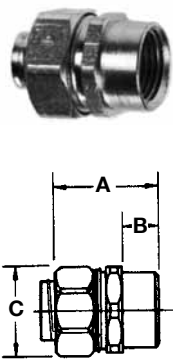
- UL Standard: 514B
- UL Listed: E14814
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065178
- NEMA: FB-1

## Options

- Grounding lugs can be provided. Contact local sales representative.

Commercial Products

COMMERCIAL PRODUCTS: LIQUIDTIGHT CONDUIT FITTINGS

	Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters			Weight Lbs./ Kgs. Per 100
			A	B	C	
<b>Female ST Connectors with Threaded Hubs</b>						
	<b>ST-38F</b>	3/8 flex, 1/2 hub	1.31/33.3	0.44/11.2	1.13/28.7	13.00/5.90
	<b>ST-50F</b>	1/2	1.31/33.3	0.44/11.2	1.25/31.8	14.00/6.35
	<b>ST-75F</b>	3/4	1.44/36.6	0.50/12.7	1.50/38.1	21.00/9.53
	<b>ST-100F</b>	1	1.56/39.6	0.69/17.5	1.81/45.9	31.00/14.06
	<b>ST-125F</b>	1-1/4	1.06/52.3	0.94/23.8	2.31/58.7	99.00/44.90
	<b>ST-150F</b>	1-1/2	2.50/63.5	1.12/28.4	2.63/66.8	143.70/65.18
	<b>ST-200F</b>	2	2.75/69.9	1.25/31.8	3.19/81.0	225.00/102.06
	<b>ST-250F</b>	2-1/2	3.12/79.2	1.38/35.1	3.94/100.1	403.10/182.84
	<b>ST-300F</b>	3	3.68/93.5	1.56/39.6	4.38/111.3	427.60/193.96
	<b>ST-400F</b>	4	3.94/100.1	1.75/44.5	5.50/139.7	662.40/300.46



# Expansion Fittings

For Rigid Metal Conduit & IMC

## Type AX

Provides 4" conduit movement

## Type AX-8

Provides 8" conduit movement

Use:

To allow for expansion and contraction in a run of rigid metal conduit.

For applications involving IMC a 15" min. length of rigid conduit should be used entering the expansion fitting due to the slightly smaller O.D. of the IMC.

Type AX provides for a maximum of 4" conduit movement (2" in either direction).

Type AX-8 provides for a maximum of 8" conduit movement (4" in either direction).

Features:

- Weatherproof
- Includes insulating bushing
- Bonding jumpers on Page CA7

Material/Finish:

Malleable or Ductile Iron/  
Hot Dip Galvanized

Optional Material:

Type AX and Type AX-8 expansion fittings are available in Copper-free Aluminum. Add letter "A" after Catalog Number (Example: AX-50A). Use ABJ jumpers shown on Page CA8.

Third Party Certification:



UL Listed: E-11853  
Wet or dry locations - use with Type BJ external bonding jumpers, per NEC 250.98



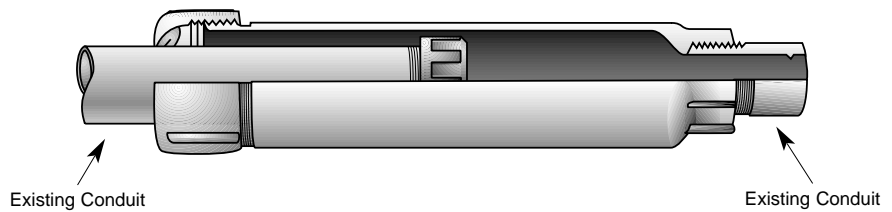
CSA Certified: 11584  
Wet or dry locations - use with Type BJ external bonding jumpers.

To Order Specify:

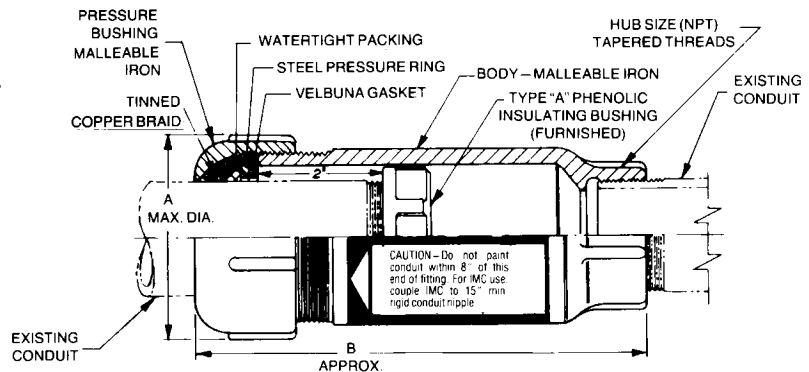
Specify bonding jumpers for steel conduit by Catalog Numbers in corresponding table.

Applicable Third Party Standards:

UL Standard: 514B  
CSA Standard: C22.2 No. 18  
Fed. Spec: W-F-408E  
NEMA: FB-1



Type AX-8 Provides for 8" Conduit Movement



Type AX Provides for 4" Conduit Movement

Trade Size (Inches)	Catalog Number	Dimensions in Inches		Catalog Number
		Max. Dia.	Overall Length	
<b>4" Conduit Movement</b>				<b>Bonding Jumper - 14"</b>
1/2	AX-50	2	6 1/4	BJ-0507-14
3/4	AX-75	2 1/4	6 3/8	BJ-0507-14
1	AX-100	2 5/8	6 5/8	BJ-1012-14
1 1/4	AX-125	3 1/8	6 5/8	BJ-1012-14
1 1/2	AX-150	3 1/2	6 5/8	BJ-1520-14
2	AX-200	4	7 1/8	BJ-1520-14
2 1/2	AX-250	4 1/2	7 1/2	BJ-2530-14
3	AX-300	5 1/8	8 1/8	BJ-2530-14
3 1/2	AX-350	6	8 1/2	BJ-3540-14
4	AX-400	6 5/8	8 5/8	BJ-3540-14
5	AX-500	8	9 1/2	BJ-5060-14
6	See EX on page CA5			
<b>8" Conduit Movement</b>				<b>Bonding Jumper - 24"</b>
1/2	AX-8-50	2	10 1/4	BJ-0507-24
3/4	AX-8-75	2 1/4	10 5/8	BJ-0507-24
1	AX-8-100	2 5/8	10 5/8	BJ-1012-24
1 1/4	AX-8-125	3 1/8	10 5/8	BJ-1012-24
1 1/2	AX-8-150	3 1/2	10 5/8	BJ-1520-24
2	AX-8-200	4	11 1/8	BJ-1520-24
2 1/2	AX-8-250	4 1/2	11 1/2	BJ-2530-24
3	AX-8-300	5 1/8	12 1/8	BJ-2530-24
3 1/2	AX-8-350	6	12 1/4	BJ-3540-24
4	AX-8-400	6 5/8	12 3/8	BJ-3540-24
5	AX-8-500	8	13 1/2	BJ-5060-24
6	See EX on page CA5			

# XJG Conduit Expansion Joints With Internal Grounding For Rigid Metal Conduit and IMC

Wet Locations

## Applications:

XJG expansion couplings are used with rigid metal conduit and IMC:

- Without the need for an external bonding jumper and clamps (up to 4")
- To couple together two (2) sections of conduit subject to longitudinal movement
- In long conduit runs to permit linear movement caused by thermal expansion and contraction.
- On long conduit runs to prevent conduit from buckling and ensuing circuit failures
- Indoors or outdoors where conduit expansion occurs and there are wide temperature ranges
- In conduit runs that cross structural joints
- In conduit runs to prevent damage to conduit supports such as in a building or on a bridge
- With optional redundant visible grounding strap

## Certifications and Compliances:

- UL Standard: 514B
- CSA Standard: C22.2 No. 18
- NEC Articles 250-77 and 300-7 (b)
- NEMA FB1
- Wet Locations

## Materials and Finishes:

### Body

- Steel-electrogalvanized
- Copper-free aluminum - natural
- *Feraloy*® iron alloy - electrogalvanized (5" + 6" only)

### Reducer

- 1/2" through 1" - Steel - electrogalvanized
- 1/4" through 6" - *Feraloy*® iron alloy - electrogalvanized and aluminum paint
- Copper-free aluminum - natural

### Gland Nut

- 1/2" through 1" - Steel - electrogalvanized
- 1/4" through 6" - *Feraloy*® iron alloy - electrogalvanized and aluminum paint
- Copper-free aluminum - natural

### Packing

- Teflon® (trademark of E.I. DuPont Co.)

### Washer

- Steel - electrogalvanized
- Copper-free aluminum - natural

### Gasket

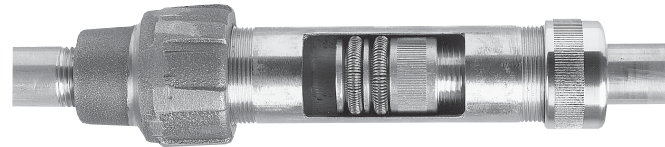
- Vellum

### Bushing

- 1/2" through 1" - Steel - electrogalvanized
- 1/4" through 6" - *Feraloy*® iron alloy - electrogalvanized and aluminum paint
- Copper-free aluminum - natural

## Crouse-Hinds

by **E.T.N**



Patented Design

## XJG – For use with rigid metal conduit and IMC

Conduit Size	Maximum Conduit Movement	Cat. #	Optional Bonding Jumper†	A Diameter	B Length	Bonding Jumper Length
1/2	4	XJG14	BJ14	1.75	6.75	20"
	8	XJG18	BJ18	1.75	10.75	30"
3/4	4	XJG24	BJ24	2.12	6.75	20"
	8	XJG28	BJ28	2.12	10.75	30"
1	4	XJG34	BJ34	2.43	7.25	20"
	8	XJG38	BJ38	2.43	11.25	30"
1 1/4	4	XJG44	BJ44	3.19	7.56	24"
	8	XJG48	BJ48	3.19	11.56	30"
1 1/2	4	XJG54	BJ54	3.68	7.87	24"
	8	XJG58	BJ58	3.68	11.87	30"
2	4	XJG64	BJ64	4.75	8.25	24"
	8	XJG68	BJ68	4.75	12.25	30"
2 1/2	4	XJG74	BJ74	4.87	9.31	24"
	8	XJG78	BJ78	4.87	13.31	36"
3	4	XJG84	BJ84	5.37	10.00	30"
	8	XJG88	BJ88	5.37	14.00	36"
3 1/2	4	XJG94	BJ94	6.62	9.81	30"
	8	XJG98	BJ98	6.62	13.81	36"
4	4	XJG104	BJ104	6.62	9.81	30"
	8	XJG108	BJ108	6.62	13.81	36"
5	8	XJ128‡	—	7.64	15.50	—
6	8	XJ148‡	—	9.56	16.00	—

†XJG expansion couplings use a metallic bushing and ground springs to create a high integrity internal ground connection. External ground straps offer a redundant ground path and easy visible indication of ground  
‡XJ128 and XJ148 are not internally grounded. A pair of 36" bonding jumpers are provided with fitting.

### Ground Springs

- Phosphor bronze - electrogalvanized

### Ground Strap

- Braided tinned copper

### U-Bolts

- Malleable iron – electrogalvanized

## Options:

### Description

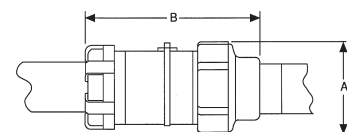
Available in copper-free aluminum  
Not available on 5" and 6" sizes

Hot dipped galvanized  
Available with redundant† ground strap for visible indication of grounding – order separately (BJ Series)

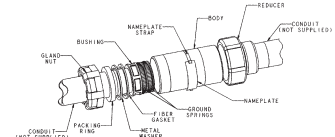
## Size Ranges:

- 1/2" through 6" conduit size
- 4" and 8" maximum conduit movement

## Dimensions In Inches:



XJG shown with optional bonding jumper



CP

## Rigid/IMC Conduit Fittings

**T&B Catalog Number:**

EK 402

**UPC Number:**

78599140802

**Status:**

Active

**Description:**

3/4 in. Three piece Coupling, Steel-Zinc Plated. For use with Rigid/IMC Conduit.

### Application

For use with rigid/IMC conduits

### General

Trade Size (inches)	3/4
Material	Steel
Finish	Zinc Plated
Connection Type	Threaded

### Dimension Information

Diameter_A (inches)	1 1/8
Diameter_B (inches)	1 11/32

### Packaging

T&B Inner Pack	25
Package in Units	50
T&B Sold in UOM	Each
T&B Weight Per UOM	16.8 lbs. per 100

### Application Support

Product Selector	sg_rigidimc_steel_couple_conn
------------------	-------------------------------

### Certifications

RoHS Compliance	Yes
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### Certifications



File Nbr:

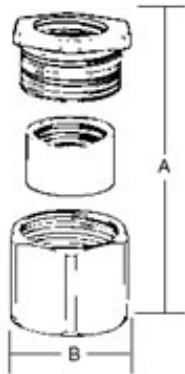
E 23018

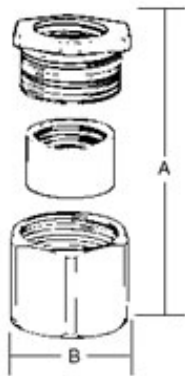
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Email:techsupport@tnb.com





## Rigid/IMC Conduit Fittings

**T&B Catalog Number:**

EK 403

**UPC Number:**

78599140804

**Status:**

Active

**Description:**

1 in. Three piece Coupling, Steel-Zinc Plated. For use with Rigid/IMC Conduit.

### Application

For use with rigid/IMC conduits

### General

Trade Size (inches)	1
Material	Steel
Finish	Zinc Plated
Connection Type	Threaded

### Dimension Information

Diameter_A (inches)	1 3/8
Diameter_B (inches)	1 5/8

### Packaging

Package in Units	25
T&B Sold in UOM	Each
T&B Weight Per UOM	28.8 lbs. per 100

### Application Support

Product Selector	sg_rigidimc_steel_couple_conn
------------------	-------------------------------

### Certifications

RoHS Compliance	Yes
-----------------	-----

### Certifications



File Nbr:

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**Rigid/IMC Conduit Fittings**

**T&B Catalog Number:**

143

**UPC Number:**

78621000143

**Status:**

Active

**Description:**

1 in. Steel locknut. For use with Rigid/IMC conduit.

**Features**

Hardened steel, malleable iron, copper-free aluminum construction

Tightens without deformation

**Application**

To connect externally threaded conduit or connector to a threadless opening in a box or enclosure.

To effectively bond conduit or connector to box or enclosure.

**General**

Material Steel

**Dimension Information**

Size (inches) 1  
 Dimension A (inches) 1 11/16  
 Dimension B (inches) 13/64

**Specifications**

3dmodel Available on Website

**Packaging**

T&B Order Multiple 50  
 T&B Inner Pack 50  
 Package in Units 500  
 T&B Sold in UOM Each  
 T&B Weight Per UOM 3.75 lbs. per 100

**Application Support**

304 Stainless Steel Corrosion Compatibility Chart Available on Website

Product Overview Available on Website

**Certifications**

RoHS Compliance Yes

**Certifications**



File Nbr:  
E 23018

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 Email:techsupport@tnb.com





## Rigid/IMC Conduit Fittings

**T&B Catalog Number:**

143

**UPC Number:**

78621000143

**Status:**

Active

**Description:**

1 in. Steel locknut. For use with Rigid/IMC conduit.

### Features

Hardened steel, malleable iron, copper-free aluminum construction

Tightens without deformation

### Application

To connect externally threaded conduit or connector to a threadless opening in a box or enclosure.

To effectively bond conduit or connector to box or enclosure.

### General

Material Steel

### Dimension Information

Size (inches) 1  
 Dimension A (inches) 1 11/16  
 Dimension B (inches) 13/64

### Specifications

3dmodel Available on Website

### Packaging

T&B Order Multiple 50  
 T&B Inner Pack 50  
 Package in Units 500  
 T&B Sold in UOM Each  
 T&B Weight Per UOM 3.75 lbs. per 100

### Application Support

304 Stainless Steel Corrosion Compatibility Chart Available on Website

Product Overview Available on Website

### Certifications

RoHS Compliance Yes

### Certifications



File Nbr:  
E 23018

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## Rigid/IMC Conduit Fittings

**T&B Catalog Number:**

142-TB

**UPC Number:**

78621000142

**Status:**

Active

**Description:**

3/4 in. Steel locknut. For use with Rigid/IMC conduit.

### Features

Hardened steel, malleable iron, copper-free aluminum construction

Tightens without deformation

### Application

To connect externally threaded conduit or connector to a threadless opening in a box or enclosure.

To effectively bond conduit or connector to box or enclosure.

### General

Material Steel

### Dimension Information

Size (inches) 3/4

Dimension A (inches) 1 3/8

Dimension B (inches) 3/16

### Specifications

3dmodel Available on Website

### Packaging

T&B Order Multiple 100

T&B Inner Pack 100

Package in Units 1000

T&B Sold in UOM Each

T&B Weight Per UOM 2.2 lbs. per 100

### Application Support

304 Stainless Steel Corrosion Compatibility Chart Available on Website

Product Overview Available on Website

### Notes

Case hardened locknuts.

### Certifications

RoHS Compliance Yes

### Certifications



File Nbr:

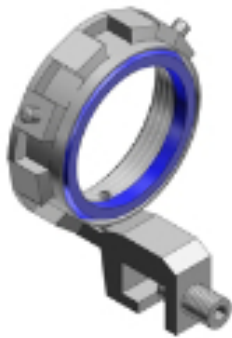
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## Rigid/IMC Conduit Fittings

### T&B Catalog Number:

3872

### UPC Number:

78621003872

### Status:

Active

### Description:

1 in. Threaded insulated Grounding Bushing, Aluminum-Electro Zinc Plated, wire range-14-4, thermoplastic insulator. For use with Rigid/IMC Conduit.

### Application

For quick installation of bonding jumper to multiple metal conduits (Rigid and IMC).

Designed to bush conductors and prevent insulation damage.

### General

Trade Size (inches)	1
Material	Malleable Iron
Finish	Electro Zinc Plated
Wire Range	14-4

### Dimension Information

Bushing Diameter (inches)	1.77
Throat Diameter (inches)	0.944
Lug Length (inches)	1.31
Swing Radius (inches)	1.535
Bushing Height (inches)	0.735
Conduit Size (inches)	1

### Specifications

3dmodel	Available on Website
---------	----------------------

### Packaging

T&B Inner Pack	25
Package in Units	50
T&B Sold in UOM	Each
T&B Weight Per UOM	18 lbs. per 100

### Application Support

T&B Instruction Sheets	ta00375-tb2
------------------------	-------------

### Notes

Availabe with DURA-PLATE Finish

### Certifications

RoHS Compliance	Yes
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### Certifications



File Nbr:

E 3060

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## Rigid/IMC Conduit Fittings

### T&B Catalog Number:

BG 802

### UPC Number:

78599140202

### Status:

Active

### Description:

3/4 in. Insulated Grounding Bushing, Malleable Iron-Zinc Plated. For use with Rigid/IMC Conduit.

### Features

105 degree C thermoplastic liners, heavy reinforced ribs.

### Application

For use with rigid/IMC conduits

### General

T&B Replacement Catalog Number BG802A

Trade Size (inches) 3/4

Material Malleable Iron

Finish Zinc Plated

### Dimension Information

Diameter\_A (inches) 1 1/4

Diameter\_B (inches) 1/2

### Packaging

T&B Inner Pack 50

Package in Units 500

T&B Sold in UOM Each

T&B Weight Per UOM 8.88 lbs. per 100

### Certifications

RoHS Compliance No

### Certifications



File Nbr:

E 3060

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## Rigid/IMC Conduit Fittings

### T&B Catalog Number:

BG 803

### UPC Number:

78599140204

### Status:

Active

### Description:

1 in. Insulated Grounding Bushing, Malleable Iron-Zinc Plated. For use with Rigid/IMC Conduit.

### Features

105 degree C thermoplastic liners, heavy reinforced ribs.

### Application

For use with rigid/IMC conduits

### General

Trade Size (inches)	1
Material	Malleable Iron
Finish	Zinc Plated

### Dimension Information

Diameter_A (inches)	1 9/16
Diameter_B (inches)	9/16

### Packaging

T&B Inner Pack	25
Package in Units	250
T&B Sold in UOM	Each
T&B Weight Per UOM	11.6 lbs. per 100

### Certifications

RoHS Compliance	No
-----------------	----

### Certifications



File Nbr:  
E 3060

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## **PVC PRODUCTS**

**CANTEX** PVC Products had its beginning over 40 years ago, as a division of a national corporation in the utility and building construction industry. The Plastics Division grew steadily in size and importance. Its product lines expanded into several major categories:

- Electrical distributors and contractors were provided with a broad line of PVC conduit and fittings.
- Power and utility companies were supplied with underground PVC duct and fittings.
- For the communications industry, PVC conduit and fittings were made available to telephone and cable companies for underground cable installations.
- Municipal public works needs were met with PVC pipe for distribution and collection.
- The commercial market need was fulfilled with PVC plumbing pipe.

Because of its success in the PVC Products business, **CANTEX** caught the eye of an international organization which was planning for expansion into PVC Products in the Western Hemisphere. In February 1992, **CANTEX** was acquired by the respected Sumitomo Corporation, a multifaceted global business leader. Out of this acquisition the **NEW CANTEX** emerged, equipped with an intense philosophy of service to its customers and a renewed emphasis on product quality that targets the challenges of a new century.

**CANTEX** is a leading producer of PVC Products, with eight manufacturing facilities located strategically from east to west across the country. These facilities feature some of the most modern production equipment and advanced process technology found anywhere in the industry. Production facilities include extrusion, injection molding, and fabrication processes to produce the broad lines of PVC Products which serve the power, utility, building construction, and communications markets.

## **ELECTRICAL PRODUCT LINE**

**CANTEX** offers a complete line of extruded and injection molded electrical conduit, duct, fittings, accessories, switch and outlet boxes.

Products include a full range of sizes in:

- Schedule 40 & 80 Conduit
- Electrical Fittings & Accessories – Molded & Fabricated
- Forte-Duct®
- Utility Duct – NEMA TC-6 & 8 EB/DB – ASTM DB-100
- Duct Fittings & Accessories
- Elbows, Bends & Sweeps – Standard & Special Radius
- EZ-FLEX® Electrical Nonmetallic Tubing & Fittings
- ENVIRO-FLEX® Liquidtight Conduit & Fittings
- Telephone Conduit – Types B-C-D
- EZ BOX® Wall and Ceiling Switch and Outlet Boxes
- Bending Equipment
- Cements

## **SERVICE**

**CANTEX** stands for a commitment to service – service that puts the customer first. We carry extensive inventories nationwide so that you get fast turnaround and complete shipments. Our efficient transportation system of hand-picked contract carriers, means on-time deliveries anywhere in the U.S. The **CANTEX** customer service team is staffed by professionals who provide immediate response and effective communications about orders and shipments.

At the **NEW CANTEX**, **WE WORK FOR THE CUSTOMER.**

## INDUSTRY ORGANIZATIONS

**CANTEX** actively supports those organizations which set standards and promote professional practices in the electrical industry. These include NEMRA, NAED, NEMA, IAEI, IEEE, ASTM, along with other associations in the construction industry.

## QUALITY ASSURANCE

**CANTEX** has a comprehensive quality control program to ensure compliance with industry standards established by Underwriters Laboratories, National Electrical Code, National Electrical Manufacturers Association, and the American Society for Testing and Materials.

From virgin raw materials blended into compounds thru extrusion or injection molding to final inspection and testing of the finished product, the manufacturing process is monitored to make sure quality standards are met or exceeded. Each plant is graded and held accountable for the quality control performance of its total output.

To further strengthen the company's goal for quality products, a centralized quality control review procedure assures that every plant is producing at a consistent level of quality for all similar products. You know you're getting the very best every time you buy from **CANTEX**.

## PVC ELECTRICAL STANDARDS BY PRODUCT

### Schedule 40 Conduit

UL 651, NEMA TC-2 and NEC-Article 352

### Utility Duct – Extra Strength

NEMA TC-6&8, DB-100 and ASTM F-512

### Schedule 80 Conduit

UL 651, NEMA TC-2 and NEC-Article 352

### Utility Duct Fittings

NEMA TC-9

### Forte-Duct UL Schedule 40 Conduit

UL 651, NEMA TC-2 and NEC-Article 352

### EZ-FLEX ENT (Electrical Nonmetallic Tubing) & Fittings

UL 1653, NEMA TC-13 and NEC Article 362

### PVC Electrical Fittings

All fittings for electrical applications conform to NEMA TC-3 and UL 514B & UL651 Utility Duct NEMA TC-6&8, ASTM F-512, (Type EB20 – UL 651A)

### ENVIRO-FLEX Liquidtight Conduit

UL1660 and NEC 356

### ENVIRO-FLEX Liquidtight Fittings

UL 514B, NEMA FB-1 and NEC 356

## Uniform Product Code – Bar Codes

### UPC-ITF

Shipping container Bar Code to identify each standard Carton of Products using interleaved 2 of 5 Symbology.



# Conduit Bodies and Junction Boxes

**CANTEX**

## Type LB



PART NO.	SIZE	STD. PKG.	UPC-ITF 3 00 88700	PKG. WT.
5133663	1/2	25	56764 2	5.38
5133664	3/4	15	56765 9	4.32
5133665	1	10	56766 6	3.01
5133666	1-1/4	10	56767 3	7.62
5133667	1-1/2	10	56701 7	9.55
5133668	2	5	56768 0	8.49
5133669	2-1/2	5	06547 6	23.11
5133670	3	5	06548 3	23.18
5133671	3-1/2	4	06549 0	28.05
5133672	4	4	06550 6	25.47

## Type LL



PART NO.	SIZE	STD. PKG.	UPC-ITF 3 00 88700	PKG. WT.
5133660	1/2	25	56769 7	5.43
5133661	3/4	15	56770 3	4.32
5133662	1	10	56771 0	4.21
5133649	1-1/4	10	06564 3	7.81
5133648	1-1/2	10	06565 0	9.85
5133647	2	5	56772 7	8.17
5133644	2-1/2	5	51756 2	25.56
5133646	3	5	51758 6	19.89
5133640	3-1/2	4	51755 5	29.87
5133645	4	4	51757 9	20.05

## Type LR



PART NO.	SIZE	STD. PKG.	UPC-ITF 3 00 88700	PKG. WT.
5133650	1/2	25	56773 4	5.43
5133651	3/4	15	56774 1	4.36
5133652	1	10	56775 8	4.21
5133653	1-1/4	10	06584 1	7.72
5133654	1-1/2	10	06585 8	9.64
5133655	2	5	56776 5	8.18
5133658	2-1/2	5	51761 6	25.56
5133656	3	5	51759 3	24.18
5133659	3-1/2	4	51762 3	29.87
5133657	4	4	51760 9	26.45



Except where noted by ▶

## Couplings

### Special Long Line Couplings – Sleeve Couplings



Sleeve Coupling (For Repair Work)  
No Internal Stop

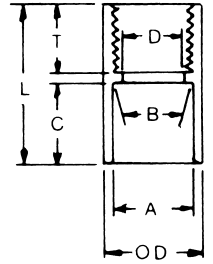
Part No.	Size	Std. Ctn. Qty.	Std. Ctn. Wt. (lbs.)
▶ E948H	1 1/2	25	5
▶ E948J	2	25	5
▶ E948K	2 1/2	25	16
▶ E948L	3	25	13
▶ E948N	4	10	8
▶ E948P	5	14	33
▶ E948R	6	6	16
▶ E948JR	2" (6" long)	15	8
▶ E948JS	2" (Sch. 40 Split Duct)	25	6
▶ E948L12	3" (12" long)	1	1
▶ E948L6	3" (6" long)	15	15
▶ E948LS	3" (Sch. 40 Split Duct)	25	17
▶ E948N12	4" (12" long)	10	28
▶ E948N7	4" (7" long)	15	25
▶ E948NS	4" (Sch. 40 Split Duct)	10	15
▶ E948PS	5" (Sch. 40 Split Duct)	1	2
▶ E948R10	6" (10" long)	6	25
▶ E948R12	6" (12" long)	6	25
▶ E948RS	6" (Sch. 40 Split Duct)	1	2

## Adapters

### Female Adapters



For adapting nonmetallic conduits to threaded fittings, metallic systems. Female threads on one end, socket end on other.



Part No.	Size	Std. Ctn. Qty.	A Typical	B Typical	Min. D	Max. OD	C Typical	T Typical	L Typical
E942D	1/2	150	.852	.836	.620	17/64	11/16	3/4	19/16
E942E	3/4	100	1.064	1.046	.822	15/16	13/16	3/4	15/8
E942F	1	50	1.330	1.310	1.046	15/8	15/16	7/8	115/16
E942G	1 1/4	30	1.677	1.655	1.377	163/64	1	7/8	2
E942H	1 1/2	25	1.918	1.894	1.607	25/32	11/8	7/8	27/32
E942J	2	30	2.393	2.369	2.064	247/64	13/16	1	25/16
E942K	2 1/2	20	2.890	2.868	2.450	311/32	15/8	11/8	215/16
E942K-CAR	2 1/2	4	2.890	2.868	2.450	311/32	15/8	11/8	215/16
E942L	3	25	3.515	3.492	3.000	331/32	13/4	11/8	31/16
E942L-CAR	3	3	3.515	3.492	3.000	331/32	13/4	11/8	31/16
E942M	3 1/2	20	4.015	3.992	3.500	41/2	17/8	11/8	31/4
E942N	4	15	4.515	4.491	4.000	51/64	2	11/8	313/64
E942N-CAR	4	7	4.515	4.491	4.000	51/64	2	11/8	313/64
E942NX9*	4	15	(Call for information)						
E942P	5	8	5.593	5.553	5.047	61/4	115/16	11/16	33/16
E942R	6	6	6.658	6.614	6.055	71/4	21/8	11/16	33/8
E942RX*	6	6	(Call for information)						

\* Long Line Adapter

## Special Schedule 40 Swedge Couplings

\*Consult factory for additional sizes

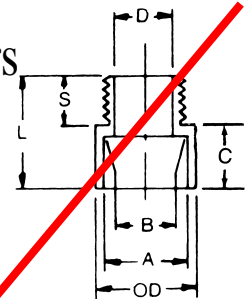


Part No.	Size	Std. Ctn. Qty.	Std. Ctn. Wt. (lbs.)
▶ E442K	2 1/2	20	13
▶ E442R	6	6	27
▶ E442T	8	2	17

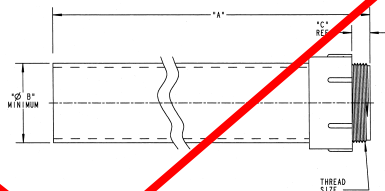
## Male Terminal Adapters



For adapting nonmetallic conduits to boxes, threaded fittings, metallic systems. Male threads on one end, socket end on other.



## Risers Schedule 40



Part No.	Size	A (Length)	B (Min.)	C	Thread Size	Std. Ctn. Qty.	Std. Ctn. Wt. (lbs.)
E954HX	1 1/2	80.00	1.567	.950	1 1/2" NPT	1	3.8
E954J	2	80.00	2.024	.825	2" NPT	1	3.7
E954JX	2	80.00	2.024	.825	2" NPT	1	5.0
E954K	2 1/2	60.00	2.418	.812	2 1/2" NPSC	1	6.0
E954KX	2 1/2	80.00	2.418	.812	2 1/2" NPSC	1	8.4
E954L	3	60.00	3.012	.798	3" NPSC	1	8.7
E954LX	3	80.00	3.012	.798	3" NPSC	1	11.0

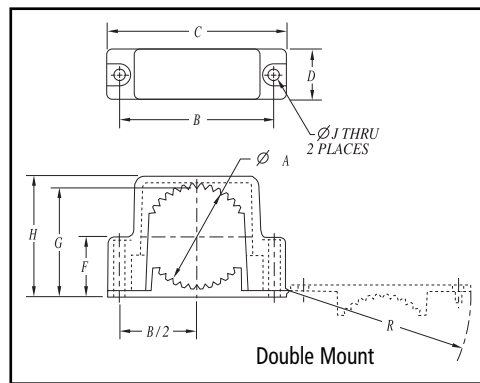
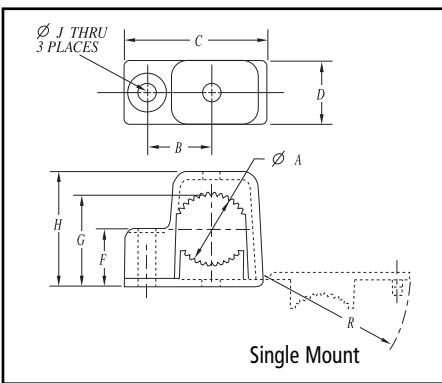
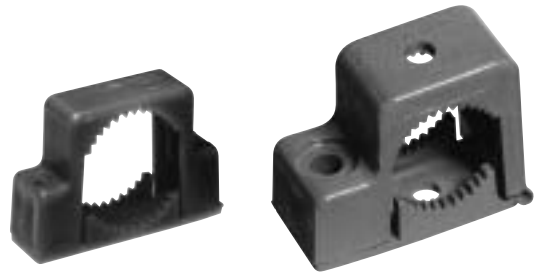
Part No.	Size	Std. Ctn. Qty.	A Typical	B Typical	Min. D	Max. OD	C Typical	S Typical	L Typical
E943D	1/2	150	.852	.836	.597	11/8	5/8	9/16	15/16
E943E	3/4	125	1.064	1.046	.800	111/32	3/4	9/16	13/8
E943F	1	50	1.330	1.310	1.018	15/8	1	11/16	125/32
E943G	1 1/4	50	1.677	1.655	1.332	21/32	1	3/4	115/16
E943H	1 1/2	25	1.918	1.894	1.566	25/32	13/16	3/4	21/16
E943J	2	50	2.393	2.369	2.000	221/32	13/16	3/4	21/8
E943K	2 1/2	25	2.890	2.868	2.376	35/16	13/4	7/8	27/8
E943K-CAR	2 1/2	5	2.890	2.868	2.376	35/16	13/4	7/8	27/8
E943L	3	45	3.515	3.492	2.954	4	15/16	7/8	31/16
E943L-CAR	3	5	3.515	3.492	2.954	4	115/16	7/8	31/16
E943M	3 1/2	30	4.015	3.992	3.440	41/2	27/16	17/8	37/16
E943N	4	20	4.515	4.491	3.940	53/32	23/8	7/8	31/2
E943N-CAR	4	20	4.515	4.491	3.940	53/32	23/8	7/8	31/2
E943P	5	5	5.593	5.553	4.815	61/4	21/3	1	35/16
E943R	6	10	6.658	6.614	5.860	71/2	23/8	1	33/8

## Snap Strap® Conduit Support Straps

Carlson's Snap Strap® offers a unique support strap designed especially for the installation of PVC conduit. Also usable for installations of rigid steel. This high strength, nonmetallic clamp allows conduit to expand and contract freely, eliminating the bowing commonly seen from the expansion and contraction of conduit caused by varying temperature changes. Finished installations have a neat, attractive appearance on exposed applications.

To be used in accordance with conduit spacing requirements per the NEC, Section 352.30. This part is not supplied with screws.

- UV inhibited for use in direct sunlight



### Single Mount

Part No.	Size: inches (mm)	Std. Ctn. Qty.	Std. Ctn. Wt. (lbs.)	A	B	C	D	F	G	H	J	R
E978DC-CAR	1/2" (16)	40	1	0.80 (20.3)	.75 (1.90)	1.63 (41.4)	0.75 (19.1)	.59 (14.9)	.99 (25.1)	1.36 (34.5)	.21 (5.33)	1.67 (42.4)
E978EC-CAR	3/4" (21)	40	3	1.00 (25.4)	.88 (22.4)	1.92 (48.7)	0.75 (19.1)	.70 (17.8)	1.20 (30.4)	1.57 (39.9)	.21 (5.33)	1.96 (49.8)
E978FC-CAR	1" (27)	30	4	1.20 (30.5)	1.02 (25.9)	2.17 (55.1)	0.75 (19.1)	.83 (21.1)	1.43 (36.3)	1.84 (46.7)	.21 (5.33)	2.22 (56.3)

### ~~Double Mount~~

Part No.	Size: inches (mm)	Std. Ctn. Qty.	Std. Ctn. Wt. (lbs.)	A	B	C	D	F	G	H	J	R
E978GC-CAR	1 1/4" (35)	15	4	1.66 (42.16)	2.75 (69.9)	3.23 (82.0)	1.00 (25.4)	.95 (24.1)	1.78 (45.2)	2.15 (54.61)	.218 (5.54)	3.28 (83.3)
E978HC-CAR	1 1/2" (41)	15	5	1.92 (48.77)	3.05 (77.5)	3.53 (89.7)	1.00 (25.4)	1.08 (27.4)	2.04 (51.8)	2.40 (60.96)	.218 (5.54)	3.58 (90.9)
E978JC-CAR	2" (53)	10	5	2.34 (59.44)	3.50 (88.9)	4.00 (101.6)	1.00 (25.4)	1.31 (33.3)	2.48 (63.0)	2.86 (72.64)	.218 (5.54)	4.06 (103.1)





# PVC Electrical Fittings & Accessories Price List

Effective August 26, 2002



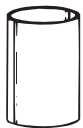
**Schedule 40 Fittings: Couplings,  
Terminal Adapters, Female Adapters**

 = Call for Availability


UL Listed except where noted with \*

	Item Number	Size	UPC Code	Pkg Qty	Pkg Wt (lbs.)	Price Per 100
--	-------------	------	----------	---------	---------------	---------------


**Standard Couplings**

	60010050	1/2	20100	150	5.0	40.50
	60010075	3/4	20101	100	5.0	49.50
	60010100	1	20102	50	4.0	76.50
	60010125	1 1/4	20103	35	3.5	102.00
	60010150	1 1/2	20104	25	3.0	142.49
	60010200	2	20105	40	8.0	186.01
	60010250	2 1/2	20106	15	5.3	328.50
	60010300	3	20107	30	15.6	542.09
	60010350	3 1/2	20108	15	9.8	599.30
	60010400	4	20109	20	16.0	836.50
	60010500	5	20110	10	12.5	2,118.02
	60010600	6	20111	5	9.0	2,707.52

**Terminal Adapters**

	60060050	1/2	20139	200	4.0	50.99
	60060075	3/4	20140	125	5.0	94.49
	60060100	1	20141	50	3.0	118.51
	60060125	1 1/4	20142	40	4.0	150.00
	60060150	1 1/2	20143	30	4.0	184.51
	60060200	2	20144	40	8.8	265.50
	60060250	2 1/2	20145	25	10.0	457.13
	60060300	3	20146	50	19.0	676.05
	60060350	3 1/2	20147	30	16.0	871.45
	60060400	4	20148	25	19.2	1,163.60
	60060500	5	20149	10	20.0	2,283.60
	60060600	6	20150	8	20.0	2,747.60

**Female Adapters**

	60070050	1/2	20151	150	5.0	57.00
	60070075	3/4	20152	100	5.0	96.00
	60070100	1	20153	50	4.0	133.50
	60070125	1 1/4	20154	30	4.0	174.30
	60070150	1 1/2	20155	25	3.0	188.06
	60070200	2	20156	15	2.5	254.99
	60070250	2 1/2	20157	15	6.0	500.02
	60070300	3	20158	30	16.8	747.61
	60070350	3 1/2	20159	20	14.0	975.42
	60070400	4	20160	15	13.0	1,000.05
	60070500	5	20161	10	13.8	2,488.98
	60070600	6	20162	6	14.4	3,285.51

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# **CONDUIT**

**Operations & Maintenance Manual  
December 2015**



16100 S. Lathrop Avenue  
 Harvey, IL 60426)  
 OFFICE / 708-225-2069  
 TOLL FREE / 800-882-5543  
 WEB / alliedeg.com



**CERTIFICATE OF COMPLIANCE  
 WITH BUY AMERICA**

January 28, 2015

Gexpro  
 Attention: Michael Neubauer  
 425 Quivas Street  
 Denver, CO 80204

**RE: C-DOT - EJMT  
 CONTRACTOR: STURGEON ELECTRIC**

To Whom It May Concern:

The following Galvanized Rigid Conduit, Electrical Metallic Tubing, and Intermediate Metal Conduit supplied by Allied Tube & Conduit complies with the requirements of 49 U.S.C. 5323(j)(1) and the applicable regulations in 49 CFR part 661 in that these products are manufactured in the U.S. from steel melted and manufactured in the U.S.

**When ordering GRC, EMT, or IMC that meets domestic regulations, use the part numbers below:**

<u>TRADE SIZE</u>	<u>GRC PART NUMBER</u>	<u>EMT PART NUMBER</u>	<u>IMC PART NUMBER</u>
1/2	278879	101543	358192
3/4	278887	101550	358184
1	278895	101568	358176
1-1/4	278903	101576	358119
1-1/2	278911	101584	358101
2	278929	101592	358168
2-1/2	278937	101600	358150
3	278945	101618	358143
3-1/2	278952	101782	358069
4	278960	101790	358051
5	278978		
6	278986		

Kwik-Couple® GRC is also manufactured in the U.S. from steel melted and manufactured in the U.S. The coupling represents approximately 15% of the total value and is sourced from Taiwan. Kwik-Couple® is a proprietary product only available through Allied Tube & Conduit and offers savings in installation and materials. The Contracting Office may allow this product to be used in Buy America projects based on cost comparisons of alternative products (GRC with standard coupling) or on the fact that this product is not manufactured by any other manufacturer.

If you have any questions regarding this certification, please contact Ruth Ensing, Certification Specialist, at 708-915-1543 or email [rensing@atkore.com](mailto:rensing@atkore.com).

Very truly yours,

Elaine Thompson  
 Director of Industry Affairs  
 Atkore International

cc: Henry Fear, I-Pro  
 Kevin Moriarty, Atkore International





# Intermediate Metal Conduit (IMC) and Kwik-Couple® IMC

## NEC recognizes Allied IMC for same uses as RIGID

### IMC Conduit

- Light-weight ductile steel conduit for long life and easy bending
- Weighs 1/3 less than rigid conduit
- Saves up to 30% in cost over GRC
- Hot galvanized exterior to increase corrosion resistance and protect against white rust
- Interior coating creates a smooth, continuous raceway for fast wire-pulling
- UL 1242 listed and manufactured in accordance with ANSI C80.6
- True Color IMC special orders available
- Available in trade sizes 1/2(16) thru 4(103)

### Kwik-Release End Cap No Tools Needed!



### ~~Kwik-Couple® IMC Steel Conduit~~

- ~~Factory-installed Kwik-Couple couplings are available on IMC rigid conduits~~
- ~~No separate couplings to purchase, store, carry or install~~
- ~~**Just line up the ends, spin the coupling forward onto the next piece and wrench tighten. It's that easy!**~~
- ~~Kwik-Release End Cap - Requires no tools~~
- ~~All the benefits of IMC Conduit~~
- ~~True Color IMC special orders available~~
- ~~Patented~~
- ~~Trade Sizes 2-1/2(63) thru 4(103)~~



## IMC (Intermediate Metal Conduit) Weights and Dimensions

Trade Size	Metric Designator	Average Outside Diameter <sup>1</sup>		Average Wall Thickness <sup>2</sup>		Approximate Weight Per 100 Ft. (30.5M)		Quantity in Master Bundle	
		in.	mm.	in.	mm.	lb.	kg.	ft.	m.
1/2	16	0.815	20.70	0.070	1.79	62	28.1	3500	1067.5
3/4	21	1.029	26.13	0.075	1.90	84	38.1	2500	762.5
1	27	1.290	32.76	0.085	2.16	119	54.0	1700	518.5
1-1/4	35	1.638	41.60	0.085	2.16	158	71.7	1350	411.8
1-1/2	41	1.883	47.82	0.090	2.29	194	88.0	1100	335.5
2	53	2.360	59.94	0.095	2.41	256	116.1	800	244.0
2-1/2	63	2.857	72.56	0.140	3.56	441	200.0	370	112.9
3	78	3.476	88.29	0.140	3.56	543	246.3	300	91.5
3-1/2	91	3.971	100.86	0.140	3.56	629	285.3	240	73.2
4	103	4.466	113.43	0.140	3.56	700	317.5	240	73.2

<sup>1</sup>Outside diameter tolerances:

- +/- .005 in. (.13mm) for trade sizes 1/2 (16mm) through 1 (25mm)
- +/- .0075 in. (.19mm) for trade sizes 1-1/4 (36mm) through 2 (53mm)
- +/- 0.10 in. (.25mm) for trade sizes 2-1/2 (63mm) through 4 (103mm).

<sup>2</sup>Wall thickness tolerances:

- + 0.15 in. (.38mm) and - .000 for trade sizes 1/2 (13mm) through 2 (53mm)
- + 0.20 in. (.51mm) and - .000 for trade sizes 2-1/2 (63mm) through 4 (103mm).

NOTE: Length = 10 ft. (3.05m) with a tolerance of +/- .25 in. (6.35mm).

NEMA Standard

### Project Information

Company Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 City: \_\_\_\_\_  
 State & Zip: \_\_\_\_\_  
 Phone: \_\_\_\_\_  
 Project Name: \_\_\_\_\_  
 City: \_\_\_\_\_  
 State: \_\_\_\_\_

# Intermediate Metal Conduit (IMC) and Kwik-Couple® IMC



A PART OF **atkore**  
INTERNATIONAL

## FEATURES & SPECIFICATIONS

Allied IMC is precision manufactured for economical protection and long lasting value for the electrical raceway system. Manufactured from premium, work hardened steel combining electrical and mechanical performance with ductility. Allied IMC is resistant to impact and is easy to cut, bend and join for smooth, continuous raceways. Allied IMC is as strong, lighter in weight, and less expensive than Rigid. In fact, it can save you as much as 30% in overall costs. Intermediate Metal Conduit, covered by Article 342 in the National Electrical Code® (NEC®), is recognized as an equipment grounding conductor in Article 250 of the NEC and also provides excellent shielding from electromagnetic fields.

## Kwik-Couple IMC Conduit

### Innovation from the conduit leaders at Allied

Allied's patented Kwik-Couple IMC reduces threaded conduit installation time and cost significantly. Kwik-Couple has an integrated coupling on the conduit exactly where you need it.

## The Allied Advantage

Allied IMC has a larger internal diameter than RIGID conduit to allow for easier fishing and wire-pulling. Allied IMC is also more "rigid" than RIGID to provide superior wiring protection in many applications.

## The National Electrical Code recognizes Allied IMC for the same uses as RIGID, including all hazardous location (classified) applications.

Allied IMC uses the same threaded couplings and fittings as RIGID conduit, and the 3/4" NPT threads (ANSI B1.20.1) are also full cut and galvanized after cutting. Color-coded end-cap thread protectors keep the threads clean and sharp, and also help to provide instant trade size recognition. Even sizes are color-coded orange, 1/2 trade sizes are yellow, and 1/4 trade sizes are green.

## Coatings

Allied's IMC is hot galvanized using Allied's patented inline Flo-Coat® process. This process combines zinc, a conversion coating, and a clear organic polymer topcoat to form a triple layer of protection against corrosion and abrasion. The interior of Allied IMC is coated with a highly

corrosion-resistant lubricating finish for easier wire-pulling. No need to worry about damage to the conduit system even when pulling through multiple 90° bends.

## EMI Shielding

Allied IMC is very effective in reducing the effects of electromagnetic fields on encased power distribution circuits, shielding computers and other sensitive electronic equipment from the effects of electromagnetic interference.

Visit [www.alliedeg.com](http://www.alliedeg.com) to obtain the **GEMI (Grounding and Electromagnetic Interference)** software analysis program.

## Codes & Standards Compliance

IMC is covered by Article 342 of the National Electric Code (NEC). It can be installed in all occupancies and locations, including Class I, Division I hazardous locations. Allied IMC is listed to Underwriters Laboratories Safety Standard UL 1242 and meets ANSI C80.6. These standards have been adopted as Federal Specifications in lieu of WWC-581-Type 2. IMC is recognized as an equipment grounding conductor by NEC Section 250-118.

Installation of IMC conduit and elbows shall be in accordance with the National Electrical Code and the UL listing information. Allied IMC is listed in UL category DYBY. Master bundles conform to NEMA standard RN2.

## Specification Data

Intermediate Metal Conduit (IMC) conduit and elbows shall be equal to that manufactured by Allied Tube & Conduit Corporation. IMC shall be hot galvanized steel O.D. with an organic corrosion resistant I.D. coating and shall be Listed to UL Safety Standard 1242 and manufactured in accordance with ANSI C80.6. It shall be listed by a nationally recognized testing laboratory with follow-up service. Threads shall be hot galvanized after cutting.

Kwik-Couple IMC is Listed to UL Safety Standard 1242 and UL 514-B. Kwik-Couple IMC is Listed for CONCRETE-TIGHT applications.

It is noted that these U.L. standards have been adopted by the federal government and separate military specifications no longer exist.



## Kwik-Couple IMC Conduit Weights and Dimensions

Trade Size	Metric Designator	Average Outside Diameter <sup>1</sup>		Average Wall Thickness <sup>2</sup>		Approximate Weight Per 100 Ft. (30.5M)		Quantity In Master Bundle	
		in.	mm.	in.	mm.	lb.	kg.	ft.	m.
2-1/2	63	2.857	72.53	0.140	3.56	441	200.0	400	122.0
3	78	3.176	80.29	0.140	3.56	543	246.2	300	91.5
3-1/2	91	3.971	100.86	0.140	3.56	629	285.3	250	76.3
4	103	4.466	113.4	0.140	3.56	700	317.5	200	61.0

<sup>1</sup>Outside diameter tolerances: +/- .010 in. (.25mm)

<sup>2</sup>Wall thickness tolerances: + .020 in. (.51mm) and -.000

NOTE: Length (w/coupling) = 10 ft. (3.05m) with a tolerance of +/- .25in. (6.35mm).

NOTE: Special orders are non-cancelable, non-returnable and non-refundable

January 1, 2015  
Manufactured By: Republic Conduit™

## Certificate of Origin and Material Test Report

This letter certifies that electrical steel conduit labeled as Republic Conduit is manufactured in the United States. The conduit is formed from U.S. melted; high percentage recycled flat rolled steel and is either Hot-Dip Galvanized or Electro-galvanized. After Galvanizing, all material receives a passivation coating to prevent white rust. The material labeled as Republic Conduit complies with the ARRA 2009 Buy America clause and conforms to the following specifications:

### Galvite® Electrical Rigid Metal Conduit-Steel (Galvite® ERMC-S)

- UL Standard -- UL 6 Fourteenth Edition, the common ANCE, CSA and UL (tri-national) standard for Electrical Rigid Metal Conduit-Steel, covering requirements for Mexico, Canada, and the United States.
- cUL listing for CSA C22.2 No. 45.1-07
- ANSI Standard -- C80.1.
- All sizes are manufactured in the U.S. at our facility in Louisville, KY.
- Trade sizes range from ½" to 6".

### Electrunite® Electrical Metallic Tubing (EMT)

- UL Standard -- UL 797 Ninth Edition, the common ANCE, CSA and UL (tri-national) standard for Electrical Metallic Tubing-Steel, covering requirements for Mexico, Canada, and the United States.
- cUL listing for CSA C22.2 No. 83.1-07
- ANSI Standard -- C80.3
- All sizes are manufactured in the U.S. in either our Cedar Springs, GA or our Louisville, KY plant.
- Trade sizes range from ½" to 4".

### Intermediate Metal Conduit (IMC)

- UL Standard -- UL 1242 Fourth Edition, for Electrical Intermediate Metal Conduit-Steel.
- ANSI Standard -- C80.6
- All sizes are manufactured in the U.S. in either our Cedar Springs, GA or our Louisville, KY plant. Trade sizes range from ½" to 4".

All of the above Republic Conduit products are made from steel which is melted and rolled in the United States.

For more information, visit [www.republicconduit.com](http://www.republicconduit.com).



Patrick R. Douglas  
Quality Manager  
Republic Conduit

### About Republic Conduit

Republic Conduit is a U.S. manufacturer of quality electrical steel conduit of multiple sizes and types. As a result of our eighty-year history in the electrical conduit industry, Republic has achieved strong name recognition. Over the years, Republic Conduit, as a domestic brand, has undergone several name changes: from Republic Steel, to LTV Steel Tubular Products, to LTV Copperweld, to Maverick Tube Corporation, and, finally, to Republic Conduit. Throughout this time, the company remained solely focused on delivering solid, quality conduit, which customers ask for by name time and time again. In October of 2006, Republic Conduit became part of the Tenaris Group.

# RepublicConduit

## Intermediate Metal Conduit

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### *Simplify Installation, Save Time, Spend Less*

As a cost effective alternative to Galvite® Electrical Rigid Metal Conduit-Steel, Republic Conduit's Intermediate Metal Conduit (IMC) is manufactured to American National Standards Institute (ANSI) specification C80.6 and Underwriters Laboratories (UL) standard 1242. It is made from high quality, flat rolled steel, and is produced using an Electric Resistance Welding process. The finished tube is uniform in outside diameter (OD), wall thickness and ductility.

Republic Conduit's IMC is fire resistant. It does not burn, decompose, or give off harmful smoke or gases in a fire. It is also compatible with concrete and overall, allows our customers to install a quality, magnetically shielded and grounded electrical wiring system quickly and cost-effectively.

Our products are also manufactured to the highest criteria of the American National Standards Institute (ANSI) and Underwriters Laboratories (UL).

Republic Conduit is committed to implementing effective quality management systems and processes. Our Georgia facility has maintained an ISO certification since 1995 and has been recertified in 2008. Also in 2008, the Kentucky facility has achieved its initial certification by successfully meeting the requirements for ISO 9001:2000.



### **Features and Benefits**

---

**Consistent Quality** – Republic Conduit's IMC is manufactured for long life and provides complete physical and mechanical protection for any electrical wiring job. For eighty years, Republic Conduit's products have been and are today manufactured to all of our customers' specifications.

**Cost-Effective** – IMC's thin walls allow for lower material and shipping costs, while its consistently accurate metallurgical properties and smooth surfaces require less installation capital spent on wiring projects. This pipe has an extended shelf life, great for usage or storage without degradation in quality.

**Easier, Faster Installs** – IMC's protective, slick, inside diameter (ID) coating (Silerslick®) reduces friction when pulling / pushing the wires. The outside diameter (OD) surfaces are zinc-coated for further corrosion protection (the entire finish stays hard and smooth in various climate conditions). An additional OD passivation treatment provides superior protection from rust.

**Trade sizes range from 1/2" to 4".**

**Conduit is manufactured in the U.S.**

A close-up photograph of a silver metal conduit pipe with several electrical wires (red, blue, and white) protruding from its end. The RepublicConduit logo is printed in black on the side of the pipe.

RepublicConduit



## Available Sizes

Republic's IMC is provided with a color coded thread protector on one end and a coupling on the other.

Inventories of our products are maintained by leading electrical distributors throughout North America. Contact our Agent in your area today or visit [www.republicconduit.com](http://www.republicconduit.com) for more information.

## Weights and Dimensions\*

Trade Size Designator	Outside Diameter (OD)				Wall Thickness				Nominal Weight per 100 Feet		Feet per Bundle	Standard Lifts				Length without Coupling	Treads per Inch	Color Code	Method	
	Minimum		Maximum		Minimum		Maximum		LBS	kg		Length		Weight						
	IN	mm	IN	mm	IN	mm	IN	mm				FEET	m	LBS	kg					
1/2	16	0.810	20.57	0.820	20.83	0.070	1.78	0.085	2.16	62	28.1	100	3500	1067.5	2170	984.1	9' 11 1/4"	14	Yellow	End Caps
3/4	21	1.024	26.01	1.034	26.26	0.075	1.91	0.090	2.29	84	38.1	50	2500	752.5	2100	952.4	9' 11 1/4"	14	Green	End Caps
1	27	1.285	32.64	1.295	32.89	0.085	2.16	0.100	2.54	119	54.0	50	1700	518.5	2023	917.5	9'11"	11.5	Orange	End Caps
1 1/4	35	1.630	41.40	1.645	41.78	0.085	2.16	0.100	2.54	158	71.7		1350	411.8	2133	967.3	9'11"	11.5	Green	End Caps
1 1/2	41	1.875	47.63	1.890	48.01	0.090	2.29	0.105	2.67	194	88.0		1100	335.5	2134	967.8	9'11"	11.5	Yellow	End Caps
2	53	2.352	59.74	2.367	60.12	0.095	2.41	0.110	2.79	256	116.1		800	244.0	2048	928.8	9'11"	11.5	Orange	End Caps
2 1/2	63	2.847	72.31	2.867	72.82	0.140	3.56	0.160	4.06	441	200.0		370	112.9	1632	740.1	9' 10 1/2"	8	Yellow	End Caps
3	78	3.466	88.04	3.486	88.54	0.140	3.56	0.160	4.06	543	246.3		300	91.5	1629	738.8	9' 10 1/2"	8	Orange	End Caps
3 1/2	91	3.961	100.61	3.981	101.12	0.140	3.56	0.160	4.06	629	285.3		240	73.2	1510	684.8	9' 10 1/4"	8	Yellow	End Caps
4	103	4.456	113.18	4.476	113.69	0.140	3.56	0.160	4.06	700	317.5		240	73.2	1680	761.9	9' 10 1/4"	8	Orange	End Caps

- The values in feet / pound units are standard. The metric equivalents may be approximate. Conduit is always identified by its English or Metric Trade Size Designator.
- Republic's IMC is provided with a color coded thread protector on one end and a coupling on the other.
- 1/2", 3/4", and 1" sizes of Republic's IMC are furnished with diamond knurled inside finish for easier wire pull / push.
- Applicable length tolerance =  $\pm 1/4"$  ( $\pm 6.35$ mm) without a coupling.
- All sizes furnished in 10' lengths.

## Specifications

Republic Conduit's Intermediate Metal Conduit is produced to the following specifications:

- ANSI – American National Standard for Electrical Intermediate Metal Conduit (EIMC) ANSI, C80.6
- National Electric Code, 2002 Article 342 (1999 NEC, Article 345)
- UL Standard for Electrical Intermediate Metal Conduit – Steel, UL 1242, File # E79211
- Federal Specification WW-C-581 (Class 2 Type A)

The above Federal Specification WW-C-581 may still be referenced; however, the federal government has canceled it and has adopted the UL 1242 standard.

For more information, visit [www.republicconduit.com](http://www.republicconduit.com).

\*All orders are subject to Republic Conduit's Terms and Conditions, a copy of which is available upon request.







## **WESTERN TUBE & CONDUIT CORPORATION**

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2001 East Dominguez Street · P.O. Box 2720 · Long Beach, California 90801-2720  
(800) 310-8823 · (310) 537-6300 · Fax (310) 604-9785

June 17, 2010

To Whom It May Concern:

This is to certify that all the Western Tube and Conduit DRigid Conduit products, all IMC conduit products, all EMT conduit products, and all EMT Conduit Kit products, in all sizes, meet the requirements of both the Buy America Act and the ARRA (American Recovery and Reinvestment Act) of 2009.

Sincerely,

A handwritten signature in black ink that reads "Jeffrey Bloom".

Quality Assurance Manager



# WESTERN TUBE & CONDUIT CORPORATION

## IMC (INTERMEDIATE METAL CONDUIT)

**Western Tube IMC** is produced by a continuous weld (ERW) process using hot galvanizing to zinc-coat the exterior surfaces evenly and smoothly. A secondary transparent organic coating provides further protection against corrosion. Manufactured in accordance with Underwriters Laboratories specification UL-1242 and with American National Standards Institute (ANSI) C80.6. Approved by the National Electrical Code (NEC) article 342 for use in place of galvanized rigid conduit and also conforms to Federal Specifications WWC-581-Type 2, which has been superseded by the UL document.

Quality controlled each step of the way - regular tests for weld strength, plating thickness, all dimensions, and uniform smoothness of the interior and exterior coating provide you with IMC conduit of the highest quality. Western Tube IMC requires approximately 33% less steel than conventional steel rigid conduit, making it lighter and having a larger inside diameter that permits simpler wire pulling.

Western Tube IMC provides superior wiring protection in many applications. NEC recognizes IMC for the same uses as RIGID, including all hazardous (classified) applications and it is threaded to be interchangeable with rigid conduit fittings and elbows and requires no change in installation procedures; bending, cutting, threading and hanging methods remain standard.

### HOT ZINC COATED INTERMEDIATE METAL CONDUIT SPECIFICATIONS

To Specify Western Tube IMC include the following:

Electrical Conductors shall be enclosed in Western Tube and Conduit Hot Zinc Coated Intermediate Metal Conduit and shall have organic coatings on both the OD and the ID, meeting all requirements of UL 1242 and ANSI C80.6, and shall be manufactured in accordance with the specifications of the National Electrical Code covering such conduit, and also be listed by Underwriters Laboratories as manufactured by Western Tube & Conduit Corporation.

Trade Size	Metric Designator	Nominal O.D.	Nominal I.D.	Nominal Wall Thickness	Nominal Wt. per Foot with coupling	Feet In Sub-Bundle	Qty. in Master Bundle	Feet in Master Bundle	Nom. Wt. Per Master Bundle	Color Designator
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IMC Weights and Specifications

in.	mm	in.	in.	in.	lbs.	ft.	qty.	ft.	lbs.	
1/2	16	0.815	0.659	0.078	0.62	100	350	3500	2170	Yellow
3/4	21	1.029	0.863	0.083	0.84	50	250	2500	2100	Green
1	27	1.290	1.104	0.093	1.19	50	170	1700	2023	Orange
1 1/4	35	1.638	1.448	0.095	1.58	-	135	1350	2133	Green
1 1/2	41	1.883	1.683	0.100	1.94	-	110	1100	2134	Yellow
2	53	2.360	2.150	0.105	2.56	-	80	800	2048	Orange
2 1/2	63	2.857	2.557	0.150	4.41	-	37	370	1632	Yellow
3	78	3.476	3.176	0.150	5.43	-	30	300	1629	Orange
3 1/2	91	3.971	3.671	0.150	6.29	-	24	240	1510	Yellow
4	103	4.466	4.166	0.150	7.00	-	24	240	1680	Orange

# Galflex® Type RWS

## Reduced Wall Steel Flexible Metal Conduit

Steel Flexible Metal Conduit • High Strength Steel Strip • UL Listed sizes 3/8" through 3"  
Sizes 5/16" and 3/8" available with CSA Listing upon request



### APPLICATIONS Suitable for use as follows:

- Environmental air-handling spaces per NEC 300.22(C)
- Power and lighting branch circuit conductors and cables for connecting receptacles, luminaires, equipment, office partitions, etc.
- Metal raceway for wires and cables per NEC (ANSI/NFPA-70) Article 348
- Motor feeder, branch, and control circuit conductors and cables
- Class 1, Class 2, Class 3 remote-control, signaling, and power-limited circuit conductors and cables
- Fire alarm system conductors and cables of power-limited or non-power-limited fire alarm circuits
- Voice, data, communications and video cables including CATV and optical fiber cables
- Concealed or exposed installations per NEC Article 348 and the applicable NEC provisions
- Elevators, hoistways, and escalators per NEC 620.21
- As a grounding conductor for lengths up to 6 feet (20A max) as per 2005 NEC 250.118(5)
- Hazardous location, Class 1, Div. 2, for flexible connectors only per 2005 NEC 501.10(B)(2) and 501.30(B)
- Electric signs and outline lighting per NEC 600.7, 600.31(1000 volts or less), and 600.32(>1000 volts)
- UL Standard 1479 1, 2, & 3 Hour Through-Penetration Fire Stop Systems: C-AJ-1462, C-AJ-1463, C-AJ-1464, W-L-1308, and W-L-1309

### STANDARDS & REFERENCES

- UL Listed per UL 1, Standard for Safety for Flexible Metal Conduit, ANSI/UL-1 for 3/8" through 3"
- CSA Listed per CSA 22.2 No. 56 per Canadian Electrical Code C22.1 Section 12-1000 for 5/16" and 3/8" trade sizes only upon request
- Meets federal specification WW-C-566c
- NEC Type Designation - Article 348, Type FMC (Flexible Metal Conduit)

### CONSTRUCTION

Galflex® Type RWS is manufactured with a galvanized, corrosion resistant, high-strength steel alloy. The metal strip is helically formed into a continuously interlocked flexible metal conduit that can withstand impact and crushing forces.



## WEIGHTS, MEASUREMENTS AND PACKAGING

TRADE SIZE (inches)	APPROX. WEIGHT (lbs./100 ft.)	INNER DIAMETER MIN./MAX. (inches)	OUTER DIAMETER MIN./MAX. (inches)	MINIMUM BENDING RADIUS (inches)	STANDARD COIL LENGTH (feet)	STANDARD REEL LENGTH (feet)
5/16*	13	0.312 / -	0.470 / 0.510	4	100	1000
3/8	19	0.375 / 0.393	0.560 / 0.610	4	100 / 250	1000
1/2	27	0.625 / 0.645	0.860 / 0.920	4	100	500 / 1000
3/4	35	0.812 / 0.835	1.045 / 1.105	5	100	500 / 1000
1	57	1.000 / 1.040	1.300 / 1.380	6	50	400
1-1/4	65	1.250 / 1.300	1.550 / 1.630	8	50	250
1-1/2	78	1.500 / 1.575	1.850 / 1.950	10	25	150
2	133	2.000 / 2.080	2.350 / 2.450	12	25	100
2-1/2	150	2.500 / -	2.860 / 3.060	15	25	100
3	190	3.000 / -	3.360 / 3.560	18	25	100
3-1/2**	220	3.500 / -	3.860 / 4.060	21	25	100
4**	270	4.000 / -	4.360 / 4.560	24	25	100

\* Trade size 5/16" is provided as UL Recognized construction.

\*\* Trade sizes 3 1/2" and 4" are non UL.

## FEATURES

- Provides mechanical protection for conductors and cable
- For use with listed connectors intended for NEC Type FMC (Flexible Metal Conduit)
- Smooth interior for easy wire pulling
- High-strength steel construction
- Hot-dipped, heavy zinc coating for rust/corrosion resistance
- Superior crush proof qualities
- Built-in flexibility for simplified positioning

## ADDITIONAL APPLICATIONS

- Listed wired fixtures per NEC 410.77(C)
- Raised floors for connection of information technology per NEC 645.5(D)(2) and 645.5(D)
- Places of assembly and theaters per NEC Articles 518 and 520
- Cranes and hoists per 2005 NEC 610.11(C)

## ONLINE CERTIFICATIONS AND TOOLS

- UL Online Certifications Directory ( [www.ul.com](http://www.ul.com) )
- CSA Online Certifications Directory ( [www.csa.ca](http://www.csa.ca) )
- UL Guide Information - Flexible Metal Conduit (DXUZ)
- CSA Product Information - Flexible Metal Conduit (1811-01)

**FULL ENGINEERING SPECIFICATIONS AVAILABLE AT [WWW.SOUTHWIRE.COM/COMMERCIALPRODUCTSPECS](http://WWW.SOUTHWIRE.COM/COMMERCIALPRODUCTSPECS)**

Galflex® Type RWS Reduced Wall Steel Flexible Metal Conduit

# LIQUID-TUFF™

## Low Smoke Zero Halogen – LSZH

### UL Liquidtight Flexible Metal Conduit Type LFMC

#### Description

- Low smoke, zero halogen raceway
- Low toxicity generation characteristics
- Hot dipped zinc galvanized low carbon steel core
- Excellent temperature ratings
- Black thermoplastic polyurethane jacket
- UL bonding strip 3/8" – 1¼" for grounding
- Sunlight resistant
- Flame retardant TPU jacket

#### Temperature Rating

- 80°C/176°F Dry
- 60°C/140°F Wet
- 70°C/158°F Oil resistant
- -40°C/ 40°F Low temperatures

#### Applications

- Wherever limiting toxic material of combustion is needed
- Direct burial and concrete embedment
- Bond wire for grounding in sizes 3/8" – 1¼" NEC® 250.118(6)
- Hazardous Locations where Flexible Connections are required per NEC® 501.10(B)(2)(3), 502.10(A)(2)(2), 502.10(B)(2)(2), 503.10(A)(3)(2), 503.10(B), 504.20



#### References & Ratings

- UL 360 File E26540
- NEC® 250, 350, 390, 501.10(B)(2)(3), 502.10(A)(2)(2), 502.10(B)(2)(2), 503.10(A)(3)(2), 503.10(B), 504.20, 553.7(B), 600.31(A), 600.32(A)(1), 610.11(C), 620.21 (A)(1)(c)(2), 620.21(A)(2)(a), 620.21(A)(2)(d)(2), 620.21(A)(3)(a), 620.21(A)(3)(a), 620.21(A)(4)(2), 620.21(B)(1), 620.21(C)(1), 645.5(E)(2), 680.42(A)(1), 682.13, 690.31(A), 695.6(D) and 695.14(E)
- Department of Defense UL 360 adopted on October 1, 1987
- ASTM® E 162 Flame Spread Index
- ASTM® E 662 Smoke Density Generation
- Bombardier SMP-800C Toxic Gas Generation
- UL 94 Tests for Flammability of Plastic Materials for Parts
- UL does not list any manufacturers liquidtight conduit as low smoke zero halogen
- Made in USA of US and/or imported materials

#### Ordering Information Product Dimensions/Bend Radius

Product Code	Trade Size (inches)	Trade Size (mm)	Coil Length (feet)	Approx. Reel Length (feet)	Weight/100 feet (pounds)	External Diameter (inches)		Internal Diameter (min/max) inches	Bend Radius (inches)
						Over Jacket (min/max)			
6701-30-00	3/8	12	100'	—	24	0.690/0.710		0.484/0.504	2
6702-30-00	1/2	16	100'	—	31	0.820/0.840		0.622/0.642	3.25
6702-45-00	1/2	16	—	500'	31	0.820/0.840		0.622/0.642	3.25
6702-60-00	1/2	16	—	1000'	31	0.820/0.840		0.622/0.642	3.25
6703-30-00	3/4	21	100'	—	47	1.030/1.050		0.820/0.840	4.25
6703-45-00	3/4	21	—	500'	47	1.030/1.050		0.820/0.840	4.25
6703-60-00	3/4	21	—	1000'	47	1.030/1.050		0.820/0.840	4.25
6704-30-00	1	27	100'	—	78	1.290/1.315		1.041/1.066	6.5
6704-41-00	1	27	—	400'	78	1.290/1.315		1.041/1.066	6.5
6705-24-00	1¼	35	50'	—	102	1.630/1.660		1.380/1.410	8
6705-40-00	1¼	35	—	200'	102	1.630/1.660		1.380/1.410	8
6705-47-00	1¼	35	—	750'	102	1.630/1.660		1.380/1.410	8
6706-24-00	1½	41	50'	—	107	1.865/1.900		1.575/1.600	9
6707-24-00	2	53	50'	—	144	2.340/2.375		2.020/2.045	11.12
6708-22-00	2½	63	25'	—	168	2.840/2.875		2.480/2.505	14.62

NOTE: All dimensions and weights are subject to normal manufacturing tolerances.





# LIQUID-TUFF™

## Low Smoke Zero Halogen – LSZH

### UL Liquidtight Flexible Metal Conduit Type LFMC

#### Scope

This specification covers AFC Cable Systems, Inc. LIQUID-TUFF™ LOW SMOKE ZERO HALOGEN (LSZH) UL Liquidtight Flexible Metal Conduit designed for use as a raceway for power, control and communication cables in accordance with Article 350 of the National Electric Code. The product is intended for applications where limiting smoke and toxic materials of combustion are important considerations. The product is Underwriters Laboratories Inc. (UL) Listed for use at 80°C (176°F) in a dry location, 60°C (140°F) in a wet location and 70°C (158°F) in an oily location. It is also UL Listed for direct burial, outdoor use, sunlight resistance and for -40°C (-40°F) low temperatures applications. UL Listed Liquidtight Flexible Metal Conduit is manufactured and tested in accordance with Underwriters Laboratories Inc. Standard UL 360. The product carries the UL Listing Mark. Underwriters Laboratories Inc. does not list any manufacturers Liquidtight Flexible Metal Conduit as being low smoke zero halogen.

#### Construction

The LIQUID-TUFF™ LSZH Liquidtight Flexible Metal Conduit shall be formed from zinc coated galvanized low carbon steel strip having a uniform width and thickness. There shall be a continuous bonding strip built into the conduit core for the 3/8 through 1 1/4 trade sizes. The construction shall be in accordance with the UL 360 Standard. The Low Smoke Zero Halogen designation shall be based upon testing to ASTM® 162 – Flame Spread Index, ASTM® E662 – Smoke Density Generation and Bombardier SMP-800C – Toxic Gas Generation. The finished LIQUID-TUFF™ LSZH Liquidtight Flexible Metal Conduit dimensions shall be in accordance with Table 5.1 of UL 360 which is summarized in Table 3.

#### Jacket – TPU

A rugged low-smoke, moisture, oil, sunlight resistant and flame retardant thermoplastic polyurethane jacket shall be applied directly over the flexible metal conduit. The physical properties of the jacket material shall comply with the UL 360 Standard. The Low Smoke Zero Halogen jacket shall be tested to and comply with ASTM® 162 – Flame Spread Index, ASTM® E662 – Smoke Density Generation and Bombardier SMP-800C – Toxic Gas Generation. The test results are summarized in Table 1. Underwriters Laboratories Inc. (UL) does not list any manufacturers jacket compound as being low smoke zero halogen. The jacket wall thickness shall be in accordance with Table 4.1 of UL 360 which is summarized in Table 2. Jacket: Black

#### Grounding

Permanent circuit ground protection is provided through the continuous bonding strip built into the conduit core in trade sizes 3/8 through 1 1/4. A separate grounding conductor is required by the NEC® for all trade sizes 1 1/2 and larger.



#### Reference Standards

UL 360	Standard for Liquidtight Flexible Steel Conduit
File Reference	UL E26540
NEC® Articles	300.22, 350, 501.10(B)(2), 502.10(A)(2), 503.10(A)(2), 620.21(A)(1)(c)(2), 620.21(A)(2)(a), 620.21(A)(2)(d)(2), 620.21(A)(3)(a), 620.21(A)(4)(2), 620.21(B)(1), 620.21(C)(1) 645.5(E)(2), 680.21, 680.42, 695.6(E) and 695.14(E)
Department of Defense	UL 360 adopted on October 1, 1987
ASTM® E 162	Flame Spread Index
ASTM® E 662	Smoke Density Generation
Bombardier SMP-800C	Toxic Gas Generation
UL 94	Tests for Flammability of Plastic Materials for Parts

#### Markings

The surface of the outer jacket shall be clearly marked with a legible print legend in compliance with the UL 360 Standard.

#### Performance Tests

In accordance with UL 360, the completed LIQUID-TUFF™ LSZH Liquidtight Flexible Metal Conduit shall meet all of the performance requirements outlined in Appendix A.

# LIQUID-TUFF™

## Low Smoke Zero Halogen – LSZH

### UL Liquidtight Flexible Metal Conduit Type LFMC

**Table 1**  
**LIQUID-TUFF™ LSZH Combustion and Flammability Properties**

PROPERTY	TEST	RESULTS
Vertical Burn (Material)	UL 94	UL Listed: V-O Rating No Flaming Drips
Vertical Burn (Conduit)	UL 360	UL Listed: Passed
Oxygen Index % (Material)	ASTM® D 2863	25%
Flame Spread Index	ASTM® E-162	Passed No Flaming Drips
Smoke Generation (Flaming)	ASTM® E662 (NFPA-258)	Ds=13 @ 1.5 min Ds=57 @ 4.0 min No Flaming Drips
Smoke Generation (Non-flaming)	ASTM® E662 (NFPA-258)	Ds=1 @ 1.5 min Ds=8 @ 4.0 min No Flaming Drips
Toxic Gas Generation	Bombardier SMP-800C	Pass

Testing performed by independent test laboratory.  
Test results available upon request.

**Table 2**  
**Jacket Thickness**

Conduit Trade		Minimum Acceptable Average Thickness of Jacket, (inches)
Trade Size	Metric Designator	
3/8	12	0.030
1/2	16	0.030
3/4	21	0.035
1	27	0.035
1¼	35	0.035
1½	41	0.040
2	53	0.040
2½	63	0.050

**Table 3**  
**Conduit Diameters**  
**Acceptable Internal and External Diameters**

Conduit Size		Internal Diameter, In.		Over Jacket, In.	
Trade Size, In.	Metric Designator	Min.	Max.	Min.	Max.
3/8	12	0.484	0.504	0.690	0.710
1/2	16	0.622	0.642	0.820	0.840
3/4	21	0.820	0.840	1.030	1.050
1	27	1.041	1.066	1.290	1.315
1¼	35	1.380	1.410	1.630	1.660
1½	41	1.575	1.600	1.865	1.900
2	53	2.020	2.045	2.340	2.375
2½	63	2.480	2.505	2.840	2.875

## Appendix A

### UL 360 Performance Tests

Resistance and High Current  
Fault Current  
Impact  
Tension  
Crushing  
Pipe Stiffness  
Flexibility  
Low Temperature Flexibility  
Zinc Coating  
Vertical Flame  
Physical Properties  
Deformation  
Mechanical Water Absorption  
Moisture Penetration  
Sunlight Resistance  
Test for Secureness of Fittings  
Test for Durability of Ink Printing



**Southwire®**

American Recovery and Reinvestment Act  
 Verification Statement

Manufacturer: Southwire Company  
 Products: Alflex®, Galflex®, Liquid tight conduits, MC  
 (Include) Cable, Low Voltage, Medium Voltage, High  
Voltage (all insulated), Airport Lighting Wire,  
Insulated Overhead Transmission Cable, Bare  
Overhead Transmission Cable, Cord,  
Telecommunications Cable

Please fill out the **Buy American Substantial Transformation Questionnaire**. Substantial transformation has occurred in the U.S. if the answer is yes to either of the following questions - Questions 1, 2, or 3. If the answer to Question 1 is yes, then this is clearly manufactured in the U.S., and the inquiry is complete. If the answer is yes for any of 2a, 2b, or 2c, then answer to Question 2 is yes. If the answer is yes for at least two of 3a, 3b, 3c, 3d, or 3e, then answer to Question 3 is yes.

**Buy American Substantial Transformation Questionnaire**

QUESTION	YES	NO
<b>1. Were all of the components of the manufactured good manufactured in the United States, and were all of the components assembled into the final product in the U.S.? (If the answer is yes, then this is clearly manufactured in the U.S., and the inquiry is complete)</b>	X	
<b>2. Was there a change in character or use of the good or the components in America? (These questions are asked about the finished good as a whole, not about each individual component)</b>		
a) Was there a change in the physical and/or chemical properties or characteristics designed to alter the functionality of the good?		
b) Did the manufacturing or processing operation result in a change of a product(s) with one use into a product with a different use?		
c) Did the manufacturing or processing operation result in the narrowing of the range of possible uses of a multi-use product?		
<b>3. Was(/were) the process(es) performed in the U.S. (including but not limited to assembly) complex and meaningful?</b>		
a) Did the process(es) take a substantial amount of time?		
b) Was(/were) the process(es) costly?		
c) Did the process(es) require particular high level skills?		
d) Did the process(es) require a number of different operations?		
e) Was substantial value added in the process(es)?		

Simple “yes” answers are insufficient to make a case that an item has been substantially transformed in the U.S. In applying these answers, “yes” answers must be documented by meaningful, informative, and specific technical descriptions of the activities in the actual process asked about in each question. These descriptions need not be of great length, but must be sufficiently detailed and clearly written to inform assistance recipients and agency reviewers about the activities that have occurred in the process(es), enough to understand their nature and purpose. They should not simply assert a conclusion, describe an end state, or essentially repeat the words of the question as a statement. Also, include the manufacturing locations within the U.S. (Town, State) in which the products specific to this project were manufactured.

Please explain the “yes” answers to the ***Buy American Substantial Transformation Questionnaire***:

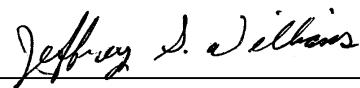
Southwire Company insulated electrical wire products are drawn and insulated in plants located in the continental United States of America, the location dependent on the particular type of wire. All copper wire is drawn from copper rod manufactured in Carrollton, Georgia by Southwire or copper rod produced by Phelps-Dodge in Utah. Aluminum wire is drawn from aluminum rod produced by Southwire in Hawesville, Kentucky. A list of Southwire Company plants is included as a third page to this verification.

I certify that the product(s) listed above by the above mentioned manufacturer have been manufactured or substantially transformed in the U.S. in accordance with the American Recovery and Reinvestment Act.

Jeffrey S. Williams  
Name

Transportation Sys. Manager  
Title

June 23, 2010  
Date

  
Signature

# Type CBUL -Liquidtight Flexible Steel Conduit

Trade Size (Inches)	Approximate Weight (lbs/100 ft)	Inner Diameter Min./Max. (inches)	Outer Diameter Min./Max. (inches)	Approx. Bend Radius* (Inches)	Standard Coil Length (feet)	Standard Reel Length (feet)
3/8	27	0.484 / 0.504	0.690 / 0.710	4	100	600
1/2	31	0.622 / 0.642	0.820 / 0.840	4	100	500/1000
3/4	40	0.820 / 0.840	1.030 / 1.050	5	100	500/1000
1	76	1.041 / 1.066	1.290 / 1.315	6	100	400
1-1/4	102	1.380 / 1.410	1.630 / 1.660	8	50	250
1-1/2	103	1.575 / 1.600	1.865 / 1.900	10	50	150
2	145	2.020 / 2.045	2.340 / 2.375	12	50	100
2-1/2	197	2.480 / 2.505	2.840 / 2.875	15	25	100
3	265	3.070 / 3.100	3.460 / 3.500	18	25	-
3-1/2	300	3.500 / 3.540	3.960 / 4.000	21	25	-
4	333	4.000 / 4.040	4.460 / 4.500	24	25	-

\* Minimum bend radius based on NEC Chapter 9, Table 2 (other bends) per Article 350

## FEATURES

- Blue color easily identifies raceways for uninterrupted computer power circuits
- A protective thermoplastic outer jacket which seals out water, liquids, abrasives, alcohol, coolants, corrosive fumes and gases, dirt, grease, mineral acids, nonconcentrated fixed alkalines, petroleum oils, salt air and spray, and weather
- Smooth metal interior for easy wiring pulling
- UV sunlight resistant jacket
- Rated for temperature range of -30°C to 80°C , 60°C Oil (-22°F to +176°F, 140°F Oil)
- Accepts standard metallic liquid-tight fittings
- Rated for direct burial applications

## ADDITIONAL APPLICATIONS

- In Hazardous Locations - where necessary for flexible connections within hazardous locations in accordance with the following:
  - Class I, Div. 2 - NEC 501.10(B)(2) & 501.30(B)
  - Class II, Div. 1 - NEC 502.10(A)(2) & 502.30(B)
  - Class II, Div. 2 - NEC 502.10(B)(2)
  - Class III, Div. 1 - NEC 503.10(A)(2) & 503.30(B)
  - Class III, Div. 2 - NEC 503.10(A)(2)
- Permitted for equipment grounding in sizes 3/8" through 1-1/4" in lengths not exceeding 6 feet per NEC 250.118(6)
- Floating building feeders and services per NEC 553.7(B)
- Boatyards & Marinas in accordance with NEC 555.13
- Cranes & Hoists in accordance with NEC 610.11(C)



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# Plasti-Bond REDH<sub>2</sub>O<sup>T</sup>

Robroy Electrical Products Division  
1100 US Highway 271 South • Gilmer, Texas 75644  
Phone: 903-843-5591 • FAX: 903-843-5595  
www.plastibond.com

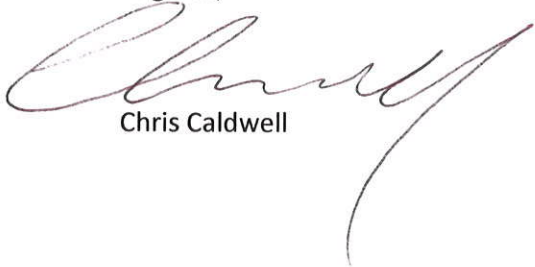
October 25, 2012

**RE: PVC Coated Products (Buy America)**

Juliann,

Good afternoon, thank you for showing interest in our PVC coated products. Per our conversation we can provide PVC coated products made from 100% domestic steel. At the time of quote please provide a copy of all requirements with your BOM. If a PO is issued please reference the Robroy quote number; this will insure the correct material is ordered. If you should have any questions please contact me at 903-843-5591 ext 217.

Regards,



Chris Caldwell

# Plasti-Bond **REDH<sub>2</sub>O**<sup>®</sup>

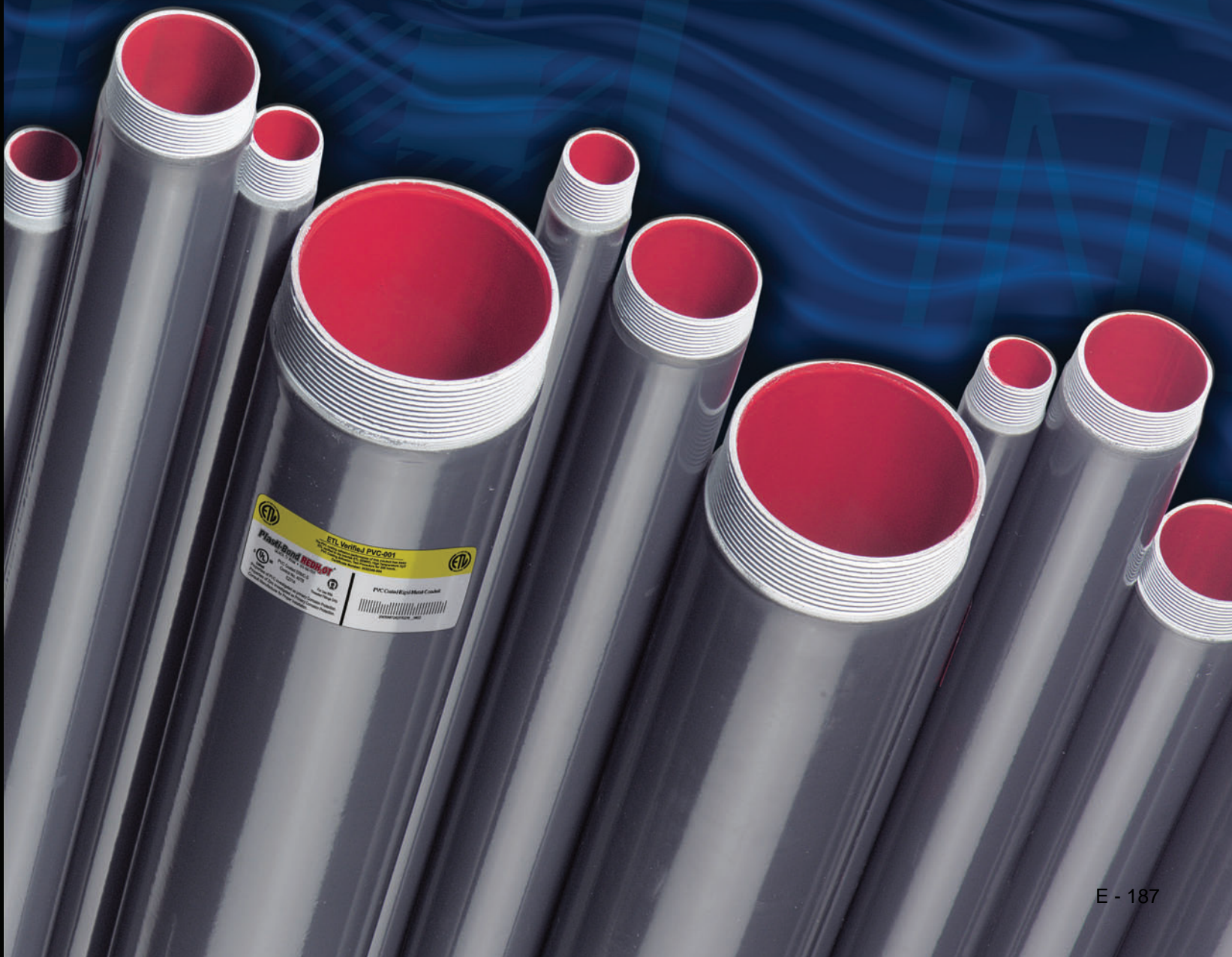
## Buyer's Guide

*Complete Product Information*

*Installation Information*

*Value Added Features & Benefits*

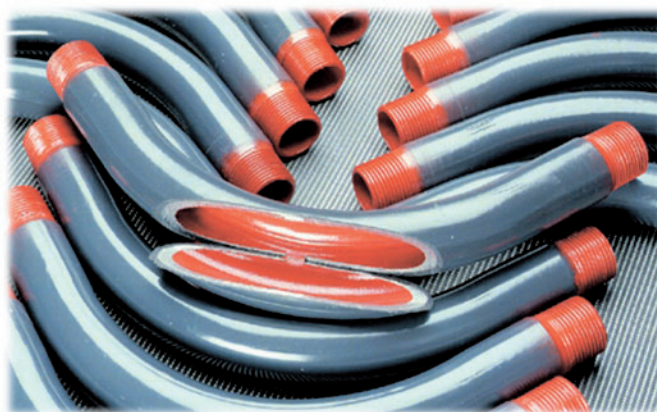
*Technical Information*





# PLASTI-BOND REDH<sub>2</sub>OT COATED ELBOWS

## STANDARD RADIUS COATED ELBOWS



### Coated Elbow Specifications

PLASTI-BOND REDH<sub>2</sub>OT factory bent standard radius elbows are available and ready to ship. Factory bent elbows are more accurate, quicker to install and more economical, because they save field bending time and do not waste materials. Electrical continuity is maintained across assembled joints.

- 40 mil Gray PVC exterior coating
- 2 mil Red urethane interior and thread coating
- 12 trade sizes from 1/2" through 6"
- Available in 90°, 60°, 45°, and 30° bends
- Plastic thread protector caps are color coded for quick identification of conduit size.

#### Thread Protector Cap Colors:

- Black- for 1/2" sizes, 1/2", 1-1/2", 2-1/2", 3-1/2"
- Red- for 1/4" sizes, 3/4", 1-1/4"
- Blue- for even sizes, 1", 2", 3", 4", 5", 6"

- UL Listed, (Standard 6) with the PVC as the primary corrosion protection for the steel conduit. The underlying zinc coating is a supplemental corrosion protection coating. Restricted for use with threaded fittings only. (UL 6 is now used in lieu of WWC 581.)

**ETL VERIFIED: Plasti-Bond Elbows are manufactured from ETL-verified conduit.**

APPLICATION

FEATURES

COMPLIANCES

### Simple Steps To Ordering

To order the PLASTI-BOND coated elbows follow these simple steps to creating a catalog number:

#### 1- Determine Proper Prefix.

- For steel conduit elbow use the prefix: **PRHELB-**
- For aluminum conduit elbow use the prefix: **PRELB-AL-**

#### 2- Add the conduit trade size needed to your catalog prefix. Example - 1/2" steel conduit elbow: **PRHELB-1/2**

#### 3- Enter an "X" to represent "by" as in "2X4". Example - **PRHELB-1/2X**

#### 4- Enter the desired elbow degree of bend. Example - 45°: **PRHELB-1/2X45**

For a coated steel, 1/2" elbow with a 45° bend, the catalog number would be: **PRHELB 1/2X45**

#### STEP 5 AND 6 FOR CONFIGURING CATALOG NUMBERS FOR LARGE RADIUS ELBOWS

#### 5- Enter an "X" to represent "by" as in "2X4". Example - **PRHELB-1/2X45X**

#### 6- Enter the desired elbow radius. Example - 30: **PRHELB-1/2X45X30**

For a coated steel, 1/2" elbow with a 45° bend, and a special radius of 30" the catalog number would be: **PRHELB-1/2X45X30**

This number can then be looked up in the listing of pricing to determine price and availability.

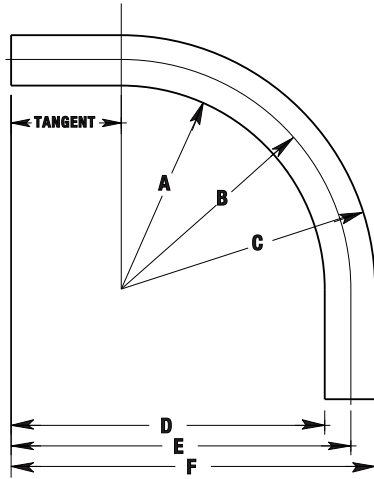
Call 903-843-5591 for custom orders, customer service and more information on **Plasti-Bond REDH<sub>2</sub>OT**.

#### APPROVAL STAMP

(See online product submittal guide at [www.plastibond.com](http://www.plastibond.com))

# STANDARD RADIUS COATED ELBOWS

## Dimensions



### Diagram Legend

- A = Radius at inside of bend.
- B = Radius at center line of bend.
- C = Radius at outside of bend.
- D = Offset at inside of bend.
- E = Offset at center of bend.
- F = Offset at outside of bend.

### STANDARD RADIUS ELBOWS

Metric Size Designators	Nominal Size Inches	DIAMETERS		Nipple Lengths Inches	RADII			OFFSET			Tangent Inches
		External Inches	Internal Inches		A Inches	(standard) B Inches	C Inches	D Inches	E Inches	F Inches	
16	1/2"	0.920"	0.632"	11-1/4"	3.79"	4.25"	4.71"	6.040"	6.500"	6.960"	2.250"
21	3/4"	1.130"	0.836"	12-1/2"	3.94"	4.50"	5.07"	6.685"	7.250"	7.815"	2.750"
27	1"	1.395"	1.063"	14-3/4"	5.05"	5.75"	6.45"	7.928"	8.625"	9.323"	2.875"
35	1-1/4"	1.740"	1.394"	17-3/4"	6.38"	7.25"	8.12"	9.567"	10.437"	11.307"	3.187"
41	1-1/2"	1.980"	1.624"	19-3/4"	7.26"	8.25"	9.24"	10.635"	11.625"	12.615"	3.375"
53	2"	2.455"	2.083"	22-1/2"	8.27"	9.50"	10.73"	12.086"	13.313"	14.541"	3.813"
63	2-1/2"	2.955"	2.489"	28"	9.02"	10.50"	11.98"	14.776"	16.253"	17.731"	5.753"
78	3"	3.580"	3.080"	32"	11.21"	13.00"	14.79"	17.000"	18.790"	20.580"	5.790"
91	3-1/2"	4.080"	3.570"	39-1/2"	12.96"	15.00"	17.04"	20.920"	22.960"	25.000"	7.960"
103	4"	4.580"	4.050"	39-1/2"	13.71"	16.00"	18.29"	20.890"	23.180"	25.470"	7.180"
129	5"	5.643"	5.073"	59-1/2"	21.18"	24.00"	26.82"	32.079"	34.900"	37.722"	10.900"
155	6"	6.705"	6.093"	76"	26.65"	30.00"	33.35"	41.088"	44.440"	47.793"	14.440"

PLASTI-BOND REDH<sub>2</sub>O<sub>T</sub> factory bent elbows are also available in larger than standard radii to accommodate your special needs. Simply follow the four steps for standard radius elbows on the previous page, then continue with Steps 5 and 6 for large radius elbows. Refer to the table below to determine which radius is available for the size of conduit you need.

To use the Large Radius Elbow table, find the elbow radius required in the first row. Then look down the column to determine which conduit sizes are available in that radius. *Use this information in Steps 5 and 6 on the previous page to build a catalog number.*

### LARGE RADIUS ELBOWS

Radius B in Inches	12"	15"	18"	18"	24"	24"	30"	30"	36"	36"	36"	42"	42"	42"	48"	48"	48"
E Offset	1'5-1/2"	1'9-1/4"	2'1/4"	2'3"	2'8"	2'10"	3'4"	3'5"	3'11"	3'11-1/4"	4'3-1/4"	4'5"	4'6"	4'9-1/2"	5'1/4"	5'1-1/4"	5'3-1/4"
Nipple Length	2'6"	3'0"	3'5"	3'10"	4'6"	4'9"	5'6"	5'9"	6'7"	6'7"	7'3"	7'4"	7'6"	8'1"	8'4"	8'6"	8'10"
Tangent	5-1/2"	6-1/4"	6-1/4"	9"	8"	10"	10"	11"	11"	11-1/4"	15-1/4"	11"	12"	15-1/2"	12-1/4"	13-1/4"	15-1/4"
Available Pipe Sizes	1" & 2"	2"	1"	1-1/2" to 3"	3/4" to 2"	2-1/2" to 5"	2" to 3"	4" to 6"	3/4" to 4"	5" only	6" only	4"	5" only	n/a	1-1/2" to 4"	5" only	6" only

# FM7™ Unilet® Conduit Outlet Bodies

For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

## Applications

- Serve as pulling fittings.
- Make bends in conduit system.
- Provide openings for splicing.
- Connect and change direction of conduit runs.
- Allow connections for branch runs.
- Permit access to conductors for maintenance.

## Features

- Smooth, rounded integral bushings in hubs protect conductor insulation.
- Accurately tapped, tapered threads for tight, rigid joints and excellent ground continuity.
- Wedge-Lok™ Form-IN-Place covers with integral gasket are approved for use in wet locations. Grayloy-iron bodies with cast covers and gasket are approved for use in wet locations.
- Unique Wedge-Lok™ clip cover design allows easy removal at any later time, without damaging the conduit body. The cover is secured with clips, not screws.
- Completely interchangeable with Crouse-Hinds<sup>+</sup> Form 7™<sup>+</sup> bodies, gaskets and covers. Equivalent FM7 and Form 7™ units have identical applications and installation dimensions.
- Flat back design provides greater cubic content for easier wire pulling, and more room for splicing. Fits flush and snug against flat surfaces for more stable installation.
- Smooth hub bushings and cover openings protect conductor insulation. Smooth hub openings allow easy conduit joining.
- Pan-head cover screws secure cover clips and provide superior screwdriver seating and torque. Cover screws and clips are captive to prevent loss.
- Hub size, body style, compliance data, maximum wire number/size and cubic capacity molded into body.

## Standard Materials

- Body: Grayloy-iron or copperfree (4/10 of 1% max.) aluminum
- Covers: Grayloy-iron, copperfree (4/10 of 1% max.) aluminum or steel
- Cover screws: stainless steel

## Standard Finishes

- Grayloy-iron bodies and covers: triplecoat — (1) zinc electroplate, (2) chromate, and (3) epoxy powder coat
- Cast aluminum bodies and covers: epoxy powder coat
- Steel covers: zinc electroplate
- Stamped aluminum covers: natural finish

## Certifications and Compliances

- UL Standard: 514A , 514B
- UL Listed: E2527
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065183
- NEMA Standard: FB-1

## Options

- PVC coating available on select aluminum bodies and covers. Add suffix **-PVC** to catalog number.



Type LB

## Illustrated Features



Conduit Body with Cast Aluminum Cover, 1" Type C shown



Grayloy™-Iron, 1" Type C shown with cut-away body and cover to illustrate Wedge-Lok™ Clip Cover detail

Illustrated views are cut away to demonstrate back configurations.



Appleton FM7 (C57, 1-1/2")  
28 Cubic Inches Capacity  
Flat-Back Design



Crouse-Hinds Form 7 (C57, 1-1/2")  
26 Cubic Inches Capacity

+ Crouse-Hinds and Form 7 are registered trademarks of Cooper Crouse-Hinds.








# FM7™ Unilet® Conduit Bodies


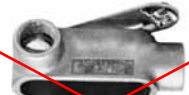



For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

Fittings  
FITTINGS: CONDUIT BODIES

## Appleton FM7 Conduit Bodies \*

Hub Size (inches)	C		LB		LL		LR		T	
	Grayloy-Iron	Aluminum ‡	Grayloy-Iron	Aluminum ‡	Grayloy-Iron	Aluminum ‡	Grayloy-Iron	Aluminum ‡	Grayloy-Iron	Aluminum ‡
										
1/2	C17	C17-SA	LB17	LB17-SA	LL17	LL17-SA	LR17	LR17-SA	T17	T17-SA
3/4	C27	C27-SA	LB27	LB27-SA	LL27	LL27-SA	LR27	LR27-SA	T27	T27-SA
1	C37	C37-SA	LB37	LB37-SA	LL37	LL37-SA	LR37	LR37-SA	T37	T37-SA
1-1/4	C47	C47-SA	LB47	LB47-SA	LL47	LL47-SA	LR47	LR47-SA	T47	T47-SA
1-1/2	C57	C57-SA	LB57	LB57-SA	LL57	LL57-SA	LR57	LR57-SA	T57	T57-SA
2	C67	C67-SA	LB67	LB67-SA	LL67	LL67-SA	LR67	LR67-SA	T67	T67-SA
2-1/2	C77	C77-SA	LB77	LB77-SA	LL77	LL77-SA	LR77	LR77-SA	T77	T77-SA
3	C87	C87-SA	LB87	LB87-SA	LL87	LL87-SA	LR87	LR87-SA	T87	T87-SA
3-1/2	—	—	LB97	LB97-SA	LL97	LL97-SA	LR97	LR97-SA	T97	T97-SA
4	—	—	LB107	LB107-SA	LL107	LL107-SA	LR107	LR107-SA	T107	T107-SA

Hub Size (inches)	E		L †		TA		TB		X	
	Grayloy-Iron	Aluminum	Grayloy-Iron	Aluminum	Grayloy-Iron	Aluminum	Grayloy-Iron	Aluminum ‡	Grayloy-Iron	Aluminum ‡
										
1/2	E17	E17-SA	L17	—	TA17	—	TB17	TB17-SA	X17	X17-SA
3/4	E27	E27-SA	L27	—	TA27	—	TB27	TB27-SA	X27	X27-SA
1	E37	E37-SA	L37	—	TA37	—	TB37	TB37-SA	X37	X37-SA
1-1/4	—	—	L47	—	TA47	—	TB47	TB47-SA	X47	X47-SA
1-1/2	—	—	L57	—	TA57	—	TB57	TB57-SA	X57	X57-SA
2	—	—	L67	—	TA67	—	TB67	TB67-SA	X67	X67-SA

\* Refer to following pages for Wiring Capacity Table.




† L Unilets have double opening and are furnished with one steel cover, assembled.

‡ PVC coating available on select aluminum bodies. Add suffix **-PVC** to catalog number.

# FM7™ Wedge-Lok™ Clip Covers, Gaskets

For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

## Appleton FM7 Blank Covers and Gaskets (Covers furnished with stainless steel screws)

Body Size (inches)	Wedge-Lok Cast Cover		Wedge-Lok Stamped Cover		Solid Neoprene Gasket
	Grayloy-Iron	Aluminum	Steel	Aluminum ‡	
					
1/2	170F	170F-SA	170	170-SA	GASK571
3/4	270F	270F-SA	270	270-SA	GASK572
1	370F	370F-SA	370	370-SA	GASK573
1-1/4	470F	470F-SA	470	470-SA	GASK574
1-1/2	570F	570F-SA	570	570-SA	GASK575
2	670F	670F-SA	670	670-SA	GASK576
2-1/2	870F	870F-SA	870	870-SA	GASK578
3	870F	870F-SA	870	870-SA	GASK578
3-1/2	970F	970F-SA	970	970-SA	GASK579
4	970F	970F-SA	970	970-SA	GASK579

### Fraction/Decimal Equivalentents (Inches)

Fraction	Decimal	Fraction	Decimal	Fraction	Decimal	Fraction	Decimal
1/16	0.06	5/16	0.31	9/16	0.56	13/16	0.81
1/8	0.13	3/8	0.38	5/8	0.63	7/8	0.88
3/16	0.19	7/16	0.44	11/16	0.69	15/16	0.94
1/4	0.25	1/2	0.50	3/4	0.75	1	1.00

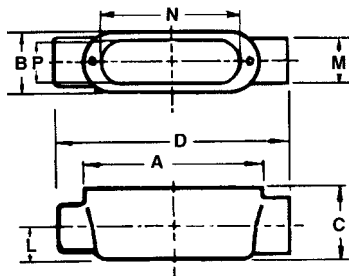
‡ PVC coating available on select aluminum covers. Add suffix **-PVC** to catalog number.

# FM7™ Unilet® Conduit Outlet Body Dimensions

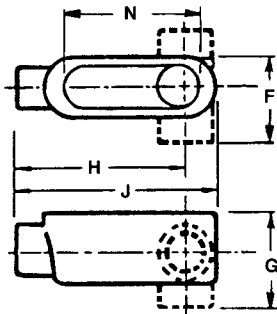
For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

Fittings

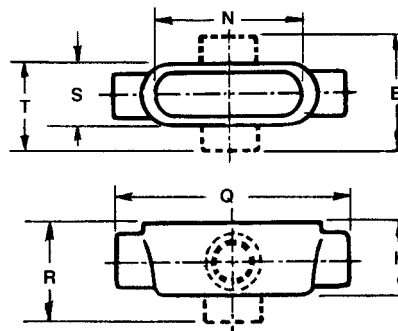
FITTINGS: CONDUIT BODIES



Type C



Type E, L, LB, LL, LR



Type T, TA, TB, X

Hub Size (Inches)	Dimensions in Inches/Millimeters																		
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	
1/2	3.63/ 92.2	1.38/ 35.1	1.38/ 35.1	5.38/ 136.7	3.31/ 84.1	2.25/ 57.2	2.25/ 57.2	3.94/ 100.1	4.56/ 115.8	1.75/ 44.5	0.63/ 16.0	1.25/ 31.8	3.19/ 81.0	0.94/ 23.9	5.63/ 143.0	2.63/ 66.8	1.56/ 39.6	2.44/ 62.0	
3/4	4.25/ 108.0	1.56/ 39.6	1.63/ 41.4	6.00/ 152.4	3.50/ 88.9	2.44/ 62.0	2.50/ 63.5	4.44/ 112.8	5.19/ 131.8	2.00/ 50.8	0.75/ 19.1	1.50/ 38.1	3.81/ 96.8	1.13/ 28.7	6.25/ 158.8	2.88/ 73.2	1.88/ 47.8	2.63/ 66.8	
1	5.00/ 127.0	1.75/ 44.5	1.88/ 47.8	7.00/ 177.8	3.88/ 98.6	2.75/ 69.9	2.88/ 73.2	5.19/ 131.8	6.00/ 152.4	2.25/ 57.2	0.88/ 22.4	1.75/ 44.5	4.50/ 114.3	1.38/ 35.1	7.25/ 184.2	3.25/ 82.6	2.00/ 50.8	3.00/ 76.2	
1-1/4	5.50/ 139.7	2.19/ 55.6	2.31/ 58.7	7.44/ 189.0	4.13/ 104.9	3.19/ 81.0	3.31/ 84.1	5.44/ 138.2	6.50/ 165.1	2.31/ 58.7	1.13/ 28.7	2.19/ 55.6	5.00/ 127.0	1.75/ 44.5	7.44/ 189.0	3.31/ 84.1	2.19/ 55.6	3.19/ 81.0	
1-1/2	6.00/ 152.4	2.44/ 62.0	2.56/ 65.0	8.19/ 208.0	4.63/ 117.6	3.50/ 88.9	3.69/ 93.7	5.94/ 150.9	7.13/ 181.1	2.56/ 65.0	1.25/ 31.8	2.44/ 62.0	5.44/ 138.2	1.94/ 49.3	8.19/ 208.0	3.63/ 92.2	2.44/ 62.0	3.56/ 90.4	
2	7.00/ 177.8	3.00/ 76.2	3.13/ 79.5	9.19/ 233.4	5.19/ 131.8	4.06/ 103.1	4.25/ 108.0	6.63/ 168.4	8.13/ 206.5	3.13/ 79.5	1.50/ 38.1	3.00/ 76.2	6.38/ 162.1	2.44/ 62.0	9.19/ 233.4	4.19/ 106.4	3.00/ 76.2	4.13/ 104.9	
2-1/2	9.00/ 228.6	4.25/ 108.0	3.63/ 92.2	12.00/ 304.8	—	5.75/ 146.1	5.13/ 130.3	8.75/ 222.3	10.50/ 266.7	3.63/ 92.2	1.75/ 44.5	3.50/ 88.9	8.38/ 212.9	3.56/ 90.4	12.00/ 304.8	—	4.25/ 108.0	5.75/ 146.1	
3	9.00/ 228.6	4.25/ 108.0	4.38/ 111.3	12.00/ 304.8	—	5.75/ 146.1	5.88/ 149.4	8.38/ 212.9	10.50/ 266.7	4.38/ 111.3	2.13/ 54.1	4.25/ 108.0	8.38/ 212.9	3.56/ 90.4	12.06/ 306.3	—	4.25/ 108.0	5.75/ 146.1	
3-1/2	11.00/ 279.4	5.25/ 133.4	4.88/ 124.0	—	—	6.94/ 176.3	6.56/ 166.6	10.25/ 260.4	12.69/ 322.3	4.88/ 124.0	2.38/ 60.5	4.75/ 120.7	10.25/ 260.4	4.50/ 114.3	14.31/ 363.5	—	5.25/ 133.4	6.94/ 176.3	
4	11.00/ 279.4	5.25/ 133.4	5.38/ 136.7	—	—	6.94/ 176.3	7.06/ 179.3	10.00/ 254.0	12.69/ 322.3	5.38/ 136.7	2.63/ 66.8	5.25/ 133.4	10.25/ 260.4	4.50/ 114.3	14.31/ 363.5	—	5.25/ 133.4	6.94/ 176.3	

# Form 35® Malleable Iron Unilet® Conduit Outlet Bodies

For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

## Applications

- Serve as pulling fittings.
- Make bends in conduit system.
- Provide openings for splicing.
- Connect and change direction of conduit runs.
- Allow connections for branch runs.
- Permit access to conductors for maintenance.

## Features

- Smooth, rounded integral bushings in hubs protect conductor insulation.
- Accurately tapped, tapered threads for tight, rigid joints and excellent ground continuity.
- Form 35 malleable iron Unilets: high tensile strength and ductility. High corrosion-resistance, high impact and shock resistance.
- Exclusive built-in easy-pulling rollers in type C (1-1/4" thru 4") and type LB (1-1/4" thru 4"): eliminate damage when cable is pulled through hubs.
- Sizes with flat-back design ideal where fitting is mounted flat against surface.
- 1/2" to 3" blank covers are domed for extra wiring space.

## Standard Materials

- Bodies: malleable iron
- Blank covers: malleable iron, steel or aluminum
- Cover screws: stainless steel
- Gaskets: neoprene or composition fiber

## Standard Finishes

- Malleable iron bodies and covers: triple-coat — (1) zinc electroplate, (2) chromate, and (3) epoxy powder coat
- Steel covers: zinc electroplate

## Certifications and Compliances

- UL Standards: 514A, 514B
- UL Listed: E2527
- CSA Standard: C22.2 No. 18.3
- CSA Certified: 065183
- NEMA Standard: FB-1

## Related Products

- For explosionproof conduit outlet bodies and boxes, see *Enclosures and Junction boxes*.



2" Type LB with rollers shown

Fittings








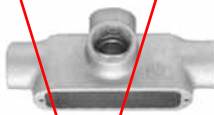


FITTINGS: CONDUIT BODIES

# Form 35® Malleable Iron Unilet® Conduit Outlet Bodies

For use with Rigid Steel, Rigid Aluminum and IMC Conduit.

FITTINGS: CONDUIT BODIES

## Threaded Type Conduit Bodies

Hub Size (Inches)	C	E	LB	LL	LR
					
1/2	C50-M	E50-M	LB50-M	LL50-M	LR50-M
3/4	C75-M	E75-M	LB75-M	LL75-M	LR75-M
1	C100-M	E100-M	LB100-M	LL100-M	LR100-M
1-1/4	C125-M ‡	E125-M	LB125-M ‡	LL125-M	LR125-M
1-1/2	C150-M ‡	E150-M	LB150-M ‡	LL150-M	LR150-M
2	C200-M ‡	—	LB200-M ‡	LL200-M	LR200-M
2-1/2	C250-M ‡	—	LB250-M ‡	LL250-M	LR250-M
3	C300-M ‡	—	LB300-M ‡	LL300-M	LR300-M
3-1/2	C350-M ‡	—	LB350-M ‡	LL350-M	LR350-M
4	C400-M ‡	—	LB400-M ‡	LL400-M	LR400-M
5	—	—	LB500-M	—	—
6	—	—	LB600-M	—	—
Hub Size (Inches)	LRL †	T	TA	TB	X
					
1/2	LRL50-M	T50-M	TA50-M	TB50-M	X50-M
3/4	LRL75-M	T75-M	TA75-M	TB75-M	X75-M
1	LRL100-M	T100-M	TA100-M	TB100-M	X100-M
1-1/4	LRL125-M	T125-M	—	TB125-M	X125-M
1-1/2	LRL150-M	T150-M	—	TB150-M	X150-M
2	LRL200-M	T200-M	—	TB200-M	X200-M
2-1/2	—	T250-M	—	—	—
3	—	T300-M	—	—	—
3-1/2	—	T350-M	—	—	—
4	—	T400-M	—	—	—

## Back Style for Form 35 Unilet Conduit Body Sizes (Inches)

Unilet Body	Flat Back	Round Back	Unilet Body	Flat Back	Round Back
C, LB	1/2 – 2	2-1/2 and up	TB	1/2 – 1-1/2	1/2, 3/4, 1, 2
E	1/2 – 1-1/2	1-1/4 and up	X	1/2 – 2	1-1/4 and up
LL, LR, T	1/2 – 2	2-1/2 and up	TA	All sizes	

† LRL Unilets have double opening and are furnished with one steel cover, assembled.

‡ Catalog numbers having roller feature, all others do not.









# Covers and Gaskets for Form 35® Unilet® Conduit Outlet Bodies

Covers Furnished with Stainless Steel Fastening Screws.

Fittings

FITTINGS: CONDUIT BODIES

## Covers and Gaskets \*

Body Size (Inches)	Blank Stamped Steel	Blank Cast Malleable	Neoprene	Composition Fiber
	 <p>Domed: 1/2" – 3"</p>  <p>Flat: 3-1/2" – 6"</p>	 <p>Flat: 1/2" – 2"</p>  <p>Domed: 2-1/2" – 4"</p>	 <p>Tear out inner section to convert to "open type" gasket.</p>	 <p>Tear out inner section to convert to "open type" gasket.</p>
1/2	K50	K50-CM	GK50-N	GK50-V
3/4	K75	K75-CM	GK75-N	GK75-V
1	K100	K100-CM	GK100-N	GK100-V
1-1/4	K125 & 150	K125 & 150-CM	GK125-150-N	GK125-150-V
1-1/2	K125 & 150	K125 & 150-CM	GK125-150-N	GK125-150-V
2	K200	K200-CM	GK200-N	GK200-V
2-1/2	K250 & 300	K250 & 300-CM	GK250-300-N	GK-250-300-V
3	K250 & 300	K250 & 300-CM	GK250-300-N	GK-250-300-V
3-1/2	K350 & 400	K350 & 400-CM	GK350-400-N	GK-350-400-V
4	K350 & 400	K350 & 400-CM	GK350-400-N	GK-350-400-V
5	K500	—	GK500-SN †	—
6	K600	—	GK600-SN †	—

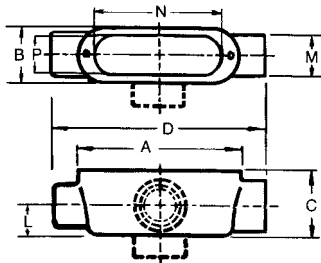
\* Refer to previous page for Wiring Capacity Table.

† Not perforated.

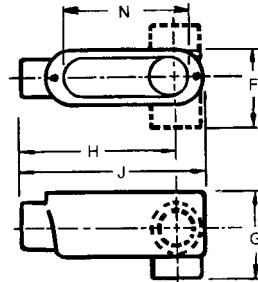
# Form 35® Malleable Iron Unilet® Conduit Outlet Bodies Dimensions

Threaded Type for use with Rigid Metal Conduit and IMC; Compression Type for use with Threadless Rigid Metal Conduit.

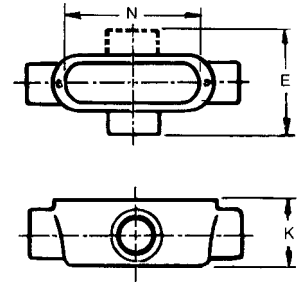
## Threaded Type (Inches/Millimeters)



Types A, C, TA, TB



Types E, LB, LL, LR, LRL



Types T, X

Hub Size	A	B	C	D	E	F	G	H	J	K	L	M	N	P
1/2	3.94/ 100.1	1.31/ 33.3	1.44/ 36.6	5.38/ 136.7	2.69/ 68.3	2.00/ 50.8	2.13/ 54.1	3.94/ 100.1	4.63/ 117.6	1.75/ 44.5	0.63/ 16.0	1.19/ 30.2	3.16/ 80.3	1.00/ 25.4
3/4	4.63/ 117.6	1.56/ 39.6	1.69/ 42.9	6.06/ 153.9	2.88/ 73.2	2.19/ 55.6	2.31/ 58.7	4.44/ 112.8	5.38/ 136.7	2.00/ 50.8	0.75/ 19.1	1.38/ 35.1	3.78/ 96.0	1.22/ 31.0
1	5.38/ 136.7	1.81/ 46.0	1.94/ 49.3	7.13/ 181.1	3.38/ 85.9	2.56/ 65.0	2.69/ 68.3	5.13/ 130.3	6.25/ 158.8	2.25/ 57.2	0.94/ 23.9	1.69/ 42.9	4.53/ 115.1	1.47/ 37.3
1-1/4	7.19/ 182.6	2.50/ 63.5	2.56/ 65.0	9.19/ 233.4	4.50/ 114.3	3.50/ 88.9	3.56/ 90.4	7.06/ 179.3	8.19/ 208.0	2.56/ 65.0	1.19/ 30.2	2.00/ 50.8	6.00/ 152.4	2.00/ 50.8
1-1/2	7.19/ 182.6	2.50/ 63.5	2.75/ 69.9	9.19/ 233.4	4.50/ 114.3	3.50/ 88.9	3.75/ 95.3	6.81/ 173.0	8.19/ 208.0	2.75/ 69.9	1.38/ 35.1	2.38/ 60.5	6.00/ 152.4	2.00/ 50.8
2	9.50/ 241.3	3.13/ 79.5	3.38/ 85.9	11.63/ 295.4	5.25/ 133.4	4.19/ 106.4	4.63/ 117.6	8.94/ 227.1	10.56/ 268.2	3.38/ 85.9	1.63/ 41.4	2.94/ 74.7	8.06/ 204.7	2.56/ 65.0
2-1/2	12.25/ 311.2	4.31/ 109.5	3.88/ 98.6	15.13/ 384.3	7.19/ 182.6	5.75/ 146.1	5.25/ 133.4	11.88/ 301.8	13.69/ 347.7	3.88/ 98.6	1.81/ 46.0	3.38/ 85.9	10.63/ 270.0	3.69/ 93.7
3	12.25/ 311.2	4.31/ 109.5	4.63/ 117.6	15.13/ 384.3	7.19/ 182.6	5.75/ 146.1	6.00/ 152.4	11.56/ 293.6	13.69/ 347.7	4.63/ 117.6	2.19/ 55.6	4.13/ 104.9	10.63/ 270.0	3.69/ 93.7
3-1/2	14.88/ 378.0	5.50/ 139.7	5.19/ 131.8	18.13/ 460.5	8.75/ 222.3	7.13/ 181.1	6.81/ 173.0	14.00/ 355.6	16.50/ 419.1	5.19/ 131.8	2.50/ 63.5	4.75/ 120.7	13.13/ 333.5	4.88/ 124.0
4	14.88/ 378.0	5.50/ 139.7	5.56/ 141.2	18.13/ 460.5	8.75/ 222.3	7.13/ 181.1	7.19/ 182.6	13.75/ 349.3	16.50/ 419.1	5.56/ 141.2	2.75/ 69.9	5.13/ 130.3	13.13/ 333.5	4.88/ 124.0
5	18.25/ 463.6	7.25/ 184.2	7.00/ 177.8	—	—	—	9.00/ 228.6	16.88/ 428.8	20.25/ 514.4	—	3.38/ 85.9	6.50/ 165.1	16.25/ 412.8	6.50/ 165.1
6	23.00/ 584.2	8.63/ 219.2	8.69/ 220.7	—	—	—	10.69/ 271.5	21.06/ 534.9	25.00/ 635.0	—	3.94/ 100.1	7.56/ 192.0	21.00/ 533.4	7.81/ 198.4

# Form 7 Conduit Bodies

## For Rigid Conduit & IMC

### Types LB, T, LL, LR

#### Use:

To provide access to conductors for pulling, splicing, maintenance and future changes/upgrades. Allows connection of straight conduit runs, branch conduit runs and 90° bends.

#### Features:

- Tapered threaded hubs (NPT).
- Flat back design for greater wiring capacity and surface mounting.
- Complete interchangeability with other manufacturers' Form 7 conduit bodies.
- Internal volume and maximum wire clearly marked on castings.
- Time-saving Clip-on™ covers in steel, gray iron or aluminum.
- For covers and gaskets, see Page - AA3 and AA4.

#### Material/Finish:

- Gray Iron/Zinc Electroplated/Aluminum Enamel
- Copper-free Aluminum/Aluminum Enamel

#### Optional Finish:

For additional corrosion protection, specify Hot Dip Galvanized. Add suffix "G" to Gray Iron catalog number. Contact your local representative for pricing and availability.

#### Third Party Certification:



UL Listed: E-18095  
Suitable for wet locations when used with gasketed covers.



CSA Certified: 009795  
Suitable for wet locations when used with gasketed covers.

#### Applicable Third Party Standards:

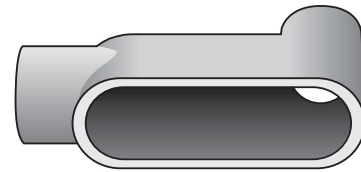
UL Standard: 514A  
CSA Standard: C22.2 No. 18  
Fed. Spec: A-A-50563  
NEMA: FB-1, FB-2.10

#### Dimensional Data:

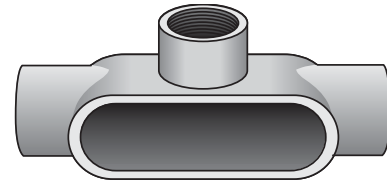
See Pages AA5 - AA7.

**Note:** Conduit bodies are suitable for use in Class I, Div. 2 hazardous locations per NEC Section 501-4(B).

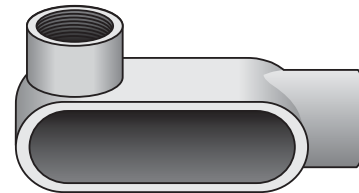
Trade Size (inches)	Catalog Number Gray Iron	Catalog Number Aluminum
1/2	LB17	LB17-SA
3/4	LB27	LB27-SA
1	LB37	LB37-SA
1 1/4	LB47	LB47-SA
1 1/2	LB57	LB57-SA
2	LB67	LB67-SA
2 1/2	LB77	LB77-SA
3	LB87	LB87-SA
3 1/2	LB97	
4	LB107	
1/2	T17	T17-SA
3/4	T27	T27-SA
1	T37	T37-SA
1 1/4	T47	T47-SA
1 1/2	T57	T57-SA
2	T67	T67-SA
2 1/2	T77	
3	T87	
3 1/2	T97	
4	T107	
1/2	LL17	LL17-SA
3/4	LL27	LL27-SA
1	LL37	LL37-SA
1 1/4	LL47	LL47-SA
1 1/2	LL57	LL57-SA
2	LL67	LL67-SA
2 1/2	LL77	
3	LL87	
3 1/2	LL97	
4	LL107	
1/2	LR17	LR17-SA
3/4	LR27	LR27-SA
1	LR37	LR37-SA
1 1/4	LR47	LR47-SA
1 1/2	LR57	LR57-SA
2	LR67	LR67-SA
2 1/2	LR77	
3	LR87	
3 1/2	LR97	
4	LR107	



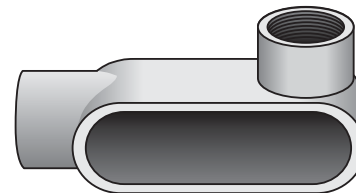
Type LB



Type T



Type LL



Type LR

# Form 7 Conduit Bodies

## For Rigid Conduit & IMC

### Types TB, TA, X, C, L, E

#### Use:

To provide access to conductors for pulling, splicing, maintenance and future changes/upgrades. Allows connection of straight conduit runs, branch conduit runs and 90° bends.

#### Features:

- Tapered threaded hubs (NPT).
- Flat back design for greater wiring capacity and surface mounting.
- Complete interchangeability with other manufacturers' Form 7 conduit bodies.
- Internal volume and maximum wire clearly marked on castings.
- Time-saving Clip-on™ covers in steel, gray iron or aluminum.
- For covers and gaskets, see Page - AA3 and AA4.

#### Material/Finish:

- Gray Iron/Zinc Electroplated/Aluminum Enamel
- Copper-free Aluminum/Aluminum Enamel

#### Optional Finish:

For additional corrosion protection, specify Hot Dip Galvanized. Add suffix "G" to Gray Iron catalog number. Contact your local representative for pricing and availability.

#### Third Party Certification:



UL Listed: E-18095  
Suitable for wet locations when used with gasketed covers.



CSA Certified: 009795  
Suitable for wet locations when used with gasketed covers.

#### Applicable Third Party Standards:

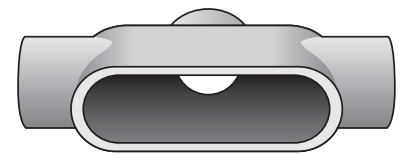
UL Standard: 514A  
CSA Standard: C22.2 No. 18  
Fed. Spec: A-A-50563  
NEMA: FB-1, FB-2.10

#### Dimensional Data:

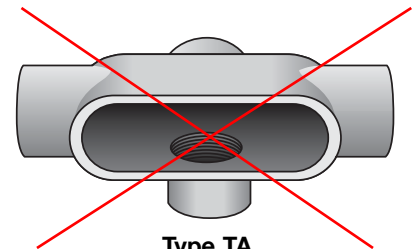
See Pages AA5 - AA7.

**Note:** Conduit bodies are suitable for use in Class I, Div. 2 hazardous locations per NEC Section 501-4(B).

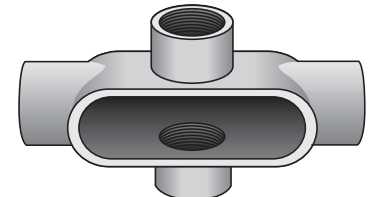
Trade Size (inches)	Catalog Number Gray Iron	Catalog Number Aluminum
½	TB17	TB17-SA
¾	TB27	TB27-SA
1	TB37	TB37-SA
1¼	TB47	TB47-SA
1½	TB57	TB57-SA
2	TB67	TB67-SA
½	TA17	
¾	TA27	
1	TA37	
1¼	TA47	
1½	TA57	
2	TA67	
½	X17	X17-SA
¾	X27	X27-SA
1	X37	X37-SA
1¼	X47	
1½	X57	X57-SA
2	X67	
½	C17	C17-SA
¾	C27	C27-SA
1	C37	C37-SA
1¼	C47	C47-SA
1½	C57	C57-SA
2	C67	C67-SA
2½	C77	C77-SA
3	C87	C87-SA
½	L17	
¾	L27	
1	L37	
1¼	L47	
1½	L57	
2	L67	
½	E17	E17-SA
¾	E27	E27-SA
1	E37	E37-SA



Type TB



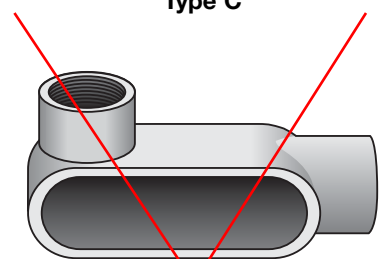
Type TA



Type X



Type C



Type L

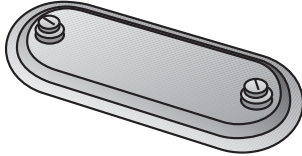
(Provided with one blank steel cover)



Type E

# Clip-on™ Stamped Steel and Aluminum Covers and Separate Gaskets

For Form 7 Conduit Bodies



Type 170

## Type 170 Stamped Steel and Aluminum Clip-on™ Cover

### Use:

To cover conduit body opening.

### Features:

- Centering tabs
- Easy installation
- Easy removal
- Nylon sealing washers

### Material/Finish:

Stamped Steel/Zinc Pre-Galvanized  
Stainless Steel Screws  
Zinc Electroplated Clips

### Optional Material:

Aluminum add suffix -SA as shown below

### Third Party Certification:



UL Listed: E-18095

Suitable for wet locations when used with gaskets, Type GASK on Form 7 conduit bodies.



CSA Certified: 009795

Suitable for wet locations when used with gaskets, Type GASK on Form 7 conduit bodies.

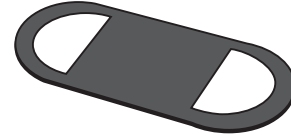
### Applicable Third Party Standards:

UL Standard: 514A

CSA Standard: C22.2 No. 18

Fed. Spec: A-A-50563

NEMA: FB-1, FB-2.10



Type GASK

## Type GASK Solid Cover Gasket

### Use:

To provide a worry-free, rain tight seal when used with Type 170 or 170F covers that have heavy-duty cover screw washers.

### Material:

Closed-Cell Neoprene.  
Temperature Rating: 212°F/100°C.

**Note:** UL/CSA not applicable.

Trade Size (inches)	Catalog Number Steel	Catalog Number Aluminum
1/2	170	170-SA
3/4	270	270-SA
1	370	370-SA
1 1/4	470	470-SA
1 1/2	570	570-SA
2	670	670-SA
2 1/2-3	870	870-SA
3 1/2-4	970	970-SA

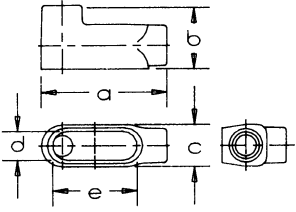
Trade Size (inches)	Catalog Number
1/2	GASK571
3/4	GASK572
1	GASK573
1 1/4	GASK574
1 1/2	GASK575
2	GASK576
2 1/2-3	GASK578
3 1/2-4	GASK579

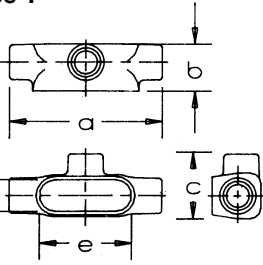


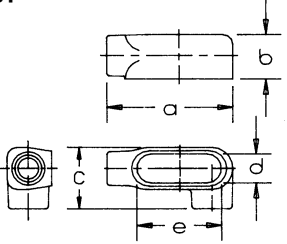
# Form 7 Conduit Bodies

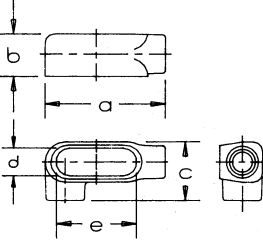
For Rigid Conduit & IMC

## Dimensional Data:

Type LB	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	LB17	1/2	4 9/16	2 1/4	1 3/8	1 15/16	3 3/16	4	N/A
	LB27	3/4	5 5/16	2 1/2	1 1/8	1 1/8	3 13/16	6.9	3 #6AWG
	LB37	1	6	2 5/8	1 1/4	1 1/4	4 1/2	10.5	3 #4AWG
	LB47	1 1/4	6 1/2	3 5/16	2 3/16	1 3/4	5	19.3	3 #3AWG
	LB57	1 1/2	7 1/8	3 11/16	2 7/16	1 15/16	5 7/16	26.5	3 #1AWG
	LB67	2	8 3/8	4 1/4	3	2 7/16	6 3/8	46	3 #1/0AWG
	LB77	2 1/2	10 1/2	5 5/8	4 1/4	3 3/16	8 3/8	102	3 #3/0AWG
	LB87	3	10 1/2	5 5/8	4 1/4	3 3/16	8 3/8	126	3 #3/0AWG
	LB97	3 1/2	12 11/16	6 3/16	5 1/4	4 1/2	10 1/4	210	3 #300MCM
	LB107	4	12 11/16	7 1/8	5 1/4	4 1/2	10 1/4	238	3 #300MC

Type T	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	T17	1/2	5 5/8	1 3/4	2 7/16	1 5/16	3 3/16	6	N/A
	T27	3/4	6 1/4	2	2 5/8	1 1/8	3 13/16	19.5	3 #6AWG
	T37	1	7 1/4	2 1/4	3	1 1/8	4 1/2	15	3 #4AWG
	T47	1 1/4	7 7/16	2 3/16	3 3/16	1 1/4	5	20	3 #3AWG
	T57	1 1/2	8 3/16	2 3/16	3 3/16	1 15/16	5 7/16	27	3 #2AWG
	T67	2	9 3/16	3 3/8	4 1/8	2 7/16	6 3/8	50	3 #2AWG
	T77	2 1/2	12	3 3/8	5 3/4	3 3/16	8 3/8	102	3 #1/0AWG
	T87	3	12 1/16	4 3/8	5 3/4	3 3/16	8 3/8	126	3 #1/0AWG
	T97	3 1/2	14 7/16	4 3/8	6 15/16	4 1/2	10 1/4	210	3 #3/0AWG
	T107	4	14 7/16	5 3/8	6 15/16	4 1/2	10 1/4	238	3 #3/0AWG

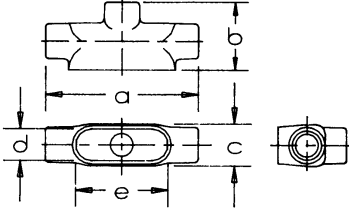
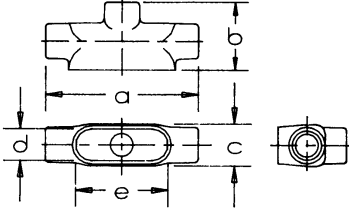
Type LL	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	LL17	1/2	4 9/16	1 3/8	2 1/4	1 5/16	3 3/16	4	N/A
	LL27	3/4	5 5/16	1 3/8	2 7/16	1 1/8	3 13/16	6.9	3 #6AWG
	LL37	1	6	1 3/8	2 3/4	1 3/8	4 1/2	10.5	3 #4AWG
	LL47	1 1/4	6 1/2	2 3/16	3 3/16	1 3/4	5	19.5	3 #2AWG
	LL57	1 1/2	7 1/8	2 3/16	3 3/16	1 15/16	5 7/16	27	3 #2AWG
	LL67	2	8 3/8	3 3/8	4 1/8	2 7/16	6 3/8	50	3 #3/0AWG
	LL77	2 1/2	10 1/2	3 3/8	5 3/4	3 3/16	8 3/8	102	3 #250MCM
	LL87	3	10 1/2	4 3/8	5 3/4	3 3/16	8 3/8	126	3 #250MCM
	LL97	3 1/2	12 11/16	4 3/8	6 15/16	4 1/2	10 1/4	210	3 #350MCM
	LL107	4	12 11/16	5 3/8	6 15/16	4 1/2	10 1/4	238	3 #350MCM

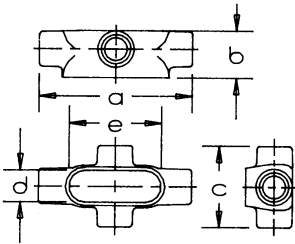
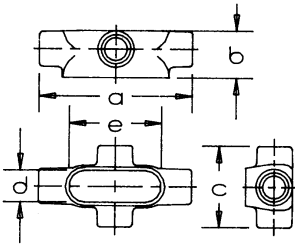
Type LR	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	LR17	1/2	4 9/16	1 3/8	2 1/4	1 5/16	3 3/16	4	N/A
	LR27	3/4	5 5/16	1 3/8	2 7/16	1 1/8	3 13/16	6.9	3 #6AWG
	LR37	1	6	1 3/8	2 3/4	1 3/8	4 1/2	10.5	3 #4AWG
	LR47	1 1/4	6 1/2	2 3/16	3 3/16	1 3/4	5	19.5	3 #2AWG
	LR57	1 1/2	7 1/8	2 3/16	3 3/16	1 15/16	5 7/16	27	3 #2AWG
	LR67	2	8 3/8	3 3/8	4 1/8	2 7/16	6 3/8	50	3 #3/0AWG
	LR77	2 1/2	10 1/2	3 3/8	5 3/4	3 3/16	8 3/8	102	3 #250MCM
	LR87	3	10 1/2	4 3/8	5 3/4	3 3/16	8 3/8	126	3 #250MCM
	LR97	3 1/2	12 11/16	4 3/8	6 15/16	4 1/2	10 1/4	210	3 #350MCM
	LR107	4	12 11/16	5 3/8	6 15/16	4 1/2	10 1/4	238	3 #350MCM

# Form 7 Conduit Bodies

For Rigid Conduit & IMC

## Dimensional Data:

Type TB	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	TB17	1/2	5 5/8	2 5/8	1 1/8	1 5/16	3 3/16	6	N/A
	TB27	3/4	6 1/4	2 7/8	1 1/8	1 1/8	3 13/16	9.5	3 #6AWG
	TB37	1	7 1/4	3 1/4	2	1 1/8	4 1/2	15	3 #4AWG
	TB47	1 1/4	7 7/16	3 5/16	2 3/16	1 3/4	5	20	3 #3AWG
	TB57	1 1/2	8 9/16	3 5/8	2 7/16	1 15/16	5 7/16	27	3 #2AWG
	TB67	2	9 9/16	4 1/4	3	2 1/16	6 3/8	50	3 #2AWG

Type X	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	X17	1/2	5 5/8	1 1/4	3 5/16	1 5/16	3 3/16	6	N/A
	X27	3/4	6 1/4	2	3 1/2	1 1/8	3 13/16	9.5	3 #6AWG
	X37	1	7 1/4	2 1/4	3 7/8	1 1/8	4 1/2	15	3 #4AWG
	X47	1 1/4	7 7/16	2 5/16	4 1/8	1 3/4	5	20	3 #3AWG
	X57	1 1/2	8 9/16	2 9/16	4 5/8	1 15/16	5 7/16	27	3 #2AWG
	X67	2	9 9/16	3 3/8	5 7/16	2 1/16	6 3/8	50	3 #2AWG

# Form 7 Conduit Bodies

For Rigid Conduit & IMC

## Dimensional Data:

Type C	Catalog Number	Trade Size	Dimensions in Inches					Volume Cu. In.	Max No. Conductors
			a	b	c	d	e		
	C17	1/2	5 <sup>3</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	4	N/A
	C27	3/4	6	1 <sup>5</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	3 <sup>3</sup> / <sub>16</sub>	6.9	3 #6AWG
	C37	1	7	1 <sup>7</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>2</sub>	10.5	3 #4AWG
	C47	1 <sup>1</sup> / <sub>4</sub>	7 <sup>7</sup> / <sub>16</sub>	2 <sup>5</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	5	20	3 #3AWG
	C57	1 <sup>1</sup> / <sub>2</sub>	8 <sup>3</sup> / <sub>16</sub>	2 <sup>7</sup> / <sub>16</sub>	2 <sup>7</sup> / <sub>16</sub>	1 <sup>19</sup> / <sub>16</sub>	5 <sup>7</sup> / <sub>16</sub>	27	3 #2AWG
	C67	2	9 <sup>3</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>8</sub>	3	2 <sup>7</sup> / <sub>16</sub>	6 <sup>3</sup> / <sub>8</sub>	50	3 #1/0AWG
	C77	2 <sup>1</sup> / <sub>2</sub>	12	3 <sup>3</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>16</sub>	8 <sup>3</sup> / <sub>8</sub>	102	3 #2/0AWG
	C87	3	12	4 <sup>3</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>4</sub>	3 <sup>9</sup> / <sub>16</sub>	8 <sup>3</sup> / <sub>8</sub>	126	3 #2/0AWG

# Set Screw and Non-Set Screw Insulated Grounding Bushings for Threadless/Threaded Rigid Metal Conduit/IMC

GIB-LS-AC and GIB-L-AC Series - with Aluminum Lay-In-Lug™ for Copper or Aluminum Conductors.

GIB-LS-BC and GIB-L-BC Series - with Bronze Lay-In-Lug™ for Copper Conductors Only.

## Applications

- GIB-LS Series insulated bushings fasten and ground threadless rigid metal conduit to an enclosure.
- GIB-L Series insulated bushings fasten and ground threaded rigid metal conduit to an enclosure.
- Can be used with a locknut to terminate conduit at an enclosure.
- Lug used to connect bonding jumper to a neutral bus bar.

## Features

- Temperature rating 150 °C.
- Insulating liner material is self-extinguishing.
- The plastic liner is tough. It won't chip, crack, swell or shrink. It resists corrosion, chemicals and temperature extremes. Surface friction is so low that wires can be pulled with virtually no abrasion on the cable insulation.

- GIB-LS Series is provided with a set-screw allowing fitting to lock bushing in any desired position.
- UL listed for use with copper or aluminum grounding conductors.
- Lugs not sold separately.

## Material/Finish

- Body: malleable iron/zinc plated
- Lug: aluminum/tin plated or bronze/bright dip
- Clamping and set screw: steel/zinc plated

## Certifications and Compliances

- UL Standard: 467
- UL Listed: E6581
- CSA Standard: C22.2 No. 41
- NEMA: FB-1

## Carlton® Rigid Nonmetallic Conduit (RNC), Fittings & Accessories

Carlton® manufactures the most complete line of nonmetallic conduits and fittings in the electrical industry. Carlton Schedule 40 and Schedule 80 conduits are designed for use aboveground and underground as described in the National Electrical Code. Specify only Carlton conduits and fittings to insure raceway system integrity.

### Features

**Ease of Installation** Nonmetallic conduits are 1/4 to 1/5 the weight of metallic systems, can be installed in less than half the time, and are easily fabricated on the job.

**Safety** Nonmetallic conduits are nonconductive, assuring a safe system.

**Impact Resistant** Carlton Schedule 40 and Schedule 80 nonmetallic conduits are resistant to sunlight and are listed for exposed or outdoor usage. The use of expansion fittings allows the system to expand and contract with temperature variations.

**Corrosion Resistant** Carlton conduits and fittings are nonmetallic and will not rust or corrode.

Carlton nonmetallic Schedule 40 and Schedule 80 conduits and elbows are manufactured to NEMA TC-2, Federal specification WC1094A and UL 651 specifications. Fittings are manufactured to NEMA TC-3, Federal specification WC1094A and UL514B. Both conduit and fittings carry respective UL or ETL Listings and UL or ETL labels.

## Schedule 40 PVC Rigid Nonmetallic Conduit (RNC). (Heavy Wall EPC)

Listed for underground applications encased in concrete or direct burial. Also for use in exposed or concealed applications aboveground.

- Sunlight resistant
- Rated for use with 90°C conductors
- Superior weathering characteristics



RUS Listed

### Schedule 40 Heavy Wall

With Integral Bell\*



Part No.		Nom. Size	Std. Crate Qty.		Wt. Per 100'	Dimensions		
10'	20'		10'	20'		O.D.	I.D.	Wall
49005-010		1/2"	6000'		17	.840	.622	.109
49007-010	49007-020	3/4"	4400'	8800'	23	1.050	.824	.113
49008-010	49008-020	1"	3600'	7200'	34	1.315	1.049	.133
49009-010	49009-020	1 1/4"	3300'	6600'	46	1.660	1.380	.140
49010-010	49010-020	1 1/2"	2250'	4500'	55	1.900	1.610	.145
49011-010	49011-020	2"	1400'	2800'	73	2.375	2.067	.154
49012-010	49012-020	2 1/2"	930'	1860'	124	2.875	2.469	.203
49013-010	49013-020	3"	880'	1760'	163	3.500	3.068	.216
49014-010	49014-020	3 1/2"	630'	1260'	196	4.000	3.548	.226
49015-010	49015-020	4"	570'	1140'	232	4.500	4.026	.237
49016-010	49016-020	5"	380'	760'	315	5.563	5.047	.258
49017-010	49017-020	6"	260'	520'	409	6.625	6.065	.280

Rigid nonmetallic conduit is normally supplied in standard 10' lengths, with one belled end per length. For specific requirements, it may be produced in lengths shorter or longer than 10', with or without belled ends.

**Use RNC Fittings with Schedule 40 and Schedule 80 Conduit.**

- Notes:**
1. Special fittings and conduit sizes will be quoted on request.
  2. DON'T FORGET TO ORDER CEMENT.
  3. Carlton reserves the right to ship to the nearest unitized quantity.



# Schedule 40 Conduit - Bell End



Meets specifications UL 651 and NEMA TC 2  
 Rated for 90° C Cable  
 Sunlight Resistant  
 10' Lengths



## Schedule 40 Conduit Belled End 10' Lengths



Part No.	Size	O.D.	I.D.	Min. Wall	Bell Depth	Approx. Wt/Ft	Feet per Pack
A52AE12	1/2	.840	.622	.109	1.750	.162	6,000
A52AE12H	1/2	.840	.622	.109	1.750	.162	3,000
A52AG12	3/4	1.050	.824	.113	2.000	.216	4,400
A52AG12H	3/4	1.050	.824	.113	2.000	.216	2,200
A52BA12	1	1.315	1.049	.133	2.250	.320	3,600
A52BA12H	1	1.315	1.049	.133	2.250	.320	1,800
A52BC12	1-1/4	1.660	1.380	.140	2.500	.434	3,300
A52BC12H	1-1/4	1.660	1.380	.140	2.500	.434	1,650
A52BE12	1-1/2	1.900	1.610	.145	2.750	.520	2,250
A52BE12H	1-1/2	1.900	1.610	.145	2.750	.520	1,130
A52CA12	2	2.375	2.067	.154	3.250	.699	1,400
A52CE12	2-1/2	2.875	2.469	.203	3.500	1.108	930
A52DA12	3	3.500	3.068	.216	4.000	1.450	880
A52DE12	3-1/2	4.000	3.548	.226	4.250	1.744	630
A52EA12	4	4.500	4.026	.237	4.750	2.067	570
A52FA12	5	5.563	5.047	.258	5.750	2.801	380
A52GA12	6	6.625	6.065	.280	6.325	3.636	260
A52JA12	* 8	8.652	7.981	.322	6.500	5.474	180

\* Non UL

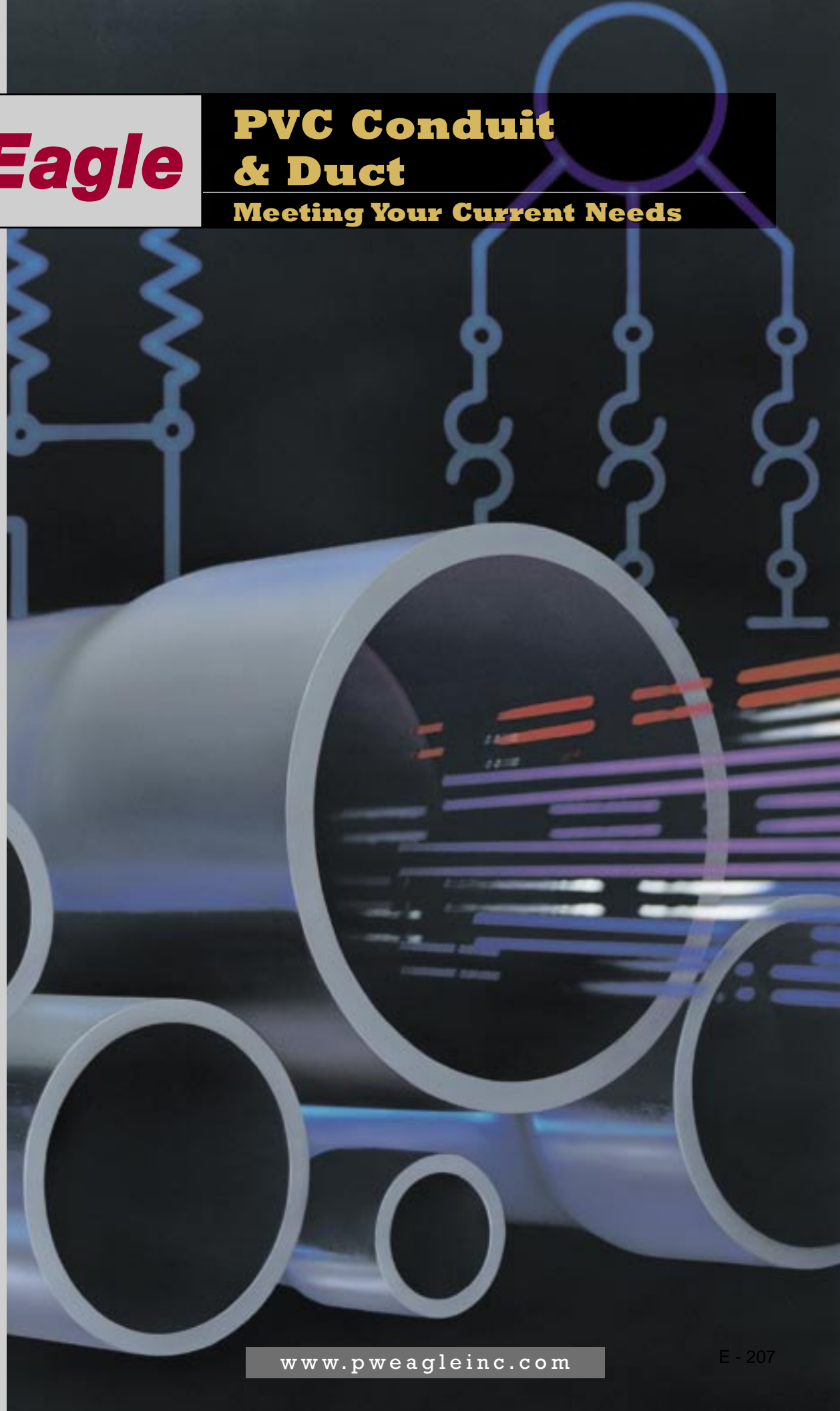
**Note:** 20' length available on request

Schedule 40 conduit complies with federal and military specifications by conforming to UL 651.

**PWEagle**

**PVC Conduit  
& Duct**

**Meeting Your Current Needs**



**PWEagle**

Electrical  
Products

**You'll find PW Eagle's complete line of conduit, duct, and fittings ideal for a variety of aboveground and underground power and communication applications—including fiber optics.**

Choose Schedule 40 PVC conduit in sizes 1/2" through 6" or Schedule 80 in sizes 1/2" through 6". Also 1" through 6" Direct Burial Duct and 2" through 6" Encased Burial Duct and Communication Duct. Plus, PW Eagle supplies an extensive line of fittings to complete even the most complex installation.

**PW Eagle defines responsive: We'll ship your order in 72 hours or less.**

We've devoted three West Coast manufacturing locations to producing PVC electrical conduit and duct. Wherever in the Western United States you've got a demanding electrical job to do—PW Eagle's ready to deliver.

**PW Eagle is dedicated to continual improvement.**

Meeting nationally recognized product standards is only the starting point for PW Eagle. Continual improvement teams of technical and production personnel operate in every PW Eagle manufacturing plant to assure you of minimum product variability and maximum product reliability.



Added value for our loyal customers is the driving force for PW Eagle quality.

All PW Eagle products are warranted to meet all applicable material specifications and to be free from defect in materials and workmanship.

Your purchase of PW Eagle conduit and duct buys you far more than long-lasting, top-grade PVC pipe. You're buying dedication to quality, a wealth of trained employees, well-equipped testing laboratories, and sophisticated manufacturing facilities. You're buying our pride in the name PW Eagle.



**Integrated Quality.** PW Eagle employs a comprehensive product quality program that includes on-line statistical control monitoring as well as off-line product testing. In addition, Quality and Process Analysts in each manufacturing plant operate as team members with production management to assure product quality throughout PW Eagle.



**Polyvinyl chloride's unique qualities offer unequalled ease of installation.**

PVC conduit and duct is exceptionally simple to install. PW Eagle PVC conduit cuts easily with a sharp handsaw or PVC cutter, and is securely joined by solvent cement.

**PW Eagle PVC lasts nearly forever.**

Our rigid, non-conducting PVC is immune to almost all types of corrosives—chemical, biological, or electrochemical—encountered in either underground or aboveground systems. PW Eagle's UL listed conduit conforms to UL's sunlight resistance requirements.



*Every length of PW Eagle PVC conduit and duct includes an integral bell end which is simple to install using easy-to-apply solvent cement.*

<b>Schedule 40 Conduit - UL Listed</b>				
Conforms to NEMA TC 2, UL 651				
Trade Size	Average Outside Diameter (inches)	Approximate Inside Diameter (inches)	Minimum Wall Thickness (inches)	Approximate Weight (lbs/100')
½	0.840	0.60	0.109	16
¾	1.050	0.80	0.113	22
1	1.315	1.03	0.133	32
1 ¼	1.660	1.36	0.140	46
1 ½	1.900	1.59	0.145	54
2	2.375	2.04	0.154	73
2 ½	2.875	2.44	0.203	120
3	3.500	3.03	0.216	170
3 ½	4.000	3.51	0.226	200
4	4.500	3.99	0.237	230
5	5.563	5.01	0.258	320
6	6.625	6.02	0.280	412

**PW Eagle PVC handles easily.**

A length of PVC conduit or duct weighs only one-fifth as much as galvanized steel conduit—one-half the weight of aluminum. A full line of fittings makes it easy to connect a PW Eagle PVC system to any other.



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# **CONDUIT SUPPORTS**

**Operations & Maintenance Manual  
December 2015**

# Metal Framing Channels

## Channel

B-Line's metal framing channel is cold formed on our modern rolling mills from 12 Ga. (2.6mm), 14 Ga. (1.9mm), and 16 Ga. (1.5mm) low carbon steel strips. A continuous slot with inturned lips provides the ability to make attachments at any point.

## Lengths

Standard lengths are 10' (3.05m) and 20' (6.09m) with length tolerance of  $\pm 1/8"$  (+3.2mm). Custom lengths are available upon request.

## Slots

B-Line's slotted series of channels offer full flexibility. A variety of pre-punched slot patterns eliminate the need for precise field measuring for hole locations. Slots offer wide adjustments in the alignment and bolt sizing.

## Holes

A variety of pre-punched  $9/16"$  (14.3 mm) diameter hole patterns are available in B-Line channels. These hole patterns provide an economical alternative to costly field drilling required for many applications.

## Knockouts

When used with series B217-20 Closure Strips, B-Line's knockout channels can be used to provide an economical U.L. listed surface raceway. Channels are furnished with  $7/8"$  (22.2 mm) knockouts on 6" (152 mm) centers, allowing for perfect fixture alignment on spans up to 20' (6.09 m).

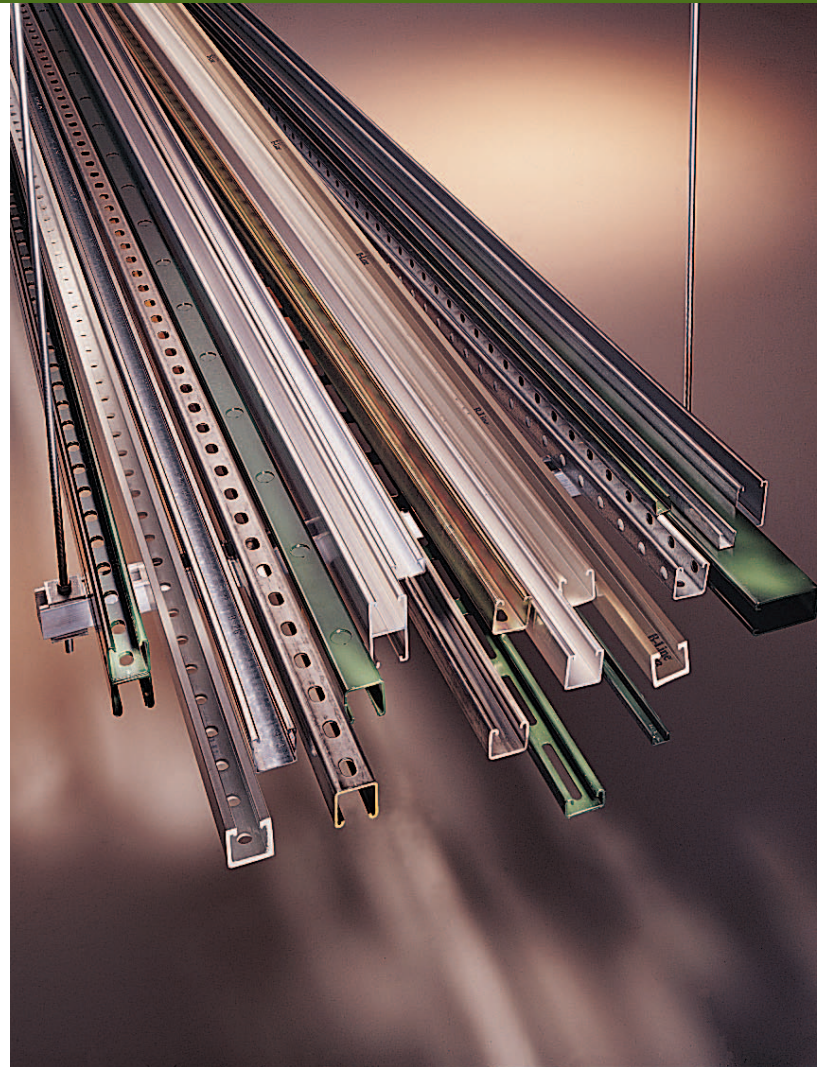
## Materials & Finishes (Unless otherwise noted)

### Steel: Plain

12 Ga. (2.6), 14 Ga. (1.9) and 16 Ga. (1.5)

### Steel: Pre-galvanized

12 Ga. (2.6), 14 Ga. (1.9) and 16 Ga. (1.5)



Finish Code	Finish	Specification
PLN	Plain	ASTM A1011, 33,000 PSI min. yield
GRN	Dura-Green	
GALV	Pre-Galvanized	ASTM A653 33,000 PSI min. yield
HDG	Hot-Dipped Galvanized	ASTM A123
YZN	Yellow Zinc Chromate	ASTM B633 SC3 Type II
SS4	Stainless Steel Type 304	ASTM A240
SS6	Stainless Steel Type 316	ASTM A240
AL	Aluminum	Aluminum 6063-T6

Note: A minimum order may apply on special material and finishes.

## Design Load

The design loads given for strut beam loads are based on a simple beam condition using an allowable stress of 25,000 psi. This allowable stress results in a safety factor of 1.68. This is based upon virgin steel minimum yield strength of 33,000 psi cold worked during rolling to an average yield stress of 42,000 psi.

## Welding

Weld spacing is maintained between 2 $1/2$  inches (63.5 mm) and 4 inches (101.6 mm) on center. Through high quality control testing of welded channels and continuous monitoring of welding equipment, B-Line provides the most consistent combination channels available today.

## Metric

Metric dimensions are shown in parentheses. Unless noted, all metric dimensions are in millimeters.

## SELECTION CHART

for Channels, Materials and Hole Patterns

Channel Type	Channel Dimensions				Material & Thickness *				Channel Hole Pattern **				
	Height		Width		Steel	Alum.	Stainless Steel		SH 9/16" x 1 1/8" slots on 2" centers	S 1 3/32" x 3" slots	H17/8 9/16" diameter holes	TH 9/16" diameter on 1 7/8" centers	KO6 7/8" diameter knockouts
							Type 304	Type 316					
				<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>						
B11	3 1/4"	(82.5)	1 5/8"	(41.3)	12 Ga.	-	-	-	<u>1</u>	<u>1</u>	<u>1</u>	-	<u>1</u>
B12	2 7/16"	(61.9)	1 5/8"	(41.3)	12 Ga.	.105	-	-	<u>1 2</u>	<u>1</u>	<u>1 2</u>	-	<u>1 2</u>
B22	1 5/8"	(41.3)	1 5/8"	(41.3)	12 Ga.	.105	12 Ga.	12 Ga.	<u>1 2 3 4</u>	<u>1 3</u>	<u>1 2 3</u>	<u>1</u>	<u>1 2</u>
B24	1 5/8"	(41.3)	1 5/8"	(41.3)	14 Ga.	.080	14 Ga.	14 Ga.	<u>1 2 3 4</u>	<u>1</u>	<u>1 2 3</u>	-	<u>1 2</u>
B26	1 5/8"	(41.3)	1 5/8"	(41.3)	16 Ga.	-	-	-	<u>1</u>	<u>1</u>	<u>1</u>	-	<u>1</u>
B32	1 3/8"	(34.9)	1 5/8"	(41.3)	12 Ga.	-	12 Ga.	-	<u>1 3</u>	<u>1</u>	<u>1 3</u>	-	<u>1</u>
B42	1"	(25.4)	1 5/8"	(41.3)	12 Ga.	-	12 Ga.	-	<u>1 3</u>	<u>1</u>	<u>1 3</u>	-	<u>1</u>
B52	1 3/16"	(20.6)	1 5/8"	(41.3)	12 Ga.	-	12 Ga.	-	<u>1</u>	<u>1</u>	<u>1</u>	-	<u>1</u>
B54	1 3/16"	(20.6)	1 5/8"	(41.3)	14 Ga.	.080	14 Ga.	14 Ga.	<u>1 2 3 4</u>	<u>1</u>	<u>1 2 3 4</u>	-	<u>1 2</u>
B56	1 3/16"	(20.6)	1 5/8"	(41.3)	16 Ga.	-	-	-	<u>1</u>	<u>1</u>	<u>1</u>	-	<u>1</u>
B62	1 3/16"	(20.6)	1 3/16"	(20.6)	18 Ga.	-	-	-	-	-	-	-	-
B72	1 3/32"	(10.3)	1 3/16"	(20.6)	18 Ga.	-	-	-	-	-	-	-	-
E7016	3/4"	(19.0)	5/8"	(15.9)	16 Ga.	-	-	-	-	-	-	-	-

The selection has been prepared to provide a reference for available channel, materials and hole patterns. Material types available for various hole patterns are defined by numbers 1 thru 4.

Some stainless steel channels with hole patterns are available on special order only.

\*Metric equivalent for thicknesses shown in chart.

12 Ga. = 2.6 mm      18 Ga. = 1.2 mm  
 14 Ga. = 1.9 mm      .105 = 2.6 mm  
 16 Ga. = 1.5 mm      .080 = 2.0 mm

\*\*1 - Steel

2 - Aluminum

3 - Type 304 Stainless Steel

4 - Type 316 Stainless Steel

Properties may vary due to commercial tolerances of the material.

Channel Part Numbering			
Example:			
B22 SH SS4 120			
Channel Type	Hole Patterns	Material/Finish	Length
B11	SH (pg. 40)	GRN	120
B12	S (pg. 40)	GALV	240
B22 †	H178 (pg. 40)	HDG	
B24 †	TH (pg. 41)	YZN	
B26	K06 (pg. 41)	SS4	
B32	SHA (pg. 41)	SS6	
B42	S58 (pg. 42)	AL	
B52 †	M (pg. 42)		
B54 †	H25 (pg. 43)		
B56	H112 † (pg. 42)		
B62	* Leave blank for no hole pattern		
B72			
E7016			

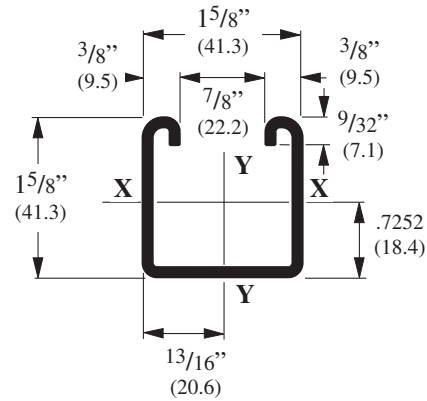
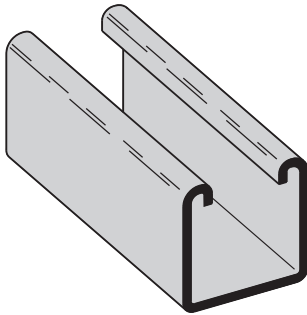
† BK style channel available in four (4) channel sizes and one (1) hole pattern only. (Example BK22H112)

Reference page 14 for general fitting and standard finish specifications.

# B22 Channel

## B22

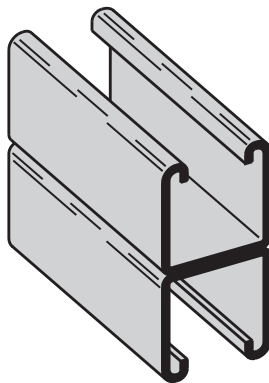
- Thickness: 12 Gauge (2.6 mm)
- Standard lengths: 10' (3.05 m) & 20' (6.09 m)
- Standard finishes: Plain, Dura-Green, Pre-Galvanized, Hot-Dipped Galvanized, Stainless Steel Type 304 or 316, Aluminum
- Weight: 1.90 Lbs./Ft. (2.83 kg/m)



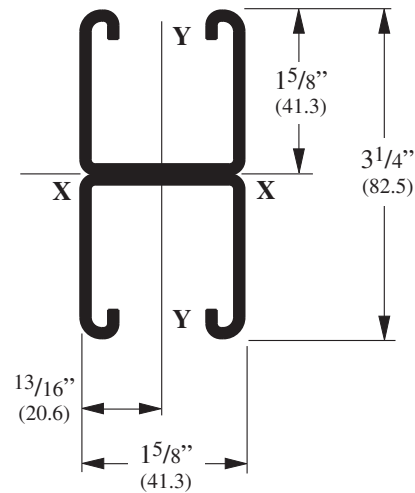
## SECTION PROPERTIES

Channel	Weight lbs./ft.    kg/m	Areas of Section sq. in.    cm <sup>2</sup>		X - X Axis						Y - Y Axis			
				Moment of Inertia (I) in. <sup>4</sup> cm <sup>4</sup>		Section Modulus (S) in. <sup>3</sup> cm <sup>3</sup>		Radius of Gyration (r) in.    cm		Moment of Inertia (I) in. <sup>4</sup> cm <sup>4</sup>		Section Modulus (S) in. <sup>3</sup> cm <sup>3</sup>	
<b>B22</b>	1.910    (2.84)	.562    (3.62)	.1912    (7.96)	.2125    (3.48)	.583    (1.48)	.2399    (9.99)	.2953    (4.84)	.653    (1.66)					
<b>B22A</b>	3.820    (5.69)	1.124    (7.25)	.9732    (40.51)	.5989    (9.81)	.931    (2.36)	.4798    (19.97)	.5905    (9.68)	.653    (1.66)					
<b>B22X</b>	6.649    (9.89)	1.956    (12.62)	4.1484    (172.67)	1.7019    (27.89)	1.456    (3.70)	1.1023    (45.88)	1.2027    (19.71)	.751    (1.91)					

Calculations of section properties are based on metal thicknesses as determined by the AISI Cold-Formed Steel Design Manual.



**B22A**  
Wt. 3.80 Lbs./Ft. (5.65 kg/m)



Reference page 14 for general fitting and standard finish specifications.

# B22 Beam Loading Data

Beam Span In.      mm		Channel Style	Uniform Load and Deflection				Uniform Load @ Deflection = 1/240 Span 1/360 Span			
			Lbs.	N	In.	mm	Lbs.	N	Lbs.	N
12	(305)	<b>B22</b>	2610	(11610)	.014	(.35)	2610	(11610)	2610	(11610)
		<b>B22A</b>	2610*	(11610)	.002	(.05)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.001	(.02)	5790*	(25755)	5790*	(25755)
18	(457)	<b>B22</b>	2269	(10093)	.031	(.79)	2269	(10093)	2269	(10093)
		<b>B22A</b>	2610*	(11610)	.007	(.18)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.003	(.07)	5790*	(25755)	5790*	(25755)
24	(609)	<b>B22</b>	1702	(7571)	.056	(1.42)	1702	(7571)	1702	(7571)
		<b>B22A</b>	2610*	(11610)	.017	(.43)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.008	(.20)	5790*	(25755)	5790*	(25755)
30	(762)	<b>B22</b>	1361	(6054)	.087	(2.21)	1361	(6054)	1294	(5756)
		<b>B22A</b>	2610*	(11610)	.033	(.84)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.017	(.73)	5790*	(25755)	5790*	(25755)
36	(914)	<b>B22</b>	1135	(5049)	.126	(3.20)	1135	(5049)	899	(3999)
		<b>B22A</b>	2610*	(11610)	.057	(1.45)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.029	(.73)	5790*	(25755)	5790*	(25755)
42	(1067)	<b>B22</b>	972	(4323)	.172	(4.37)	972	(4323)	660	(2936)
		<b>B22A</b>	2610*	(11610)	.091	(2.31)	2610*	(11610)	2610*	(11610)
		<b>B22X</b>	5790*	(25755)	.046	(1.17)	5790*	(25755)	5790*	(25755)
48	(1219)	<b>B22</b>	851	(3785)	.224	(5.69)	758	(3372)	505	(2246)
		<b>B22A</b>	2405	(10698)	.125	(3.17)	2405	(10698)	2405	(10698)
		<b>B22X</b>	5790*	(25755)	.068	(1.73)	5790*	(25755)	5790*	(25755)
54	(1371)	<b>B22</b>	756	(3363)	.284	(7.21)	599	(2664)	399	(1775)
		<b>B22A</b>	2138	(9510)	.158	(4.01)	2138	(9510)	2024	(9003)
		<b>B22X</b>	5790*	(25755)	.097	(2.46)	5790*	(25755)	5790*	(25755)
60	(1524)	<b>B22</b>	681	(3029)	.351	(8.91)	485	(2157)	323	(1437)
		<b>B22A</b>	1924	(8558)	.195	(4.95)	1924	(8558)	1640	(7295)
		<b>B22X</b>	5645	(25110)	.130	(3.30)	5645	(25110)	5645	(25110)
66	(1676)	<b>B22</b>	619	(2753)	.424	(10.77)	401	(1784)	267	(1187)
		<b>B22A</b>	1749	(7780)	.236	(5.99)	1749	(7780)	1355	(6027)
		<b>B22X</b>	5132	(22828)	.158	(4.01)	5132	(22828)	5132	(22828)
72	(1829)	<b>B22</b>	567	(2522)	.505	(12.83)	337	(1499)	225	(1001)
		<b>B22A</b>	1603	(7130)	.281	(7.14)	1603	(7130)	1139	(5066)
		<b>B22X</b>	4704	(20924)	.188	(4.77)	4704	(20924)	4704	(20924)
78	(1981)	<b>B22</b>	524	(2331)	.593	(15.06)	287	(1276)	191	(849)
		<b>B22A</b>	1480	(6583)	.330	(8.38)	1455	(6472)	970	(4315)
		<b>B22X</b>	4342	(19314)	.220	(5.59)	4342	(19314)	4270	(18994)
84	(2133)	<b>B22</b>	486	(2162)	.687	(17.45)	248	(1103)	165	(734)
		<b>B22A</b>	1374	(6112)	.383	(9.73)	1255	(5582)	837	(3723)
		<b>B22X</b>	4032	(17935)	.255	(6.48)	4032	(17935)	3682	(16378)
90	(2286)	<b>B22</b>	454	(2019)	.789	(20.04)	216	(961)	144	(640)
		<b>B22A</b>	1283	(5707)	.440	(11.17)	1093	(4862)	729	(3243)
		<b>B22X</b>	3763	(16738)	.293	(7.44)	3763	(16738)	3207	(14265)
96	(2438)	<b>B22</b>	425	(1890)	.898	(22.81)	190	(845)	126	(560)
		<b>B22A</b>	1202	(5347)	.500	(12.70)	961	(4275)	640	(2847)
		<b>B22X</b>	3528	(15693)	.334	(8.48)	3528	(15693)	2819	(12539)
102	(2591)	<b>B22</b>	400	(1779)	1.013	(25.73)	168	(747)	112	(498)
		<b>B22A</b>	1132	(5035)	.565	(14.35)	851	(3785)	567	(2522)
		<b>B22X</b>	3320	(14768)	.377	(9.57)	3320	(14768)	2497	(11107)
108	(2743)	<b>B22</b>	378	(1681)	1.136	(28.85)	150	(667)	100	(445)
		<b>B22A</b>	1069	(4755)	.633	(16.08)	759	(3376)	506	(2251)
		<b>B22X</b>	3136	(13949)	.422	(10.72)	3136	(13949)	2227	(9906)
114	(2895)	<b>B22</b>	358	(1592)	1.266	(32.15)	134	(596)	90	(400)
		<b>B22A</b>	1013	(4506)	.706	(17.93)	681	(3029)	454	(2019)
		<b>B22X</b>	2971	(13215)	.471	(11.96)	2971	(13215)	1999	(8892)
120	(3048)	<b>B22</b>	340	(1512)	1.403	(35.63)	121	(538)	81	(360)
		<b>B22A</b>	962	(4279)	.782	(19.86)	615	(2735)	410	(1824)
		<b>B22X</b>	2822	(12553)	.521	(13.23)	2706	(12037)	1804	(8024)

Based on simple beam condition using an allowable design stress of 25,000 psi (172 MPa) in accordance with MFMA, with adequate lateral bracing (see page 11 for further explanation). Actual yield point of cold rolled steel is 42,000 psi. To determine concentrated load capacity at mid span, multiply uniform load by 0.5 and corresponding deflection by 0.8. \*Failure determined by weld shear.

Reference page 14 for general fitting and standard finish specifications.



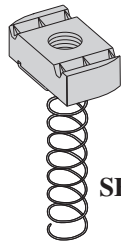
# B22 Column Loading Data

Unbraced Height		Channel Style	Max. Column Loading K = .80				Max. Column Loading (Loaded @ C.G.)					
			Loaded@ C.G.		Loaded@ Slot Face		K = .65		K = 1.0		K = 1.2	
			Lbs.	N	Lbs.	N	Lbs.	N	Lbs.	N	Lbs.	N
In.	mm											
12	(305)	<b>B22</b>	10454	(46502)	4276	(19120)	10598	(47142)	10222	(45470)	9950	(44260)
		<b>B22A</b>	21625	(96193)	7002	(31146)	21677	(96424)	21539	(95810)	21433	(95339)
		<b>B22X</b>	46948	(208835)	18975	(84405)	47061	(209338)	46761	(208003)	46531	(206980)
18	(457)	<b>B22</b>	9950	(44260)	4153	(18473)	10253	(45607)	9481	(42173)	8955	(39834)
		<b>B22A</b>	21433	(95339)	6959	(30955)	21551	(95863)	21239	(94476)	21001	(93417)
		<b>B22X</b>	46531	(206980)	18859	(83899)	46787	(208119)	46110	(205107)	45593	(202808)
24	(609)	<b>B22</b>	9311	(41417)	3993	(17762)	9801	(43597)	8582	(38174)	7801	(34700)
		<b>B22A</b>	21164	(94142)	6898	(30684)	21373	(95072)	20819	(92607)	20397	(90730)
		<b>B22X</b>	45947	(204382)	18693	(84440)	46401	(206402)	45198	(201051)	44282	(196976)
30	(762)	<b>B22</b>	8582	(38174)	3802	(16912)	9268	(41226)	7601	(33811)	6595	(29336)
		<b>B22A</b>	20819	(92607)	6821	(30341)	21145	(94057)	20279	(90205)	19619	(87269)
		<b>B22X</b>	45198	(201051)	18485	(82225)	45906	(204200)	44026	(195837)	42593	(189463)
36	(914)	<b>B22</b>	7801	(34700)	3589	(15964)	8676	(38593)	6595	(28336)	5392	(23985)
		<b>B22A</b>	20397	(90730)	6728	(29927)	20866	(92816)	19619	(87269)	18669	(83044)
		<b>B22X</b>	44282	(196976)	18233	(81104)	45300	(201504)	42593	(189463)	40530	(180286)
42	(1067)	<b>B22</b>	6998	(31128)	3360	(14946)	8048	(35799)	5595	(24888)	4444	(19768)
		<b>B22A</b>	19898	(88511)	6620	(29447)	20537	(91353)	18840	(83804)	17546	(78048)
		<b>B22X</b>	43198	(192154)	17940	(79801)	44586	(198328)	40901	(181937)	38092	(169441)
48	(1219)	<b>B22</b>	6193	(27548)	3118	(13869)	7401	(32921)	4718	(20987)	3791	(16863)
		<b>B22A</b>	19322	(85948)	6496	(28895)	20157	(89663)	17940	(79801)	16251	(72288)
		<b>B22X</b>	41948	(186594)	17604	(78306)	43761	(194568)	38948	(173254)	35281	(156938)
54	(1371)	<b>B22</b>	5392	(23985)	2864	(12740)	6746	(30008)	4090	(18193)	3310	(14723)
		<b>B22A</b>	18669	(83044)	6263	(27859)	19276	(87745)	16920	(75264)	14782	(65753)
		<b>B22X</b>	40530	(180286)	16973	(75499)	42825	(190495)	36733	(163396)	32092	(142752)
60	(1524)	<b>B22</b>	4718	(20987)	2631	(11703)	6093	(27103)	3616	(16085)	2936	(13060)
		<b>B22A</b>	17940	(79801)	5340	(23753)	19244	(85601)	15781	(70197)	13141	(58454)
		<b>B22X</b>	38948	(173249)	14471	(64370)	41779	(185842)	34260	(152396)	28529	(126903)
66	(1676)	<b>B22</b>	4202	(18691)	2434	(10827)	5441	(24203)	3242	(14421)	2634	(11716)
		<b>B22A</b>	17134	(76216)	4587	(20404)	18712	(83235)	14521	(64592)	11328	(50389)
		<b>B22X</b>	37198	(165465)	12431	(55296)	40624	(180704)	31525	(140230)	24593	(109395)
72	(1829)	<b>B22</b>	3791	(16863)	2264	(10071)	4869	(21658)	2936	(13060)	2381	(10591)
		<b>B22A</b>	16251	(72288)	3968	(17650)	18129	(80642)	13141	(58454)	9524	(42365)
		<b>B22X</b>	35281	(156938)	10753	(47832)	39358	(175073)	28529	(126903)	20676	(91971)
78	(1981)	<b>B22</b>	3456	(15373)	2116	(9412)	4412	(19625)	2680	(11921)	2166	(9635)
		<b>B22A</b>	15291	(68018)	3456	(15373)	17496	(77826)	11642	(51786)	8115	(36097)
		<b>B22X</b>	33197	(147667)	9366	(41662)	37984	(168961)	25275	(112429)	17617	(78364)
84	(2133)	<b>B22</b>	3176	(14127)	1984	(8825)	4037	(17957)	2461	(10947)	1980	(8807)
		<b>B22A</b>	14255	(63409)	3028	(13469)	16812	(74783)	10076	(44820)	6998	(31128)
		<b>B22X</b>	30947	(137659)	8206	(36502)	36499	(162355)	21875	(97305)	15192	(67577)
90	(2286)	<b>B22</b>	2936	(13060)	1867	(8305)	3724	(16565)	2270	(10097)	1816	(8078)
		<b>B22A</b>	13141	(58454)	2667	(11863)	16077	(71514)	8778	(39046)	6096	(27116)
		<b>B22X</b>	28529	(126903)	7227	(32147)	34903	(155256)	19057	(84770)	13234	(58868)
96	(2438)	<b>B22</b>	2728	(16583)	1761	(7833)	3456	(15373)	2101	(9346)	1671	(7433)
		<b>B22A</b>	11951	(53160)	2359	(10493)	15291	(68018)	7715	(34318)	5357	(23829)
		<b>B22X</b>	25945	(115409)	6393	(28437)	33197	(147667)	16749	(74503)	11630	(51733)
102	(2591)	<b>B22</b>	2545	(11321)	1664	(7402)	3225	(14345)	1951	(8678)	1542**	(6343)
		<b>B22A</b>	10678	(47498)	2093	(9310)	14455	(64299)	6834	(30399)	4746	(21111)
		<b>B22X</b>	23182	(103118)	5672	(25230)	31382	(139594)	14836	(65994)	10303	(45830)
108	(2743)	<b>B22</b>	2381	(10591)	1575	(7006)	3022	(13442)	1816	(8078)	1426**	(68599)
		<b>B22A</b>	9524	(42365)	1867	(8305)	13568	(60353)	6096	(27116)	4233	(18829)
		<b>B22X</b>	20676	(91971)	5059	(22503)	29456	(131027)	13234	(58868)	9190	(40879)
114	(2895)	<b>B22</b>	2234	(9937)	1494	(6645)	2842	(12642)	1694	(7535)	1322**	(5880)
		<b>B22A</b>	8548	(38023)	1675	(7451)	12630	(56181)	5471	(24336)	3799**	(16899)
		<b>B22X</b>	18558	(82550)	4539	(20190)	27420	(121970)	11877	(52831)	8247	(36684)
120	(3048)	<b>B22</b>	2101	(9346)	1418	(6307)	2680	(11921)	1583**	(7041)	1228**	(5462)
		<b>B22A</b>	7715	(34318)	1512	(6726)	11642	(51786)	4937	(21961)	3429**	(15253)
		<b>B22X</b>	16749	(74503)	4097	(18224)	25275	(112429)	10718	(47676)	7444	(33112)

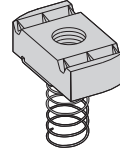
\*\*Where the slenderness ratio  $\frac{KL}{r}$  exceeds 200, and K = end fixity factor, L = actual length and r = radius of gyration.

Reference page 14 for general fitting and standard finish specifications.

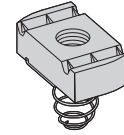
Note: See page 50 for resistance to slip & page 51 for pull-out strength.



**700  
SERIES**



**200  
SERIES**



**500  
SERIES**

## SPRING NUT

Part No.	Thread Size	Fits Channel Sizes	Nut Thickness		Wt./C	
					Lbs.	kg
N721	#8-32	B11 & B12	1/4"	(6.3)	7.0	(3.17)
N221	#8-32	B22, B24, B26, B32	1/4"	(6.3)	7.0	(3.17)
N521	#8-32	B42, B52, B54, B56	1/4"	(6.3)	7.0	(3.17)
N727	#10-32	B11 & B12	1/4"	(6.3)	7.0	(3.17)
N227	#10-32	B22, B24, B26, B32	1/4"	(6.3)	7.0	(3.17)
N527	#10-32	B42, B52, B54, B56	1/4"	(6.3)	7.0	(3.17)
N722	#10-24	B11 & B12	1/4"	(6.3)	7.0	(3.17)
N222	#10-24	B22, B24, B26, B32	1/4"	(6.3)	7.0	(3.17)
N522	#10-24	B42, B52, B54, B56	1/4"	(6.3)	7.0	(3.17)
N724	1/4-20	B11 & B12	1/4"	(6.3)	6.7	(3.04)
N224	1/4-20	B22, B24, B26, B32	1/4"	(6.3)	6.7	(3.04)
N524	1/4-20	B42, B52, B54, B56	1/4"	(6.3)	6.7	(3.04)
N723	5/16-18	B11 & B12	1/4"	(6.3)	6.7	(3.04)
N223	5/16-18	B22, B24, B26, B32	1/4"	(6.3)	6.7	(3.04)
N523	5/16-18	B42, B52, B54, B56	1/4"	(6.3)	6.7	(3.04)
N728	3/8-16	B11 & B12	3/8"	(9.5)	9.3	(4.22)
N228	3/8-16	B22, B24, B26, B32	3/8"	(9.5)	9.3	(4.22)
N528	3/8-16	B42, B52, B54, B56	3/8"	(9.5)	9.3	(4.22)
N726	7/16-14	B11 & B12	3/8"	(9.5)	8.8	(3.99)
N226	7/16-14	B22, B24, B26, B32	3/8"	(9.5)	8.8	(3.99)
N526	7/16-14	B42, B52, B54, B56	3/8"	(9.5)	8.8	(3.99)
N725	1/2-13	B11 & B12	1/2"	(12.7)	11.6	(5.26)
N225	1/2-13	B22, B24, B26, B32	1/2"	(12.7)	11.6	(5.26)
N525	1/2-13	B42, B52, B54, B56	3/8"	(9.5)	8.8	(3.99)
N755	5/8-11	B11 & B12	1/2"	(12.7)	16.4	(7.44)
N255	5/8-11	B22, B24, B26, B32	1/2"	(12.7)	16.4	(7.44)
N555	5/8-11	B42, B52, B54, B56	3/8"	(9.5)	10.2	(4.62)
N775	3/4-10	B11 & B12	1/2"	(12.7)	14.5	(6.58)
N275	3/4-10	B22, B24, B26, B32	1/2"	(12.7)	14.5	(6.58)
N575	3/4-10	B42, B52, B54, B56	3/8"	(9.5)	8.8	(3.99)
N778	7/8-9	B11 & B12	1/2"	(12.7)	12.5	(5.67)
N278	7/8-9	B22, B24, B26, B32	1/2"	(12.7)	12.5	(5.67)

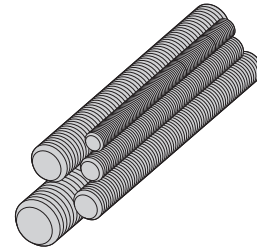
# Hardware

## ATR

### ALL THREADED ROD

- Available in 36" (91.4 cm), 72" (182.9 cm), 120" (304.8 cm), 144" (365.7 cm) lengths
- Safety Factor of 5 on recommended load
- Standard finish: Zinc-Plated, Stainless Steel Type 304

Part No. & Size	Threads Per Inch	Recommended Load		Wt./C Ft. (3048.0 cm)	
		Lbs.	kN	Lbs.	kg
ATR 1/4"	20	240	(1.07)	12	(5.44)
ATR 5/16"	18	400	(1.78)	19	(8.62)
ATR 3/8"	16	730	(3.24)	29	(13.15)
ATR 1/2"	13	1350	(6.00)	53	(24.04)
ATR 5/8"	11	2160	(9.60)	89	(40.37)
ATR 3/4"	10	3230	(14.37)	123	(55.79)
ATR 7/8"	9	4480	(19.93)	170	(77.11)
ATR 1"	8	5900	(26.24)	225	(102.06)

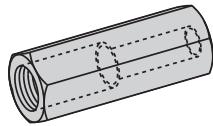
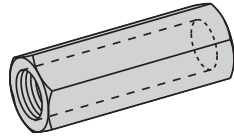


## B655 ROD COUPLING

### B656 REDUCER ROD COUPLING

- Load rating for each coupler meets All Threaded Rod value
- Standard finish: Zinc-Plated, Stainless Steel Type 304

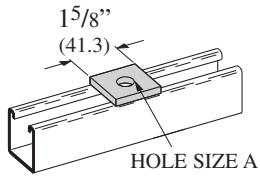
Part No.	Size	Recommended Load		Length		Wt./C	
		Lbs.	kN			Lbs.	kg
B655-1/4	1/4"-20	240	(1.07)	7/8"	(22.2)	1.9	(.86)
B655-5/16	5/16"-18	380	(1.69)	7/8"	(22.2)	1.8	(.81)
B655-3/8	3/8"-16	730	(3.24)	1 1/8"	(28.6)	3.6	(1.63)
B655-1/2	1/2"-13	1350	(6.00)	1 3/4"	(44.4)	11.3	(5.12)
B655-5/8	5/8"-11	1810	(8.05)	2 1/8"	(54.0)	17.6	(7.98)
B655-3/4	3/4"-10	2710	(12.05)	2 1/4"	(57.1)	28.1	(12.74)
B655-7/8	7/8"-9	3770	(16.77)	2 1/2"	(63.5)	57.2	(25.94)
B655-1	1"-8	4960	(22.06)	2 3/4"	(69.8)	73.7	(33.43)



Part No.	Size	Recommended Load		Length		Wt./C	
		Lbs.	kN			Lbs.	kg
B656-3/8 x 1/4	3/8"-16 & 1/4"-20	240	(1.07)	1"	(25.4)	3.7	(1.68)
B656-1/2 x 3/8	1/2"-13 & 3/8"-16	610	(2.71)	1 1/4"	(31.7)	6.6	(2.99)
B656-5/8 x 1/2	5/8"-11 & 1/2"-13	1130	(5.02)	1 1/4"	(31.7)	11.6	(5.26)
B656-3/4 x 5/8	3/4"-10 & 5/8"-11	1810	(8.05)	1 1/2"	(38.1)	20.6	(9.34)
B656-7/8 x 3/4	7/8"-9 & 3/4"-10	2710	(12.05)	1 3/4"	(44.4)	39.4	(17.87)

## B200-B202-2

•Standard finishes: ZN, GRN, HDG, SS4, SS6, AL

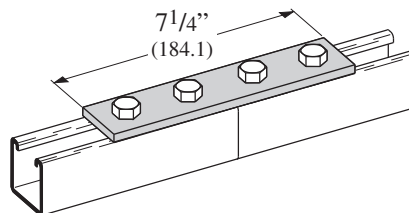


## SQUARE WASHER

Part No.	A	(A)	Bolt Size	Wt./C	
				Lbs.	kg
B200	3/8"	(9.5)	5/16" (7.9)	18	(8.1)
B201	7/16"	(11.1)	3/8" (9.5)	18	(8.1)
B202	9/16"	(14.2)	1/2" (12.7)	17	(7.7)
B202-1	11/16"	(17.4)	5/8" (15.9)	16	(7.2)
B202-2	13/16"	(20.6)	3/4" (19.0)	15	(6.8)

## B341 FOUR HOLE SPLICE PLATE

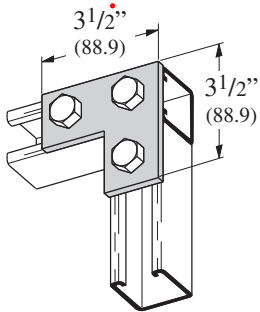
•Standard finishes: ZN, GRN, HDG  
•Wt./C 76 Lbs. (34.5 kg)



Reference page 58 for general fitting and standard finish specifications.

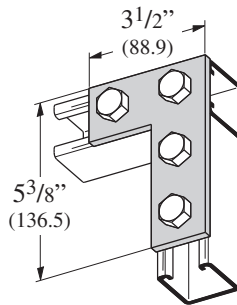
**B140**  
**THREE HOLE CORNER PLATE**

- Standard finishes: ZN, GRN, HDG, SS4
- Wt./C 56 Lbs. (25.4 kg)



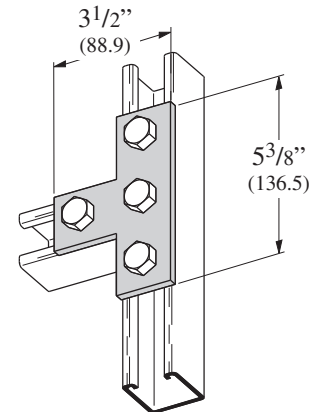
**B143**  
**FOUR HOLE CORNER PLATE**

- Standard finishes: ZN, GRN, HDG, SS4
- Wt./C 75 Lbs. (34.0 kg)



**B133**  
**FOUR HOLE TEE PLATE**

- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 75 Lbs. (34.0 kg)

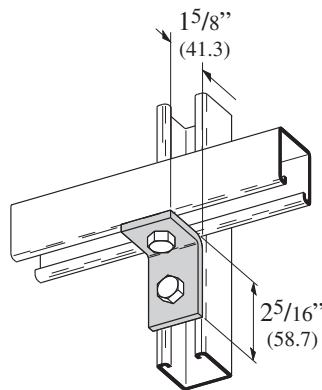




# 90° Angle Fittings

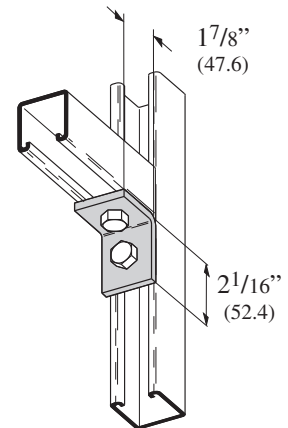
## **B101** **TWO HOLE CORNER ANGLE**

- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 37 Lbs. (16.8 kg)



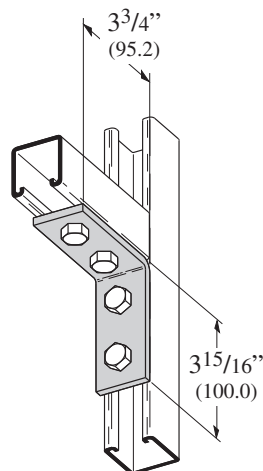
## **B230** **TWO HOLE CORNER ANGLE**

- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 37 Lbs. (16.8 kg)



## **B115** **FOUR HOLE CORNER ANGLE**

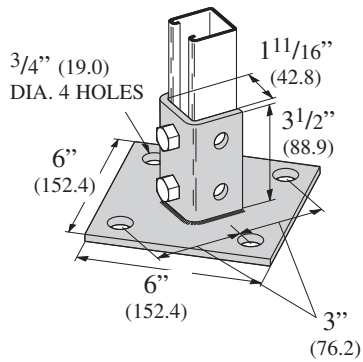
- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 76 Lbs. (34.5 kg)



Reference page 58 for general fitting and standard finish specifications.

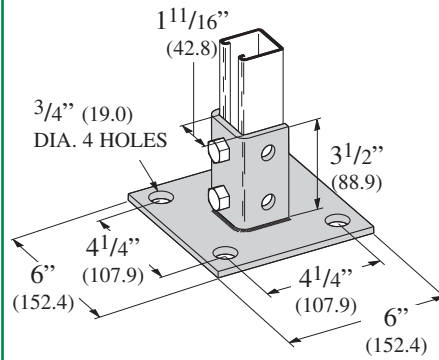
## B280 POST BASE FOR B22

- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 392 Lbs. (177.8 kg)



## B280SQ POST BASE FOR B22

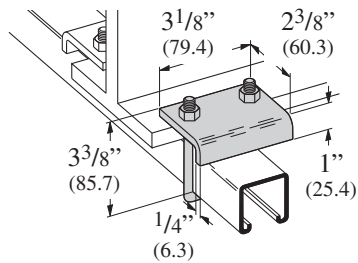
- Standard finishes: ZN, GRN, HDG, SS4, AL
- Wt./C 392 Lbs. (177.8 kg)



Reference page 58 for general fitting and standard finish specifications.

## B441-22 BEAM CLAMP

- Design Load 1200 Lbs. (5.34 kN)  
when used in pairs
- Safety Factor of 5
- $3/4$ " (19.0) Max. Flange Thickness
- For use with  $1^{3/16}$ " (20.6) to  $1^{5/8}$ " (41.3)  
high channel
- Recommended Torque:  
150 in-lbs. (16.9 N•m)
- Sold in pieces
- Other flange thickness variations  
are available, contact B-Line  
Engineering for sizes
- Standard finishes: ZN, HDG, SS4
- Wt./C 87 Lbs. (39.4 kg)



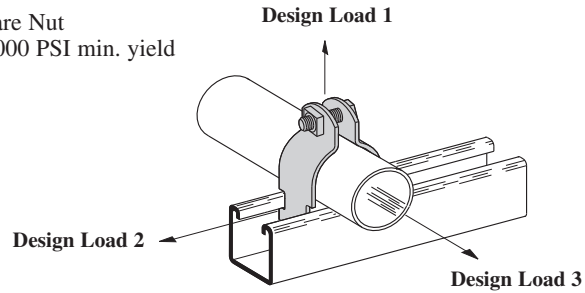
Reference page 98 for general fitting and standard finish specifications.

# Pipe Clamps

## B2000 SERIES PIPE AND CONDUIT CLAMPS

- Safety Factor of 5
- Add PA to suffix for pre-assembled pipe clamps
- Includes Combination Recess Hex Head Machine Screw and Square Nut
- Material: 16 Ga. (1.5), 14 Ga. (1.9), 12 Ga. (2.6) ASTM A1011 33,000 PSI min. yield and 11 Ga. (3.0) ASTM A1011HSLA Gr. 50
- Standard finishes: ZN, HDG, SS4, SS6, AL

Note: For EMT sizes 2 1/2" and larger use rigid conduit sizes.



Pipe/Conduit Clamps & Hangers

### ~~THIN WALL CONDUIT (EMT) CLAMPS~~

Part No.	Conduit Size		Material Thickness		Design Load 1		Design Load 2		Design Load 3		Wt./C	
	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg
<del>B2000</del>	<del>3/8"</del>	<del>(10)</del>	<del>16 Ga. (1.5)</del>	<del>400 (1.78)</del>	<del>50 (.22)</del>	<del>50 (.22)</del>	<del>10 (4.5)</del>					
<del>B2001</del>	<del>1/2"</del>	<del>(15)</del>	<del>16 Ga. (1.5)</del>	<del>400 (1.78)</del>	<del>50 (.22)</del>	<del>50 (.22)</del>	<del>10 (4.5)</del>					
<del>B2002</del>	<del>3/4"</del>	<del>(20)</del>	<del>16 Ga. (1.9)</del>	<del>400 (1.78)</del>	<del>50 (.22)</del>	<del>50 (.22)</del>	<del>11 (5.0)</del>					
<del>B2003</del>	<del>1"</del>	<del>(25)</del>	<del>14 Ga. (1.9)</del>	<del>600 (2.67)</del>	<del>75 (.33)</del>	<del>75 (.33)</del>	<del>16 (7.2)</del>					
<del>B2004</del>	<del>1 1/4"</del>	<del>(32)</del>	<del>14 Ga. (1.9)</del>	<del>600 (2.67)</del>	<del>75 (.33)</del>	<del>75 (.33)</del>	<del>19 (8.6)</del>					
<del>B2005</del>	<del>1 1/2"</del>	<del>(40)</del>	<del>12 Ga. (2.6)</del>	<del>800 (3.56)</del>	<del>125 (.56)</del>	<del>125 (.56)</del>	<del>28 (12.7)</del>					
<del>B2006</del>	<del>2"</del>	<del>(50)</del>	<del>12 Ga. (2.6)</del>	<del>800 (3.56)</del>	<del>125 (.56)</del>	<del>125 (.56)</del>	<del>33 (14.9)</del>					

### RIGID CONDUIT OR PIPE CLAMPS

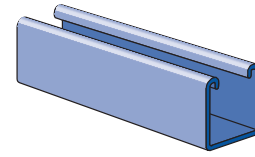
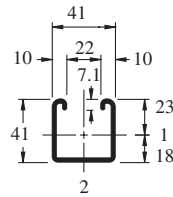
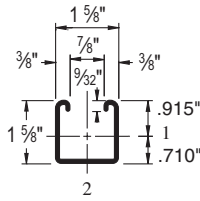
Part No.	Conduit Size		Material Thickness		Design Load 1		Design Load 2		Design Load 3		Wt./C	
	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg	Lbs.	kg
B2001	3/8"	(10)	16 Ga. (1.5)	400 (1.78)	50 (.22)	50 (.22)	10 (4.5)					
B2008	1/2"	(15)	16 Ga. (1.5)	400 (1.78)	50 (.22)	50 (.22)	11 (5.0)					
B2009	3/4"	(20)	14 Ga. (1.9)	600 (2.67)	75 (.33)	75 (.33)	15 (6.8)					
B2010	1"	(25)	14 Ga. (1.9)	600 (2.67)	75 (.33)	75 (.33)	16 (7.2)					
B2011	1 1/4"	(32)	14 Ga. (1.9)	600 (2.67)	75 (.33)	75 (.33)	20 (9.1)					
B2012	1 1/2"	(40)	12 Ga. (2.6)	800 (3.56)	125 (.56)	125 (.56)	30 (13.6)					
B2013	2"	(50)	12 Ga. (2.6)	800 (3.56)	125 (.56)	125 (.56)	34 (15.4)					
B2014	2 1/2"	(65)	12 Ga. (2.6)	800 (3.56)	125 (.56)	125 (.56)	38 (17.2)					
B2015	3"	(80)	12 Ga. (2.6)	800 (3.56)	125 (.56)	125 (.56)	44 (19.9)					
B2016	3 1/2"	(90)	11 Ga. (3.0)	1000 (4.45)	200 (.89)	150 (.67)	61 (27.6)					
B2017	4"	(100)	11 Ga. (3.0)	1000 (4.45)	200 (.89)	150 (.67)	66 (29.9)					
B2018	4 1/2"	(115)	11 Ga. (3.0)	1000 (4.45)	200 (.89)	150 (.67)	70 (31.7)					
B2019	5"	(125)	11 Ga. (3.0)	1000 (4.45)	200 (.89)	150 (.67)	77 (34.9)					
B2020	6"	(150)	11 Ga. (3.0)	1000 (4.45)	200 (.89)	150 (.67)	100 (45.3)					
B2021	7"	(175)	11 Ga. (3.0)	1000 (4.45)	250 (1.11)	200 (.89)	115 (52.1)					
B2022	8"	(200)	11 Ga. (3.0)	1000 (4.45)	250 (1.11)	200 (.89)	128 (58.0)					
B2130	10	(254)	11 Ga. (3.0)	1000 (4.45)	250 (1.11)	200 (.89)	160 (72.6)					
B2132	12"	(305)	11 Ga. (3.0)	1000 (4.45)	250 (1.11)	200 (.89)	185 (83.9)					

Reference page 110 for general fitting and standard finish specifications.





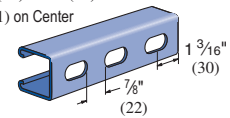
### P1000®



Wt/100 Ft: 189 Lbs (281 kg/100 m)  
 Allowable Moment 5,070 In-Lbs (570 N•m)  
 12 Gauge Nominal Thickness .105" (2.7mm)

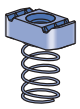
### P1000 T

Slots are  
 1 1/8" (29) x 3/16" (14)  
 2" (51) on Center



Wt/100 Ft: 185 Lbs (275 kg/100 m)

### CHANNEL NUTS (REFER TO HARDWARE SECTION FOR DETAILS)



**P1006-0832**  
**P1006-1024**  
**P1006-1420**  
**P1007**  
**P1008**  
**P1009**  
**P1010**



**P1008T**  
**P1006T1420**  
**P1010T**



**P1024**  
**P1012S**  
**P1023S**



**P3006-0832**  
**P3006-1024**  
**P3006-1420**  
**P3007**  
**P3008**  
**P3009**  
**P3010**



**P3016-0632**  
**P3016-0832**  
**P3016-1024**  
**P3016-1420**



**P1012**  
**P1023**  
**P1024S**

Channel Finishes: PL, GR, HG, PG; Standard Lengths: 10' & 20'

1 1/8" Channel  
 Telestrut System  
 Nuts & Hardware  
 General Fittings  
 Pipe/Conduit Supports  
 Electrical Fittings  
 Concrete Inserts  
 1 1/4" Framing System  
 1 3/16" Framing System  
 Fiberglass System  
 Special Metals  
 PrimeAngle System  
 Product Index

**PLAIN (PL)**

Plain finish designation means that the channel retains the oiled surface applied to the raw steel during the rolling process. The fittings have the original oiled surface of the bar-stock material.

**Pregalvanized Zinc (PG)  
ASTM A653**

Pregalvanized steel is zinc coated by a hot dip process. Steel strip from a coil is fed through a continuous zinc coater which cleans, fluxes and coats the steel with molten zinc. After cooling, the steel is recoiled.

The pregalvanized zinc coating conforms to a G-90 thickness designation per ASTM A653. The zinc thickness is .75 MIL or .45 oz./sq. ft. of surface area.

This coating is offered on Unistrut channel and tubing and is a well-proven, time-tested performer for indoor and outdoor applications. For severe corrosion applications, hot dip galvanizing, as described below, is a good alternative.

**HOT DIP GALVANIZED (HG)  
ASTM A123 OR A153**

In hot dip galvanizing, the finished part is immersed in a bath of molten zinc. This method results in complete zinc coverage and a thicker coating than pregalvanized or plated zinc.

The zinc coating is typically 2.6 MIL or 1.5 oz./sq. ft. of surface area.

This is the coating of choice for applications where severe corrosion is a design factor.

**SPECIAL COATING**

When specific applications require other than standard available finishes, special finishes can be supplied per customer requirements.

**Electroplated Zinc (EG)  
ASTM B633, Type III SC1 or SC3**

In the electroplating process, the part to be zinc coated is immersed in a solution of zinc ions. An electric current causes the zinc to be deposited on the part.

SC1 (mild) has a Zinc coating of 0.2 and is recommended for dry indoor use. SC1 is the standard finish thickness.

SC3 (Severe) has a Zinc coating of 0.5 mill and is the standard finish thickness only on UL Listed raceway products.

**Perma-Gold (ZD)  
ASTM B633, Type II SC1 or SC3**

Similar to the EG process except in a yellow color.

SC1 (mild) has a Zinc coating of 0.2 and is recommended for dry indoor use. SC1 is the standard finish thickness

SC3 (Severe) has a Zinc coating of 0.5 mill and is the standard finish thickness only on UL Listed raceway products.

**Zinc Coating**

Unistrut products are available in four types of zinc coatings:

- Electroplated (EG)
- Perma-Gold (ZD)
- Pregalvanized (PG)
- Hot Dip Galvanized (HG).

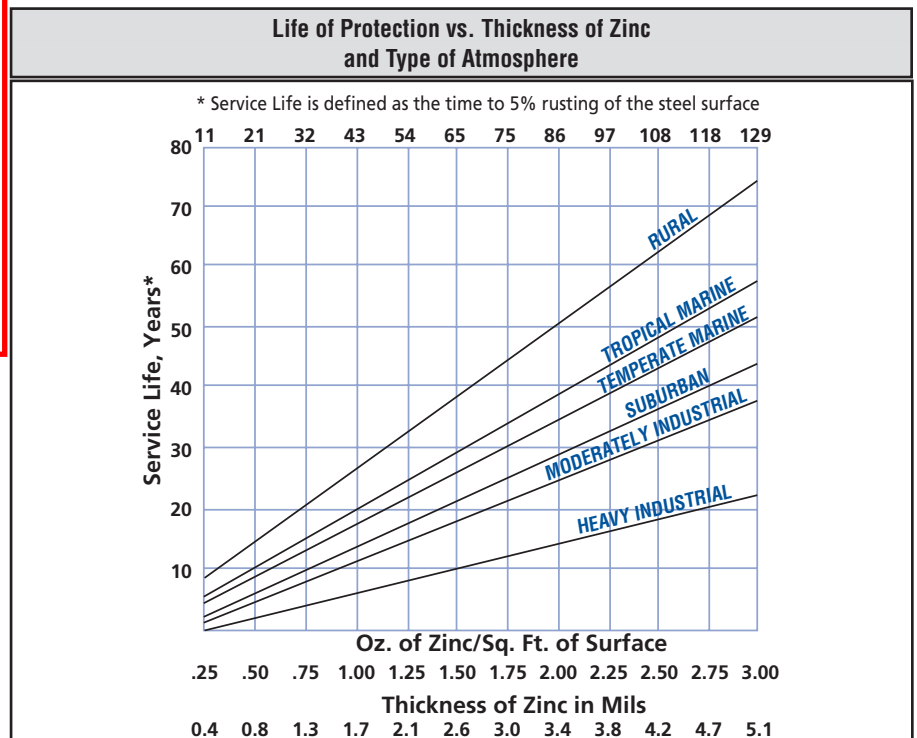
Zinc offer two types of protection:

- Barrier: The zinc coating protects the steel substrate from direct contact with the environment.
- Sacrificial: The zinc coating will protect scratches, cut edges, etc. through an anodic sacrificial process.

The service life of zinc coating is directly related to the zinc coating thickness as shown below.

Comparison of Zinc Finishes	
Finish	Zinc Thickness
Hot Dip Galvanized	2.6 MIL
Pre-galvanized	0.75 MIL
Electro-Galvanized (SC1)	0.2 MIL
Electro-Galvanized (SC3)	0.5 MIL
Perma-Gold (SC1)	0.2 MIL
Perma-Gold (SC3)	0.5 MIL

As shown in the graph, when the zinc coating is double, the service life is double under most conditions.



P1000 - BEAM LOADING

Span In	Max. Allowable Uniform Load Lbs	Defl. at Uniform Load In	Uniform Loading at Deflection		
			Span/180 Lbs	Span/240 Lbs	Span/360 Lbs
24	1,690	0.06	1,690	1,690	1,690
36	1,130	0.13	1,130	1,130	900
48	850	0.22	850	760	500
60	680	0.35	650	480	320
72	560	0.50	450	340	220
84	480	0.68	330	250	160
96	420	0.89	250	190	130
108	380	1.14	200	150	100
120	340	1.40	160	120	80
144	280	2.00	110	80	60
168	240	2.72	80	60	40
192	210	3.55	60	50	NR
216	190	4.58	50	40	NR
240	170	5.62	40	NR	NR

P1000 - COLUMN LOADING

Unbraced Height In	Max. Allowable Load at Slot Face Lbs	Maximum Column Load Applied at C.G.			
		K = 0.65 Lbs	K = 0.80 Lbs	K = 1.0 Lbs	K = 1.2 Lbs
24	3,550	10,740	9,890	8,770	7,740
36	3,190	8,910	7,740	6,390	5,310
48	2,770	7,260	6,010	4,690	3,800
60	2,380	5,910	4,690	3,630	2,960
72	2,080	4,840	3,800	2,960	2,400
84	1,860	4,040	3,200	2,480	1,980
96	1,670	3,480	2,750	2,110	1,660
108	1,510	3,050	2,400	1,810	**
120	1,380	2,700	2,110	**	**
144	1,150	2,180	1,660	**	**

P1000/P1001 - ELEMENTS OF SECTION

Parameter	P1000		P1001	
Area of Section	0.555	In <sup>2</sup>	1.111	In <sup>2</sup>
Axis 1-1				
Moment of Inertia (I)	0.185	In <sup>4</sup>	0.928	In <sup>4</sup>
Section Modulus (S)	0.202	In <sup>3</sup>	0.571	In <sup>3</sup>
Radius of Gyration (r)	0.577	In	0.914	In
Axis 2-2				
Moment of Inertia (I)	0.236	In <sup>4</sup>	0.471	In <sup>4</sup>
Section Modulus (S)	0.290	In <sup>3</sup>	0.580	In <sup>3</sup>
Radius of Gyration (r)	0.651	In	0.651	In

Notes:

\* Load limited by spot weld shear.

\*\* KL/r > 200

NR = Not Recommended.

- Above loads include the weight of the member. This weight must be deducted to arrive at the net allowable load the beam will support.
- Long span beams should be supported in such a manner as to prevent rotation and twist.
- Allowable uniformly distributed loads are listed for various simple spans, that is, a beam on two supports. If load is concentrated at the center of the span, multiply load from the table by 0.5 and corresponding deflection by 0.8.
- See page 56 for lateral bracing reduction charts.
- For Pierced Channel, Beam Load Values in the tables are multiplied by the following factor:

"DS" Series	70%	"T" Series	85%
"KO" Series	95%	"H3" Series	90%
"SL" Series	85%	"HS" Series	90%



### P1000 - BEAM LOADING (METRIC)

Span mm	Max Allowable Uniform Load kN	Defl. at Uniform Load mm	Uniform Loading at Deflection		
			Span/180 kN	Span/240 kN	Span/360 kN
600	7.6	1	7.6	7.6	7.6
750	6.1	2	6.1	6.1	5.9
1,000	4.6	4	4.6	4.6	3.3
1,250	3.6	6	3.6	3.2	2.1
1,500	3.1	9	3.0	2.2	1.5
1,750	2.6	12	2.2	1.6	1.1
2,000	2.3	15	1.6	1.2	0.8
2,500	1.8	24	1.1	0.8	0.5
3,000	1.5	34	0.8	0.5	0.4
3,500	1.3	46	0.5	0.4	0.3
4,000	1.2	62	0.4	0.3	0.2
4,500	1.0	78	0.3	0.3	0.2
5,000	0.9	97	0.3	0.2	NR
6,000	0.8	136	0.2	NR	NR

### P1000 - COLUMN LOADING (METRIC)

Unbraced Height mm	Maximum Allowable Load at Slot Face kN	Maximum Column Load Applied at C.G.			
		K = 0.65 kN	K = 0.80 kN	K = 1.0 kN	K = 1.2 kN
600	15.8	48.0	44.3	39.4	34.8
750	15.2	44.0	39.4	33.8	28.9
1,000	13.7	37.5	32.0	26.1	21.3
1,250	12.1	31.6	26.1	20.3	16.5
1,500	10.7	26.7	21.3	16.5	13.4
1,750	9.6	22.7	17.8	13.8	11.3
2,000	8.7	19.3	15.3	11.9	9.6
2,250	7.9	16.9	13.4	10.4	8.2
2,500	7.2	15.0	11.9	9.1	**
2,750	6.7	13.5	10.6	8.1	**

### P1000/P1001 - ELEMENTS OF SECTION (METRIC)

Parameter	P1000	P1001
Area of Section	3.58 cm <sup>2</sup>	7.16 cm <sup>2</sup>
Axis 1-1		
Moment of Inertia (I)	7.68 cm <sup>4</sup>	38.62 cm <sup>4</sup>
Section Modulus (S)	3.30 cm <sup>3</sup>	9.36 cm <sup>3</sup>
Radius of Gyration (r)	1.46 cm	2.32 cm
Axis 2-2		
Moment of Inertia (I)	9.80 cm <sup>4</sup>	19.60 cm <sup>4</sup>
Section Modulus (S)	4.75 cm <sup>3</sup>	9.50 cm <sup>3</sup>
Radius of Gyration (r)	1.65 cm	1.65 cm

**Notes:**

\* Load limited by spot weld shear.

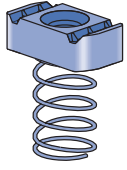
\*\* KL/r > 200

NR = Not Recommended.

- Above loads include the weight of the member. This weight must be deducted to arrive at the net allowable load the beam will support.
- Long span beams should be supported in such a manner as to prevent rotation and twist.
- Allowable uniformly distributed loads are listed for various simple spans, that is, a beam on two supports. If load is concentrated at the center of the span, multiply load from the table by 0.5 and corresponding deflection by 0.8.
- See page 56 for lateral bracing reduction charts.
- For Pierced Channel, Beam Load Values in the tables are multiplied by the following factor:

"DS" Series	70%	"T" Series	85%
"KO" Series	95%	"H3" Series	90%
"SL" Series	85%	"HS" Series	90%

CHANNEL NUT WITH SPRING

	Part Number	Nut Size Thread	Wt/100 pcs Lbs (kg)	Use With
	P1006-0832	#8 -32	7 (3.2)	<b>P1000, P1100, P2000, P3000</b>
	P1006-1024	#10 -24	7 (3.2)	
	P1006-1420	¼" -20	7 (3.2)	
	P1007	⅝" -18	6 (2.7)	
	P1008	¾" -16	10 (4.5)	
	P1009	7/16" -14	9 (4.1)	
	P1010	½" -13	12 (5.4)	

1 5/8" Channel

Telestrut System

Nuts & Hardware

General Fittings

Pipe/Conduit Supports

Electrical Fittings

Concrete Inserts

1 1/4" Framing System

1 3/16" Framing System

Fiberglass System

Special Metals

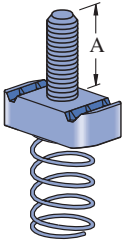
PrimeAngle System

Product Index





### CHANNEL STUD NUT WITH SPRING



All Stud Nut grooves are serrated.

Special stud lengths and thread lengths can be supplied upon request.

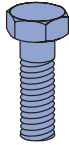
Part No.	Thread	"A" Stud In (mm)	Wt/100 pcs Lbs (kg)
P2378-1	¼" - 20	1 (25)	8 (3.6)
P2378-2		1¼ (31)	9 (4.1)
P2378-3		1½ (38)	9 (4.1)
P2379-1	⅝" - 18	1 (25)	12 (5.4)
P2379-2		1¼ (32)	12 (5.4)
P2379-3		1½ (38)	13 (5.9)
P2380-1	⅜" - 16	1 (25)	13 (5.9)
P2380-2		1¼ (32)	13 (5.9)
P2380-3		1½ (38)	13 (5.9)
P2380-4		1¾ (45)	15 (6.8)

**Use With P1000, P1100, P2000, P3000**

Part No.	Thread	"A" Stud In (mm)	Wt/100 pcs Lbs (kg)
P2380-5	⅜" - 16	2 (51)	16 (7.3)
P2380-6		2¼ (57)	16 (7.3)
P2381-2	½" - 13	1 (25)	14 (6.4)
P2381-3		1¼ (32)	15 (6.8)
P2381-4		1½ (38)	17 (7.7)
P2381-5		1¾ (45)	18 (8.2)
P2381-6		2 (51)	19 (8.6)
P2381-7	⅝" - 11	2¼ (57)	20 (9.1)
P2382-2		1¼ (32)	18 (8.2)
P2382-3		1½ (38)	20 (9.1)

**Use With P1000, P1100, P2000, P3000**

### HEX HEAD CAP SCREWS



Part No.	Size	Wt/100 pcs Lbs (kg)
HHCS025044EG	¼" x 7/16"	1.0 (0.5)
HHCS025075EG	¼" x ¾"	1.3 (0.6)
HHCS025150EG	¼" x 1½"	2.6 (1.2)
HHCS031125EG	⅝" x 1¼"	3.6 (1.6)
HHCS037075EG	⅜" x ¾"	4.0 (1.8)
HHCS037087EG	⅜" x 7/8"	4.4 (2.0)
HHCS037100EG	⅜" x 1"	4.5 (2.0)
HHCS037125EG	⅜" x 1¼"	5.3 (2.4)
HHCS037150EG	⅜" x 1½"	6.0 (2.7)
HHCS037200EG	⅜" x 2"	7.6 (3.4)
HHCS037225EG	⅜" x 2¼"	8.4 (3.8)
HHCS037250EG	⅜" x 2½"	9.2 (4.2)
HHCS050094EG	½" x 15/16"	9.1 (4.2)
HHCS050119EG	½" x 1¾"	10.2 (4.6)
HHCS050150EG	½" x 1½"	11.6 (5.3)
HHCS050175EG	½" x 1¾"	13.1 (5.9)
HHCS050200EG	½" x 2"	14.6 (6.6)
HHCS050225EG	½" x 2¼"	16 (7.3)
HHCS050250EG	½" x 2½"	17.5 (7.9)

### HEX SLOTTED MACHINE SCREWS



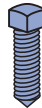
Part No.	Size	Wt/100 pcs Lbs (kg)
HSMS025050EG	¼" x ½"	1.4 (0.6)
HSMS025062EG	¼" x ⅝"	1.5 (0.7)
HSMS025075EG	¼" x ¾"	1.7 (0.8)
HSMS031100EG	⅝" x 1"	2.6 (1.2)
HSMS031125EG	⅝" x 1¼"	3.0 (1.4)
HSMS031150EG	⅝" x 1½"	3.4 (1.5)
HSMS037125EG	⅜" x 1¼"	5.3 (2.4)

### FLAT HEAD MACHINE SCREWS



Part No.	Size	Wt/100 pcs Lbs (kg)
HFMS025062EG	¼" x ⅝"	1.2 (0.5)
HFMS031100EG	⅝" x 1"	2.6 (1.2)
HFMS050100EG	½" x 1"	9.3 (4.2)

### CONE POINT SET SCREWS



Part No.	Size	Wt/100 pcs Lbs (kg)
HCSS025100EG	¼" x 1"	2.8 (1.3)
HCSS031150EG	⅝" x 1½"	3.9 (1.8)
HCSS037150EG	⅜" x 1½"	4.5 (2.0)
HCSS037200EG	⅜" x 2"	6.1 (2.8)
HCSS050150EG	½" x 1½"	8.5 (3.9)
HCSS050200EG	½" x 2"	11.4 (5.2)
HCSS062150EG	⅝" x 1½"	14.5 (6.6)
HCSS062200EG	⅝" x 2"	23.0 (10.4)

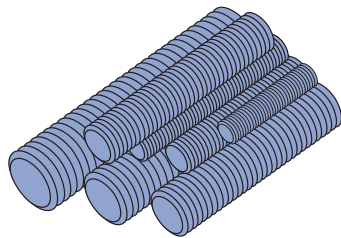
### ROUND HEAD MACHINE SCREWS



Part No.	Size	Wt/100 pcs Lbs (kg)
HRMS025050EG	¼" x ½"	1 (0.5)
HRMS025075EG	¼" x ¾"	1.2 (0.6)
HRMS025100EG	¼" x 1"	1.5 (0.7)
HRMS031100EG	⅝" x 1"	2.6 (1.2)
HRMS031125EG	⅝" x 1¼"	3.0 (1.4)
HRMS037100EG	⅜" x 1"	4.1 (1.9)
HRMS037125EG	⅜" x 1¼"	4.7 (2.1)
HRMS037150EG	⅜" x 1½"	5.3 (2.4)

15/16" Channel  
 Telesit System  
 Nuts & Hardware  
 General Fittings  
 Pipe/Conduit Supports  
 Electrical Fittings  
 Concrete Inserts  
 1 1/4" Framing System  
 1 3/16" Framing System  
 Fiberglass System  
 Special Metals  
 PrimeAngle System  
 Product Index

STEEL THREADED ROD



Standard Length 12' (3.7m)

Low Carbon Steel  
 F<sub>y</sub> = 32,000 psi minimum  
 F<sub>t</sub> = 52,000 psi minimum

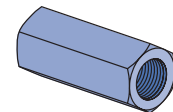
Part No.	Size	Wt/100 Ft. Lbs (kg)
HTHR025	1/4" x 20	13 (5.9)
HTHR031	5/16" x 18	20 (9.1)
HTHR037	3/8" x 16	30 (13.6)
HTHR044	7/16" x 14	30 (13.6)
HTHR050	1/2" x 13	53 (24.0)
HTHR062	5/8" x 11	84 (38.1)
HTHR075	3/4" x 10	124 (56.2)
HTHR087	7/8" x 9	170 (77.1)
HTHR100	1" x 8	223 (101.2)

LOAD CARRYING CAPACITY OF THREADED HOT ROLLED STEEL  
 CONFORMING TO ASTM A575 AND A576

Threaded Rod Loads for Piping Applications (based on MSS SP-58)		
Nominal Dia.	Root Area In <sup>2</sup> (mm <sup>2</sup> )	Max. Safe Load at 650°F (343°C) Lbs (kN)
3/8"	0.068 (43.9)	730 (3.25)
1/2"	0.126 (81.3)	1,350 (6.01)
5/8"	0.202 (130.3)	2,160 (9.61)
3/4"	0.302 (194.8)	3,230 (14.37)
7/8"	0.419 (270.3)	4,480 (19.93)
1"	0.552 (356.1)	5,900 (26.24)

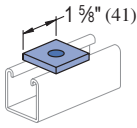
Threaded Rod Loads for Structural Applications (Based on AISC, Steel Construction Manual, ASD, 9th Edition. Per AISC, Allowed Tensile Stress = 0.33 * F <sub>u</sub> )		
Nominal Dia.	Nominal Area In <sup>2</sup> (mm <sup>2</sup> )	Allowed Tension Load Lbs (kN)
1/4"	0.049 (31.6)	840 (3.74)
3/8"	0.110 (71.0)	1,890 (8.41)
1/2"	0.150 (96.8)	2,570 (11.43)
5/8"	0.196 (126.5)	3,360 (14.95)
3/4"	0.442 (285.4)	7,580 (33.72)
7/8"	0.601 (388.0)	10,310 (45.86)
1"	0.785 (506.8)	13,470 (59.92)

STEEL COUPLER NUTS



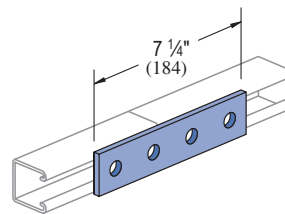
Part Number	Size	Length In (mm)	Wt/100 pcs Lbs (kg)
HRCN025	1/4" - 20	7/8" (22)	1.9 (0.9)
HRCN031	5/16" - 18	1 3/4" (45)	7.5 (3.4)
HRCN037	3/8" - 16	1 3/4" (45)	9.0 (4.1)
HRCN044	7/16" - 14	1 3/4" (45)	10.4 (4.7)
HRCN050	1/2" - 13	1 3/4" (45)	10.0 (4.5)
HRCN062	5/8" - 11	2 1/8" (54)	18.0 (8.2)
HRCN075	3/4" - 10	2 1/4" (57)	28.0 (12.7)
HRCN087	7/8" - 9	2 1/2" (64)	55.0 (24.9)
HRCN100	1" - 8	2 3/4" (70)	73.0 (33.1)

P1062, P1063, P1064,  
P1964, P2471, P2490



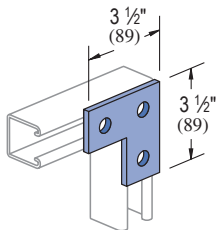
Part No.	Bolt Size	Hole Size	Wt/100 pcs Lbs (kg)
P1062	5/16"	1 1/2"	18 (8.2)
P1063	3/8"	7/16"	18 (8.2)
P1064	1/2"	9/16"	17 (7.7)
P1964	5/8"	1 1/16"	16 (7.3)
P2471	3/4"	1 3/16"	15 (6.8)
P2490	7/8"	1 5/16"	14 (6.4)

P1067



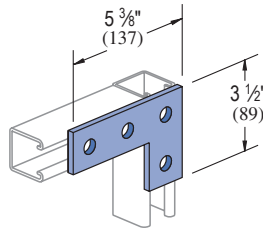
Wt/100 pcs: 78 Lbs (35.4 kg)

P1036



Wt/100 pcs: 58 Lbs (26.3 kg)

P1380 A



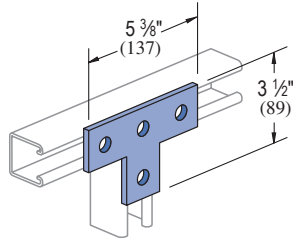
Wt/100 pcs: 80 Lbs (36.3 kg)

Standard Dimensions for 1 5/8" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)

Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 1 3/16" (21mm); Hole Spacing - On Center: 1 7/8" (48mm); Width: 1 5/8" (41mm); Thickness: 1/4" (6mm)

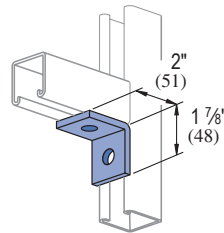


**P1031**



Wt/100 pcs: 80 Lbs (36.3 kg)

**P1026**



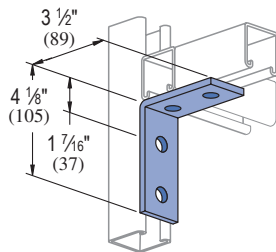
Wt/100 pcs: 38 Lbs (17.2 kg)

**Standard Dimensions for 1 5/8" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)**

Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 1 3/16" (21mm); Hole Spacing - On Center: 1 7/8" (48mm); Width: 1 5/8" (41mm); Thickness: 1/4" (6mm)

Product Index  
PrimeAngle System  
Special Metals  
Fiberglass System  
1 3/16" Framing System  
1 1/4" Framing System  
Concrete Inserts  
Electrical Fittings  
Pipe/Conduit Supports  
General Fittings  
Nuts & Hardware  
Telesstrut System  
1 5/8" Channel

**P1325**



Wt/100 pcs: 78 Lbs (35.4 kg)

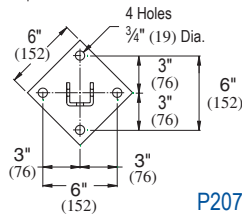
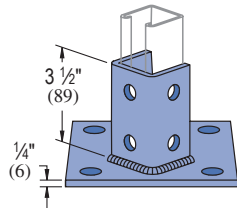
Standard Dimensions for 1 1/2" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)

Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 1 3/16" (21mm); Hole Spacing - On Center: 1 7/8" (48mm); Width: 1 1/2" (41mm); Thickness: 1/4" (6mm)

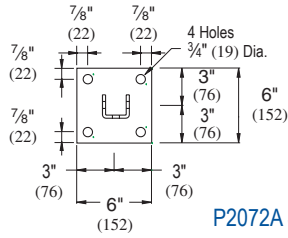


1 1/2" Channel  
Telesrnut System  
Nuts & Hardware  
General Fittings  
Pipe/Conduit Supports  
Electrical Fittings  
Concrete Inserts  
1 1/4" Framing System  
1 3/16" Framing System  
Fiberglass System  
Special Metals  
PrimeAngle System  
Product Index

**P2072A, P2072A SQ**



P2072A



P2072A SQ

Wt/100 pcs: 373 Lbs (169.2 kg)

Standard Dimensions for 1 1/2" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)

Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 13/16" (21mm); Hole Spacing - On Center: 1 1/8" (48mm); Width: 1 1/2" (41mm); Thickness: 1/4" (6mm)

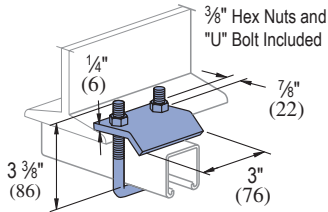
Note : When used for mechanical supports, load capacities of brackets and fittings should be in compliance with the American Standard Code for Pressure Piping.





Product Index  
 PrimeAngle System  
 Special Metals  
 Fiberglass System  
 13/16" Framing System  
 1 1/4" Framing System  
 Concrete Inserts  
 Electrical Fittings  
 Pipe/Conduit Supports  
 General Fittings  
 Nuts & Hardware  
 Telestrut System  
 1 5/8" Channel

**P2785**



• For use with Beams up to 3/4" (19)  
 Flanges and with  
 Channels P1000, P1100, P2000,  
 P3000, P3300, P3301,  
 P4000, P4001, P4100, and P4101.

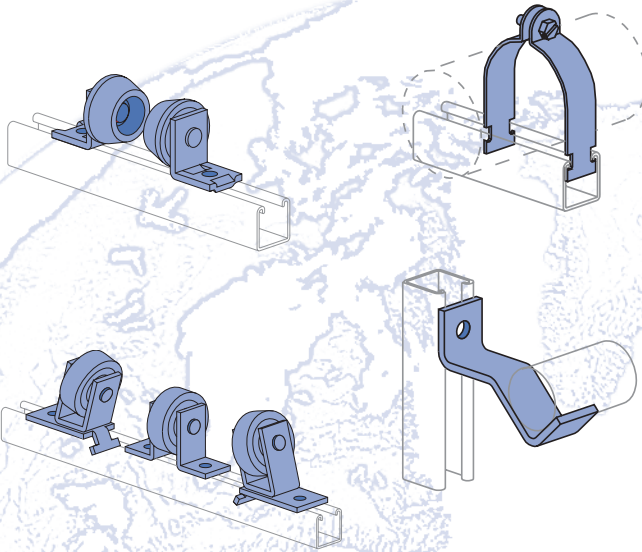
Design Load Each  
 1000 Lbs (4.45 kN)  
 Use in Pairs Only

Wt/100 pcs: 83 Lbs (37.6 kg)

**Note:** When used for mechanical supports, load capacities of brackets and fittings should be in compliance with the American Standard Code for Pressure Piping. Clamps are designed to be used with W, M, S & HP Shape beams, Standard C & Misc. MC Channels, Angles & Structural Tees. Clamps must be used in pairs where indicated. For beam clamps with HG finish, standard hardware is EG finish. For optional stainless steel hardware, please contact the factory for availability.



# PIPE/CONDUIT SUPPORTS



Pipe/Conduit Clamps ..... 102-105

Unicushion® ..... 106

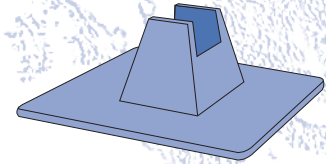
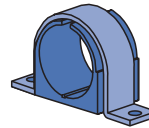
Pipe & Tubing (Cush-A-Clamp®) Clamps ..... 107-110

Pipe Hangers ..... 111

Pipe Rollers ..... 111-112

Pipe Brackets ..... 113

Reference Tables ..... 114-120



## MATERIAL

Unistrut pipe clamps, unless noted, are punch-press made from hot-rolled, pickled and oiled steel plates, strip or coil, and conform to ASTM specifications A1008, A575, A576, A635, or A36. The fitting steel also meets the physical requirements of ASTM A1011 SS GR 33. The pickling of the steel produces a smooth surface free from scale.

Many items are also available in stainless steel.

Consult factory for ordering information.

## FINISHES

Pipe supports are available in:

- Electro-galvanized (EG), conforming to ASTM B633 Type III SC1
- Hot-dipped galvanized (HG), conforming to ASTM A123 or A153 (hardware)
- Perma-Green III (GR), and plain (PL).

## APPLICATION

Unistrut pipe clamps, pipe hangers, brackets and rollers are designed for the support of electrical and mechanical services. Supports to meet nearly every requirement can be attained using Unistrut Metal Framing components.

## DIMENSIONS

Imperial dimensions are illustrated in inches. Metric dimensions are shown in parenthesis or as noted. Unless noted, all metric dimensions are in millimeters and rounded to one decimal place.

## DESIGN BOLT TORQUE

BOLT SIZE	1/4"-20	5/16"-18	3/8"-16	1/2"-13	5/8"-11	3/4"-10
Rec.Torque Ft/Lbs (N*m)	6 (8)	11 (15)	19 (26)	50 (68)	100 (136)	125 (170)
Max Torque Ft/Lbs (N*m)	7 (9)	15 (20)	25 (34)	70 (95)	125 (170)	135 (183)

Note: When tightening 1/4" screws used with a two piece pipe clamp, a torque of 5 foot pounds (60 inch-pounds) should be used.

## DESIGN LOAD

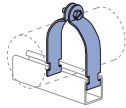
Design load data, where shown, is based on the ultimate strength of the connection with a safety factor of 5.0, unless otherwise noted.

## Pipe Clamps In Special Materials (P1109, P1211, P1425, P2024 Series)

Material	Add Suffix to P/N	Example
Steel Strap, Everdur Hardware	E	P1109 E
Copper Coated Steel Strap & Hardware	CC	P1109 CC
Aluminum Material: Malleable Iron.	AL	P1109 AL
Stainless Steel 304 or 316	SS or ST	P1109 SS
Plastic Coated Steel Straps	PC	P1109 PC



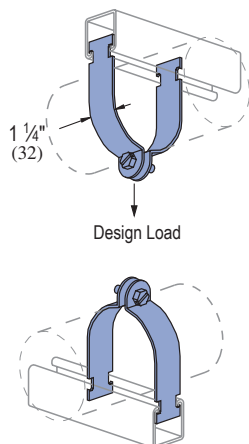
Pipe & Conduit Clamps



P1109 - Pg 102

**P1109 THRU P1126**

**PIPE CLAMPS FOR RIGID STEEL CONDUIT**



Part No.	Conduit Size In	O.D. Size In (mm)	Thickness Gauge (mm)	Wt/100 pcs Lbs (kg)	Design Load Lbs (kN)
P1109	3/8	0.675 17.1	16 1.5	10 4.5	400 1.78
P1111	1/2	0.840 21.3	16 1.5	11 5.0	400 1.78
P1112	3/4	1.050 26.7	14 1.9	15 6.8	600 2.67
P1113	1	1.315 33.4	14 1.9	17 7.7	600 2.67
P1114	1 1/4	1.660 42.2	14 1.9	19 8.6	600 2.67
P1115	1 1/2	1.900 48.3	12 2.7	29 13.2	800 3.56
P1117	2	2.375 60.3	12 2.7	34 15.4	800 3.56

Part No.	Conduit Size In	O.D. Size In (mm)	Thickness Gauge (mm)	Wt/100 pcs Lbs (kg)	Design Load Lbs (kN)
P1118	2 1/2	2.875 73.0	12 2.7	40 18.1	800 3.56
P1119	3	3.500 88.9	12 2.7	47 21.3	800 3.56
P1120	3 1/2	4.000 101.6	11 3.0	62 28.1	1,000 4.45
P1121	4	4.500 114.3	11 3.0	67 30.4	1,000 4.45
P1123	5	5.563 141.3	11 3.0	80 36.3	1,000 4.45
P1124	6	6.625 168.3	10 3.4	102 46.3	1,000 4.45
P1126	8	8.625 219.1	10 3.4	130 59.0	1,000 4.45

Slotted hex head screw and nut included with EG or HG Finish.

1 5/8" Channel  
 Telestrut System  
 Nuts & Hardware  
 General Fittings  
 Pipe/Conduit Supports  
 Electrical Fittings  
 Concrete Inserts  
 1 1/4" Framing System  
 1 3/16" Framing System  
 Fiberglass System  
 Special Metals  
 PrimeAngle System  
 Product Index



"The Diamond of the Industry"

## Conduit Hangers with Bolts

- To fasten and secure EMT or rigid conduit to threaded rod, insulator supports, or directly to mounting surface
- Furnished with nut and bolt to accelerate installation
- For use in wet or dry locations
- Bright Electro Zinc Finish



## Selection Table

Cat. #	Trade Size	Conduit Size Rigid	EMT	Unit / CTN	Std / Pkg	WT/100
CHBO	0	3/8"-1/2"	1/2"	50	250	7
CHB1	1	3/4"	3/4"	50	250	7
CHB2	2	1"	1"	25	125	8
CHB25	2-1/2	-	1-1/4"	20	100	11
CHB3	3	1-1/4"	1-1/2"	20	100	11
CHB4	4	1-1/2"	-	10	50	19
CHB5	5	2"	2"	10	50	22
CHB6	6	2-1/2"	2-1/2"	-	25	28
CHB7	7	3"	3"	-	20	31
CHB8	8	3-1/2"	3-1/2"	-	10	32
CHB9	9	4"	4"	-	10	37

\* Made in America Product also available - add "US" Suffix to catalog number when ordering.



"The Diamond of the Industry"

## Rigid Steel Straps

- To securely fasten and support Rigid or Intermediate metal conduit to the mounting surface
- For use in wet or dry locations
- Bright electro zinc finish for corrosion protection



## One-Hole Rigid Type

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
CSR251	1/4"	100	1000	2
CSR371	3/8"	100	1000	3
CSR501	1/2"	50	500	4
CSR751	3/4"	50	250	5
CSR1001	1"	50	250	8
CSR1251	1-1/4"	25	125	11
CSR1501	1-1/2"	20	100	17
CSR2001	2"	10	50	22
CSER2501	2-1/2"	-	20	42
CSER3001	3"	-	10	49
CSER3501	3-1/2"	-	10	71
CSER4001	4"	-	10	78

## One-Hole BX Type

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
CSBX381	12-2, 12-3, 10-2, 10-3	100	1000	1

## Two-Hole Rigid Type

Cat. #	Size	Unit Ctn	Std Pkg	WT/ 100
CSR502*	1/2"	50	500	2
CSR752*	3/4"	50	250	3
CSR1002*	1"	50	250	5
CSR1252*	1-1/4"	25	125	7
CSR1502*	1-1/2"	20	100	12
CSR2002*	2"	10	50	15
CSER2502*	2-1/2"	-	20	17
CSER3002*	3"	-	10	23
CSER3502*	3-1/2"	-	10	26
CSER4002*	4"	-	10	33



# Rigid Metal Conduit, IMC or EMT Hang-On® Hangers

## Applications

- To secure rigid metal conduit, IMC or EMT to threaded rod, supports or direct to mounting surface.

## Features

- Available with bolt or swing bolt.

## Material/Finish

- Steel/zinc plated

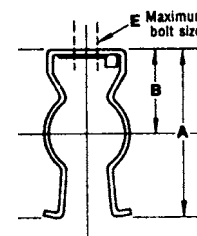
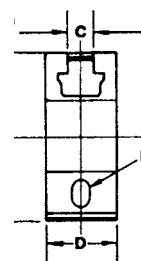
## Certifications and Compliances

- UL Standard: 2239
- UL Listed: E336499
- CSA Standard: C22.2 No. 18.4
- CSA Certified: 065178

Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters						Weight Lbs./Kgs. Per 100
		A	B	C	D	E	F	

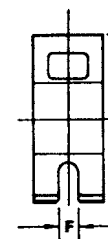
### Hang-On® Conduit Hangers with Bolts — Steel/Zinc Plated

H50WB	1/2	1.88/ 47.8	0.88/ 22.4	0.28/ 7.1	0.75/ 19.1	0.25/ 6.4	0.28/ 7.1	6.00/ 2.72
H75WB	3/4	2.00/ 50.8	0.91/ 23.1	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.28/ 7.1	7.00/ 3.18
H100WB	1	2.41/ 61.2	1.16/ 29.5	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.28/ 7.1	9.00/ 4.08
H125WB	1-1/4	2.81/ 71.4	1.38/ 35.1	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.28/ 7.1	10.00/ 4.54
H150WB	1-1/2	3.22/ 81.8	1.63/ 41.4	0.69/ 17.5	1.00/ 25.4	0.31/ 7.9	0.28/ 7.1	16.00/ 7.26
H200WB	2	3.75/ 95.3	1.88/ 47.8	0.34/ 8.6	1.25/ 31.8	0.31/ 7.9	0.28/ 7.1	25.80/ 11.70
H250WB	2-1/2	4.22/ 107.2	2.13/ 54.1	0.34/ 8.6	1.25/ 31.8	0.31/ 7.9	0.28/ 7.1	26.00/ 11.79
H300WB	3	4.88/ 124.0	2.38/ 60.5	0.34/ 8.6	1.25/ 31.8	0.31/ 7.9	0.28/ 7.1	30.00/ 13.61
H350WB	3-1/2	5.38/ 136.7	2.69/ 68.3	0.34/ 8.6	1.25/ 31.8	0.31/ 7.9	0.28/ 7.1	38.00/ 17.24
H400WB	4	6.44/ 163.6	3.00/ 76.2	0.53/ 13.5	1.75/ 44.5	0.50/ 12.7	0.53/ 13.5	90.00/ 40.82



### Hang-On® Conduit Hangers with Swing Bolts — Steel/Zinc Plated

H50-SWB	1/2	1.72/ 43.7	0.88/ 22.4	0.28/ 7.1	0.75/ 19.1	0.25/ 6.4	0.20/ 5.1	5.70/ 2.59
H75-SWB	3/4	1.84/ 46.7	0.91/ 23.1	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.20/ 5.1	7.00/ 3.18
H100-SWB	1	2.34/ 59.4	1.16/ 29.5	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.20/ 5.1	8.80/ 4.00
H125-SWB	1-1/4	2.66/ 67.6	1.38/ 35.1	0.28/ 7.1	0.88/ 22.4	0.25/ 6.4	0.20/ 5.1	10.00/ 4.54
H150-SWB	1-1/2	3.06/ 77.7	1.63/ 41.4	0.34/ 8.6	1.00/ 25.4	0.31/ 7.9	0.20/ 5.1	16.00/ 7.26
H200-SWB	2	3.59/ 91.2	1.88/ 47.8	0.34/ 8.6	1.25/ 31.8	0.31/ 7.9	0.20/ 5.1	25.80/ 11.70





# NEER Conduit Hangers

## CH-B: With Bolts and Nuts

### Application

- Secure and suspend rigid conduit, IMC, EMT or PVC conduit from overhead supports.

### Features

- Furnished with carriage bolt.

### Standard Material/Finish

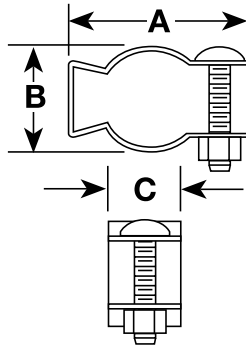
- Steel/zinc plated

### Certifications and Compliances

- UL Standard: 2239
- UL Listed: E333806



CH-050-B



Trade Size (Inches)	Catalog Number	Dimensions in Inches/Millimeters		
		A	B	C
3/8 and 1/2	CH-050-B	1.93/49.0	0.91/23.1	0.75/19.1
3/4	CH-100-B	2.16/54.9	1.10/27.9	0.75/19.1
1	CH-200-B	2.42/61.5	1.37/34.8	0.88/22.4
1-1/4TW	CH-250-B	2.72/69.1	1.55/39.4	0.88/22.4
1-1/4HW	CH-300-B	2.85/72.4	1.90/48.3	0.88/22.4
1-1/2	CH-400-B	3.15/80.0	1.93/49.0	1.00/25.4
2	CH-500-B	3.73/94.7	1.20/30.5	1.01/25.7
2-1/2	CH-600-B	4.65/118.1	3.35/85.1	1.13/28.7
3	CH-700-B	5.30/134.6	3.90/99.1	1.19/30.2
3-1/2	CH-800-B	5.75/146.1	4.05/102.9	1.25/31.8
4	CH-900-B	6.40/162.6	5.05/128.3	1.25/31.8

COMMERCIAL PRODUCTS: RIGID, IMC AND EMT CLAMPS AND HANGERS

# Beam Clamps, Straps, Clamps and Clamp Backs for Rigid Metal Conduit or IMC

## Applications

- Beam clamp: provides support for conduit hanging systems.
- Two-Hole Straps: used to support rigid metal conduit and IMC.
- Clamp Backs: provide spacing from mounting surface when used with pipe clamps.

## Material/Finish


- Beam clamps: malleable iron/hot dip galvanized
- Straps: steel/zinc electroplate

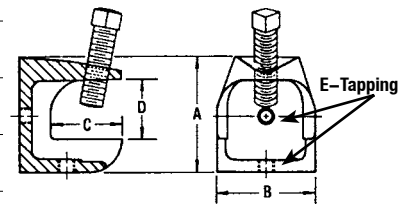
## Certifications and Compliances


- CSA Standard: C22.2 No. 18.4
- CSA Certified: 065178

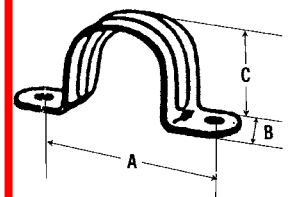
## Options

- PVC coating available on select clamps. Add suffix **-PVC** to catalog number.

Catalog Number	Dimensions in Inches/Millimeters					Weight Lbs./Kgs. Per 100
	A	B	C	D	E	
<b>Beam Clamps – Malleable Iron – Hot Dipped Galvanized</b>						
 BH-500 †	1.63/41.4	1.00/25.4	0.88/22.4	0.94/23.9	0.25/6.4 – 20.00/508.0	22.00/ 9.98
BH-500-10	1.63/41.4	1.00/25.4	0.88/22.4	0.94/23.9	10.00/254.0 – 24.00/609.6	21.5/ 9.75
BH-501 †	1.81/46.0	1.50/38.1	1.13/28.7	0.94/23.9	0.31/7.9 – 18.00/457.2	45.00/ 20.41
BH-502 †	2.06/52.3	2.00/50.8	1.38/35.1	1.00/25.4	0.38/9.7 – 16.00/406.4	83.00/ 37.65
BH-503 †	2.25/57.2	2.63/66.8	1.69/42.9	1.13/28.7	0.50/12.7 – 13.00/330.2	152.00/ 68.95



Catalog Number	Trade Size (Inches)	Dimensions in Inches/Millimeters				Hole Diameter	Weight Lbs./Kgs. Per 100
		A	B	C			
<b>2-Hole Straps – Steel/Zinc Electroplate</b>							
 CF-250	1/4	1.25/31.8	0.63/16.0	0.63/16.0	0.19/4.8	1.60/0.73	
CF-375	3/8	1.50/38.1	0.63/16.0	0.75/19.1	0.19/4.8	1.20/0.54	
CF-500	1/2	1.59/40.4	0.63/16.0	0.91/23.1	0.19/4.8	1.40/0.64	
CF-750	3/4	2.09/53.1	0.63/16.0	1.06/26.9	0.19/4.8	1.60/0.73	
CF-100	1	2.44/62.0	0.75/19.1	1.38/35.1	0.19/4.8	3.50/1.59	
CF-125	1-1/4	2.66/67.6	0.75/19.1	1.75/44.5	0.25/6.3	4.00/1.81	
CF-150	1-1/2	3.59/91.2	1.00/25.4	2.00/50.8	0.25/6.3	9.00/4.08	
CF-200	2	4.06/103.1	1.25/31.8	2.50/63.5	0.25/6.3	12.00/5.44	
CF-250H	2-1/2	4.38/111.3	1.00/25.4	2.81/71.4	0.27/6.9	5.70/2.59	
CF-300H	3	5.00/127.0	1.00/25.4	3.38/85.9	0.27/6.9	8.00/3.63	
CF-350H	3-1/2	6.25/158.8	1.00/25.4	3.88/98.6	0.33/8.4	8.70/3.95	
CF-400H	4	7.00/177.8	1.25/31.8	4.38/111.3	0.28/7.1	9.40/4.26	



† PVC coating available on select clamps. Add suffix **-PVC** to catalog number.

# Rigid/Intermediate Grade Conduit Fittings

- Conduit Clamps



## CABLE AND CONDUIT HANGERS – STEEL

With Bolt



Cat. #	Conduit Size EMT	Conduit Sizes Rigid	Unit Qty.	Std. Pkg.	Wt. Lbs. Per 100
0B	1/2"	3/8" & 1/2"	100	400	6
1B	3/4"	3/4"	100	400	6
2B	1"	1"	100	600	8
2 1/2 B	1 1/4"	—	100	—	10
3 B	1 1/2"	1 1/4"	100	—	11
4 B	—	1 1/2"	100	—	16
5 B	2"	2"	50	—	23
6 B	2 1/2"	2 1/2"	50	—	29
7 B	3"	3"	25	—	31
8 B	3 1/2"	3 1/2"	10	—	38
9 B	4"	4"	10	—	38

## CONDUIT CLAMPS

### Applications:

- Right Angle – to attach the conduit run at a 90° angle to a beam or structural member
- Paralled Type – to attach the conduit run parallel to a beam or structural member

### Right Angle Type – ElectroGalvanized – Iron



Cat. #	Trade Size	Load Rating Lbs	Std. Pkg.	Wt. Lbs. Per 100
RAC50HD	1/2"	30	50	37
RAC75HD	3/4"	50	50	40
RAC100HD	1"	60	50	42
RAC125HD	1 1/4"	75	25	49
RAC150HD	1 1/2"	80	25	54
RAC200HD	2"	100	25	71
RAC250HD	2 1/2"	125	10	95
RAC300HD	3"	165	10	107
RAC350HD	3 1/2"	200	10	120
RAC400HD	4"	330	10	131

Rigid Intermediate

## BEAM CLAMPS/INSULATOR SUPPORTS – MALLEABLE IRON

### Standard Finishes:

- Zinc Plated

UL File No. E-184283



Cat. #	Base Size	Jaw Open	Max. Wt. Support	Tapped Holes	Unit Qty.	Std. Pkg.	Wt. Lbs. Per 100
528	3/4"	5/8"	230	10 – 24	25	100	14
529	3/4"	5/8"	230	1/4" – 20	25	100	13
530	1"	3/4"	230	10 – 24	25	100	23
531	1"	3/4"	230	1/4" – 20	25	100	24
532	1 1/2"	3/4"	290	5/16" – 18	50	50	47
533	2"	7/8"	330	3/8" – 16	25	—	81
534	2 1/2"	7/8"	800	1/2" – 13	25	—	155

### Parallel Type – ElectroGalvanized – Iron



Cat. #	Trade Size	Load Rating Lbs	Std. Pkg.	Wt. Lbs. Per 100
PARC50HD	1/2"	30	50	50
PARC75HD	3/4"	50	50	53
PARC100HD	1"	60	50	60
PARC125HD	1 1/4"	75	25	70
PARC150HD	1 1/2"	80	25	82
PARC200HD	2"	100	25	132
PARC250HD	2 1/2"	125	25	192
PARC300HD	3"	165	10	194
PARC350HD	3 1/2"	200	10	216
PARC400HD	4"	330	10	232

## Beam Clamps/Insulator Supports – Steel



Cat. #	Base Size	Jaw Opening	Tapped Holes	Unit Qty.	Wt. Lbs. Per 100
529 S	3/4"	5/8"	1/4" – 20	50	13

# Rigid/Intermediate Grade Conduit Fittings

- Conduit Clamps



## CLAMPS – MALLEABLE IRON

### Applications:

- To support rigid conduit and IMC to mounting surface

UL File No. E-184283



Cat. #	Size	Unit Qty.	Std. Pkg.	Wt. Lbs. Per 100
510	1/2"	100	600	6
511	3/4"	50	300	8
512	1"	50	300	13
513	1 1/4"	25	100	20
514	1 1/2"	20	120	30
515	2"	10	60	64
516*	2 1/2"	5	30	104
517*	3"	2	12	120
518*	3 1/2"	2	12	150
519*	4"	2	12	220
520†	5"	1	5	380
521†	6"	1	5	690

\*Also for use with Thinwall (EMT) Conduit  
†Not UL Listed

## STRAPS – STEEL GALVANIZED

### Applications:

- Used to secure rigid conduit or IMC to mounting surface

### Two Hole

UL File No. E-184283



Cat. #	Size	Unit Qty.	Wt. Lbs. Per 100
496 2	3/8"	250	2
496 3	1/2"	150	2
496 4	3/4"	100	3
496 5	1"	50	7
496 6	1 1/4"	50	8
496 7	1 1/2"	50	10
496 8	2"	25	15
496 9	2 1/2"	25	19
496 10	3"	25	23
496 11	3 1/2"	25	93
496 12	4"	10	108

## CLAMPBACKS/SPACERS – MALLEABLE IRON

### Applications:

- To provide space between conduit and mounting surface

UL File No. E-184283



Cat. #	Size	Unit Qty.	Std. Pkg.	Wt. Lbs. Per 100
CB1	1/2"	25	300	8
CB2	3/4"	25	300	10
CB3	1"	25	100	12
CB4	1 1/4"	25	100	21
CB5	1 1/2"	25	100	42
CB6	2"	10	60	40
CB7	2 1/2"	10	60	49
CB8	3"	10	60	62
CB9	3 1/2"	10	10	91
CB10	4"	10	10	110
CB11†	5"	5	5	135
CB12†	6"	5	5	225

†Not UL Listed

## CLAMPS "SNAP-ON" – STEEL

### Applications:

- To support rigid conduit and IMC to mounting surface

### Heavy Gauge

UL File No. E-184283



Cat. #	Size	Unit Qty.	Std. Pkg.	Wt. Lbs. Per 100
410*	1/2"	100	500	5
411*	3/4"	50	500	6
412*	1"	50	250	11
413*	1 1/4"	50	250	13
414	1 1/2"	25	100	20
415	2"	25	25	22
206*	2 1/2"	25	25	64
207*	3"	25	25	71
208*	3 1/2"	10	10	120
209*	4"	10	10	130

\*CSA Certified

Rigid Intermediate

# Pipe Straps

For Rigid Conduit & IMC

## Type 14-S

Use: To support Rigid Conduit and IMC.

Features: Snap type - double ribbed

Material/Finish: Steel/Zinc Plated

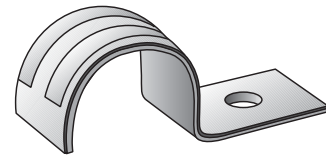
Applicable Third Party Standards:

Fed. Spec: FF-S-760

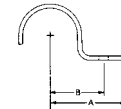
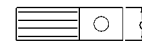
Note:

2½" through 4" sizes also suitable for EMT.

Trade Size (inches)	Steel Straps Catalog Number	Dimensions in Inches			Minimum Recommended Bolt Dia.
		A	B	C	
¼	14-50S	2¼	1¼ <sub>16</sub>	¾	¼
¾	14-75S	2¾	1½ <sub>16</sub>	¾	¼
1	14-100S	2¾	1½ <sub>16</sub>	¾	¼
1¼	14-125S	3½	1½ <sub>8</sub>	1	5 <sub>16</sub>
1½	14-150S	3¾	1 <sup>13</sup> / <sub>16</sub>	1½	¾
2	14-200S	4¾	2½	1¼	¾
2½	14-250S	6¾	2¾	1¼	½
3	14-300S	6¾	3	1¼	½
3½	14-350S	7¾	3¾	1½	5 <sub>8</sub>
4	14-400S	8¾	3 <sup>15</sup> / <sub>16</sub>	1½	5 <sub>8</sub>



Type 14-S



## Type THR

Use: To support Rigid Conduit and IMC.

Features: Snap type - double ribbed

Material/Finish: Steel/Zinc Plated

Third Party Certification:



CSA Certified: 104691

½" through 2" sizes only

Applicable Third Party Standards:

CSA C22.2 No.18

Fed. Spec: FF-S-760

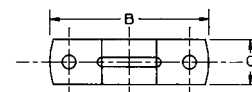
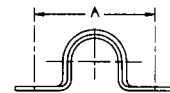
Note:

2½" through 4" sizes also suitable for EMT.

Trade Size (inches)	Steel Straps Catalog Number	Dimensions in Inches			Minimum Recommended Bolt Dia.
		A	B	C	
¼	THR-50S	1¾	2¼	5 <sub>8</sub>	¾
¾	THR-75S	1 <sup>27</sup> / <sub>32</sub>	2 <sup>5</sup> / <sub>16</sub>	¾	¾
1	THR-100S	2 <sup>5</sup> / <sub>16</sub>	2 <sup>15</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>32</sub>	¼
1¼	THR-125S	2 <sup>15</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>32</sub>	¼
1½	THR-150S	3 <sup>5</sup> / <sub>32</sub>	3 <sup>15</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>32</sub>	¼
2	THR-200S	4¼	5	2 <sup>3</sup> / <sub>32</sub>	¼
2½	THR-250S	4 <sup>11</sup> / <sub>16</sub>	5 <sup>23</sup> / <sub>32</sub>	1	5 <sub>16</sub>
3	THR-300S	5 <sup>11</sup> / <sub>16</sub>	6¾	1	5 <sub>16</sub>
3½	THR-350S	6 <sup>5</sup> / <sub>16</sub>	7 <sup>5</sup> / <sub>16</sub>	1	5 <sub>16</sub>
4	THR-400S	6 <sup>27</sup> / <sub>32</sub>	7 <sup>13</sup> / <sub>16</sub>	1	5 <sub>16</sub>



Type THR



## Type 14-G

Use:

To support Rigid Conduit and IMC.

Material/Finish:

Malleable Iron/Hot Dipped Galvanized

Third Party Certification:



CSA Certified: 009795.

Applicable Third Party Standards:

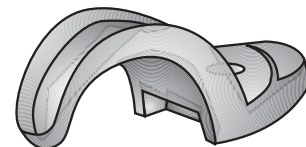
CSA: C22.2 No.18

Fed. Spec: FF-S-760

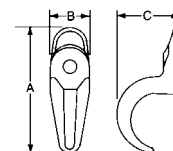
Note:

2½" through 4" sizes also suitable for EMT.

Malleable Straps Catalog Number	Conduit Size Inches	Dimensions in Inches			Minimum Recommended Bolt Dia.
		A	B	C	
14-18G	⅛	1 <sup>15</sup> / <sub>16</sub>	½	½	#10
14-25G	¼	1 <sup>19</sup> / <sub>32</sub>	1 <sup>9</sup> / <sub>32</sub>	5 <sub>8</sub>	¼
14-38G	⅜	1¼	5 <sub>8</sub>	¾	¼
14-50G	½	2¼	2 <sup>1</sup> / <sub>32</sub>	1 <sup>1</sup> / <sub>16</sub>	¼
14-75G	¾	2 <sup>9</sup> / <sub>16</sub>	¾	1 <sup>1</sup> / <sub>32</sub>	¼
14-100G	1	3 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>16</sub>	1½	¼
14-125G	1¼	3 <sup>1</sup> / <sub>4</sub>	7 <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	¾
14-150G	1½	6¼	1	2½	¾
14-200G	2	5 <sup>1</sup> / <sub>16</sub>	1½	2 <sup>1</sup> / <sub>16</sub>	½
14-250G	2½	5 <sup>5</sup> / <sub>16</sub>	1¾	3 <sup>1</sup> / <sub>16</sub>	½
14-300G	3	7 <sup>1</sup> / <sub>16</sub>	1¾	3 <sup>1</sup> / <sub>16</sub>	½
14-350G	3½	8 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4 <sup>3</sup> / <sub>8</sub>	¾
14-400G	4	8 <sup>1</sup> / <sub>16</sub>	2	5	¾
14-500G	5	10 <sup>7</sup> / <sub>16</sub>	2¼	6 <sup>1</sup> / <sub>2</sub>	¾
14-600G	6	12½	3 <sup>3</sup> / <sub>8</sub>	7½	1



Type 14-G



# Clamp Backs & Conduit Spacers

For Rigid Conduit, IMC & EMT

## Clamp Backs

### Use:

Provides spacing from mounting surface when used with malleable iron pipe straps.

### Material:

Malleable Iron

### Finish:

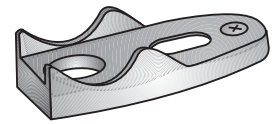
Hot Dip Galvanized

### Third Party Certification:

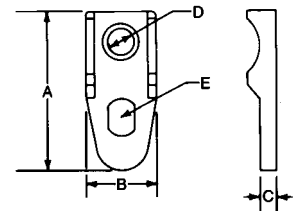


CSA Certified: 009795

Trade Size (inches)	Catalog Number	Dimensions in Inches				
		A	B	C	D	E
1/2	141G	1 1/16	1 1/8	3/8	3/8	3/8 x 1/2
3/4	142G	2 1/2	1 1/8	1/4	7/8	7/16 x 1/16
1	143G	3 3/16	1 1/8	3/16	3/8	9/16 x 1/16
1 1/4	144G	3 11/16	1 1/8	5/16	1/2	9/16 x 17/32
1 1/2	145G	3 9/16	1 1/2	3/16	9/16	19/32 x 23/32
2	146G	5 5/8	2	3/8	9/16	5/8 x 13/16
2 1/2	147G	5 3/4	2 1/2	3/8	1/32	5/8 x 1 1/8
3	148G	7 1/8	2 13/16	3/8	15/32	5/8 x 1 1/8
3 1/2	149G	8	3 3/32	7/16	15/32	1 1/16 x 1 11/32
4	150G	8 3/4	3 3/16	3/8	15/32	23/32 x 1 13/32
5	151G	10 1/16	3 7/16	1/2	1/32	7/32 x 1 17/16
6	152G	6	12	3 13/16	9/16	1 1/4 x 2



Clamp Back



### Applicable Third Party Standards:

CSA Standard: C22.2 No. 18

## Conduit Spacers

### Use:

For use with malleable iron pipe straps and clamp back, to provide additional spacing between conduit and mounting surface.

### Features:

- Spacers fit snugly under clamp back and makes possible additional spacing away from the mounting surface. Spacers can stack up into each other so that conduit can be installed at any desired distance from walls or ceilings.

### Materials:

Malleable Iron

### Finish:

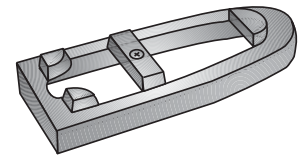
Hot Dip or Mechanical Galvanized

### Third Party Certification:

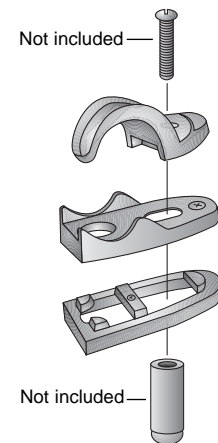


CSA Certified: 009795

Trade Size (inches)	Catalog Number	Dimensions in Inches		
		Length	Width	Thickness
1/2	141-NG	2 1/2	1 1/8	1/4
3/4	142-NG	2 1/2	1 1/8	1/4
1	143-NG	3 3/16	1 1/8	1/4
1 1/4	144-NG	3 3/4	1 1/4	1/4
1 1/2	145-NG	3 15/16	1 9/16	1/4
2	146-NG	5 5/16	2 3/16	1/4
2 1/2	147-NG	5 13/16	2 9/16	3/8
3	148-NG	7 3/16	2 13/16	3/8
3 1/2	149-NG	8	3 1/4	3/8
4	150-NG	8 3/4	3 7/16	3/8



Nest Back Fitting



Typical Installation



# Beam Clamps

## Type IS

### Use:

Provides support for conduit hanging systems.

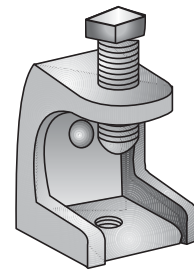
### Material:

Malleable Iron clamp  
Steel Screw, case hardened

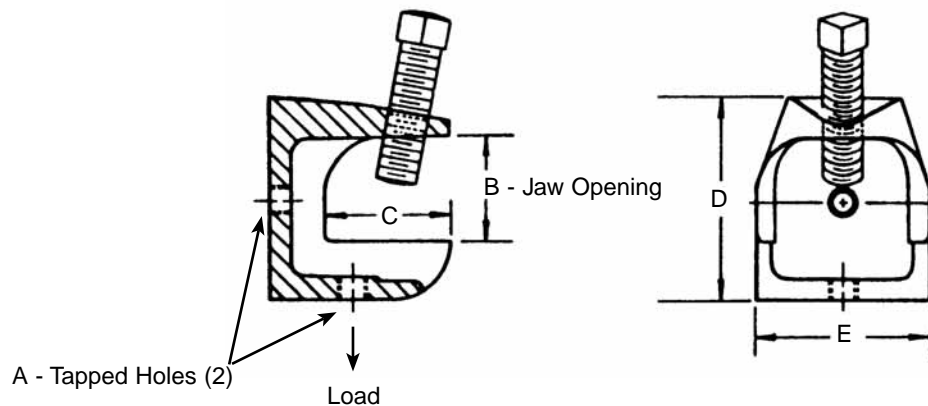
### Finish:

Clamp - Hot Dip Galvanized  
Screw - Zinc Electroplated

Catalog Number	A Tapped Holes	B Jaw Opening	Dimensions in Inches			Max. Load (lbs.)
			C	D	E	
IS-500	¼ - 20	1 <sup>5</sup> / <sub>16</sub>	7 <sup>7</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>8</sub>	1	335
IS-509	10 - 24	1 <sup>5</sup> / <sub>16</sub>	7 <sup>7</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>8</sub>	1	335
IS-501	5 <sup>5</sup> / <sub>16</sub> - 18	1 <sup>5</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>13</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	525
IS-502	3 <sup>3</sup> / <sub>8</sub> - 16	1	1 <sup>3</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	2	750
IS-503	½ - 13	1 <sup>1</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>4</sub>	2 <sup>5</sup> / <sub>8</sub>	900



Type IS



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**PANEL BOARDS,**  
**TRANSFORMERS, & SAFETY**  
**SWITCHES**

**Operations & Maintenance Manual**  
**December 2015**



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**For warranty support**

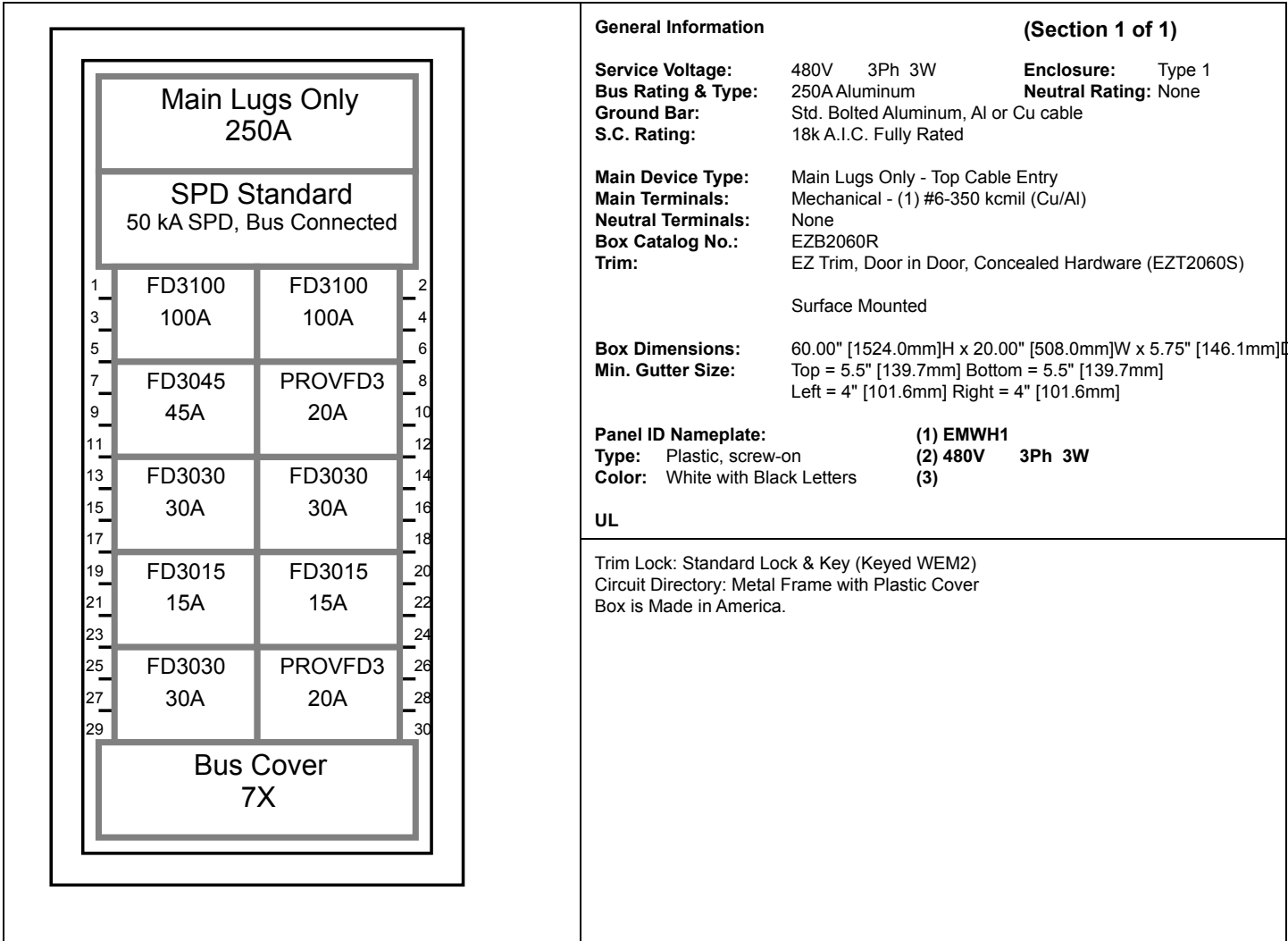
**877-ETNCARE**

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of Eaton Electrical products**

**(800) 525-2000**

**For on-site field service,  
commissioning & maintenance**

**(800) 498-2678**



**General Information (Section 1 of 1)**

**Service Voltage:** 480V 3Ph 3W  
**Bus Rating & Type:** 250A Aluminum  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 18k A.I.C. Fully Rated

**Enclosure:** Type 1  
**Neutral Rating:** None

**Main Device Type:** Main Lugs Only - Top Cable Entry  
**Main Terminals:** Mechanical - (1) #6-350 kcmil (Cu/Al)  
**Neutral Terminals:** None  
**Box Catalog No.:** EZB2060R  
**Trim:** EZ Trim, Door in Door, Concealed Hardware (EZT2060S)

Surface Mounted

**Box Dimensions:** 60.00" [1524.0mm]H x 20.00" [508.0mm]W x 5.75" [146.1mm]D  
**Min. Gutter Size:** Top = 5.5" [139.7mm] Bottom = 5.5" [139.7mm]  
 Left = 4" [101.6mm] Right = 4" [101.6mm]

**Panel ID Nameplate:** (1) EMWH1  
**Type:** Plastic, screw-on (2) 480V 3Ph 3W  
**Color:** White with Black Letters (3)

**UL**

Trim Lock: Standard Lock & Key (Keyed WEM2)  
 Circuit Directory: Metal Frame with Plastic Cover  
 Box is Made in America.

**Device Modifications:**

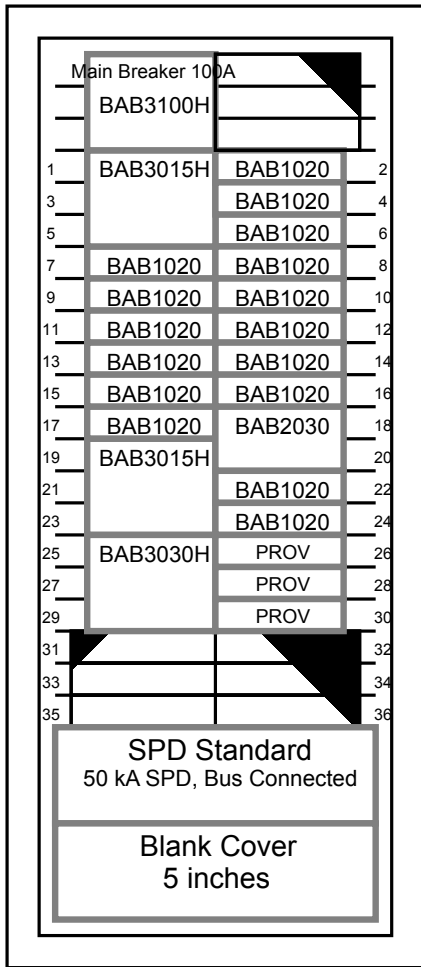
Ref #	Description

**Branch Devices**

Qty	Poles	Trip	Frame	Amps	kAIC
2	3	100	FD	225	18
2	3	15	FD	225	18
3	3	30	FD	225	18
1	3	45	FD	225	18
2	3		PROVFD3		

**Notes:**

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	APPROVED BY	DATE	JOB NAME CDOT - EJMT	DESIGNATION EMWH1	
	VERSION 1.0.0.3	TYPE PRL3a	DRAWING TYPE Final		
NEG-ALT Number DN800129X5K2-R000	REVISION 0	DWG SIZE A	G.O. SDN0598403	ITEM 0011	SHEET 1 of 1



**General Information**

**(Section 1 of 1)**

**Service Voltage:** 208Y/120V 3Ph 4W      **Enclosure:** Type 1  
**Bus Rating & Type:** 100A Aluminum      **Neutral Rating:** 100A  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 10k A.I.C. Fully Rated

**Main Device Type:** Main Breaker - Top Cable Entry  
**Main Terminals:** Mechanical - (1) #8-1/0 (Cu/Al)  
**Neutral Terminals:** Mechanical - (1) #14-1/0 (Cu/Al)  
**Box Catalog No.:** EZB2048R  
**Trim:** EZ Trim, Door in Door, Concealed Hardware (EZT2048S)

Surface Mounted

**Box Dimensions:** 48.00" [1219.2mm]H x 20.00" [508.0mm]W x 5.75" [146.1mm]D  
**Min. Gutter Size:** Top = 5.5" [139.7mm] Bottom = 5.5" [139.7mm]  
Left = 6.0" [152.4mm] Right = 6.0" [152.4mm]

**Panel ID Nameplate:** (1) EMWL1  
**Type:** Plastic, screw-on (2) 208Y/120V 3Ph 4W  
**Color:** White with Black Letters (3)

**NEC Lighting & Appliance, UL CTL** \*\*\*Non-Interchangeable Main Device\*\*\*

Trim Lock: Standard Lock & Key (Keyed WEM2)  
Circuit Directory: Metal Frame with Plastic Cover  
Box is Made in America.  
Main Circuit Breaker Trip Type: Thermal-Magnetic.

**Device Modifications:**  
Ref #      Description

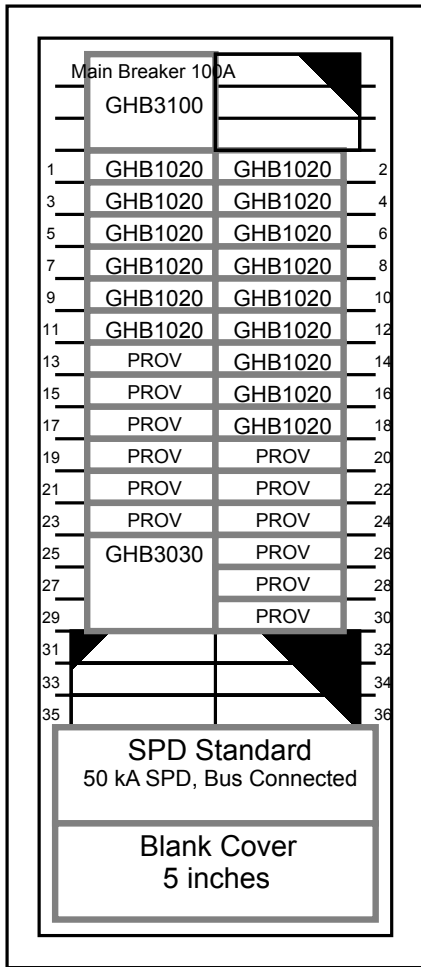
<b>Branch Devices</b>						
Qty	Poles	Trip	Frame	Amps	kAIC	
1	3	30	BAB	100	10	
2	3	15	BAB	100	10	
1	2	30	BAB	100	10	
16	1	20	BAB	100	10	
3	1		PROV			

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VERSION 1.0.0.3	TYPE PRL1a	DRAWING TYPE Final			
NEG-ALT Number DN800129X5K2-R000	REVISION 0	DWG SIZE A	G.O. SDN0598403	ITEM 002I	SHEET 1 of 1





**General Information**

**(Section 1 of 1)**

**Service Voltage:** 208Y/120V 3Ph 4W      **Enclosure:** Type 1  
**Bus Rating & Type:** 100A Aluminum      **Neutral Rating:** 100A  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 65k A.I.C. Fully Rated

**Main Device Type:** Main Breaker - Top Cable Entry  
**Main Terminals:** Mechanical - (1) #10-1/0 (Cu/Al)  
**Neutral Terminals:** Mechanical - (1) #14-1/0 (Cu/Al)  
**Box Catalog No.:** EZB2048R  
**Trim:** EZ Trim, Door in Door, Concealed Hardware (EZT2048S)

Surface Mounted

**Box Dimensions:** 48.00" [1219.2mm]H x 20.00" [508.0mm]W x 5.75" [146.1mm]D  
**Min. Gutter Size:** Top = 5.5" [139.7mm] Bottom = 5.5" [139.7mm]  
Left = 5.75" [146.1mm] Right = 5.75" [146.1mm]

**Panel ID Nameplate:** (1) EMEL1  
**Type:** Plastic, screw-on (2) 208Y/120V 3Ph 4W  
**Color:** White with Black Letters (3)

**NEC Lighting & Appliance, UL CTL** \*\*\*Non-Interchangeable Main Device\*\*\*

Trim Lock: Standard Lock & Key (Keyed WEM2)  
Circuit Directory: Metal Frame with Plastic Cover  
Box is Made in America.  
Main Circuit Breaker Trip Type: Thermal-Magnetic.

**Device Modifications:**  
Ref #      Description

Branch Devices						
Qty	Poles	Trip	Frame	Amps	kAIC	
1	3	30	GHB	100	65	
15	1	20	GHB	100	65	
12	1		PROV			

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APPROVED BY	DATE	JOB NAME CDOT - EJMT	DESIGNATION EMEL1		
VERSION 1.0.0.3	TYPE PRL2a	DRAWING TYPE Final			
NEG-ALT Number DN800129X5K2-R000	REVISION 0	DWG SIZE A	G.O. SDN0598403	ITEM 003I	SHEET 1 of 1



**ANSI/NEMA PB 1.1-2013**

*General Instructions for Proper Installation, Operation, and Maintenance of  
Panelboards Rated 600 Volts or Less*

*Published by*

**National Electrical Manufacturers Association**  
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## Foreword

This publication is a guide of practical information containing instructions for the proper installation, operation, and maintenance of panelboards rated 600 volts or less.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency regarding installation, operation, or maintenance.

It is recommended that work described in this set of instructions be performed only by qualified personnel familiar with the construction and operation of panelboards and that such work be performed only after reading this complete set of instructions. For specific information not covered by these instructions, you are urged to contact the manufacturer of the panelboard directly.

In the preparation of this standards publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product section by contacting the following: These recommendations will be reviewed periodically and updated as necessary.

Senior Technical Director, Operations  
National Electrical Manufacturers Association  
1300 North 17th Street, Suite 900  
Rosslyn, Virginia 22209

Publication PB 1.1- 2013 revises and supersedes PB 1.1-2007.

This standards publication was developed by the Panelboard and Distribution Board Product Group of the LVDE Section. Product Group approval of the standard does not necessarily imply that all Product Group members voted for its approval or participated in its development. At the time it was approved, the Product Group was composed of the following members:

Eaton Corporation.—Pittsburgh, PA  
GE Industrial Solutions—Plainville, CT  
Hubbell, Inc.—Orange, CT  
Milbank Manufacturing Company—Kansas City, MO  
Penn Panel & Box Company—Collingdale, PA  
Reliance Controls Corporation—Racine, WI  
Siemens Industry, Inc.—Norcross, GA  
Schneider Electric —Palatine, IL



## **Section 1**

### **SCOPE**

This publication covers single panelboards or groups of panel units suitable for assembly in the form of single panelboards, including buses, and with or without switches or automatic overload protective devices (fuses or circuit breakers), or both. These units are used in the distribution of electricity at 600 volts and less with:

1600—ampere mains or less

1200—ampere branch circuits or less

Specifically excluded are live-front panelboards, panelboards employing cast enclosures for special service conditions, and panelboards designed primarily for residential and light commercial service equipment.

## Section 2 REFERENCES

**National Fire Protection Association (NFPA)**  
Batterymarch Park  
Quincy, MA 02269

NFPA 70  
NFPA 70E

*National Electrical Code®*  
*Standard for Electrical Safety in the Workplace*

**National Electrical Manufacturers Association (NEMA)**  
1300 North 17th Street, Suite 900  
Rosslyn, Virginia 22209

AB 4

*Guidelines for Inspection and Preventative Maintenance of Molded Case Circuit  
Breakers Used in Commercial and Industrial Applications*

PB 2.2

*Application Guide for Ground Fault Protective Devices for Equipment*  
*Guidelines for Handling Water Damaged Electrical Products*

## Section 3 GENERAL

**WARNING—HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. UNLESS OTHERWISE SPECIFIED, INSPECTION AND MAINTENANCE SHOULD ONLY BE PERFORMED ON PANELBOARDS AND EQUIPMENT TO WHICH POWER HAS BEEN TURNED OFF, DISCONNECTED AND ELECTRICALLY ISOLATED SO THAT NO ACCIDENTAL CONTACT CAN BE MADE WITH ENERGIZED PARTS. FOLLOW ALL MANUFACTURER'S WARNINGS AND INSTRUCTIONS.**

Safety-related work practices, as described in NFPA 70E, should be followed at all times. All requirements of the *National Electrical Code*® NFPA 70 should be followed.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

### 3.1 SUCCESSFUL OPERATION OF PANELBOARDS

The successful operation of panelboards is dependent upon proper installation, operation, and maintenance. Neglecting fundamental installation and maintenance requirements may lead to personal injury, death, or damage to electrical equipment or other property.

### 3.2 QUALIFIED PERSONNEL

Installation, operation, and maintenance of panelboards should be conducted only by qualified personnel.

### 3.3 DEFINITION OF QUALIFIED PERSONNEL

For purposes of these guidelines, a qualified person is one who is familiar with the installation, construction, and operation of the equipment and the hazards involved. In addition, the person is:

#### 3.3.1 Requirements

Knowledgeable of the requirements of the *National Electrical Code*® and of all other applicable codes, laws, and standards.

#### 3.3.2 Established Safety Practices

Trained and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.

#### 3.3.3 Protective Equipment

Trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing in accordance with established safety practices.

#### 3.3.4 First Aid

Trained in rendering first aid.

### **3.4 SUITABLE RATINGS**

Verify that all equipment being installed has ratings suitable for the installation.

## **Section 4**

### **INSTALLATION OF PANELBOARD CABINETS (BOXES)**

#### **4.1 INSTALLATION INSTRUCTIONS**

Installation of the cabinet in a neat and workmanlike manner. Follow the manufacturer's installation instructions.

#### **4.2 LOCATION IN BUILDING**

Locate the cabinet so that it is readily accessible and not exposed to physical damage.

#### **4.3 FLAMMABLE MATERIAL**

Locate the cabinet well away from flammable material.

#### **4.4 UNUSUAL SERVICE CONDITIONS**

Do not locate the cabinet where it will be exposed to ambient temperatures above 40°C (104°F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, mechanical shock, high humidity, tilting, or unusual operating conditions, unless the cabinet/panelboard combination has been designed and so identified by the manufacturer for these conditions.

#### **4.5 INDOOR DAMP LOCATIONS**

Locate or shield the cabinet so as to prevent moisture and water from entering and accumulating therein. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

#### **4.6 WET LOCATIONS**

Cabinets should be specifically approved for wet locations. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

#### **4.7 CLEARANCE FROM CEILING**

Do not locate the cabinet against a non-fireproof ceiling; allow a space of 3 feet between the ceiling and cabinet unless an adequate fireproof shield is provided.

#### **4.8 SPACE AROUND THE CABINET**

When selecting a location, provide sufficient access and working space around the cabinet (see Section 110.26 of the *National Electrical Code*®). The width of the working space in front of the panelboard should be at least 30 inches, or the width of the cabinet, whichever is greater, and this space should not be used as storage. The working space should have adequate lighting and a minimum head room of 6 feet 6 inches.

#### **4.9 MOUNTING OF CABINET**

The cabinet should be reliably secured to the mounting surface. Do not depend on wooden plugs driven into holes in masonry, concrete, plaster, or similar materials. (See Section 110.13 of the *National Electrical Code*®.)

#### **4.10 FLUSH MOUNTING IN WALL**

In walls of concrete, tile, or other noncombustible material, install the cabinet so that its front edge will not set back more than 1/4 inch from the finished surface. In walls of wood or other combustible material, cabinets should be flush with or project beyond the finished surface. (See Section 312.3 of the *National Electrical Code*®.)

#### **4.11 UNUSED OPENINGS IN CABINET**

Effectively close unused openings in the cabinet to provide protection which is substantially equivalent to that afforded by the wall of the cabinet.

#### **4.12 GROUNDING OF PANELBOARD CABINETS**

Ground the cabinet as specified in Article 250 of the *National Electrical Code*®. When the cabinet contains service equipment, it is necessary to bond the cabinet to the grounded (neutral) service conductor.



## Section 5 INSTALLATION OF CONDUIT AND CONDUCTORS

### 5.1 CONDUITS INSTALLATION

Conduits should be installed so as to prevent moisture or water from entering and accumulating within the enclosure. Provision should be made to protect conductors from abrasion in accordance with Article 312 of the *National Electrical Code*®.

### 5.2 KNOCKOUTS REMOVAL

Knockouts should be removed as follows:

**IMPORTANT—Remove knockouts, ONE AT A TIME, alternating INWARD and OUTWARD.**

#### 5.2.1 First Step—Remove Center Knockout

Remove center knockout INWARD.

##### 5.2.1.1 Screwdriver Blade

Place screwdriver blade against point farthest from tie and strike INWARD (Figure 1). Bend back and forth to break tie.

#### 5.2.2 Next Step—Remove Rings

Remove rings ONE AT A TIME without straining remaining rings.

##### 5.2.2.1 Pry First Ring

Pry first ring OUTWARD with screwdriver midway between ties, using pliers flat against box under screwdriver (Figure 2). Bend ring sections OUTWARD with pliers, then back and forth to break ties (Figure 5-3).

##### 5.2.2.2 Second Ring

Remove second ring INWARD by striking screwdriver (with blade against point midway between ties) then breaking ring sections inward and back and forth to break ties.

### 5.3 NATIONAL ELECTRICAL CODE®, ARTICLE 300

Refer to the *National Electrical Code*®, Article 300 for proper wiring methods. See 6.7 for making proper connections.

### 5.4 CONDUCTOR LENGTH

Keep conductor length to a minimum within the wiring gutter. Excessive conductor length will result in additional heating and may result in overheating. However, conductors should be long enough to reach the terminal location in a manner that avoids strain on the terminal.

### 5.5 EXERCISE CARE

Exercise care to maintain the largest practical bending radius of conductors; otherwise the insulation may be damaged and terminal connections may become loosened. Deflection of conductors shall comply with *NEC*® Section 312.6.

**5.6 NATIONAL ELECTRICAL CODE®, SECTION 725.136**

Refer to the *National Electrical Code*®, Section 725.136 for the separation requirements for conductors of Class 2 and Class 3 remote-control, signaling and power-limited circuits.

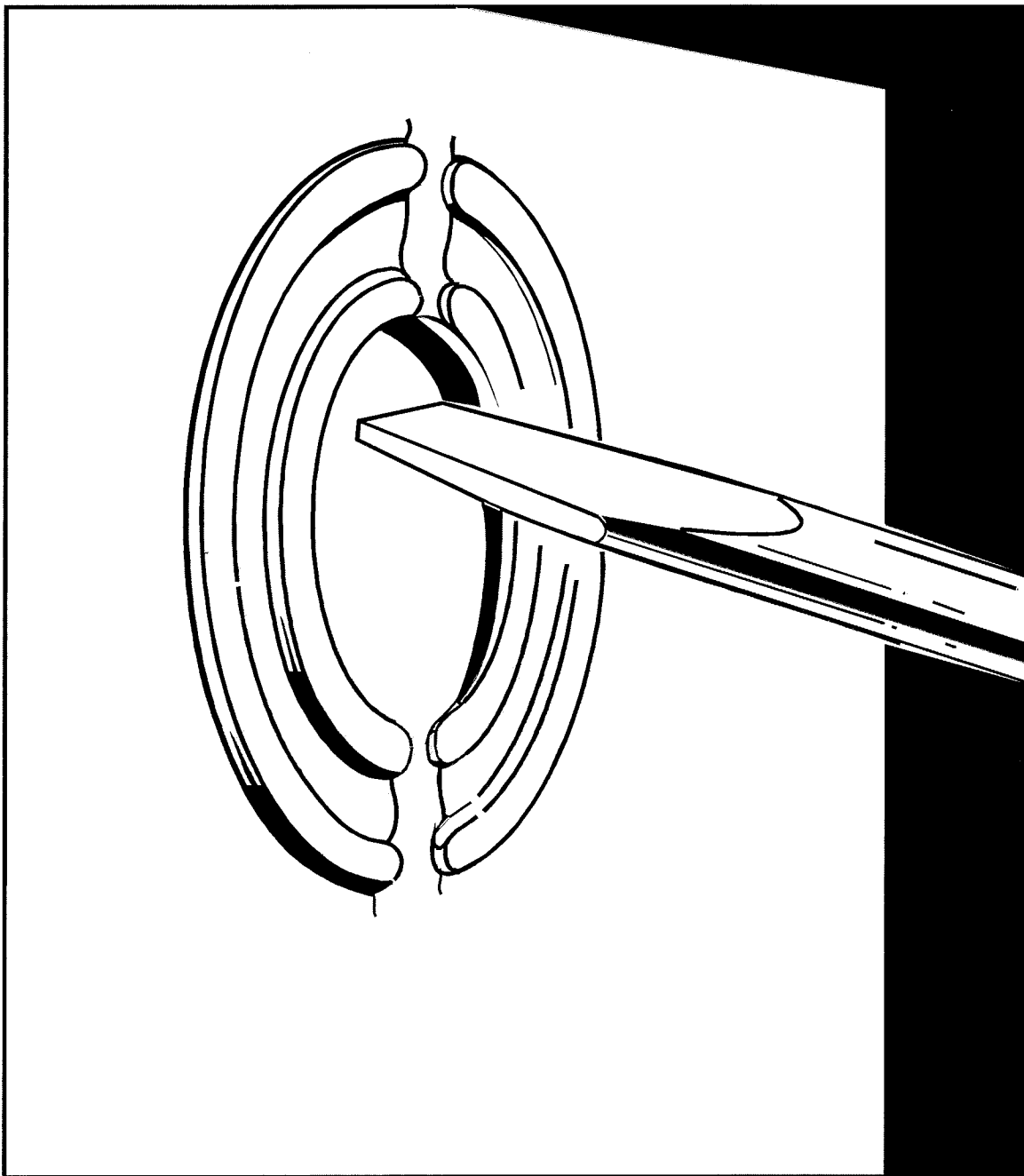


Figure 5-1  
KNOCKOUT REMOVAL—STEP 1

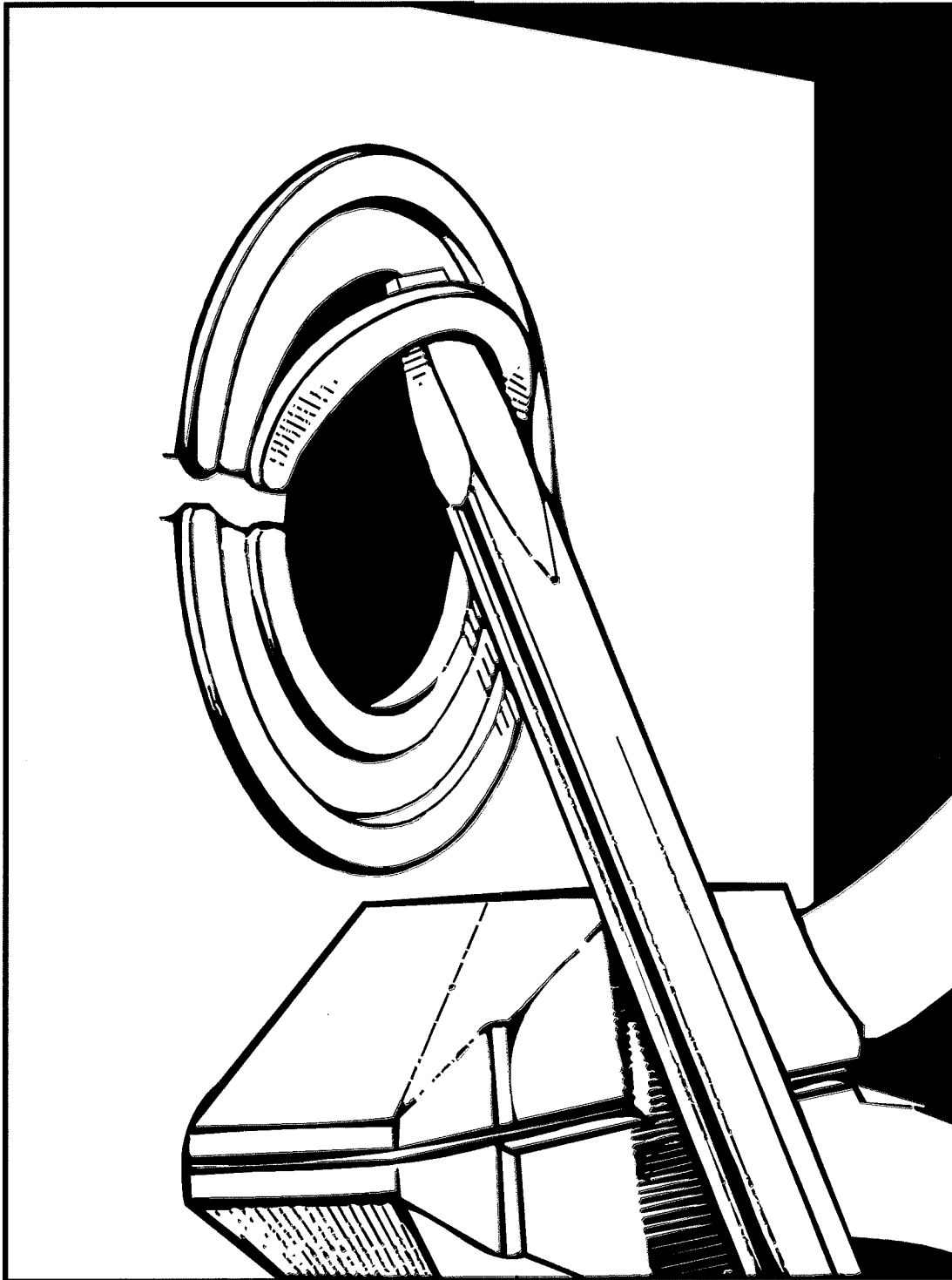


Figure 5-2  
KNOCKOUT REMOVAL—STEP 2

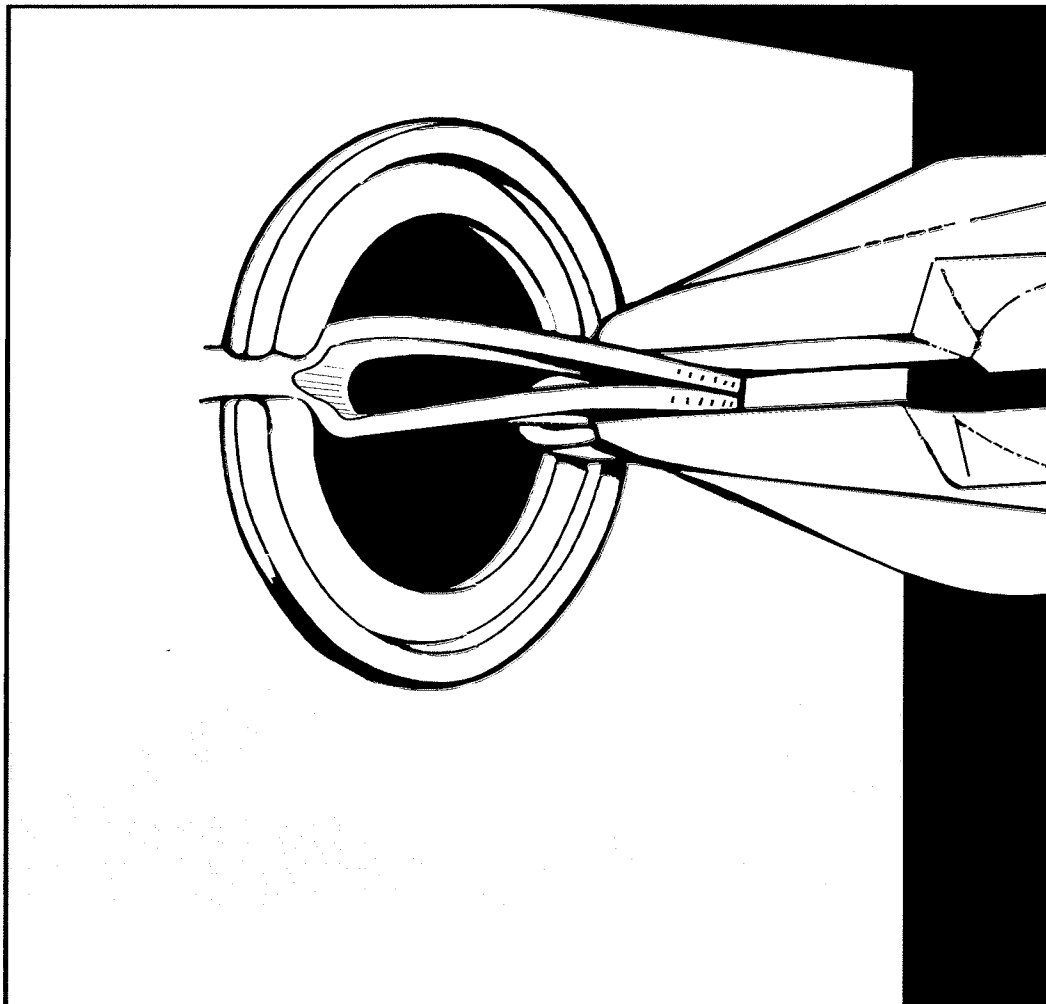


Figure 5-3  
KNOCKOUT REMOVAL—STEP 3

## **Section 6 INSTALLATION OF PANELBOARD**

### **6.1 PROPER STORAGE**

Store the panelboard in a clean, dry place located so that mechanical damage from work personnel in the area is not likely to happen.

### **6.2 UNPACKING**

Care should be exercised in unpacking the panelboard to prevent damage and loss of instruction materials and loose parts.

### **6.3 INSPECTION**

Check for shipping damage and check to make sure that the panelboard is the correct one for installation in the cabinet.

### **6.4 CARE**

Care should be taken to protect the panelboard internal parts from contamination during the installation process.

#### **6.4.1 Cleaning**

Clean the cabinet of all foreign materials. If parts at connection points are spattered with cement, plaster, paint, or other foreign material, remove the foreign materials with great care to avoid damage to the plating.

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### **6.5 MANUFACTURER'S INSTRUCTIONS**

Carefully follow the manufacturer's instructions and labels.

### **6.6 INSTALLATION**

#### **6.6.1 Alignment Devices**

Adjust the alignment devices where provided.

#### **6.6.2 Panelboard**

Install the panelboard, finalize its alignment, and tighten it securely in the cabinet.

#### **6.6.3 Flange of Deadfront Shield**

Unless otherwise instructed by the manufacturer, adjust the panelboard so that the flange of the deadfront shield is no more than 3/16 inch from (1) the front of the cabinet for surface mounting or (2) the surrounding wall surfaces for flush mounting.



## **6.7 LINE AND BRANCH CONDUCTORS**

Connect Line and Branch Conductors

### **6.7.1 Conductors**

Use care in stripping insulation from conductors so as not to nick or ring the conductor. For aluminum, clean all oxide from the stripped portion and apply an antioxidant compound.

#### **6.7.1.1 Wiring Gutters**

Distribute and arrange conductors neatly in the wiring gutters. (See Section 5.)

#### **6.7.1.2 Types and Temperature Ratings**

Care should be exercised to ensure that the types and temperature ratings of conductors being installed in the panelboard are suitable for use with the terminals, which have been provided.

#### **6.7.1.3 Tighten All Terminals**

Use the manufacturer's torque values. (See 7.1).

## **6.8 PANELBOARD GROUNDING AND BONDING**

Ground the panelboard cabinet in accordance with 4.12. (See Section 408.40 of the *National Electrical Code*®.)

### **6.8.1 Equipment Grounding Conductors**

Where separate equipment grounding conductors are used, prepare equipment grounding conductors in accordance with 6.7.1 and connect them to the equipment grounding terminal bar. Check to be sure that the terminal bar is securely bonded to the cabinet or panelboard frame and that it is not connected to the neutral bar except at service equipment (as permitted in Section 250.28 of the *National Electrical Code*®) or at separately derived systems (as permitted in Section 250.30 of the *National Electrical Code*®).

NOTE—An equipment grounding terminal bar is not always required. For example, when a properly installed metallic raceway is used as the equipment grounding path or when the grounded conductor terminals (neutral bar) complies with the conditions of the last sentence of Section 408.40 of the *National Electrical Code*®.

## **6.9 PROPER TYPE OR CLASS AND RATING**

When installing circuit breakers or fuses, ensure that they are of the proper type or class and rating.

## **6.10 DEBRIS**

Clean the cabinet of all debris, which has accumulated during the panelboard installation. Ensure that all foreign materials, including cement, plaster and paint (overspray) are cleaned and removed. Remove all such materials with great care to avoid damage to conductors, plating, etc. (see 6.4.1).

## **6.11 STEPS IN SECTION 7**

If the job is complete, perform the steps in Section 7 and then install the cabinet front (see Section 8).

## **Section 7**

### **STEPS TO BE TAKEN BEFORE ENERGIZING**

#### **7.1 ACCESSIBLE ELECTRICAL CONNECTIONS**

Tighten all accessible electrical connections to the manufacturer's torque specifications. If such information is not provided with the equipment, consult the manufacturer.

#### **7.2 BLOCKS AND PACKING MATERIALS**

Make certain that all blocks and packing materials used for shipment have been removed from all component devices and the panelboard.

#### **7.3 SWITCHES, CIRCUIT BREAKERS, AND OTHER OPERATING MECHANISMS**

Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely. If devices with self-test function are installed, perform test and verify proper operation per the manufacturer's instructions.

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

#### **7.4 SHORT CIRCUITS AND GROUND FAULTS**

To make sure that the system is free from short circuits and ground faults, conduct an insulation resistance test phase to ground and phase to phase with the switches or circuit breakers in both the open and closed positions. If the resistance reads less than 1 megohm while testing with the branch circuit devices in the open position, the system may be unsafe and should be investigated. If after investigation and possible correction, low readings are still observed, the manufacturer should be contacted. Some electronic equipment (metering, SPD, etc.) may be damaged by this testing. Refer to the manufacturer's equipment markings for guidelines.

#### **7.5 GROUND FAULT PROTECTION SYSTEM**

Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230.95 of the *National Electrical Code*® and NEMA PB 2.2, *Application Guide for Ground Fault Protective Devices for Equipment*.

#### **7.6 ADJUSTABLE TIME CURRENT TRIP DEVICE SETTINGS**

Set any adjustable time current trip device settings to the proper values.

NOTE—Experience has indicated that damage from overcurrent can be reduced if the devices used for overload and short-circuit protection are set to operate instantaneously (that is, without intentional time delay) at 115 percent of the highest value of phase current which is likely to occur as the result of any anticipated motor starting or welding currents.

#### **7.7 GROUNDING CONNECTIONS**

Check to determine that all grounding connections are properly made. If the panelboard is used as service equipment, make certain that the neutral, if present, is properly bonded to the cabinet.

## **7.8 FOREIGN MATERIAL**

Remove all foreign material from the panelboard and cabinet before installing the cabinet front. Make certain that all deadfront shields are properly aligned and tightened. Install the cabinet front in accordance with Section 8.

## **Section 8 INSTALLATION OF CABINET FRONT**

### **8.1 CABINET FRONT OR TRIM PACKAGE**

The cabinet front or trim package is designed to prevent damage to the front during shipment and handling.

### **8.2 UNPACKING**

Care should be used when unpacking and handling the cabinet front.

### **8.3 COVERS AND DOORS**

Install covers, close doors, and make certain that no conductors are pinched and that all enclosure parts are properly aligned and tightened. Hinged covers or doors must open a minimum of 90 degrees when installed.

### **8.4 TOUCH-UP**

A suitable paint or other corrosion-resistant finish should be applied to those places where the finish is damaged.

### **8.5 FRONT ALIGNMENT**

The cabinet front may be provided with an adjusting means to align it squarely with the building even though the cabinet may be slightly out of plumb with the building.

## **Section 9 ENERGIZING EQUIPMENT**

**WARNING—HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. ENERGIZING A PANELBOARD FOR THE FIRST TIME AFTER INITIAL INSTALLATION OR MAINTENANCE IS POTENTIALLY DANGEROUS.**

### **9.1 QUALIFIED PERSONNEL**

Only qualified personnel should energize equipment for the first time. If short circuit conditions caused by damage or poor installation practices have not been detected in the procedures specified in Section 7, serious personal injury and damage can occur when the power is turned on.

### **9.2 LOAD ON THE PANELBOARD**

There should be no load on the panelboard when it is energized. Turn off all of the downstream loads.

### **9.3 ENERGIZED IN SEQUENCE**

The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Turn the devices on with a firm positive motion.

### **9.4 LOADS SUCH AS LIGHTING CIRCUITS, CONTACTORS, HEATERS, AND MOTORS**

After all main, feeder, and branch circuit devices have been closed, loads such as lighting circuits, contactors, heaters, and motors may be turned on.

## Section 10 MAINTENANCE

### 10.1 MAINTENANCE PROGRAM

A maintenance program for panelboards should be conducted on a regularly scheduled basis in accordance with the following:

### 10.2 PANELBOARD WHICH HAS BEEN CARRYING ITS REGULAR LOAD FOR AT LEAST 3 HOURS

A panelboard which has been carrying its regular load for at least 3 hours just prior to inspection should be field tested by feeling the deadfront surfaces of circuit breakers, switches, interior trims, doors, and enclosure sides with the palm of the hand. If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary. Thermographic (infrared) scanning has become a useful method of investigating thermal performance.

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Safety related work practices, as described in NFPA 70E, should be followed at all times.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

### 10.3 INSPECT PANELBOARD ONCE EACH YEAR

Inspect the panelboard once each year or after any severe short circuit.

### 10.4 ACCUMULATION OF DUST AND DIRT

If there is an accumulation of dust and dirt, clean out the panelboard by using a brush, vacuum cleaner, or clean lint-free rags. Avoid blowing dust into circuit breakers or other components. Do not use a blower or compressed air.

#### 10.4.1 Visible Electrical Joints and Terminals

Carefully inspect all visible electrical joints and terminals in the bus and wiring system.

#### 10.4.2 Conductors and Connections

Visually check all conductors and connections to be certain that they are clean and secure. Loose and/or contaminated connections increase electrical resistance which can cause overheating. Such overheating is indicated by discoloration or flaking of insulation and/or metal parts. Pitting or melting of connecting surfaces is a sign of arcing due to a loose or otherwise poor connection. Parts which show evidence of overheating or looseness should be cleaned and re-torqued or replaced if damaged. Tighten bolts and nuts at bus joints to manufacturer's torque specifications.



**CAUTION—DO NOT REMOVE PLATING FROM ALUMINUM PARTS IN JOINTS OR TERMINATIONS. DAMAGE TO PLATING CAN RESULT IN OVERHEATING. REPLACE DAMAGED ALUMINUM PARTS.**

#### **10.4.3 Fuse Clip Contact Pressure and Contact Means**

Examine fuse clip contact pressure and contact means. If there is any sign of overheating or looseness, follow the manufacturer's maintenance instructions or replace the fuse clips. Loose fuse clips can result in overheating.

#### **10.4.4 Plug Fuses**

Re-tighten plug fuses.

#### **10.4.5 Conditions Which Caused Overheating**

Be sure that all conditions which caused the overheating have been corrected.

### **10.5 PROPER AMPERE, VOLTAGE, AND INTERRUPTING RATINGS**

Check circuit breakers, switches, and fuses to ensure they have the proper ampere, voltage, and interrupting ratings. Ensure that non-current-limiting devices are not used as replacements for current-limiting devices. Never attempt to defeat rejection mechanisms which are provided to prevent the installation of the incorrect class of fuse.

#### **10.5.1 Mechanisms Free and in Proper Working Order**

Operate each switch or circuit breaker several times to ensure that all mechanisms are free and in proper working order. Replace as required. See NEMA AB-4 for maintenance of molded case circuit breakers.

### **10.6 OPERATION OF ALL MECHANICAL COMPONENTS**

Check the operation of all mechanical components. Replace as required.

#### **10.6.1 Switch Operating Mechanisms**

Exercise switch operating mechanisms and external operators for circuit breakers to determine that they operate freely to their full on and off positions.

#### **10.6.2 Integrity of Electrical and Mechanical Interlocks**

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

#### **10.6.3 Missing or Broken Parts**

Whenever practical, check all devices for missing or broken parts, proper spring tension, free movement, corrosion, dirt, and excessive wear.

#### **10.6.4 Manufacturer's Instructions**

Adjust, clean, and lubricate or replace parts according to the manufacturer's instructions.

##### **10.6.4.1 Clean Nonmetallic Light Grease or Oil**

Use *clean* nonmetallic light grease or oil as instructed.

##### **10.6.4.2 Molded Case Circuit Breakers**

Do *not* oil or grease parts of molded case circuit breakers.

#### **10.6.4.3 Clean, Light Grease**

If no instructions are given on the devices, sliding copper contacts, operating mechanisms, and interlocks may be lubricated with clean, light grease.

#### **10.6.4.4 Excess Lubrication**

Wipe off excess lubrication to avoid contamination.

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#### **10.6.5 Accessible Copper Electrical Contacts, Blades, and Jaws**

Clean and dress readily accessible copper electrical contacts, blades, and jaws according to the manufacturer's instructions when inspection indicates the need.

### **10.7 DAMAGED INSULATING MATERIAL AND ASSEMBLIES**

Look for and replace damaged insulating material and assemblies where sealing compounds have deteriorated.

### **10.8 MOISTURE OR SIGNS OF PREVIOUS WETNESS OR DRIPPING**

Look for any moisture or signs of previous wetness or dripping inside the cabinet.

NOTE—Condensation in conduits or dripping from outside sources is one known cause of panelboard malfunction.

#### **10.8.1 Conduits Which Have Dripped Condensate**

Seal off any conduits which have dripped condensate, and provide means for further condensate to drain away from the panelboard.

#### **10.8.2 Cracks or Openings**

Seal off any cracks or openings which have allowed moisture to enter the enclosure. Eliminate the source of any dripping on the enclosure and any other source of moisture.

#### **10.8.3 Insulating Material Which is Damp or Wet**

Replace or thoroughly dry and clean any insulating material, which is damp or wet or shows an accumulation of deposited material from previous wettings.

#### **10.8.4 Component Devices Which Show Evidence of Moisture Damage**

Inspect all component devices. Replace any component device which shows evidence of moisture damage or has been subjected to water damage or flooding. Additional information may be found in the NEMA document "Guidelines for Handling Water Damaged Electrical Products."

### **10.9 BEFORE CLEANUP AND CORRECTIVE ACTION IS ATTEMPTED**

In the event of water damage, e.g., flooding or sprinkler discharge, the manufacturer should be consulted before clean up and corrective action is attempted.

#### **10.10 SEVERE ELECTRICAL SHORT CIRCUIT**

If a severe electrical short circuit has occurred, the excessive currents may have resulted in structural component and/or bus and conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. Examine all devices and bus supports for cracks or breakage. The manufacturer should be consulted before cleanup and correction is attempted.

#### **10.11 GROUND FAULT PROTECTION SYSTEM**

Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230.95 of the *National Electrical Code®* and NEMA PB 2.2 *Application Guide for Ground Fault Protective Devices for Equipment*.

#### **10.12 INSULATION RESISTANCE**

Check insulation resistance (see 7.4) under any of the following conditions:

##### **10.12.1 Severe Short Circuit**

If a severe short circuit has occurred (see 10.10);

##### **10.12.2 Parts Replaced**

If it has been necessary to replace parts or clean insulating surfaces;

##### **10.12.3 Panelboard Exposed to High Humidity**

If the panelboard has been exposed to high humidity, condensation, or dripping moisture.

## Section 11 PERMISSIBLE LOADING OF PANELBOARDS

### 11.1 **NATIONAL ELECTRICAL CODE®**

In compliance with the *National Electrical Code*®, the normal continuous loads (3 hours or more) of panelboard circuits should be not more than 80 percent of the rating of the overcurrent protective device, unless the marking of the device indicates that it is suitable for continuous duty at 100 percent of its rating.

### 11.2 **HARMONICS IN ELECTRICAL SYSTEM**

Some types of electrical equipment cause harmonics in the electrical system, which may result in overheating. This condition should be considered when determining panelboard loading.

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## Product Selection

QUICKLAG Type BAB  
Single-Pole

## QUICKLAG Type: BA 10,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
10	BAB1010	BAB2010	BAB2010H ③	BAB3010H ③
15	BAB1015 ①②	BAB2015	BAB2015H	BAB3015H
20	BAB1020 ①②	BAB2020	BAB2020H	BAB3020H
25	BAB1025	BAB2025	BAB2025H	BAB3025H
30	BAB1030	BAB2030	BAB2030H	BAB3030H
35	BAB1035	BAB2035	BAB2035H	BAB3035H
40	BAB1040	BAB2040	BAB2040H	BAB3040H
45	BAB1045	BAB2045	BAB2045H	BAB3045H
50	BAB1050	BAB2050	BAB2050H	BAB3050H
55	BAB1055	BAB2055	BAB2055H	BAB3055H
60	BAB1060	BAB2060	BAB2060H	BAB3060H
70	BAB1070	BAB2070	BAB2070H	BAB3070H
80	—	BAB2080	BAB2080H	BAB3080H
90	—	BAB2090	BAB2090H	BAB3090H
100	BAB1100	BAB2100	BAB2100H	BAB3100H
110	—	BAB2110	—	—
125	—	BAB2125	—	—

## QUICKLAG Type: BA Non-Automatic Switches

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
50	BAB1050N	—	BAB2050N	BAB3050N
60	BAB1060N	—	BAB2060N	BAB3060N
100	BAB1100N	—	BAB2100N	BAB3100N

## QUICKLAG Type: QBHW 22,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	QBHW1015 ①	QBHW2015	QBHW2015H	QBHW3015H
20	QBHW1020 ①	QBHW2020	QBHW2020H	QBHW3020H
25	QBHW1025	QBHW2025	QBHW2025H	QBHW3025H
30	QBHW1030	QBHW2030	QBHW2030H	QBHW3030H
35	QBHW1035	QBHW2035	QBHW2035H	QBHW3035H
40	QBHW1040	QBHW2040	QBHW2040H	QBHW3040H
45	QBHW1045	QBHW2045	QBHW2045H	QBHW3045H
50	QBHW1050	QBHW2050	QBHW2050H	QBHW3050H
55	QBHW1055	QBHW2055	QBHW2055H	QBHW3055H
60	QBHW1060	QBHW2060	QBHW2060H	QBHW3060H
70	QBHW1070	QBHW2070	QBHW2070H	QBHW3070H
80	—	QBHW2080	QBHW2080H	QBHW3080H
90	—	QBHW2090	QBHW2090H	QBHW3090H
100	—	QBHW2100	QBHW2100H	QBHW3100H
110	—	QBHW2110	—	—
125	—	QBHW2125	—	—

**Notes**

- ① Switching duty rated for 120 Vac fluorescent light applications.
- ② For special low-magnetic breaker, order **BAB1015L1** or **BAB1020L1**.
- ③ Not UL listed.



### QUICKLAG Type: HBAX 42,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	HBAX1015 <sup>①</sup>	HBAX2015	—	HBAX3015H
20	HBAX1020 <sup>①</sup>	HBAX2020	—	HBAX3020H
25	HBAX1025	HBAX2025	—	HBAX3025H
30	HBAX1030	HBAX2030	—	HBAX3030H
35	HBAX1035	HBAX2035	—	HBAX3035H
40	HBAX1040	HBAX2040	—	HBAX3040H
45	HBAX1045	HBAX2045	—	HBAX3045H
50	HBAX1050	HBAX2050	—	HBAX3050H
55	HBAX1055	HBAX2055	—	HBAX3055H
60	HBAX1060	HBAX2060	—	HBAX3060H
70	HBAX1070	HBAX2070	—	HBAX3070H
80	—	HBAX2080	—	HBAX3080H
80	—	HBAX2080	—	HBAX3080H
90	—	HBAX2090	—	HBAX3090H
100	—	HBAX2100	—	HBAX3100H

### QUICKLAG Type: HBAW 65,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	HBAW1015 <sup>①</sup>	HBAW2015	—	HBAW3015H
20	HBAW1020 <sup>①</sup>	HBAW2020	—	HBAW3020H
25	HBAW1025	HBAW2025	—	—
30	HBAW1030	HBAW2030	—	—

### Dimensions

Approximate Dimensions in Inches (mm)

### Shipping Data

Number of Poles	Carton Quantity	Approximate Weight Lbs (kg)	Dimensions
1	24	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)
2	12	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)
3	8	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)

### Note

<sup>①</sup> Switching duty rated for 120 Vac fluorescent light applications.



*Powering Business Worldwide*

# Eaton SPD Series Surge Protective Device For Integrated Units



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## 1.0 Introduction

### 1.1 Manual Organization

This Installation Manual describes the safe installation, testing and operation of the Eaton® SPD Series Surge Protective Device (SPD).

This manual is organized into seven sections, as follows:

- 1.0 Introduction
- 2.0 Installation
- 3.0 Operating Features
- 4.0 Troubleshooting
- 5.0 Specifications
- 6.0 Ordering Guidelines
- 7.0 Warranty

### 1.2 Product Overview

The Eaton SPD Series protects critical electrical and electronic equipment from damage by power surges. This is done by shunting high energy lightning surges (and other transient disturbances) away from the equipment being protected. It does this in nanoseconds by providing a low impedance surge path to ground while supporting power frequency voltage.

The Eaton SPD Series is designed to mount on Panelboards, Switchgear, Switchboards, Busway, and Motor Control Centers (MCCs). It is available with surge current capacity ratings from 50 to 400kA.

The Eaton SPD Series is available in three feature packages (Basic, Standard, and Standard with Surge Counter), as described in Section 3, "Operating Features." Each model is available in Delta, Wye, and Split Phase wiring configurations.

All Eaton SPD Series models have been tested and certified by Underwriter's Laboratory (UL®), to comply with UL Standard 1449, 3<sup>rd</sup> Edition.

Eaton's One-Port low-voltage Surge Protective Device Wye Models SPD120480Y2C, SPD160480Y2C, SPD200480Y2C and Delta Models SPD120480D2C, SPD160480D2C, SPD200480D2C meet the requirements of IEC 61643-11 / EN 61643-11, Part 11: Test Class II, and are intended to be installed in indoor applications with a degree of protection rated IP 00.

### 1.3 Safety Precautions

A licensed/qualified electrician must complete all instructions in this manual in accordance with the National Electric Code (NEC®), state, and local codes, or other applicable country codes. All applicable local electrical codes supersede these instructions.

#### **⚠WARNING**

**IMPROPER INSTALLATION COULD CAUSE DEATH, INJURY AND EQUIPMENT DAMAGE. FOLLOW ALL WARNINGS AND CAUTIONS. COMPLETELY READ AND UNDERSTAND THE INFORMATION IN THIS INSTRUCTION MANUAL BEFORE ATTEMPTING TO INSTALL OR OPERATE THIS EQUIPMENT.**

**IMPROPER WIRING COULD CAUSE DEATH, INJURY AND/OR EQUIPMENT DAMAGE. ONLY LICENSED/QUALIFIED ELECTRICIANS WHO ARE TRAINED IN THE INSTALLATION AND SERVICE OF ELECTRICAL SERVICES ARE TO INSTALL AND SERVICE THIS EQUIPMENT.**

**HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE SPD DURING NORMAL OPERATION. FOLLOW ALL SAFE WORK PRACTICES TO AVOID ELECTRICAL SHOCK.**

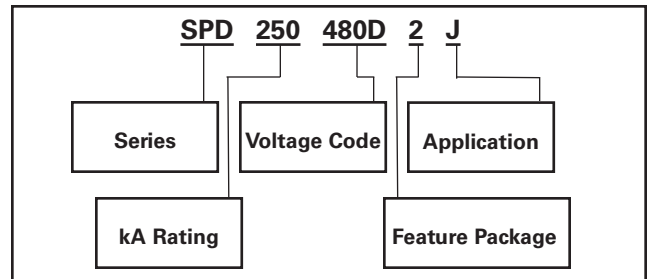
#### **⚠WARNING**

**ARC FLASH DURING INSTALLATION COULD CAUSE INJURY. USE APPROPRIATE SAFETY PRECAUTIONS AND EQUIPMENT FOR ARC FLASH PROTECTION.**

### 1.4 Catalog Numbering System

Each Eaton SPD Series unit has a name plate that identifies the parameters used for manufacture. These parameters are expressed in letters and numbers, to reflect the Series, kA Rating, Voltage Code, Feature Package, and Application.

**Table 1. Catalog Numbering System**



For example, a 480 volt Delta (3-wire plus Ground) for use in an MCC application requires an SPD model SPD 250480D2J, where:

SPD = SPD model,

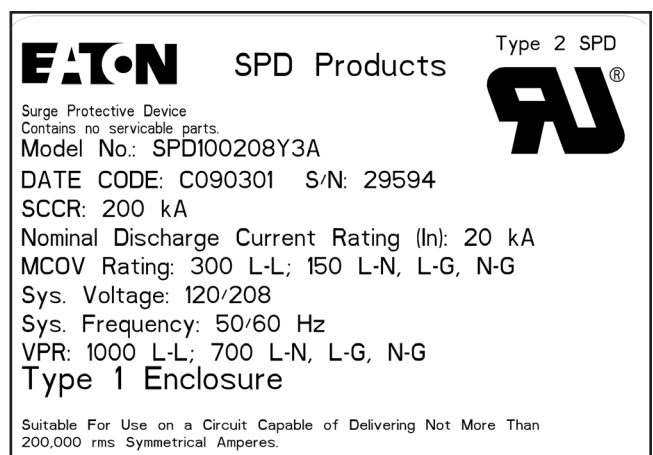
250 = the kA rating (50 – 400 kA),

480D = the voltage,

2 = the feature package (Basic, Standard, Standard With Surge Counter), and,

J = the Application Suffix (such as Direct Bus Mounted in a panelboard or Connected Through a Circuit Breaker).

These numbers appear as part of the product label attached to the front left side of the SPD. See Figure 1.



**Figure 1. Product Label**

## 1.5 Equipment Testing

### **⚠WARNING**

**CONDUCTING DIELECTRIC, MEGGER, OR HI-POTENTIAL TESTING WITH THE SPD INSTALLED WILL CAUSE INTERNAL DAMAGE TO THE SPD. THE SPD WILL ALSO CAUSE THE TEST TO FAIL.**

Every Eaton SPD Series unit is tested at the factory for dielectric breakdown. No further SPD testing is required for installation.

If you desire to test distribution equipment by performing dielectric, megger, or hi-potential tests, any installed SPD **must** be disconnected from the power distribution system to prevent damage to the unit.

Follow this procedure to safely disconnect the SPD:

1. Remove bus connected SPDs completely from the installation prior to performing any form of hi-potential testing.
2. Isolate SPDs connected via conductors as follows:
  - a. 3-wire delta SPDs: Turn off the circuit breaker to isolate the SPD, if connected through a circuit breaker.
  - b. Wye connected SPDs: Turn off the circuit breaker **and** remove the Neutral connection.
3. Remove MCC units with SPDs from the MCC structure.

## 2.0 Installation

### **⚠WARNING**

**INSTALLING AN SPD THAT IS IMPROPERLY RATED FOR THE ELECTRICAL SYSTEM VOLTAGE COULD CREATE A POTENTIALLY HAZARDOUS CONDITION, RESULTING IN INJURY OR EQUIPMENT DAMAGE.**

### 2.1 Preparation for Installation

#### **⚠CAUTION**

**EATON SPD SERIES PRODUCTS MUST BE INSTALLED OR REPLACED BY A QUALIFIED ELECTRICIAN TO AVOID INJURY OR EQUIPMENT DAMAGE.**

Before installing an Eaton SPD Series unit, do the following:

- Verify that the area is clear of any dirt, debris or clutter that may hamper the installation process.
- Verify that there is enough space in the cabinet or MCC to install the SPD. See Section 2.3, "Installation Procedures" for dimensions.
- Confirm that all tools and equipment needed for the installation are available.
- Confirm that the system voltage and wiring configuration is the same as the SPD you are installing. Check the voltage rating label on the front left side of the SPD. See Figure 1.

### **⚠WARNING**

**TURN OFF THE POWER SUPPLY BEFORE WORKING IN ANY ELECTRICAL CABINET OR ON ANY CIRCUIT BREAKER PANEL. FAILURE TO DO SO COULD RESULT IN INJURY OR DEATH FROM ELECTRICAL SHOCK.**

### **NOTICE**

**A POOR GROUND, OR GROUNDING/BONDING VIOLATIONS, COULD PREVENT THE SPD FROM PERFORMING AS SPECIFIED.**

**DO NOT USE THE SPD TO CARRY OR PASS THROUGH GROUND TO OTHER DEVICES OR LEADS. DAMAGE TO THE EQUIPMENT MAY RESULT.**

- Check the facility grounding system. All grounding, bonding, and earthing must meet the NEC and any other national, state and local electrical codes.

### 2.2 Installation Locations

Eaton's SPD Series can be installed directly to the bus for Panelboard applications.

The SPD can also be connected through a circuit breaker for installations in Panelboards, Switchboards, Switchgear, MCC's and Busway applications.

Follow these guidelines to determine the best location for mounting this product.

#### 2.2.1 Direct Bus Mount Applications

- Install the SPD on the load side of the main breaker. Connect the SPD directly to the bus located as close as possible to the main breaker.

#### 2.2.2 Connected Through a Circuit Breaker Applications

- Install the SPD next to the first breaker after the incoming main lugs or main breaker.

### 2.3 Installation Procedures

#### 2.3.1 Direct Bus Mount Applications

1. Verify that the SPD you are about to install is rated for the application voltage and system. See Table 5 in Section 6, "Ordering Guidelines".
2. Follow all national, state and local electrical codes when connecting the SPD.
3. Before mounting the SPD, first determine the bus bar configuration. If the panelboard uses an offset B-Phase bus bar configuration, no action is required. If the panelboard uses a coplanar bus bar configuration, remove the bus bar extension bushing from the back of the SPD and discard. See Figure 2.
4. Mount the SPD to the support brackets (customer supplied) using #10 fasteners and tighten to 4.1 Nm (36 in-lbs). See Figures 4 and 5 for mounting details.
5. Install the bus mount fasteners and tighten to 4.1 Nm (36 in-lbs). See Figure 3.

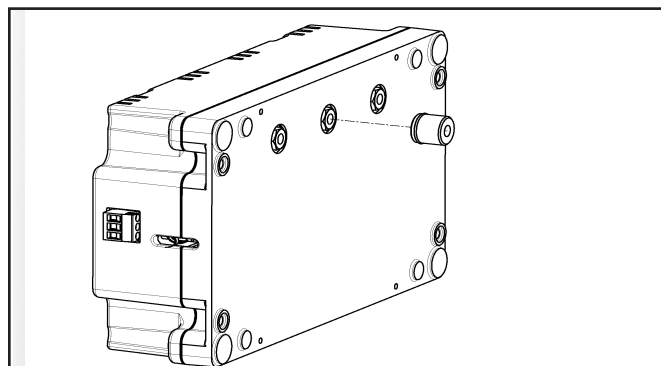


Figure 2. Bus Bar Extension Bushing



- Select the correct wiring diagram for the SPD you are installing. You must refer to this diagram while wiring the SPD. See Figures 6, 7, 8, and 9, on page 4.

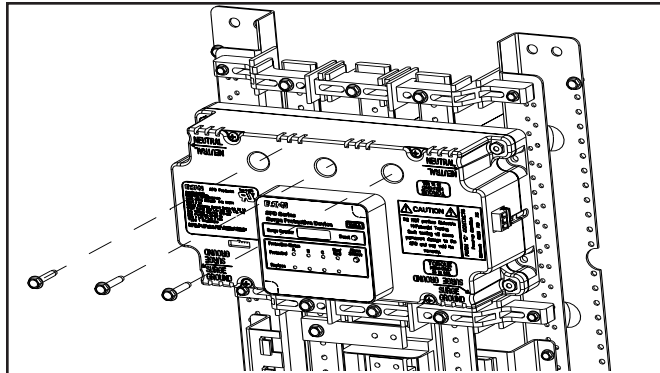


Figure 3. Bus Connection

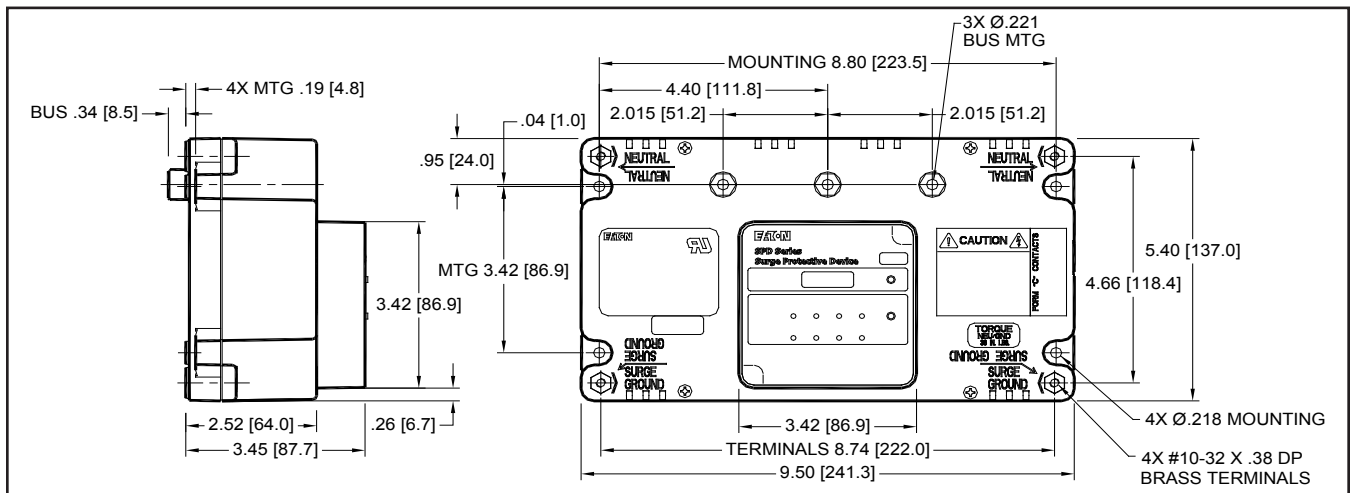


Figure 4. Dimensions for 50-200kA Units

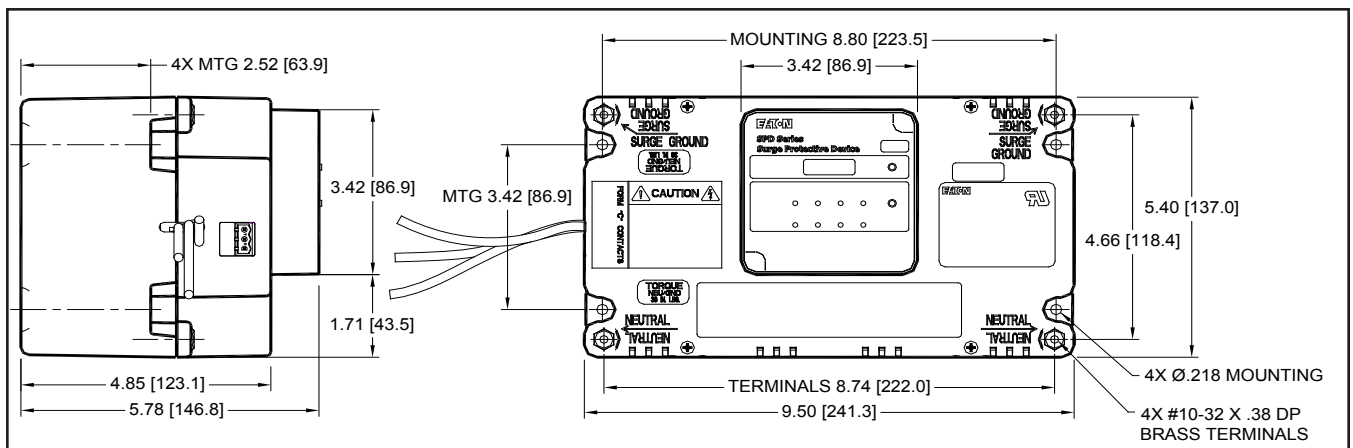


Figure 5. Dimensions for 250-400kA Units

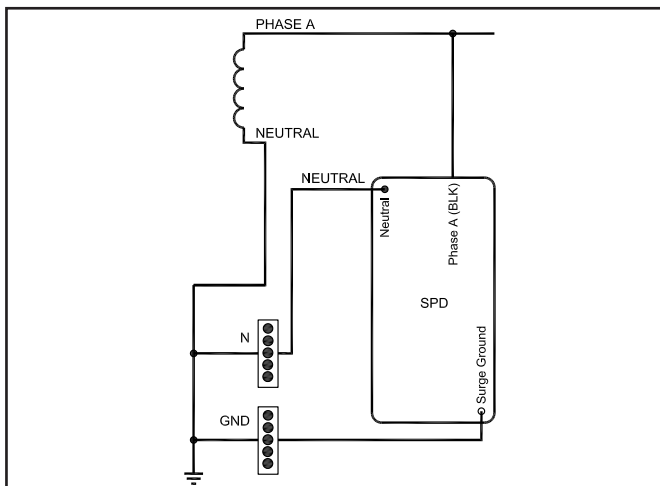


Figure 6. Wiring - Single Phase Units (230 L)

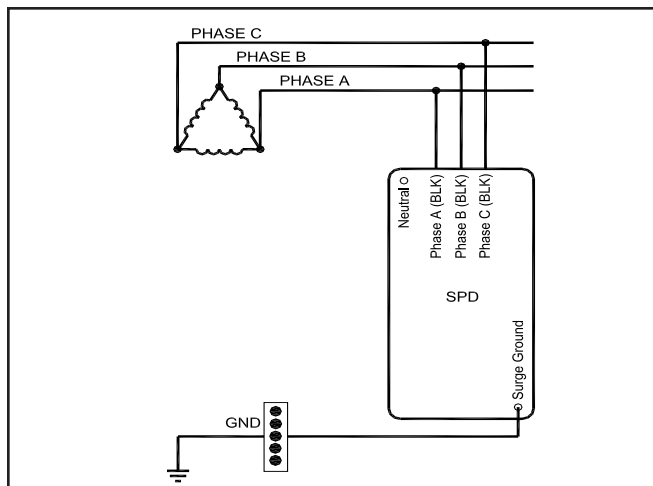


Figure 8. Wiring - 3-Phase Delta Units

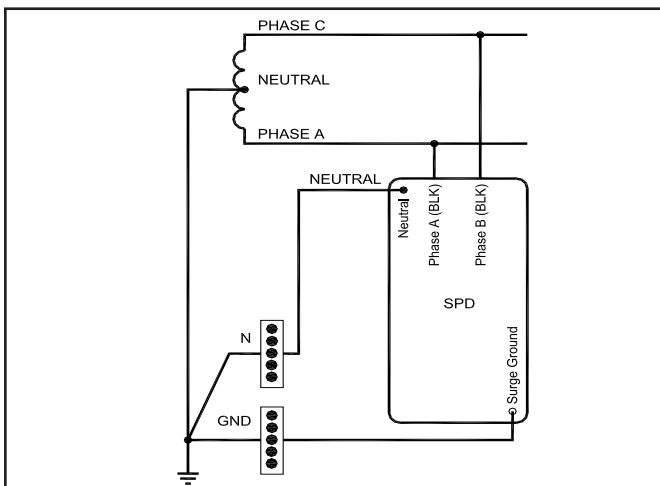


Figure 7. Wiring - Split Phase Units

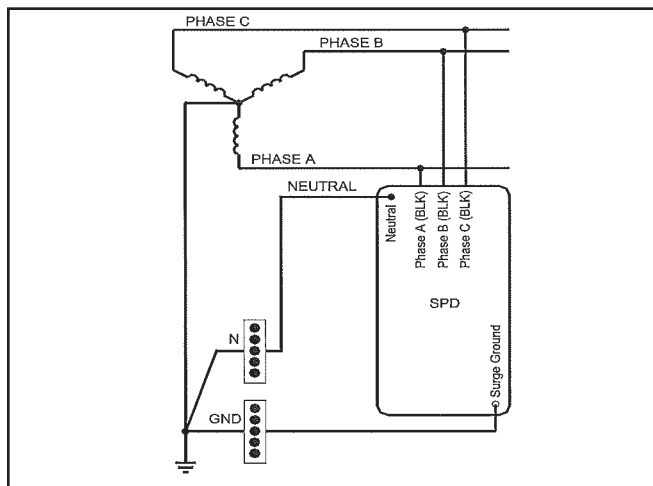


Figure 9. Wiring - 3-Phase Wye Units

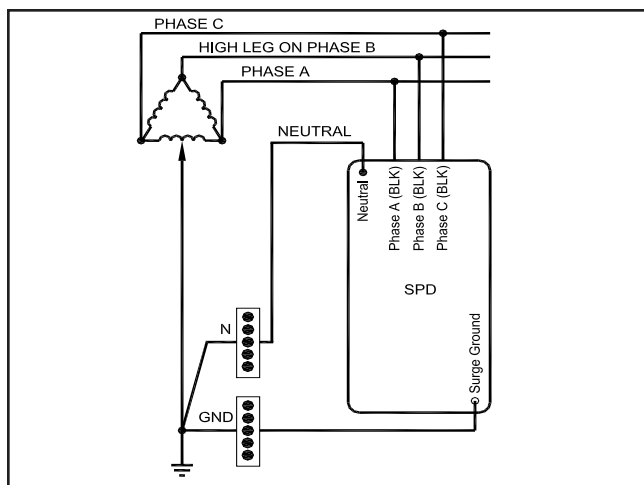


Figure 10. Wiring - High Leg Delta Units

**Note:** Please consult the factory for 240 delta high leg (4W+G) applications with high leg on the 'C' Phase.

- Connect the System Ground wire (green) to the SPD's Surge Ground connection using a ring terminal suitable for use with a #10 fastener and a #10-32 x 3/8" fastener (customer supplied). Tighten the Surge Ground connection to 4.1 Nm (36 in-lbs). If the system uses an isolated ground, connect the isolated ground wire to Surge Ground. There are two Surge Ground connection points provided on the SPD. Connect **only one** of them. See Figure 11.

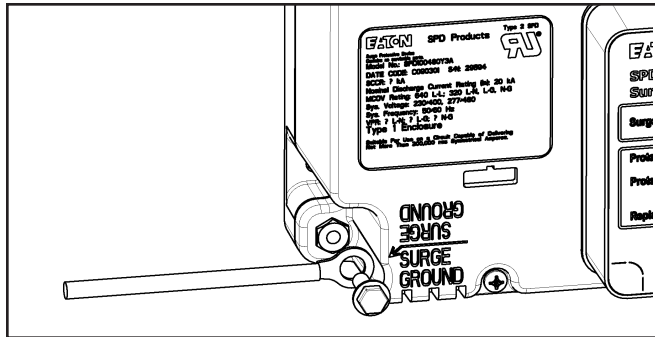


Figure 11. Ground Connection

- If equipped, connect the System Neutral wire (grey or white) to the SPD. Connect the System Neutral wire to the SPD's Neutral connection using a ring terminal suitable for use with a #10 fastener and a #10-32 x 3/8" fastener (customer supplied). Tighten the Neutral connection to 4.1 Nm (36 in-lbs). There are two Neutral connection points provided on the SPD. Connect **only one** of them. See Figure 12.

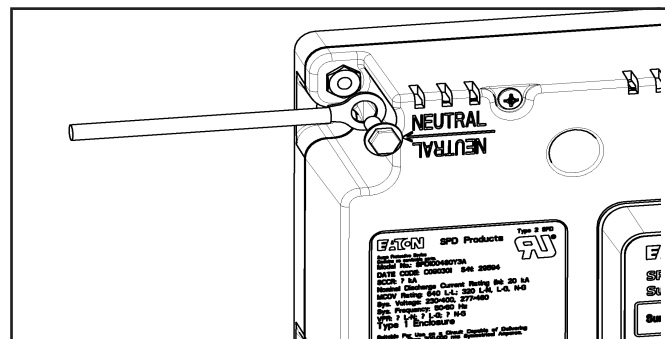


Figure 12. Neutral Connection

- The SPD (Standard and Standard with Surge Counter models) also has an available connection for remote monitoring of the Form C relay contacts. See Figure 13. This is a green connector located on the side of the SPD. To make the connection, remove the green connector and install the remote monitor leads (connector supports 12-24AWG wire). Fasten the remote monitoring wires to the N.O., N.C and COM connection points per the label on the front of the SPD. Contacts are rated: 150 Vac or 125 Vdc at 1A. Follow all national, state and local electrical codes. With wiring complete, plug the green connector into the SPD.

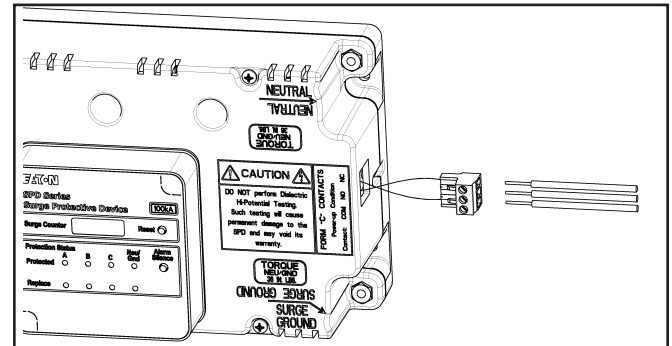


Figure 13. Form C Connection

- Install the dead-front panel to complete the installation.

### 2.3.2 Connected Through a Circuit Breaker Applications

- Verify that the SPD you are about to install is rated for the application voltage and system. See Table 5 in Section 6, "Ordering Guidelines".
- Follow all national, state and local electrical codes when connecting the SPD.
- Mount the SPD to the support brackets (customer supplied) using #10 x 2-3/4" fasteners and tighten to 4.1 Nm (36 in-lbs). For 50-200kA models, see Figure 4 for mounting dimensions. For 250-400kA models, see Figure 5 for mounting dimensions. **Note:** Mount the SPD as close as possible to the circuit breaker.
- Determine the wire length required to connect to the breaker and cut Phase wires to the appropriate length. (To maximize SPD performance, wire length should be as short as possible). **Note:** For wire lengths longer than 4", Phase wires should be twisted once for each 4" of wire length to maximize SPD performance.
- Connect Phase wire to circuit breaker. NEC requires that conductors to a surge device be protected by an overcurrent protection device. The cables on the SPD are #10 AWG, therefore would require a 30A 3-pole breaker. See Figure 14, and the wiring diagrams shown in Figures 6, 7, 8 and 9.

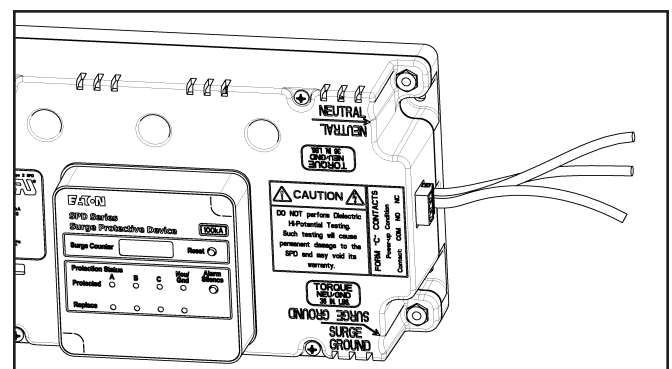


Figure 14. Phase Connections

6. Connect the System Ground wire (green) to the SPD's Surge Ground connection using a ring terminal suitable for use with a #10 fastener and #10-32 x 3/8" fastener (customer supplied). Tighten the Surge Ground connection to 4.1 Nm (36 in-lbs). If the system uses an isolated ground, connect the isolated ground wire to Surge Ground. There are two Surge Ground connection points provided on the SPD. Connect **only one** of them. See Figure 11.
7. If equipped, connect the System Neutral wire (grey or white) to the SPD. Connect the System Neutral wire to the SPD's Neutral connection using a ring terminal suitable for use with a #10 fastener and a #10-32 x 3/8" fastener (customer supplied). Tighten the Neutral connection to 4.1 Nm (36 in-lbs). There are two Neutral connection points provided on the SPD. Connect **only one** of them. See Figure 12.
8. The SPD (Standard and Standard with Surge Counter models) also has a connection available for remote monitoring of the Form C relay contacts. See Figure 14. This is a green connector located on the side of the SPD. To make the connection, remove the green connector and install the remote monitor leads (connector supports 12-24 AWG wire). Fasten the remote monitoring wires to the N.O., N.C. and COM connection points per the label on the front of the SPD. Contacts are rated: 150 Vac or 125 Vdc at 1A. Follow all national, state and local electrical codes. With wiring complete, plug the green connector into the SPD.
9. The final step of the SPD installation depends on the specific application. The various applications are listed below by catalog suffix.
  - a. Suffix 'B': This is the Remote Display Panel (RDP) option. The RDP option requires the addition of a factory supplied RDP cable. See Section 3.3, "Remote Display Panel (RDP) Option" for Cable Catalog numbers.
    1. Install the RDP using cutout and mounting dimensions provided in Figure 15.

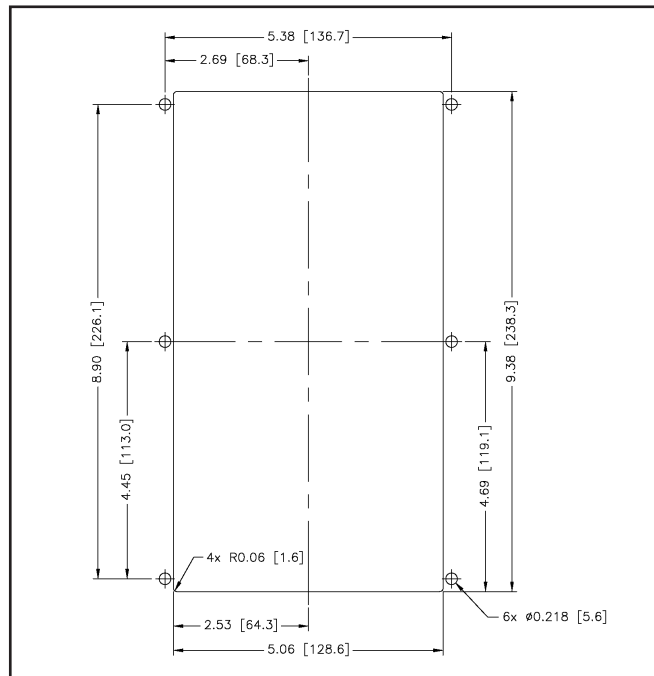


Figure 15. RDP Cutout and Mounting

2. Connect the RDP cable to the SPD. Use tie wraps (already on the SPD) to secure the cable to the SPD. See Figure 16. Cable can be routed as a right or left dress.

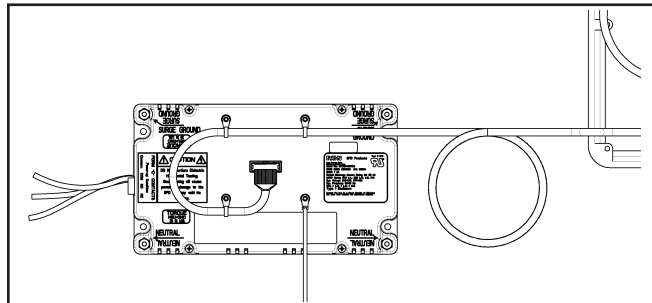


Figure 16. RDP to SPD Connection

3. Connect the RDP cable to the display. Use tie wraps (already on the RDP) to secure the cable to the RDP. See Figure 17.

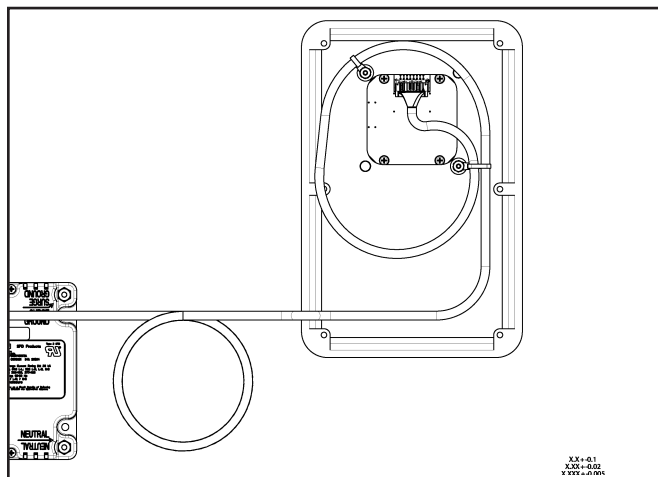


Figure 17. RDP Cable to Display Connection

- b. Suffix 'C': This unit is intended for use in Panelboard, Switchboard, and Busway applications.
  1. Ensure that the dead-front or door has the appropriate cut-out to accommodate the SPD Display. See Figure 4 or Figure 5.
  2. Install dead-front or door and secure.
- c. Suffix 'J': This unit is intended for MCC applications that require a NEMA 12 enclosure rating.
  1. Ensure that the MCC bucket door has the appropriate cut-out to accommodate the SPD Display. See Figure 4 or Figure 5.
  2. Place an appropriate NEMA 12 rated gasket around the Display opening on the inside of the door.
  3. Install the door and secure.

### 3.0 Operating Features

#### 3.1 General

The Eaton SPD Series comes in three feature packages: Basic, Standard, and Standard with Surge Counter. The operating specifics of each feature package are described below.

The Eaton SPD Series requires no operator involvement, other than to monitor the display panel to determine status of the SPD.

After system power is applied, the SPD automatically begins protecting downstream electrical equipment from voltage transients.

Some SPD units have a Form C relay contact that allows for the remote indication of SPD status. Form C contact wires are connected via a three terminal connector. See Figure 13.

#### 3.2 Displays and Indicators

All Eaton SPD Series units (Basic, Standard, and Standard With Surge Counter) use a display panel to indicate system status. The display panel is slightly different for each feature package.

Each display has both green and red light emitting diodes (LEDs) to indicate the status of the protection on each phase. Green indicates the phase is fully protected. Red indicates a loss of protection. Wye, Split Phase and High-Leg Delta units have an additional set of green/red LEDs to indicate status of Neutral/Ground protection.

When the LEDs turn red, an audible alarm will also sound on units equipped with an audible alarm.

Specific operating conditions displayed for each Eaton SPD Series Feature Package are described below.

##### 3.2.1 Basic Feature Package

The Eaton SPD Basic Feature Package display is shown in Figure 18.



Figure 18. Basic Feature Package Display

The Basic Feature Package has the following features:

- Green LEDs: Illumination indicates the phase is fully protected, and operating normally, with all protection active and available. Green LEDs also indicate Neutral to Ground protection on units with a Neutral wire. Green LEDs do not indicate on/off status of power.
- Red LEDs: Illumination indicates a loss of protection, and that one or more protective devices are now inactive and unavailable for that Phase. Red LEDs also indicate Neutral to Ground protection on units with a Neutral wire. Red LEDs do not indicate on/off status of power.

##### 3.2.2 Standard Feature Package

The Eaton SPD Series Standard Feature Package display is shown in Figure 19.



Figure 19. Standard Feature Package Display

The Standard Feature Package has the following features:

- All features of the Basic Feature Package.
- One Form C relay contact rated at 150Vac or 125Vdc @1A.
  - Normal operating conditions. N.O. = OPEN. N.C. = CLOSED.
  - Loss of protection on any phase or loss of power. N.O. = CLOSED. N.C. = OPEN.
- Audible alarm with Reset push button.
- EMI/RFI filtering.

##### 3.2.3 Standard With Surge Counter Feature Package

The Eaton SPD Series Standard With Surge Counter Feature Package display is shown in Figure 20.



Figure 20. Standard With Surge Counter Feature Package Display

The Standard With Surge Counter Feature Package has the following features:

- All features of the Standard Feature Package.
- LCD screen that displays surge count.
- Reset button to RESET the surge counter to zero.

### 3.2.4 SPD Display Rotation

The SPD display can be rotated on the SPD enclosure, up to 360 degrees. This allows you to position the display for the best visibility regardless of the position in which the SPD is installed.

Rotations are at 90, 180, and 270 degrees.

For a typical horizontal mounting see Figure 21. For a typical vertical mounting see Figure 22.

Reposition the SPD display as follows:

1. Remove power from the unit.
2. Remove and discard the perforated overlay material at the two opposite corners of the display.
3. Remove the two phillips head screws that hold the display.
4. Rotate the display to the desired position. Be careful not to overstress the display ribbon cable.
5. Place the display back onto the SPD enclosure. Again, be careful not to overstress or crimp the ribbon cable.
6. Replace the two phillips head screws. Tighten screws to 1.35 Nm (12 in-lbs).
7. Restore power to the unit.

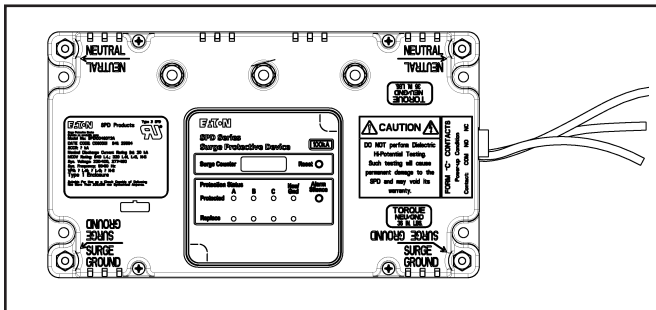


Figure 21. Typical Horizontal Display Mounting

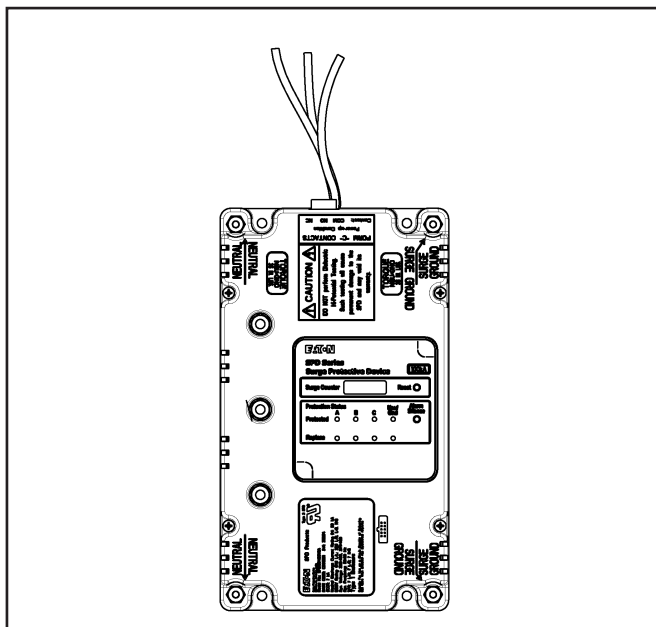


Figure 22. Typical Vertical Display Mounting

### 3.3 Remote Display Panel (RDP) Option

The Eaton Series SPD displays may be monitored on a remote display panel (RDP). This is indicated by the catalog style with a 'B' suffix (such as SPD250480D2B).

A separately purchased RDP cable is required to connect the SPD unit to the display.

Table 2 lists these cables and their part numbers.

Table 2. RDP Cable Options

Description	Catalog No.
4 ft. Cable for RDP	SPDRDCAB04
8 ft. Cable for RDP	SPDRDCAB08
12 ft. Cable for RDP	SPDRDCAB12

### 3.4 IEC Approved Models

Eaton's One-Port low-voltage Surge Protective Device Wye Models SPD120480Y2C, SPD160480Y2C, SPD200480Y2C and Delta Models SPD120480D2C, SPD160480D2C, SPD200480D2C meet the requirements of IEC 61643-11 / EN 61643-11, Part 11: Test Class II, and are intended to be installed in indoor applications with a degree of protection rated IP 00.

The SPD Delta and Wye Models are intended for use with a 3 Phase TN-S System with PE and Neutral Distribution, 5 conductor with a minimum 10 AWG or 6 mm<sup>2</sup>. The Delta Models are also intended for use with a 3 Phase TN-C System with PEN Distribution, 4 conductor with a minimum 10 AWG or 6mm<sup>2</sup>. Screws used for connection to ground shall be #10-32 x 3/8" and shall not be zinc or aluminum. This product is not serviceable and contains no replaceable parts.

Additional product information and ratings for IEC Applications:

- The SPD contains internal disconnects with a short circuit current rating  $I_{SCCR}$  of 200kA.
- Residual Current IPE for this product is 5 mA.
- Operating temperature is Normal -5°C to 40°C (23°F to 104°F).
- Humidity range is 5% through 95% non-condensing.
- The SPD may be mounted directly to earthed conductive surface, installed as per this manual.
- Temporary overvoltage rating  $U_T = 402.6$  V.
- Withstand or safe failure mode, for  $t_T = 120$  minutes,  $U_T = 526$  V.
- Modes of protection as marked on a Wye SPD = L-L, L-N, L-G(PE), N-G(PE).
- Modes of protection as marked on a Delta SPD = L-L, L-G(PE).



## 4.0 Troubleshooting

Many SPD failures result from improper installation. Once the SPD is installed properly, it is a highly reliable unit.

If the SPD does not function properly, first confirm that it is installed properly. See Section 2, "Installation."

If the SPD malfunctions after it has been operating routinely, refer to Table 3. This Troubleshooting Chart identifies possible causes and solutions to the malfunction. Further assistance may be obtained by calling Eaton's Applications Engineers, at 1-800-809-2772, option 4, sub-option 2, including being directed to the warranty process if applicable.

**Table 3. Troubleshooting Chart**

Condition	Probable Cause	Solution
Green LEDs ON (1 per phase) and one Green LED ON for Neu/Gnd Protection	Normal operation	N/A.
Audible Alarm OFF, Form C (N.C.) contact in the CLOSED state	Normal operation	N/A.
Phase Green LED is OFF, same Phase Red LED is ON, Audible Alarm is ON	Phase protection compromised or lost Extended Temporary Overvoltage (TOV) Significant surge event	Replace SPD Check electrical system for TOV sources, correct, replace SPD Replace SPD
Neu/Gnd Green LED is OFF, Neu/Gnd Red LED is ON, Audible Alarm is ON (for models with Neutral connections)	Neu/Gnd protection is compromised or lost Significant surge event	Replace SPD Replace SPD
All phase Green LEDs OFF, all phase RED LEDs ON, Audible Alarm is ON	All phase protection is compromised or lost SPD <u>rated</u> voltage is less than <u>system</u> voltage Extended Temporary Overvoltage (TOV) Significant surge event	Replace SPD Replace SPD with correct voltage model Check electrical system for TOV sources, correct, replace SPD Replace SPD
One of the display Red LEDs is ON. Audible Alarm is OFF	Audible Alarm Silence button has been depressed and Alarm is silenced	Normal operation If power is cycled and a fault condition still exists, the Audible Alarm will reactivate
All Green and Red LEDs are OFF, LCD display (on Surge Counter models) is OFF	SPD is not connected to a power source	Check system voltage at SPD connection Check SPD connections

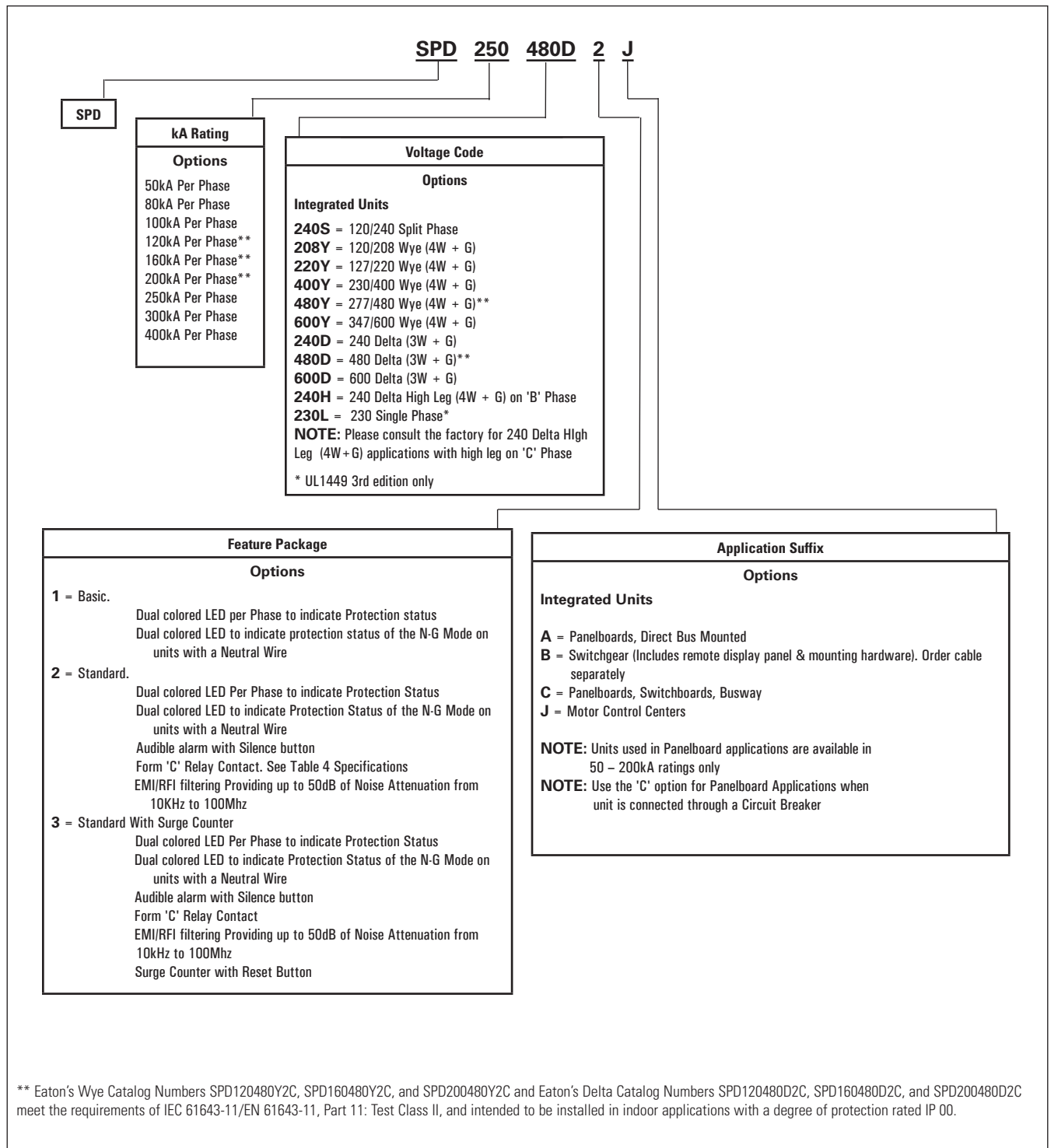
## 5.0 Specifications

**Table 4. Specifications**

Description	Specification
Surge current capacity per phase	50, 80, 100, 120, 160, 200, 250, 300, 400 kA ratings available
Nominal discharge current (I <sub>n</sub> )	20kA
Short circuit current rating (SCCR)	200kA
SPD Type	Basic feature package = Type 1 (can also be used in Type 2 applications) Standard and Standard with Surge Counter feature packages = Type 2
Standard split phase voltages available	120/240
Single phase	230
Three phase wye system voltages available	120/208, 127/220, 230/400, 277/480, 347/600
Three phase delta system voltages	240, 480, 600
Three phase high leg delta system voltages	120/240
Input Power Frequency	50/60 Hz
Power consumption (Basic units) 208Y, 220Y, 230L, 240S, 240D, and 240H voltage codes	0.5W
400Y and 480Y and 480D voltage codes	1.1W
600Y and 600D voltage codes	1.3W
Power consumption (Standard and Standard with Surge Counter units) 208Y, 220Y, 230L, 240S, 240D, and 240H voltage codes	0.6W
400Y, 480Y, and 480D Basic voltage codes	1.7W
600Y and 600D voltage codes	2.1W
Protection modes	Single split phase .....L-N, L-G, N-G, L-L Single phase .....L-N, L-G, N-G Three phase Wye..... L-N, L-G, N-G, L-L Three phase delta.....L-G, L-L Three phase high leg delta.....L-N, L-G, N-G, L-L
Maximum continuous operating voltage (MCOV) 208Y, 220Y, 240S, 240D, and 240H voltage codes	150 L-N, 150 L-G, 150 N-G, 300 L-L
230L, 400Y and 480Y voltage codes	320 L-N, 320 L-G, 320 N-G, 640 L-L
600Y voltage code	420 L-N, 420 L-G, 420 N-G, 840 L-L
240 D voltage code	320 L-G, 320 L-L
480 D voltage code	640L- L-G, 640 L-L
600D voltage code	840 L-G, 840 L-L
Ports	1
Operating temperature	-40 through 50° C (-40 through 122° F)
Operating humidity	5% through 95%, non-condensing
Operating altitude	Up to 16,000 ft (5000 m)
Seismic withstand capability	Meets or exceeds the requirements specified in the IBC® 2006, CBC 2007, and UBC® Zone 4
Weight	50-200kA - Approximately 1.6 kg (3.5 lbs) – 250 - 400kA - Approximately 3.2kg (7.0 lbs)
Form C relay contact ratings	150 Vac or 125 Vdc, 1A maximum
Form C relay contact logic	Power on, normal state - NO contact = OPEN, NC contact = CLOSED Power off, fault state, - NO contact = CLOSED, NC contact = OPEN
EMI/RFI filtering attenuation (Standard and Standard With Surge Counter)	Up to 50 dB from 10 kHz to 100 MHz
Agency certifications and approvals	UL1449 3rd Edition recognized component for the US and Canada, UL1283 (Type 2 SPDs only) IEC 61643-11/EN 61643-11, Part 11: Test Class II. See Section 6.0 Ordering Guidelines for specific models.
Warranty	10 Years, 15 Years if the product is properly registered with Eaton.

## 6.0 Ordering Guidelines

Table 5. Eaton SPD Series



**Example: SPD 250480D2J = SPD Series, 250kA Per Phase, 480D Voltage, Standard Feature Package, Motor Control Center Application.**

## 7.0 Warranty

Eaton warrants these products for a period of 10 years from the date of delivery to the purchaser, 15 years if the product is properly registered with Eaton, to be free from defects in both workmanship and materials. Eaton assumes no risk or liability for results of the use of the products purchased from it, including but without limiting the generality of the foregoing: (1) The use in combination with any electrical or electronic components, circuits, systems, assemblies, or any other materials or substances; (2) Unsuitability of any product for use in any circuit or assembly.

Purchaser's rights under the warranty shall consist solely of requiring Eaton to repair, or at Eaton's sole discretion, replace, free of charge, F.O.B. factory, and defective items received at said factory within said term determined by Eaton to be defective. The giving of or failure to give any advice or recommendations by Eaton shall not constitute any warranty by or impose any liability upon Eaton. The foregoing constitutes the sole and exclusive liability of Eaton AND IS IN LIEU OF ANY AND ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY AS TO THE MERCHANTABILITY, FITNESS FOR PURPOSE SOLD, DESCRIPTION, QUALITY, PRODUCTIVENESS OR ANY OTHER MATTER.

In no event shall Eaton be liable for special or consequential damages or for delay in performance of the warranty.

This warranty does not apply if the product has been misused, abused, altered, tampered with, or used in applications other than specified on the nameplate. At the end of the warranty period, Eaton shall be under no further warranty obligation expressed or implied.

The product covered by this warranty certificate can only be repaired or replaced by the factory. For help on troubleshooting the SPD, or for warranty information, call 1-800-809-2772, Option 4, sub-option 2. Repair or replacement units will be returned collect. If Eaton finds the return to be a manufacturer's defect, the product will be returned prepaid.

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Electrical Sector  
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Cleveland OH 44122  
United States  
1-800-809-2772, option 4, sub-option 2  
Eaton.com

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*Powering Business Worldwide*



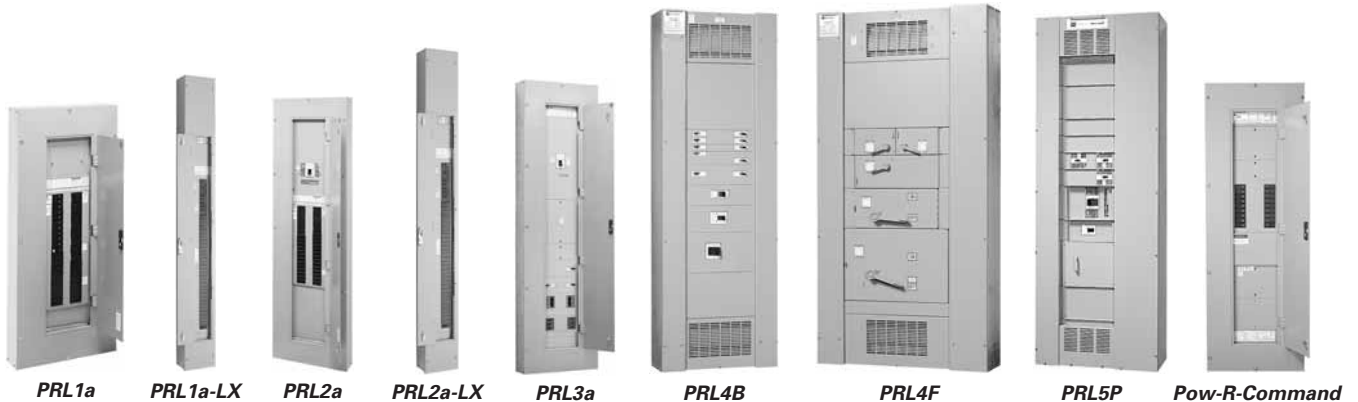
# Cutler-Hammer

## Current Cutler-Hammer Panelboards

Renewal Parts

Supersedes RP.38F.01.T.E  
pages 1 – 48 dated February 2000

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**Table 1. Product History Time Line**

Product	1985	1990	1995	Present
Cutler-Hammer PRL1a, 2a			← Oct. 1996 →	
Cutler-Hammer PRL3a			← Mar. 1994 →	
Cutler-Hammer PRL4B/F	←			Oct. 1987 →
Cutler-Hammer PRL5P			← Aug. 1995 →	
Cutler-Hammer PRL1a, 2a-LX			← Dec. 1997 →	
Cutler-Hammer Pow-R-Command			← Mar. 1996 →	

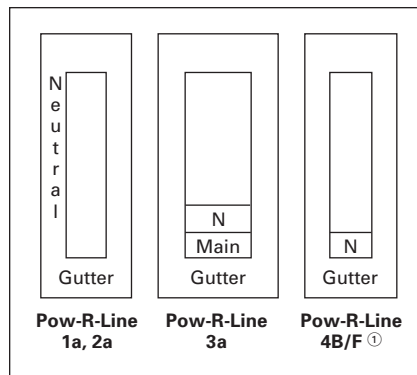
## Procedure for Identifying Panelboard Type

The current line of Pow-R-line C panelboards was introduced in 1993.

A panelboard is identified by data found on the nameplate. Pow-R-Line C panelboard nameplates are different in appearance, but all have the same critical information:

- Ampere rating of the main.
- Ampere rating of the neutral.
- Type of service (phase/wire).
- Manufacturing location.
- Type of panel.
- General order number.

In the event the nameplate is missing, it may still be possible to identify the panel type by location of the neutral bar. The illustrations to the right shows the position of the neutral in the panelboard.



**Figure 1. Position of the Neutral in the Panelboard**

① PRL4F panels with vertical mounted main switch will have the neutral mounted at the opposite end the main.

Box width may also help identify the panelboard type. Standard width for PRL1a, PRL2a, and PRL3a is 20.00 inches (508.0 mm). PRL4 standard widths are 24.00, 36.00 and 44.00 inches (609.6, 914.4 and 1117.6 mm).

**WARNING**

HAZARDOUS VOLTAGE WILL CAUSE SEVERE INJURY OR DEATH. TURN OFF POWER SUPPLY TO EQUIPMENT BEFORE WORKING ON IT.

## Procedure for Identifying Renewal Parts

1. Identify the type of panelboard, i.e. PRL1a, PRL2a, PRL3a, PRL4, PRL5P by reading the nameplate. Follow the procedure listed to the left.
2. Refer to the listing below and turn to the proper section in this brochure to identify standard parts.

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3. This book identifies those replacement parts most frequently ordered and which are readily available from stock. These parts can be ordered by style or catalog number to speed up processing and delivery.

### Distributor Ordering Instructions

1. Specify part by style/part number.
2. Refer to PL01400001E for pricing information. Discount Symbol CE9 applies.
3. Turn to **Page 4** to locate nearest Satellite Plant.
4. Enter the order on the satellite plant via mail, fax or phone.
5. Selling policy 25-000 applies.

**Cutler-Hammer Satellite Plants**



Figure 2. Satellite Plants

**Atlanta**

7990-A 2nd Flag Drive  
Austell, GA 30001  
Phone 770-944-1022  
FAX 770-944-2033

**Baltimore**

6671 Santa Barbara Court, Suite A  
Elkridge, MD 21227  
Phone 410-796-7777  
FAX 410-796-7755

**Chicago**

959 AEC Drive  
Wood Dale, IL 60191  
Phone 630-860-3500  
FAX 630-860-3569

**Cleveland**

4711 Hinkley Industrial Parkway  
Cleveland, OH 44109  
Phone 216-485-1940  
FAX 216-485-1943

**Dallas**

1100 Avenue T  
Grand Prairie, TX 75050  
Phone 972-988-3339  
FAX 972-641-6435

**Denver**

14101 East 33rd Place, Suite F  
Aurora, CO 80011  
Phone: 303-371-7844  
FAX 303-371-4175

**Hartford**

625 Day Hill Road  
Windsor, CT 06095  
Phone 860-688-7330  
FAX 860-688-4982

**Houston**

10810 West Little York, Suite 100  
Houston, TX 77041  
Phone 713-688-8430  
FAX 713-688-3764

**Los Angeles**

2021 Locust Court  
Ontario, CA 91761  
Phone 909-923-2040  
FAX 909-923-2344

**New Jersey**

96 Stemmers Lane  
Westampton, NJ 08060  
Phone 609-835-4230  
FAX 609-835-4777

**Orlando**

3827 St. Valentine Way  
Orlando, FL 32811  
Phone 407-843-3863  
FAX 407-841-9135

**Phoenix**

7160 South Harl Avenue  
Tempe, AZ 85283  
Phone 480-777-3957  
FAX 480-777-3958

**Raleigh**

2933 S. Miami Blvd., Suite 111  
Durham, NC 27703  
Phone 919-544-7074  
FAX 919-572-9751

**San Francisco**

20919 Cabot Boulevard  
Hayward, CA 94545  
Phone 510-784-8981  
FAX 510-784-8980

**Seattle**

18657 72nd Avenue South  
Kent, WA 98032  
Phone 425-251-9081  
FAX 425-251-0079

**St. Louis**

12947 Gravois Road  
St. Louis, MO 63127  
Phone: 314-842-7797  
FAX 314-842-2552

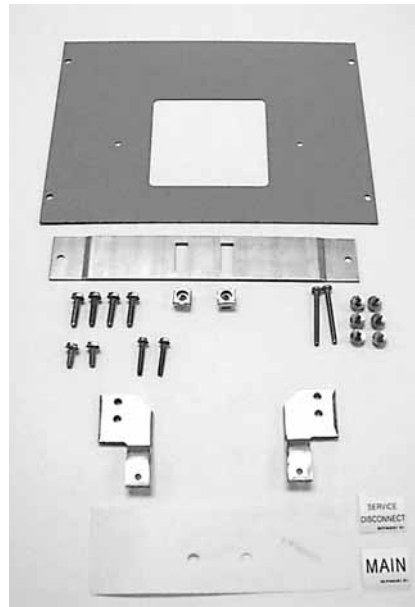
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**PRL1a, 2a Connector Kits**

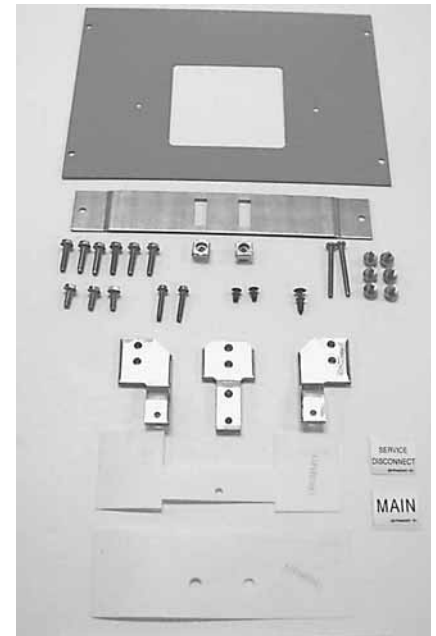
**Table 2. Vertical Breaker Assemblies**

Device Type ①	Device Mounting	3-Phase		1-Phase	
		Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
		Catalog Number			
F-Frame ② (100 Ampere Maximum)	Top Fed Bottom Fed	KB13AFT KB13AFB	KB13SFT KB13SFB	KB11AFT KB11AFB	KB11SFT KB11SFB
F-Frame ③ (225 Ampere Maximum)	Top Fed Bottom Fed	KB23AFT KB23AFB	KB23SFT KB23SFB	KB21AFT KB21AFB	KB21SFT KB21SFB
J-Frame	Top Fed Bottom Fed	KB43AJT KB43AJB	KB43SJT KB43SJB	KB41AJT KB41AJB	KB41SJT KB41SJB
K-Frame	Top Fed Bottom Fed	KB43AKT KB43AKB	KB43SKT KB43SKB	KB41AKT KB41AKB	KB41SKT KB41SKB

- ① Order main or sub-feed breaker separately when ordering above connector kits.
- ② EHD, FD, HFD, FDC.
- ③ FD, HFD, FDC, ED, EDH, EDC.



**KB11AFT**



**KB13AFT**

**PRL1a, 2a Connector Kits**

**Table 3. 100 Ampere Lug Assemblies**

Lug Type	Panel Lug Options ①	Wire Size Range	Quantity Per Phase	3-Phase		1-Phase	
				Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
				Catalog Number			
Aluminum/Copper Mechanical	STD	#14 – 1/0	1	KL13AMS	KL13SMS	KL11AMS	KL11SMS
	SFL	#14 – 1/0	2	KL13AMF	KL13SMF	KL11AMF	KL11SMF
	OVS	#6 – 300 kcmil	1	KL13AMO	KL13SMO	KL11AMO	KL11SMO
Crimp	STD	#8 – 1/0	1	KL13AVS	KL13SVS	KL11AVS	KL11SVS
	SFL	#8 – 1/0	2	KL13AVF	KL13SVF	KL11AVF	KL11SVF
	OVS	#4 – 300 kcmil	1	KL13AVO	KL13SVO	KL11AVO	KL11SVO
Copper Mechanical	STD	#14 – 1/0	1	—	KL13SCS	—	KL11SCS
	SFL	#14 – 1/0	2	—	KL13SCF	—	KL11SCF
	OVS	#6 – 250 kcmil	1	—	KL13SCO	—	KL11SCO

① STD = Standard lugs. Use for main or through-feed.  
 SFL = Sub-feed lugs.  
 OVS = Oversize lugs. Use for main or through-feed.



**KL13AMS**



**KL11AVS**

**PRL1a, 2a Connector Kits**

**Table 4. 225 Ampere Lug Assemblies**

Lug Type	Panel Lug Options ①	Wire Size Range	Quantity Per Phase	3-Phase		1-Phase	
				Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
				Catalog Number			
Aluminum/Copper Mechanical	STD	#6 – 300 kcmil	1	KL23AMS	KL23SMS	KL21AMS	KL21SMS
	SFL	#6 – 300 kcmil	2	KL23AMF	KL23SMF	KL21AMF	KL21SMF
	OVS	4/0 – 500 kcmil	1	KL23AMO	KL23SMO	KL21AMO	KL21SMO
Crimp	STD	#4 – 300 kcmil	1	KL23AVS	KL23SVS	KL21AVS	KL21SVS
	SFL	#4 – 300 kcmil	2	KL23AVF	KL23SVF	KL21AVF	KL21SVF
	OVS	2/0 – 500 kcmil	1	KL23AVO	KL23SVO	KL21AVO	KL21SVO
Copper Mechanical	STD	#6 – 250 kcmil	1	—	KL23SCS	—	KL21SCS
	SFL	#6 – 250 kcmil	2	—	KL23SCF	—	KL21SCF
	OVS	1/0 – 600 kcmil	1	—	KL23SCO	—	KL21SCO

① STD = Standard lugs. Use for main or through-feed.  
 SFL = Sub-feed lugs.  
 OVS = Oversize lugs. Use for main or through-feed.



**KL23AMS**



**KL21AVS**

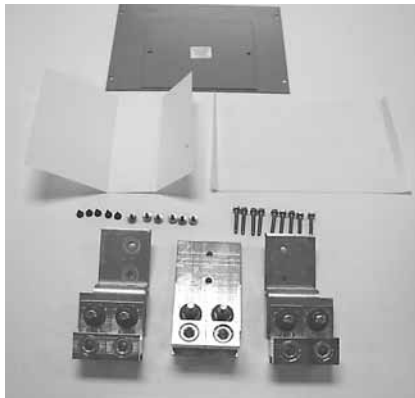


**PRL1a, 2a Connector Kits**

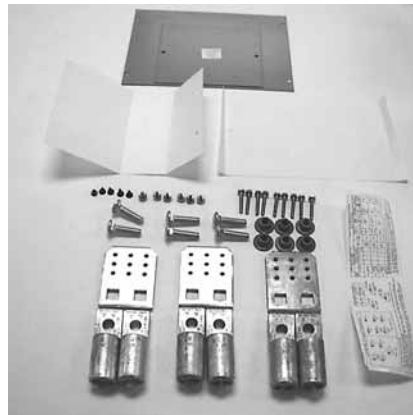
**Table 5. 400 Ampere Lug Assemblies**

Lug Type	Panel Lug Options ①	Wire Size Range	Quantity Per Phase	3-Phase		1-Phase	
				Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
				Catalog Number			
Aluminum/Copper Mechanical	STD	4/0 – 500 kcmil	2	KL43AMS	KL43SMS	KL41AMS	KL41SMS
	SFL	N/A	N/A	—	—	—	—
	OVS	3/0 – 750 kcmil	2	KL43AMO	KL43SMO	KL41AMO	KL41SMO
Crimp	STD	2/0 – 500 kcmil	2	KL43AVS	KL43SVS	KL41AVS	KL41SVS
	SFL	N/A	N/A	—	—	—	—
	OVS	500 – 750 kcmil	2	KL43AVO	KL43SVO	KL41AVO	KL41SVO
Copper Mechanical	STD	1/0 – 600 kcmil	1	—	—	—	—
	SFL	N/A	N/A	—	—	—	—
	OVS	1/0 – 600 kcmil	1	—	KL43SCO	—	KL41SCO

① STD = Standard lugs. Use for main or through-feed.  
 SFL = Sub-feed lugs.  
 OVS = Oversize lugs. Use for main or through-feed.



**KL43AMS**



**KL43AVS**

## PRL1a Horizontally Mounted Connector Kit Assemblies

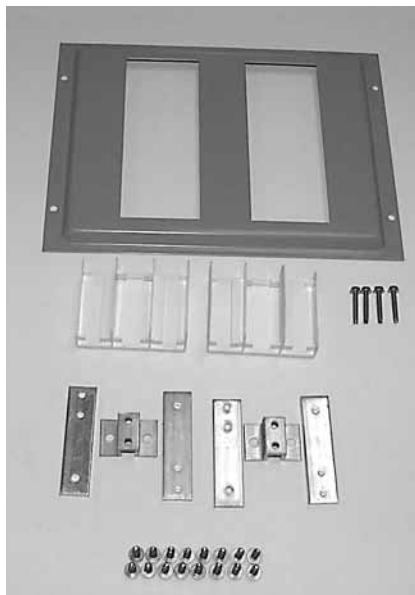
**Table 6. Bolt-on QUICKLAG Breaker Assemblies**

Breaker Frame	Drawing Number ①	Branch Circuit Quantity	3-Phase		1-Phase	
			Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
			Item Number			
BA, BAB, QBH, QBGF, QBHGF, QBGFEP, QBHGFEP	1C96608	12	G01	G03	G05	G07
		18	G09	G11	G13	G15
		30	G17	G19	G21	G23
		42	G25	G27	G29	G31
		48	G33	G35	G37	G39
		54	G41	G43	G45	G47
		72	G49	G51	G53	G55
		96	G57	G59	G61	G63

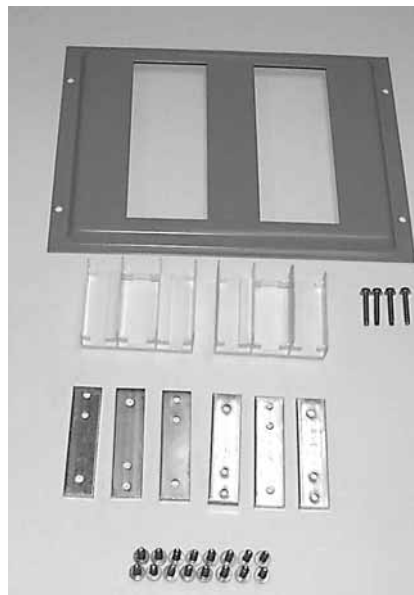
① Order the basic drawing number, along with the equivalent G-number that's needed.

**Note:** When determining branch circuit quantity, remember:

1. QUICKLAG breakers with shunt trips require one additional circuit.
2. UL® listed lighting and appliance (CTL) panelboards **cannot** exceed 42 electrically connected circuits in a single enclosure.
3. When bare copper is specified, use the silver-plated groups.
4. **Order breakers separately with connector kit.**



**1C96608G01**



**1C96608G05**

## PRL1a Horizontally Mounted Connector Kit Assemblies

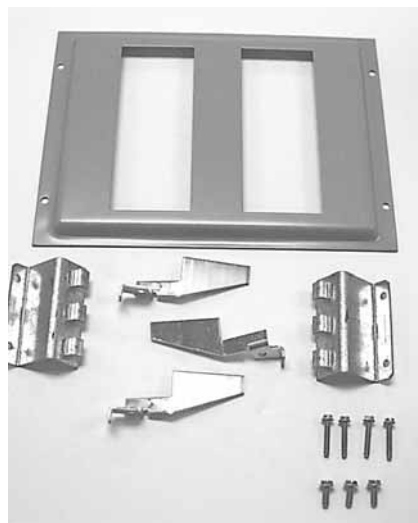
Table 7. Plug-in QUICKLAG Breaker Assemblies

Breaker Frame	Drawing Number ①	Branch Circuit Quantity	3-Phase		1-Phase	
			Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
			Item Number			
HQP, QPHW, QHPX, QPGF, QPHGF, QPGFEP, QPHGFEP	2C11642	12	—	G03	—	G07
		18	—	G11	—	G15
		30	—	G19	—	G23
		42	—	G27	—	G31
		48	—	G35	—	G39
		54	—	G43	—	G47
72	—	G51	—	G55		
96	—	G59	—	G63		

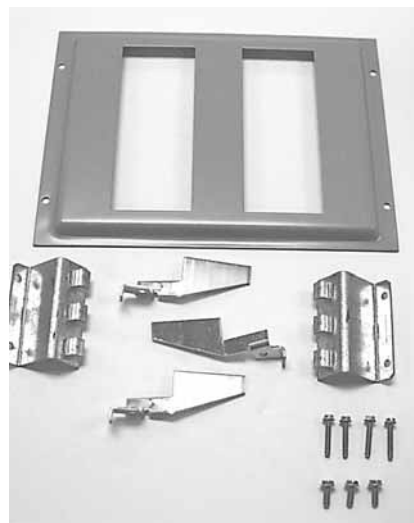
① Order the basic drawing number, along with the equivalent G-number that's needed.

**Note:** When determining branch circuit quantity, remember:

1. QUICKLAG breakers with shunt trips require one additional circuit.
2. UL listed lighting and appliance (CTL) panelboards **cannot** exceed 42 electrically connected circuits in a single enclosure.
3. When aluminum is specified, use the silver-plated groups.
4. The sum of the horizontally twin mounted breakers **shall not exceed 140 amperes**.
5. **Order breakers separately with connector kit.**



2C11642G03



2C11642G07

## PRL2a Horizontally Mounted Connector Kit Assemblies

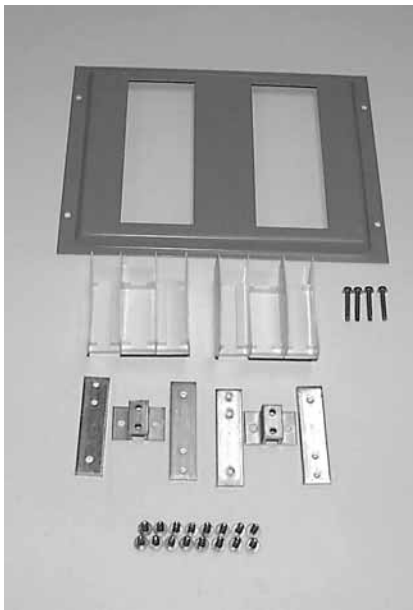
**Table 8. GB, GHB, GHQ, GHBS Breaker Assemblies**

Breaker Frame	Drawing Number ①	Branch Circuit Quantity	3-Phase		1-Phase	
			Tin-Plated Aluminum Connector	Silver-Plated Copper Connector	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
			Item Number			
GB, GHB, GHQ GHBS	1C96609	12	G01	G03	G05	G07
		18	G09	G11	G13	G15
		30	G17	G19	G21	G23
		42	G25	G27	G29	G31
		48	G33	G35	G37	G39
		54	G41	G43	G45	G47
		72	G49	G51	G53	G55
		96	G57	G59	G61	G63

① Order the basic drawing number, along with the equivalent G-number that's needed.

**Note:** When determining branch circuit quantity, remember:

1. QUICKLAG breakers with shunt trips require one additional circuit.
2. UL listed lighting and appliance (CTL) panelboards **cannot** exceed 42 electrically connected circuits in a single enclosure.
3. When bare copper is specified, use the silver-plated groups.
4. **Order breakers separately with connector kit.**



**1C96609G01**

**PRL1a, 2a Neutral Assemblies**

**Table 9. 100 Ampere Neutral Assemblies** ①

Panel Main Bus Ampere Rating	Neutral Rating	Lug Type	Drawing Number ②	Panel Lug Options ③	Wire Size Range	Quantity	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
							Item Number	
100	100%	Mechanical	1C96646	STD SFL/TFL OVS	#14 – 1/0	1	G02	G03
					#14 – 1/0	2	G05	G07
					#6 – 300 kcmil	1	G09	G11
	Crimp	1C96647	STD SFL/TFL OVS	#8 – 1/0	1	G01	G03	
				#8 – 1/0	2	G05	G07	
				#4 – 300 kcmil	1	G09	G11	
	Copper	1C96648	STD SFL/TFL OVS	#14 – 1/0	1	—	G03	
				#14 – 1/0	2	—	G07	
				#6 – 250 kcmil	1	—	G11	
200%	Mechanical	1C96649	STD SFL/TFL OVS	#6 – 300 kcmil	1	G02	G03	
				#6 – 300 kcmil	2	G06	G07	
				4/0 – 500 kcmil	1	G09	G11	
	Crimp	1C96650	STD SFL/TFL OVS	#4 – 300 kcmil	1	G01	G03	
				#4 – 300 kcmil	2	G05	G07	
				2/0 – 500 kcmil	1	G09	G11	
Copper	1C96651	STD SFL/TFL OVS	#6 – 250 kcmil	1	—	G03		
			#6 – 250 kcmil	2	—	G07		
			1/0 – 600 kcmil	1	—	G11		

① The assemblies shown on this page are for panelboards that mount in 30.00 – 90.00-inch (762.0 – 2286.0 mm) high enclosures only. Reference **Page 15** for assemblies for panelboards that mount in 21.00 – 27.00-inch (533.4 – 685.8 mm) high enclosures.

② Order the basic drawing number, along with the equivalent G-number that’s needed.

③ STD = Standard lugs.  
SFL/TFL = Sub-feed and through-feed lugs.  
OVS = Oversize lugs.



**1C96646G01**

**PRL1a, 2a Neutral Assemblies**

**Table 10. 225 Ampere Neutral Assemblies ①**

Panel Main Bus Ampere Rating	Neutral Rating	Lug Type	Drawing Number ②	Panel Lug Options ③	Wire Size Range	Quantity	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
							Item Number	
225	100%	Mechanical	1C96649	STD SFL/TFL OVS	#6 – 300 kcmil	1	G02	G03
					#6 – 300 kcmil	2	G06	G07
					4/0 – 500 kcmil	1	G09	G11
	Crimp	1C96650	STD SFL/TFL OVS	#4 – 300 kcmil	1	G01	G03	
				#4 – 300 kcmil	2	G05	G07	
				2/0 – 500 kcmil	1	G09	G11	
	Copper	1C96651	STD SFL/TFL OVS	#6 – 250 kcmil	1	—	G03	
				#6 – 250 kcmil	2	—	G07	
				1/0 – 600 kcmil	1	—	G11	
200%	Mechanical	1C96652	STD SFL/TFL OVS	4/0 – 500 kcmil	2	G01	G03	
				N/A	N/A	G05	G07	
				3/0 – 750 kcmil	2	G09	G11	
	Crimp	1C96653	STD SFL/TFL OVS	2/0 – 500 kcmil	2	G01	G03	
				N/A	N/A	G05	G07	
				500 – 750 kcmil	2	G09	G11	
Copper	1C96654	STD SFL/TFL OVS	1/0 – 600 kcmil	1	—	G03		
			N/A	N/A	—	G07		
			1/0 – 600 kcmil	1	—	G11		

① The assemblies shown on this page are for panelboards that mount in 30.00 – 90.00-inch (762.0 – 2286.0 mm) high enclosures.

② Order the basic drawing number, along with the equivalent G-number that's needed.

③ STD = Standard lugs.

SFL/TFL = Sub-feed and through-feed lugs.

OVS = Oversize lugs.



**1C96649G01**



## PRL1a, 2a Neutral Assemblies

Table 11. 400 Ampere Neutral Assemblies ①

Panel Main Bus Ampere Rating	Neutral Rating	Lug Type	Drawing Number ②	Panel Lug Options ③	Wire Size Range	Quantity	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
							Item Number	
400	100%	Mechanical	1C96652	STD	4/0 – 500 kcmil	2	G01 G05 G09	G03 G07 G11
				SFL/TFL	N/A	N/A		
			OVS	3/0 – 750 kcmil	2			
		Crimp	1C96653	STD	2/0 – 500 kcmil	2	G01 G05 G09	G03 G07 G11
		SFL/TFL		N/A	N/A			
			OVS	500 – 750 kcmil	2			
		Copper	1C96654	STD	1/0 – 600 kcmil	1	— —	G03 G07 G11
				SFL/TFL	N/A	N/A		
			OVS	1/0 – 600 kcmil	1			

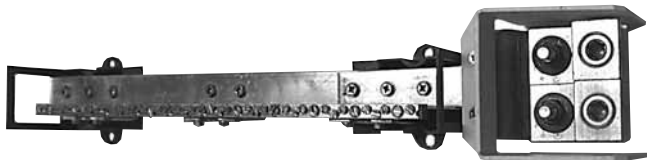
① The assemblies shown on this page are for panelboards that mount in 30.00 – 90.00-inch (762.0 – 2286.0 mm) high enclosures.

② Order the basic drawing number, along with the equivalent G-number that's needed.

③ STD = Standard lugs.

SFL/TFL = Sub-feed and through-feed lugs.

OVS = Oversize lugs.



1C96652G01

**PRL1a, 2a Neutral Assemblies**

**Table 12. 100 Ampere Neutral Assemblies for 21.00 – 27.00-Inch (533.4 – 685.8 mm) High Enclosures Only ①**

Panel Main Bus Ampere Rating	Neutral Rating	Lug Type	Drawing Number ②	Panel Lug Options ③	Wire Size Range	Quantity	Tin-Plated Aluminum Connector	Silver-Plated Copper Connector
							Item Number	
100	100%	Mechanical	1C96645	STD	#14 – 1/0 #14 – 1/0 N/A	1 2 N/A	G01	G03
		SFL/TFL		G05			G07	
		OVS		—			—	
	Crimp	N/A	STD	N/A	N/A	N/A	—	—
		SFL/TFL	N/A	N/A	N/A	—	—	
		OVS	N/A	N/A	N/A	—	—	
	Copper	N/A	STD	N/A	N/A	N/A	—	—
		SFL/TFL	N/A	N/A	N/A	—	—	
		OVS	N/A	N/A	N/A	—	—	
200%	Mechanical	1C97022	STD	#6 – 300 kcmil #6 – 300 kcmil N/A	1 2 N/A	G01	G03	
			SFL/TFL			G05	G07	
			OVS			—	—	
	Crimp	N/A	STD	N/A	N/A	N/A	—	—
		SFL/TFL	N/A	N/A	N/A	—	—	
		OVS	N/A	N/A	N/A	—	—	
Copper	N/A	STD	N/A	N/A	N/A	—	—	
	SFL/TFL	N/A	N/A	N/A	—	—		
	OVS	N/A	N/A	N/A	—	—		

① The assemblies shown on this page are for panelboards that mount in 21.00 – 27.00-inch (533.4 – 685.8 mm) high enclosures only. Reference **Page 12** for assemblies for panels that mount in 36.00, 48.00, 60.00, 72.00 and 90.00-inch (914.4, 1219.2, 1524.0, 1828.8 and 2286.0 mm) high enclosures.

② Order the basic drawing number, along with the equivalent G-number that's needed.

③ STD = Standard lugs.  
SFL/TFL = Sub-feed and through-feed lugs.  
OVS = Oversize lugs.



**1C96645G01**

### PRL1a, 2a Ground Assemblies

Table 13. Standard Ground

Drawing Number ①	Enclosure Height in Inches (mm)	Bar Material	Item Number
5158C05	24.00 (609.6)	Aluminum/Copper	G01
		Copper	G03
	36.00 (914.4), 48.00 (1219.2), 60.00 (1524.0), 72.00 (1828.8), 90.00 (2286.0)	Aluminum/Copper	G02
		Copper	G04

① Order the basic drawing number, along with the equivalent G-number that's needed (example 5158C05G01).



5158C05G01



5158C05G02

Table 14. Isolated Ground

Drawing Number ②	Enclosure Height in Inches (mm)	Bar Material	Item Number
2C11296	24.00 (609.6)	Aluminum/Copper	G01
		Copper	G02
	36.00 (914.4), 48.00 (1219.2), 60.00 (1524.0), 72.00 (1828.8), 90.00 (2286.0)	Aluminum/Copper	G03
		Copper	G04

② Order the basic drawing number, along with the equivalent G-number that's needed (example 5158C05G01).

### PRL1a, 2a Service Entrance Kits

Table 15. PRL1a, 2a Service Entrance Kits

Drawing Number ③	Panel Ampere Rating	Tin-Plated Aluminum	Bare Copper	Silver-Plated Copper	Tin-Plated Copper
		Item Number			

**Mechanical Main Lugs or Main Breakers**

4180B62	100 – 225	G01	G02	G03	G04
4180B62	400	G05	G06	G07	G08

**Compression (Crimp) Main Lugs**

4180B62	100 – 225	G09	G10	G11	G12
4180B62	400	G13	G14	G15	G16

**Copper Main Lugs**

4180B62	100 – 225	—	G18	G19	G20
4180B62	400	—	G22	G23	G24

③ Order the basic drawing number, along with the equivalent G-number that's needed (example 5158C05G01).



4180B62G01

**PRL1a, 2a Deadfront Covers**

**Note:** Does not apply to PRL4 sub-chassis.

**Table 16. Assembly**

Drawing Number ①	Standard Enclosure Height in Inches (mm)						
	24.00 (609.6)	36.00 (914.4)	42.00 (1066.8)	48.00 (1219.2)	60.00 (1524.0)	72.00 (1828.8)	90.00 (2286.0)
1C96638	G01	G02	G07	G03	G04	G05	G06

① Order the basic drawing number, along with the equivalent G-number that's needed (example 1C96638G01).

**Table 17. Vertically Mounted Devices**

Mounting Arrangement	Device/Frame	Drawing Number ②	Mounting Position	Item Number
Vertical	100 Ampere MLO, SFL, TFL or F-Frame (100 Ampere Maximum)	4180B03	Top Bottom	H01 H01
	225 Ampere MLO, SFL, TFL or F-Frame (225 Ampere Maximum)	4180B61	Top Bottom	H01 H01
	400 Ampere MLO, SFL, TFL or J-Frame	4180B04	Top Bottom	H01 H02
	400 Ampere MLO, TFL or K-Frame	4180B05	Top Bottom	H01 H02
Blank Covers in Inches (mm)	1.00 (25.4) 2.00 (50.8) 3.00 (76.2)	4180B08	N/A N/A N/A	H01 H02 H03
	4.00 (101.6) 5.00 (127.0) 6.00 (152.4)		N/A N/A N/A	H04 H05 H06
	7.00 (177.8) 8.00 (203.2) 9.00 (228.6)		N/A N/A N/A	H07 H08 H09
	10.00 (254.0) 11.00 (279.4) 12.00 (304.8)		N/A N/A N/A	H10 H11 H12
	13.00 (330.2) 14.00 (355.6) 15.00 (381.0) 16.00 (406.4)		N/A N/A N/A N/A	H13 H14 H15 H16

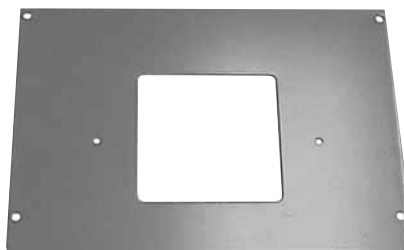
② Order the basic drawing number, along with the equivalent H-number that's needed (example 4180B03H01).



**1C96638G01**



**4180B08H03**



**4180B03H01**

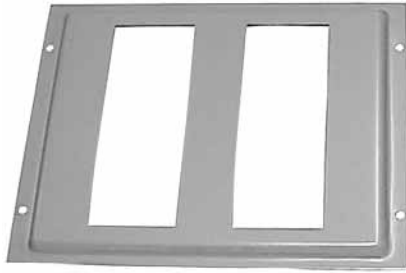
**PRL1a, 2a Deadfront Covers**

**Note:** Does not apply to PRL4 sub-chassis.

**Table 18. Horizontally Mounted Devices**

Mounting Arrangement	Device/Frame	Drawing Number ①	Branch Circuit Quantity	Item Number	Quantity Required
Horizontal	BA, BAB, QBH, QBGF, QBHGF, QBGFEP, QBHGFEP	1C96619	12	H01	1
			18	H02	1
			30	H04	1
			42	H06	1
			48	H03	2
			54	H03 and H04	1 Each
	GB, GHB, GHQ, GHBS	1C96620	12	H01	1
			18	H02	1
			30	H04	1
			42	H06	1
			48	H03	2
			54	H03 and H04	1 Each
			72	H05	2
			96	H07	2

① Order the basic drawing number, along with the equivalent H-number that's needed (example 1C96619H01).



1C96619H01



1C96620H01



5155C62H01



4180B52H01

**Table 19. Filler Covers**

Device/Frame	Drawing Number	Item Number
F, J, K ②	4180B52	H01
QUICKLAG, GB, GHB ③	5155C62	H01

② Filler covers are required in addition to deadfront cover whenever MLO, SFL or TFL are specified.

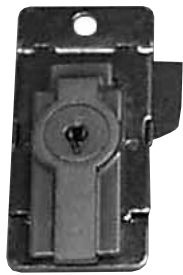
③ Filler covers are required in addition to deadfront cover whenever a branch provision is specified.

## Panelboard Trim Locks

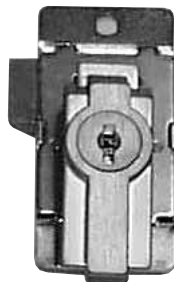
Panelboard trims use different trim locks, see pictures below for styles and part numbers. Contact your nearest Satellite for availability on the styles listed below. See **Page 4** for Satellite listings.

**Table 20. Panelboard Trim Locks**

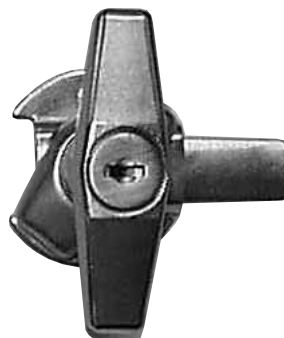
Description	Catalog Number
For use on left-handed door. (Hinged on left side.)	<b>K80522</b>
For use on right-handed door. (Hinged on right side.)	<b>K80133</b>
T-Handle lock, at one time used on all trims over 48.00 inches (1219.2 mm) in height. Also used on outdoor NEMA 12/3R trims.	<b>K80429</b>
Used on PRL4 lighting and power panels as standard.	<b>1A32258H03</b>
Used on PRL1, 2, 3 and PRL1a, 2a, 3a lighting panels as standard. WEM 2 key.	<b>5155C81G01</b>



**K80522**



**K80133**



**K80429**



**1A32258H03**



**5155C81G01**

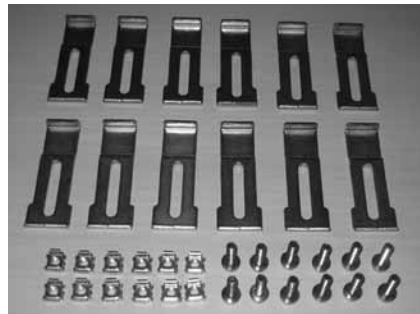


### Panelboard Fastrim Clamps and Screw-on Hardware Kits

For panelboard trim clamps, contact your nearest Satellite for availability on the styles listed below. See **Page 4** for Satellite listings.

**Table 21. Panelboard Fastrim Clamps and Screw-on Hardware Kits**

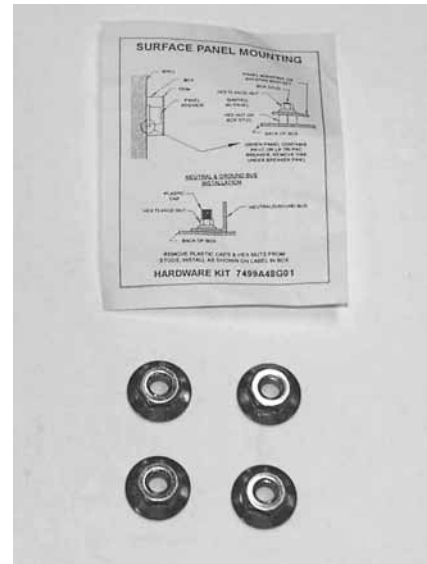
Description	Style Number
Trim clamps — used on PRL1a, 2a, 3a fastrims. (6 per bag.)	2C11641G02
Trim screws — used on PRL1a, 2a, 3a, 4B standard trim. (10 per bag.)	5157C83G06
Chassis mounting hardware bag — PRL1a, 2a, 3a panels.	7499A48G04



2C11641G02



5157C83G06



7499A48G04

**PRL3a Parts Section** **Page**

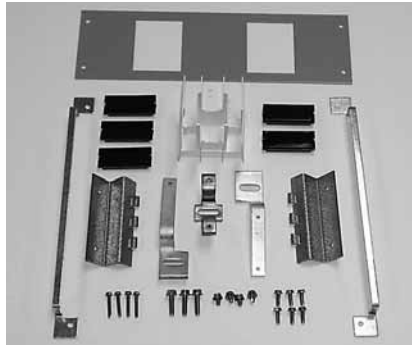
Connector Kits, Branch Breakers . . . . .	21
Quicklag . . . . .	21
GB, GHB, GHBS. . . . .	21
Twin Mounted F-Frame 150 Ampere Maximum . . . .	22
Single Mounted F-Frame 175 – 225 Ampere Maximum .	22
Ground Assemblies . . . . .	23
Service Entrance Kits . . . . .	23
Deadfront Covers . . . . .	23 – 25

**PRL3a Horizontally Mounted Connector Kit Assemblies**

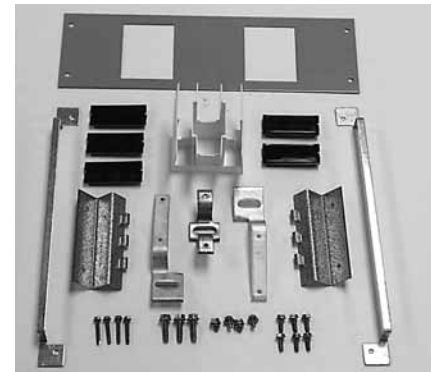
**Table 22. Connector Kit Assemblies**

Devices	Circuits or Pole	3-Phase		1-Phase		Notes
		Catalog Number	Phase	Catalog Number	Phase	
BA, BAB, QBGF, QBH, QBHGF, QBGFEP, QBHGFEF	6	KPRL3ABA06	A/B/C	KPRL3ABA06-1	A/C	(2) 100 Ampere Devices Maximum
	12	KPRL3ABA12	A/B/C	KPRL3ABA12-1	A/C	
	18	KPRL3ABA18	A/B/C	KPRL3ABA18-1	A/C	
	24	KPRL3ABA24	A/B/C	KPRL3ABA24-1	A/C	
GB, GHB, GHQ, GHBS	6	KPRL3AGB06	A/B/C	KPRL3AGB06-1	A/C	
	12	KPRL3AGB12	A/B/C	KPRL3AGB12-1	A/C	
	18	KPRL3AGB18	A/B/C	KPRL3AGB18-1	A/C	
	24	KPRL3AGB24	A/B/C	KPRL3AGB24-1	A/C	

Three-phase kits contain A, B and C phase connectors. Single-phase kits contain A and C phase connectors, deadfront cover, hardware and instructions to twin mount breakers across from each other. **Maximum amperes connected to any one connector cannot exceed 200 amperes.**



**KPRL3ABA06**



**KPRL3AGB06**

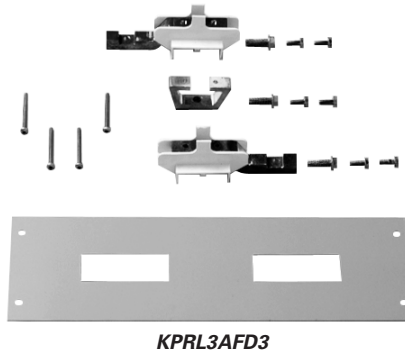
## PRL3a F-Frame Horizontally Mounted Connector Kit Assemblies

Table 23. Connector Kit Assemblies

Devices	Circuits or Pole	3-Phase		1-Phase		Notes
		Catalog Number	Phase	Catalog Number	Phase	
EHD, FD, FDB, HFD, FDC (150 Ampere Maximum Twin Mount)	3-Pole Breaker	KPRL3AFD3	A/B/C	—	—	(2) 150 Ampere Devices Maximum
	2-Pole Breaker	KPRL3AFD2	A/C	KPRL3AFD2	A/C	
	1-Pole Breaker	KPRL3AFD1	A/C	KPRL3AFD1	A/C	
FD, HFD, FDC, ED, EDH, EDC (175 – 225 Ampere Single Mount) ①	3-Pole Breaker	KPRL3AED3	A/B/C	—	—	(1) 225 Ampere Maximum Single Mounted
	2-Pole Breaker	KPRL3AED2	A/C	KPRL3AED2	A/C	

① F-Frame devices rated above 150 amperes must be single mounted. No twin mounting acceptable.

Connector kits contain phase connectors, deadfront cover, hardware and instructions to mount breakers. Order breakers separately when ordering connector kit.



### PRL3a Ground Assemblies

**Table 24. PRL3a Ground Assemblies**

Material	Standard	Isolated
	Catalog Number	
Aluminum/Copper Copper Only	5158C05G02 5158C05G04	2C11296G02 2C11296G04



5158C05G02

### PRL3a Service Entrance Kits

**Table 25. PRL3a Service Entrance Kits**

Style Number ①	Panel Ampere Rating	Tin-Plated Aluminum	Bare Copper	Silver-Plated Copper	Tin-Plated Copper
		Item Number			

**Mechanical Main Lugs or Main Breakers**

5078A98	100	G01	G02	G03	G04
	250 – 600	G13	G14	G15	G16

**Crimp Main Lugs**

5078A98	100	G05	G06	G07	G08
	250 – 600	G17	G18	G19	G20

**Copper Main Lugs**

5078A98	100	G09	G10	G11	G12
	250 – 600	G21	G22	G23	G24

① When ordering, use complete style number (example 100 Ampere Tin-Plated Aluminum 5078A98G01).



5078A98G01

### PRL3a Deadfront Covers

**Table 26. Assembly ②**

Style Number ③	Chassis Height/Item Number				
	14X	23X	31X	40X	53X
6559C59	G01	G02	G03	G04	G05

② Assembly groups include the frame only (two rails and two end covers). Reference **Pages 24 and 25** for specific device covers. All connector kits ship with a deadfront cover for that device.

③ When ordering, use complete style number (example 14X High Assembly 6559C59G01).



6559C59G01

**PRL3a Vertical Devices Deadfront Covers**

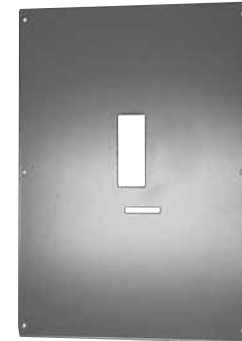
**Table 27. Vertical Mounting Position**

Device/Frame	Trip Unit Type	Style Number ①	"X" Space Required	Item Number	
				Without Lock-offs ①	With Lock-offs ①
EHD, FD, FDB, HFD, FDC, ED, EDH, EDC (Top) ②	N/A	<b>4176B68</b>	7X	H01	H03
EHD, FD, FDB, HFD, FDC, ED, EDH, EDC (Bottom) ②	N/A		7X	H04	H05
FD, HFD, FDC, ED, EDH (Top) ③	N/A	<b>4180B93</b>	10X	H01	H03
FD, HFD, FDC, ED, EDH (Bottom) ③	N/A		10X	H04	H05
J-Frame (Bottom)	N/A	<b>4176B60</b>	14X	H01	H02
J-Frame (Top)	N/A		14X	H03	H04
K-Frame (Bottom)	Thermal-Mag.	<b>4176B61</b>	15X	H01	H02
K-Frame (Bottom)	Electronic		15X	H03	H04
K-Frame (Top)	Thermal-Mag.		15X	H05	H06
K-Frame (Top)	Electronic		15X	H07	H08
L-Frame (Bottom)	Thermal-Mag.	<b>4176B51</b>	17X	H01	H02
L-Frame (Bottom)	Electronic		17X	H03	H04
L-Frame (Top)	Thermal-Mag.		17X	H05	H06
L-Frame (Top)	Electronic		17X	H07	H08
FB-P (Top Only)	N/A	<b>4176B70</b>	9X	H02	H02
LA-P (Top Only)	N/A	<b>4176B57</b>	21X	H01	H01
FCL	N/A	<b>4176B70</b>	9X	H01	H01
LCL (Top)	N/A	<b>4176B56</b>	21X	H01	H02
LCL (Bottom)	N/A		21X	H03	H04
Neutral/Blank Cover	N/A	<b>4176B72</b>	1X	H01	—
			2X	H02	
			3X	H03	
			4X	H04	
			5X	H05	
			6X	H06	
			7X	H07	
			8X	H08	
			9X	H09	
			10X	H10	
			11X	H11	
			12X	H12	
J-Frame Sub-Feed Twin Bottom	N/A	<b>4176B79</b>	20X	H01	H02 (2 L/O) H03 (1 L/O RT) H04 (1 L/O LT)
J-Frame Sub-Feed Twin Top	N/A	<b>4176B79</b>	20X	H05	H05 (2 L/O) H07 (1 L/O RT) H08 (1 L/O LT)
PT363 (Top)	N/A	<b>4180B79</b>	7X	H01	—
PT363 (Bottom)	N/A		7X	H02	
PT364 (Top)	N/A		9X	H03	
PT364 (Bottom)	N/A		9X	H04	

① When ordering covers, order complete style and item numbers (example 4176B68H01).

② 4/0 Maximum acceptable terminal size.

③ 300 kcmil maximum acceptable terminal size.



**J Main 4176B60H04**



**Neutral Blank Cover 4176B72H04**

## PRL3a Horizontal Devices Deadfront Covers

**Table 28. Horizontal Mounting Position**

Device/Frame	Device Poles	Style Number ①	Total Circuit Quantity	"X" Space Required	Item Number
EHD, FD, FDB, HFD, FDC (Twin Mounted)	1, 2 or 3	<b>4178B08</b>	6	3X	H01
			12	6X	H02
			18	9X	H03
			24	12X	H04
			30	15X	H05
			36	18X	H06
			42	21X	H07
			48	24X	H08
			EHD, FD, FDB, HFD, FDC (Twin Mounted)	1 or 2	<b>4179B39</b>
8	4X	H02			
12	6X	H03			
16	8X	H04			
20	10X	H05			
24	12X	H06			
28	14X	H07			
32	16X	H08			
EHD, FD, FDB, HFD, FDC (Twin Mounted)	1	<b>4179B40</b>			
FD, HFD, FDC, ED, EDH, EDC (Single Mounted)	3	<b>4179B41</b>	3	3X	H01
FD, HFD, FDC, ED, EDH, EDC (Single Mounted)	2	<b>4179B42</b>	2	2X	H01
CA, CAH, HCA	3	<b>4176B66</b>	3	3X	H01
CA, CAH, HCA	2	<b>4176B80</b>	2	2X	H01
BA, BAB, BABRP, BABRSP QBH, QBGF, QBGFEP, QBHGFEP	1, 2 or 3	<b>4176B67</b>	6	3X	H01
			12	5X	H02
			18	8X	H03
			24	10X	H04
GB, GHB, GHBS, GHBGFEP, HGHB, GHQ	1, 2 or 3	<b>4176B69</b>	6	3X	H01
			12	5X	H02
			18	8X	H03
			24	10X	H04
Pow-R-Command Controller	N/A	<b>4180B91</b>	N/A	5X	H01
Pow-R-Command Expansion	N/A	<b>4180B91</b>	N/A	7X	H02
				16X	H03

① When ordering covers, order complete style and item number (example 4178B08H01).

## PRL3a Deadfront Cover Blank Fillers

**Table 29. PRL3a Deadfront Cover Blank Fillers**

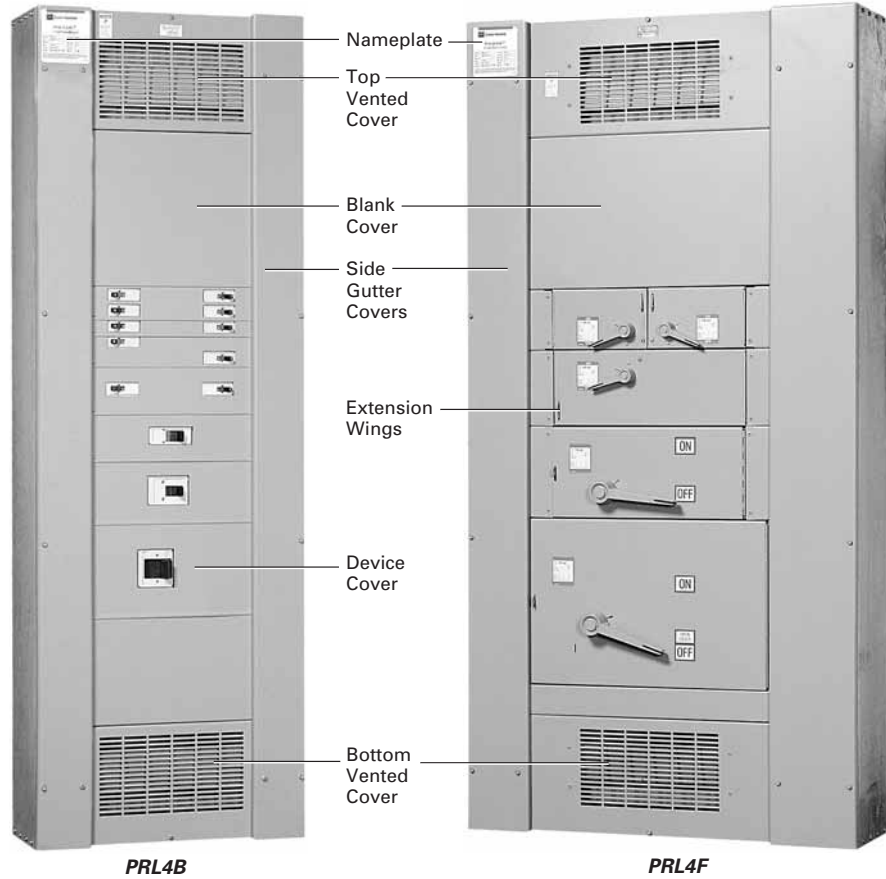
Device/Frame	Poles	Style Number
F-Frame	1, 2 or 3	<b>4178B06H01</b>
C-Frame	2	<b>6555C40H01</b>
C-Frame	3	<b>6555C41H01</b>
QUICKLAG, GB, GHB, GHBS	1, 2 or 3	<b>5155C62H01</b>



**BAB Cover 4176B67H01**

<b>PRL4B/F Parts Section</b>	<b>Page</b>
Vented Cover Assemblies and Side Gutter Covers . . . . .	26
PRL4 Blank Covers . . . . .	27
PRL4 Breaker Connector Kits . . . . .	28
PRL4 Fusible FDPW Switch Connector Kit . . . . .	29
PRL4 Breaker Retrofit Kits . . . . .	30
PRL4 Fusible Retrofit Kits . . . . .	30
PRL4 Energy Sentinel . . . . .	31
PRL1a, 2a, 3a and PRL4 Special Trims and Enclosures . . . . .	32

**PRL4 Vented Cover Assemblies**



**Table 30. Vented Cover Assemblies and Side Gutter Covers — Dimensions in Inches (mm)**

NEMA 1 Box			Catalog Number	Vented Cover Assembly <sup>②</sup> Style Number	Side Gutter Covers			
Dimensions					Left		Right	
Height	Width	Depth <sup>①</sup>			Size	Style Number	Size	Style Number
57.00 (1447.8)	24.00 (609.6)	10.40 (264.2)	BX2457	6574C74G02	5.00 (127.0) x 57.00 (1447.8)	6555C20H01	5.00 (127.0) x 57.00 (1447.8)	6555C20H01
73.00 (1854.2)	24.00 (609.6)		BX2473	6574C74G03	5.00 (127.0) x 73.00 (1854.2)	6555C21H01	5.00 (127.0) x 73.00 (1854.2)	6555C21H01
90.00 (2286.0)	24.00 (609.6)		BX2490	6574C74G04	5.00 (127.0) x 90.00 (2286.0)	6555C25H01	5.00 (127.0) x 90.00 (2286.0)	6555C25H01
73.00 (1854.2)	36.00 (914.4)	36.00 (914.4)	BX3673	6574C74G05	6.00 (152.4) x 73.00 (1854.2)	6555C22H01	8.00 (203.2) x 73.00 (1854.2)	6555C23H01
90.00 (2286.0)	36.00 (914.4)		BX3690	6574C74G06	6.00 (152.4) x 90.00 (2286.0)	6555C26H01	8.00 (203.2) x 90.00 (2286.0)	6555C27H01
73.00 (1854.2)	44.00 (1117.6)	44.00 (1117.6)	BX4473	6574C74G05	8.00 (203.2) x 73.00 (1854.2)	6555C23H01	14.00 (355.6) x 73.00 (1854.2)	6555C24H01
90.00 (2286.0)	44.00 (1117.6)		BX4490	6574C74G06	8.00 (203.2) x 90.00 (2286.0)	6555C27H01	14.00 (355.6) x 90.00 (2286.0)	6555C28H01

① Covers add .90 inches (22.9 mm) to box depth for overall enclosure depth of 11.30 inches (287.0 mm).

② Cover assembly consists of 2 side rails, top and bottom vented covers.

**Important:** Order individual device covers and blanks separately.

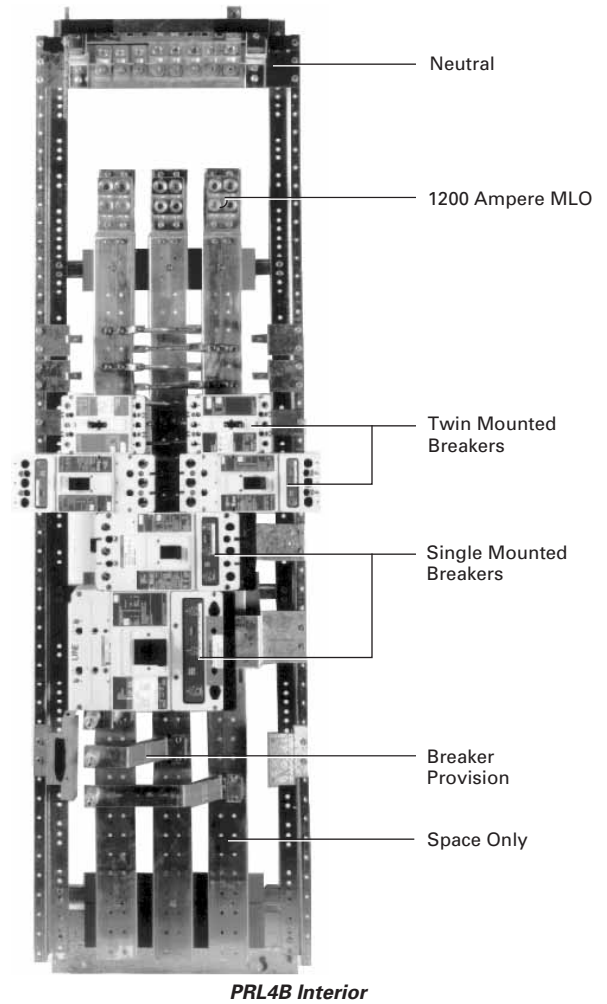


**PRL4 Blank Covers**

Used to cover blank space on chassis. All PRL4 cover heights are measured in "X" units. 1X equals 1.38 inches (35.1 mm).

**Table 31. PRL4 Blank Covers**

Cover Size	Style Number	
	24.00-Inch (609.6 mm) Width Box	36.00, 44.00-Inch (914.4, 1117.6 mm) Width Box
1X	6554C01H01	6554C02H01
2X	6554C01H02	6554C02H02
3X	6554C01H03	6554C02H03
4X	6554C01H13	6554C02H13
5X	6554C01H14	6554C02H14
6X	6554C01H04	6554C02H04
7X	6554C01H05	6554C02H05
9X	6554C01H06	6554C02H06
10X	6554C01H07	6554C02H07
11X	6554C01H08	6554C02H08
12X	6554C01H09	6554C02H09
13X	6554C01H10	6554C02H10
15X	6554C01H11	6554C02H11
20X	6554C01H12	6554C02H12



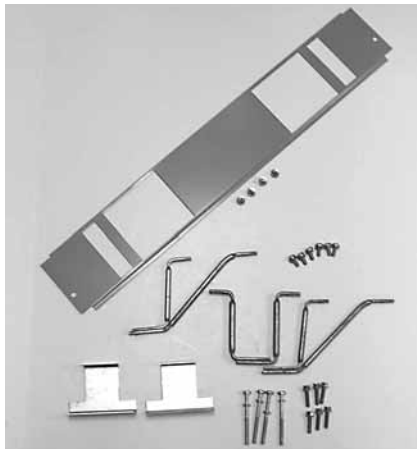
## PRL4 Breaker Connector Kits

### Breaker Connector Kits

Each kit includes copper connectors, mounting brackets, covers, hardware and instructions for mounting breaker(s) in a PRL4. **Breakers are not included.** Contact your local Satellite plant for availability and application information (see **Page 4**).

### Connector Kit

Each kit includes copper connectors mounting brackets, cover, hardware and instructions.



Connector Kit

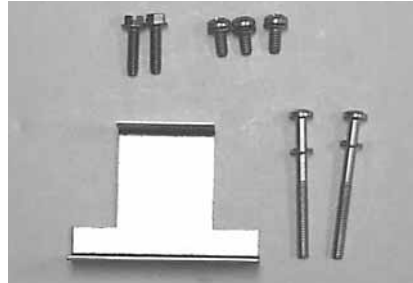
Table 32. Breaker Connector Kits

Breaker Frame	Space Required		Poles	Mounting Type	Connector Kit Catalog Number
	Inches (mm)	"X"			
EHD, FD, HFD EHD, FD, FDB, HFD, FDC ED, EDH, EDC	2.75 (69.9)	2X	1 ① 2 2	Twin Twin Twin	KPRL4FD1 KPRL4FD2 KPRL4ED2
EHD, FD, FDB, HFD, FDC FCL, FB-P, FD/LFD ED, EDH, EDC JD, JDB, HJD, JDC JD, JDB, HJD, JDC	4.13 (104.9)	3X	3 3 3 2, 3 2,3	Twin Twin Twin Single Twin	KPRL4FD KPRL4FBP KPRL4ED KPRL4JDS KPRL4JDT ②
DK, KD, KDB, HKD, KDC DK, KD, KDB, HKD, KDC CKD, CHKD	5.50 (139.7)	4X	2, 3 2,3 2,3	Single Twin Single	KPRL4KDS KPRL4KDT ③ KPRL4CKD ④
LCL LA-P LD, LDB, HLD, LDC, CLD, LC MDL, HMDL NB-P CND, CHND ND, HND	8.25 (209.5)	6X	2, 3 2, 3 2, 3 2, 3 2, 3 3 2, 3	Single Single Single Single Single Single Single	KPRL4LCL ② KPRL4LAP ② KPRL4LD ② KPRL4MC ② KPRL4NBP ③ KPRL4CND ③④ KPRL4ND ②

- ① Two sets of twin mounted 1-pole breakers.
- ② 36.00-inch (914.4 mm) minimum box width required.
- ③ 44.00-inch (1117.6 mm) box width required.
- ④ Requires density rated bus in existing panel chassis.

### Hardware Kit

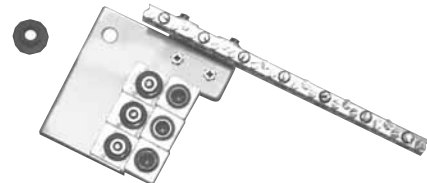
Each kit includes mounting bracket(s) and mounting hardware only. Use the appropriate Connector Kit catalog number and add an "H" to designate hardware only (example: KPRL4FD-H).



Hardware Kit

### Standard Ground Bus

Copper bus with (3) 6 – 300 kcmil lugs plus a 24-circuit terminal bar with #14 – 1/0 wire range.



6572C746G01

## PRL4 Fusible Connector Kits

### Fusible Switch Connector Kits

Each kit includes copper connectors, extension wings (when required), hardware and instructions to mount a fusible switch. **Switches are not included.** Contact your local Satellite plant for availability and application information (see **Page 4**).

Table 33. Fusible Switch Connector Kits

Switch Height		Switch Ampere Rating	3-Pole Switch		Connector Kit
Inches (mm)	"X" Space Required		240 Volts	600 Volts	
			Catalog Number		
5.50 (139.7)	4X	30 – 30 60 – 60 100 – 100	FDPWT3211R FDPWT3222R FDPWT3233R	FDPWT3611R FDPWT3622R —	— KPR44X ① —
6.88 (174.8)	5X	100 – 100	—	FDPWT3633R	KPRL45X ①
8.25 (209.6)	6X	200 200 – 200	FDPBS324R FDPBT3244R	FDPBS364R FDPBT3644R	KPRL4B6XS KPRL4B6XT ②
12.38 (314.5)	9X	400	FDPW325R	FDPW365R	KPRL4W9X
15.13 (384.3)	11X	600 800	FDPW326R FDPW327	FDPW366R FDPW367	KPRL4W11X KPRL4W11X ②
20.63 (524.0)	15X	1200	FDPW328	FDPW368	KPRL4W15X ②

① These connector kits will fit the FDP and FDPW switches.

② 44.00-inch (1117.6 mm) box width required for both R and J fuse applications.

## PRL4 Breaker and Fusible Switch Retrofit Kits

### Breaker Retrofit Kits

Each kit includes **one** breaker, copper connectors, covers, hardware and instructions to mount in a PRL4.

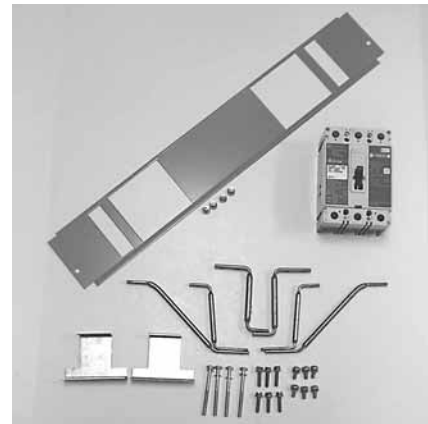
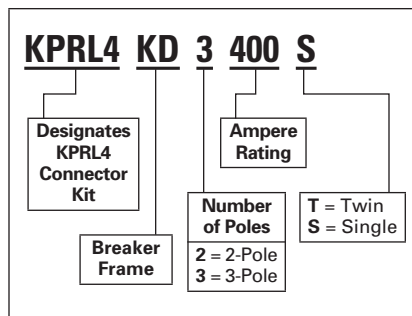
**Table 34. Breaker Retrofit Kits**

Breaker Frame	Frame Ampere Rating	Trip Range	Mounting Type
EHD FDB FD HFD FDC FCL FB-P	100	15 – 100 15 – 100 15 – 100 15 – 100 15 – 100 15 – 100 15 – 100	Twin Twin Twin Twin Twin Twin Twin
FDB	150	110 – 150	Twin
FD HFD FDC ED EDH EDC	225	110 – 225 110 – 225 110 – 225 100 – 225 100 – 225 100 – 225	Twin Twin Twin Twin Twin Twin
JD HJD JDC	250	70 – 250 70 – 250 70 – 250	Twin/Single Twin/Single Twin/Single
DK KD HKD KDC CKD LCL LA-P	400	100 – 400 100 – 400 100 – 400 100 – 400 125 – 400 70 – 400	Twin/Single Twin/Single Twin/Single Twin/Single Single Single Single
LD CLD HLD CHLD LDC CLDC	600	300 – 600 300 – 600 300 – 600 300 – 600 300 – 600 300 – 600	Single Single Single Single Single Single
MDL CMDL HMDL CHMDL	800	300 – 800 300 – 800 300 – 800 300 – 800	Single Single Single Single
ND CND HND CHND NDC CNDC	1200	600 – 1200 600 – 1200 600 – 1200 600 – 1200 600 – 1200 600 – 1200	Single Single Single Single Single Single

### How to Order a Breaker Retrofit Kit by Catalog Number

Use “KPRL4” prefix and add catalog number of breaker as shown below. Use suffix “T” or “S” to denote twin or single mounting. Twin mounting indicates that one set of connectors is required to mount two breakers (of similar frames) opposite one another. **RETROFIT KIT INCLUDES ONE BREAKER ONLY, FOR EITHER SINGLE OR TWIN MOUNTED APPLICATIONS.**

**Table 35. Catalog Numbering System — Breaker Retrofit Kit**



**Breaker Retrofit Kit**

### Fusible Retrofit Kits

Each kit includes a 3-pole switch, copper connectors, extension wings (if required), hardware and instructions to horizontally mount in a PRL4.

### How to Order a Fusible Retrofit Kit by Catalog Number

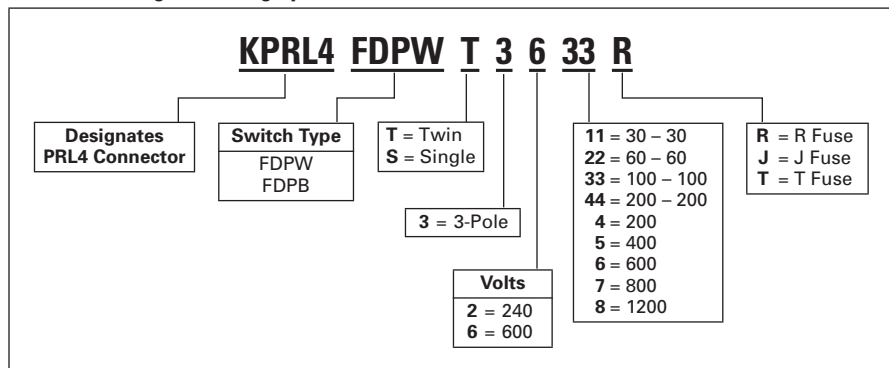
Use “KPRL4” prefix and add catalog number of appropriate switch (refer to **Page 29** for 3-pole switch catalog number).

**Example:** The Retrofit Kit catalog number for a 600 volt, 100 ampere twin FDPW switch is:

**Table 36. Fusible Retrofit Kits**

Switch Ampere Rating	Switch Type	Mounting Type
30 – 30 60 – 60 100 – 100	FDPW FDPW FDPW	Twin Twin Twin
100 200 200 – 200	FDPW FDPB FDPB	Single Single Twin
400 600 800 1200	FDPW FDPW FDPW FDPW	Single Single Single Single

**Table 37. Catalog Numbering System — Fusible Retrofit Kit**



**PRL4 Energy Sentinel**



*Energy Sentinel*

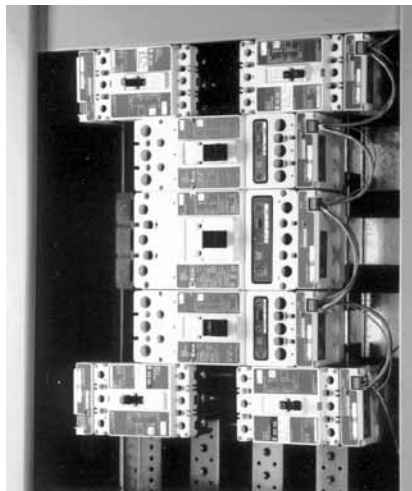
The IQ Energy Sentinel is a submetering device that mounts directly on a circuit breaker and monitors both power and energy with an overall accuracy of 99%.

This high system accuracy is achieved by use of the Cutler-Hammer SURE Plus Chip, which is a sophisticated microprocessor.

All that is necessary to complete an IQ Energy Sentinel installation is to insert it into the load side of a breaker, feed the load conductors through it, and run the shielded twisted pair wire for communications. The IQ Energy Sentinel has a nonvolatile memory, is powered by the circuit breaker, and can be applied on 3-phase, 4-wire or single-phase, 3-wire systems.

The space-saving design characteristics of the IQ Energy Sentinel mean they can be quickly and easily retrofitted onto Series C® circuit breakers in existing equipment...with no additional space required. Additionally, IQ Energy Sentinel can be installed when upgrading to Series C from older breakers that are physically interchangeable...with no additional space required.

Power and energy information from IQ Energy Sentinels can be communicated to a PC, a panel mounted Central Energy Display (CED), or even existing building management or distribution control systems.



*Energy Sentinels Installed*

**IQ Central Energy Display**



*IQ Central Energy Display*

The IQ Central Energy Display may be panel mounted or located remotely (up to 7500 feet [2286 m] away). It displays power, peak demand, and energy readings of up to 50 IQ Energy Sentinels and eight IQ Data Plus meters.

Additional capabilities include: peak demand alarming, demand and energy totals for groups of IQ Energy Sentinels and IQ Data Plus 11 digital meters.

Refer to your local Satellite for retrofit and upgrade options available for existing equipment.

**Table 38. Energy Sentinel**

Series C Breaker Frame	Voltage ac	Maximum Amperes	Catalog Number
F	120/208, 120/240	150	<b>IQESF208</b>
F	277/480	150	<b>IQESF480</b>
J	120/208, 120/240	250	<b>IQESJ208</b>
J	277/480	250	<b>IQESJ480</b>
K	120/208, 120/240	350	<b>IQESK208</b>
K	277/480	350	<b>IQESK480</b>

## PRL1a, 2a, 3a Special Trims and Enclosures

### Ventilated Trim

Required on PRL1a, 2a, 3a, 600 ampere and above panels only. Order by adding the letter "V" to the standard trim catalog number. **Add 10% to standard trim list price.**

**Example:** LT2072S becomes LTV2072S.



Ventilated Trim

### Fastrim

Used when concealed trim mounting hardware is required for PRL1a, 2a and PRL3a. Trim clamps are included and shipped with the trim. Order by adding the letter "F" to the standard trim catalog number. **Add 20% to standard trim list price.**

**Example:** LT2072S becomes LTF2072S.

For trim clamps only, refer to **Page 20.**



Fastrim

### Door-In-Door

Piano hinge on the right side of the trim provides access to the wiring gutters without requiring removal of the trim. Order by adding the letters "DD" to the standard trim catalog number. **Add 20% to standard trim list price.**

**Example:** LT2072S becomes LTDD2072S.



Door-in-Door

### Type 12/3R Enclosures

The complete enclosure consists of a box and trim. The enclosure meets code requirements for both Type 12 (dust-tight) and Type 3R (rainproof) standards. Features include a laser cut trim with rounded corners, concealed

hinges and a T-handle lock. Gasketing is provided around the trim door. The box is gasketed and made from code gauge steel with dripshield and is painted ANSI-61.



Type 12/3R Enclosures

**Table 39. Type 12/3R Enclosures for PRL1a, 2a, 3a**

Box Dimensions in Inches (mm)			Catalog Number	
Height	Width	Depth	Box	Trim
24.00 (609.6)	20.00 (508.0)	6.00 (152.4)	VWPB2024	LWPT2024
36.00 (914.4)			VWPB2036	LWPT2036
48.00 (1219.2)			VWPB2048	LWPT2048
60.00 (1524.0)	20.00 (508.0)	6.00 (152.4)	VWPB2060	LWPT2060
72.00 (1828.8)			VWPB2072	LWPT2072
90.00 (2286.0)			VWPB2090	LWPT2090

**PRL4 Special Trims and Enclosures**

**Door-In-Door Trim**



*Door-In-Door Trim*

A piano hinge on the right side of the trim provides access to the wiring gutter without requiring the removal of the trim. When used with a standard PRL4 box, a special mounting channel must be used to add extra depth to the enclosure.

An extra depth box, not requiring a mounting channel, is another available option. Contact your local Satellite for ordering information.

**Table 40. Special Trims and Enclosures**

Standard Box Catalog Number	Mounting Channel Style Number	Door-In-Door Trim Catalog Number	
		Surface	Flush
BX2457 BX2473 BX2490	8708C82G02 8708C82G03 8708C82G04	LDD2457STW LDD2473STW LDD2490STW	LDD2457FTW LDD2473FTW LDD2490FTW
BX3673 BX3690 BX4473 BX4490	8708C82G05 8708C82G06 8708C82G07 8708C82G08	LDD3673STW LDD3690STW LDD4473STW LDD4490STW	LDD3673FTW LDD3690FTW LDD4473FTW LDD4490FTW

**Type 12/3R Enclosures**



*Type 12, 24.00 Inches (609.6 mm) Wide*



*Type 3R, 36.00 Inches (914.4 mm) Wide*

PRL4 enclosures are available in both Type 12 (dust-tight) and Type 3R (rainproof) designs. The 24.00-inch (609.6 mm) wide enclosure includes a single hinged door while the 36.00-inch (914.4 mm) wide is provided with double hinged doors. The side gutter covers are an integral part of the box in all styles. Sizes and catalog numbers are shown in the table below.

**Table 41. Type 12/3R Enclosures**

Enclosure Dimensions in Inches (mm)			Catalog Number	
Height	Width	Depth	Type 3R	Type 12
57.00 (1447.8) 73.00 (1854.2) 90.00 (2286.0)	24.00 (609.6) 24.00 (609.6) 24.00 (609.6)	13.90 (353.1)	RPC2457 RPC2473 RPC2490	DPC2457 DPC2473 DPC2490
73.00 (1854.2) 90.00 (2286.0)	36.00 (914.4) 36.00 (914.4)		RPC3673 RPC3690	DPC3673 DPC3690



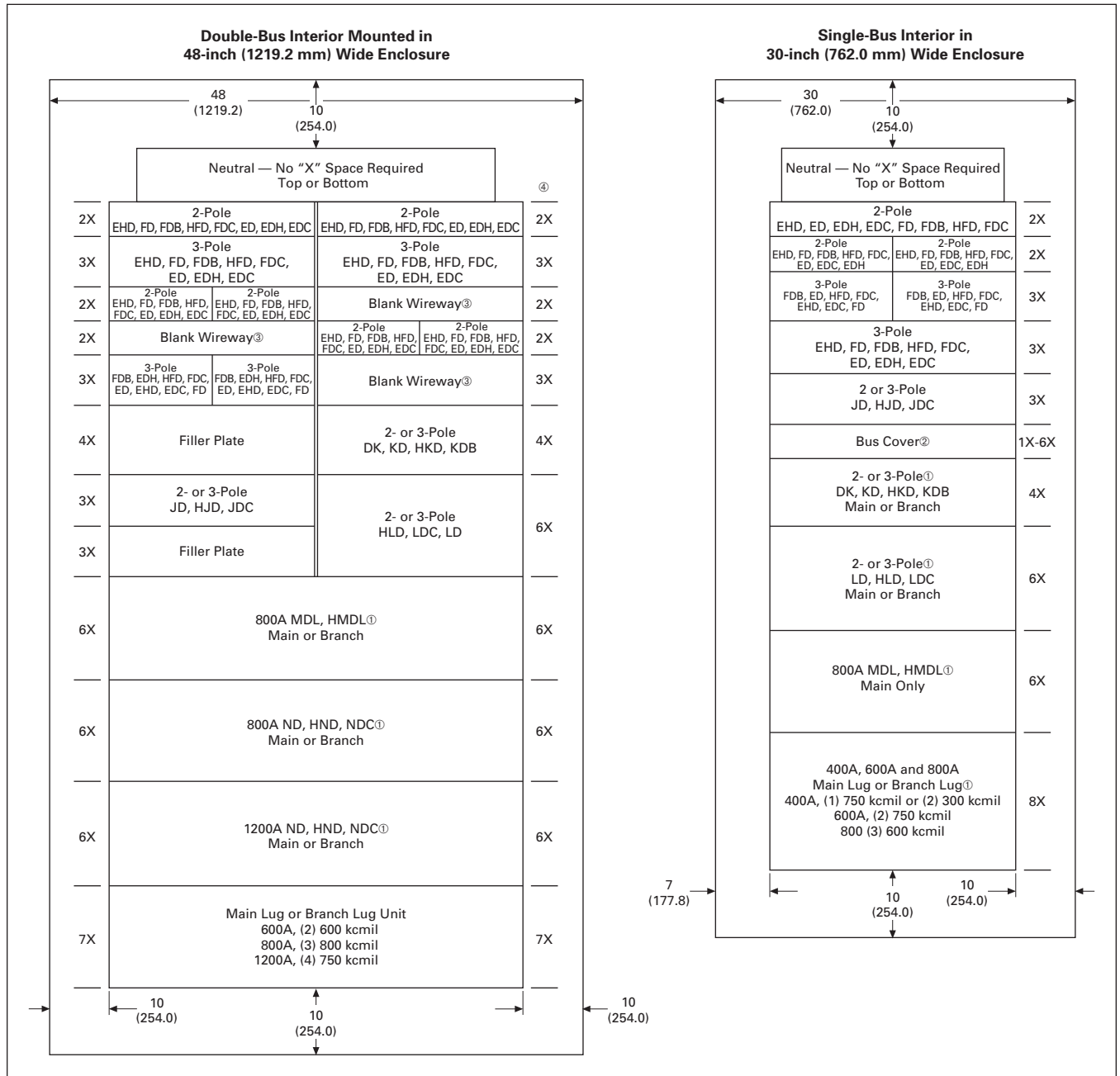
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### Ordering Procedure

- Step 1** Select the correct part or Branch Device. When selecting, you need to know the following:
- Panelboard type.
  - Amperage.
  - System voltage.
  - Available short circuit rating.
  - Number of poles available.
  - Size and number of wires per phase.
  - "X" space required.

- Step 2** Refer to the 5P panelboard layout on **Page 35** to verify the amount of "X" space available.
- Step 3** Create a 5P breaker unit catalog number, by following the instructions on **Page 36**, or order the catalog number for parts on **Pages 38 through 40**.
- Step 4** Determine if extra filler covers are required. Additional filler covers may be necessary to fill the unused space. Refer to **Page 40** for filler plate information.

**PRL5P Chassis Layout**

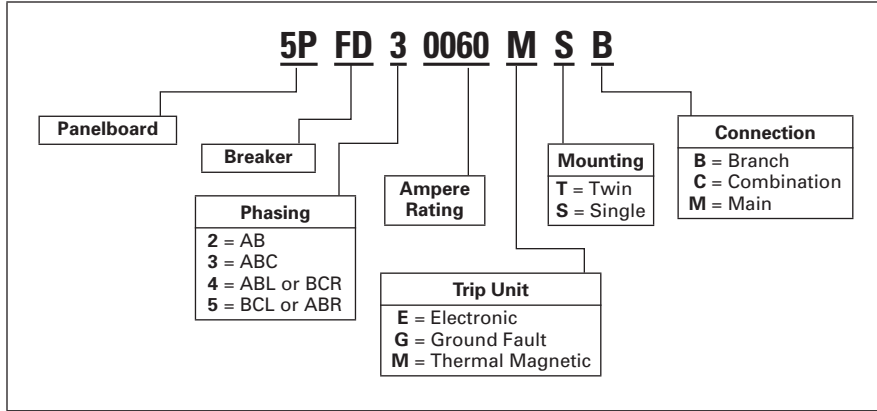


**Figure 3. PRL5P Chassis Layout — Dimensions in Inches (mm)**

- ① If used as a main device, must be mounted at the neutral end of panel.
- ② Fixed bus covers are required for unused spaces if NEC® six circuit disconnect rule is to be met.
- ③ Blank wireway fillers are required opposite any dual breaker unit.
- ④ One "X" = 1.38 inches (35.1 mm).

## PRL5P Breaker Assemblies Catalog Numbers

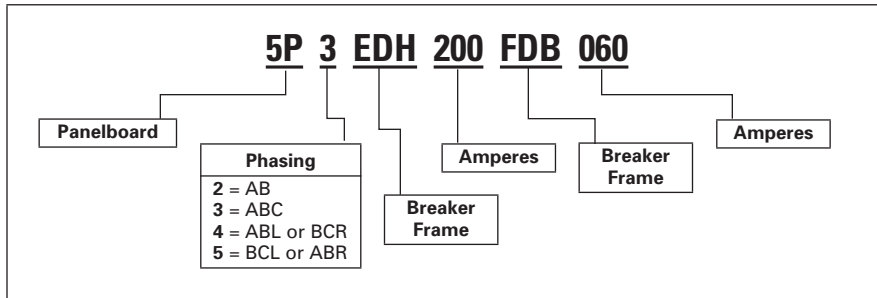
Table 42. Catalog Numbering System — 5P Single or Twin Breakers with Adapters



A plug-on unit is a complete assembly with a circuit breaker and mounting adapter to mount on a 5P panelboard.

Single indicates units that may be mounted in a single or double bus panel, and twin indicates double bus panels only. See **Tables 44 and 45** on **Page 37**.

Table 43. Catalog Numbering System — 5P Dual Breakers with Adapters



Any two F-Frame breakers listed may be mounted on the same 2X or 3X dual breaker adapter.

Dual breaker adapters may be used in single or double bus panels. Dual breaker adapters can **NOT** be mounted across from another adapter in a double bus panel. See **Table 46** on **Page 37**.

**Branch Devices**

Single-pole breakers in single adapter units. Include two or three single-pole 15 – 60 ampere assembled on one unit. (One X = 1.38 inches [35.1 mm])

**Table 44. Single-Pole Breakers in Single Adapter Units**

Breaker Type	Ampere Rating	Interrupting Rating (kA Sym.)				"X" Space Required
		120 Vac	240 Vac	277 Vac	125 Vdc	
EHD	15 – 60	—	—	14	10	2X
FD	15 – 60	—	—	25	10	2X
HFD	15 – 60	—	—	65	10	2X
EHD	15 – 60	—	—	14	10	3X
FD	15 – 60	—	—	25	10	3X
HFD	15 – 60	—	—	65	10	3X

**Table 45. 2- and 3-Pole Breakers in Single Adapter Units**

Breaker Type	Ampere Rating	Interrupting Rating (kA Sym.)				"X" Space Required
		240 Vac	480 Vac	600 Vac	250 Vdc	
ED	100 – 225	65	—	—	—	3X
EDH	100 – 225	100	—	—	—	3X
EDC	100 – 225	200	—	—	—	3X
EHD	15 – 60	18	14	—	10	3X
EHD	70 – 100	18	14	—	10	3X
FD	15 – 60	65	25	18	10	3X
FD	70 – 100	65	25	18	10	3X
FD	110 – 225	65	25	18	10	3X
HFD	15 – 60	100	65	25	22	3X
HFD	70 – 100	100	65	25	22	3X
HFD	110 – 225	100	65	25	22	3X
FDC	15 – 60	200	100	35	22	3X
FDC	70 – 100	200	100	35	22	3X
FDC	110 – 225	200	100	35	22	3X
JD, JDB	70 – 225	65	35	18	10	3X
JD, JDB	250	65	35	18	10	3X
HJD	70 – 225	100	65	25	22	3X
HJD	250	100	65	25	22	3X
JDC	70 – 225	200	100	35	22	3X
JDC	250	200	100	35	22	3X
DK	100 – 400	65	—	—	—	4X
KD, KDB	250 – 400	65	35	25	10	4X
HKD	250 – 400	100	65	35	22	4X
KDC	250 – 400	200	100	50	22	4X
LD, LDB	300 – 600	65	35	25	22	6X
HLD ①②	300 – 600	100	65	35	25	6X
LDC	300 – 600	200	100	50	25	6X
MDL ①②	400 – 800	65	50	25	22	6X
HMDL ①②	400 – 800	100	65	35	25	6X
ND	400 – 1200	65	50	25	—	6X
HND ①②	400 – 1200	100	65	35	—	6X
NDC	400 – 1200	200	100	50	—	6X

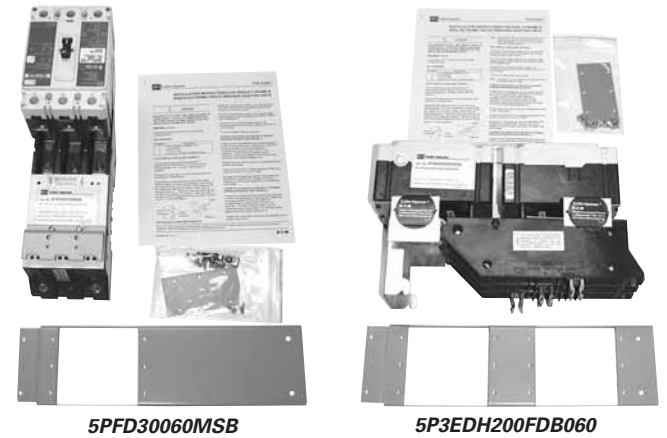
① For use only in double bus chassis panelboards.  
 ② 100% rated breakers are **NOT** available in 5P panelboards.

Dual breaker adapters — Any two breakers listed in **Table 46** may be mounted on the same 2X or 3X dual breaker adapter.

Dual breaker adapters may be used in single or double bus chassis. Dual breaker adapters can **NOT** be mounted across from another in a double bus chassis. (One X = 1.38 inches [35.1 mm])

**Table 46. Dual Breaker Adapters**

Breaker Type	Ampere Rating	Interrupting Rating (kA Sym.)				"X" Space Required
		240 Vac	480 Vac	600 Vac	250 Vdc	
ED	100 – 225	65	—	—	—	3X
EDH	100 – 225	100	—	—	—	3X
EDC	100 – 225	200	—	—	—	3X
EHD	15 – 60	18	14	—	10	3X
EHD	70 – 100	18	14	—	10	3X
FD	15 – 60	65	25	18	10	3X
FD	70 – 100	65	25	18	10	3X
FD	110 – 225	65	25	18	10	3X
HFD	15 – 60	100	65	25	22	3X
HFD	70 – 100	100	65	25	22	3X
HFD	110 – 225	100	65	25	22	3X
FDC	15 – 60	200	100	35	22	3X
FDC	70 – 100	200	100	35	22	3X
FDC	110 – 225	200	100	35	22	3X



## PRL5P Main or Through-Feed Lugs

Table 47. PRL5P Main or Through-Feed Lugs

Description	Ampere Rating	Wire Size Range	"X" Space Required	Catalog Number
<b>Single Bus Chassis Mounting</b>				
Ampere Lug Unit	400	(1) 1/0 – 500 or (2) 1/0 – 250 kcmil	8X	5PLUG3400SC
Ampere Lug Unit	600	(2) 1/0 – 500 kcmil	8X	5PLUG3600SC
Ampere Lug Unit	800	(2) #2 – 500 or (3) #2 – 400 kcmil	8X	5PLUG3800SC
<b>Double Bus Chassis Mounting</b>				
1200 Ampere Lug Unit	600 – 1200	(4) #4 – 750 kcmil	7X	5PLUG31200TC



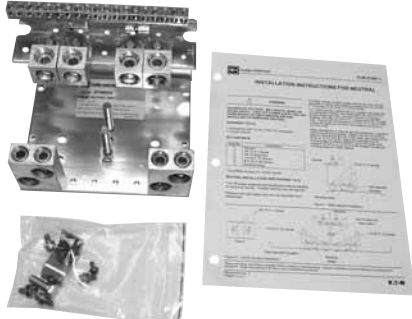
5PLUG3800SC



5PLUG31200TC

**PRL5P Neutrals and Grounds**

**Neutral Assembly**



**5PN800A**

**Table 48. Neutral Assemblies with Lugs**

Incoming Number of Cables and Wire Size	Catalog Number
(4) 250 – 500 kcmil 800 Amperes Aluminum/Copper	5PN800A
(4) 250 – 500 kcmil 800 Amperes Copper	5PN800C
(4) 250 – 500 kcmil 1200 Amperes Aluminum/Copper	5PN1200A
(4) 250 – 500 kcmil 1200 Amperes Copper	5PN1200C

**Table 49. Additional Lugs for Neutral Assemblies**

Description	Catalog Number
(1) 1/0 – 750 kcmil or (2) 1/0 – 300 kcmil Aluminum/Copper	5PNL400
(2) 250 – 500 kcmil Aluminum/Copper	5PNL600
(3) 3/0 – 750 kcmil Aluminum/Copper	5PNL800
(4) 3/0 – 750 kcmil Aluminum/Copper	5PNL1200

**Ground Bar Type**

1200 Amperes Aluminum/Copper	5PG1200A
1200 Amperes Copper	5PG1200C

**Ground Bar Assemblies**



**5PG1200A**

**Table 50. Grounded "B" Phase Adapter Kits**

Ampere Rating	Main Device	Catalog Number
<b>Single Bus Chassis</b>		
400	Main Lugs	5PCGBLUG400S
600	Main Lugs	5PCGBLUG600S
600	LD Breaker	5PCGBLD600S
800	Main Lugs	5PCGBLUG800S
<b>Double Bus Chassis</b>		
800	MD Breaker	5PCGBMD800T
1200	Main Lugs	5PCGBLUG1200T
1200	ND Breaker	5PCGBND1200T

## PRL5P Box, Trim and Deadfront Filler Plates

Table 51. PRL5P Box, Trim and Deadfront Filler Plates

Chassis "X" Factor	Catalog Number		
	Back Box	Trim	Trim Door Kit
<b>Single Bus Chassis — 30.00-Inch (762.0 mm) Wide Box</b>			
24X	5PB2430G	5PT2430S	5PD24S
32X	5PB3230G	5PT3230S	5PD32S
40X	5PB4030G	5PT4030S	5PD40S
<b>Double Bus Chassis — 48.00-Inch (1219.2 mm) Wide Box</b>			
24X	5PB2448G	5PT2448S	5PD24T
32X	5PB3248G	5PT3248S	5PD32T
40X	5PB4048G	5PT4048S	5PD40T

Table 52. Deadfront Filler Plates

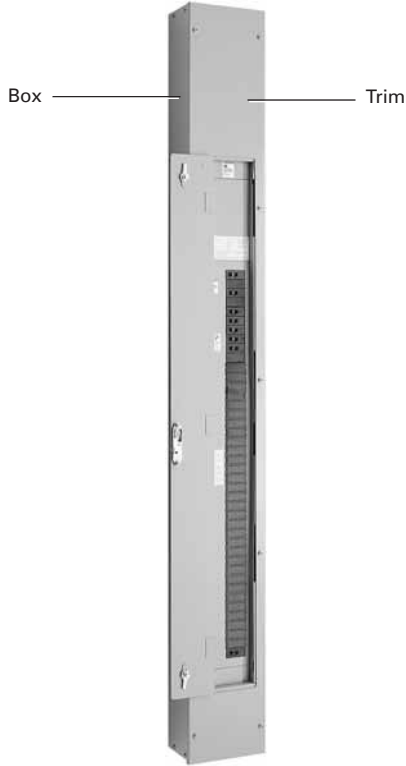
Vertical "X" Increment	Catalog Number	
	Single Bus Chassis ①	Double Bus Chassis
1X	5PFP1S	5PFP1T
2X	5PFP2S	5PFP2T
3X	5PFP3S	5PFP3T
4X	5PFP4S	5PFP4T
5X	5PFP5S	5PFP5T
6X	5PFP6S	5PFP6T

① These fillers are also used across from a breaker unit in a double bus chassis.





**PRL1a, 2a-LX**



**Table 53. Type 1 Box and Trims**

Box Height in Inches (mm)	Catalog Number		
	Box	Surface Trim Standard	Surface Trim Door-In-Door
<b>Incoming Location Top Fed</b>			
69.00 (1752.6)	YSC969	LTC969S	LTCD969S
78.00 (1981.2)	YSC978	LTC978S	LTCD978S
81.00 (2057.4)	YSC981	LTC981S	LTCD981S
90.00 (2286.0)	YSC990	LTC990S	LTCD990S
<b>Incoming Location Bottom Fed</b>			
69.00 (1752.6)	YSC969	LTC969SB	LTCD969SB
78.00 (1981.2)	YSC978	LTC978SB	LTCD978SB
81.00 (2057.4)	YSC981	LTC981SB	LTCD981SB
90.00 (2286.0)	YSC990	LTC990SB	LTCD990SB

## Pow-R-Command

For replacement parts, see PRL3a Section, **Page 21**. Parts available are the following:

- Connector kits.
- Ground assemblies.
- Service entrance kits.
- Deadfront covers.
- Trim locks.



*Pow-R-Command*

## Additional Services

Since virtually all panelboards are supplied to meet specific customer requirements, other parts not listed in this publication might occasionally be needed. Price and availability for parts not shown here may be obtained by contacting your local Satellite plant and providing a complete description of the part along with the data on the panelboard nameplate.

Should you experience difficulty in determining what replacement parts are needed, contact your local Satellite Plant Manager who can provide help to:

- Identify and recommend replacement parts.
- Remove damaged parts and instruct you in how to install replacement parts.
- Verify the correct connector kits which should be ordered for each circuit breaker or fusible switch.
- Retrofit existing panelboard boxes with new Pow-R-Line interiors.
- Provide a recommended spare parts list.

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*Powering Business Worldwide*

## Dry-Type Transformers General Information

Custom Transformers must be approved by TRC - Avery Creek

This is a custom-manufactured product. Once it is released for manufacturing, it cannot be cancelled. This product cannot be returned for credit.

- Custom Transformer Style Number: V48M28T30EETRUS
- Transformer Type: General Purpose Vented
- Phase: 3
- kVA: 30
- Primary Volts: 480
- Secondary Volts: 208Y/120
- Temperature Rise: 150C with 220C Insulation System
- Winding Material: Aluminum
- Enclosure Type: NEMA 2 (N3R w/opt'l weathershield)
- Frequency (Hz): 60
- Easy Install: N
- Made In America: Y

### Standard Values

- K-Factor: 1
- TAPS: 2@+2.5%, 4@-2.5%
- Sound Reduction (dB): 0
- NEMA ST20 Sound Level (dB): 45
- DOE 10 CFR Part 431 (2007) Efficient (NEMA TP-1): Y
- Infrared Viewing Window: None

### Field-Installed Accessories Included

- Lug Kit: LKS1

### Customized Values

- CUSTOM: Certified Test Report Y
- CUSTOM: Made In America Y
- 
- CUSTOM: OSHPD Compliant (verify mounting method in OSP) N
- 

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	SUSAN HINTON	4/23/2015			
	APPROVED BY	DATE	JOB NAME	CDOT - EJMT	
			DESIGNATION	DT-3, DT-3	
	VERSION	TYPE		DRAWING TYPE	
	1.0.0.1	Dry-Type Transformer		Final	
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET
DN800129X5K2-R000	0	A	SDN0598403	004	1 of 1



*Powering Business Worldwide*



# Instructions for Installation, Operation, and Maintenance of Dry-Type Distribution Transformers

# Instrucciones para la instalación, operación y mantenimiento de los Transformadores de Distribución Tipo Seco

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**WARNING**

**ALWAYS TURN OFF THE POWER SUPPLYING THIS EQUIPMENT BEFORE WORKING INSIDE. FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.**

**1. INTRODUCTION**

Transformers should be installed and serviced only by competent personnel familiar with good safety practices. These instructions are written for such personnel and are not intended as a substitute for adequate training and experience in the use of transformers. Refer to NEMA Standard ST-20 for more information on general application requirements.

**2. RECEIVING**

All dry-type distribution transformers are completely assembled and carefully tested at the factory before being shipped.

Upon receipt of the transformer:

- Inspect it for possible shipping damage.
- Check the bill of lading for possible shortages.

If shipping damage occurs, a claim should immediately be filed with the carrier. Notify the local sales office with the carrier's name and the extent of the damage.

**3. LIFTING AND HANDLING****WARNING**

**FAILURE TO PROPERLY LIFT THE TRANSFORMER MAY CAUSE DAMAGE TO THE PRODUCT, OTHER PROPERTY, OR RESULT IN PERSONAL INJURY.**

**ALWAYS MOVE A VENTILATED DESIGN TRANSFORMER IN AN UPRIGHT POSITION ONLY. FAILURE TO DO SO COULD RESULT IN TRANSFORMER DAMAGE.**

**Ventilated design transformers:**

- Use spreaders with lifting chains or slings connected to the holes located on both sides panels or remove the top cover to access the lifting holes on each end of the top of the core-coil assembly.

OR

- Lift the unit with a fork lift when a pallet is provided.
- For further information see Figure 1 on Page 3.

**Encapsulated design transformers (above 2 kVA):**

- Lift the transformer by its lifting brackets.

OR

- Lift the unit with a fork lift when a pallet is provided.
- For further information see Figure 2 on Page 3.

**ADVERTENCIA**

**SIEMPRE DESENERGICE ESTE EQUIPO ANTES DE TRABAJAR EN ÉL. EL NO HACERLO PUEDE CAUSAR LESIONES PERSONALES SERIAS, MUERTE O DAÑOS A LA PROPIEDAD.**

**1. INTRODUCCION**

Los transformadores deben ser instalados y mantenidos por personal calificado y conocedor de prácticas de seguridad. Estas instrucciones van dirigidas a ellos sin intención de sustituir la adecuada capacitación y experiencia en transformadores. Consulte el estándar N.E.M.A. (National Electrical Manufacturers Association E.U.A.) ST-20 para requisitos de aplicaciones generales.

**2. ARRIVO**

Todos los transformadores de distribución tipo seco son completamente ensamblados y cuidadosamente probados en la fábrica antes de ser enviados.

Al recibir el transformador:

- Inspeccione si se ocasionaron daños debido al transporte.
- Verifique las partes para posibles faltantes.

En caso de ocurrir daño por transporte, levante un reporte con el transportista. Avise a la oficina local de ventas, provea el nombre del transportista y el alcance del daño.

**3. IZADO Y MANEJO****ADVERTENCIA**

**LEVANTAR Y/O MOVER EL TRANSFORMADOR INCORRECTAMENTE PUEDE AFECTARLO, CAUSAR DAÑOS A LA PROPIEDAD O LESIONES PERSONALES.**

**TRASLADÉ LAS UNIDADES VENTILADAS SIEMPRE EN POSICIÓN VERTICAL. EL NO HACERLO DAÑARÁ EL TRANSFORMADOR.**

**Transformadores de Diseño Ventilado:**

- Para izar use travesaño con cadena por los orificios redondos ubicados en los paneles laterales o por dentro de la unidad en la parte superior del ensamble del núcleo (remueva la tapa superior).

o

- Use montacargas si el transformador está sobre una tarima.
- Para referencia vea la Figura 1 en la página 3.

**Transformadores de Diseño Encapsulado (mayores de 2 kVA):**

- Levante la unidad por las ménsulas.

o

- Levante la unidad con montacargas cuando se provea tarima.
- Para referencia, vea la Figura 2 en la página 3.

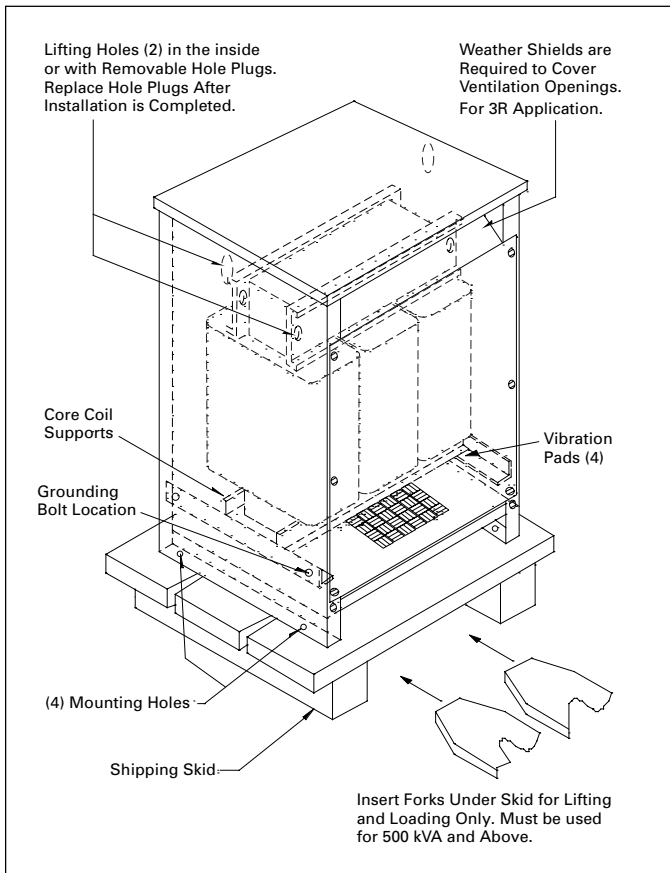


Figure 1 Typical Ventilated Transformer.

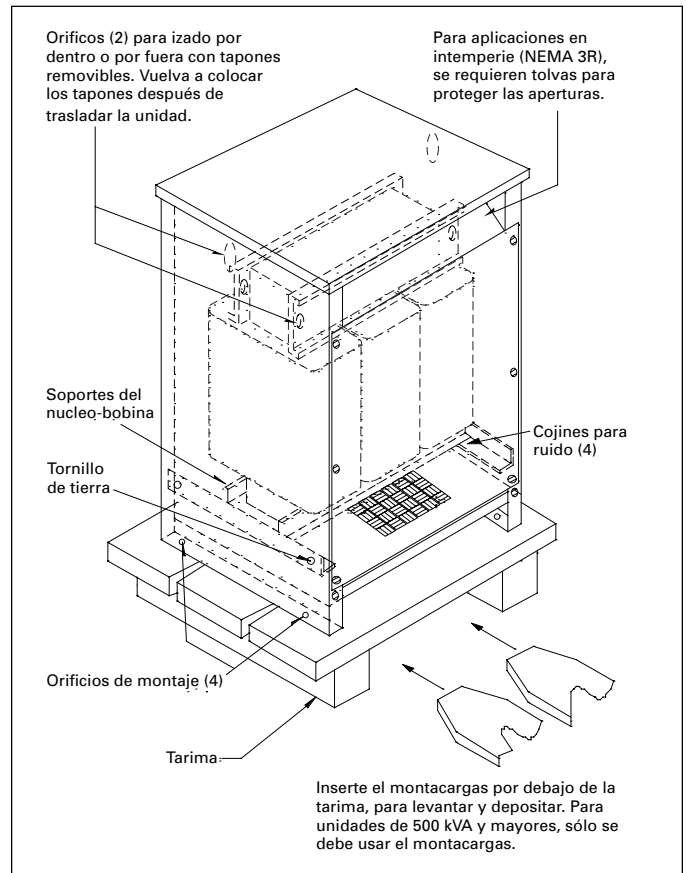


Figura 1 Transformador típico ventilado.

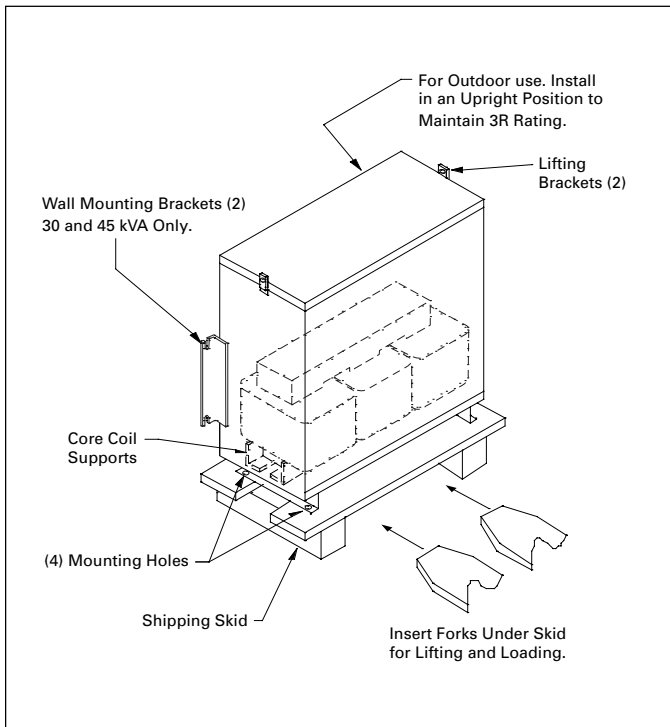


Figure 2 Typical Encapsulated Transformer.

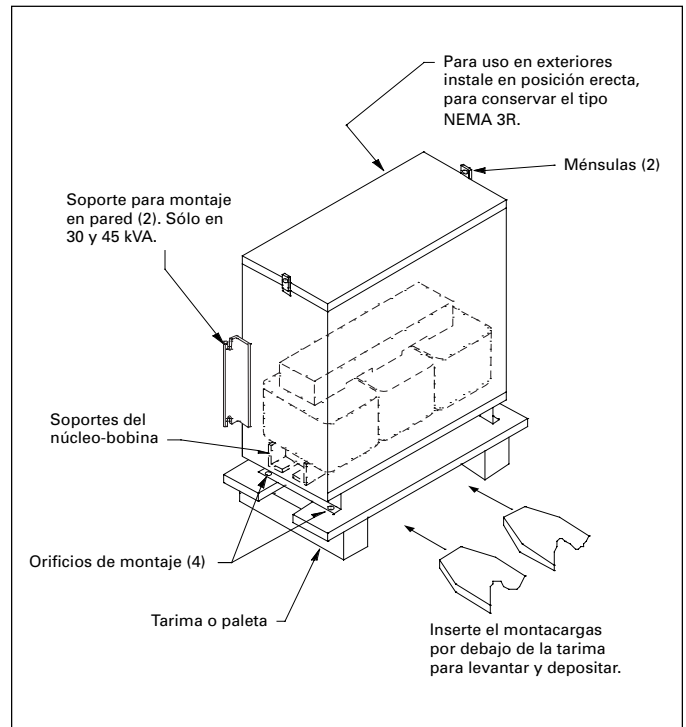


Figura 2 Transformador típico encapsulado.

#### 4. STORAGE PRIOR TO ENERGIZATION

Store dry-type transformers in their original shipping cartons indoors in a clean, dry, temperature stable environment.

#### 5. LOCATION AND MOUNTING

##### All dry-type transformers:

- Locate the transformer in an area where the transformer is easily accessible and serviceable.
- Install the unit in accordance with the requirements of Article 450 of the National Electrical Code and other appropriate local codes.
- Install the unit in a protected electrical circuit. Do not subject the transformer to voltage surges unless it is properly protected.
- Transformers are not tamper proof and should be installed in secured locations away from all unauthorized personnel.
- Locate unit in a well ventilated area free from excessive moisture, dust, dirt, or explosive/corrosive gases or vapors.
- Locate ventilated units at least 6 inches from front and rear structure to assure proper air circulation. Avoid any obstruction to the bottom and top panel ventilation openings.
- Install transformer on a surface strong enough to support the weight of the unit.
- Install ventilated transformers in an upright position only.
- Encapsulated transformers for indoor use may be mounted in any position. For outdoor application encapsulated transformers must be installed in an upright position to maintain a 3R rating.

#### 6. HOW TO REDUCE SOUND TRANSMISSION

All transformers make some sound mainly due to the vibration generated in its core by alternating flux. NEMA ST-20 defines the sound levels for dry-type distribution transformers as shown in Table 1.

**Table 1**

kVA	NEMA Average Sound Level (dB) <sup>①</sup>	
	1.2 kV Class	Above 1.2 kV
0-9	40	45
10-50	45	50
51-150	50	55
151-300	55	58
301-500	60	60
501-700	62	62
701-1000	64	64
1001-1500	65	65

<sup>①</sup> Applies to general purpose transformers only.

#### 4. ALMACENAJE PREVIO A CONEXION

Mantenga los transformadores en su empaque original, en interiores secos, limpios y a temperatura estable.

#### 5. LOCALIZACION Y MONTAJE

##### Transformadores de Diseño Ventilado y Encapsulado:

- Coloque el transformador donde pueda ser inspeccionado y tener acceso a él en cualquier momento.
- Instale la unidad de acuerdo a lo provisto en el artículo 450 del N.E.C. (Código Nacional Eléctrico E.U.A.) y/o los códigos o normas locales aplicables.
- Instale la unidad en un circuito eléctrico protegido. No exponga el transformador a sobrevoltajes a menos que esté adecuadamente protegido.
- Los transformadores son fácilmente accesados y por ello deben ser instalados en lugares seguros, lejos de toda persona no autorizada.
- Ubique las unidades en un área ventilada, libre de humedad excesiva, polvo, suciedad o vapores o gases explosivos o corrosivos.
- Ubique el transformador ventilado retirado un mínimo de 15 cm. de estructuras frontal y posterior para asegurar la apropiada circulación de aire. Evite cualquier obstrucción a las aperturas de ventilación de los paneles superior e inferior.
- Instale el transformador sobre una superficie suficientemente rígida para soportar el peso de la unidad.
- Instale los transformadores ventilados en posición vertical solamente.
- Los transformadores encapsulados para uso en interiores pueden ser montados en cualquier posición. Para uso en exteriores deben ser instalados sólo en posición vertical para mantener la nominación N.E.M.A. 3R.

#### 6. COMO REDUCIR LA TRANSMISION DE SONIDO

Todos los transformadores generan sonido principalmente por la vibración generada en el núcleo por el flujo magnético alternante. NEMA ST-20 define los máximos niveles promedio de sonido para transformadores de distribución tipo seco como se muestra en la Tabla 1.

**Tabla 1**

kVA	Nivel de sonido promedio de N.E.M.A. (dB) <sup>①</sup>	
	Clase 1.2 kV	Mayores de Clase 1.2 kV
0-9	40	45
10-50	45	50
51-150	50	55
151-300	55	58
301-500	60	60
501-700	62	62
701-1000	64	64
1001-1500	65	65

<sup>①</sup> Aplica a transformadores de uso general solamente.

All general purpose dry-type distribution transformers are designed to meet NEMA ST-20 established sound levels. However, to minimize the potential for sound transmission to surrounding structures and sound reflection, follow these instructions:

1. Mount the transformer away from corners, walls or ceilings. For installation which must be near a corner, use sound absorbing materials on the walls and ceiling.
2. Use flexible conduit to make the connections to the transformers.
3. Locate the transformers as far away as possible from areas where sound is objectionable.

## 7. CONNECTING CABLES TO TRANSFORMER TERMINATIONS

Any standard cable of the conductor size specified in N.E.C. Section 310 can be used. Recommended external cable should be rated 90°C (sized at 75% ampacity) for encapsulated designs and 75°C for ventilated designs. Connectors should be selected on the basis of the type cable and cable size used to wire the specific transformer.

- Remove access panels to wiring compartment.
- Install conduit and wiring through sides and/or bottom of transformer case into wiring compartment.
- Top entry of cable should be avoided.
- Clean all electrical joints.
- Connect primary wiring first to correct terminal as shown on the transformer nameplate.
- Insulate any unused tap leads and verify tap connections are tight.
- Energize unit and measure secondary voltage to verify correct voltage.
- De-energize primary circuit and connect secondary wiring to terminations in accordance with nameplate wiring diagram.
- Make sure all connections are tight.
- Re-install access panels.

### Grounding

As required by the National Electrical Code, connect a ground cable to the transformer enclosure. The transformer core is grounded to enclosure.

## 8. ENERGIZATION AND OPERATION GUIDELINES

For ventilated designs only, if moisture is evident, the unit should be dried out by placing it in an oven or by blowing heated air over it. The temperature should not exceed 110° C (230°F) to prevent damage to wiring insulation.

When the tests and connections are complete, the transformer may be energized.

Todos los transformadores de distribución tipo seco son diseñados para cumplir con los niveles de sonido establecidos por NEMA, norma ST-20. Aún así para minimizar la transmisión potencial de sonido y su reflexión, siga estas instrucciones:

1. Monte el transformador alejado de esquinas, paredes y techos. En caso contrario, use materiales absorbentes de sonido en las paredes.
2. Use tubo conduit flexible para hacer las conexiones al transformador.
3. Coloque la unidad lo más retirada posible de áreas en las que el nivel de ruido sea un factor limitante.

## 7. CONEXION DE CABLES A LAS TERMINALES DEL TRANSFORMADOR

Puede usar cualquier cable conductor aislado, del calibre especificado por N.E.C. o los códigos aplicables. El cable de uso exterior recomendado debe ser para 90°C (calculado al 75% de ampacidad) en diseños encapsulados, y para 75°C en diseños ventilados. Los conectores deberán seleccionarse de acuerdo al tipo y al calibre del cable conductor utilizado en la conexión al transformador específico.

- Remueva los páneces o tapas de acceso al compartimiento de alambrado.
- Instale tubo conduit y el cableado por el fondo o los lados del gabinete del transformador hacia el compartimiento de terminales.
- Evite el acceso de cable por la parte superior del gabinete de diseños ventilados.
- Limpie todas las uniones eléctricas.
- Conecte primero la sección primaria a la terminal correcta, según se muestre en la placa de datos.
- Aisle todo tap (derivación) sin usar y revise que los taps conectados estén apretados.
- Energice la conexión primaria y mida el voltaje en la sección secundaria, verificando que sea el voltaje correcto.
- Desenergice y prepare la conexión en la sección secundaria de acuerdo al diagrama de la placa de datos.
- Asegúrese que todas las conexiones han sido apretadas.
- Reinstale los páneces o tapas de acceso al compartimiento de conductores.

### Conexión a tierra (potencial cero)

Conecte el cable de tierra física al gabinete del transformador, así como lo requiere el N.E.C.. El núcleo del transformador ya ha sido aterrizado al gabinete.

## 8. GUIA DE ENERGIZADO Y OPERACION

Para diseños ventilados solamente: si existe humedad evidente, seque la unidad ya sea dentro de un horno o soplando aire caliente por ella. La temperatura no debe exceder 110°C (230°F) para prevenir daños al alambrado.

Una vez probado el transformador y terminadas las conexiones, el transformador puede ser energizado.

Do not make any connections other than those shown on the nameplate or diagram. Do not change connections or taps while the unit is energized.

This dry-type transformer was built and tested in accordance with applicable standards of American National Standards Institute and National Electrical Manufacturers's Association.

The following operations guides are excerpts from these standards.



## WARNING

**IT IS IMPORTANT TO FOLLOW THE GUIDELINES SET FORTH BELOW. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, PROPERTY DAMAGE, OR REDUCED TRANSFORMER LIFE.**

The maximum allowed overvoltage is 5% above rated secondary voltage at rated kVA load with load power factor at least 80%. If the transformer is energized while the secondary is not connected to a load, then the voltage applied to the primary must not result in a voltage exceeding 110% of the rated secondary voltage.

Continuous overload capability is not deliberately designed into general purpose transformers. For short term overload capability, See ANSI C57.96-01.250 for guidelines and limitations.

Transformers depend entirely on the surrounding air for adequate ventilation. The ambient should not exceed 40°C (104°F) and the average temperature of the air for any 24 hour period should not exceed 30°C (86°F). For operation at higher ambients, transformer loading should be reduced 0.6% of rated KVA for each degree above 30°C average ambient to a maximum of 50°C (122°F).

The transformer may be connected in parallel with other transformers if the phase angle shift is the same; phase rotation is the same; transformers' turn ratios and voltage ratings are within a 0.5% range; and the percent impedance on the same kVA base is within a  $\pm 7.5\%$  range.

Transformers are normally designed for operation at altitudes below 1000 meters (3300 feet). To operate a transformer above 1000 meters, it is necessary to reduce the kVA load and to increase the electrical insulation clearances between energized terminals. Refer to NEMA ST-20 for detailed guidelines.

## 9. MAINTENANCE AND REPAIR



## WARNING

**BEFORE ATTEMPTING REPAIRS, FOLLOW THE INSTRUCTIONS SET FORTH BELOW. DE-ENERGIZE THE TRANSFORMER BEFORE MAKING REPAIRS. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.**

It is the responsibility of the owner to inspect, maintain and keep the transformer in good repair.

Report all failures during the warranty period to your local sales office prior to repairs. All warranty repairs must be made or approved by the manufacturer.

No intente realizar conexiones no mostradas en la placa de datos. No intente modificaciones o cambio de derivaciones (taps) con el transformador energizado.

Este transformador tipo seco fué construido y probado de acuerdo a normas aplicables A.N.S.I. (American National Standards Institute, E.U.A.)

Las siguientes instrucciones de operación son extractos de esas normas.



## ADVERTENCIA

**ES IMPORTANTE SEGUIR LAS RECOMENDACIONES QUE SE MENCIONAN. EL NO ACATARLAS PUEDE RESULTAR EN LESIONES PERSONALES SEVERAS, MUERTE, DAÑO EN PROPIEDAD O REDUCCIÓN DE LA VIDA ÚTIL DEL TRANSFORMADOR.**

El máximo sobrevoltaje permitido es 5% sobre el voltaje nominal secundario, a carga (kVA) nominal, con un factor de potencia de al menos 80%. Si el transformador se energiza sin que el secundario esté conectado a una carga, entonces el voltaje aplicado al primario no debe provocar un voltaje secundario mayor al 110% del nominal.

Los transformadores de uso general no están intencionalmente diseñados para soportar sobrecargas continuas. Para información y orientación sobre la operación de sobrecarga en periodos cortos de tiempo, consulte A.N.S.I. C57.96-01.250.

Los transformadores ventilados dependen completamente del aire circundante para su adecuada ventilación. El ambiente no debe exceder los 40°C (104°F) y el promedio de temperatura del aire, en un periodo de 24 horas, no debe exceder los 30°C (86°F). Para operación a mayores temperaturas, la carga del transformador se reduce un 0.6% de la potencia nominal en KVA por cada grado sobre 30°C (86°F) de ambiente promedio, hasta un máximo de 50°C (122°F).

El transformador puede conectarse en paralelo con otros transformadores si: el ángulo de fase es el mismo, la rotación de fase es igual, la relación de vueltas y los voltajes nominales están dentro de un 0.5% del rango, y el porcentaje de impedancia, basado en mismos KVA, está dentro del rango de  $\pm 7.5\%$ .

Los transformadores normalmente se diseñan para operar a altitudes por debajo de 1000 metros ( 3300 Ft. ). Operando sobre 1000m es necesario reducir la carga en KVA e incrementar los claros entre terminales energizadas. Consulte N.E.M.A. ST-20 para más detalles.

## 9. MANTENIMIENTO Y REPARACION



## ADVERTENCIA

**ANTES DE INTENTAR DAR SERVICIO, SIGA LAS INSTRUCCIONES QUE SE DARÁN. DESENERGICE ESTE EQUIPO ANTES DE TRABAJAR EN ÉL. EL NO HACERLO PUEDE CAUSAR LESIONES PERSONALES SEVERAS, MUERTE O DAÑOS EN PROPIEDAD.**

Es responsabilidad del propietario la inspección, mantenimiento y reparación del transformador.

Durante la vigencia de la garantía notifique toda falla a su oficina de ventas antes de reparar. Toda reparación bajo garantía debe ser hecha o aprobada por el fabricante.

Practically no maintenance is required on a dry-type transformer but inspect it periodically as indicated below:

- De-energize transformer.
- Check for any accumulation of dust or dirt on the terminations or vents. If necessary, remove by vacuuming, brushing, or blowing dry air. Special care should be taken when blowing with dry air to prevent further damage to the product or injury to maintenance personnel from flying particles.
- Inspect insulators, terminals, terminal boards, for tracking (discharge), breaks, cracks, or burns. Clean or repair if necessary.
- Check terminal quality and connections, including taps, for tightness. Replace or tighten as necessary.
- Inspect ground connections and ground contact surfaces. Tighten or repair if needed.
- For ventilated designs only, if moisture is evident, the unit should be dried out by placing it in an oven or by blowing heated air over it. The temperature should not exceed 110°C (230°F) to prevent damage to installation wiring.
- Inspect the paint finish for scratches or wear. Repair the finish if necessary.

## 10. SAFETY

The installation, operation and maintenance of a transformer presents numerous potential unsafe conditions, including, but not limited to the following:

- Improper tap changing operation
- Lethal voltages
- Moving machinery
- Heavy components

All applicable safety procedures as OSHA requirements, regional and local safety requirements, safe working practices, and good judgement must be used by personnel when installing, operating, and/or maintaining such equipment.

Unless otherwise stated, failure to adhere to the following could result in severe bodily damage, injury, death, or property damage. Refer to appropriate areas of this instruction book for further instructions.

1. When the transformer is energized, the electrical terminations are at high voltages. Close exposure to these parts could result in death by electrocution.
2. Do not remove case panels and/or doors when the transformer is energized. Do not energize transformer for operation until the panels are properly installed.
3. Improper or inadequate maintenance could result in reduced transformer life, cause personal injury, death, or property damage.

## 11. DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

There are no understandings, agreements, representations or warranties, express or implied, including warranties of merchantability

El transformador tipo seco prácticamente no necesita mantenimiento; aún así, acostumbre revisarlo de la manera siguiente:

- Desenergice el transformador.
- Busque polvo y suciedad acumulados en terminales y respiraderos. De ser necesario, remueva con aspiradora, cepillando o soplando aire seco. Se debe tener cuidado especial al soplar aire seco para prevenir posibles daños al producto o al personal con las partículas sueltas.
- Revise quebraduras, quemaduras y fisuras en aislantes, terminales y soportes de terminales. Limpie o repare si es necesario.
- Revise la calidad y firmeza de terminales y contactos, incluyendo los taps. Apriete o reemplace si es necesario.
- Revise conexiones y superficies de contacto a tierra ( potencial cero). Limpie, apriete o repare si es necesario.
- Para diseños ventilados solamente, en caso de humedad evidente, la unidad debe ser secada ya sea dentro de un horno o soplando aire caliente. La temperatura no debe exceder 110°C (230° F) para prevenir daño al alambrado.
- Inspeccione raspaduras o deterioro en el acabado de la pintura exterior del gabinete. Retoque de ser necesario.

## 10. SEGURIDAD

La instalación, operación y mantenimiento de un transformador presenta numerosas condiciones inseguras, incluyendo entre otras:

- Modificar arreglo de derivaciones (taps) inapropiadamente
- Voltajes mortales
- Equipo en movimiento
- Partes y componentes pesados

Todos los procedimientos de seguridad como los requeridos por O.S.H.A. (Occupational Safety & Health Administration, E.U.A.), instituciones como C.F.E., I.M.S.S. y S.T.P.S. (MEX) u otros aplicables, requerimientos locales y regionales deben ser usados por el personal para instalar y/o dar mantenimiento al equipo, así como también seguir prácticas de seguridad y buen juicio.

A menos que se especifique lo contrario, el no apearse a lo siguiente puede causar daños y lesiones personales, muerte y daños en propiedad. Vea las secciones apropiadas de este manual para más información.

1. Cuando el transformador está energizado las terminales eléctricas mantienen un alto potencial (voltaje). El exponerse a estas partes puede causar muerte por electrocución.
2. No remueva los paneles o tapas cuando el transformador esté energizado. No energice el transformador sin haber reinstalado dichos elementos.
3. El mantenimiento pobre o inapropiado reduce la vida útil de la unidad, puede causar lesiones personales, muerte o daño a la propiedad.

## 11. LIMITES EN RESPONSABILIDAD Y GARANTIA

No hay entendimientos, acuerdos, representaciones o garantías, expresas o implícitas, incluyendo garantías de mercadeo o



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*Powering Business Worldwide*

## Safety Switch General Information

### Global Specifications

System Voltage	600 VAC
Switch Type	Single Throw - Heavy Duty
Poles/Blades	3-Pole
Amperage	200
Protection	Fusible with No Neutral
Enclosure Type	NEMA 1
Fuse Clips	Standard
Switch Lugs	Standard
Fungus Proof Treatment	N
Lock-On Provision	N
Fuse Pullers	N
Control Pole	N
Ground Lugs	N
316 Stainless	N
Stainless Mechanism	N
Mill Duty	N

### Nameplate

### Field Installed Kits

QUANTITY	DESCRIPTION
1	"R" Fuse Adapter Kit : DS46FK (Field Installed)

### Safety Switch Catalog No.

DH364FGK

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	SUSAN HINTON	4/23/2015				
	APPROVED BY	DATE	JOB NAME	CDOT - EJMT		
			DESIGNATION	200A/3P/F/N1		
	VERSION	TYPE		DRAWING TYPE		
	1.0.0.1	Safety Switch General Information		Final		
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET	
DN800129X5K2-R000	0	A	SDN0598403	006	1 of 1	



## Safety Switch General Information

### Global Specifications

System Voltage	600 VAC
Switch Type	Single Throw - Heavy Duty
Poles/Blades	3-Pole
Amperage	30
Protection	Fusible with No Neutral
Enclosure Type	NEMA 1
Fuse Clips	Standard
Switch Lugs	Standard
Fungus Proof Treatment	N
Lock-On Provision	N
Fuse Pullers	N
Control Pole	N
Ground Lugs	N
316 Stainless	N
Stainless Mechanism	N
Mill Duty	N

### Nameplate

### Field Installed Kits

QUANTITY	DESCRIPTION
1	"R" Fuse Adapter Kit : DS16FK (Field Installed)

### Safety Switch Catalog No.

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			DESIGNATION	30A/3P/F/N1		
	VERSION	TYPE		DRAWING TYPE		
	1.0.0.1	Safety Switch General Information		Final		
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET	
DN800129X5K2-R000	0	A	SDN0598403	008	1 of 1	

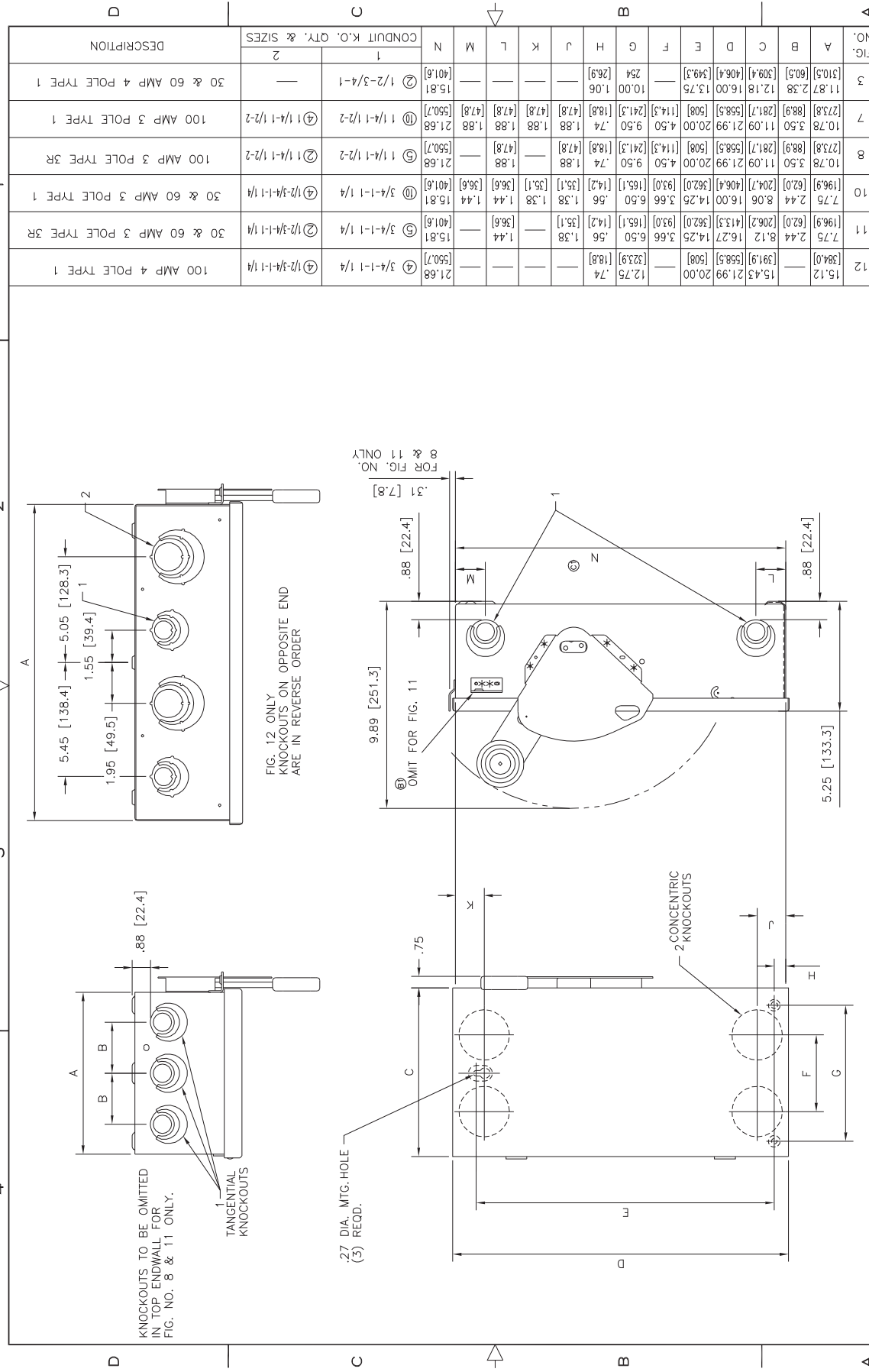


FIG. 12 ONLY  
KNOCKOUTS ON OPPOSITE END  
ARE IN REVERSE ORDER

FIG. 11 ONLY  
KNOCKOUTS ON OPPOSITE END  
ARE IN REVERSE ORDER

NO.	FIG.	CONDUIT K.O. QTY. & SIZES		DESCRIPTION
		1	2	
12		④ 3/4-1-1/4	—	100 AMP 4 POLE TYPE 1
11		② 1/2-3/4-1-1/4	—	30 & 60 AMP 3 POLE TYPE 3R
10		④ 1/2-3/4-1-1/4	—	30 & 60 AMP 3 POLE TYPE 1
9		② 1/4-1-1/2	—	100 AMP 3 POLE TYPE 3R
8		② 1/4-1-1/2	—	100 AMP 3 POLE TYPE 1
7		④ 1/4-1-1/2	—	100 AMP 3 POLE TYPE 1
6		—	—	30 & 60 AMP 4 POLE TYPE 1

REV.	DESCRIPTION	DATE	BY	CHKD.
1	REVISION	10/13/08	MS	MS

**CUTLER-HAMMER**  
CLEVELAND, OHIO  
THE DIMENSION SHEET FOR 30, 60, & 100 AMP  
TYPE 1 & 3 3P & 4P

DTR. DATE: EDDIE CARSON 10/5/82  
APPR. J. BISCHOF 10/5/82  
FILENAME: 95-255.DWG  
SCALE: 1=3

REVISION: C1  
PRODUCT CODE: BD90  
REVISE TO NUMBER: DW89-1069

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SHEET NO.: 1 OF 1

GO/NEG-Alt-Date: SDN0598403-R000-4/23/2015		Job Name: CDOT - EJMT	
Item Number: 008	Catalog Number: DH361FGK	Designation: 30A/3P/F/N1	



*Powering Business Worldwide*



# **NEMA KS 3**

## **GUIDELINES FOR INSPECTION AND PREVENTIVE MAINTENANCE OF SWITCHES USED IN COMMERCIAL AND INDUSTRIAL APPLICATIONS**

**NEMA Standards Publication KS 3-2010**

*Guidelines for Inspection and Preventive Maintenance  
of Switches Used in Commercial and Industrial Applications*

*Published by:*

**National Electrical Manufacturers Association**

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## Foreword

This is the first edition of NEMA Standards Publication KS 3. To ensure that a meaningful publication was developed, draft copies were sent to a number of individuals and organizations in the public sector having an interest in or responsibility for the purchase, testing, application, use, and preventive maintenance of these products. Their resulting comments and suggestions provided a vital user and general interest input prior to final NEMA approval and resulted in a number of substantive changes to this publication. This publication will be periodically reviewed by the Switches Voting Classification of NEMA for any revisions necessary to keep it up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Technical Services  
National Electrical Manufacturers Association  
1300 North 17th Street  
Rosslyn, Virginia 22209

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Schneider Electric—Palatine, IL

## Introduction

NEMA KS 3 deals with guidelines for inspection and preventive maintenance of switches used in commercial and industrial applications. These guidelines are to be used to identify switches requiring maintenance or replacement. Good practice includes periodic switch maintenance during plant shutdown or during a regular maintenance period as specified, for example, in NFPA 70B. When a switch operates automatically, good practice dictates that the source of the overcurrent should be located, and if it is suspected that the operation was at or near the interrupting rating, the switch condition should be checked prior to circuit re-energization.

When appropriately maintained, switches provide reliable protection for many years. The exact lifetime of the switch, however, is determined by the switch's operational duty and by its environment.

With respect to operational duty, for some circuits there will be occasional overload conditions or low-current fault conditions. Here the operating life will be tens of years. In other circuits, there may be high short-circuit-current faults but it should be noted that bolted faults at the switch interrupting rating are rarely encountered. Short circuit events can significantly reduce the operating life of the switch and may necessitate replacement of the switch. Switches in this Guideline are evaluated to three different UL Standards: UL 98 *Enclosed and Dead-Front Switches*, UL 977 *Fused Power-Circuit Devices*, and UL 1429 *Pullout Switches*. They are subjected to thousands of endurance test operations; overload test operations; and two interrupting tests at maximum short-circuit-current rating. Thus switches have an extensive but finite interrupting capability, and switches that experience multiple high short-circuit-current faults should receive a thorough inspection and be replaced if necessary.

With respect to environmental effects, switches are sometimes exposed to high ambient temperatures, high humidity, and other ambient conditions that are hostile to long term performance. For example, industries may have corrosive environments or could be associated with dusty environments that could affect operating parts.

It is not intended that switches be disassembled for inspection. Rather, NEMA KS 3 should be referenced during periodic maintenance or during specific inspection following a high short-circuit-current fault. This document is intended to ensure that switches are well maintained, and provides guidelines for switch replacement.

This document is divided into separate sections as follows:

**Section 1** presents the scope and referenced standards.

**Section 2** details the safety procedures to be followed.

**Section 3** deals with general guidance.

**Section 4** deals with inspection procedures and describes thermal checks (4.2) and visual checks (4.3) of the enclosure and switch condition. Overheating of the switch would necessitate further investigation, and cracks in the insulation systems would certainly necessitate switch replacement.

**Section 5** deals with preventive maintenance and ensures that the switch's life is not compromised by external conditions. The objectives are that the switch operates in a clean environment and that the terminals are in good condition (5.2), that fuses (if required) are connected properly (5.3), and that wire connectors are in good condition and are correctly torqued (5.4).

**Section 6** deals with non-destructive test procedures that can be used to verify specific operating characteristics of switches. These include the Mechanical Operation Test (6.2), the Insulation Resistance Test (6.3), and the Individual Pole Resistance Test (millivolt drop test) (6.4). Non-compliance to one or more of these tests could necessitate switch replacement.

**Section 7** deals with the operation of accessory devices. Failure of an accessory would lead to replacement of that accessory, or switch replacement if accessories are not removable.

In summary, following an automatic overcurrent interruption at or near its interrupting rating, the condition of any protective device should be checked prior to circuit re-energization. Switches that have experienced multiple high short-circuit-current faults, as evidenced by conditions at the source of the faults, should receive a thorough inspection per the guidelines of NEMA KS 3. This document should also be used for recommended, periodic, preventive maintenance.



## Section 1 GENERAL

### 1.1 Scope

NEMA Standards Publication KS 3 sets forth, for use by qualified personnel<sup>1</sup>, a number of basic procedures that may be used for the inspection and preventive maintenance of switches used in industrial and commercial applications rated up to and including 600 V 50/60 Hz ac or ac/dc.

**NOTE**—Consult the manufacturer for other manufacturer-specific ratings.

The *National Electrical Code*<sup>®</sup> defines several switch types: General Use Switch, Isolating Switch, Motor-Circuit Switch, and Double-Throw Switch. In most cases, a switch is capable of interrupting/disconnecting its rated current at its rated voltage. An Isolating Switch does not have an interrupting rating and is actuated after the circuit has been opened by some other means. A Motor-Circuit Switch is rated in horsepower and is capable of interrupting the maximum overload current of a motor with the same horsepower rating.

The methods outlined may be used to verify specific characteristics of a switch that was originally built and tested in compliance with the requirements of NEMA Standards Publication KS 1. These methods are intended for field application and are, therefore, non-destructive in nature. Accordingly, these methods cannot be used to verify all performance capabilities of a switch since verification of some capabilities requires tests of a destructive nature.

Many tests, including those of a destructive nature, as defined in KS 1, are performed on representative samples of switches by the manufacturer, as part of a routine program of factory inspection.

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original manufacturer. Such switches should be removed from service.

### 1.2 Referenced Standards

In this publication, reference is made to the latest edition of the standards listed below. Copies are available from the indicated sources.

**National Fire Protection Association**  
1 Batterymarch Park  
Quincy, MA 02169

NFPA 70    *National Electrical Code*<sup>®</sup>  
NFPA 70B    *Recommended Practice for Electrical Equipment Maintenance*  
NFPA 70E    *Standard for Electrical Safety in the Workplace*

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<sup>1</sup> For purposes of these guidelines, a qualified person is one who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training to recognize and avoid the hazards involved. In addition, the person is trained:

- and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.
- in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing, in accordance with established safety practices.
- in first aid.

**National Electrical Manufacturers Association**

1300 North 17th Street  
Suite 1752  
Rosslyn, Virginia 22209

*Evaluating Water-Damaged Electrical Equipment*

- NEMA KS 1 *Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)*  
NEMA KS 2 *Distribution Equipment Switch Application and Maintenance Guide, A User's Reference*  
NEMA 250 *Enclosures for Electrical Equipment (1000 Volts Maximum)*

**Underwriters Laboratories, Inc.**

333 Pfingsten Road  
Northbrook, IL 60062

- UL 98 *Enclosed and Dead-Front Switches*  
UL 977 *Fused Power-Circuit Devices*  
UL 1429 *Pullout Switches*

## Section 2 SAFETY PROCEDURES

The inspection and preventive maintenance of switches in service require the user to take all necessary precautions to avoid being injured.

### 2.1 Warning

#### 2.1.1 Switch Testing

**WARNING—Hazardous voltages in electrical equipment can cause death or severe personal injury. Turn off and lock out the power supplying this equipment before performing any of the following operations.**

Unless otherwise specified in this publication, inspection, preventive maintenance, and testing must always be performed on equipment that is de-energized (note that certain tests require control power to conduct the test). Verify that there is no voltage present on incoming line and load terminals (and on control power terminals, if present) and between these terminals and ground to positively ascertain that the equipment is totally de-energized. The disconnecting or isolating means on the line side of the devices being checked and/or tested must be locked in the OFF position to ensure that the equipment will remain de-energized during these procedures.

Safety related work practices described in NFPA 70E must be followed at all times.

#### 2.1.2 Test Equipment

**WARNING—High voltages involved with some test equipment can cause death or serious injury. Do not touch or permit anyone else to touch the switch or the test leads when voltage is applied. Strict adherence to the safety procedures recommended by the manufacturers of the test equipment is required.**

### 2.2 Safety Procedure

In all the following clauses, where removal of the enclosure cover is necessary, the following safety steps must be taken in the sequence shown.

- 2.2.1 Operate the switch to the OFF position. Turn OFF all power supplying the switch to electrically isolate it from all other circuits.
- 2.2.2 Open the enclosure and verify that there is no voltage on the incoming and load conductors (including control power conductors, if present) and between these conductors and ground to positively ascertain that the equipment is de-energized.
- 2.2.3 If disconnection of power and accessory leads, cables, or bus bars is required, be sure to properly identify all connections to ensure safe and accurate reconnection.
- 2.2.4 Before any functional tests are performed, be sure to connect the test switch with properly rated cable torqued to the recommended values marked on the rating label of the switch.

### 2.3 Reinstallation Safety Procedure

- 2.3.1 Do not re-energize equipment until all connections (power and control) are thoroughly checked for accuracy and tightness (torqued to value listed on the rating label), internal areas of enclosure are cleaned of any conductive loose parts or debris, all switches are turned off, and all enclosure covers are reinstalled.

- 2.3.2** If it is necessary to replace the switch, make sure the new switch is properly rated for the application.

### **Section 3 GUIDELINES**

#### **3.1 To Avoid Damaged or Otherwise Inoperable Switches Being Inadvertently Returned to Service**

To avoid damaged or otherwise inoperable switches being inadvertently returned to service, it is suggested that such switches be destroyed.

#### **3.2 Guidance Regarding Inspection and Preventive Maintenance Procedures**

Industrial users have requested guidance regarding inspection and preventive maintenance procedures that could be carried out on a regularly scheduled basis. Sections 4 through 7 of this publication set forth guidelines for inspection, preventive maintenance, and testing. These clauses may be applied independently or in combination to establish such a program. For additional assistance, consult the manufacturer's published instructions or NFPA 70B.

#### **3.3 For Information Regarding Switch Performance and Application**

For information regarding switch performance and application refer to NEMA Standards Publications KS 1 and KS 2, respectively.

#### **3.4 Water-Damaged Switches**

Switches that are known to have been subjected to water damage should be replaced. For additional information, refer to the NEMA document *Evaluating Water-Damaged Electrical Equipment*.

#### **3.5 Switch Inspection Once Each Year**

It is recommended to inspect switches once each year or after any short circuit event.

## Section 4 INSPECTION PROCEDURES

### 4.1 General

The following inspection practices are recommended.

### 4.2 Exposed Surfaces Temperature Check

#### 4.2.1 Purpose

To determine if there is excessive temperature on the external cover of a switch.

**CAUTION**—Severe burns can result from high temperatures. Do not hold hand or fingers in contact with surfaces if excessive heat is felt.

#### 4.2.2 Procedure

A switch that has been carrying its regular load for at least 3 hours just prior to inspection should be tested by feeling the external deadfront surfaces with the palm of the hand.

#### 4.2.3 Results

If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary. Thermographic (infrared) scanning has become a useful method of investigating thermal performance. Further investigation may be necessary. Proceed to 4.3.

### 4.3 Inspection of Enclosure Interior

#### 4.3.1 Purpose

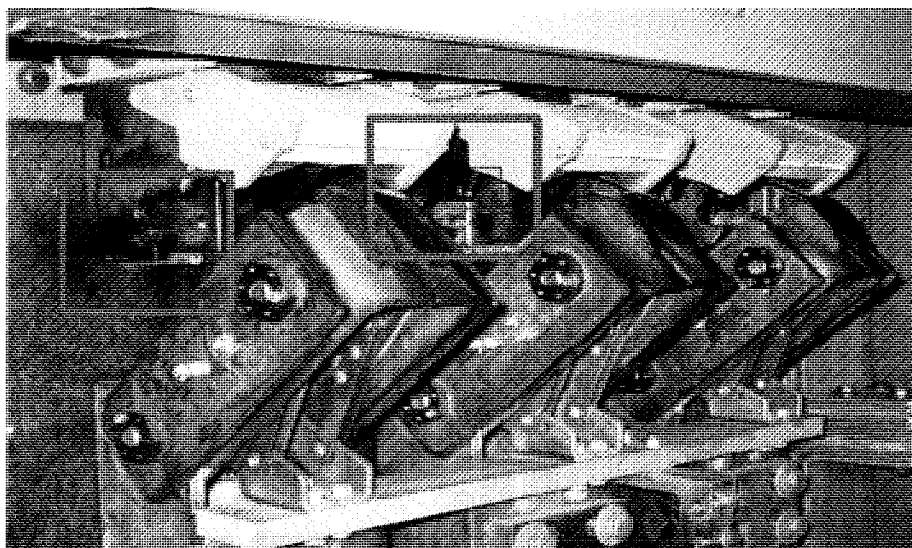
To evaluate the operating environment, the apparent condition of the switch, that proper conductors have been used, and if there is any visual indication that overheating has occurred.

#### 4.3.2 Procedure

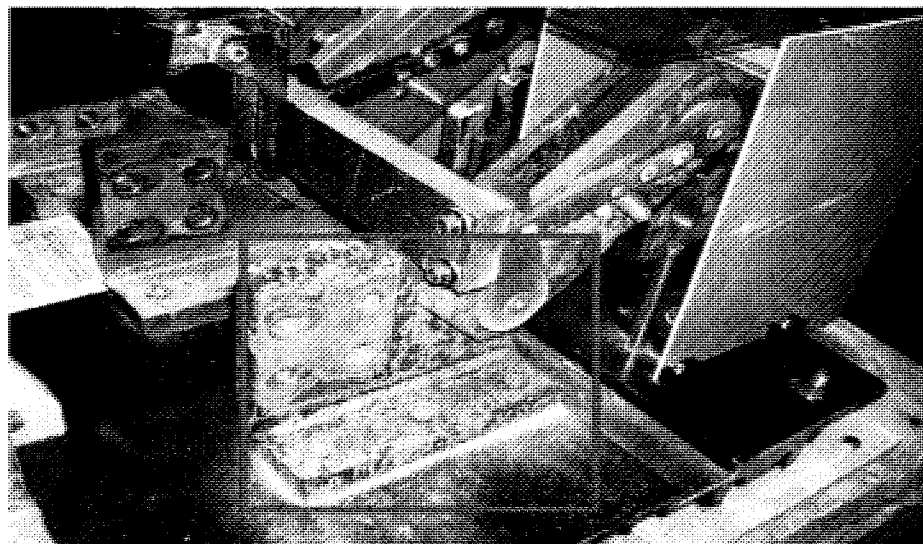
**WARNING**—Follow all safety procedures described in Section 2.

- 4.3.2.1 After being properly isolated, verify that the switch has been properly applied within its marked ratings. If the switch has not been applied within its ratings, it should be replaced with a switch suitable for the application.
- 4.3.2.2 Examine the switch surfaces for the presence of dust, dirt, soot, grease, or moisture. If such contamination is found, the surfaces should be cleaned. Refer to 5.2.2.1 for cleaning and precautionary instructions.
- 4.3.2.3 Examine the switch bases for cracks. The integrity of the base is important in withstanding the stresses imposed during operation. Switches should be replaced if cracks are found.
- 4.3.2.4 Verify that the conductors are of the correct size and type for the application. Visually check all electrical connections to the switch to be certain that such connections are clean and secure. Loose or contaminated connections increase electrical resistance, which can damage insulation and conductors and interfere with proper switch operation. Increased electrical resistance causes overheating of a connection. Such overheating is indicated by discoloration or cracks of the switch bases, discoloration or flaking of external metal parts, or melting or blistering of adjacent wire insulation. Pitting or melting of connection surfaces is a sign of arcing due to a loose or otherwise poor connection. (See Figures 1 and 2.)

- a. If there is no evidence of looseness, e.g., overheating, do not disturb or tighten the connections.
- b. If there is evidence of overheating (as noted in 4.2) or arcing, an investigation of the cause should be made and corrective steps taken. (See Section 5.)



**Figure 1**  
**Pitting**



**Figure 2**  
**Heat Damage**

**4.3.2.5** Examine the switch for evidence of a high short circuit closing operation. Any of the following observations will warrant performing the Section 6 Test Procedures or the replacement of the switch. In some cases, switch interior renewal parts can be obtained from the manufacturer to bring the assembly back to a serviceable condition.



Evidence of excessive high current switch closing operation includes:

- Bright metal or metallic deposits on insulating surfaces or the enclosure interior
- An excessive number of small, bright metal balls resting on the enclosure bottom end wall
- Excessive black film on insulating surfaces or the enclosure interior adjacent to the contact air gap or arc chute exhaust
- Enclosure shape distortion caused by excessive internal pressure
- Contacts not fully engaging or closing
- Rough mechanism operation

#### **4.3.2.6 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the installation safety procedures given in 2.3 in conjunction with any installation instructions provided by the manufacturer.

## Section 5 PREVENTIVE MAINTENANCE

### 5.1 General

Under normal conditions, properly applied switches require maintenance only for verification of environmental conditions and that the correct enclosure type for those conditions is being used. However, when inspections determine an abnormal condition and indicate the possibility of damage, it may be necessary to perform certain maintenance steps. This clause is intended to assist the user in performing these steps.

These steps cover the only maintenance that should be performed on switches unless specifically authorized by the switch manufacturer.

### 5.2 Environmental Evaluation

#### 5.2.1 Purpose

To examine the operating environment and the switch's physical condition. Preventive maintenance and corrective actions are included as appropriate.

#### 5.2.2 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

The switch enclosure must be opened to perform the following steps and, in some cases, it will be necessary to remove the switch from the enclosure.

**5.2.2.1** After being properly isolated, examine the switch surfaces for dust, dirt, soot, or moisture. If evidence of contaminants or moisture is found, or more than a thin film of dust, dirt, or soot is seen, the switch should be cleaned as suggested below.

The insulating surfaces of the switch should be cleaned using a lint free dry cloth, brush, or vacuum cleaner. Avoid blowing material into the switch or into surrounding equipment.

**CAUTION—**Commercial cleaners and lubricants may attack and damage the plastic insulating materials of the switch. Therefore, such cleaners should not be used. Only the methods described in 5.2.2.1 should be used. Follow manufacturer's recommendations for the use of grease.

Steps should be taken to eliminate the source of the contamination or to provide an appropriate enclosure that will protect against the future entry of contaminants. With respect to the prevention of moisture, the switch should be housed in an enclosure appropriate for the environment.

**5.2.2.2** Examine the switch and terminations for signs of overheating as described in 4.3.2.4. If such evidence is found, the following maintenance steps should be performed.

**5.2.2.2.1** Copper switch terminals and connecting straps (wire connectors and bus bars) can normally be cleaned. They should be carefully disassembled, cleaned, and dressed, following the manufacturer's instructions. All metal and abrasive particles should be removed before reassembling. Care should be taken to ensure that the switch terminals and connecting straps are properly torqued during re-installation.

**CAUTION—**When performing this procedure, extreme care should be exercised to prevent any damage to plated connections or mechanical disturbance to the switch and to prevent any particles from entering the switch mechanism, contacts, or arc suppression areas.

If the damage is extensive, or cannot be corrected by dressing the surfaces, the damaged parts should be replaced if they are intended by the manufacturer to be replaceable. If the damaged parts are not intended to be replaceable, the complete switch and/or bus connections should be replaced.

**5.2.2.2.2** Aluminum wire connectors and bus bars cannot be cleaned or repaired; therefore, they must be replaced.

**5.2.2.2.3** If wire conductors are damaged, the damaged lengths of the conductors should be cut off before reinstalling the conductors. (See 5.4.)

### **5.3 Fuse Provisions**

**5.3.1** If the switch has fuses and a fuse base, visually check the fuse connections to the switch for evidence of looseness, overheating, or arcing on the fuse clips or mounting arrangements for the fuse. (See 4.3.2.4.)

**5.3.2** If the connecting surfaces show evidence of overheating, the switch and fuses should be replaced.

**5.3.3** If there is no evidence of overheating or looseness, do not disturb or tighten the connections.

### **5.4 Wire Connectors**

**5.4.1** If conductors are removed from the wiring connectors, the following steps should be performed.

**5.4.1.1** Examine wire connectors. If the wire connectors appear to be in good condition, they may be reused. If the connectors, screws, or their plating appear worn or damaged, or there is evidence of cross threading or binding, the connector assembly should be replaced.

**5.4.1.2** If the wire conductors are damaged, the damaged wires should be repaired or replaced.

**5.4.1.3** When required, an oxide inhibiting compound should be applied.

**5.4.1.4** All wire connectors should be torqued in accordance with the nameplate marking or the switch manufacturer's instructions.

### **5.5 Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3.

## Section 6 TEST PROCEDURES

### 6.1 General

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original switch manufacturer. The following non-destructive tests may be used to verify specific operational characteristics of switches: mechanical operation test, insulation resistance test, and individual pole resistance test (millivolt drop test).

### 6.2 Mechanical Operation Test

#### 6.2.1 Purpose

To verify that the switch mechanism is operating freely.

#### 6.2.2 Equipment

Appropriately rated continuity indicating device.

#### 6.2.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**6.2.3.1** After disconnecting and locking out all power, operate the switch ON and OFF 2 or 3 times. The switch handle should operate smoothly without binding.

**6.2.3.2** Using an ohmmeter or other indicating device, verify that all switch contacts are open when the handle is in the OFF position and closed when the handle is in the ON position.

**6.2.3.3** For switches that are provided with mechanical trip provisions (generally indicated by a test button), operate the tripping means according to the manufacturer's instructions. With the switch in the tripped position, verify that the contacts are open using an ohmmeter (or other indicating device). Reset the switch according to the manufacturer's instructions and operate the switch to the ON and OFF positions. Use an ohmmeter (or other indicating device) to verify that all the contacts are closing and opening respectively.

#### 6.2.4 Results

The switch must be repaired or replaced if:

- a. The contacts are not open with the switch in the OFF position
- b. The contacts are not closed with the switch in the ON position
- c. The switch does not reset
- d. The mechanical trip provisions (if provided) do not trip the switch

#### 6.2.5 Reinstallation Procedure

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

### 6.3 Insulation Resistance Test

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance tests may damage electronic or other accessory components. Refer to the manufacturer's instructions for guidelines.

**NOTE**—Where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.

See Figure 3 for typical test set-up.

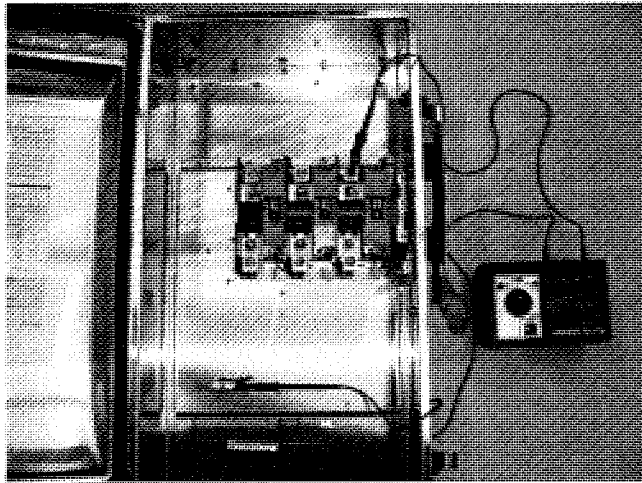
#### 6.3.1 Purpose

To determine the adequacy of the insulation between line and load terminals, between poles, and between each pole and ground.

#### 6.3.2 Equipment

Perform dielectric tests in accordance with the manufacturer's instructions.

This test requires an insulation resistance tester capable of applying a voltage of at least 500 volts. It should also be noted that more in-depth information can be obtained when 1000 volt testers are used since they are more likely to detect deteriorated insulation systems. (See Figure 3.)



**Figure 3**  
**Typical Insulation Resistance Test Set-Up**

#### 6.3.3 Procedure

**WARNING**—Follow all safety procedures described in Section 2.

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance test may damage electronic or other accessory components. To avoid such damage, the following procedure should be adhered to closely. Do not apply test voltages to accessory terminals.

**6.3.3.1** After disconnecting and locking out all power supplying the device to be tested, remove the switch from the electrical system. In cases where the switch can be safely isolated/disconnected from line and load connections as installed, the test may be performed with the switch in its equipment.

#### **6.3.4 Test**

**6.3.4.1** All exposed metal parts except line, load, and accessory terminals should be electrically connected together.

**6.3.4.2** Using an insulation resistance tester, apply a voltage of at least 500 volts to determine the resistance. Voltage is to be applied as follows.

**WARNING—High Voltage—Do not touch switch or leads.** See 2.1.2 for proper safety procedure.

**6.3.4.2.1** Between line and load terminals of each individual pole with the switch in the OFF position and tripped position if possible.

**6.3.4.2.2** Between terminals of adjacent poles with the switch in the ON position.

**6.3.4.2.3** From line terminals to the metal enclosure with the switch in the ON position.

#### **6.3.5 Results**

All resistance readings should be one megohm or greater for each measurement. If any reading is less than one megohm, the switch should be replaced or the manufacturer should be consulted before restoring the switch to service. Any reading less than one megohm may indicate contaminated, unsound, or cracked insulating material.

#### **6.3.6 Reinstall Switch**

If applicable, reinstall the switch following the manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

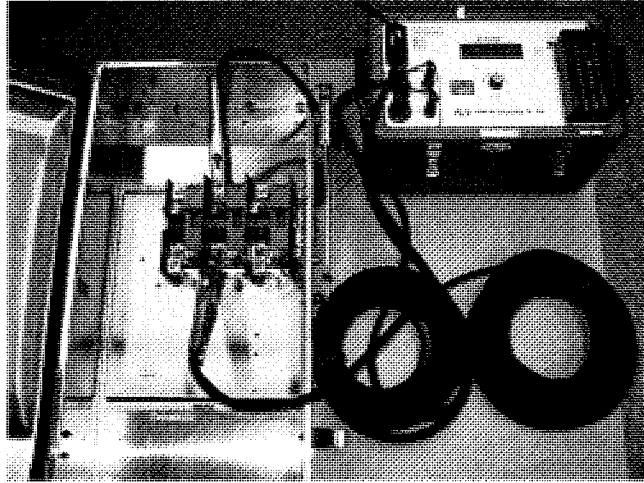
#### **6.3.7 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

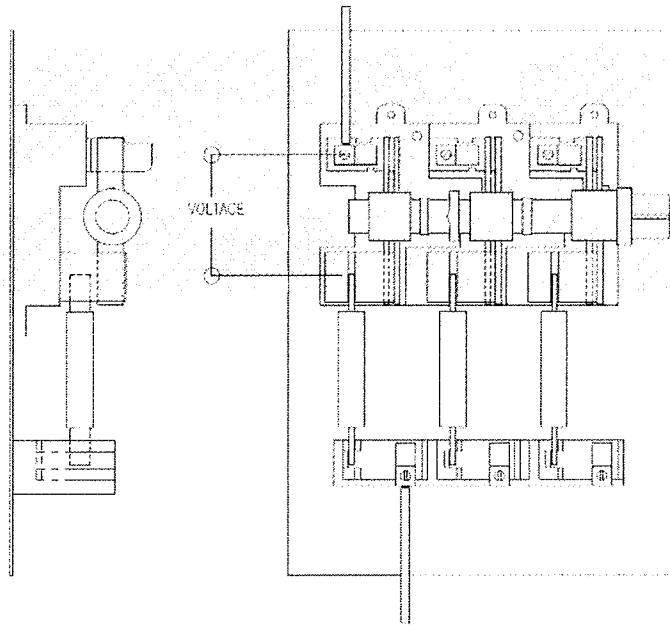
#### **6.4 Individual Pole Resistance Test (Millivolt Drop)**

See Figure 4, Figure 5, and Figure 6 for typical test set up.

**NOTE**—The switch should be removed from the equipment for this test. In cases where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.

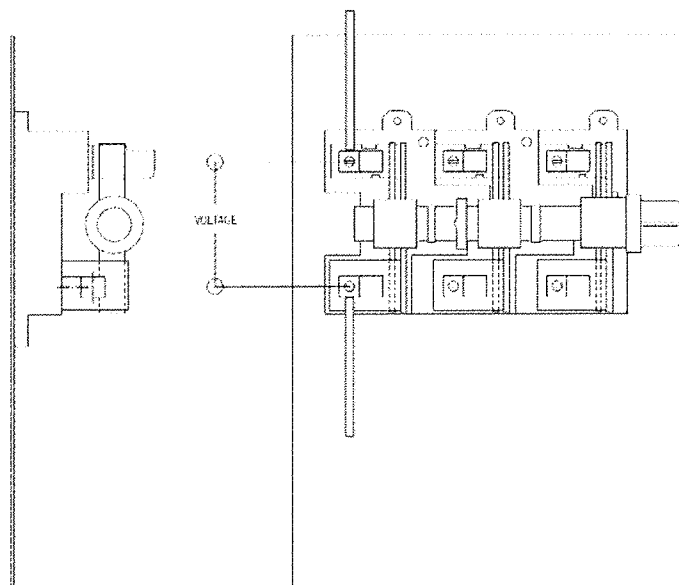


**Figure 4**  
**Individual Pole Resistance Test Set-Up**



**Figure 5**  
**Fused Switch Individual Pole Resistance Test Set-Up**





**Figure 6**  
**Non-Fused Switch Individual Pole Resistance Test Set-Up**

#### 6.4.1 Purpose

To assess the electrical integrity of internal connections and contacts in a switch. This can be done by conducting a millivolt drop test across the line and load terminals of each pole with the switch contacts closed.

The millivolt drop (resistance) of a switch pole can vary significantly because of inherent variability in the extremely low resistance of the electrical contacts and connectors. Such variations do not necessarily predict unacceptable performance and should not be used as the sole criteria for determination of acceptability.

#### 6.4.2 Equipment

**6.4.2.1** This test should be conducted using a 24 volt, or less, direct current power supply capable of supplying the rated current of the switch. For switch rated higher than 500 amperes, the power supply should be capable of delivering no less than 500 amperes.

**6.4.2.2** If the above equipment is not available for field tests, a Digital Low Resistance Ohmmeter (DLRO), or 4-point tester, capable of 10 to 100 amperes (dc) may be used.

**NOTE**—Use of a multimeter or low current ohmmeter in place of the power supply will not provide an accurate or reliable measurement of millivolt drop and should not be used.

**CAUTION**—Do not exceed the current rating of the fuse where the fuse cannot be isolated from the test circuit.

#### 6.4.3 Procedure

**WARNING**—Follow all safety procedures described in Section 2.

**6.4.3.1** After being properly isolated, remove the switch from the enclosure. In cases where the switch can be safely isolated/disconnected as installed, the test may be performed with the switch in its equipment.

#### **6.4.4 Test**

**NOTE**—If the switch is equipped with an under-voltage trip release, energize the trip release to allow proper operation of the switch.

**6.4.4.1** The test is performed as follows.

**6.4.4.1.1** Apply test current across a pole equal to the switch rating (or 500 Amperes minimum for switch rated in excess of 500 Amperes). Record the millivolt drop and the test current. Do not maintain current for more than 1 minute. If this equipment is not available, use the following test.

**6.4.4.1.2** Apply test current across a pole of 10 Amperes, or the Ampere rating of the switch, for switch rated less than 100 Amperes. For switch rated more than 100 Amperes, apply a test current across a pole of 100 Amperes. Record the millivolt drop and the test current, or resistance. Do not maintain current for more than 1 minute.

**6.4.4.1.3** De-energize the test circuit. Manually operate the switch to the OFF and then ON positions.

**6.4.4.1.4** Repeat steps 6.4.4.1.1 and 6.4.4.1.2 for a total of three readings on the pole being tested.

**6.4.4.1.5** Repeat steps 6.4.4.1.1 through 6.4.4.1.3 for each of the remaining poles of the switch.

#### **6.4.5 Results**

Test results will vary according to the switch ampere rating and manufacturer. The manufacturer should be consulted to determine the maximum allowable voltage drop. If the average test values of any pole of the switch exceed the maximum allowable drop, the switch may have reached the end of life and additional tests may have to be conducted.

**NOTE**—Inconsistent readings could be the result of oxide films or foreign material on the contact surfaces, depending on the service history of the switch. If high millivolt or high resistance readings are detected, refer to the manufacturer's recommendations, and if necessary, clean and/or lubricate the contact surfaces, then repeat tests in this section. If results are still out of acceptable range, the switch should not be returned to service.

#### **6.4.6 Reinstall Switch**

If applicable, reinstall the switch following manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

#### **6.4.7 Reinstallation Procedure**

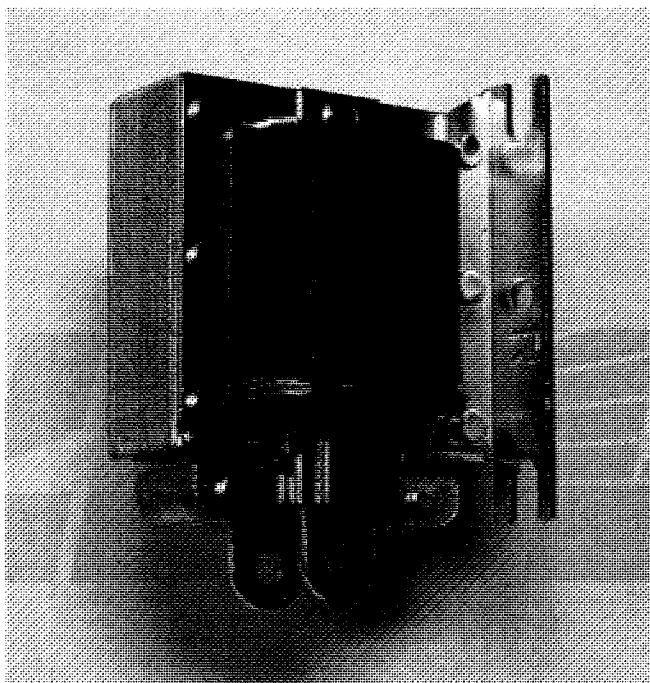
For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## Section 7 ACCESSORY DEVICE TEST PROCEDURES

### 7.1 General

If testing instructions for the specific accessory being tested are available from the manufacturer, those instructions should be followed to verify the operation of the accessory. If the manufacturer's instructions are not available, the tests described below may be used to verify the basic operation of the accessory.

### 7.2 Shunt Trip Release Tests



**Figure 7**  
**Sample Shunt Trip Release**

#### 7.2.1 Purpose

To verify that the shunt trip release device (Figure 7) will trip the switch when energized.

#### 7.2.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

#### 7.2.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

**7.2.3.1** After disconnecting and locking out all power, isolate the shunt trip solenoid leads from the control circuit for testing.

**7.2.3.2** Connect a test power supply to the terminals (or leads) of the shunt trip release device.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

**7.2.3.3** Operate the switch to the ON position.

**7.2.3.4** Set the power supply voltage to 75% of the rated voltage of the shunt trip and energize. The switch should open. If the switch with shunt trip release is used in a ground fault relay system, use 55% of the rated voltage instead of 75% of the rated voltage.

**CAUTION**—If the switch does not open within 1 to 2 seconds, turn off the test power supply to prevent possible damage to the shunt trip release coil.

**7.2.3.5** When the test is completed, turn off the test power supply, disconnect it from the shunt trip release device terminals (or leads), and reconnect the control circuit wires to the shunt trip release device terminals (or leads). If an under-voltage trip release device was connected during the test, turn off the test power supply, disconnect the test power supply wires, and reconnect the control circuit wires to the under-voltage release device.

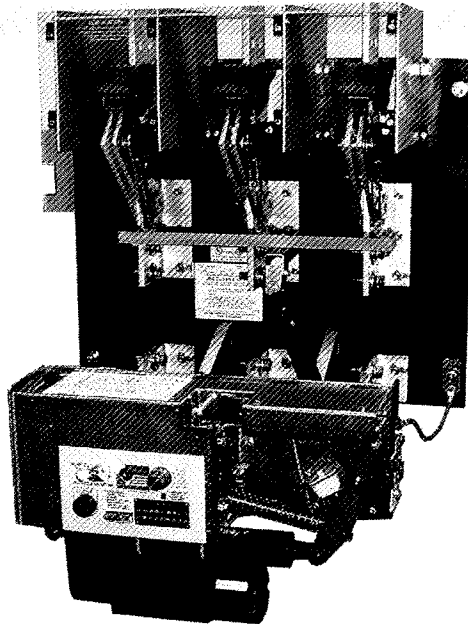
#### **7.2.4 Results**

The switch should open when the power supply to the shunt trip release is turned on. If the switch does not open, check the connections and repeat the test. If the switch still does not open, replace the shunt trip release, if replaceable. If it is not possible to replace the shunt trip release, the switch should be replaced.

#### **7.2.5 Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3 and the manufacturer's instructions.

### **7.3 Electrical Operator Tests**



**Figure 8**  
**Sample Electrical Operator / Switch Assembly**

### 7.3.1 Purpose

To verify that the electrical operator (Figure 8) will operate the switch to the ON and OFF positions.

### 7.3.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

### 7.3.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

**7.3.3.1** After disconnecting and locking out all power, remove the control circuit wires from the terminals of the electrical operator.

**7.3.3.2** Set test power supply to the rated voltage of the electrical operator and connect to the terminals of the electrical operator marked “common” and “close” or “on.”

**7.3.3.3** With the switch in the OFF position, turn on the test power supply. The switch contacts should close.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

**7.3.3.4** Turn the test power supply off. Disconnect its leads to the electrical operator.

**7.3.3.5** Connect the test power supply leads to the terminals of the electrical operator marked “common” and “open” or “off.”

**7.3.3.6** With the switch in the ON position, turn on the test power supply. The switch contacts should open.

**7.3.3.7** When the test is completed, turn off the test power supply, disconnect it from the electrical operator terminals, and reconnect the control circuit wires to the electrical operator terminals.

**NOTE—**It may also be possible to test the operation of the electrical operator by leaving the control circuit wiring in place and energized and pushing the “open” and “close” buttons on the operator. Follow step 7.3.3 to ensure that the main power to the switch is disconnected, but the power to the control circuits would be left in place.

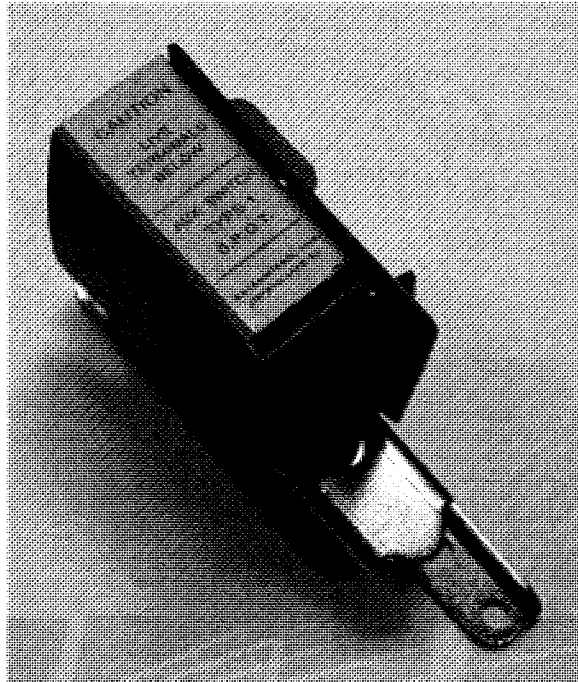
### 7.3.4 Results

The switch should operate to the ON and OFF positions when the above steps are followed. If the switch does not operate properly, check the connections and ensure that there is no obvious obstruction of the operating mechanism and repeat the test. If the electrical operator still does not operate properly, it should be replaced.

### 7.3.5 Reinstallation Procedure

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## 7.4 Auxiliary Switch Tests



**Figure 9**  
**Sample Auxiliary Switch**

### 7.4.1 Purpose

To verify that the contacts of the auxiliary switch(es) (see Figure 9) change status when the main switch contacts are opened and closed.

### 7.4.2 Equipment

This test requires an ohmmeter or low voltage continuity tester.

### 7.4.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

- 7.4.3.1 Remove the control circuit wires from the terminals (or leads) of the auxiliary switch(es).
- 7.4.3.2 Starting with the main switch in the OFF position, use an ohmmeter or continuity tester connected to the terminals (or leads) of each auxiliary switch, to verify that its contact position (open or closed) is in agreement with the wiring diagram provided by the manufacturer.
- 7.4.3.3 Connect the ohmmeter or low voltage continuity tester to the terminals (or leads) of one auxiliary switch to monitor the contact.
- 7.4.3.4 Operate the main switch to the ON position. The auxiliary switch contact should change position.
- 7.4.3.5 Repeat steps 7.4.3.2 through 7.4.3.4 for each auxiliary switch.

**7.4.3.6** When the test is completed, reconnect the control circuit wires to the terminals (or leads) of the auxiliary switch(es). If an under-voltage trip release device was connected, refer to 7.2.3.5 for instructions.

#### **7.4.4 Results**

Each auxiliary contact should change position (move from open to closed or vice versa) as the main switch is operated from the OFF to ON or ON to OFF positions. If the auxiliary switches do not perform correctly, check the connections and repeat the test. If performance is still incorrect, the auxiliary switches should be replaced; or if the auxiliary switch is not replaceable, replace the complete switch.

#### **7.4.5 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

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*Powering Business Worldwide*



## Safety Switches

Renewal Parts

New Information

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DH325FRK to DH361NDK-10 .....	5
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DH362UCK to DH363UGK2 .....	7
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Table 1. Safety Switch Renewal Parts

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DG224NGK	Switching Base	70-7820-2	Fuse Base	70-7820-4 ①	—	70-7833-4	70-7820-6
DG224NRK	Switching Base	70-7820-2	Fuse Base	70-7820-4 ①	—	70-7833-4	70-7820-7
DG225FGK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG225FRK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG225NGK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG225NRK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG226FGK	Switch Interior Assembly	70-8064-3	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG226FRK	Switch Interior Assembly	70-8064-3	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG226NGK	Switch Interior Assembly	70-8064-3	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG226NRK	Switch Interior Assembly	70-8064-3	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG324NGK	Switching Base	70-7820	Fuse Base	70-7820-4 ②	—	70-7833-4	70-7820-6
DG324NRK	Switching Base	70-7820	Fuse Base	70-7820-4 ②	—	70-7833-4	70-7820-7
DG324UGK	Switching Base	70-7820-3	—	—	—	70-7833-4	70-7820-6
DG324URK	Switching Base	70-7820-3	—	—	—	70-7833-4	70-7820-7
DG325FGK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG325FRK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG325NGK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG325NRK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DG325UGK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DG325URK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DG326FGK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG326FGK-EXC	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG326FRK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG326NGK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG326NRK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DG326UGK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DG326URK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH221FDK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221FGK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NDK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NDK5	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NGK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NGK5	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NRK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH221NWK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-3
DH221NWKX	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-8304	70-7813-3
DH222NDK	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NDK5	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NGK	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NGK5	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NRK	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NRK5	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-2
DH222NWK	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-7813	70-7813-3
DH222NWKX	Switching Base	70-7758-36	Fuse Base	70-7997-4	70-7758-34	70-8304	70-7813-3
DH223NDK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH223NGK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH223NRK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH223NRK5	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH223NWK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-3
DH223NWKX	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-8304	70-7813-3
DH224NDK	Switching Base	70-7759-7	Fuse Base	70-7759-4 ①	70-7759-11	70-7833-4	70-7833-2
DH224NGK	Switching Base	70-8266-3	Fuse Base	70-8266-4 ①	70-7759-11	70-7833-4	70-7833-2
DH224NRK	Switching Base	70-8266-3	Fuse Base	70-8266-4 ①	70-7759-11	70-7833-4	70-7833-2
DH224NWK	Switching Base	70-7759-7	Fuse Base	70-7759-4 ①	70-7759-11	70-7833-4	70-7833-3
DH224NWKX	Switching Base	70-7759-7	Fuse Base	70-7759-4 ①	70-7759-11	70-8305	70-7833-3
DH225FDK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225FGK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225FRK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225FRK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225NDK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225NGK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225NPK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH225NRK	Switch Interior Assembly	70-8063-3	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2

① Two used.

② Three used.

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH225NWK DH225NWKX DH226FDK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8063-3 70-8063-3 70-8064-3	Fuse Base Fuse Base Fuse Base	70-8063-7 70-8063-7 70-8064-7	70-8063-8 70-8063-8 70-8064-8	70-7833-5 70-8305-2 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH226FGK DH226FPK DH226FRK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8064-3 70-8064-3 70-8064-3	Fuse Base Fuse Base Fuse Base	70-8064-7 70-8064-7 70-8064-7	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH226FWK DH226NDK DH226NGK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8064-3 70-8064-3 70-8064-3	Fuse Base Fuse Base Fuse Base	70-8064-7 70-8064-7 70-8064-7	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH226NPK DH226NRK DH226NWK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8064-3 70-8064-3 70-8064-3	Fuse Base Fuse Base Fuse Base	70-8064-7 70-8064-7 70-8064-7	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH227FDK DH227FGK DH227NDK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8065-3 70-8065-3 70-8065-3	Fuse Base Fuse Base Fuse Base	70-8065-7 70-8065-7 70-8065-7	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH227NGK DH227NPK DH227NRK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8065-3 70-8065-3 70-8065-3	Fuse Base Fuse Base Fuse Base	70-8065-7 70-8065-7 70-8065-7	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH227NWK DH261FDK DH261FDK6	Switch Interior Assembly Switching Base Switching Base	70-8065-3 70-7758-17 70-7758-17	Fuse Base Fuse Base Fuse Base	70-8065-7 70-7758-30 70-7758-30	70-8064-8 70-7758-34 70-7758-34	70-7833-6 70-7813 70-7813	70-7833-3 70-7813-2 70-7813-2
DH261FGK DH261FGK6 DH261FWK	Switching Base Switching Base Switching Base	70-7758-17 70-7758-17 70-7758-17	Fuse Base Fuse Base Fuse Base	70-7758-30 70-7758-30 70-7758-30	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH261FWKX DH261UGK DH262FDK	Switching Base Switching Base Switching Base	70-7758-17 70-7758-18 70-7997-3	Fuse Base — Fuse Base	70-7758-30 — 70-7997-6	70-7758-34 — 70-7758-34	70-8304 70-7813 70-7813	70-7813-3 70-7813-2 70-7813-2
DH262FDK6 DH262FGK DH263FDK	Switching Base Switching Base Switching Base	70-7997-3 70-7997-3 70-7758-9	Fuse Base Fuse Base Fuse Base	70-7997-6 70-7997-6 70-7758-25	70-7758-34 70-7758-34 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH263FGK DH263UDK DH263UGK	Switching Base Switching Base Switching Base	70-7758-9 70-7758-11 70-7758-11	Fuse Base — —	70-7758-25 — —	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH264FDK DH264FGK DH264FWK	— — —	— — —	Fuse Base Fuse Base Fuse Base	70-7759-5 ① 70-8266-4 ① 70-7759-5 ①	70-7759-11 70-7759-11 70-7759-11	70-7833-4 70-7833-4 70-7833-4	70-7833-2 70-7833-2 70-7833-3
DH264FWKX DH264UDK DH264UDK2	— — —	— — —	Fuse Base Lower Base & Connector Lower Base & Connector	70-7759-5 ① 70-7759-6 ② 70-7759-6 ②	70-7759-11 70-7759-11 70-7759-11	70-8305 70-7833-4 70-7833-4	70-7833-3 70-7833-2 70-7833-2
DH265FDK DH265FDK3 DH265FGK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8063-5 70-8063-5 70-8063-5	Fuse Base Fuse Base Fuse Base	70-8063-7 70-8063-7 70-8063-7	70-8063-8 70-8063-8 70-8063-8	70-7833-5 70-7833-5 70-7833-5	70-7833-2 70-7833-2 70-7833-2
DH265UDK DH265UGK DH266FDK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8063 70-8063 70-8064-5	— — Fuse Base	— — 70-8064-7	70-8063-8 70-8063-8 70-8064-8	70-7833-5 70-7833-5 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH266FGK DH266UDK DH266UGK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8064-5 70-8064 70-8064	Fuse Base — —	70-8064-7 — —	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH267FDK DH267FGK DH267UDK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8065-5 70-8065-5 70-8065	Fuse Base Fuse Base —	70-8065-7 70-8065-7 —	70-8064-8 70-8064-8 70-8064-8	70-7833-6 70-7833-6 70-7833-6	70-7833-2 70-7833-2 70-7833-2
DH267UGK DH321FCK DH321FDK	Switch Interior Assembly Switching Base Switching Base	70-8065 70-7758-14 70-7758-14	— Fuse Base Fuse Base	— 70-7758-26 70-7758-26	70-8064-8 70-7758-34 70-7758-34	70-7833-6 — 70-7813	70-7833-2 — 70-7813-2
DH321FDK2JK DH321FDK5 DH321FGK	Switching Base Switching Base Switching Base	70-7831 70-7758-14 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7831-3 70-7758-26 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH321FGK2 DH321FGK2JK DH321FRK	Switching Base Switching Base Switching Base	70-7758-14 70-7831 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7831-3 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH321FRK2JK DH321FRK5 DH321FWK	Switching Base Switching Base Switching Base	70-7831 70-7758-14 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7831-3 70-7758-26 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH321FWKX DH321FWK2JK DH321NCK	Switching Base Switching Base Switching Base	70-7758-14 70-7831 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7831-3 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-8304 70-7813 —	70-7813-3 70-7813-3 —

① Two used.  
② Three used.

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH321NDK DH321NDKWL DH321NDKW	Switching Base Switching Base Switching Base	70-7758-14 70-7758-14 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7758-26 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH321NDK3 DH321NGK DH321NRK	Switching Base Switching Base Switching Base	70-7758-14 70-7758-14 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7758-26 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH321NWK DH321NWKWL DH321NWKW	Switching Base Switching Base Switching Base	70-7758-14 70-7758-14 70-7758-14	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7758-26 70-7758-26	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH321NWKX DH322FCK DH322FDK	Switching Base Switching Base Switching Base	70-7758-14 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7758-26 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-8304 — 70-7813	70-7813-3 — 70-7813-2
DH322FGK DH322FRK DH322FRK5	Switching Base Switching Base Switching Base	70-7997 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH322FWK DH322FWKX DH322NCK	Switching Base Switching Base Switching Base	70-7997 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-7813 70-8304 —	70-7813-3 70-7813-3 —
DH322NDK DH322NDKWL DH322NDKW	Switching Base Switching Base Switching Base	70-7997 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH322NGK DH322NRK DH322NRK5	Switching Base Switching Base Switching Base	70-7997 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH322NWK DH322NWKWL DH322NWKW	Switching Base Switching Base Switching Base	70-7997 70-7997 70-7997	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7997-5 70-7997-5	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH322NWKX DH323FCK DH323FDK	Switching Base Switching Base Switching Base	70-7997 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7997-5 70-7758-21 70-7758-21	70-7758-34 70-7758-35 70-7758-35	70-8304 — 70-7813	70-7813-3 — 70-7813-2
DH323FDK-10 DH323FD3WRK DH323FGK	Switching Base Switching Base Switching Base	70-7758-3 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7758-21 70-7758-21 70-7758-21	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH323FRK DH323NCK DH323NDK	Switching Base Switching Base Switching Base	70-7758-3 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7758-21 70-7758-21 70-7758-21	70-7758-35 70-7758-35 70-7758-35	70-7813 — 70-7813	70-7813-2 — 70-7813-2
DH323NDKWL DH323NDKW DH323NGK	Switching Base Switching Base Switching Base	70-7758-3 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7758-21 70-7758-21 70-7758-21	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH323NGK2 DH323NRK DH323NWK	Switching Base Switching Base Switching Base	70-7758-3 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7758-21 70-7758-21 70-7758-21	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH323NWKWL DH323NWKW DH323NWKX	Switching Base Switching Base Switching Base	70-7758-3 70-7758-3 70-7758-3	Fuse Base Fuse Base Fuse Base	70-7758-21 70-7758-21 70-7758-21	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-8304	70-7813-3 70-7813-3 70-7813-3
DH324FCK DH324FDK DH324FGK	Switching Base Switching Base Switching Base	70-8266 70-7759 70-8266	Fuse Base Fuse Base Fuse Base	70-8266-4 ② 70-7759-4 ② 70-8266-4 ②	70-7759-11 70-7759-11 70-7759-11	— 70-7833-4 70-7833-4	— 70-7833-2 70-7833-2
DH324FRK DH324FRK5 DH324FWKX	Switching Base Switching Base Switching Base	70-8266 70-8266 70-7759	Fuse Base Fuse Base Fuse Base	70-8266-4 ② 70-8266-4 ② 70-7759-4 ②	70-7759-11 70-7759-11 70-7759-11	70-7833-4 70-7833-4 70-8305	70-7833-2 70-7833-2 70-7833-3
DH324NCK DH324NDK DH324NDKWL	Switching Base Switching Base Switching Base	70-8266 70-7759 70-7759	Fuse Base Fuse Base Fuse Base	70-8266-4 ② 70-7759-4 ② 70-7759-4 ②	70-7759-11 70-7759-11 70-7759-11	— 70-7833-4 70-7833-4	— 70-7833-2 70-7833-2
DH324NDKW DH324NDK5 DH324NGK	Switching Base Switching Base Switching Base	70-7759 70-7759 70-8266	Fuse Base Fuse Base Fuse Base	70-7759-4 ② 70-7759-4 ② 70-8266-4 ②	70-7759-11 70-7759-11 70-7759-11	70-7833-4 70-7833-4 70-7833-4	70-7833-2 70-7833-2 70-7833-2
DH324NGK2 DH324NRK DH324NRK5	Switching Base Switching Base Switching Base	70-8266 70-8266 70-8266	Fuse Base Fuse Base Fuse Base	70-8266-4 ② 70-8266-4 ② 70-8266-4 ②	70-7759-11 70-7759-11 70-7759-11	70-7833-4 70-7833-4 70-7833-4	70-7833-2 70-7833-2 70-7833-2
DH324NWK DH324NWKWL DH324NWKX	Switching Base Switching Base Switching Base	70-7759 70-7759 70-7759	Fuse Base Fuse Base Fuse Base	70-7759-4 ② 70-7759-4 ② 70-7759-4 ②	70-7759-11 70-7759-11 70-7759-11	70-7833-4 70-7833-4 70-8305	70-7833-3 70-7833-3 70-7833-3
DH325FDK DH325FGK DH325FPK	Switch Interior Assembly Switch Interior Assembly Switch Interior Assembly	70-8063-4 70-8063-4 70-8063-4	Fuse Base Fuse Base Fuse Base	70-8063-7 70-8063-7 70-8063-7	70-8063-8 70-8063-8 70-8063-8	70-7833-5 70-7833-5 70-7833-5	70-7833-2 70-7833-2 70-7833-2

② Three used.



Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH325FRK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325FWK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-3
DH325FWKX	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-8305-2	70-7833-3
DH325NDK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NDKLW	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NGK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NPK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NPKLW	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NRK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH325NWK	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-3
DH325NWKLW	Switch Interior Assembly	70-8063-4	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-3
DH326FDK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326FGK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326FPK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326FRK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326FWK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-3
DH326NDK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NDKLW	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NGK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NPK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NPKLW	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NRK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NWK	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH326NWKLW	Switch Interior Assembly	70-8064-4	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH327FDK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH327FGK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH327FPK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH327FRK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH327FWK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-3
DH327NGK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH327NRK	Switch Interior Assembly	70-8065-4	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH328FGK	Switch Interior Assembly	70-8453-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH328FRK	Switch Interior Assembly	70-8453-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH328NGK	Switch Interior Assembly	70-8453-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH328NRK	Switch Interior Assembly	70-8453-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH361FCK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	—	—
DH361FDK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FDK2	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FDK2WR	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FDK2WRK	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FDK2WRW	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FDK26	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FDK46	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FDK6	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FDK6JK	Switching Base	70-7831-2	Fuse Base	70-7831-3	70-7758-34	70-7813	70-7813-2
DH361FD3WRK	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FD4WRK	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FD5WRK	Switching Base	70-7758-14	Fuse Base	70-7758-26	70-7758-34	70-7813	70-7813-2
DH361FGK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FGK6	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361FGK6JK	Switching Base	70-7831-2	Fuse Base	70-7831-3	70-7758-34	70-7813	70-7813-2
DH361FG6WRK	Switching Base	70-7758-2	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-2
DH361FRK	Switching Base	70-7758-15	Fuse Base	70-7758-28	70-7758-34	70-7813	70-7813-2
DH361FRK6	Switching Base	70-7758-15	Fuse Base	70-7758-28	70-7758-34	70-7813	70-7813-2
DH361FRK6JK	Switching Base	70-7831-2	Fuse Base	70-7831-3	70-7758-34	70-7813	70-7813-2
DH361FWK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-3
DH361FWK-316	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-3
DH361FWKX	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-8304	70-7813-3
DH361FWK2	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-3
DH361FWK2WR	Switching Base	70-7758	Fuse Base	70-7758-19	70-7758-35	70-7813	70-7813-3
DH361FWK26	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-3
DH361FWK6	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-3
DH361FWK6JK	Switching Base	70-7831-2	Fuse Base	70-7831-3	70-7758-34	70-7813	70-7813-3
DH361NCK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	—	—
DH361NDK	Switching Base	70-7758-12	Fuse Base	70-7758-27	70-7758-34	70-7813	70-7813-2
DH361NDK-10	Switching Base	70-7758-12	Fuse Base	70-7758-27	—	70-7813	70-7813-2

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH361NDKWL DH361NDKW DH361NDK6JK	Switching Base Switching Base Switching Base	70-7758-12 70-7758-12 70-7831-2	Fuse Base Fuse Base Fuse Base	70-7758-27 70-7758-27 70-7831-3	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH361NGK DH361NRK DH361NWK	Switching Base Switching Base Switching Base	70-7758-12 70-7758-12 70-7758-12	Fuse Base Fuse Base Fuse Base	70-7758-27 70-7758-28 70-7758-27	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH361NWKWL DH361NWKW DH361NWKW2	Switching Base Switching Base Switching Base	70-7758-12 70-7758-12 70-7758-12	Fuse Base Fuse Base Fuse Base	70-7758-27 70-7758-27 70-7758-27	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH361NWKX DH361UCK DH361UDK-CPG	Switching Base Switching Base Switching Base	70-7758-12 70-7758-13 70-7758-13	Fuse Base — —	70-7758-27 — —	70-7758-34 70-7758-34 70-7758-34	70-8304 — 70-7813	70-7813-3 — 70-7813-2
DH361UDK-LS DH361UDK2-LS DH361UD5WRK	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7758-13	— — —	— — —	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH361UGK DH361UGK-CSA DH361UGK2	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7758-13	— — —	— — —	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH361UGK3 DH361URK DH361URK-CSA	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7758-13	— — —	— — —	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH361URK-NP-FP DH361URK2 DH361URK3	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7758-13	— — —	— — —	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH361UWK DH361UWK-CPG DH361UWK-LS	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7758-13	— — —	— — —	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH361UWKW DH361UWKW2 DH362FCK	Switching Base Switching Base Switching Base	70-7758-13 70-7758-13 70-7997-2	— — Fuse Base	— — 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 —	70-7813-3 70-7813-3 —
DH362FDK DH362FDK2 DH362FDK2WR	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7758-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7758-20	70-7758-34 70-7758-34 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362FDK2WR-SP DH362FDK2WRW DH362FDK26	Switching Base Switching Base Switching Base	70-7758-2 70-7758-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7758-20 70-7758-20 70-7997-7	70-7758-35 70-7758-35 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362FDK3 DH362FDK6 DH362FD3WRK	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7758-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7758-20	70-7758-34 70-7758-34 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362FD4WRK DH362FD5WRK DH362FGK	Switching Base Switching Base Switching Base	70-7758-2 70-7758-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7758-20 70-7758-20 70-7997-7	70-7758-35 70-7758-35 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362FGK6 DH362FGK6JK DH362FG6WRK	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7758-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7758-20	70-7758-34 70-7758-34 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362FRK DH362FRK6 DH362FWK	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH362FWKX DH362FWK2WR DH362FWK26	Switching Base Switching Base Switching Base	70-7997-2 70-7758-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7758-20 70-7997-7	70-7758-34 70-7758-35 70-7758-34	70-8304 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH362FW5WRK DH362NCK DH362NDK	Switching Base Switching Base Switching Base	70-7758-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7758-20 70-7997-7 70-7997-7	70-7758-35 70-7758-34 70-7758-34	70-7813 — 70-7813	70-7813-3 — 70-7813-2
DH362NDKWL DH362NDKW DH362NDK36	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362NDK6 DH362NGK DH362NGK6	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH362NRK DH362NWK DH362NWKWL	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-3 70-7813-3
DH362NWKW DH362NWKW2 DH362NWKX	Switching Base Switching Base Switching Base	70-7997-2 70-7997-2 70-7997-2	Fuse Base Fuse Base Fuse Base	70-7997-7 70-7997-7 70-7997-7	70-7758-34 70-7758-34 70-7758-34	70-7813 70-7813 70-8304	70-7813-3 70-7813-3 70-7813-3



Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH362UUCK	Switching Base	70-7758-13	—	—	70-7758-34	—	—
DH362UDK-CPG	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UDK-LS	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UDK2-LS	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UDK2WR	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-2
DH362UDK2WRCP10	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-2
DH362UD5WRK	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-2
DH362UGK	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UGK-CSA	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UGK2	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UGK3	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362URK	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362URK-CSA	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362URK-NP-FP	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362URK2	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362URK3	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-2
DH362UWK	Switching Base	70-7758-13	—	—	70-7758-34	70-7813	70-7813-3
DH362UWK-CPG	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-3
DH362UWK-LS	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-3
DH362UWKW	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-3
DH362UWKW2	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-3
DH362UWK2WR	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-2
DH362UW5WRK	Switching Base	70-7758-4	—	—	70-7758-35	70-7813	70-7813-3
DH363FCK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	—	—
DH363FDK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FDK2	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FDK2WR	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FDK26	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FDK6	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FD3WRK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FD3WRK-EXC	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FD4WRK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FGK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FGK6	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FRK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FRK-HRC	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FRK6	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363FWK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363FWKX	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-8304	70-7813-3
DH363FWK26	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363FW5WRK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363NCK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	—	—
DH363NDK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NDKLW	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NDKW	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NDK6	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NGK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NGK6	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NRK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-2
DH363NWK	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363NWKLW	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363NWKW	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363NWKW2	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-7813	70-7813-3
DH363NWKX	Switching Base	70-7758-3	Fuse Base	70-7758-21	70-7758-35	70-8304	70-7813-3
DH363UUCK	Switching Base	70-7758-5	—	—	70-7758-35	—	—
DH363UDK	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDK-CP	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDK-NP-FP	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDK-10	Switching Base	70-7758-5	—	—	—	70-7813	70-7813-2
DH363UDKW	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDKW2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDK2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UDK3	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UGK	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UGK2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH363URK	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363URK-NP-FP	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363URK2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363URK3	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-2
DH363UWK	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWK-316	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWKW	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWKW2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWKX	Switching Base	70-7758-5	—	—	70-7758-35	70-8304	70-7813-3
DH363UWK2	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWK3	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH363UWK34	Switching Base	70-7758-5	—	—	70-7758-35	70-7813	70-7813-3
DH364FCK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	—	—
DH364FDK	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364FDK2	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364FDK26	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364FDK6	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364FGK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364FGK6	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364FRK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364FRK6	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364FWK	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-3
DH364FWKX	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-8305	70-7833-3
DH364FWK26	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-3
DH364NCK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	—	—
DH364NDK	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364NDKLW	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364NDKW	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-2
DH364NGK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364NGK6	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364NRK	Switching Base	70-8266	Fuse Base	70-8266-4	70-7759-11	70-7833-4	70-7833-2
DH364NWK	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-3
DH364NWKLW	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-3
DH364NWKW	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-7833-4	70-7833-3
DH364NWKX	Switching Base	70-7759	Fuse Base	70-7759-5	70-7759-11	70-8305	70-7833-3
DH364UCK	Switching Base	70-8266-2	—	—	70-7759-11	—	—
DH364UDK	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UDK-CP	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UDK-NP-FP	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UDK-10	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UDKW	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UDK2	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364UGK	Switching Base	70-8266-2	—	—	70-7759-11	70-7833-4	70-7833-2
DH364UGK2	Switching Base	70-8266-2	—	—	70-7759-11	70-7833-4	70-7833-2
DH364UGK3	Switching Base	70-8266-2	—	—	70-7759-11	70-7833-4	70-7833-2
DH364URK	Switching Base	70-8266-2	—	—	70-7759-11	70-7833-4	70-7833-2
DH364URK-H	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-2
DH364URK2	Switching Base	70-8266-2	—	—	70-7759-11	70-7833-4	70-7833-2
DH364UWK	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-3
DH364UWK-316	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-3
DH364UWKW	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-3
DH364UWKX	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-8305	70-7833-3
DH364UWK2	Switching Base	70-7759-2	Lower Base & Connector	70-7759-6 ②	70-7759-11	70-7833-4	70-7833-3
DH365FDK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365FGK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365FGK6	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365FPK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365FRK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365FWK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-3
DH365FWKX	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-8305-2	70-7833-3
DH365NDK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NDKLW	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NDKW	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NGK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NPK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NPKLW	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2

② Three used.

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH365NRK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NWK	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365NWKLW	Switch Interior Assembly	70-8063-6	Fuse Base	70-8063-7	70-8063-8	70-7833-5	70-7833-2
DH365UDK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UDK-CP	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UDKW	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UDK2	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UGK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UPK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UPKW	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365URK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365URK-NP-FP	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365URK2	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-2
DH365UWK	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-3
DH365UWKW	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-7833-5	70-7833-3
DH365UWKX	Switch Interior Assembly	70-8063-2	—	—	70-8063-8	70-8305-2	70-7833-3
DH366FDK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366FGK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366FGK-EXC	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366FPK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366FRK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366FWK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-3
DH366NDK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NDKLW	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NGK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NPK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NPKLW	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NRK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366NWK	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-3
DH366NWKLW	Switch Interior Assembly	70-8064-6	Fuse Base	70-8064-7	70-8064-8	70-7833-6	70-7833-2
DH366UDK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366UDKW	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366UDK2	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366UGK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366UPK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366URK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH366UWK	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-3
DH366UWKW	Switch Interior Assembly	70-8064-2	—	—	70-8064-8	70-7833-6	70-7833-3
DH367FDK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367FGK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367FPK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367FRK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367FWK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-3
DH367NGK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367NGK-NKO	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367NRK	Switch Interior Assembly	70-8065-6	Fuse Base	70-8065-7	70-8064-8	70-7833-6	70-7833-2
DH367UDK	Switch Interior Assembly	70-8065-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH367UGK	Switch Interior Assembly	70-8065-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH367UPK	Switch Interior Assembly	70-8065-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH367URK	Switch Interior Assembly	70-8065-2	—	—	70-8064-8	70-7833-6	70-7833-2
DH367UWK	Switch Interior Assembly	70-8065-2	—	—	70-8064-8	70-7833-6	70-7833-3
DH368FGK	Switch Interior Assembly	70-8065-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH368FRK	Switch Interior Assembly	70-8065-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH368NGK	Switch Interior Assembly	70-8065-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH368NRK	Switch Interior Assembly	70-8065-2	Fuse Base	70-8453-3	70-8453-4	—	—
DH368UGK	Switch Interior Assembly	70-8453	—	—	70-8453-4	—	—
DH368URK	Switch Interior Assembly	70-8453	—	—	70-8453-4	—	—
DH421FDK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH421FGK	Switching Base	70-7758-16	Fuse Base	70-7758-29	70-7758-34	70-7813	70-7813-2
DH422FDK	Switching Base	70-7758-6	Fuse Base	70-7758-22	70-7758-35	70-7813	70-7813-2
DH422FGK	Switching Base	70-7758-6	Fuse Base	70-7758-22	70-7758-35	70-7813	70-7813-2
DH423FDK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH423FGK	Switching Base	70-7758-7	Fuse Base	70-7758-23	70-7758-35	70-7813	70-7813-2
DH424FDK	Switching Base	70-7759-9	Fuse Base	70-7759-4 <sup>③</sup>	70-7759-12	70-7833-4	70-7833-2
DH424FGK	Switching Base	Consult Factory	Fuse Base	Consult Factory	Consult Factory	70-7833-4	70-7833-2
DH425FGK	Switch Interior Assembly	70-8270	Fuse Base	70-8063-7	70-8270-4	70-7833-5	70-7833-2

③ Four used.

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DH426FGK DH461FGK DH461UDK	Switch Interior Assembly Switching Base Switching Base	70-8271 70-7758-36 70-7758-40	Fuse Base Fuse Base —	70-8064-7 70-7758-38 —	70-8270-4 70-7758-34 70-7758-34	70-7833-6 70-7813 70-7813	70-7833-2 70-7813-2 70-7813-2
DH461UGK DH461UWK	Switching Base Switching Base	70-7758-40 70-7758-42 ①	— —	— —	70-7758-34 70-7758-35 ①	70-7813 70-7813	70-7813-2 70-7813-3
DH462FGK DH462UDK DH462UGK	Switching Base Switching Base Switching Base	70-7758-37 70-7758-13 70-7758-13	Fuse Base — —	70-7758-39 — —	70-7758-35 70-7758-34 70-7758-34	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH462UWK DH463FDK DH463FGK	Switching Base Switching Base Switching Base	70-7758-42 ① 70-7758-7 70-7758-7	— Fuse Base Fuse Base	— 70-7758-23 70-7758-23	70-7758-35 ① 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-3 70-7813-2 70-7813-2
DH463UDK DH463UGK DH463UWK	Switching Base Switching Base Switching Base	70-7758-42 70-7758-42 70-7758-42	— — —	— — —	70-7758-35 70-7758-35 70-7758-35	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH464FDK DH464FGK DH464UDK	Switching Base Switching Base Switching Base	70-7759-9 Consult Factory 70-7759-10	Fuse Base Fuse Base Lower Base & Connector	70-7759-5 ③ Consult Factory 70-7759-6 ③	70-7759-12 Consult Factory 70-7759-12	70-7833-4 70-7833-4 70-7833-4	70-7833-2 70-7833-2 70-7833-2
DH464UGK DH465FGK DH465UGK	Switching Base Switch Interior Assembly Switch Interior Assembly	Consult Factory 70-8270-2 70-8270-3	— Fuse Base —	— 70-8063-7 —	Consult Factory 70-8270-4 70-8270-4	70-7833-4 70-7833-5 70-7833-5	70-7833-2 70-7833-2 70-7833-2
DH466FGK DH466UGK DH661FDK	Switch Interior Assembly Switch Interior Assembly Switching Base	70-8271-2 70-8271-3 70-7758-12 ①	Fuse Base — Fuse Base	70-8064-7 — 70-7758-27 ①	70-8270-4 70-8270-4 70-7758-34 ①	70-7833-6 70-7833-6 70-7813	70-7833-2 70-7833-2 70-7813-2
DH661UDK DH661UDK2 DH661UDK3	Switching Base Switching Base Switching Base	70-7758-13 ① 70-7758-13 ① 70-7758-13 ①	— — —	— — —	70-7758-34 ① 70-7758-34 ① 70-7758-34 ①	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-2
DH661UWK DH661UWK2 DH661UWK3	Switching Base Switching Base Switching Base	70-7758-5 ① 70-7758-5 ① 70-7758-5 ①	— — —	— — —	70-7758-35 ① 70-7758-35 ① 70-7758-35 ①	70-7813 70-7813 70-7813	70-7813-3 70-7813-3 70-7813-3
DH662FDK DH662UDK DH662UWK	Switching Base Switching Base Switching Base	70-7758-2 ① 70-7758-4 ① 70-7758-5 ①	Fuse Base — —	70-7758-20 ① — —	70-7758-35 ① 70-7758-35 ① 70-7758-35 ①	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH663FDK DH663UDK DH663UWK	Switching Base Switching Base Switching Base	70-7758-3 ① 70-7758-5 ① 70-7758-5 ①	Fuse Base — —	70-7758-21 ① — —	70-7758-35 ① 70-7758-35 ① 70-7758-35 ①	70-7813 70-7813 70-7813	70-7813-2 70-7813-2 70-7813-3
DH663UWK-316 DH664UDK DH664UDK3 DH664UWK	Switching Base Switching Base Switching Base Switching Base	70-7758-5 ① 70-7759-13 70-7759-13 70-7759-13	— Lower Base & Connector Lower Base & Connector Lower Base & Connector	— 70-7759-6 ④ 70-7759-6 ④ 70-7759-6 ④	70-7758-35 ① 70-7759-11 ① 70-7759-11 ① 70-7759-11 ①	70-7813 70-7833-4 70-7833-4 70-7833-4	70-7813-3 70-7833-2 70-7833-2 70-7833-3
DP111NGB DP111NRB DP221NGB	— — —	— — —	— — —	— — —	— — —	— — —	— — —
DP221NRB DT221UGK DT221URK-NPS	— Switching Base Switching Base	— 70-7758-5 70-7758-5	— — —	— — —	— — —	— — —	— — —
DT221URK-NPS-BS DT221URKPS DT222UGK	Switching Base Switching Base Switching Base	70-7758-5 70-7758-5 70-7758-5	— — —	— — —	— — —	— — —	— — —
DT222URK-NPS DT222URK-NPS-BS DT222URKPS	Switching Base Switching Base Switching Base	70-7758-5 70-7758-5 70-7758-5	— — —	— — —	— — —	— — —	— — —
DT223UGK DT223URK-NPS DT223URK-NPS-BS	Switching Base Switching Base Switching Base	70-7758-5 ① 70-7758-5 70-7758-5	— — —	— — —	— — —	— — —	— — —
DT223URKPS DT223URKPS-N DT224FGK	Switching Base Switching Base Switching Base	70-7758-5 70-7758-5 70-8058-2	— — Fuse Base	— — 70-8060	— — 70-7759-11	— — —	— — —
DT224FRK DT224UGK DT224UGK-FB	Switching Base Switching Base Switching Base	70-8058-2 70-8059 70-8059	Fuse Base — —	70-8060 — —	70-7759-11 — —	— — —	— — —
DT224URK DT224URK-EXC DT224URK-N	Switching Base Switching Base Switching Base	70-8059 70-8059 70-8059	— — —	— — —	— — —	— — —	— — —

① Two used.  
③ Four used.  
④ Six used.



Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DT224URK-NPS	Switching Base	70-8059	—	—	—	—	—
DT224URK-NPS-BS	Switching Base	70-8059	—	—	—	—	—
DT224URKPS	Switching Base	70-8059	—	—	—	—	—
DT225UGK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT225URK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT225URK-N	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT225URK-NPS	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT225URK-NPS-BS	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT225URKPS	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT226UGK	Switch Base Assembly ⑤	70-8083-5	Switch Base Assembly ⑥	70-8083-6	—	—	70-7833-7
DT261UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT262UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT263UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT264UGK	Switching Base	70-8059-2	—	—	—	—	—
DT264URK	Switching Base	70-8059-2	—	—	—	—	—
DT265UGK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT265URK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT266UGK	Switch Base Assembly ⑤	70-8083-5	Switch Base Assembly ⑥	70-8083-6	—	—	70-7833-7
DT266URK	Switch Base Assembly ⑤	70-8083-5	Switch Base Assembly ⑥	70-8083-6	—	—	70-7833-7
DT321FGK	—	—	—	—	70-7758-35 ①	—	—
DT321FRK	—	—	—	—	70-7758-35 ①	—	—
DT321UGK	Switching Base	70-7758-5	—	—	—	—	—
DT322FGK	Switching Base	70-7758	Fuse Base	70-7758-19 ①	70-7758-35 ①	—	—
DT322FRK	Switching Base	70-7758	Fuse Base	70-7758-19 ①	70-7758-35 ①	—	—
DT322NWK	Switching Base	70-7758	Fuse Base	70-7758-19 ①	70-7758-35 ①	—	—
DT322UGK	Switching Base	70-7758-5	—	—	—	—	—
DT323FGK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT323FRK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT323FWK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT323NWK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT323UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT323URK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT324FGK	Switching Base	70-8058	Fuse Base	70-8060	70-7759-11	—	—
DT324FRK	Switching Base	70-8058	Fuse Base	70-8060	70-7759-11	—	—
DT324FWK	Switching Base	70-8058	Fuse Base	70-8060	70-7759-11	—	—
DT324NWK	Switching Base	70-8058	Fuse Base	70-8060	70-7759-11	—	—
DT324UGK	Switching Base	70-8059-3	—	—	—	—	—
DT324URK	Switching Base	70-8059-3	—	—	—	—	—
DT325FGK	Switch Base Assembly	70-8084	Fuse Base	70-8085	70-8063-8	—	70-7833-7
DT325FRK	Switch Base Assembly	70-8084	Fuse Base	70-8085	70-8063-8	—	70-7833-7
DT325NWK	Switch Base Assembly	70-8084	Fuse Base	70-8085	70-8063-8	—	70-7833-7
DT325UDK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT325UGK	Switch Base Assembly ⑤	70-8083	Switch Base Assembly ⑥	70-8083-2	—	—	70-7833-7
DT326FGK	Switch Base Assembly	70-8084-3	Fuse Base	70-8085-3	70-8064-8	—	70-7833-7
DT326FRK	Switch Base Assembly	70-8084-3	Fuse Base	70-8085-3	70-8064-8	—	70-7833-7
DT326UGK	Switch Base Assembly ⑤	70-8083-5	Switch Base Assembly ⑥	70-8083-6	—	—	70-7833-7
DT327UGK	Switch Base Assembly ⑤	70-8083-9	Switch Base Assembly ⑥	70-8083-10	—	—	70-7833-7
DT327UGK-N	Switch Base Assembly ⑤	70-8083-9	Switch Base Assembly ⑥	70-8083-10	—	—	70-7833-7
DT361FGK	Switching Base	70-7758	Fuse Base	70-7758-19 ①	70-7758-35 ①	—	—
DT361UDK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361UGKW	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361UGK22	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361URK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361UWK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT361UWK33	Switching Base	70-7758-5 ①	—	—	—	—	—
DT362FGK	Switching Base	70-7758-2	Fuse Base	70-7758-20 ①	70-7758-35 ①	—	—
DT36UDK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT362UGK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT362URK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT362UWK	Switching Base	70-7758-5 ①	—	—	—	—	—
DT363FGK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT363FRK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—
DT363FWK	Switching Base	70-7758-3	Fuse Base	70-7758-21 ①	70-7758-35 ①	—	—

① Two used.

⑤ Upper.

⑥ Lower.

Catalog Number	Base or Assembly		Fuse Base and Lower Assembly		Line Shields	Operating Mechanism	Operating Handle
	Type	Part Number	Type	Part Number			
DT363NWK DT363UDK DT363UGK	Switching Base Switching Base Switching Base	70-7758-3 70-7758-5 ① 70-7758-5 ①	Fuse Base — —	70-7758-21 ① — —	70-7758-35 ① — —	— — —	— — —
DT363URK DT363UWK DT364FGK	Switching Base Switching Base Switching Base	70-7758-5 ① 70-7758-5 ① 70-8058	— — Fuse Base	— — 70-8060	— — 70-7759-11	— — —	— — —
DT364FRK DT364FWK DT364NWK	Switching Base Switching Base Switching Base	70-8058 70-8058 70-8058	Fuse Base Fuse Base Fuse Base	70-8060 70-8060 70-8060	70-7759-11 70-7759-11 70-7759-11	— — —	— — —
DT364UDK DT364UGK DT364UGK-N	Switching Base Switching Base Switching Base	70-8059-3 70-8059-3 70-8059-3	— — —	— — —	— — —	— — —	— — —
DT364URK DT364UWK DT365FGK	Switching Base Switching Base Switch Base Assembly	70-8059-3 70-8059-3 70-8084-2	— — Fuse Base	— — 70-8085-2	— — 70-8063-8	— — —	— — 70-7833-7
DT365FRK DT365NWK DT365UDK	Switch Base Assembly Switch Base Assembly Switch Base Assembly ⑤	70-8084-2 70-8084-2 70-8083	Fuse Base Fuse Base Switch Base Assembly ⑥	70-8085-2 70-8085-2 70-8083-2	70-8063-8 70-8063-8 —	— — —	70-7833-7 — 70-7833-7
DT365UGK DT365UGK-N DT365UGK33	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switch Base Assembly ⑤	70-8083 70-8083 70-8083	Switch Base Assembly ⑥ Switch Base Assembly ⑥ Switch Base Assembly ⑥	70-8083-2 70-8083-2 70-8083-2	— — —	— — —	70-7833-7 70-7833-7 70-7833-7
DT365URK DT365UWK DT366UGK	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switch Base Assembly ⑤	70-8083 70-8083 70-8083-5	Switch Base Assembly ⑥ Switch Base Assembly ⑥ Switch Base Assembly ⑥	70-8083-2 70-8083-2 70-8083-6	— — —	— — —	70-7833-7 — 70-7833-7
DT366UGK-N DT366URK DT366UWK	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switch Base Assembly ⑤	70-8083-5 70-8083-5 70-8083-5	Switch Base Assembly ⑥ Switch Base Assembly ⑥ Switch Base Assembly ⑥	70-8083-6 70-8083-6 70-8083-6	— — —	— — —	70-7833-7 70-7833-7 70-7833-7
DT367UGK DT367UGK-N DT367URK	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switch Base Assembly ⑤	70-8083-9 70-8083-9 70-8083-9	Switch Base Assembly ⑥ Switch Base Assembly ⑥ Switch Base Assembly ⑥	70-8083-10 70-8083-10 70-8083-10	— — —	— — —	70-7833-7 70-7833-7 70-7833-7
DT367URK-N DT461URK DT461UWK	Switch Base Assembly ⑤ Switching Base Switching Base	70-8083-9 70-7758-42 70-7758-42	Switch Base Assembly ⑥ — —	70-8083-10 — —	— — —	— — —	70-7833-7 — —
DT462URK DT463URK DT463URK2	Switching Base Switching Base Switching Base	70-7758-42 70-7758-42 70-7758-42	— — —	— — —	— — —	— — —	— — —
DT464UGK DT464URK DT465UGK	Switching Base Switching Base Switch Base Assembly ⑤	70-8059-4 70-8059-4 70-8272	— — Switch Base Assembly ⑥	— — 70-8272-2	— — —	— — —	— — 70-7833-7
DT465URK DT466UGK DT466URK	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switch Base Assembly ⑤	70-8272 70-8273 70-8273	Switch Base Assembly ⑥ Switch Base Assembly ⑥ Switch Base Assembly ⑥	70-8272-2 70-8273-2 70-8273-2	— — —	— — —	70-7833-7 70-7833-7 70-7833-7
DT467UGK DT467URK DT661URK	Switch Base Assembly ⑤ Switch Base Assembly ⑤ Switching Base	70-8274 70-8274 70-7758-5 ③	Switch Base Assembly ⑥ Switch Base Assembly ⑥ —	70-8274-2 70-8274-2 —	— — —	— — —	70-7833-7 70-7833-7 —
DT662URK DT663URK	Switching Base Switching Base	70-7758-5 ③ 70-7758-5 ③	— —	— —	— —	— —	— —

- ① Two used.
- ③ Four used.
- ⑤ Upper.
- ⑥ Lower.

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# **CUMMINS 350kW** **GENERATOR**

**Operations & Maintenance Manual**  
**December 2015**



## OPERATION & MAINTENANCE MANUAL

Project Name: Eisenhower Johnson Memorial Tunnel  
Date: 04/24/2015

Contractor:  
Sturgeon Electric  
12150 East 112<sup>th</sup> Ave  
Henderson, CO 80640  
(303) 853-7651

Equipment Supplier:  
Cummins Rocky Mountain  
8211 East 96<sup>th</sup> Avenue  
Henderson, CO 80640  
(800) 927-7201

350 kW Generator Set  
300 Amp Automatic Transfer Switch



Sales Representative: Nathan Zeleski  
Phone #: 303-927-2205  
Email: Nathan.zeleski@cummins.com

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**Power  
Generation**

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**Rocky  
Mountain**



Operation & Maintenance

Eisenhower-Johnson  
Memorial Tunnel

350 kW Generator Set  
300 Amp ATS

CRM Project#: 66545

CONTRACTOR:  
Sturgeon Electric  
12150 East 112th Ave  
Henderson, CO 80640  
(303) 853-7651

EQUIPMENT SUPPLIER:  
Cummins Rocky Mountain  
8211 East 96th Avenue  
Henderson, CO 80640  
(800) 927-7201



## **Operation & Maintenance**

Eisenhower-Johnson Memorial Tunnel

350 kW Generator Set  
300 Amp Automatic Transfer Switch

Contractor:

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12150 East 112th Ave  
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Henderson, CO 80640  
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# Health and Safety

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**Power  
Generation**

## General Information

### Generator Set

## FOREWORD

The purpose of this manual is to provide the users with sound, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins Power Generation Limited cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation Limited policy of continuous development and improvement, information may change at any time without notice. The users should therefore ensure that before commencing any work, they have the latest information available.

Users are respectfully advised that it is their responsibility to employ competent persons to carry out any installation work in the interests of good practice and safety. Consult your Authorised Distributor for further installation information. It is essential that the utmost care is taken with the application, installation and operation of any diesel engine due to their potentially hazardous nature. Careful reference should also be made to other Cummins Power Generation Limited literature, in particular the Controller, and the Engine Operation and Maintenance Manuals.

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## SECTION 1 – INTRODUCTION

### 1. Introduction

#### 1.1 General Information

Personnel engaged in the installation, commissioning, operation and maintenance of generator sets must be competent and experienced in these fields. They must also comply with all relevant and current statutory requirements and regulations, including the provisions of the Health and Safety at Work Act (1974), and any modification and amendment that may subsequently become a legal requirement, together with any local requirements/regulations.

Before operating the generator set, read this manual and become familiar with the equipment and its operation (including all controls, manually operated valves and shutdown devices). Correct operation and maintenance is essential for safe and efficient operation of this set.

Read and become familiar with the Safety Precautions listed in this manual and within any other manuals related to the equipment. Many accidents result from a failure to observe fundamental safety rules and precautions.

There are many potential hazards that can occur during the operation of a generator set, which cannot always be anticipated. Therefore a warning cannot be included in the manual for every possible circumstance that might involve a potential hazard.

Should a procedure be used that has not been specifically recommended, then the personnel involved must be satisfied that it is safe and will not damage the generator set.

#### 1.2 Safety Precautions

Copy and post these suggestions in potentially hazardous areas.

##### 1.2.1 Engine Warning



**WARNING: DO NOT OPERATE AN ENGINE WHERE THERE ARE, OR CAN BE, COMBUSTIBLE VAPOURS.**

**THESE VAPOURS CAN BE SUCKED THROUGH THE AIR INTAKE SYSTEM AND CAUSE ENGINE ACCELERATION AND OVER-SPEEDING, WHICH CAN RESULT IN A FIRE, OR AN EXPLOSION.**

**WHERE AN ENGINE, DUE TO ITS APPLICATION, MIGHT OPERATE IN A COMBUSTIBLE ENVIRONMENT, SUITABLE OVERSPEED SHUTDOWN DEVICES MUST BE FITTED.**

**THE EQUIPMENT OWNER AND OPERATOR ARE RESPONSIBLE FOR SAFE OPERATION IN A HOSTILE ENVIRONMENT.**


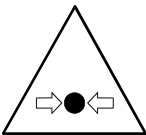
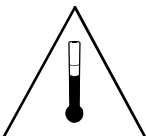


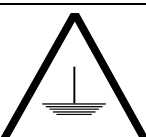
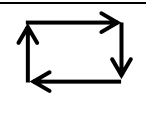
**CONSULT YOUR AUTHORISED DEALER FOR FURTHER INFORMATION.**

## 1.3 Generator Plant Safety Code

Before operating the generator set, read *the Operation and Maintenance* manuals and become familiar with them and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

### 1.3.1 Generator Set Warning Labels

Warning signs are provided on the generator set at the point of risk. To avoid injury, always take the necessary precautions - as indicated on the sample signs shown below:

	<p><b>Caution / Warning.</b>                  Indicates a risk of personal injury.</p>
	<p><b>Caution / Warning of Pressure Hazard.</b>                  Indicates a risk of personal injury from pressurised fluids.</p>
	<p><b>Caution / Warning of Temperature Hazard.</b>                  Indicates a risk of personal injury from high temperature.</p>
	<p><b>Caution / Warning of Radio Frequency Hazard.</b>                  Indicates a risk of operating radio frequency communications equipment in the vicinity of the generator set.</p>
	<p><b>Caution / Warning of High Voltage Hazard.</b>                  Indicates a risk of personal injury from electric shock.</p>
	<p><b>Caution / Warning of High Voltage Hazard.</b>                  Indicates that earth leads only must be connected at this point.</p>
	<p><b>Caution.</b>                  Indicates a risk of personal injury from equipment that may be subject to Automatic Starting.</p>

## SECTION 2 – WARNING NOTES

### 2. Warning Notes

#### 2.1 Warning, Caution and Note Styles Used In This Manual

The following safety styles found throughout this manual indicate potentially hazardous conditions to the operator, service personnel or the equipment.



**WARNING;** WARNS OF A HAZARD THAT MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.



*Caution:* Warns of a hazard or an unsafe practice that can result in product or property damage.



*Note:* A short piece of text giving information that augments the current text.

#### 2.2 Warnings



**WARNING:** IT IS IMPORTANT TO READ AND UNDERSTAND ALL SAFETY NOTICES PROVIDED IN THIS MANUAL. IMPROPER OPERATION OR MAINTENANCE COULD RESULT IN A SERIOUS ACCIDENT OR DAMAGE TO THE EQUIPMENT CAUSING INJURY OR DEATH.

##### 2.2.1 Electricity



**WARNING:** ELECTRICITY CAN KILL! LETHAL VOLTAGES MAY BE PRESENT IN MUCH OF THE EQUIPMENT REFERRED TO IN THIS MANUAL.

##### 2.2.2 High Pressures



**WARNING:** LIQUIDS OR GASES THAT ARE HIGHLY PRESSURISED CAN PASS THROUGH THE SKIN AND INTO THE BODY. THEY CAN ALSO CAUSE DAMAGE TO EQUIPMENT.

##### 2.2.3 Maintenance



**WARNING:** ONLY AUTHORISED AND COMPETENT PERSONNEL WHO ARE FAMILIAR WITH THE EQUIPMENT AND ITS OPERATION SHOULD CARRY OUT MAINTENANCE.



**WARNING:** DEPENDENT UPON THE CONTROL SYSTEM FITTED, THIS UNIT MAY OPERATE AUTOMATICALLY AND COULD START WITHOUT WARNING.



*Caution:* If using a fork-lift truck, during installation or re-siting of the generator set, ensure the forks are correctly aligned at right angles to the bedframe before inserting into the fork-lift pockets.



**WARNING:** MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. USE EXTREME CAUTION AROUND HOT MANIFOLDS, MOVING PARTS, ETC..

TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT METAL PARTS SUCH AS RADIATOR, TURBOCHARGER AND EXHAUST SYSTEM.



**WARNING:** TO COMPLETE MAINTENANCE TASKS AT HEIGHT, SUITABLE EQUIPMENT FOR PERFORMING THESE TASKS MUST BE USED IN ACCORDANCE WITH THE LOCAL GUIDELINES AND LEGISLATION. FAILURE TO FOLLOW THESE GUIDELINES AND LEGISLATION CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.



## 2.2.4 Supply Isolation



**Caution:** *If the engine has been running recently, or if the optional battery charger has been switch on, explosive gases (given off during battery charging) may be present in the vicinity of the batteries. Ensure the area is well ventilated before disconnecting batteries.*



**Caution:** *Remove AC power to the cooling system heaters before disconnecting battery leads. Heaters will run continuously without DC power and can overheat and damage heater.*



**WARNING:** **BEFORE CARRYING OUT ANY MAINTENANCE, ISOLATE ALL SUPPLIES TO THE GENERATOR SET AND ANY CONTROL PANELS. RENDER THE SET INOPERATIVE BY DISCONNECTING THE PLANT BATTERY.**



**Note:** *Shut down the generator set as described in the Operation and Maintenance Manual supplied with the set.*

1. Turn the Mode switch on the control panel to Off (O).
2. Remove the key from the Mode switch (if applicable), and account for all other keys for safekeeping.
3. As an additional precaution, thoroughly ventilate the plant room before disconnecting any leads.
4. Isolate and lock off the heater control box, where fitted.
5. Isolate and lock off the supply to the battery charger, where fitted.
6. Isolate the fuel supply to the engine
7. Disconnect the starting batteries and control system batteries, (if separate). Disconnect the negative (-) cable first.
8. Fit Warning notices at each of the above points to indicate Maintenance in Progress – Plant Immobilised for Safe Working.

## 2.2.5 Reinstatement of Supply

Reinstate all protective devices removed or disconnected during Maintenance or Overhaul, before putting the set back into Service.

The procedure for reinstatement is the reverse of the procedure for isolation.

## SECTION 3 – STANDARDS

### 3. Standards

#### 3.1 Radio Frequency

The apparatus has been tested according to EN 61000-6-2:1999 (IEC 61000-6-2:1999) and BS EN 61000-6-4:2007, specifying the limits of radio frequency immunity and emissions to meet the essential requirements of the EMC directive 2004/108/EC.

From these tests the manufacturer has established that as a precaution against undue effects, no radio frequency communications equipment should be operated at a distance of less than three metres from any part of the apparatus when the generator set could, or is relied upon to, provide power.

The effective separation distance should be increased if the radio frequency communications equipment is found to interfere with the apparatus, the onus lies with the customer to effectively test for adverse effects on the apparatus before usage of the equipment.



**NO RADIO FREQUENCY COMMUNICATIONS EQUIPMENT  
MAY BE OPERATED IN THE VICINITY OF THIS APPARATUS**

*Figure 3-1 Radio Frequency Warning*

#### 3.2 Standards, Codes & Regulations

The generator set and its control system are manufactured under a registered quality control system approved to BS EN ISO 9001 (2000). The following regulations are observed where applicable:

- The Health & Safety at work Act 1974
- The Control of Substances Hazardous to Health Regulations 2002, (SI 2002 No. 2677)
- IEE Wiring Regulations for Electrical Installations (16th Edition)
- The Electricity at Work Regulations 1989
- The Environmental Protection Act 1990
- The Health & Safety at Work Regulations 1992
- The EMC Directive 2004/108/EC
- The LV Directive 73/23/EEC as amended by Directive 93/68/EEC
- The Machinery Directive 98/37/EC
- The Noise Directive 2000/14/EC as amended
- The Gas Act 1986 (Natural Gas Generator Sets)

### 3.3 Build Standards

The generator set and its control system have been designed, constructed and tested generally in accordance with the following Standards where applicable:

<b>BS 4999</b> <b>(IEC 60034<sup>1</sup>)</b>	General requirements for rotating electrical machines
<b>BS 5000-3:2006</b> <b>(IEC 60034<sup>1</sup>)</b>	Rotating electrical machines of particular types or for particular applications
<b>BS ISO 3046-3:2006<sup>2</sup></b>	Reciprocating internal combustion engines: performance
<b>BS 7671:2001</b>	Requirements for electrical installations IEE Wiring Regulations (16 <sup>th</sup> Edition)
<b>BS ISO 8528<sup>2</sup></b>	Reciprocating internal combustion engine driven alternating current generating sets
<b>BS EN 61000-6-2:1999</b> <b>(IEC61000-6-2:1999<sup>2</sup>)</b>	Electromagnetic compatibility. Generic emission standard
<b>BS EN 61000-6-4:2007</b>	Electromagnetic compatibility. Generic immunity standard
<b>BS EN 60439</b> <b>(IEC 60439<sup>2</sup>)</b> <b>(EN 60439<sup>2</sup>)</b>	Specification for low-voltage switchgear and control gear assemblies
<b>BS EN 60947-1:2007</b> <b>(IEC 947<sup>1</sup>)</b> <b>(EN 60947<sup>2</sup>)</b>	Specification for low voltage switchgear and control gear
<b>BS EN 60204-1:2006</b>	Safety of Machinery – Electrical Equipment of Machines
<b>UL 508A</b>	Specification for Control Panels

1. A related, but not equivalent, standard: A BSI publication, the content of which to any extent at all, short of complete identity or technical equivalence, covers subject matters similar to that covered by a corresponding international standard.
2. An identical standard: A BSI publication identical in every detail with a corresponding international standard.

## SECTION 4 – SAFETY PRECAUTIONS

### 4. Safety Precautions

#### 4.1 General



**WARNING: RISK OF INJURY**



On generator sets that can be started automatically or from a remote location, a warning plate should be displayed prominently indicating, pictorially, to personnel that the set may start automatically without warning.



Appropriate personal protective equipment should be worn when working on the generator set or on any associated equipment.



Information on first aid procedures and facilities should be displayed near the set.



The area around the generator set should be clear of obstructions and dangerous objects. In addition, the floor should be kept clean, dry and clear of oil deposits.



Maintenance work, particularly in confined areas, should be carried out by a minimum of two operators working together.



Never lift the generator set using the engine or alternator lifting lugs. Refer to the lifting recommendation drawings and/or Installation Manual for further details.



*Caution: If fork-lift pockets have been provided to re-position the generator set, ensure that the forks of the fork-lift truck are at right angles to the bedframe before inserting them into the pockets provided.*



Only lifting devices of suitable capacity should be used.



**WARNING: TO COMPLETE MAINTENANCE TASKS AT HEIGHT REFER TO LOCAL LEGISLATIVE REQUIREMENTS. SUITABLE EQUIPMENT FOR PERFORMING THESE TASKS MUST BE USED IN ACCORDANCE WITH THE LOCAL GUIDELINES AND LEGISLATION. FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.**



**WARNING: LIFTING AND REPOSITIONING ON THE GENERATOR SET MUST ONLY BE CARRIED OUT USING SUITABLE LIFTING EQUIPMENT, SHACKLES AND SPREADER BARS IN ACCORDANCE WITH LOCAL GUIDELINES AND LEGISLATION BY SUITABLY TRAINED AND EXPERIENCED PERSONNEL. INCORRECT LIFTING CAN RESULT IN SEVERE PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE. FOR MORE INFORMATION CONTACT YOUR AUTHORISED DISTRIBUTOR.**

#### 4.2 Electrical Hazards















**WARNING: RISK FROM ELECTRIC SHOCK**



Before carrying out any maintenance, isolate all supplies to the generator set and any control panels. Render the set inoperative by disconnecting the plant battery – refer to Section 2.2.4 - Supply Isolation. See also the Operation and Maintenance Manuals supplied with the set.





Only suitably trained and qualified engineers, who are authorised to do so, should connect the generator set load, operate or perform maintenance on the set. Connection must also be in compliance with relevant codes and standards.

-  The generator set should only be connected to loads compatible with its electrical characteristics and rated output.
-  Medium or high voltage acts differently than low voltage. Special equipment and training is required to work on, or around, medium or high voltage equipment. Do not work on energized equipment. Due to the nature of medium or high voltage electrical equipment, induced or residual voltage remains even after the equipment is disconnected from the power source.
-  The metalwork of the generating set, bed frame and other exposed parts must be bonded to an effective earth point.
-  Do not touch any electrically energised part of the generator set or cables/conductors with any part of the body or with any non-electrically insulated object.
-  Do not operate the generator set with any terminal box cover open.
-  Ensure that all connections are insulated.
-  Ensure that all electrical equipment and connections are kept clean and dry.
-  Replace any defective terminal covers and wiring immediately and ensure that all terminations are secure.
-  Reinstate all protective devices removed or disconnected during maintenance or overhaul, before putting the generator set back into service.
-  The appropriate neutral earthing requirements must be complied with, or adequate means incorporated to ensure that an isolated neutral system is adequately protected against voltage rises and undetected earth faults. In the situation where the generator set is operated in parallel with a network supply, the user must be satisfied that the neutral earthing switch gear (where fitted), is operational and that the associated protection devices are fully functional. Permission must have been obtained from the local electricity supply utility, before parallel operation is considered.
-  Do not connect generator set directly to any building electrical system. Hazardous voltages can flow from the set into the utility line. This creates a potential for electrocution, or property damage. Connect only through an approved isolation switch or an approved paralleling device.
-  To prevent irreparable damage to the battery charging system:
  - Never disconnect the battery whilst the set is running
  - Never disconnect the charging leads whilst the set is running
  - Disconnect the battery and charge alternator before electric arc welding on the set



*Note: The charge alternator output lead is live at all times.*

-  Follow all applicable electrical safety codes.
-  Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

## 4.3 Engine Waste



**WARNING; INCORRECT DISPOSAL OF ENGINE WASTE IS ENVIRONMENTALLY HARMFUL AND PRESENTS A HEALTH RISK.  
SOME ENGINE WASTE IS COMBUSTIBLE AND IS THEREFORE A FIRE RISK.**



Dispose of unwanted or absorbed substances through an authorised contractor who will transport and correctly dispose of the waste to a licensed site.  
*For further information refer to Section 5 - Substances Hazardous to Health.*

## 4.4 Exhaust Gas Hazards



**WARNING: RISK FROM TOXIC FUMES**



Exhaust fumes are toxic and all necessary measures must be taken to ensure that they do not escape into, or re-circulate within, the plant room or associated buildings. Exhaust gases contain carbon monoxide, an odourless and colourless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms include: dizziness; nausea; headache; sleepiness; inability to think coherently. Persons affected should seek fresh air immediately and be kept active. If symptoms persist, seek medical attention. Shut down the generator set and do not operate until it has been inspected and repaired.



Visually and audibly inspect the exhaust system. Ensure that all exhaust components are secured and true (not warped).



Do not use exhaust gases to heat a compartment.



Ensure that the generator set is kept well ventilated. Thoroughly ventilate the plant room to remove all fumes and explosive vapours **before** disconnecting or connecting battery cables thus reducing the possibility of accidental sparks causing an explosion.



Ensure that the exhaust outlet is kept free from obstruction.



Should repeated attempts to start the engine fail, unburnt fuel gas may build up in the exhaust system creating a potentially dangerous situation. Allow these gases to disperse before carrying out further attempts to start.

## 4.5 Natural Gas



### WARNING: RISK OF ASPHYXIATION AND EXPLOSION



Natural gas is dangerous if leakage occurs. Relatively low levels of gas leakage in confined areas can cause explosions if ignited.



Inhalation of large volumes of natural gas can cause asphyxiation and death. If leakage occurs isolate the gas supply, do not operate any equipment (electrical or otherwise) that may cause a spark or may be a source of ignition, evacuate the building and fully ventilate the area. Only suitably qualified personnel who are fully trained to handle natural gas emergencies are to be allowed near the plant room or generator set(s) in such emergencies.



Ensure that gas pipes and gas trains are installed in compliance with relevant codes, standards and local requirements.



Welding equipment, blowlamps and any other source of ignition that may cause natural gas to ignite should **not** be used in the Plant Room unless all gas pipes have been purged.



Incomplete or unsealed gasways should never be left unattended without all reasonable precautions being taken to inform others of the disconnection and potential danger i.e. Warning Signs etc. Metal pipes should **always** be sealed with metal pipe fittings.



Electrical earth bonding on all gas pipes and gas components should be regularly checked for security and good electrical contact.



If a gas leak is suspected:

- Do not operate any electrical equipment or switches in the plant room, these can cause sparks.
- Immediately evacuate all personnel from the plant room and then ventilate the building.
- Shutdown the generator set(s) by fully shutting the gas train shut-off valve(s).
- Fully shut all external gas supply valves to the generator set(s).
- Alert the emergency services and local gas supplier.



## 4.6 Fire Hazards



### WARNING: RISK OF FIRE



With the use of fuel, lubricating oils and batteries there is a fire hazard. Naked flames or sparks should not be allowed near the generator set, fuel tank, gas train and batteries. Explosive fuel and oil vapours are always present in the vicinity of a generator set, while a battery on charge can produce inflammable hydrogen gas.



Leakage of Natural Gas, at relatively low levels and in confined areas, can cause explosions and fires if ignited.



An area in the vicinity of the generator set should be designated a NO SMOKING area and one that is prohibited to unauthorised persons.



Ensure that adequate ventilation is maintained within the plant room at all times. Thoroughly ventilate the plant room to remove all fumes and explosive vapours **before** disconnecting or connecting battery cables thus reducing the possibility of accidental sparks causing an explosion.



Providing suitable bunding to contain any spillage or leakage from the generator set is the responsibility of others. The volumes of fluids involved can be established from the data supplied with the set.



No loose items of equipment or combustible material should be left on or near any part of the generator set. Remove all unnecessary oil and grease from the unit and clean up fuel and oil spills immediately.



In the event of a fuel or oil leak, the spillage should be absorbed using a proprietary material (e.g. Fuller's Earth granules, or similar). Sawdust should not be used, as this will create a fire hazard. Appropriate fire fighting equipment should be readily available - (class A, B and C [dry powder] type fire extinguishers are recommended).



Inspect the fuel system before each operation and periodically while running.



Do not refill the fuel tank while the generator set is running, unless the tanks are outside the engine compartment. Fuel contact with a hot engine or exhaust is a potential fire hazard.



Keep a fire extinguisher available in or near the plant room and in other areas throughout the site. Use the correct extinguisher for the area.

## 4.7 Fluids



### **WARNING: RISK OF TOXIC CHEMICALS**



There is a health risk associated with exposure to fuel, lubricating oils, coolant additives and battery electrolyte. Avoid contact with these fluids and always wear the appropriate personal protective equipment. Reference should be made to Section 5 for general information and to the Material Safety Data Sheets (MSDS) obtainable from the relevant suppliers/manufacturers.



Benzene and lead, found in some diesel oils, have been identified as causing cancer or reproductive toxicity. When checking, draining or adding diesel, take care not to ingest, breathe the fumes, or contact the diesel.



Used engine oils have been identified as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes or contact used oil.



Avoid fluid spillage and discard clothing contaminated by fuel oil, coolant, lubricants or battery electrolyte.



Ensure that remote fuel storage systems are installed in compliance with relevant codes, standards and local requirements.



Fuel lines must be adequately secured and free of leaks. Fuel connection to the engine should be made with an approved flexible line. Do not use zinc coated or copper fuel lines with diesel fuel.



Ensure all fuel supplies have a positive shut-off valve.



The user should also contact their supplier of fluids used in the generator set for Manufacturers' recommendations on Health and Safety.

## 4.8 High Temperature Hazards



### **WARNING: RISK OF BURNING AND SCALDING**



While the generator set is running, and for a period following shutdown, avoid contact with exhaust, radiator and other components that are likely to become hot. At all times, avoid contact with hot oil, hot coolant and hot exhaust gases.



Hot coolant is under pressure. DO NOT attempt to remove a radiator or heat exchanger pressure cap while the generator set is running. Always allow the set to cool completely before doing so.



DO NOT drain coolant or lubricating oil until the generator set has cooled completely.

## 4.9 Moving Part Hazards



### WARNING: RISK OF INJURY



Safety guards and covers must be securely fitted and all cubicle doors, cover-plates, etc, should be firmly in place while the generator set is in operation.



Keep hands and loose clothing away from moving parts. Do not wear jewellery while servicing any part of the generator set.



Never step on the generator set. It can stress and break unit components, possibly resulting in dangerous operating conditions – from leaking fuel, leaking exhaust fumes, etc.



Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. Thoroughly ventilate the plant room to remove all fumes and explosive vapours **before** disconnecting or connecting battery cables thus reducing the possibility of accidental sparks causing an explosion.



Avoid contact with any moving part.

## 4.10 Noise



### WARNING: RISK OF DAMAGE TO HEARING



Generator sets emit noise. Ensure that the doors of any enclosure, or room that contains a generator set, display a suitable pictogram warning that hearing protection must be worn. It is the responsibility of personnel exposed to noise to ensure that they are provided with suitable ear protection, e.g. ear defenders.

Whilst there is a correlation between the emission and exposure levels, this cannot be used reliably to determine whether or not further precautions are required. Factors that influence the actual level of exposure of work-force include the characteristics of the work room, the other sources of noise, etc. i.e. the number of machines and other adjacent processes, and the length of time for which an operator is exposed to the noise. Also the permissible exposure level can vary from country to country.

Information on noise emissions can be found in the Engine Operator Manual supplied with your generator set. The figures quoted are emission levels and are not necessarily safe working levels.

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## **SECTION 5 - SUBSTANCES HAZARDOUS TO HEALTH**

### **5. Substances Hazardous to Health**

The generator set(s) covered by this manual contains several substances that require special consideration when handling to avoid becoming hazardous to health and safety.

Operators of generating plant and machinery must obtain the relevant suppliers' Material Safety Data Sheets, and information/instructions therein should take precedent over the information provided within this document. In the absence of the suppliers' information, the following information may be used on a temporary basis only. In addition to preventing hazards to personal health, these instructions are designed to minimise environmental damage and pollution.

The information contained herein is based on the data available to us. It is the responsibility of the user to comply with any relevant laws and regulations that may exist.

## 5.1 Antifreeze (Fleetguard – ES compleat/EG premix)

This antifreeze is also known as an ethylene glycol based coolant; summer coolant; coolant additive. It is a purple coloured, viscous liquid, with a mild chemical odour, is soluble in water and harmful. It contains ethylene glycol, and diethylene glycol. Ethylene glycol is a potentially hazardous constituent.

The substance has a boiling point of 107°C, and a flash point of 121°C.

It is used as an engine coolant additive, and can be found in engine cooling systems, and heat exchangers. Installers, operators and maintainers are likely to encounter this substance.

### 5.1.1 Hazardous Reactions

Ethylene glycol is combustible when exposed to heat or flame and can react vigorously with oxidants. Moderate explosive hazard in form of vapour when exposed to heat or flame. Hazardous products resulting from combustion or decomposition include carbon monoxide, carbon dioxide and acrid smoke. Self-contained breathing apparatus must be worn in the event of fume build up.

Avoid strong oxidising agents – incompatible with sulphuric acid, nitric acid, caustics and aliphatic amines.

It may cause neurological signs and symptoms, and kidney damage. It is also a skin and eye irritant.

Very toxic in particulate form upon inhalation. Harmful if swallowed, lethal dose for humans reported to be 100ml.

### 5.1.2 Protective Measures

Refrain from eating, drinking or smoking when using the product. Adopt a high standard of personal hygiene. In case of skin contact, wash immediately with soap and water.

Ensure good ventilation and avoid heat sources. Avoid breathing mist, if there is a risk of vapour, or particulate, use a suitable organic vapour mask.

Eye protection, gloves, overalls, impervious apron should be used. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly.

### 5.1.3 Storage / Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Keep cool, out of sunlight, away from naked flames and strong acids, do not freeze. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Contain leak/spill with sand, earth or non-combustible, absorbent material to prevent entry of substance into drainage/sewerage system, water-courses and land. Eliminate all ignition sources, use plastic shovel to transfer to suitable container and dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

## 5.1.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, alcohol resistant foam, dry powder, or water spray.  
Fire fighters to use self contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterways, drains and drinking water supplies.
- Ingestion  
Toxic by ingestion. If swallowed induce vomiting **only** under the advice of a Doctor or poison control centre.  
Delayed treatment may result in fatality.
- Inhalation (of vapour)  
Remove from further exposure. In case of irritation to lungs or throat, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Flush copiously with water or preferably eye-wash solution for at least five minutes. Seek medical advice.
- Skin  
Wash thoroughly with soap and water, and seek medical attention if irritation develops. Change clothing if necessary and wash before re-use.
- Spillage  
Soak-up using an absorbent material and dispose of this as directed under Storage/Transport (Section 5.1.3).



## 5.2 Antifreeze (Valvoline coolant premix)

This antifreeze is a green, viscous liquid, which is practically odourless, and soluble in water. It contains ethylene glycol, and diethylene glycol. Ethylene glycol is a potentially hazardous constituent.

The substance has a boiling point between 171-203°C, with a flash point of 118°C, and a vapour pressure of 0.4mm Hg at 20°C.

It is used as an engine coolant additive, and can be found in engine cooling systems, and heat exchangers. Installers, operators and maintainers are likely to encounter this substance.

### 5.2.1 Hazardous Reactions

This product is considered stable but must be kept away from oxidising agents.

In the event of a fire, or excessive heat, there is a risk of the containing drum bursting.

At elevated temperatures vapour, or particulate, may irritate respiratory tract and continued exposure is reported to induce unconsciousness. Harmful, or fatal, if swallowed. Contact may cause skin sensitisation.

### 5.2.2 Protective Measures

Refrain from eating, drinking or smoking when using the product. Adopt a high standard of personal hygiene. In case of skin contact, wash with soap and clean water.

Ensure good ventilation and avoid heat sources. If there is a risk of vapour, or particulate, use a suitable organic vapour mask.

Use eye protection, rubber or PVC gloves, overalls, impervious apron. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly.

### 5.2.3 Storage / Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Keep cool, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Contain leak/spill with sand or earth, and prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

## 5.2.4 Emergency Action

- Fire  
Extinguishing media:  
Large fires - alcohol resistant foam, or water fog.  
Small fires - CO<sub>2</sub>, alcohol resistant foam, dry chemical, sand, earth or water fog.  
Fire-fighters to use self contained breathing apparatus. Keep fire exposed containers cool.  
Prevent run-off from entering waterways, drains and drinking water supplies.
- Ingestion  
Harmful or fatal if swallowed. Rinse mouth with water. If conscious, give water to drink and obtain medical advice.
- Inhalation (of vapour)  
Remove from further exposure. In case of irritation to lungs or throat, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Flush copiously with water or preferably eye-wash solution for at least fifteen minutes. If irritation persists seek medical advice.
- Skin  
Wash thoroughly with soap and water, and seek medical attention if irritation develops. Change clothing if necessary and wash before re-use.
- Spillage  
Soak-up using an absorbent material and dispose of this as directed under Storage/Transport (Section 5.2.3).

## 5.3 Antifreeze (Valvoline – MPG Coolant 50/50)

This antifreeze is also known as a propylene glycol based coolant. It is a colourless liquid with a mild odour, and although soluble in water should be used undiluted. It contains 2-propane diol, ethylhexanoic acid (sodium salt), and aliphatic acid. 2-propane diol, and ethylhexanoic acid are considered to be potentially hazardous constituents.

The substance has a flash point of 112°C min.

It is used as an engine coolant, suitable for open and closed cooling systems, and can be found in the engine cooling system. Installers, operators and maintainers are likely to encounter this substance.

### 5.3.1 Hazardous Reactions

This product is considered stable but must be kept away from strong oxidizing agents, acids, and sources of ignition. Oxides of carbon, aldehydes and ketones are products of decomposition.

Prolonged contact, as with clothing wetted with the substance, may cause more severe irritation and discomfort, seen as local redness and swelling.

If more than several mouthfuls are swallowed, abdominal discomfort, nausea and diarrhoea may occur.

### 5.3.2 Protective Measures

Refrain from eating, drinking or smoking when using this product. Adopt a high standard of personal hygiene. In the case of skin contact, wash with soap and water. Cold water may be used.

Ensure good ventilation and avoid heat sources. Wear appropriate respirator when ventilation is inadequate.

Use a lab coat, impervious gloves and eye protection. Avoid contamination inside the gloves and if clothes become contaminated, discontinue use and clean thoroughly.

### 5.3.3 Storage / Transport

Store and transport only in correctly marked, tightly closed, containers. Keep cool, out of sunlight and away from naked flames. Keep away from incompatibles such as oxidizing agents, and acids. Water contamination should be avoided.

Absorb any leak/spill with an inert material and put the spilled material in an appropriate waste disposal container. Dispose of unwanted or absorbed substance through an authorized contractor to a licensed site. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

### 5.3.4 Emergency Action

- Fire  
Extinguishing media: Use water fog, dry powder, foam or carbon dioxide. Water or foam may cause frothing. If a leak or spill has not ignited, use water fog to disperse the vapours. Do not use a water jet.  
Fire-fighters to use self contained breathing apparatus. Keep fire-exposed containers cool. Prevent large quantities from entering waterways, drains and drinking water supplies.
- Ingestion  
If patient is conscious and can swallow, give two glasses of water (500ml). Induce vomiting as directed by medical personnel.
- Inhalation (of vapour)  
If irritation, headache, nausea or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult, or symptoms persist.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
- Skin  
Wash thoroughly with soap and water for several minutes. Get medical attention if skin irritation develops or persists.
- Spillage  
Contain spill if possible, and dispose of as directed under Storage/Transport (Section 5.3.3).

## 5.4 Antifreeze (Valvoline – MPG Coolant 67/33)

This antifreeze is also known as a propylene glycol based coolant. It is a colourless liquid with a slight characteristic odour, easily soluble in cold water. It contains 2-propane diol, ethylhexanoic acid (sodium salt), and aliphatic acid. 2-propane diol, and ethylhexanoic acid are considered to be potentially hazardous constituents.

It has a boiling point greater than 120°C (248°F) and a flash point Closed Cup greater than 115°C (239°F).

It is used as an engine coolant, suitable for open and closed cooling systems, and can be found in the engine cooling systems. Installers, operators and maintainers are likely to encounter this substance.

### 5.4.1 Hazardous Reactions

This product is considered stable but must be kept away from strong oxidizing agents, acids and sources of ignition. Carbon oxides (CO, CO<sub>2</sub>) and water, and some metallic oxides are products of decomposition.

Prolonged contact, as with clothing wetted with the substance, may cause more severe irritation and discomfort, seen as local redness and swelling.

If more than several mouthfuls are swallowed, abdominal discomfort, nausea and diarrhoea may occur.

Contains material which may cause birth defects based on animal data.

### 5.4.2 Protective Measures

Refrain from eating, drinking or smoking when using this product. Adopt a high standard of personal hygiene. In the case of skin contact, wash with soap and water. Cold water may be used.

Ensure good ventilation and avoid heat sources.

Wear appropriate respirator when ventilation is inadequate. Use a lab coat, impervious gloves and eye protection. Avoid contamination inside the gloves and if clothes become contaminated, discontinue use and clean thoroughly.

### 5.4.3 Storage / Transport

Store and transport only in correctly marked, tightly closed, containers. Keep cool, out of sunlight and away from sources of ignition. Keep away from incompatibles such as oxidizing agents, and acids. Water contamination should be avoided.

Absorb with an inert material and put the spilled material in an appropriate waste disposal container. Dispose of unwanted or absorbed substance through an authorized contractor to a licensed site. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

#### 5.4.4 Emergency Action

- Fire  
Extinguishing media:  
Small Fire - Use dry chemical powder, or CO<sub>2</sub>.  
Large Fire – Use water spray, fog or foam. Do not use a water jet.  
  
Fire-fighters to use self contained breathing apparatus and full turnout gear. Keep fire-exposed containers cool. Prevent large quantities from entering waterways, drains and drinking water supplies.
- Ingestion  
Do not induce vomiting unless directed to do so by medical personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.
- Inhalation (of vapour)  
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Obtain medical attention.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Flush eyes with plenty of water for minimum of fifteen minutes. Cold water may be used. Obtain medical attention.
- Skin  
Wash thoroughly with soap and water for several minutes. Get medical attention if skin irritation develops. Cold water may be used.
- Spillage  
Contain spill if possible, and dispose of as directed under Storage/Transport (Section 5.4.3).

## 5.5 Coolant Treatment – Water Filter

Fleetguard DCA-4/powder/paste/pellet is also known as a coolant additive, or engine coolant treatment. It is a white solid (powder or pellet) or blue paste inside a filter container, having a mild chemical odour, and soluble in water. It contains dipotassium phosphate, potassium nitrate, sodium molybdate, sodium nitrite, mercaptobenzo thiazole, sodium silicate. Potentially hazardous constituents are alkaline salts, nitrates, nitrites, etc.

For industrial use only it is used as an engine coolant additive and as such it is used in engine cooling systems, heat exchangers, and radiators. Installers, operators and maintainers are likely to encounter these substances.

### 5.5.1 Hazardous Reactions

Incompatible with strong acids and oxidising materials. In contact with strong acids may form nitrous oxide gas.

Contact of sodium nitrate with combustible materials and organic matter may cause fire. Sodium nitrite intensifies fires of other materials. When heated to decomposition,  $\text{No}_x$  and  $\text{K}_2\text{O}$  emitted.

Dust may irritate nasal passages. Prolonged or repeated contact with the skin will cause irritation. Will irritate eyes on contact. Harmful if swallowed.

### 5.5.2 Protective Measures

Adopt a high standard of personal hygiene. In case of skin contact wash immediately with soap and water.

Ensure good ventilation and avoid heat sources.

Use eye protection, dust mask, PVC gloves, overalls and plastic aprons. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly. Use a respirator to avoid inhalation of dust.

### 5.5.3 Storage / Transport

Store and transport only in correctly marked containers. Keep cool, out of sunlight and away from naked flames. Keep product dry and container closed when not in use. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Sweep up and return to container for use if not contaminated. Prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted substance through a licensed chemical disposal service.



## 5.5.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, dry powder, water.  
Fire-fighters to use self contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterways, drains and drinking water supplies.
- Ingestion  
Toxic by ingestion. Seek medical advice immediately.
- Inhalation (of vapour)  
Remove from further exposure. In case of irritation to lungs or throat, seek medical advice.
- Eyes  
Flush copiously with water for at least fifteen minutes. Seek medical advice immediately.
- Skin  
Wash immediately with soap and water. Seek medical advice if irritation develops or persists. Change clothing if necessary and wash before re-use.
- Spillage  
Sweep up and return to container if not contaminated. Discard contaminated product as directed under Storage/Transport (Section 5.5.3).

## 5.6 Coolant Treatment - Liquid Additive

Fleetguard DCA-4 Liquid is also known as a coolant additive, or liquid cooling conditioner. It is a pale blue liquid with a mild chemical odour. It contains potassium phosphate, potassium nitrate, sodium molybdate, sodium nitrite, adipic acid. The potentially hazardous constituents being alkaline salts, nitrates, nitrites, etc.

This substance has a boiling point of 100°C; vapour pressure of 760mm Hg at 100°C, and is soluble in water.

It is used as an engine coolant additive, and can be found in engine cooling systems, heat exchangers, and radiators. Installers, operators and maintainers are likely to encounter this product.

### 5.6.1 Hazardous Reactions

Sodium nitrite/potassium nitrate are strong oxidisers. Avoid organic matter (including wood), cyanides, strong acids, salts and urea. This product may ignite with heat or friction. When heated to decomposition,  $\text{NO}_x$ ,  $\text{K}_2\text{O}$ , sodium monoxide, carbon monoxide and carbon dioxide are emitted.

Contact will cause irritation to both skin and eyes. Inhalation may cause nasal passage and upper respiratory tract irritation. Ingestion can cause severe vomiting, shock and death. Ingestion of sodium nitrite can result in motor activity changes, coma, and decreased blood pressure.

### 5.6.2 Protective Measures

Adopt a high standard of personal hygiene. In case of skin contact irrigate with copious quantities of clean water.

Ensure good ventilation and avoid heat sources. Avoid breathing mist. Observance of good housekeeping rules will ensure general safety.

Use eye protection goggles, PVC gloves, overalls, impervious apron. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly. No special respiratory precautions are necessary in normal use.

### 5.6.3 Storage / Transport

Store and transport only in correctly marked containers. Keep cool (but do not freeze), out of sunlight and away from naked flames and strong acids. Keep product container closed when not in use. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Prevent entry of liquid into drainage/sewerage system, water-courses and land. Use industrial absorbent and place in suitable container. Dispose of unwanted liquid through an authorised contractor to a licensed chemical disposal service.

## 5.6.4 Emergency Action

- Fire  
Extinguishing media: Water, carbon dioxide, dry powder.  
Fire fighters should wear self-contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterways, drains and drinking water supplies.
- Ingestion  
Toxic by ingestion. Ingestion can cause severe vomiting, shock and death. Ingestion of sodium nitrite can result in motor activity changes, coma, and decreased blood pressure.  
Seek medical advice immediately.
- Inhalation (of vapour)  
Remove to fresh air. If symptoms persist seek medical advice.
- Eyes  
Flush copiously with water for at least fifteen minutes. Seek medical advice immediately.
- Skin  
Wash immediately with soap and water. If irritation develops or persists seek medical advice. Change clothing if necessary and wash before re-use.
- Spillage  
Contain leak/spill and prevent entry of liquid into drainage/sewerage system, water-courses and land. Use industrial absorbent and dispose of as directed under Storage/Transport (Section 5.6.3).

## 5.7 Gas Oil

This product is also known as Red Diesel, Fuel Oil, and type A1 or A2. It can be pale red or a clear liquid with a characteristic mild odour. It contains catalytically cracked oil, petroleum distillates, quinizarin, and gas oil marker dye red. The catalytically cracked oil and petroleum distillates are potentially hazardous constituents.

The substance has an initial boiling point of 180°C, a flash point greater than 56°C, and a vapour pressure less than 0.7mm Hg at 20°C and has negligible solubility in water.

It is used as a fuel for off-road diesel powered vehicles and stationary engines, and can be found in fuel tanks, pipes and injection systems. The substance should not be used for any other purpose without contacting the manufacturer or supplier. Installers, operators and maintainers are likely to encounter this substance.

### 5.7.1 Hazardous Reactions

This liquid is flammable. Avoid smoking, heat sources, such as welding and naked flames, sparks and static electricity build-up. Thermal decomposition products are hazardous, containing CO<sub>x</sub>, NO<sub>x</sub> and SO<sub>x</sub> compounds.

The vapour is explosive. High vapour concentrations can cause respiratory irritation, dizziness, nausea, and loss of consciousness. Excessive and prolonged exposure to the mist can cause chronic inflammatory reaction of the lungs and a form of pulmonary fibrosis.

Avoid strong oxidising agents, e.g. chlorates which may be used in agriculture.

Gas oil is slightly irritating to the skin and has a de-fatting action. Toxicity following single exposure to high level of gas oil is of low order. Prolonged, repeated skin contact may de-fat the skin resulting in possible skin irritation and dermatitis. In some cases warty, cancerous growths have occurred.

### 5.7.2 Protective Measures

Ensure good ventilation and avoid heat sources. Observance of good housekeeping rules will ensure general safety. Do not smoke. Avoid breathing mist.

When working on, or testing, injection equipment, special care is required to avoid perforation of skin by high pressure fuel. Use eye protection in the event of a suspected high pressure leak.

Adopt a high standard of personal hygiene. In the case of skin contact, wash well with soap and water.

Use gloves and overalls, and eye protection goggles if there is risk of splashing. Use oil impervious gloves and avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly. Contaminated clothing should be removed, soaked with water, and laundered before re-use.

No special respiratory precautions are necessary in normal use.

DO NOT use as a solvent for removing dirt/grease etc, from skin.

### 5.7.3 Storage / Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Keep cool, out of sunlight and away from naked flames. Electrical continuity is required between the transport and storage vessels during product transfer.

Contain leak/spill with sand, earth or other suitable material, and prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

Inform local and fire authorities should the product reach waterways, drains etc.

## 5.7.4 Emergency Action

- Fire  
Extinguishing media:  
Large fire – Foam/water fog. Never use water jet.  
Small fire - foam/dry powder, AAAF, CO<sub>2</sub>, sand, earth.  
Avoid making sparks. Fire fighters to use self-contained breathing apparatus. Keep fire exposed containers cool, using water fog/spray. Prevent run-off from entering waterway, drains and drinking water supplies.
- Ingestion  
Do not induce vomiting. Wash the mouth out with water, and send to hospital immediately.
- Inhalation (of vapour)  
Remove from further exposure. Obtain medical assistance immediately.
- Aspiration (inhalation of liquid)  
If, following ingestion of gas oil, vomiting occurs, there is danger of aspiration into the lungs. This would cause intense local irritation and chemical pneumonitis that can be fatal. Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least five minutes. If irritation persists seek medical advice.
- Skin  
Wash thoroughly with soap and water. Change clothing if necessary.  
If high pressure injection has occurred prompt surgical attention is required.
- Spillage  
Absorb using sand, earth or other suitable material. Dispose of unwanted or absorbed flammable material as directed under Storage/Transport (Section 5.7.3).

## 5.8 Grease – Chevron SRI No. 2

This is formulated with ISOSYN® base stocks, a synthetic polyurea ashless organic thickener, and high performance rust and oxidation inhibitors. Its texture is smooth and buttery and its colour is dark green. All the components of this material are in compliance with the EU Seventh Amendment Directive 92/32/EEC.

The substance has a boiling point >371.1°C (700°F) and is insoluble in water but soluble in hydrocarbons. The substance has a flash point (Cleveland Open Cup) 260°C (500°F) (Min).

It is a high temperature ball and roller bearing grease and is used in generators, alternators, starters, air-conditioning units and unsealed electric motor bearings operating under moist conditions. Installers, operators and maintainers are likely to encounter this product.

### 5.8.1 Hazardous Reactions

This product is considered to be stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. May react with strong oxidizing agents such as chlorates, nitrates, peroxides etc. There are no known results of decomposition and none are expected.

This material will burn although it is not easily ignited. Dependent on combustion conditions a complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved. Combustion may form oxides of Nitrogen, Zinc, and Magnesium.



*Note: Do not use pressure to empty drum or explosion may result.*

Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have a potential of generating an accumulation of electrostatic charge.

### 5.8.2 Protective Measures

Ensure good ventilation and avoid heat sources. Prevent small spills and leakages to avoid the hazard of slipping.

Adopt a high standard of personal hygiene. In the case of skin contact, apply a waterless hand cleaner, mineral oil or petroleum jelly then wash thoroughly with soap and water.

No special respiratory precautions are necessary in normal use and with adequate ventilation. If prolonged or repeated skin contact is likely, oil impervious gloves MUST be worn, and eye protection should be used.

High pressure injection under the skin may occur due to the rupture of pressurised lines.

### 5.8.3 Storage/Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Store away from heat, sparks, flame or strong oxidants and combustible materials.

Contain leak/spill and prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

## 5.8.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, foam, dry powder, and water fog.  
In enclosed areas fire-fighters MUST use self-contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterway, drains and drinking water supplies.
- Unusual Fire/Explosion Hazard  
Do not use pressure to empty drum or explosion may result.
- Ingestion  
If swallowed, give water or milk to drink. Do not induce vomiting. Seek medical advice.
- Inhalation (of vapour)  
Remove from further exposure. If respiratory discomfort or coughing occurs, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least fifteen minutes. If irritation persists seek medical advice.
- Skin  
To remove the material from skin, apply a waterless hand cleaner, mineral oil or petroleum jelly then wash thoroughly with soap and water. Remove and clean oil soaked clothing daily and wash affected area.  
  
In an accident involving high-pressure equipment, this product may be injected under the skin. Such an accident may result in a small, sometimes bloodless, puncture wound. However, because of its driving force, material injected into a fingertip can be deposited into the palm of the hand. Within 24 hours there is usually a great deal of swelling, discolouration, and intense throbbing pain. Immediate treatment at a surgical emergency centre is recommended.
- Spillage  
Eliminate all sources of ignition in vicinity of spilled material. Contain spilled liquid with sand or other suitable absorbent. Dispose of used material as directed under Storage/Transport (Section 5.8.3).



## 5.9 Grease – Exxon Polyrex<sup>®</sup> EM

This polyurea grease is formulated with Base oil and additives including Amines, C12-14-ALKYL, 1-5 ISOOCTYL Phosphates. It is blue coloured grease with a mild odour.

The substance has a boiling point of 330°C (626°F) and a flash point of 204°C (400°F) (Estimated for oil, ASTM D-92 [COC]). It is insoluble in water.

It is high temperature ball and roller bearing grease and is used for long-life and corrosion resistance, even in salt water. Installers, operators and maintainers are likely to encounter this product.

### 5.9.1 Hazardous Reactions

Under normal conditions of use, this product is not considered hazardous. This product is considered to be stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Keep containers closed when not in use. Store away from heat, strong oxidizing agents and combustible material. Product does not decompose at ambient temperatures, however carbon monoxide, sulphur oxides, aldehydes and other decomposition products may be found in the case of incomplete combustion.



*Note: Empty containers retain residue and may explode causing injury or death. Do not pressurise, or expose to any source of ignition.*

### 5.9.2 Protective Measures

Ensure good ventilation and avoid heat sources. Prevent small spills and leakages to avoid the hazard of slipping.

Adopt a high standard of personal hygiene. In the case of skin contact, wash thoroughly with soap and water.

No special respiratory precautions are necessary in normal use and with adequate ventilation. If prolonged or repeated skin contact is likely, oil impervious gloves MUST be worn, and eye protection should be used.

High pressure injection under the skin may occur due to the rupture of pressurised lines.

### 5.9.3 Storage/Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Store away from heat, sparks, flame or strong oxidants and combustible materials.

Contain leak/spill and prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

Do not attempt to refill or clean container. Empty drums should be completely drained, properly closed/sealed and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with all applicable regulations.

## 5.9.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, foam, dry powder, and water fog. Water or foam may cause frothing.  
In enclosed areas fire-fighters MUST use self-contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterway, drains and drinking water supplies.
- Unusual Fire/Explosion Hazard  
Do not use pressure to empty drum or an explosion may result.
- Ingestion  
Do not induce vomiting. Seek medical advice.
- Inhalation (of vapour)  
Remove from further exposure. If respiratory discomfort or coughing occurs, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water. If irritation persists seek medical advice.
- Skin  
To remove the material from skin, wash thoroughly with soap and water. Remove and clean oil soaked clothing daily and wash affected area.  
In an accident involving high-pressure equipment, this product may be injected under the skin. Regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of the injury.
- Spillage  
Eliminate all sources of ignition in vicinity of spilled material. Contain spilled liquid with sand or other suitable absorbent. Dispose of used material as directed under Storage/Transport (Section 5.9.3).

## 5.10 Grease – Klüber Asonic GHY72

This is Ester oil based grease with polyurea thickener. It is a beige coloured paste having a characteristic odour.

Using the DIN ISO 2176 (BASE OIL) flash method, the substance has a flash point >200°C (392°F).

It is used to lubricate bearings where good resistance to water washout and corrosion are required. Installers, operators and maintainers are likely to encounter this product.

### 5.10.1 Hazardous Reactions

This product is considered to be stable. However it is incompatible with strong oxidizing agents. In case of fire, carbon monoxide and hydrocarbons can be released.

Prolonged skin contact may cause skin irritation and/or dermatitis.

### 5.10.2 Protective Measures

Ensure good ventilation and avoid heat sources. Prevent small spills and leakages to avoid the hazard of slipping.

Adopt a high standard of personal hygiene. In the case of skin contact, clean skin thoroughly with soap and water, and apply skin cream.

No special respiratory precautions are necessary in normal use and with adequate ventilation. If prolonged or repeated skin contact is likely, oil impervious gloves MUST be worn, and eye protection should be used.

High pressure injection under the skin may occur due to the rupture of pressurised lines.

### 5.10.3 Storage/Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Store away from heat, sparks, flame or strong oxidants and combustible materials.

Contain leak/spill and prevent entry of substance into drainage/sewerage system, water-courses and land.

The code of waste has to correspond to the Council Directive 75/442/EEC and be specific as far as the related sector and process are concerned. Can be incinerated when in compliance with local, state and federal regulations.

Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

Offer rinsed packaging material to local recycling facilities.

## 5.10.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, foam, dry powder, and water fog. High volume water jet is unsuitable as an extinguishing medium.  
In enclosed areas fire-fighters MUST use self-contained breathing apparatus. In case of fire carbon monoxide and hydrocarbons can be released.  
Keep fire exposed containers cool. Prevent run-off from entering waterway, drains and drinking water supplies.
- Ingestion  
Do not induce vomiting. Seek medical advice.
- Inhalation (of vapour)  
Remove from further exposure. If respiratory discomfort or coughing occurs, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least fifteen minutes. If irritation persists seek medical advice.
- Skin  
To remove the material from skin wash thoroughly with soap and water, apply skin cream. Remove and clean oil soaked clothing daily and wash affected area.
- Spillage  
Eliminate all sources of ignition in vicinity of spilled material. Contain spilled liquid with sand or other suitable absorbent. Dispose of used material as directed under Storage/Transport (Section 5.10.3).

## 5.11 Grease – Mobilgrease XTC

This grease is also known as NLGI No. 1 lithium soap-based product. It is highly viscous, dark brown in colour, and with a mild odour. It contains bitumen or vacuum residue, zinc alkyl and long-chain alkyl dithiophosphates. Based on available information this product is not expected to produce adverse effects on health when used for the intended application and the recommendations provided in the MSDS are followed.

The substance has a boiling point greater than 316°C and has negligible solubility in water. The substance has a flash point greater than 204°C and a vapour pressure of less than 0.1mm Hg at 20°C.

It is for industrial use only and is used in high speed flexible gearing and couplings in industrial situations for high speed and high temperature coupling applications. The use of hand-operated grease guns at low ambient temperatures, without auxiliary heat, is discouraged. Installers, operators and maintainers are likely to encounter this substance.

### 5.11.1 Hazardous Reactions

Under normal conditions of use, this product is not considered hazardous according to regulatory guidelines, although excessive exposure may result in eye, skin or respiratory irritation.

### 5.11.2 Protective Measures

Ensure good ventilation and avoid heat sources. Prevent small spills and leakages to avoid the hazard of slipping.

Adopt a high standard of personal hygiene. In the case of skin contact, wash with soap and water.

No special respiratory precautions are necessary in normal use and with adequate ventilation. If prolonged or repeated skin contact is likely, oil impervious gloves MUST be worn, and eye protection should be used.

High pressure injection under the skin may occur due to the rupture of pressurised lines.

### 5.11.3 Storage/Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Store away from heat, sparks, flame or strong oxidants and combustible materials.

Contain leak/spill and prevent entry of substance into drainage/sewerage system, water-courses and land. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.

### 5.11.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, foam, dry powder, and water fog.  
In enclosed areas fire-fighters MUST use self-contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterway, drains and drinking water supplies.
- Ingestion  
Do not induce vomiting. Seek medical advice if discomfort occurs.
- Inhalation (of vapour)  
Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least five minutes. If irritation persists seek medical advice.
- Skin  
Wash thoroughly with soap and water. Remove and clean oil soaked clothing daily and wash affected area.
- Spillage  
Contain spilled liquid with sand or other suitable absorbent. Dispose of used material as directed under Storage/Transport (Section 5.11.3).

## 5.12 Grease –Val-Lith EP 2

This is a lithium based grease having a liquid (paste) consistency, is light brown in colour, and has a slight characteristic sulphurous odour. The preparation is not classified as dangerous according to Directive 1999/45/EC and its amendments. This product is not classified according to the EU regulations.

The substance has a boiling point of 371°C and is insoluble in water. The substance has a flash point - closed cup greater than 221°C.

It is used in automotive and industrial equipment for the lubrication of bearings and shaft joints to reduce ingress of moisture over a wide temperature range. Installers, operators and maintainers are likely to encounter this product.

### 5.12.1 Hazardous Reactions

The product is considered to be stable. However do not expose containers to heat or sources of ignition. It is reactive with oxidising agents. Results of decomposition are carbon oxides (CO, CO<sub>2</sub>), water, and some metallic oxides.

Repeated or prolonged exposure is not known to aggravate medical conditions.

### 5.12.2 Protective Measures

Ensure good ventilation and avoid heat sources. Prevent small spills and leakages to avoid the hazard of slipping.

Adopt a high standard of personal hygiene. In the case of skin contact, wash with soap and water.

No special respiratory precautions are necessary in normal use and with adequate ventilation. Wear a lab coat and wash hands after handling.

### 5.12.3 Storage/Transport

Store and transport only in correctly marked containers. Keep containers tightly sealed when not in use. Store in a well ventilated area, away from heat, and combustible materials.

Wear boots and gloves and use a tool to scoop up solid or absorbed material. Dispose of unwanted or absorbed substance through an authorised contractor to a licensed site.



## 5.12.4 Emergency Action

- Fire  
Extinguishing media:  
Small fires - CO<sub>2</sub>, dry chemical powder.  
Larger fires - water spray, fog or foam. For safety reasons do not use a full water jet.  
Fire-fighters should wear self-contained breathing apparatus, and full turnout gear. Keep fire exposed containers cool.
- Ingestion  
Do not induce vomiting. Seek medical advice if discomfort occurs.
- Inhalation (of vapour)  
Remove from further exposure. Seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least fifteen minutes. If irritation persists seek medical advice.
- Skin  
Wash thoroughly with soap and water. Remove oil soaked clothing daily and wash before reuse. Clean shoes thoroughly before reuse. Obtain medical attention.
- Spillage  
Use a tool to scoop up solid or absorbed material and dispose of used material as directed under Storage/Transport (Section 5.12.3).

## 5.13 Lubrication Oil – Premium Blue E 15W40

Also known as oil, lube oil, sump oil, new oil is a dark, viscous liquid with a slight, characteristic odour. The base oil contains; distillates (petroleum), solvent-dewaxed heavy paraffinic. It is not classified as dangerous according to Directive 1999/45/EC and its amendments, and is not classified according to the EU regulations.

It has a boiling point greater than 150°C, a flash point Open Cup of 220°C (Cleveland), and is insoluble in cold water.

It is used in engine lubrication oil systems, sump pan and filters, make-up tanks and piping systems as a lubrication oil for use in wide range of diesel engines operating under severe conditions. Installers, operators and maintainers are likely to encounter this product.

### 5.13.1 Hazardous Reactions

This product is stable although slightly re-active with oxidising agents. Results of decomposition are carbon oxides (CO, CO<sub>2</sub>) and water.

Although harmful if swallowed or aspirated (breathed in), repeated or prolonged exposure is not known to aggravate medical conditions.

Used oil may contain harmful combustion by-products and unburnt fuel that will cause skin reactions as detailed for fuel. Particular care must be taken if oil from a severely overheated engine is handled - use impervious gloves, lab coat and safety glasses.

Do not breathe vapour/spray.

### 5.13.2 Protective Measures

Ensure good ventilation and avoid heat sources.

Adopt a high standard of personal hygiene. In case of skin contact, wash thoroughly with soap and water.

Use safety glasses, impervious gloves and lab coat. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly.

No special respiratory precautions are necessary in normal use. Do not breathe vapour/spray when handling hot materials.

### 5.13.3 Storage / Transport

Store and transport only in correctly marked containers. Keep containers tightly sealed when not in use. Keep in a cool, well ventilated area, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water.

Wear splash goggles, full suit, boots and gloves. Absorb leak/spill with an inert material and dispose of unwanted or absorbed substance through an authorised contractor to a licensed site. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

### 5.13.4 Emergency Action

- Fire  
Extinguishing media:  
Large fire – Use water spray, fog or foam. Do not use water jet.  
Small fire – Use dry chemical powder or CO<sub>2</sub>.  
Fire-fighters to use self contained breathing apparatus and full turnout gear. Keep fire exposed containers cool.
- Ingestion  
Do not induce vomiting. Obtain medical advice immediately.
- Inhalation (of vapour)  
Remove from further exposure. Obtain medical attention.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Flush copiously with water or preferably eye-wash solution for at least fifteen minutes. Obtain medical advice.
- Skin  
Wash thoroughly with soap and water. Obtain medical advice if irritation develops. Change clothing if necessary and wash before re-use.
- Spillage  
Absorb with an inert material and dispose of this as directed under Storage/Transport (Section 5.13.3).

## 5.14 Sulphuric Acid Battery Quality 1140 – 1400 SG (15-50%)

Also known as battery acid, battery electrolyte, electrolyte, this is a colourless to dark brown liquid, with a characteristic acrid, acidic odour. It is readily soluble in water forming a dilute, corrosive solution. Sulphuric acid battery quality 1140 – 1400sg (15-50%) contains aqueous solutions of sulphuric acid including all grades between 1140(10%) – 1400(50%). Sulphuric acid is a potentially hazardous product.

It has a boiling point between 104°C – 124°C, and a vapour pressure of 6.2mm Hg at 20°C.

In solution it is used as an electrolyte for lead acid batteries. These batteries are used in the starting and control systems on generating sets. Installers, operators and maintainers are likely to encounter this product.

### 5.14.1 Hazardous Reactions

The product is considered to be stable. However it may give rise to hazardous fumes in a fire. Violent reaction with water generates heat and may cause an explosion. Attacks many metals liberating hydrogen gas. Combustion will generate oxides of sulphur.

Avoid contact with body tissue. Causes destruction of body tissue, severe burns.

Inhalation of the spray mist may produce severe irritation of the respiratory tract. May be fatal if swallowed, causing burns to mouth, throat and stomach. Corrosive to eyes. Repeated or prolonged exposure to spray mist may produce chronic eye irritation, severe skin irritation, and respiratory irritation leading to frequent attacks of bronchial infection.

### 5.14.2 Protective Measures

Ensure good ventilation and avoid heat sources. Fumes must be positively removed from confined spaces by fume extraction.

Adopt a high standard of personal hygiene. Use total eye protection goggles, acid-resistant gloves (e.g. PVC), overalls, acid resistant apron and rubber boots. Note that handling contaminated clothing may result in acid burns.

No special respiratory precautions are necessary in normal use, however respiratory protection should be used if there is a risk of uncontrolled exposure to vapour. Avoid contact with acid mist if large quantities of batteries are being charged or if working close to charging batteries.

### 5.14.3 Storage / Transport

Store and transport only in correctly marked containers and keep tightly sealed when not in use. Stock tanks should be banded separately, away from organic substances such as wood, paper, straw, and other reactive chemicals. Prevent water or steam from entering container at all times. Suitable storage materials are PTFE, and glass. Store in rubber-lined tanks for acid concentrations less than 70%. Do not store in metal drums, nylon, or plasticised PVC.

Keep cool, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

In case of spillage, contain using earth, sand or other inert material and transfer to suitable containers. Arrange disposal in accordance with local regulations. Advise the Emergency Services if the substance has entered a watercourse or sewer, or has contaminated soil or vegetation.

### 5.14.4 Emergency Action

- Fire  
Keep containers and surroundings cool with water spray. Water must not enter tanks or containers. Select extinguishing media appropriate to other materials involved.  
It may give rise to hazardous fumes in a fire. Violent reaction with water generates heat and may cause an explosion. Prevent run-off from entering waterways, drains and drinking water supplies.  
Fire-fighters to wear full protective clothing and use self contained breathing apparatus.
- Ingestion  
Do not induce vomiting. Wash out mouth with water. Give sips of cold water or milk to soothe the affected parts. Ingested acid must be diluted by approximately x 100, to render harmless to tissues. Obtain medical advice immediately.
- Inhalation (of vapour)  
Remove from further exposure. If breathing stops or shows signs of failing, give artificial respiration. Do not use mouth to mouth ventilation. If there is difficulty in breathing, give oxygen. Keep warm and at rest. Obtain medical attention urgently.
- Aspiration (inhalation of liquid)  
Obtain immediate medical assistance.
- Eyes  
Irrigate copiously with water or preferably eye-wash solution for at least fifteen minutes. Seek medical advice.
- Skin contact  
Flush area with copious quantities of water, preferably under a shower. Remove contaminated clothing, which should be washed or dry-cleaned before re-use.  
Obtain medical attention if blistering or redness persists.
- Spillage  
Wear appropriate protective clothing. Ventilate the area to dispel possible toxic, decomposition fumes. Contain and absorb using earth, sand or other inert material. Transfer to suitable container for disposal in accordance with local regulations as directed under Storage/Transport (Section 5.14.3).

### 5.14.5 Special Note: Identification of Usage



**WARNING: CARE MUST BE TAKEN TO IDENTIFY THAT THE SULPHURIC ACID 'BATTERY ELECTROLYTE' OR 'ELECTROLYTE' IS THE CORRECT SUBSTANCE FOR USE IN A BATTERY. A VIOLENT CHEMICAL REACTION WILL OCCUR IF SULPHURIC ACID IS ACCIDENTALLY MIXED WITH ALKALINE BATTERY ELECTROLYTE.**

### 5.14.6 Special Note: Concentrated Sulphuric Acid



**WARNING: DO NOT ADD WATER TO ACID - A VIOLENT REACTION WILL OCCUR.**

In some cases, sulphuric acid may be purchased in concentrated form. This is a clear viscous liquid. Do not attempt to add this type of acid to batteries. Dilution should only be attempted by experienced personnel. If spillage of concentrated acid occurs contact emergency services immediately and quote hazard code 1830.

### 5.14.7 Special Note: Lead Acid Batteries

Lead acid batteries contain significant quantities of metallic lead, which is harmful. Provided that the battery is not dismantled in any way, there is no risk of heavy metal poisoning from batteries. Use gloves when connecting and adopt a high standard of personal hygiene. Batteries can be recycled, and used batteries should be disposed of in accordance with local authority environmental health regulations.

## 5.15 Potassium Hydroxide – Solid

This is also known as caustic potash – solid. It is white, odourless, and may be granules, flakes, pellets, powder, lumps, solid blocks or sticks. Potassium hydroxide is potentially a hazardous product.

When added to distilled water it is used as battery electrolyte (NiCad batteries only). These batteries are used in the starting and control systems of generating sets. Installers, operators and maintainers are likely to encounter this product.

### 5.15.1 Hazardous Reactions

Highly corrosive, this product reacts with water to produce a caustic solution and heat. (N.B. sufficient heat can be generated with moisture to ignite combustible materials).

Reacts violently with acids. Attacks aluminium, lead, tin, zinc and their alloys, releasing flammable hydrogen gas. Reacts with ammonium salts giving ammonia.

Non flammable and non combustible in bulk form but when in battery may be associated with explosive gases.



*Note: Heating will cause pressure rise with risk of bursting - keep drums cool.*

Avoid contact with body tissue. The highly corrosive nature of this product causes severe burns to eyes and skin.

### 5.15.2 Protective Measures

Ensure good ventilation and avoid heat sources.

Adopt a high standard of personal hygiene.

Use total eye protection goggles, plastic or rubber gloves (e.g. PVC), overalls, apron and rubber boots. Note that handling contaminated clothing may result in damage to the skin. It is advised to have an eyewash bottle with clean water in the vicinity.

No special respiratory precautions are necessary in normal use.

### 5.15.3 Storage / Transport

Store and transport only in correctly marked containers and keep tightly sealed when not in use. Keep cool, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Wearing total personal protection, cover a spillage with earth or sand and transfer to another container. Arrange disposal in accordance with local regulations. If the substance has entered a water course or sewer, or has contaminated soil or vegetation, please advise the Emergency Services.

### 5.15.4 Emergency Action

- Fire  
Non-combustible. Keep drums cool to reduce risk of bursting.
- Ingestion  
Do not induce vomiting. Drink copious quantities of milk. In all cases obtain immediate medical attention.
- Inhalation (of vapour)  
Remove from further exposure. In cases of irritation to lungs or throat seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical attention.
- Eyes  
Irrigate copiously with water. In all cases obtain immediate medical attention.
- Skin  
Remove contaminated clothing and flush affected skin with copious quantities of water. Cover with dry gauze. Change clothing if necessary and wash before re-use.
- Spillage  
Wearing protective clothing, cover spillage with earth or sand. Transfer to another container in accordance with local regulations as directed under Storage/Transport (Section 5.15.3).



## 5.16 Potassium Hydroxide – Solution

Also known as NiCad battery electrolyte, or electrolyte, this is a clear colourless liquid, readily soluble in water forming a diluted corrosive solution and considered to be a potentially hazardous product. Non flammable and non combustible in bulk form but when in battery may be associated with explosive gases. These NiCad batteries are used in the starting and control systems of generating sets. Installers, operators and maintainers are likely to encounter this product.

### 5.16.1 Hazardous Reactions

Highly corrosive this product reacts violently with acids. Attacks aluminium, lead, tin, zinc and their alloys, releasing flammable hydrogen gas. Reacts with ammonium salts to produce ammonia. When in battery it may be associated with explosive gases.

Avoid contact with body tissue. The highly corrosive nature of this product causes severe burns to eyes and skin.

### 5.16.2 Protective Measures

Ensure good ventilation and avoid heat sources. The fumes given off when batteries are charging is an explosive mixture of hydrogen and oxygen. Fumes must be positively removed from confined spaces by fume extraction. Use insulated tools when fitting batteries or making connections. Avoid sparks or naked flames in vicinity of battery, especially when charging.

Adopt a high standard of personal hygiene.

Use total eye protection goggles, plastic or rubber gloves (e.g. PVC), overalls, apron and rubber boots. Note that handling contaminated clothing may result in damage to the skin.

No special respiratory precautions are necessary in normal use. Avoid contact with electrolyte mist if large quantities of batteries are being charged or if working close to charging batteries.

### 5.16.3 Storage / Transport

Store and transport only in correctly marked containers, and keep tightly sealed when not in use. Keep cool, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers and water-courses.

Cover a spillage with earth or sand and transfer to another container. Arrange disposal in accordance with local regulations. If the substance has entered a water course or sewer, or has contaminated soil or vegetation, please advise the Emergency Services.

## 5.16.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, dry powder, or Halon. DO NOT use water or water based foam.  
Fire fighters to use self contained breathing apparatus. Keep fire exposed containers cool. Prevent run-off from entering waterways drains and drinking water supplies.
- Ingestion  
Do not induce vomiting. Drink copious quantities of milk. In all cases obtain immediate medical attention.
- Inhalation (of vapour)  
Remove from further exposure. In cases of irritation to lungs or throat seek medical advice.
- Aspiration (inhalation of liquid)  
Obtain immediate medical attention.
- Eyes  
Irrigate copiously with water. In all cases obtain immediate medical attention.
- Skin  
Remove contaminated clothing and flush affected skin with copious quantities of water. Cover with dry gauze. Change clothing if necessary and wash before re-use.
- Spillage  
Wearing protective clothing, cover spillage with earth or sand. Transfer to another container in accordance with local regulations as directed under Storage/Transport (Section 5.16.3).

## 5.16.5 Special Note: Identification of Usage



**WARNING: CARE MUST BE TAKEN TO IDENTIFY THAT THE ALKALINE BATTERY ELECTROLYTE IS THE CORRECT SUBSTANCE FOR USE IN A BATTERY. A VIOLENT CHEMICAL REACTION WILL OCCUR IF ALKALINE BATTERY ELECTROLYTE IS ACCIDENTALLY MIXED WITH SULPHURIC ACID 'BATTERY ELECTROLYTE' OR 'ELECTROLYTE' IN A LEAD-ACID BATTERY.**

## 5.16.6 Special Note: Disposal

The simple electrochemistry of a NiCad battery brings alkaline electrolyte into contact with nickel-cadmium plates. No structural degradation can occur.

Provided that the battery is not dismantled in any way, there is minimal risk to personnel provided the above precautions are met. Do not dispose of the battery in land fill, and do not incinerate. Batteries can be recycled and should be returned to the manufacturer for recycling at the end of their life.

## 5.17 Natural Gas

Also known as Methane, this gas is not visible. A strong smell may be detectable if the gas has been treated with a smell additive for leakage detection. Natural Gas is piped to the generator set and would be found in the gas pipeline, gas train or generator set carburetor system. It is soluble in water, alcohol, ether and most organic Solvents. Installers, operators and maintainers are likely to encounter this product.

### 5.17.1 Hazardous Reactions

Extremely flammable/explosive at **low** levels in Air Atmosphere (4% to 15% Gas in Air). Relatively low levels of gas leakage in confined areas can cause explosions and fires if a spark occurs to ignite it. Inhalation of large volumes of natural gas can cause asphyxiation and death.

Effects of over exposure include headaches, dizziness, drowsiness, nausea or vomiting. Gas under pressure can penetrate skin; high concentrations can damage eyesight or cause blindness.

### 5.17.2 Protective Measures

Ensure good ventilation and avoid heat sources. Ensure all pipelines, gas train and fittings are gas tight and free from leaks. If leakage occurs isolate the gas supply, do not operate any electrical equipment which may cause a spark or become a source of ignition. Fully ventilate the area, and evacuate the building. Contact suitably qualified personnel who are fully trained to handle natural gas emergencies

No special respiratory precautions are necessary in normal use.

In the event of a gas leakage, eye protection goggles, rubber gloves (e.g. PVC) and breathing apparatus may be required.

### 5.17.3 Storage / Transport

Gas pipeline – not applicable.

### 5.17.4 Emergency Action

- Fire  
Extinguishing media: CO<sub>2</sub>, dry powder, or Halon, Sand, Waterspray Fog, Mist or Water Based Foam. In the event of fire, attempt to shut off the gas supply and immediately inform the local fire authority and gas supplier. Natural gas is extremely flammable and may re-ignite after fire is extinguished. Carbon Dioxide (CO<sub>2</sub>) and Carbon Monoxide (CO) gas is released when burning.
- Ingestion  
Not expected to be a Health Risk via this route.
- Inhalation (of vapour)  
Remove from further exposure. Inhalation can cause headaches, dizziness, nausea or vomiting. High vapour concentrations can lead to general narcotic effect or unconsciousness. High volumes of gas or vapour displaces oxygen content available for breathing and can cause asphyxiation and death.
- Aspiration (inhalation of liquid)  
Not applicable.
- Eyes  
Gas under pressure can penetrate skin; high concentrations can damage eyesight or cause blindness.
- Skin  
In the event of a gas leakage, eye protection goggles, rubber gloves (e.g. PVC) and breathing apparatus may be required.
- Spillage  
In the event of Gas leakage, isolate the gas supply, ventilate the area and inform the local supplier. Do **not** operate electrical switches, mobile phones, torches etc, or any other equipment that may cause a spark to ignite gas – these should be removed or rendered inoperable. In circumstances of excessive leakage, evacuate the building and call the emergency services and the local gas supplier.

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PREMIUM BLUE SAE 15W-40  
DIESEL ENGINE OIL  
VV70505

**1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING**

Ashland	Regulatory Information Number	1-800-325-3751
P.O. Box 2219	Telephone	614-790-3333
Columbus, OH 43216	Emergency telephone	1-800-ASHLAND (1-800-274-5263)

Product name	PREMIUM BLUE SAE 15W-40 DIESEL ENGINE OIL
Product code	VV70505
Product Use Description	No data

**2. HAZARDS IDENTIFICATION**

**Emergency Overview**

Appearance: liquid, amber

CAUTION! PROLONGED OR REPEATED CONTACT MAY DRY THE SKIN AND CAUSE IRRITATION AND BURNS.

**Potential Health Effects**

**Routes of exposure**

Inhalation, Skin contact, Eye Contact, Ingestion

**Eye contact**

Unlikely to cause eye irritation or injury.

**Skin contact**

May cause mild skin irritation. Prolonged or repeated contact may dry the skin. Symptoms may include redness, burning, drying and cracking of skin, and skin burns.

**Ingestion**

Swallowing small amounts of this material during normal handling is not likely to cause harmful effects. Swallowing large amounts may be harmful. This material can get into the lungs during swallowing or vomiting. This results in lung inflammation and other lung injury.

**Inhalation**

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It is possible to breathe this material under certain conditions of handling and use (for example, during heating, spraying, or stirring). Breathing small amounts of this material during normal handling is not likely to cause harmful effects. Breathing large amounts may be harmful. Symptoms are not expected at air concentrations below the recommended exposure limits, if applicable (see Section 8.).

**Aggravated Medical Condition**

Preexisting disorders of the following organs (or organ systems) may be aggravated by exposure to this material: skin, lung (for example, asthma-like conditions)

**Symptoms**

Signs and symptoms of exposure to this material through breathing, swallowing, and/or passage of the material through the skin may include: stomach or intestinal upset (nausea, vomiting, diarrhea), irritation (nose, throat, airways), Abdominal pain

**Target Organs**

No data

**Carcinogenicity**

This material is not listed as a carcinogen by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), or the Occupational Safety and Health Administration (OSHA). Used motor oil has been shown to cause skin cancer in laboratory animals continually exposed by repeated applications. Avoid prolonged or repeated skin contact.

**Reproductive hazard**

There are no data available for assessing risk to the fetus from maternal exposure to this material.

**3. COMPOSITION/INFORMATION ON INGREDIENTS**

<b>Components</b>	<b>CAS-No.</b>	<b>Concentration</b>
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC	64742-54-7	>=80-<90%

**4. FIRST AID MEASURES**

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### **Eyes**

If symptoms develop, move individual away from exposure and into fresh air. Flush eyes gently with water while holding eyelids apart. If symptoms persist or there is any visual difficulty, seek medical attention.

### **Skin**

Remove contaminated clothing. Wash exposed area with soap and water. If symptoms persist, seek medical attention. Launder clothing before reuse.

### **Ingestion**

Seek medical attention. If individual is drowsy or unconscious, do not give anything by mouth; place individual on the left side with the head down. Contact a physician, medical facility, or poison control center for advice about whether to induce vomiting. If possible, do not leave individual unattended.

### **Inhalation**

If symptoms develop, move individual away from exposure and into fresh air. If symptoms persist, seek medical attention. If breathing is difficult, administer oxygen. Keep person warm and quiet; seek immediate medical attention.

### **Notes to physician**

**Hazards:** Acute aspiration of large amounts of oil-laden material may produce a serious aspiration pneumonia. Patients who aspirate these oils should be followed for the development of long-term sequelae. Repeated aspiration of small quantities of mineral oil can produce chronic inflammation of the lungs (i.e. lipoid pneumonia) that may progress to pulmonary fibrosis. Symptoms are often subtle and radiological changes appear worse than clinical abnormalities. Occasionally, persistent cough, irritation of the upper respiratory tract, shortness of breath with exertion, fever, and bloody sputum occur. Inhalation exposure to oil mists below current workplace exposure limits is unlikely to cause pulmonary abnormalities.

**Treatment:** No information available.

## **5. FIRE-FIGHTING MEASURES**

### **Suitable extinguishing media**

Carbon dioxide (CO<sub>2</sub>), Dry chemical, Foam, Water spray

### **Hazardous combustion products**



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carbon dioxide and carbon monoxide, oxides of sulfur, nitrogen and phosphorus, various hydrocarbons

**Precautions for fire-fighting**

Never use welding or cutting torch on or near drum (even empty) because product (even just residue) can ignite explosively. Wear full firefighting turn-out gear (full Bunker gear), and respiratory protection (SCBA). DO NOT direct a solid stream of water or foam into hot, burning pools of liquid since this may cause frothing and increase fire intensity. Frothing can be violent and possibly endanger any firefighter standing too close to the burning liquid.

**Flammability Class for Flammable Liquids**

Combustible Liquid Class IIIB

**6. ACCIDENTAL RELEASE MEASURES**

**Personal precautions**

For personal protection see section 8. Spills of this material are very slippery.

**Environmental precautions**

Prevent run-off to sewers, streams or other bodies of water. If run-off occurs, notify proper authorities as required, that a spill has occurred.

**Methods for cleaning up**

Persons not wearing protective equipment should be excluded from area of spill until clean-up has been completed. Stop spill at source, dike area of spill to prevent spreading, pump liquid to salvage tank. Remaining liquid may be taken up on sand, clay, earth, floor absorbent, or other absorbent material and shoveled into containers.

**Other information**

Notify the proper authorities as required that a spill has occurred. Comply with all applicable federal, state, and local regulations.

**7. HANDLING AND STORAGE**

**Handling**

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Containers of this material may be hazardous when emptied. Since emptied containers retain product residues (vapor, liquid, and/or solid), all hazard precautions given in the data sheet must be observed.

**Storage**

Store in a cool, dry, ventilated area, away from incompatible substances.

**8. EXPOSURE CONTROLS / PERSONAL PROTECTION**

**Exposure Guidelines**

**General advice**

These recommendations provide general guidance for handling this product. Personal protective equipment should be selected for individual applications and should consider factors which affect exposure potential, such as handling practices, chemical concentrations and ventilation. It is ultimately the responsibility of the employer to follow regulatory guidelines established by local authorities.

**Exposure controls**

General room ventilation should be adequate for normal conditions of use. However, if unusual operating conditions exist, provide sufficient mechanical (general and/or local exhaust) ventilation to maintain exposure below exposure guidelines (if applicable) or below levels that cause known, suspected or apparent adverse effects.

**Eye protection**

Not required under normal conditions of use. Wear splash-proof safety goggles if material could be misted or splashed into eyes.

**Skin and body protection**

Wear resistant gloves (consult your safety equipment supplier).  
Wear normal work clothing including long pants, long-sleeved shirts and foot covering to prevent direct contact of the product with the skin. Launder clothing before reuse. If skin irritation develops, contact your facility health and safety professional or your local safety equipment supplier to determine the proper personal protective equipment for your use.

**Respiratory protection**

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Respiratory protection is not required under normal conditions of use.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical state</b>	liquid
<b>Form</b>	No data
<b>Colour</b>	amber
<b>Odour</b>	No data
<b>Boiling point/boilingrange</b>	218.30 °C / 424.9 °F
<b>pH</b>	No data
<b>Flash point</b>	(>)389.8 °F / 198.8 °C
<b>Evaporation rate</b>	No data
<b>Explosion limits</b>	1 %(V) 6 %(V)
<b>Vapour pressure</b>	0.01 hPa @ 70.00 °F / 21.11 °C
<b>Vapour density</b>	No data
<b>Density</b>	0.8744 g/cm <sup>3</sup> @ 60.01 °F / 15.56 °C 7.27 lb/gal @ 60.1 °F / 15.6 °C
<b>Solubility</b>	No data
<b>Partition coefficient: n-octanol/water</b>	No data
<b>Autoignition temperature</b>	No data

## 10. STABILITY AND REACTIVITY

### Stability

Stable

### Conditions to avoid

excessive heat

### Incompatible products

strong oxidizing agents

### Hazardous decomposition products

carbon dioxide and carbon monoxide, oxides of sulfur, nitrogen and phosphorus, various hydrocarbons

### Hazardous reactions

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No data

**Thermal decomposition**

No data

**11. TOXICOLOGICAL INFORMATION**

**Acute oral toxicity**

DISTILLATES (PETROLEUM),  
HYDROTREATED HEAVY  
PARAFFINIC

LD 50 Rat: > 15 g/kg

**Acute inhalation toxicity**

**Acute dermal toxicity**

DISTILLATES (PETROLEUM),  
HYDROTREATED HEAVY  
PARAFFINIC

LD 50 Rabbit: > 5 g/kg

**12. ECOLOGICAL INFORMATION**

**Aquatic toxicity**

**Acute and Prolonged Toxicity to Fish**

No data

**Acute Toxicity to Aquatic Invertebrates**

No data

**Environmental fate and pathways**

No data

**13. DISPOSAL CONSIDERATIONS**

**Waste disposal methods**

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Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Ashland Distribution's Environmental Services Group at 800-637-7922.

**14. TRANSPORT INFORMATION**

Dangerous goods descriptions (if indicated above) may not reflect package size, quantity, end-use or region-specific exceptions that can be applied. Consult shipping documents for descriptions that are specific to the shipment.

**15. REGULATORY INFORMATION**

**California Prop. 65**

This product does not contain any chemicals known to State of California to cause cancer, birth, or any other reproductive defects.

**SARA Hazard Classification** Acute Health Hazard

**SARA 313 Component(s)**

ZINC COMPOUNDS 1.6072%

	<b>Health</b>	<b>Flammability</b>	<b>Reactivity</b>	<b>Other</b>
<b>HMIS</b>	1	1	0	
<b>NFPA</b>	1	1	0	

**16. OTHER INFORMATION**

The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This MSDS has been prepared by Ashland's Environmental Health and Safety Department (1-800-325-3751).



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## MATERIAL SAFETY DATA SHEET

### SECTION 1: IDENTIFICATION

- Product identifier** : **ES COMPLEAT COOLANT EG PREMIX (ETHYLENE GLYCOL BASED COOLANT)**
- Product Code(s)** : CC2825 (1 Gallon / 3.785 L Bottle of 50/50 Premix); CC2826 (55 gallon / 208 L Drum of 50/50 Premix); CC2827 (Bulk of 50/50 Premix); CC2848 (5 Gallon / 18.9 L Pail of 50/50 Premix); CC2834 (Tote tanks); CC8975 (1 gallon / 3.785 L Bottle of 40/60 Premix); CC8976 (5 Gallon / 18.9 L Pail of 40/60 Premix); CC8977 (55 Gallon / 208 L Drum of 40/60 Premix); CC8978 (250 Gallon / 1000 L of 40/60 Premix); CC2863 (55 Gallon / 208 L Drum of 60/40 Premix).
- Product Use** : Premixed antifreeze / coolant.
- Chemical Family** : Mixture.
- Supplier's name and address:**  
**Cummins Filtration**  
1200 Fleetguard Road  
Cookeville, TN, U.S.A.  
38506
- Manufacturer's name and address:**  
Refer to Supplier
- Information Telephone #** : (931) 526-9551 (Hours of operation: 24 Hours per day, 7 days per week)
- 24 Hr. Emergency Tel #** : Chemtrec 1-800-424-9300 (Within Continental U.S.); Chemtrec 703-527-3887 (Outside U.S.).

### SECTION 2 - HAZARDS IDENTIFICATION

- Classification** : WHMIS classification:  
Class D1B (Materials Causing Immediate and Serious Toxic Effects, Toxic Material);  
Class D2A (Materials Causing Other Toxic Effects, Very Toxic Material).
- OSHA: This material is classified as hazardous under OSHA regulations (29CFR 1910.1200). Hazardous classification:  
Acute Health Hazard;  
Chronic Health Hazard.
- Emergency Overview** : Blue liquid. No odour.  
Warning! POISON! Harmful or fatal if swallowed. Harmful if absorbed through the skin. May cause nausea, vomiting, headache and other central nervous system effects. Could also cause convulsions, coma, respiratory arrest and death. Can cause kidney damage. May cause liver effects. Possible birth defect hazard - contains material that may cause birth defects, based on animal data.

### POTENTIAL HEALTH EFFECTS:

#### Signs and symptoms of short-term (acute) exposure

- Inhalation* : Toxic in particulate form by inhalation. May cause irritation to the nose, throat and upper respiratory tract. If mists are inhaled, may cause tearing, general anesthesia, headache, coughing, respiratory stimulation, nausea, vomiting, pulmonary, kidney and liver damage.
- Skin* : May cause mild skin irritation. Product may be absorbed and cause symptoms similar to those listed for ingestion.
- Eyes* : May cause mild eye irritation. Symptoms may include inflammation and tearing.
- Ingestion* : Harmful or fatal if swallowed. Human poison by ingestion (lethal dose of Ethylene glycol for humans reported to be 100 mL). Symptoms may include pain, headache, nausea, vomiting, dizziness, drowsiness and other central nervous system effects. Initially, the central nervous system is stimulated, followed by depression. Could cause cyanosis (bluish discoloration of the skin due to deficient oxygenation of the blood). May potentially result in lethal kidney damage. Could also cause convulsions, coma, respiratory arrest and death.

#### Effects of long-term (chronic) exposure

- Carcinogenic status** : Prolonged or repeated ingestion may cause bladder or kidney stones.  
: See TOXICOLOGICAL INFORMATION, Section 11.

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**Additional health hazards** : Potential teratogen. See TOXICOLOGICAL INFORMATION, Section 11.

**Potential environmental effects** : See ECOLOGICAL INFORMATION, Section 12.

**SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS**

<u>Ingredients</u>	<u>CAS #</u>	<u>Wt.%</u>
Ethylene glycol	107-21-1	40.00 - 70.00
Diethylene glycol	111-46-6	0.10 - 1.00

**SECTION 4 - FIRST AID MEASURES**

- Inhalation** : Immediately remove person to fresh air. If breathing has stopped, give artificial respiration. Obtain medical attention if symptoms develop and persist.
- Skin contact** : Immediately flush with plenty of water, while removing contaminated clothing. If irritation persists, seek prompt medical attention. Launder clothing before reuse.
- Eye contact** : Immediately flush eye(s) with plenty of water. After initial flushing, remove any contact lenses if worn, and continue flushing for at least 5 to 10 minutes. If irritation persists, seek prompt medical attention.
- Ingestion** : Toxic if swallowed. Call a physician or Poison Control Centre immediately. Induce vomiting ONLY under the direct supervision of qualified medical personnel or a poison control centre. Never give anything by mouth to an unconscious person.
- Notes For Physician** : Prompt medical attention is important. Delayed treatment may result in fatality. This product is a CNS depressant. Use of ethanol may be helpful to counter the toxic effects of ethylene glycol by interfering with the absorption rate in the stomach and intestine.

**SECTION 5 - FIRE FIGHTING MEASURES**

- Fire hazards/conditions of flammability** : Not flammable under normal conditions of handling. However, may ignite if exposed to extreme heat and flame. Closed containers may rupture if exposed to excess heat or flame due to a build-up of internal pressure.
- Flammability classification (OSHA 29 CFR 1910.1200)** : Combustible Liquid Class III B.
- Oxidizing properties** : None known.
- Explosion data: Sensitivity to mechanical impact / static discharge** : Not expected to be sensitive to mechanical impact or static discharge.
- Suitable extinguishing media** : Use media suitable to the surrounding fire such as water fog or fine spray, alcohol foams, carbon dioxide and dry chemical.
- Special fire-fighting procedures/equipment** : Firefighters should wear proper protective equipment and self-contained breathing apparatus with full face piece operated in positive pressure mode. Move containers from fire area if safe to do so. Water spray may be useful in cooling equipment exposed to heat and flame.
- Hazardous combustion products** : Carbon oxides, formaldehyde and other irritating fumes and smoke.
- NFPA Rating** : 0 - Minimal    1 - Slight    2 - Moderate    3 - Serious    4 - Severe  
 : *Health: 2    Flammability: 1    Instability: 0    Special Hazards: None*

**SECTION 6 - ACCIDENTAL RELEASE MEASURES**

- Personal precautions** : Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. All persons dealing with clean-up should wear the appropriate protective equipment including self-contained breathing apparatus. Refer to Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION, for additional information on acceptable personal protective equipment.

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- Environmental precautions** : Ensure spilled product does not enter drains, sewers, waterways, or confined spaces. If necessary, dike well ahead of the spill to prevent runoff into drains, sewers, or any natural waterway or drinking supply.
- Spill response/cleanup** : Remove all sources of ignition. Ventilate area of release. Stop spill or leak at source if safely possible. Contain and absorb spilled liquid with non-combustible, inert absorbent material (e.g. sand), then place absorbent material into a container for later disposal (see Section 13). Use plastic or aluminum shovels to transfer absorbed waste material into drums. Contaminated absorbent material may pose the same hazards as the spilled product. Notify the appropriate authorities as required.
- Prohibited materials** : Use non-flammable absorbent only.
- Special spill response procedures** : In case of a transportation accident, contact CHEMTREC at 1-800-424-9300 or International at 1-703-527-3887. If a spill/release in excess of the EPA reportable quantity is made into the environment, immediately notify the national response center in the United States (phone: 1-800-424-8002).  
 US CERCLA Reportable quantity (RQ): Ethylene glycol (5000 lbs. / 2270 kg).

**SECTION 7 - HANDLING AND STORAGE**

- Safe Handling procedures** : This material is a harmful liquid. Wear suitable protective equipment during handling. Refer to Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION, for additional information on acceptable personal protective equipment. Use with adequate ventilation. Do not ingest. Avoid breathing vapour or mist. Avoid contact with eyes, skin and clothing. Wash with soap and water after handling. Keep away from extreme heat and flame. Keep away from acids and other incompatibles. Use caution when opening cap. Keep containers tightly closed when not in use. Empty containers retain residue (liquid and/or vapour) and can be dangerous. Keep out of the reach of children.
- Storage requirements** : Store in a cool, dry, well-ventilated area. Store away from areas of excessive heat, open flames, sparks, and other possible sources of ignition. Keep away from incompatibles. Storage area should be clearly identified, clear of obstruction and accessible only to trained and authorized personnel. Inspect periodically for damage or leaks. No smoking in the area.
- Incompatible materials** : Strong oxidizing agents; Strong acids; Strong alkalis; Halogenated compounds; Alkali metals; Ketones.
- Special packaging materials** : Always keep in containers made of the same materials as the supply container.

**SECTION 8 - EXPOSURE CONTROLS AND PERSONAL PROTECTION**

<u>Exposure Limits</u>				
<u>Ingredients</u>	<u>ACGIH TLV</u>		<u>OSHA PEL</u>	
	<u>TWA</u>	<u>STEL</u>	<u>PEL</u>	<u>STEL</u>
Ethylene glycol	100 mg/m <sup>3</sup> (ceiling)	N/Av	*50 ppm (125 mg/m <sup>3</sup> ) (ceiling)	N/Av
Diethylene glycol	*10 mg/m <sup>3</sup>	N/Av	N/Av	N/Av

\*Note: The OSHA PEL listed above for Ethylene glycol is a final rule / vacated value. The ACGIH TLV listed above for Diethylene glycol is an AIHA WEEL.

- Ventilation and engineering measures** : Use sufficient mechanical ventilation to maintain exposures below the TLV.
- Respiratory protection** : No special precautions required. Respiratory protection is required if the concentrations exceed the TLV. NIOSH-approved respirators are recommended. Seek advice from respiratory protection specialists. Respirators should be selected based on the form and concentration of contaminants in air, and in accordance with OSHA (29 CFR 1910.134) or CSA Z94.4-02.
- Skin protection** : Gloves impervious to the material are recommended. Advice should be sought from glove suppliers.
- Eye / face protection** : Chemical splash goggles are recommended. A full face shield may also be necessary.



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**Other protective equipment** : Emergency showers and eyewash facilities should be nearby. Wear a chemically resistant apron and long sleeves when dispensing, to prevent skin contact.

**General hygiene considerations** : Avoid breathing vapour or mist. Avoid contact with eyes, skin and clothing. When using do not eat or drink. When using do not smoke. Upon completion of work, wash hands before eating, drinking, smoking or use of toilet facilities. Remove soiled clothing and wash it thoroughly before reuse.

**SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES**

<b>Physical state</b>	: Liquid.	<b>Appearance</b>	: Blue liquid.
<b>Odour</b>	: No odour.	<b>Odour threshold</b>	: 25 ppm (Ethylene glycol)
<b>pH</b>	: 10.2 - 10.8		
<b>Boiling point</b>	: 107°C / 224.6°F	<b>Specific gravity</b>	: 1.06 - 1.09
<b>Melting/Freezing point</b>	: N/Av	<b>Coefficient of water/oil distribution</b>	: N/Av
<b>Vapour pressure (mmHg @ 20° C / 68° F)</b>	: N/Av	<b>Solubility in water</b>	: Complete
<b>Vapour density (Air = 1)</b>	: N/Av	<b>Evaporation rate (n-Butyl acetate = 1)</b>	: N/Av
<b>Volatile organic Compounds (VOC's)</b>	: N/Av	<b>Volatiles (% by weight)</b>	: N/Av
<b>Flash point</b>	: N/Av		
<b>Flash point Method</b>	: COC	<b>Auto-ignition temperature</b>	: N/Av
<b>Lower flammable limit (% by vol.)</b>	: N/Av	<b>Upper flammable limit (% by vol.)</b>	: N/Av
<b>Flame Projection Length</b>	: N/Av	<b>Flashback observed</b>	: N/Av

**Section 10: Stability And Reactivity**

<b>Stability and reactivity</b>	: Stable under the recommended storage and handling conditions prescribed.
<b>Hazardous polymerization</b>	: Will not occur.
<b>Conditions to avoid</b>	: Avoid excessive heat, sparks and open flame. Do not use in areas without adequate ventilation.
<b>Materials To Avoid And Incompatibility</b>	: Incompatible materials (see Section 7).
<b>Hazardous decomposition products</b>	: None known, refer to hazardous combustion products in Section 5.

**SECTION 11 - TOXICOLOGICAL INFORMATION**

<b>Target organs</b>	: Eyes, skin, respiratory system, central nervous system, liver and kidneys.
<b>Routes of exposure</b>	: <i>Inhalation:</i> YES <i>Skin Absorption:</i> YES <i>Skin &amp; Eyes:</i> YES <i>Ingestion:</i> YES
<b>Toxicological data</b>	: There is no available data for the product itself, only for the ingredients. See below for individual ingredient acute toxicity data.

<b>Ingredients</b>	<b>LC<sub>50</sub>(4hr)</b> <b>inh, rat</b>	<b>LD<sub>50</sub></b>	
		<b>(Oral, rat)</b>	<b>(Rabbit, dermal)</b>
Ethylene glycol	2725 mg/m <sup>3</sup> (aerosol)	4000 mg/kg	9530 uL/kg
Diethylene glycol	> 4600 mg/m <sup>3</sup> (aerosol)	12,565 mg/kg (rat); 2688 mg/kg (rabbit)	13,300 mg/kg

<b>Carcinogenic status</b>	: No components are listed as carcinogens by ACGIH, IARC, OSHA or NTP.
<b>Reproductive effects</b>	: None known.
<b>Teratogenicity</b>	: Contains ethylene glycol, which may cause teratogenic effects at doses which are not maternally toxic, based on animal data.
<b>Mutagenicity</b>	: None known.
<b>Epidemiology</b>	: Not available.

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- Sensitization to material** : None known.
- Synergistic materials** : Not available.
- Irritancy** : Mild.
- other important hazards** : CNS depression may result from extreme exposures.
- Conditions aggravated by overexposure** : Pre-existing skin or eye disorders, and impaired liver or kidney functions.





**SECTION 12 - ECOLOGICAL INFORMATION**

- Ecotoxicity** : No data is available on the product itself. The ecological characteristics of this product have not been fully investigated. The product should not be allowed to enter drains or water courses, or be deposited where it can affect ground or surface waters.
- Mobility** : No information available.
- Persistence** : No information available.
- Bioaccumulation potential** : No information available.
- Other Adverse Environmental effects** : No information available.

**SECTION 13 - DISPOSAL CONSIDERATIONS**

- Handling for Disposal** : Handle waste according to recommendations in Section 7.
- Methods of Disposal** : Dispose in accordance with all applicable federal, state, provincial and local regulations. Contact your local, state, provincial or federal environmental agency for specific rules.
- RCRA** : If this product, as supplied, becomes a waste in the United States, it may meet the criteria of a hazardous waste as defined under RCRA, Title 40 CFR 261. It is the responsibility of the waste generator to determine the proper waste identification and disposal method. For disposal of unused or waste material, check with local, state and federal environmental agencies.

**SECTION 14: TRANSPORT INFORMATION**

Regulatory Information	UN Number	Shipping Name	Class	Packing Group	Label
49CFR/DOT	None	Not regulated.	Not regulated	none	
<b>49CFR/DOT Additional information</b>	Not regulated when the quantity of Ethylene glycol is less than 5000 pounds per container. If the quantity of Ethylene glycol is greater than 5000 pounds per container, the following DOT shipping description applies: RQ Environmentally hazardous substances, liquid, n.o.s. (Contains: Ethylene glycol), 9, UN3082, III.				
TDG	None	Not regulated.	Not regulated	-None-	
<b>TDG Additional information</b>	None.				
ICAO/IATA	None	Not regulated.	Not regulated	-None-	
<b>ICAO/IATA Additional information</b>	None.				
IMDG	None	Not regulated.	Not regulated	-None-	
<b>IMDG Additional information</b>	None.				



**ES COMPLEAT COOLANT EG PREMIX (ETHYLENE GLYCOL BASED COOLANT)**

MSDS No.:LT16587a

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**SECTION 15 - REGULATORY INFORMATION**

**US Federal Information:**

TSCA: All listed ingredients appear on the Toxic Substances Control Act (TSCA) inventory.

CERCLA Reportable Quantity (RQ) (40 CFR 117.302): Ethylene glycol (5000 lbs. / 2270 kg).

SARA TITLE III: Sec. 302, Extremely Hazardous Substances, 40 CFR 355: No Extremely Hazardous Substances are present in this material.

SARA TITLE III: Sec. 311 and 312, MSDS Requirements, 40 CFR 370 Hazard Classes: Immediate (Acute) health hazard; Chronic health hazard. Under SARA Sections 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are 500 pounds for the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SARA TITLE III: Sec. 313, Toxic Chemicals Notification, 40 CFR 372: This product may be subject to SARA notification requirements, since it contains Toxic Chemical constituents above their de minimus concentrations. This product contains: Ethylene glycol.

**US State Right to Know Laws:**

New Jersey Labeling Requirements: This product contains the following substances required to be disclosed on product labeling: Ethylene glycol (CAS # 107-21-1); Water (CAS # 7732-18-5); Dipotassium phosphate (CAS # 7758-11-4); Diethylene glycol (CAS # 111-46-6); Sodium tetraborate, anhydrous (CAS # 1330-43-4); Sodium molybdate (CAS # 7631-95-0). Ethylene glycol is considered a hazardous substance in the State of New Jersey.

California Proposition 65: This product contains chemicals known to the State of California to cause cancer and/or reproductive harm. This product contains trace amounts of: 1,4-Dioxane; Ethylene oxide; Acetaldehyde.

**International Information:**

WHMIS information: This product is a WHMIS Controlled Product. It meets one or more of the criteria for a controlled product provided in Part IV of the Canadian Controlled Products Regulations (CPR). Refer to Section 2 for a WHMIS Classification for this product.

Canadian Environmental Protection Act (CEPA) information: All ingredients listed appear on the Domestic Substances List (DSL).

**This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and this MSDS contains all the information required by the CPR.**

**SECTION 16 - OTHER INFORMATION**

**HMIS Rating** : \* - Chronic hazard 0 - Minimal 1 - Slight 2 - Moderate 3 - Serious 4 - Severe  
*Health: \*2 Flammability: 1 Reactivity: 0*

**Legend** : ACGIH: American Conference of Governmental Industrial Hygienists  
 AIHA: American Industrial Hygiene Association  
 CAS: Chemical Abstract Services  
 CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980  
 CFR: Code of Federal Regulations  
 CSA: Canadian Standards Association  
 DOT: Department of Transportation  
 EPA: Environmental Protection Agency  
 HMIS: Hazardous Materials Identification System  
 HSDB: Hazardous Substances Data Bank  
 IARC: International Agency for Research on Cancer  
 IATA: International Air Transport Association  
 ICAO: International Civil Aviation Organisation  
 IMDG: International Maritime Dangerous Goods  
 Inh: Inhalation  
 LC: Lethal Concentration  
 LD: Lethal Dose

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- N/Ap: Not Applicable
- N/Av: Not Available
- NFPA: National Fire Protection Association
- NIOSH: National Institute of Occupational Safety and Health
- NTP: National Toxicology Program
- OSHA: Occupational Safety and Health Administration
- PEL: Permissible exposure limit
- RCRA: Resource Conservation and Recovery Act
- RTECS: Registry of Toxic Effects of Chemical Substances
- SARA: Superfund Amendments and Reauthorization Act
- STEL: Short Term Exposure Limit
- TLV: Threshold Limit Values
- TWA: Time Weighted Average
- WEEL: Workplace Environmental Exposure Level
- WHMIS: Workplace Hazardous Materials Identification System

**References**

- 1. ACGIH, Threshold Limit Values and Biological Exposure Indices for 2009.
- 2. International Agency for Research on Cancer Monographs, searched 2010.
- 3. Canadian Centre for Occupational Health and Safety, CCHInfoWeb databases, 2010 (Chempendium and RTECs).
- 4. Material Safety Data Sheet from manufacturer.
- 5. US EPA Title III List of Lists - October 2006 version.
- 6. California Proposition 65 List - April 2, 2010 version.

<p><b>Prepared for:</b>          Cummins Filtration          Cookeville, Tennessee, U.S.A., 38506          Telephone: (931) 526-9551  <a href="http://www.cumminsfiltration.com/html/en/index.html">http://www.cumminsfiltration.com/html/en/index.html</a>          Please direct all enquiries to Cummins Filtration.</p>	
<p><b>Prepared by:</b>          ICC The Compliance Center Inc.  <a href="http://www.thecompliancecenter.com">http://www.thecompliancecenter.com</a></p>	

**DISCLAIMER OF LIABILITY**

The information in this MSDS was obtained from sources, which we believe are reliable. However, since the conditions of handling and use are beyond our control, we assume no liability for damages incurred by use of this material. This MSDS was prepared, and is to be used, for this product only. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that may exist. If the product is used as a component in another product, this information may not be applicable. Users of this product should satisfy themselves that the conditions and methods of use assure the product is used safely. No representations or warranties, either expressed or implied, of any nature are made hereunder with respect to the information contained herein. It is the responsibility of the user to comply with any and all federal, state, or local laws and regulations that may exist. Nothing contained herein is to be construed as a recommendation for use in violation of any applicable laws or regulations.

**MSDS Preparation Date (dd/mm/yyyy)**

: 21/04/2006

**MSDS Reviewed Date (dd/mm/yyyy)**

: 13/05/2010

**Revision No.**

: 3

**Revision Information**

- (M)SDS sections updated:
- 2. HAZARDS IDENTIFICATION.

**END OF DOCUMENT**

**MATERIAL SAFETY DATA SHEET**  
**LEAD ACID BATTERY WET, FILLED WITH**  
**ACID**  
 (US, CN, EU Version for International Trade)

**SECTION 1: PRODUCT AND COMPANY IDENTIFICATION**

**PRODUCT NAME:** Lead Acid Battery Wet, Filled With Acid  
**OTHER PRODUCT NAMES:** Electric Storage Battery, SLI or Industrial Battery, UN2794

**MANUFACTURER:** East Penn Manufacturing Company, Inc.  
**DIVISION:** Dekal Road  
**ADDRESS:** Lyon Station, PA 19536 USA

**EMERGENCY TELEPHONE NUMBERS:** US: CHEMTREC 1-800-424-9300  
 CN: CHEMTREC 1-800-424-9300  
 Outside US: 1-703-527-3887

**NON-EMERGENCY HEALTH/SAFETY INFORMATION:** 1-610-682-6361

**CHEMICAL FAMILY:** This product is a wet lead acid storage battery. May also include gel/absorbed electrolyte type lead acid battery types.

**PRODUCT USE:** Industrial/Commercial electrical storage batteries.

This product is considered a Hazardous Substance, Preparation or Article that is regulated under US-OSHA; CAN-WHMIS; IOSH; ISO; UK-CHIP; or EU Directives (67/548/EEC-Dangerous Substance Labelling, 98/24/EC-Chemical Agents at Work, 99/45/EC-Preparation Labelling, 2001/58/EC-MSDS Content, and 1907/2006/EC-REACH), and an MSDS/SDS is required for this product considering that when used as recommended or intended, or under ordinary conditions, it may present a health and safety exposure or other hazard.

Additional Information

This product may not be compatible with all environments, such as those containing liquid solvents or extreme temperature or pressure. Please request information if considering use under extreme conditions or use beyond current product labelling.


**SECTION 2: HAZARDS IDENTIFICATION**

**GHS Classification:**

Health	Environmental	Physical
Acute Toxicity – Not listed (NL) Eye Corrosion – Corrosive* Skin Corrosion – Corrosive* Skin Sensitization – NL Mutagenicity/Carcinogenicity – NL Reproductive/Developmental – NL Target Organ Toxicity (Repeated) – NL	Aquatic Toxicity – NL	NFPA – Flammable gas, hydrogen (during charging) CN - NL EU - NL

\*as sulfuric acid

**GHS Label: Lead Acid Battery, Wet**

<b>Symbols:</b> C (Corrosive)	
	
<b>Hazard Statements</b> Contact with internal components may cause irritation of severe burns. Irritating to eyes, respiratory system, and skin.	<b>Precautionary Statements</b> Keep out of reach of children. Keep containers tightly closed. Avoid heat, sparks, and open flame while charging batteries. Avoid contact with internal acid.

**EMERGENCY OVERVIEW:** May form explosive air/gas mixture during charging. Contact with internal components may cause irritation or severe burns. Irritating to eyes, respiratory system, and skin. Prolonged

# MATERIAL SAFETY DATA SHEET

## LEAD ACID BATTERY WET, FILLED WITH ACID

(US, CN, EU Version for International Trade)

inhalation or ingestion may result in serious damage to health. Pregnant women exposed to internal components may experience reproductive/developmental effects.

### POTENTIAL HEALTH EFFECTS:

**EYES:** Direct contact of internal electrolyte liquid with eyes may cause severe burns or blindness.  
**SKIN:** Direct contact of internal electrolyte liquid with the skin may cause skin irritation or damaging burns.  
**INGESTION:** Swallowing this product may cause severe burns to the esophagus and digestive tract and harmful or fatal lead poisoning. Lead ingestion may cause nausea, vomiting, weight loss, abdominal spasms, fatigue, and pain in the arms, legs and joints.  
**INHALATION:** Respiratory tract irritation and possible long-term effects.

### ACUTE HEALTH HAZARDS:

Repeated or prolonged contact may cause mild skin irritation.

### CHRONIC HEALTH HAZARDS:

Lead poisoning if persons are exposed to internal components of the batteries. Lead absorption may cause nausea, vomiting, weight loss, abdominal spasms, fatigue, and pain in the arms, legs and joints. Other effects may include central nervous system damage, kidney dysfunction, and potential reproductive effects. Chronic inhalation of sulfuric acid mist may increase the risk of lung cancer.

### MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:

Respiratory and skin diseases may predispose the user to acute and chronic effects of sulfuric acid and/or lead. Children and pregnant women must be protected from lead exposure. Persons with kidney disease may be at increased risk of kidney failure.

### Additional Information

No health effects are expected related to normal use of this product as sold.

## SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

<u>INGREDIENTS (Chemical/Common Names):</u>	<u>CAS No.:</u>	<u>% by Wt:</u>	<u>EC No.:</u>
Lead, inorganic	7439-92-1	43-70 (average: 65)	231-100-4
Sulfuric acid	7664-93-9	20-44 (average: 25)	231-639-5
Antimony	7440-36-0	0-4 (average: 1)	231-146-5
Arsenic	7440-38-2	<0.01	231-148-6
Polypropylene	9003-07-0	5-10 (average: 8)	NA
NA: Not applicable; ND: Not determined			

### Additional Information

These ingredients reflect components of the finished product related to performance of the product as distributed into commerce.

## SECTION 4: FIRST AID MEASURES

**EYE CONTACT:** Flush eyes with large amounts of water for at least 15 minutes. Seek immediate medical attention if eyes have been exposed directly to acid.  
**SKIN CONTACT:** Flush affected area(s) with large amounts of water using deluge emergency shower, if available, shower for at least 15 minutes. Remove contaminated clothing. If symptoms persist, seek medical attention.  
**INGESTION:** If swallowed, give large amounts of water. Do NOT induce vomiting or aspiration into the lungs may occur and can cause permanent injury or death.  
**INHALATION:** If breathing difficulties develop, remove person to fresh air. If symptoms persist, seek medical attention.

## SECTION 5: FIRE-FIGHTING MEASURES

### SUITABLE/UNSUITABLE EXTINGUISHING MEDIA:

Dry chemical, carbon dioxide, water, foam. Do not use water on live electrical circuits.

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**SPECIAL FIREFIGHTING PROCEDURES & PROTECTIVE EQUIPMENT:**

Use appropriate media for surrounding fire. Do not use carbon dioxide directly on cells. Avoid breathing vapours. Use full protective equipment (bunker gear) and self-contained breathing apparatus.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:**

Batteries evolve flammable hydrogen gas during charging and may increase fire risk in poorly ventilated areas near sparks, excessive heat or open flames.

**SPECIFIC HAZARDS IN CASE OF FIRE:**

Thermal shock may cause battery case to crack open. Containers may explode when heated.

Additional Information

Firefighting water runoff and dilution water may be toxic and corrosive and may cause adverse environmental impacts.

**SECTION 6: ACCIDENTAL RELEASE MEASURES**

**PERSONAL PRECAUTIONS:**

Avoid Contact with Skin. Neutralize any spilled electrolyte with neutralizing agents, such as soda ash, sodium bicarbonate, or very dilute sodium hydroxide solutions.

**ENVIRONMENTAL PRECAUTIONS:**

Prevent spilled material from entering sewers and waterways.

**SPILL CONTAINMENT & CLEANUP METHODS/MATERIALS:**

Add neutralizer/absorbent to spill area. Sweep or shovel spilled material and absorbent and place in approved container. Dispose of any non-recyclable materials in accordance with local, state, provincial or federal regulations.

Additional Information

**Lead acid batteries and their plastic cases are recyclable.** Contact your East Penn representative for recycling information.

**SECTION 7: HANDLING AND STORAGE**

**PRECAUTIONS FOR SAFE HANDLING AND STORAGE:**

- Keep containers tightly closed when not in use.
- If battery case is broken, avoid contact with internal components.
- Do not handle near heat, sparks, or open flames.
- Protect containers from physical damage to avoid leaks and spills.
- Place cardboard between layers of stacked batteries to avoid damage and short circuits.
- Do not allow conductive material to touch the battery terminals. A dangerous short-circuit may occur and cause battery failure and fire.

**OTHER PRECAUTIONS (e.g.; Incompatibilities):**

Keep away from combustible materials, organic chemicals, reducing substances, metals, strong oxidizers and water.

**SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION**

**ENGINEERING CONTROLS/SYSTEM DESIGN INFORMATION:**

Charge in areas with adequate ventilation.

**VENTILATION:**

General dilution ventilation is acceptable.

**RESPIRATORY PROTECTION:**

Not required for normal conditions of use. See also special firefighting procedures (Section 5).

**EYE PROTECTION:**

Wear protective glasses with side shields or goggles.

**SKIN PROTECTION:**

Wear chemical resistant gloves as a standard procedure to prevent skin contact.

**OTHER PROTECTIVE CLOTHING OR EQUIPMENT:** Chemically impervious apron and face shield recommended when adding water or electrolyte to batteries.

**Wash Hands after handling.**

**EXPOSURE GUIDELINES & LIMITS:**

# MATERIAL SAFETY DATA SHEET

## *LEAD ACID BATTERY WET, FILLED WITH ACID*

(US, CN, EU Version for International Trade)

### EXPOSURE GUIDELINES & LIMITS:

OSHA	Permissible Exposure Limit (PEL/TWA)	Lead, inorganic (as Pb)	0.05 mg/m <sup>3</sup>
		Sulfuric acid	1.00 mg/m <sup>3</sup>
		Antimony	0.50 mg/m <sup>3</sup>
		Arsenic	0.01 mg/m <sup>3</sup>
		Lead, inorganic (as Pb)	0.05 mg/m <sup>3</sup>
ACGIH	2007 Threshold Limit Value (TLV)	Sulfuric acid	0.20 mg/m <sup>3</sup>
		Antimony	0.50 mg/m <sup>3</sup>
		Arsenic	0.01 mg/m <sup>3</sup>
		Lead, inorganic (as Pb)	0.15 mg/m <sup>3</sup>
		Sulfuric acid	1.00 mg/m <sup>3</sup>
Quebec	Permissible Exposure Value (PEV)	Sulfuric acid	3.00 mg/m <sup>3</sup> TWA
		Antimony	0.50 mg/m <sup>3</sup> STEV
		Arsenic	0.10 mg/m <sup>3</sup>
		Lead (designated substance)	0.10 mg/m <sup>3</sup>
		Sulfuric acid	1.00 mg/m <sup>3</sup> TWAEV
Ontario	Occupational Exposure Level (OEL)	Sulfuric acid	3.00 mg/m <sup>3</sup> STEV
		Antimony	0.50 mg/m <sup>3</sup>
		Arsenic (designated substance)	0.01 mg/m <sup>3</sup>
		Lead, inorganic (as Pb)	0.15 mg/m <sup>3</sup>
		Sulfuric acid	1.00 mg/m <sup>3</sup>
Netherlands	Maximaal Aanvaarde Concentratie (MAC)	Sulfuric acid	2.00 mg/m <sup>3</sup>
		Lead, inorganic (as Pb)	0.10 mg/m <sup>3</sup>
Germany	Maximale Arbeitsplatzkonzentrationen (MAK)	Sulfuric acid	1.00 mg/m <sup>3</sup> TWA
		Lead, inorganic (as Pb)	0.50 mg/m <sup>3</sup> STEL
United Kingdom	Occupational Exposure Standard (OES)	Antimony	0.50 mg/m <sup>3</sup>
		Lead	0.15 mg/m <sup>3</sup>
		Antimony	0.50 mg/m <sup>3</sup>
		Arsenic	0.10 mg/m <sup>3</sup>

TWA: 8-Hour Time-Weighted Average; STE: Short-Term Exposure; mg/m<sup>3</sup>: milligrams per cubic meter of air; NE: Not Established; STEV: Short-Term Exposure Value; TWAEV: Time-Weighted Average Exposure Value; STEL: Short-Term Exposure Limit

### Additional Information

- Batteries are housed in polypropylene cases which are regulated as total dust or respirable dust only when they are ground up during recycling. The OSHA PEL for dust is 15 mg/m<sup>3</sup> as total dust or 5 mg/m<sup>3</sup> as respirable dust.
- May be required to meet Domestic Requirements for a Specific Destination(s).

### SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

<b>APPEARANCE:</b>	Industrial/commercial lead acid battery
<b>ODOUR:</b>	Odourless
<b>ODOUR THRESHOLD:</b>	NA
<b>PHYSICAL STATE:</b>	Sulfuric Acid: Liquid; Lead: solid
<b>pH:</b>	<1
<b>BOILING POINT:</b>	235-240° F (113-116° C) (as sulfuric acid)
<b>MELTING POINT:</b>	NA
<b>FREEZING POINT:</b>	NA
<b>VAPOUR PRESSURE:</b>	10 mmHg
<b>VAPOUR DENSITY (AIR = 1):</b>	> 1
<b>SPECIFIC GRAVITY (H<sub>2</sub>O = 1):</b>	1.27-1.33
<b>EVAPORATION RATE (n-BuAc=1):</b>	< 1
<b>SOLUBILITY IN WATER:</b>	100% (as sulfuric acid)
<b>FLASH POINT:</b>	Below room temperature (as hydrogen gas)
<b>AUTO-IGNITION TEMPERATURE:</b>	NA
<b>LOWER EXPLOSIVE LIMIT (LEL):</b>	4% (as hydrogen gas)
<b>UPPER EXPLOSIVE LIMIT (UEL):</b>	74% (as hydrogen gas)



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**PARTITION COEFFICIENT:** NA  
**VISCOSITY (poise @ 25° C):** Not Available  
**DECOMPOSITION TEMPERATURE:** Not Available

### FLAMMABILITY/HMIS HAZARD CLASSIFICATIONS (US/CN/EU): As sulfuric acid

HEALTH: 3                      FLAMMABILITY: 0                      REACTIVITY: 2

### SECTION 10: STABILITY AND REACTIVITY

**STABILITY:** This product is stable under normal conditions at ambient temperature.  
**INCOMPATIBILITY (MATERIAL TO AVOID):** Strong bases, combustible organic materials, reducing agents, finely divided metals, strong oxidizers, and water.  
**HAZARDOUS DECOMPOSITION BY-PRODUCTS:** Thermal decomposition will produce sulfur dioxide, sulfur trioxide, carbon monoxide, sulfuric acid mist, and hydrogen.  
**HAZARDOUS POLYMERIZATION:** Will not occur  
**CONDITIONS TO AVOID:** Overcharging, sources of ignition

### SECTION 11: TOXICOLOGICAL INFORMATION

#### ACUTE TOXICITY (Test Results Basis and Comments):

Sulfuric acid: LD50, Rat: 2140 mg/kg  
LC50, Guinea pig: 510 mg/m<sup>3</sup>

Lead: No data available for elemental lead

#### SUBCHRONIC/CHRONIC TOXICITY (Test Results and Comments):

Repeated exposure to lead and lead compounds in the workplace may result in nervous system toxicity. Some toxicologists report abnormal conduction velocities in persons with blood lead levels of 50 µg/100 ml or higher. Heavy lead exposure may result in central nervous system damage, encephalopathy and damage to the blood-forming (hematopoietic) tissues.

#### Additional Information

- Very little chronic toxicity data available for elemental lead.
- Lead is listed by IARC as a 2B carcinogen: possible carcinogen in humans. Arsenic is listed by IARC, ACGIH, and NTP as a carcinogen, based on studies with high doses over long periods of time. The other ingredients in this product, present at equal to or greater than 0,1% of the product, are not listed by OSHA, NTP, or IARC as suspect carcinogens.
- The 19<sup>th</sup> Amendment to EC Directive 67/548/EEC classified lead compounds, but not lead in metal form, as possibly toxic to reproduction. Risk phrase 61: May cause harm to the unborn child, applies to lead compounds, especially soluble forms.

### SECTION 12: ECOLOGICAL INFORMATION

#### PERSISTENCE & DEGRADABILITY:

Lead is very persistent in soils and sediments. No data available on biodegradation.

#### BIOACCUMULATIVE POTENTIAL (Including Mobility):

Mobility of metallic lead between ecological compartments is low. Bioaccumulation of lead occurs in aquatic and terrestrial animals and plants, but very little bioaccumulation occurs through the food chain. Most studies have included lead compounds, not solid inorganic lead.

#### AQUATIC TOXICITY (Test Results & Comments):

Sulfuric acid: 24-hour LC50, fresh water fish (*Brachydanio rerio*): 82 mg/l  
96-hour LOEC, fresh water fish (*Cyprinus carpio*): 22 mg/l (lowest observable effect concentration)

Lead (metal): No data available

#### Additional Information

- No known effects on stratospheric ozone depletion.
- Volatile organic compounds: 0% (by Volume)
- Water Endangering Class (WGK): NA

### SECTION 13: DISPOSAL CONSIDERATIONS

# MATERIAL SAFETY DATA SHEET

## LEAD ACID BATTERY WET, FILLED WITH ACID

(US, CN, EU Version for International Trade)

**WASTE DISPOSAL METHOD:** Following local, State/Provincial, and Federal/National regulations applicable to end-of-life characteristics will be the responsibility of the end-user.

**HAZARDOUS WASTE CLASS/CODE:** US - Not applicable to finished product as manufactured for distribution into commerce.  
CN – Not applicable to finished product as manufactured for distribution into commerce.  
EWC – Not applicable to finished product as manufactured for distribution into commerce.

<u>Additional Information</u>
Not Included – <b>Recycle</b> or dispose as allowed by local jurisdiction for the end-of-life characteristics as-disposed.

<b>SECTION 14: TRANSPORT INFORMATION</b>
--

**GROUND – US-DOT/CAN-TDG/EU-ADR/APEC-ADR:**

Proper Shipping Name	Batteries, Wet, Filled with Acid	ID Number	UN2794
Hazard Class	8	Labels	Corrosive
Packing Group	III		

**AIRCRAFT – ICAO-IATA:**

Proper Shipping Name	Batteries, Wet, Filled with Acid	ID Number	UN2794
Hazard Class	8	Labels	Corrosive
Packing Group	III		

*Reference IATA packing instructions 870*

**VESSEL – IMO-IMDG:**

Proper Shipping Name	Batteries, Wet, Filled with Acid	ID Number	UN2794
Hazard Class	8	Labels	Corrosive
Packing Group	III		

*Reference IMDG packing instructions P801*

**Additional Information**

Transport requires proper packaging and paperwork, including the Nature and Quantity of goods, per applicable origin/destination/customs points as-shipped.

<b>SECTION 15: REGULATORY INFORMATION</b>
---

<b>INVENTORY STATUS:</b>
All components are listed on the TSCA; EINECS/ELINCS; and DSL, unless noted otherwise below.

**U.S. FEDERAL REGULATIONS:**

TSCA Section 8b – Inventory Status: All chemicals comprising this product are either exempt or listed on the TSCA Inventory.

TSCA Section 12b – Export Notification: If the finished product contains chemicals subject to TSCA Section 12b export notification, they are listed below:

<u>Chemical</u>	<u>CAS #</u>
None	NA

**CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT)**

Chemicals present in the product which could require reporting under the statute:

<u>Chemical</u>	<u>CAS #</u>
Lead	7439-92-1
Sulfuric acid	7664-93-9

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

The finished product contains chemicals subject to the reporting requirements of Section 313 of SARA Title III.

<u>Chemical</u>	<u>CAS #</u>	<u>% wt</u>
Lead	7439-92-1	65
Sulfuric acid	7664-93-9	25

**CERCLA SECTION 311/312 HAZARD CATEGORIES:** Note that the finished product is exempt from these regulations, but lead and sulfuric acid above the thresholds are reportable on Tier II reports.

Fire Hazard	No
Pressure Hazard	No

# MATERIAL SAFETY DATA SHEET

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(US, CN, EU Version for International Trade)

Reactivity Hazard	No
Immediate Hazard	Yes (Sulfuric acid is Corrosive)
Delayed Hazard	No

Note: Sulfuric acid is listed as an Extremely Hazardous Substance.

### STATE REGULATIONS (US):

#### California Proposition 65

The following chemicals identified to exist in the finished product as distributed into commerce are known to the State of California to cause cancer, birth defects, or other reproductive harm:

<u>Chemical</u>	<u>CAS #</u>	<u>% Wt</u>
Arsenic (as arsenic oxides)	7440-38-2	<0.1
Strong inorganic acid mists including sulfuric acid	NA	25
Lead	7439-92-1	65

### California Consumer Product Volatile Organic Compound Emissions

This Product is not regulated as a Consumer Product for purposes of CARB/OTC VOC Regulations, as-sold for the intended purpose and into the industrial/Commercial supply chain.

### INTERNATIONAL REGULATIONS (Non-US):

#### Canadian Domestic Substance List (DSL)

All ingredients remaining in the finished product as distributed into commerce are included on the Domestic Substances List.

#### WHMIS Classifications

Class E: Corrosive materials present at greater than 1%

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the Controlled Products Regulations.

#### NPRI and Ontario Regulation 127/01

This product contains the following chemicals subject to the reporting requirements of Canada NPRI +/- or Ont. Reg. 127/01:

<u>Chemical</u>	<u>CAS #</u>	<u>% Wt</u>
Lead	7439-92-1	65
Sulfuric acid	7664-93-9	25

European Inventory of Existing Commercial Chemical Substances (EINECS)

All ingredients remaining in the finished product as distributed into commerce are exempt from, or included on, the European Inventory of Existing Commercial Chemical Substances.

#### European Communities (EC) Hazard Classification according to directives 67/548/EEC and 1999/45/EC.

<u>R-Phrases</u>	<u>S-Phrases</u>
35, 36, 38	1/2, 26, 30, 45

### Additional Information

This product may be subject to Restriction of Hazardous Substances (RoHS) regulations in Europe and China, or may be regulated under additional regulations and laws not identified above, such as for uses other than described or as-designed/as-intended by the manufacturer, or for distribution into specific domestic destinations.

### SECTION 16: OTHER INFORMATION

#### OTHER INFORMATION:

Distribution into Quebec to follow Canadian Controlled Product Regulations (CPR) 24(1) and 24(2).

Distribution into the EU to follow applicable Directives to the Use, Import/Export of the product as-sold.

#### Sources of Information:

International Agency for Research on Cancer (1987), *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Overall Evaluations of Carcinogenicity: An updating of IARC Monographs Volumes 1-42, Supplement 7, Lyon, France.*

Ontario Ministry of Labour Regulation 654/86. Regulations Respecting Exposure to Chemical or Biological Agents.

RTECS – Registry of Toxic Effects of Chemical Substances, National institute for Occupational Safety and Health.

#### MSDS/SDS PREPARATION INFORMATION:

DATE OF ISSUE: 16 December 2011

SUPERCEDES: 03 May 2011

#### DISCLAIMER:

This Material Safety Data Sheet is based upon information and sources available at the time of preparation or revision date.

**MATERIAL SAFETY DATA SHEET**  
***LEAD ACID BATTERY WET, FILLED WITH***  
***ACID***  
**(US, CN, EU Version for International Trade)**

The information in the MSDS was obtained from sources which we believe are reliable, but are beyond our direct supervision or control. We make no Warranty of Merchantability, Fitness for any particular purpose or any other Warranty, Expressed or Implied, with respect to such information and we assume no liability resulting from its use. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product. It is the obligation of each user of this product to determine the suitability of this product and comply with the requirements of all applicable laws regarding use and disposal of this product. For additional information concerning East Penn Manufacturing Co., Inc. products or questions concerning the content of this MSDS please contact your East Penn representative.

**END**



**Rocky  
Mountain**

# Tab #1

# Bill of Materials



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**Bill of Materials**  
**Eisenhower - Johnson Memorial Tunnel**  
**350 kW Natural Gas Generator Set**  
**300 Amp Automatic Transfer Switch**  
**Sturgeon Electric**

**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
1		<b>Generator Set</b>	
2	1	Genset - Spark Ign, Natural Gas, 60Hz, <b>350kW</b>	GFEB
3		KTA19SLB, 530 HP, 8.5:1	ENG
4		N/A	CAT
5		Duty Rating - Standby Power	A331-2
6		Listing - UL 2200	L090-2
7		<b>Natural Gas</b>	C002-2
8		Enclosure - Carbon Steel, Onan Green, Base Mtd, Weather Protective	F200-2
9		Generator - HCI434F (ADS #342), 60Hz, Winding 311 - 12 Wire, 0.8pf	B415-2
10		<b>Voltage - 277/480, 3ph</b>	R002-2
11		Exciter / Regulator - PMG, 3 Phase Sensor	B184-2
12		120 VAC Resistive Generator Heater	A292-2
13		<b>Set Control - Power Command 3.3</b>	H704-2
14		Controls Facing Left	H609-2
15		Radiator Cooled	E082-2
16		Shutdown - Low Coolant Level	H389-2
17		Coolant Heater - Dual 208V / 3750W	H557-2
18		Sightglass on Radiator	E098-2
19		Engine Governor - Electronic, Isochronous Only	A366-2
20		Engine Starter - 24VDC Electric	A334-2
21		Battery Charging Alternator - Normal Output	A333-2
22		Engine Air Cleaner - Normal Duty	D041-2
23		Lube Oil, Engine Filled Prior to Shipment	H706-2
24		Anti-Freeze - 50/50 Mix, System Filled Prior to Shipment	H669-2
25		Oil Heater - 208/240V 1ph	H479-2
26		Extension - Oil Drain	H268-2
27		Extension - Engine Coolant Drain	E089-2
28		Bargraph - AC Analog Meters	H606-2
29		Manuals in English	L050-2
30		Battery Rack	F065-2
31		120/240 VAC Input, 12A / 24V Output	KB59-2
32		Relays - Genset Status (User Configured)	K631-2
33		Circuit Breaker - TM_150A_80%, 600/525V	KS63-2
34		Circuit Breaker - LSi_400A_80%, 600/525V	KM43-3
35		GFCI Outlets on Enclosure	K102-2
36		Genset Warranty - Standby Power 2 years / 400 hours	L029-2

**Bill of Materials**  
**Eisenhower - Johnson Memorial Tunnel**  
**350 kW Natural Gas Generator Set**  
**300 Amp Automatic Transfer Switch**  
**Sturgeon Electric**  
**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
37		<b>Cont.</b>	
38		Shunt Trip - 24VDC, Circuit Breaker	KM72-2
39		Aux Contacts - Form C, SPDT, Circuit Breaker	KM69-2
40			
41		<b>Heaters</b>	
42	1	Dual Engine Water Jacket Heaters - Single Phase	H557
43		<b>208 VAC = 3,750 Watts, 18.03 Amps Total</b>	
44		<b>Shore Power VAC Supplied By Others</b>	
45			
46	1	Engine Oil Pan Heater, Single Phase	H479
47		<b>208 VAC = 300 Watts / 1.44 Amps</b>	
48		<b>Shore Power VAC Supplied By Others</b>	
49			
50		<b>Configurable Inputs - Dry Contact Only - PCC 3.3</b>	
51		<b>Warning Or Fault Is Shown on The LCD Display</b>	
52		Cust. Fault #1 - Battery Charger AC Failure	
53		Cust. Fault #2 - Spare	
54		Cust. Input #3 - Spare	
55		Cust. Input #4 - Spare	
56		<b>Use Stranded Wire Only For Genset Connections</b>	
57			
58		<b>Optional Common Alarm Run Relays - PCC 3.3</b>	
59	1	Common Alarm Relays-Genset Status, User Configured	K631
60		<b>Relay Ratings: 10 Amps @ 30 VDC</b>	
61		<b>(2) Form-A &amp; (2) Form-B Contacts Per Relay</b>	
62		Cust. Relay #1 - Configurable for any Warning or Shutdown	
63		Cust. Relay #2 - Configurable for any Warning or Shutdown	
64		Cust. Relay #3 - Configurable for any Warning or Shutdown	
65		<b>Standard Configurable Relay Outputs:</b>	
66		<b>N/O Relay Ratings: 2 Amps @ 30 VDC, 3 Amps @ 120 VAC</b>	
67		Cust. Output #4 - Configurable for any Warning or Shutdown	
68		<b>Installed In The PCC 3.3 Genset Control Cabinet</b>	
69		<b>Use Stranded Wire Only For Genset Connections</b>	
70			
71			
72			



**Bill of Materials**  
**Eisenhower - Johnson Memorial Tunnel**  
**350 kW Natural Gas Generator Set**  
**300 Amp Automatic Transfer Switch**  
**Sturgeon Electric**  
**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
73			
74		<b>Remote Annunciator Panel - Universal</b>	
75	1	Cummins PCCNet Network Annunciator Panel-	0300-5929-02
76		20 Light, RS485, Flush/Surface NEMA Type 1 Enclosure	
77		Cust. Fault #1 - Spare	
78		Cust. Fault #2 - Spare	
79		Cust. Fault #3 - Spare	
80		<b>Network Data Cabling Requirements:</b>	
81		Belden 9729 or Equivalent. Two Pair of Stranded 24 AWG (or Larger)	
82		Twisted Pair Cable With Shield. Shield Must Be Ground At	
83		One End Only. Daisy Chain Network Items.	
84		Do Not Exceed 4000 Feet Cable Length. Run in Dedicated Conduit.	
85		<b>Annunciator Power Requirements:</b> Twin Power Conductors.	
86		Stranded, 12 OR 24 VDC Based On Genset Control Voltage.	
87		<b>Standard Binding:</b> NFPA 110 Genset Alarms	
88		<b>Supplied loose For Installation By Others</b>	
89		<b>Use Stranded Wire Only For Genset Connections</b>	
90			
91		<b>LG 400AF/400AT (Main Line Circuit Breaker)</b>	
92	1	Square D - 400 Amp L-Frame Circuit Breaker	KM43
93		Ref. Square D Catalog #0611CT1001	
94		L-Frame-400 Amp Current Sensor Set @ <b>400 Amp Trip</b>	
95		UL Listed, 3-Pole, <b>80% Rated</b>	
96		Interrupting Rating 65 kA @ 240 VAC	
97		Interrupting Rating 35 kA @ 480 VAC	
98		<b>Micrologic Standard 3.3S LSI Trip Unit</b>	
99		Adjustable Trip Unit - 125A thru 400A	
100	1	Shunt Trip-Line Circuit Breaker 24VDC	KM72
101	1	Auxiliary Contacts-Line Circuit Breaker	KM69
102		NEMA Type 1 Enclosure	
103		Full Neutral Bus & Ground Bond	
104		<b>Mechanical Lugs: (1) #2 AWG-600 kcmil Cu Cable Per Phase or</b>	
105		<b>Mechanical Lugs: (1) #2 AWG-500 kcmil Al Cable Per Phase</b>	
106		<b>Mounted On The Left Side Of The Generator - Bottom Entry</b>	
107			
108			

**Bill of Materials**  
**Eisenhower - Johnson Memorial Tunnel**  
**350 kW Natural Gas Generator Set**  
**300 Amp Automatic Transfer Switch**  
**Sturgeon Electric**  
**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
109			
110		<b>HG 150AF/150AT (Main Line Circuit Breaker)</b>	
111	1	Square D Local Main Line Circuit Breaker	KS63
112		Ref. Square D Catalog #0611CT0401R7/05	
113		Square D/PowerPact 150 Amp HG-Frame/ <b>150 Amp Trip</b>	
114		UL Listed, 3-Pole, <b>80% Rated</b>	
115		Interrupting Rating 65 kA @ 240 VAC	
116		Interrupting Rating 35 kA @ 480 VAC	
117		<b>Molded Case, Thermo-Magnetic Trip Unit</b>	
118	1	1 SPDT Switch- Aux. Contact or Trip Alarm	KM69
119	1	24 VDC Shunt Trip	KM72
120		NEMA Type 1 Enclosure	
121		Full Neutral Bus & Ground Bond	
122		<b>Mechanical Lugs: (1) #14 AWG-3/0 AWG Al/Cu Cable Per Phase</b>	
123		<b>Mounted On The Right Side Of The Generator - Bottom Entry</b>	
124			
125		<b>Cummins NPower Engine Coolant &amp; Lube Oil</b>	
126	1	Initial Fill of Engine Coolant, Ethylene Glycol 50/50-28 Gallon	CC2734
127	1	Initial Fill of Lube Oil, Ultra Low Ash Lubrication Oil-10 Gallon	V705200
128			
129		<b>Cummins N-Power Warranty</b>	
130	1	Warranty: 2-Year Base Warranty - Emergency Standby Power	L029
131		From Initial Date Of Start-Up	
132			
133		<b>Engine Starting System</b>	
134	2	Diesel Engine Starting Batteries, 8D Lead/Acid Type	908D
135	2	Kim Battery Warming Pads, <b>120 VAC, 75 Watt Each</b>	KB7515
136	1	Thermostat, On at 40°F, Off at 60°F	DIT46
137	1	SENS EnerGenius Battery Charger, NFPA-110 Alarms	NRG22-10-RC
138		<b>10 Amp @ 12/24 VDC Output, 60HZ-120/208-240 VAC Input</b>	
139		<b>Shore Power VAC Supplied By Others</b>	
140			
141			
142			
143			
144			

**Bill of Materials**  
**Eisenhower - Johnson Memorial Tunnel**  
**350 kW Natural Gas Generator Set**  
**300 Amp Automatic Transfer Switch**  
**Sturgeon Electric**  
**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
145			
146		<b>Fuel System Accessories</b>	
147	1	Fuel Strainer - Gaseous, 2in NPT	149-0751
148	1	Flexible Fuel Connection - Gaseous, 2in NPT	MM-2-15
149		<b>Miscellaneous Pipe &amp; Connections Supplied By Others</b>	
150			
151		<b>Generator Enclosure</b>	
152	1	Steel Weather Protective Enclosure	F200
153		NEC Compliant	
154		Drop-Over Style	
155		14 Gauge (Panels) 12 Gauge (Posts) Steel Construction	
156		Five Hinged, Recessed, Key Lockable Doors	
157		Corrosion Resistant Hardware	
158		Cambered Roof	
159	1	Internally Mounted Critical Exhaust Silencer W/ Rain Cap	EXH
160	1	GFCI Outlets on Enclosure	K102
161	1	Extension-Engine Coolant Drain	E089
162	1	Extension-Engine Oil Drain	H268
163		<b>Double E-Coat Paint - Onan Green</b>	
164			
165			
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**CRM Project # 66545, Revision # 1, Date 03/03/2015**

Line	Qty.	Description	Part Number
181			
182		<b>ATS</b>	
183	1	Transfer Switch-Onan,PwrCmd, <b>150 Amp</b>	OTPC150
184		<b>Poles-3</b>	A028-7
185		Application-Utility To Genset	A035-7
186		Listing-UL 1008/CSA Certification	A046-7
187		Frequency-60 Hertz	A044-7
188		System-3 Phase,3 Wire Or 4 Wire	A042-7
189		<b>Voltage-480 Vac</b>	R026-7
190		<b>Cabinet-Type 1</b>	B001-7
191		<b>Control-Transfer Switch,Level 1</b>	C023-7
192		<b>Display-Digital</b>	M018-7
193		<b>Module-Relay Signal</b>	M023-7
194		Auxiliary Relay-Switch In Emergency Position-24VDC	L102-7
195		Auxiliary Relay-Switch In Normal Position-24VDC	L103-7
196		Transfer Switch Warranty - Yr 0-2: Parts, Labor and Travel;	G010-7
197		Yr 3-5: Parts Only; Yr 6-10: Main Contacts Only	
198		Common Parts Listing	CP01-7
199		Product Revision - A	SPEC-A
200			
201		<b>CRM On-Site Testing</b>	
202	1	CRM Site Tests:	4-Hour Load Test
203		4-Hour Load Test With CRM Resistive Load Bank	
204			
205		<b>CRM On-Site Training</b>	
206	1	Cummins Factory-Authorized Service Representative To	Personnel Training
207		Train Owner's Maintenance Personnel.	
208			
209		<b>O&amp;M Manuals</b>	
210	5	Hard Copies of Operation & Maintenance Manuals	O&M
211	1	Electronic Copy of Operation & Maintenance Manuals	O&M On CD
212			
213			
214			
215			
216			



**Rocky  
Mountain**

# Tab #2 Generator Manuals



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# Installation Manual



## Generator Set

### Cummins NPower GF Series



This manual contains proprietary information to equipment produced by Cummins NPower LLC and Cummins Inc. and is being supplied solely for the purpose of operating, maintaining, and servicing the natural gas generator set purchased from Cummins NPower LLC.

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## Cummins NPower LLC Generator Sets Limited Warranty

### Commercial Generating Set

This limited warranty applies to all Cummins NPower LLC (hereinafter referred to as "Cummins NPower" branded commercial generating sets and associated accessories (hereinafter referred to as "Product"). This warranty covers any failures of the Product, under normal use and service, which result from a defect in material or factory workmanship.

### Warranty Period:

The warranty start date for stationary Product is the date of initial start up, demonstration or 18 months after factory ship date, whichever is sooner. The warranty start date for rental or oil and gas products is the date of receipt of Product by the end customer. See table for details.

#### Base Warranty Duration (Whichever occurs first)

Rating	Months	Maximum Hours
Emergency Standby Power (ESP)	12	500
Prime Power (PRP)	12	Unlimited

**Emergency Standby Power (ESP)** is defined as the maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a reliable utility power outage. The permissible average power output over 24 hours of operation shall not exceed 70% of the ESP. For applications supporting an unreliable utility service, the Prime Power (PRP) rating should be used.

**Prime Power (PRP)** is defined as being the maximum power which a generating set is capable of delivering continuously while supplying a variable electrical load. The permissible average power output over 24 hours of operation shall not exceed 70% of the PRP.

### Cummins NPower Responsibilities:

In the event of a failure of the Product during the warranty period due to defects in material or workmanship, Cummins NPower will only be responsible for the following costs:

- All parts and labor required to repair the Product.
- Reasonable travel expenses to and from the Product site location.
- Maintenance items that are contaminated or damaged by a warrantable failure.

### Owner Responsibilities:

The owner will be responsible for the following:

- Notifying Cummins NPower distributor or dealer within 30 days of the discovery of failure.
- Installing, operating, commissioning and maintaining the Product in accordance with Cummins NPower's published policies and guidelines.
- Providing evidence for date of commissioning.
- Providing sufficient access to and reasonable ability to remove the Product from the installation in the event of a warrantable failure.

In addition, the owner will be responsible for:

- Incremental costs and expenses associated with Product removal and reinstallation resulting from difficult or non-standard installations.
- Costs associated with rental of generating sets used to replace the Product being repaired.
- Costs associated with labor overtime and premium shipping requested by the owner.
- All downtime expenses, fines, all applicable taxes, and other losses resulting from a warrantable failure.



### **Limitations:**

This limited warranty does not cover Product failures resulting from:

- Inappropriate use relative to designated power rating or application guidelines.
- Normal wear and tear, negligence, accidents or misuse.
- Improper and/or unauthorized installation.
- Lack of maintenance or unauthorized repair.
- Noncompliance with any Cummins NPower published guideline or policy.
- Use of improper or contaminated fuels, coolants or lubricants.
- Improper storage before and after commissioning.
- Owner's delay in making Product available after notification of potential Product problem.
- Replacement parts and accessories not authorized by Cummins NPower.
- Use of Battle Short Mode.
- Owner or operator abuse or neglect such as: operation without adequate coolant or lubricants; over-fueling; over-speeding; lack of maintenance to lubricating, cooling or air intake systems; late servicing and maintenance; improper storage, starting, warm-up, run-in or shutdown practices, or for progressive damage resulting from a defective shutdown or warning device.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the generating set.

This limited warranty does not apply to:

- Costs of maintenance, adjustments, installation, commissioning or start-up.
- Starting batteries, heating elements, trailers and enclosures.
- Components added to the Product after shipment from Cummins NPower.

Please contact your local Cummins NPower Distributor for clarification concerning these limitations.

### **Extended Warranty**

Cummins NPower offers the Cummins ENCOMPASS Extended Coverage program for parts and labor as listed in Cummins Bulletin # 3624424 for a period of 5 years or 2000 hours.

### **Cummins NPower Right to Failed Components:**

Failed components claimed under warranty remain the property of Cummins NPower. Cummins NPower has the right to reclaim any failed component that has been replaced under warranty.

**THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS NPOWER IN REGARD TO THE PRODUCT. CUMMINS NPOWER MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT IS CUMMINS NPOWER LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

This limited warranty shall be enforced to the maximum extent permitted by applicable law. This limited warranty gives the owner specific rights that may vary from state to state or from jurisdiction to jurisdiction.



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# Section 1 - Safety

IMPORTANT SAFETY INSTRUCTIONS - This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries. SAVE THESE INSTRUCTIONS.

Before operating the generator set (genset), read the Operator's Manual and become familiar with it and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

## 1.1 Advisory and Cautionary Statements

Advisory and Cautionary Statements are used throughout this manual to call attention to special information, correct operating procedures, and safety precautions.

**NOTE:** *A general advisory statement relating to equipment operation and maintenance procedures.*

**IMPORTANT:** *A specific advisory statement intended to prevent damage to the equipment or associated components.*

Cautionary Statements consist of three levels:



**This symbol warns of immediate hazards which will result in severe personal injury or death.**



**This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.**



**CAUTION**  
*This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.*



**CAUTION**  
**Fuel And Fumes Are Flammable.**

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while the engine is running unless the tanks are outside the engine compartment. Fuel contact with the hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. The fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Natural gas is lighter than air, and will tend to gather under hoods. Propane is heavier than air, and will tend to gather in sumps or low areas. NFPA code requires all persons handling propane to be trained and qualified.
- Be sure all fuel supplies have a positive shut-off valve.
- Be sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

---

 **WARNING**

***Exhaust Gases Are Deadly. The engine exhaust from this product contains chemicals known to the State of California and some of its constituents cause cancer, birth defects, or other reproductive harm.***

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

 **WARNING**

***Moving Parts Can Cause Severe Personal Injury or Death.***

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, then disconnect the starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps. Keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

 **WARNING**

***Electrical Shock Can Cause Severe Personal Injury or Death.***

- Disconnect electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

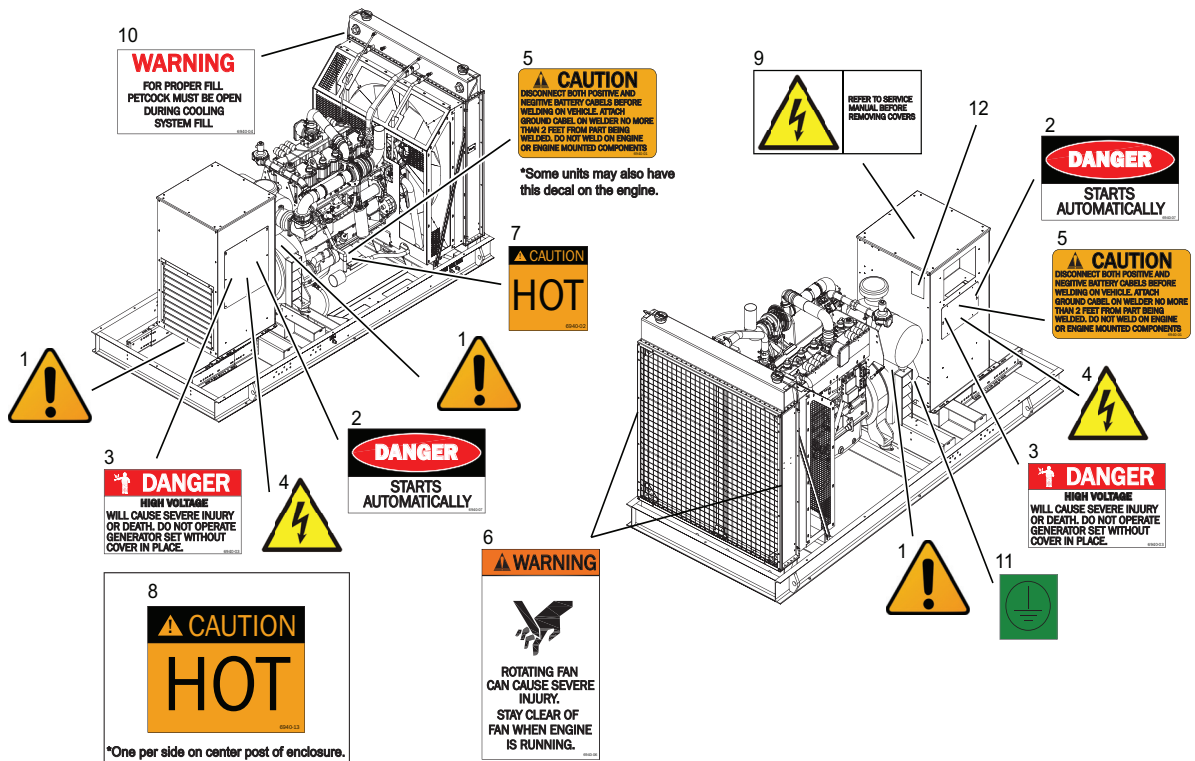
### **General Safety Precautions**

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires involve combustible and flammable liquid fuels and gaseous fuels; Class C fires involve live electrical equipment. (Ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.



- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breathe or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, turbo charger, and exhaust system.

## 1.2 Safety/Data Labels



- |  |  |
|--|--|
| 1. Decal, Caution                            | 8. Decal, Caution Hot, Lg (P/N 6940-13)<br>(Enclosed Units Only) |
| 2. Decal, Danger Auto Start (P/N 6940-07)    | 9. Decal, Caution Cover  |
| 3. Decal, Danger High Voltage (P/N 6940-03)  | 10. Decal, Warning Petcock (P/N 6940-04)<br>(KTA19 Only)         |
| 4. Decal, Caution Shock Hazard               | 11. Decal, Ground  |
| 5. Decal, Caution Welding (P/N 6940-01)      | 12. Data Tag, Genset (P/N 24588)                                 |
| 6. Decal, Warning Rotating Fan (P/N 6940-06) |  |
| 7. Decal, Caution Hot, Sm (P/N 6940-02)      |  |

Figure 1-1 Generator Decal Locations (typical)

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**KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE**



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## Section 2 - Introduction

### 2.1 About This Manual

This manual provides installation instructions for the generator set models listed on the front cover. This includes the following information:

**Mounting Recommendations** - for fastening the generator set to the base and space requirements for normal operation and service.

**Mechanical and Electrical Connections** - covers most aspects of the generator set installation. Pre-start - checklist of items or procedures needed to prepare generator set for operation.

**Initial Startup** - tests the complete system to ensure proper installation, satisfactory performance, and safe operation. Refer to Operator Manual for troubleshooting information.

**Installation Checklist** - reference checks upon completion of installation.

This manual DOES NOT provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), additional information is required. Review standard installation practices. For engineering data specific to the generator set, refer to the Specification and Data Sheets. For application information, refer to Cummins Application Manual T-030, Liquid Cooled Generator Sets.

### 2.2 Installation Overview

These installation recommendations apply to typical installations with standard model generator sets. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your nearest Cummins distributor for assistance.

### 2.3 Application and Installation

A power generation system must be carefully planned and correctly installed for proper operation. This involves two essential elements: application and installation.

**Application** (as it applies to generator set installations) refers to the design of the complete power generation system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, and cooling, exhaust, and fuel systems. Each component must be correctly designed so the complete system will function as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers or other trained specialists are responsible for the design of the complete standby system and for selecting the materials and products required.

**Installation** refers to the actual set-up and assembly of the power generation system. The installers set up and connect the various components of the system as specified in the system design plan. The complexity of the system normally requires the special skills of qualified electricians, plumbers, sheet metal workers, etc. to complete the various segments of the installation. This is necessary so all components are assembled using standard methods and practices.

### 2.4 Safety Considerations

The generator set has been carefully designed to provide safe and efficient service when properly installed, maintained, and operated. However, the overall safety and reliability of the complete system is dependent on many factors outside the control of the generator set manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the generator set exactly as specified in this manual. All systems external to the generator (fuel, exhaust, electrical, etc.) must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

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## 2.5 Standby Heating Devices

In accordance with NFPA 110, Cummins NPower recommends installing generator sets (life safety systems) equipped with engine jacket water coolant heaters in locations where the minimum ambient temperature is below 4°C (40°F). NFPA also requires that the engine jacket water coolant be maintained at a minimum of 32°C (90°F) and, for most applications, accept the emergency load in 10 seconds or less.

The Engine Cold (Code 1435) message, in conjunction with illumination of the warning light is provided to meet the requirements of NFPA 110. The engine cold sensing logic initiates a warning when the engine jacket water coolant temperature falls below 21°C (70°F). In applications where the ambient temperature falls below 4°C (40°F), a cold engine may be indicated even though the coolant heaters are connected. Under these conditions, although the generator set may start, it may not be able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions may be necessary to warm the engine before applying a load.

## 2.6 Product Modifications

Agency certified products purchased from Cummins NPower comply only with those specific requirements and as noted on company product specification sheets. Subsequent modifications must meet commonly accepted engineering practices and/or local, state and national codes and standards. Product modifications must be submitted to the local authority having jurisdiction for approval.

The information, specifications, and recommended guidelines in this manual are based on information in effect at the time of printing. Cummins Npower, LLC. and Cummins, Inc. reserves the right to make changes at any time without obligation. If you find differences between your engine and the information in this manual, contact your local Cummins Authorized Repair Location or call 1-800-DIESEL (1-800-343-7357) toll free in the U.S. and Canada.

## 2.7 Product Inquiries (Model 150 GFPA)

For Model 150 GFPA engine related inquiries, contact a PSI representative at the service department technical support line at 1-888-331-5764 or e-mail [service@powergreatlakes.com](mailto:service@powergreatlakes.com). For questions relating to the generator controls on this model, please contact Npower Service at 1-866-831-7620 or [www.cumminsnpower.com](http://www.cumminsnpower.com) for more information.



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## Section 3 - Installation

### 3.1 Mounting the Generator Set

Generator set installations must be engineered so the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. The complete installation must comply with all local and state building codes, fire ordinances, and other applicable regulations. Consider these requirements before installation:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of generator set air
- Non-combustible mounting surface
- Discharge of exhaust gases
- Electrical connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation

#### 3.1.1 Location

Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power service entrance. Exhaust must not be able to enter or accumulate around inhabited areas.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions. An optional housing is available for outside operation.



#### **WARNING**

***Incorrect installation, service, or parts replacement, can result in severe personal injury, death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and mechanical component installation.***

**IMPORTANT:** *Depending on location and intended use, federal, state, or local laws and regulation may require the customer to obtain an air quality emissions permit before beginning installation of the genset. Be sure to consult local pollution control or air quality authorities before completing construction plans.*

#### 3.1.2 Mounting

Generator sets are mounted on a steel skid that provides proper support. The engine-generator assembly is isolated from the skid frame by rubber mounts that provide adequate vibration isolation for normal installations. Where required by building codes or special isolation needs, generator sets may be mounted on rubber pads or mechanical spring isolators. The use of unapproved isolators may result in harmful resonances and may void the genset warranty.

Mount the generator set on a substantial and level base such as a concrete pad. A non-combustible material must be used for the pad.

Use 16 mm or (5/8) inch anchored mounting bolts to secure the generator set skid to the floor to prevent movement.

#### 3.1.3 Access To Set

Generally, at least 1 meter (3 ft) of clearance should be provided on all sides of the generator set for maintenance and service access. (Increase clearance by width of door if optional housing is used.) A raised foundation or slab of 150 mm (6 in) or more above floor level will make servicing easier.

Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the transfer switch so that it is available at all times.

### 3.1.4 Mechanical Connections

The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation and cooling systems. Before starting any type of fuel installation, all pertinent state and local codes must be complied with and the installation must be inspected before the unit is put in service.

**IMPORTANT:** *All pipe threaded fuel system fittings, including container fittings, must be assembled using a pipe joint sealing compound designed for use with natural gas or propane as applicable per industry standards.*

### 3.1.5 Base Drains (Optional)

Some units are equipped with drain extensions that allow for oil or coolant (or both) drains to be brought out to the base edge for convenient maintenance. These drains have an in-line ball valve or Fumoto valve installed for control. Factory drains require no further installation at site.

## 3.2 Fuel System

These gensets can be equipped to operate on:

- Natural gas
- Combination of natural gas and propane (Dual Fuel for select models)

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt or contaminants of any kind. Clean all fuel system components before installing.

### 3.2.1 Fuel Lines - Routing

A flexible fuel hose(s) or section of flexible fuel hose(s) must be used between the engine's fuel system and fuel supply line to protect the fuel system from damage caused by vibration, expansion and contraction. Genset fuel supply line must be dedicated supply line from utility.



### CAUTION

**Fuel leaks create fire and explosion hazards which can result in severe personal injury or death. Always use flexible tubing between engine and fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.**

Installation of the fuel hose must be done according to all applicable codes and standards, and installation recommendations provided by the manufacturer. The flexible hose used must be approved by the hose manufacturer for use with the genset fuel type and product application.

Support fuel lines to restrain movement and prevent chaffing or contact with sharp edges, electrical wiring and hot exhaust parts.



### CAUTION

**Sparks and hot surfaces can ignite fuel, leading to severe personal injury or death. Do not route fuel lines near electrical wiring or hot exhaust parts.**

Fuel lines must be routed and secured per local, state and national codes.

Install a dry-type fuel filter ahead of the service pressure regulator to protect the sensitive pressure regulating components and orifices downstream from rust, scale and other solid substances carried along in the gas stream.

### 3.2.2 Natural Gas/Propane Vapor/Propane Liquid Fuel System (Dual Fuel System)



### WARNING

**Gaseous fuels are flammable and explosive and can cause severe personal injury or death. Do not smoke if you smell gas or are near fuel tanks or fuel-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away from genset and areas sharing ventilation. Keep a type ABC fire extinguisher handy.**



### WARNING

**NFPA No. 58 requires all persons handling and operating propane to be trained in proper handling and operating procedures.**

Gaseous-fuel supply system design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance must comply with the applicable codes. See NFPA No. 37, No. 54, and No. 58.

Most codes require both manual and electric (battery-powered) shutoff valves ahead of the flexible fuel hose(s). The manual valve should be of the indicating



type. The electric valve should be wired so that the valve is closed when the genset is off.

The recommendations in Cummins Application Manual T-030 should be followed in regard to fuel supply system pipe sizes, manual shut-off valves, fuel filters, and gas pressure regulators.

### 3.2.3 Fuel Supply Pressure

#### **! WARNING**

**High gas supply pressure can cause gas leaks which can lead to fire and severe personal injury or death. Gas supply pressure must be adjusted to Specifications by qualified personnel.**

For propane (vapor withdrawal) and natural gas, the maximum permissible fuel supply pressure is 5.0 kPa (20 in WC) and the recommended minimum is 3.7 kPa (15 in WC).

For propane (liquid withdrawal), the maximum permissible fuel supply pressure is 2,153 kPa (312 psi) under any operating condition.

#### **! WARNING**

**Gaseous fuel leaks into an inadequately ventilated space can lead to explosive accumulations of gas. Natural gas rises when released into the air and can accumulate under overhanging hoods and inside housings and buildings. Propane sinks when released into the air and can accumulate inside housings, basements and other below-grade spaces. Precautions must be taken to prevent gas leaks and the accumulation of gaseous fuel in the event of a leak.**

### 3.2.4 Check Gas Leaks and Correct

All fuel-system connections, including the container with associated valves and fittings, must be tested for leaks with a soap and water solution or equivalent, while the system is under pressure.

### 3.2.5 Fuel Heater (Optional-MOH models only)

PECO fuel heaters are available on some MOH models. They are designed to provide heating of engine fuel for optimal performance of the Genset. The PECO Fuel Heater is designed to provide uninterrupted fuel flow in cold temperature environments when it is needed most. Factory Fuel Heater requires power source to be wired. See owner's manual for instructions.

### 3.2.6 Regulator (Optional)

Prime regulators are available on some models for fuel pressure reduction from source. Regulators vary by manufacturer and model. Check with your distributor or service technician for details on use and settings of your Regulator. Factory Regulator requires no further installation at site, connect fuel supply.

### 3.2.7 Fuel Filters (Optional-MOH models only)

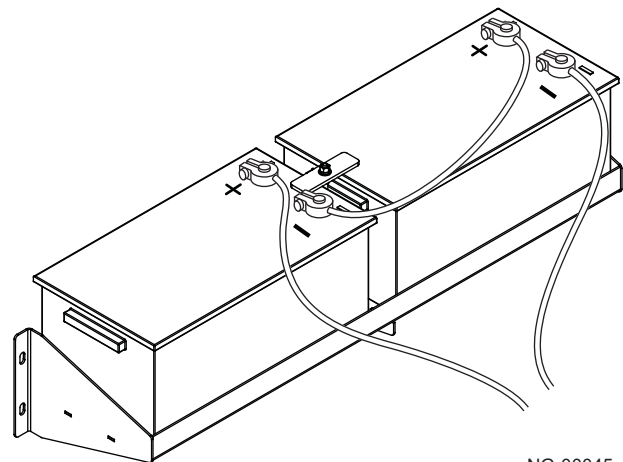
Our in-line fuel filters are designed for optimal performance of the generator set. They provide the best choice for Customers who want to extend service intervals and increase Genset uptime. Optional pressure indicators and automatic drains are available on some models. Check the installation and service manuals for your specific filter (models vary by unit) for details. Factory Fuel Filter require no further installation at site, connect fuel supply.

## 3.3 Battery Selection

The minimum recommended reserve capacity (SAE RC) and cold cranking ampere (SAE CCA) values for a particular engine can be found on the Model specific Genset specification sheet is provided with the genset (visit [www.cumminsnpower.com](http://www.cumminsnpower.com) for genset specifications). RC and CCA definitions can be found in SAE Standard J537. All battery information is for lead/acid batteries.

### 3.3.1 Battery Requirements

For battery replacement information, refer to [Figure 3-1](#). Batteries may be supplied by Cummins Distribution as an option, or may be supplied by the customer.



NG-00045

**Figure 3-1 Series Battery Connection - 24 VDC**

---

## WARNING

**Battery electrolyte (sulfuric acid) is highly caustic and can burn clothing and skin. Wear acid impervious neoprene gloves and safety goggles, or full face shield, when working with the batteries. Always disconnect the negative (-) battery cable first and attach the negative (-) battery cable last.**

## CAUTION

**DO NOT connect battery charging cables to any electronic control system component. This can damage the electronic control system.**

### 3.3.2 Battery Installation

1. Provide adequate room for servicing or replacing the batteries. Provide protection from extremes of temperature and weather.
2. Locate the batteries near the engine or increase the size of the conductors as required by applicable codes. Ensure that the batteries are configured properly for 24 VDC standard operations. Refer to [Figure 3-1](#).
3. Check the battery cables and connections to ensure they are installed correctly and in good condition.

**NOTE:** Coat the terminals with NOCO/Anti-OX to prevent corrosion. Install the cables and tighten the battery connections.

## WARNING

**Batteries can emit explosive gases during charging. Always ventilate the compartment before servicing the batteries. Remove sources of spark or open flame. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.**

## 3.4 Exhaust System

### WARNING

**Inhalation of exhaust gases can result in severe personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.**

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlets away from any air inlets to avoid gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation and light loads. Regularly inspect the exhaust system both visually and audibly to see that the entire system remains fume tight and safe for operation.

### WARNING

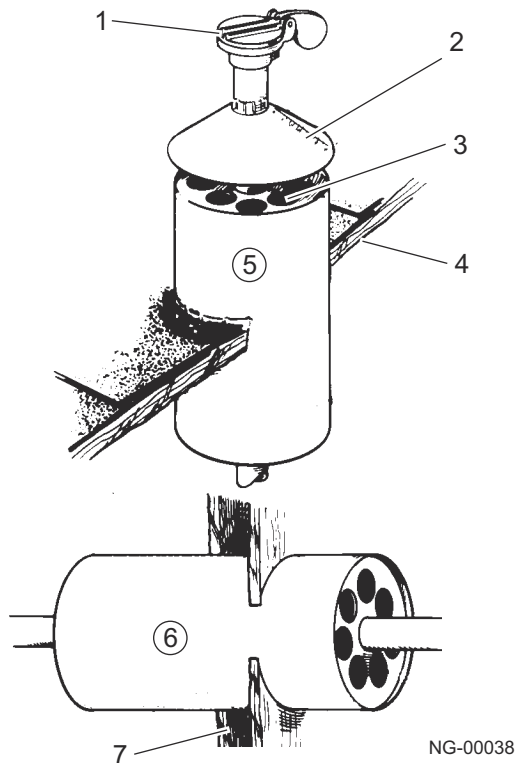
**Inhalation of exhaust gasses can result in severe personal injury or death. Use extreme care during installation to provide a tight exhaust system. Terminate exhaust pipe away from enclosed or sheltered areas, windows, doors and vents.**

For indoor installation, the exhaust system shall use sealed joint type fittings, (for example NPT fittings) to provide a tighter exhaust system. Use of slip type fittings (secured with a muffler clamp) may allow leakage of exhaust gases into the building.

The exhaust system design should meet Federal, State and local code requirements.

Use an approved thimble ([Figure 3-2](#)) where exhaust pipes pass through walls or partitions. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This includes structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a non-combustible wall or roof, such as concrete. Refer to NFPA 37 Stationary Combustion Engines and Gas Turbines” for accepted design practices. Build according to the code requirements in effect at the installation site.





1. Rain Cap
2. Drip Cap
3. Holes in End of Inner Sleeve
4. Roof
5. Thimble in Vertical Orientation
6. Thimble in Horizontal Orientation
7. Wall of Partition

**Figure 3-2 Mounting Exhaust Thimble**

### **! WARNING**

**Hot exhaust pipes can start a fire and cause severe injury or death if improperly routed through walls. Use an approved thimble where exhaust pipes pass through walls or partitions.**

Rain caps are available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

Use a section of flexible exhaust pipe between the engine and remainder of exhaust system. Support exhaust system to prevent weight from being applied to engine exhaust outlet.

### **! CAUTION**

**Weight applied to the engine exhaust components can result in damage. Support the muffler and exhaust piping so no weight or stress is applied to engine exhaust.**

**IMPORTANT:** Liability for injury, death, damage, and warranty expense due to use of unapproved mufflers or modifications to the exhaust system becomes the responsibility of the person installing the unapproved muffler or performing the modification. Contact a Cummins NPower distributor for approved exhaust system parts.

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for muffler and tailpipe. Pitch a horizontal run of exhaust pipe **DOWNWARD** (away from engine) to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins. Refer to [Figure 3-3](#).

Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 305 mm (12 in) of clearance if the pipes pass close to a combustible wall or partition. Before installing insulation on exhaust system components, check the exhaust system for leaks while operating the genset under full load and correct all leaks.

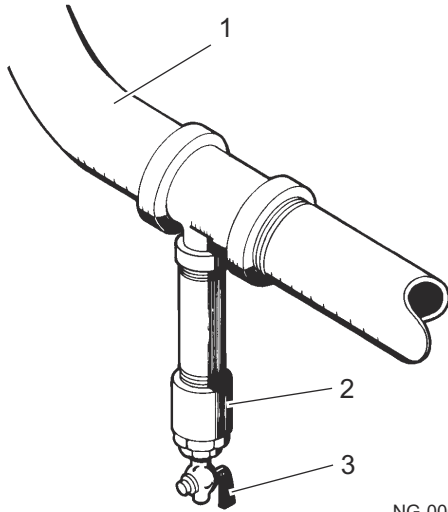
### **! WARNING**

**Exhaust pipes are very hot and they can cause severe personal injury or death from direct contact or from fire hazard. Shield or insulate exhaust pipes if there is danger of personal contact or when routed through walls or near other combustible materials.**

### **3.5 Installation of Sensors**

On select model specific engines the natural gas, O<sub>2</sub> and temp sensors to be mounted in exhaust ports located pre and post catalyst. See [Figure 3-4](#) and [Figure 3-5](#). Customer is responsible for installation of sensors. Reference AEB 10.124

**NOTE:** 4.00' clearance for insulation and other items around sensors is required.



1. Exhaust Line
2. Condensation Trap
3. Valve Handle (shown in open position)

**Figure 3-3 Condensation Trap**

### 3.6 Air Fuel Ratio (AFR) Controller

Select model specific natural gas engines are equipped with an air fuel ratio controller, and are designed to meet emission requirements for EPA, SI, and NSPS codes. The engines are also capable of meeting NSPS emissions standards with an AFR controller and factory supplied catalyst.

The AFR control system uses a  $O_2$  sensor architecture with catalyst, if applicable, to control exhaust emissions. The AFR control system controls fuel flow based on exhaust  $O_2$ . The controller opens or closes the fuel control valve (FCV) in the fuel line based on feedback from the  $O_2$  sensor(s).

### 3.7 Catalyst-Removable Elements (Only available on some models)

Some Gensets require a 3-way or Oxidation catalyst to meet emission requirements. There is a precious metals element inside the housing of the catalyst that converts exhaust to EPA requirements. Some catalysts have a removable body that can be replaced with a new element when required. Most catalysts come installed on Genset from factory. Some catalysts require customer mounting. Check with your distributor or service technician for details on your product.

### 3.8 Engine 3-Way Catalyst (Model Specific)

The natural gas 3-way catalyst reduces the oxides of nitrogen ( $NO$ ,  $NO_2$ ), and hydrocarbons (HC) from the natural gas exhaust. Read this manual before installing, operating or servicing the engine equipped with a natural gas catalytic converter.

The natural gas 3-way catalyst, when installed properly, meets state and local emission reduction requirements on  $NO$ ,  $NO_2$ ,  $CO$ , and  $HC$  as OEM technology on stoichiometric natural gas engine. Removal of these devices without prior approval from the state and regulatory agencies can be constituted as tampering.



#### **CAUTION**

***Handle the natural gas 3-way catalyst with care. Do not hammer or drop the unit. Do not weld or drill holes in the body of the natural gas 3-way catalyst without prior approval of Cummins® or its distributors.***

#### 3.8.1 Installation and Applications Guidelines

The following are recommendations for installation and application of natural gas 3-way catalyst for select models of natural gas engines. It is recommended that systems incorporating natural gas 3-way catalyst be designed by, or in conjunction with Cummins Engineering. In order to receive Cummins approval of the 3-way catalyst installation, the installation shall meet the following requirements. (Exceptions to these requirements shall be approved by Cummins Engineering.)

1. The 3-way catalyst and housing shall be the correct part number for the application.
2. The 3-way catalyst shall be mounted with a mounting system strong enough to support both the additional weight and dynamic loads.
3. It is recommended to use exhaust piping material compatible with the 3-way catalyst housing material, either cold-rolled steel or appropriate grade of stainless steel.
4. The exhaust piping shall be supported separately from the 3-way catalyst.
5. The 3-way catalyst is designed to be supported by the piping to which it is attached. See [Figure 3-4](#) and [Figure 3-5](#).

- 
6. Do not impose external force(s) on the catalyst housing greater than 22.7 kg (50 lb) in any direction.
  7. It is required to put a flexible tubing (i.e. bellows or flex pipe) between the engine and the beginning of the exhaust piping. This will isolate the 3-way catalyst and other downstream components from engine vibration.
  8. For vertical flow mounting, ensure that the stack above the catalyst is independently supported. See [Figure 3-5](#).
  9. Avoid cantilevering loads off the end of the 3-way catalyst.
  10. The engine oil shall meet CES 20074 or better specifications as required by the engine manufacturer.
  11. The catalyst must be installed to guarantee air exhaust temperature into the catalyst of 482°-649° C (900°-1200° F). Any temperature outside this range may affect catalyst performance or life.
  12. The catalyst can be installed either upstream or downstream of the silencer to obtain sufficient exhaust inlet temperatures.

### **3.8.2 Owner's Responsibilities**

1. The owner is responsible for keeping the natural gas 3-way catalyst system on the equipment because the removal of the system may cause a violation of the local emission regulations.
2. The owner is responsible for periodic inspection of the system in accordance with these and other operational instructions.
3. The owner is responsible for maintaining the operation of the engine in a way that would NOT adversely affect the natural gas 3-way catalyst system. Any misfire, stack detonations, oil or debris in the exhaust system, shall be recorded in the equipment's service record.
4. The owner is responsible for maintaining complete oil consumption and service records, as well as software files, where applicable, and to make them available to a requesting Cummins® authorized repair location for troubleshooting purposes.

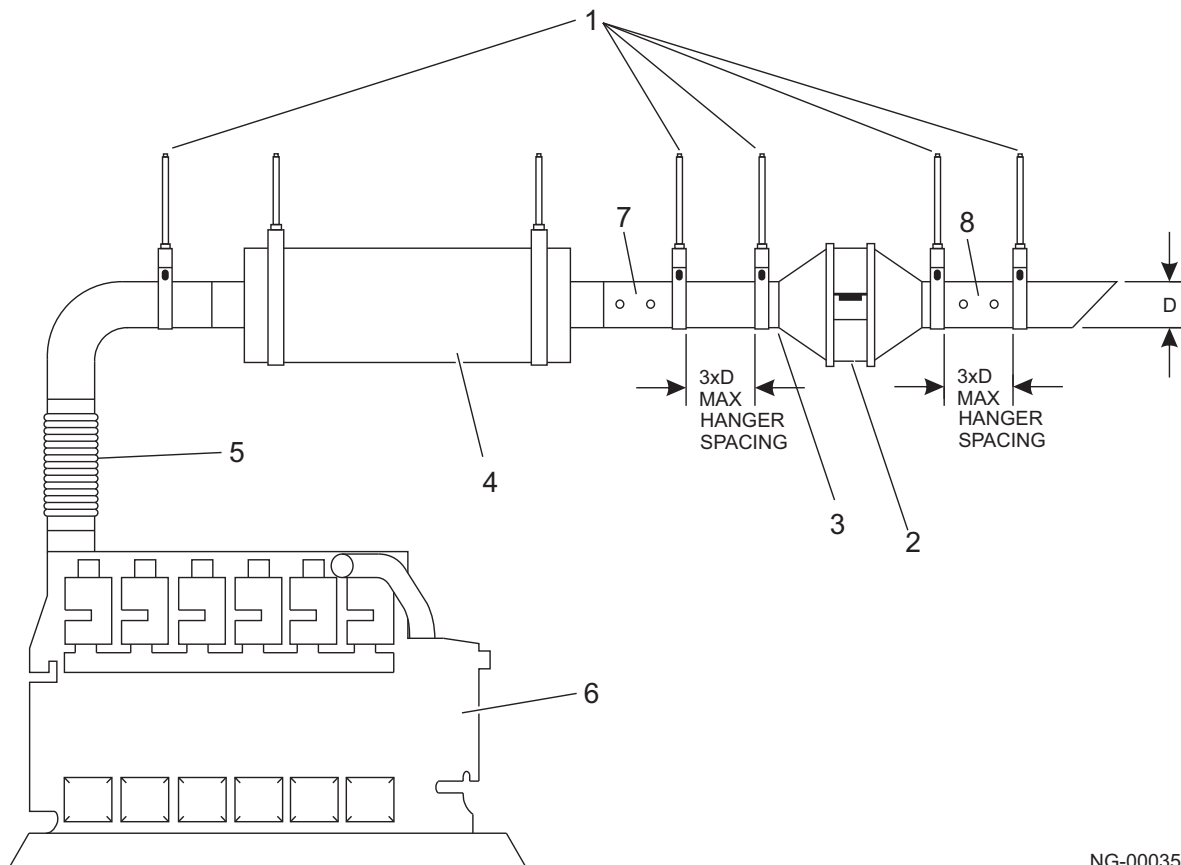
### 3.8.3 Preparation



## WARNING

**Do not touch the surface of the existing silencer during or up to 30 minutes after operation. All surfaces are hot and can cause personal injury.**

1. Ensure the engine ignition system and air-fuel ratio controller system is functioning properly per the manufacturer's specifications prior to starting installation of the 3-way catalyst.
2. Depress E-Stop.
3. Disconnect the equipment batteries.
4. Turn off the fuel supply.
5. Ensure the engine and auxiliary equipment are safely locked out and can not be engaged.



NG-00035

1. Hangers
2. 3-Way Catalyst (Model specific)
3. Air Exhaust Temperature 482°-649° C (900°-1200° F)
4. Silencer
5. Expansion Joint
6. Engine
7. Pre O2 and Temp Sensor Port (180° offset)
8. Post O2 and Temp Sensor Port

**Figure 3-4 Recommended Horizontal Mounting Configuration (Typical)**

### 3.8.4 3-Way Catalyst Installation



#### WARNING

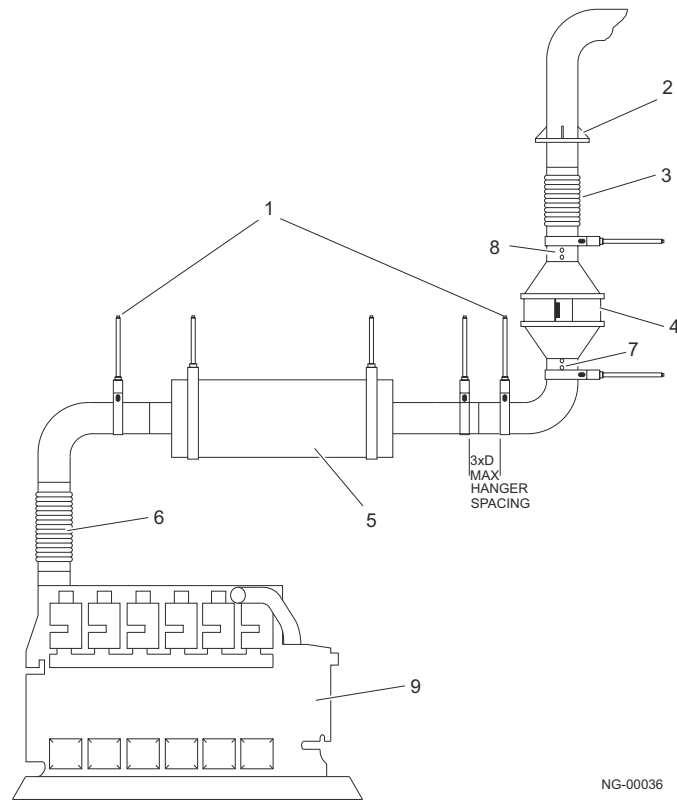
To reduce the possibility of personal injury, use a hoist or get assistance to lift the assembly.



#### CAUTION

The existing exhaust pipe silencer hangers can not hold the weight of a natural gas catalyst. Install appropriate customer supplied natural gas 3-way catalyst mounting brackets.

1. Bolt the natural gas 3-way catalyst mounting bracket (supplied by the customer according to the application), to a solid structure.
2. Install the customer supplied mounting clamps to the natural gas 3-way catalyst housing. Tighten the mounting clamps enough to hold them in place (per Figure 3-4 and Figure 3-5) and to allow movement to connect the inlet and outlet exhaust pipes.
3. Connect the inlet and outlet exhaust pipes to the catalyst inlet and outlet.
4. Connect the customer supplied mounting clamps to the catalyst mounting bracket.
5. Tighten the natural gas catalyst mounting clamps.



- |                               |  |
|-------------------------------|--|
| 1. Hangers                    | 6. Expansion Joint                           |
| 2. Fixed Support              | 7. Pre O2 and Temp Sensor Port (180° offset) |
| 3. Expansion Joint (optional) | 8. Post O2 and Temp Sensor Port              |
| 4. 3-Way Catalyst             | 9. Engine                                    |
| 5. Silencer                   |  |

Figure 3-5 Recommended Vertical Mounting Configuration (Typical)

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### 3.9 Air Fuel Setting and Emission Measurement

This procedure shall be performed at the time of installation of the natural gas 3-way catalyst, after any re-assembly, and periodically per schedule provided by manufacturer throughout the life of the 3-way catalyst.

Follow the air fuel ratio controller's instructions and engine manufacturer's instructions to set the air fuel ratio. Analyze the engine exhaust gases with a Nox, CO, or HC analyzer down stream of the 3-way catalyst.

If the emissions do not meet specifications, replace the catalyst module(s) as needed.

### 3.10 Ventilation and Cooling

Generator sets dissipate heat and fumes that must be removed by proper cooling and ventilation.

Generator sets in factory-mounted housings for outdoor installation are designed for proper cooling and ventilation.

Indoor installations require careful design with respect to cooling and ventilation. In an indoor installation, all radiator cooling air must be discharged outdoors. Duct adapter kits are available. See [Figure 3-6](#) for a typical indoor installation.

### WARNING

**Engine or radiator cooling air may carry deadly carbon monoxide gas which can cause asphyxiation and death. All engine or radiator cooling air must be discharged outdoors. Do not use it for heating a room or compartment.**

### 3.11 Vents and Ducts

For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement.

Size the vents and ducts so they are large enough to allow the required flow rate of air. The "free area" of ducts must be as large as the exposed area of the radiator. Refer to the genset data sheet for the airflow requirements and allowed airflow restriction.

### 3.12 Oil Reservoir (Optional)

5 or 10 gallon Oil Tanks are optional on some units to allow for extended service intervals between maintenance. These tanks are typically plumbed to an Oil Maintainer Switch that controls the flow into the engine oil pan. It is imperative the switch is functioning properly without obstruction and if the switch is vented, the vent is not obstructed as well. The tank should be filled with oil per Engine Manufacturer guidelines.

### 3.13 Dampers

Dampers or louvres protect the generator set and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the generator set.

In cooler climates movable or discharge dampers are used. These dampers allow the air to be recirculated back to the equipment room. This enables the equipment room to be heated while the generator set engine is still cold, increasing the engine efficiency.

### 3.14 Radiator Set Cooling Requirements

Radiator set cooling air is drawn past the control end of the set by a pusher fan that blows air through the radiator ([Figure 3-6](#)). Locate the air inlet to the rear of the set. Make the inlet vent opening 1-1/2 times larger than the radiator area.

**NOTE:** *Louvers and screens over air inlet and outlet openings restrict air flow and vary widely in performance. A louver assembly with narrow vanes, for example, tends to be more restrictive than one with wide vanes. The effective open area specified by the louver or screen manufacturer should be used.*

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

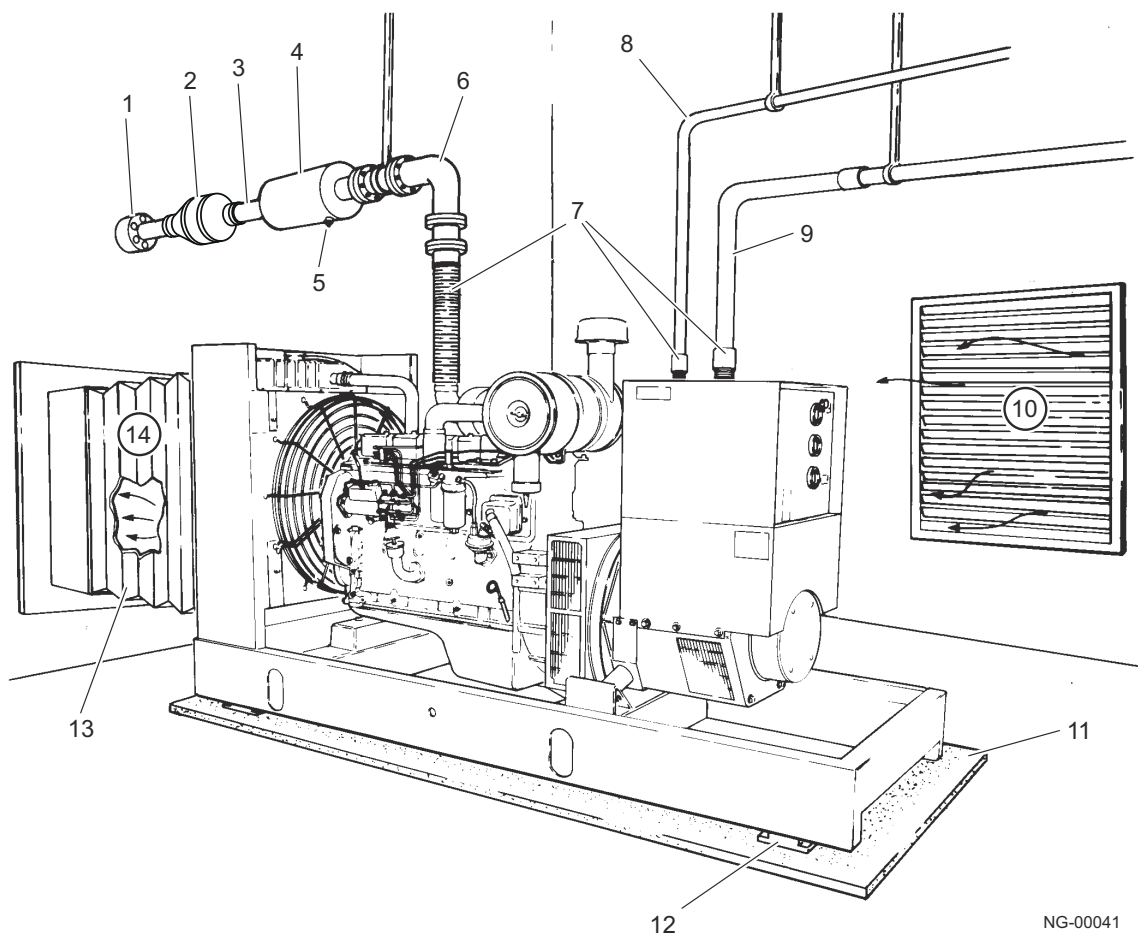
Attach a canvas or sheet metal duct to the air outlet opening using screws and nuts so duct can be removed for maintenance purposes. The duct prevents recirculation of heated air. Before installing the duct, remove the radiator core guard.

### 3.15 Remote Radiator Cooling Requirements (Available on All Models)

The remote radiator cooling system substitutes a remote mounted radiator and an electrically driven fan in place of mounted components. Removal of the radiator and the fan from the set reduces noise levels without forcing dependence on a continuous cooling water supply (necessary with heat exchanger cooling). The remote radiator installation must be completely protected against freezing.

Remote radiator plumbing will vary with installation. Follow recommendations given in Cummins Application Manual T-030. See product Data Sheet provided with the genset (visit [www.cumminsnpower.com](http://www.cumminsnpower.com) for genset specifications) for friction head and static head limits.

**IMPORTANT:** Before filling cooling system, check all hardware for security. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger or remote mounted radiator options.



- |                            |                                  |
|----------------------------|----------------------------------|
| 1. Thimble                 | 8. Control Wiring                |
| 2. 3-Way Catalyst          | 9. Power Wiring                  |
| 3. Exhaust Line            | 10. Air Inlet                    |
| 4. Silencer                | 11. Level Concrete Base          |
| 5. Condensation Drain Plug | 12. Seismic Isolators (Optional) |
| 6. Sweeping Elbow          | 13. Flexible Bellows             |
| 7. Flexible Sections       | 14. Air Outlet                   |

**Figure 3-6 Generator Set Installation (Typical)**







## Section 4 - Controls

### 4.1 Control System Overview

The PowerCommand Control (PCC) which is a micro-processor-based control can be provided in a mechanical and electronic version. All generator set control functions are contained on one circuit board (Base board). The Base board provides engine speed governing (optional), main alternator voltage output regulation, and complete generator set monitoring. The operating software provides control of the

generator set and its performance characteristics and displays performance information on a digital display panel. It accepts menu-driven control and set-up input from the push button switches on the front panel.

For specific information on the control panel for your unit, please refer to the following documentation provided separately from this manual.

Description	Application	Part Number
PCC 1.1 (1302) Owner's Manual	Standby/Prime	900-0661
PCC 2.2 (2300) Operator Manual	Standby/Prime	900-0665
PCC 3.3 (3300) Owner's Manual	Standby/Prime/Paralleling	A029M414

Table 4-1

### 4.2 Control Wiring Installation

The generator set control panel box contains connection points for remote control and monitor options.

#### CAUTION

**Stranded copper wire must be used for all customer connections to the control panel. Solid copper wire may break due to genset vibration.**

Use flexible conduit for all wiring connections to the generator set. All conduit used for control wiring is attached to the control housing.

Route the control wiring through the control housing and access holes. Access holes should be used according to where the wires are terminated inside the control box.

A compression type strain-relief connector should be used to prevent dust, insects, etc. from entering the control box.

Use cable ties to keep control wiring away from sharp edges and AC power cables within the control housing.

### 4.3 Remote Monitor/Control Connections (PCC)

Customer monitor/control connections are attached to terminal block TB-1. Optional equipment such as a remote annunciator panel, sensing devices used to monitor genset operation, remote start/stop switches, battery charger, etc. are attached to TB-1. Refer to the customer connections diagram in [Section 7 - Wiring Diagrams](#).

#### CAUTION

**Always run control circuit wiring in a separate metal conduit from AC power cables to avoid inducing currents that could cause problems within the control.**

Table 4-2

Temperature rating of wire that is intended to be used for connection of the unit.	Copper conductors only	Aluminum conductors or copper-clad conductors <sup>a</sup>
		Row 1
60 or 75° C	Use either <sup>b</sup> AWG, 60° C or <sup>c</sup> AWG, 75° C copper wire.	Use 60° C wire, either <sup>b</sup> AWG copper or <sup>b</sup> AWG aluminum; or 75° C wire, either <sup>c</sup> AWG copper or <sup>c</sup> AWG aluminum.
		Row 2
60° C	Use <sup>b</sup> AWG, 60° C copper wire.	Use 60° C wire, either <sup>b</sup> AWG copper or <sup>b</sup> AWG aluminum.
		Row 3
75° C	Use <sup>c</sup> AWG, 75° C copper wire.	Use 75° C wire, either <sup>c</sup> AWG copper or <sup>c</sup> AWG aluminum.
		Row 4
90° C	Use <sup>c</sup> AWG, 90° C copper wire.	Use 90° C wire, either <sup>c</sup> AWG copper or <sup>c</sup> AWG aluminum.
<sup>a</sup> Reference to copper wire is not to be included when wiring terminals are intended for only the conductors specified in the code.		
<sup>b</sup> The wire size for 60° C wire is not required to be included in the marking; however, when it is included, it shall be based on the ampacities given in Table 310-16 of the National Electrical Code, ANS/NFPA 70, for 60° C wire and the derating factor described in 12.1.3.		
<sup>c</sup> The conductor size shall be no smaller than the larger of the following: <ol style="list-style-type: none"> <li>1. The conductor size used for the temperature test; or</li> <li>2. The 75° C wire size based on the ampacities given in Table 310-16 of the National Electrical Code, ANSI/NFPA 70, and the derating factor described in 12.1.3.</li> </ol>		

**Digital Connections:** Connection points, other than relayed outputs, network, switched B+ and B+ are considered digital connections to terminal strip TB-1. The type/gauge wire to use for these connections are:

- Less than 305 m (1000 ft), use 20 gauge stranded copper wire.
- 305 to 610 m (1000 to 2000 ft), use 18 gauge stranded copper wire.

**Relay Connections:** Due to the wide variety of devices that can be attached to the relay outputs of TB1, the electrical contractor must determine the gauge of the stranded copper wire that is used at this installation site. Refer to PCC Customer Connections diagram in [Section 7 - Wiring Diagrams](#).

**Network Connections:** Refer to 900-0366 Power-Command Network Installation and Operation Manual for the type/gauge wire to use for these connections or refer to [Figure 4-1](#).

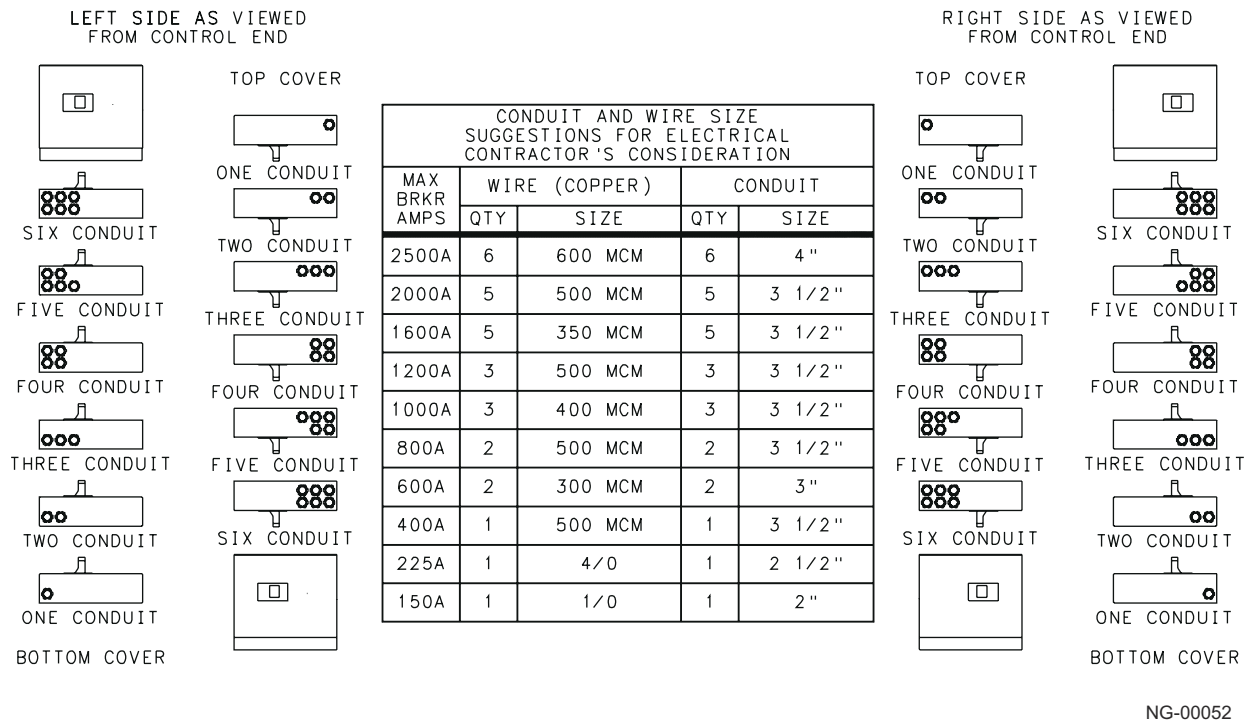


Figure 4-1

**Switched B+:** (Fused at 5 amps.) Same as Relay Connection description.

**B+:** (Fused at 10 amps.) Same as Relay Connection description.

#### 4.4 Control Relays (Optional)

### CAUTION

**Damage to the base board can occur if the voltage suppressors are not installed across relay coils (A1/A2) of control relays K11, K12 and K13 before connecting genset battery cables.**

The three optional control relays are rail mounted inside the control panel housing. Each relay is a 4-pole relay with 2 poles normally open and two poles normally closed.

These relays are used to control auxiliary equipment, such as fans, pumps and motorized air dampers. Energizing of the relays is user definable.

The contacts are rated at 10 amps at 600 VAC.

Refer to Customer Connections diagram in [Section 7 - Wiring Diagrams](#).

#### 4.5 AC Electrical Connections

This section provides the procedure that is used to connect the AC electrical system of the genset.

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Place the control panel run switch in the OFF position. Turn off or remove AC power from the battery charger, depress the E-Stop, and then remove the negative (-) battery cable from the set starting battery.

### WARNING

**Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.**

**Ventilate battery area before working on or near battery—Wear goggles—E-Stop gen set and disconnect charger before disconnecting battery**

**cables—Disconnect negative (-) cable first and reconnect last.**

**⚠ CAUTION**

**Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.**

**⚠ WARNING**

**Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.**

**⚠ WARNING**

**Each of the operations described in this section should be done only by persons trained and experienced in electrical maintenance. Improper procedures may result in property damage, bodily injury or death.**

Connecting the genset AC electrical system involves:

- Installation of transfer switch
- Generator output voltage selection
- Load cable connection
- Standard and optional AC equipment connections (e.g., control box heater, coolant heater, etc.).

Local regulations often require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire sizes, materials used, etc. must conform to the requirements of electrical codes in effect at the installation site. Contractor guidelines for appropriate conduit and wire sizing for this generator set can be found by referring to [Figure 4-1](#).

**⚠ WARNING**

**Improper wiring can cause a fire or electrocution, resulting in severe personal injury or death and/or property and equipment damage.**

Before starting the genset, check to make sure that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation.

Check that the load cables from the genset are properly connected.

Socket Size Across Flats		Tightening Torque	
mm	inch	N-m	lb inches
3.2	1/8	5.1	45
4.0	5/32	11.4	100
4.8	3/16	13.8	120
5.6	7/32	17.0	150
6.4	1/4	22.6	200
7.9	5/16	31.1	275
9.5	3/8	42.4	375
12.7	1/2	56.5	500
14.3	9/16	67.8	600

**Table 4-3**

**⚠ WARNING**

**Backfeed to utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after building main switch is opened.**

**4.6 AC Wiring**

**4.6.1 Generator Voltage Connections**

The available generator output voltages and maximum current ratings are specified on the generator set nameplate. Line-to-neutral voltage is always the lower voltage shown and line-to-line voltage is the higher rating.


These generators can be configured to the nameplate voltages as shown on the Reconnection Diagram located in the generator manual supplied with this equipment. Many of the voltages listed will require reconfiguration of the generator output leads on the connection terminal block. This reconfiguration must only be done by service personnel that are trained and experienced to perform electrical installation. The generator set was adjusted to produce a specified voltage during production verification testing


prior to shipment. The installer must always check the stator lead terminal block connections and perform any necessary reconnect to obtain the voltage required. Refer to applicable Alternator Installation, Service & Maintenance Manual as identified in [Table 4-4](#).

Description	Application	Part Number
Alternator Installation, Service and Maintenance Manual	UCI, UCM, UCD 224 & 274	UCH-027
Alternator Installation, Service and Maintenance Manual	HCI Series	UCI-056

**Table 4-4**

Some generator sets are capable of producing a wide range of voltages and connection configurations, others have specific limited capabilities. Refer to wiring diagram and generator voltages (from the nameplate) when reviewing the voltage connection information and use the wiring diagram supplied with your generator set when actually performing load connections.

 **CAUTION**  
**Reconfiguring generator sets to higher voltages can exceed the voltage capability of the specific generator windings. This will damage the generator, decrease line current, and render line circuit breakers too large. Consult with your distributor before performing reconnection for a different voltage.**

 **CAUTION**  
**Reconfiguring generator sets to lower voltages can reduce generator set ratings, and also increase line current, rendering line circuit breakers too small. Consult with your distributor before performing reconnection for a different voltage.**

#### 4.6.2 Load Connections

Flexible conduit and stranded conductors must be used for connections to take up movement of the generator set.

All loads are connected to the generator by bolting stranded load wires to the appropriate terminals on the generator reconnection terminal block or circuit breaker lugs. The terminals are stamped U, V, W and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2 and L3; and N with L0 respectively).

#### 4.6.3 Load Balancing

When connecting loads to the generator set, balance the loads so the current flow from each line terminal (L1, L2 and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value and no line current exceeds the nameplate rating of the generator. Check the current flow from each line after connections by observing the control panel display.

#### 4.6.4 Current Transformers

The CT's must be installed as noted in the following CT Installation Requirements.

Refer to the reconnection diagram to identify the output leads/phase that must be routed through each CT, and also appropriate transformer post selection for meter sensing leads. The transformers are labeled CT1, CT2 and CT3 on the reconnection wiring diagram. (The reconnection diagram is located on the upper side cover of the control housing.)

##### CT Installation Requirements:

The CT has a dot on one side. This dot must be facing toward the generator (conventional current flowing into the dot). A dot is also used to indicate pin 1 of the CT.

- a. CT1 - U load leads (A phase)
- b. CT2 - V load leads (B phase)
- c. CT3 - W load leads (C phase)
- d. Route the appropriate load wires through each CT. The CT's have dual secondaries (3 posts). The CT secondary wire marked 1 is connected to post 1 of the CT. CT secondary wire marked 2/3 is connected to post 2 for high voltage gensets or to post 3 for low voltage gensets. (Refer to the Reconnection Diagram in [Section 7 - Wiring Diagrams](#).)

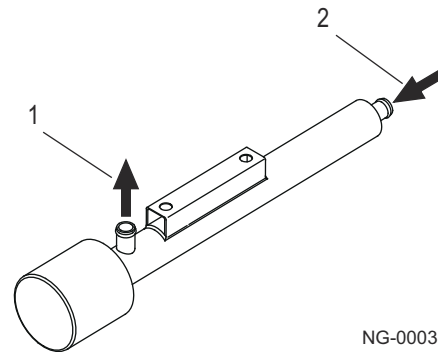
## 4.7 Coolant Heater (Optional)

### CAUTION

*The coolant heater must not be operated while the cooling system is empty or damage to the heater will occur.*

Coolant heaters keep the engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces startup time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

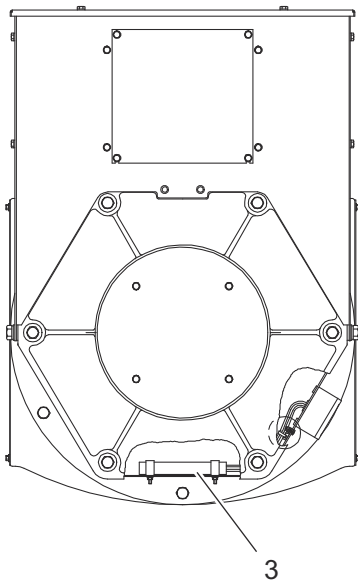
Figure 4-2 shows a typical coolant heater. Connect the heater to a source of power that will be on during the time the engine is not running. Be sure the voltage rating is correct for the heater element rating and that the thermostat is set to the correct temperature prior to starting.



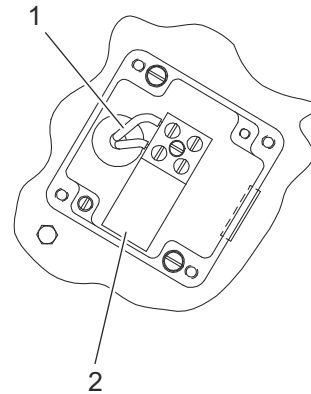
NG-00033

1. Coolant Outlet
2. Coolant Inlet

**Figure 4-2 Coolant Heater**



1. Heater Leads
2. Heater Terminal Box



NG-00042

3. Heater

**Figure 4-3 Generator Heater Installation (Typical)**

### 4.7.1 Battery Heater (Optional)

Battery heaters ensure the batteries are ready for starting the engine in cold standby conditions. They also protect against condensation during standby and prevent corrosive damage of electrical components in high humidity environments. Factory Battery Heater requires power source to be wired. See owner's manual for instructions.

### 4.7.2 Control Heater (Optional)

Control heaters protect the control cabinet components from condensation during standby and prevent corrosive damage of electrical and mechanical components in high humidity environments. Heaters are available for most PowerCommand Controls models. Factory Control heater is wired and requires no further installation at site.

---

#### 4.7.3 Breather Heater (Optional)

This heater is designed to prevent crankcase breather freezing. The heater has a set point of 50° F. If the ambient temperature inside the enclosure drops below 50° F, the heater will automatically switch on. Factory Breather heater is wired and requires no further installation at site.

#### 4.8 Generator Heater (Optional)



#### **WARNING**

***Water or moisture inside a generator increases the possibility of flashing and electrical shock, which can cause equipment damage and severe***

***personal injury or death. Do not use a generator which is not dry inside and out.***

A generator heater(s) is used to help keep the generator free of condensation when the generator set is not running. During cool and humid conditions, condensation may form within a generator, creating flashing and shock hazards.

Figure 4-3 illustrates the installation of two heater elements. Connect the heater(s) to a source of power that will be on during the time the engine is not running. Power connections are made to the terminal block in the heater terminal box. Be sure the voltage rating is correct for the heater element rating.







## Section 5 - Pre-Start Preparation

Before attempting the initial start of the generator set, be sure to complete the Installation Checklist in Section 6.

### 5.1 Electrical System

Verify all electrical connections are secure and all wiring is complete and inspected. Replace and secure any access panels that may have been removed during installation.

### 5.2 Battery Connections

#### **WARNING**

**Accidental starting of the generator set can cause severe personal injury or death. Make sure that the Run/Off/Auto switch on the control panel is set to the Off position before connecting the battery cables.**

Starting the unit requires batteries per the model specific genset data sheet as provided with the genset (visit [www.cumminsnpower.com](http://www.cumminsnpower.com) to locate specifications). E-Stop the genset before the connection or disconnection of battery cables. Connect positive battery cable before connecting negative battery cable to prevent arcing.

Service the batteries as necessary. If an automatic transfer switch is installed without a built-in charge circuit, connect a separate battery charger. A battery charger is required when the PowerCommand Controller is set to the Awake mode.

### 5.3 InPower Service Tool General Information (PCC)

InPower is a PC based service tool for the PowerCommand Controller (PCC) to be used by Cummins authorized factory service technicians. InPower is used to:

- Make adjustments to the controls trims and settings.
- Perform diagnostics and monitoring.
- Create a capture file of the controls trims and settings.
- Update control calibrations (InPower PRO version).

#### **WARNING**

**Ignition of explosive battery gases can cause severe personal injury or death. Always connect negative (-) battery cable last to prevent arcing.**

#### **WARNING**

**Ventilate battery area before working on or near battery. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.**

### 5.4 PCC Options Pre-Start Checks

All generator set configuration options are set at the factory except for site related options, (e.g., Language, Start/Stop Time Delays, Cycle Crank, Customer Fault 1 and 2, etc.

Adjustment of these options are divided into two categories within the menu driven system. These two categories are *Setup* and *Controller Configuration/Adjust*.

The *Setup* submenus are intended for qualified service personnel only and require a password to modify these submenus. The *Controller Configuration* and *Adjust* submenus are intended for service personnel and site personnel.

The *Controller Configuration*, submenus are used to change the default language, temperature units, and pressure units to be displayed in menus.

The *Adjust* submenus allow site personnel to calibrate the generator set voltage/frequency, idle speed and start/stop time delays. For the pre-start checks, adjustment of only the start/stop delays is required. Refer to the model specific Power Controller (PCC) Manual for installation, operator, and service information per [Table 4-1](#).

### 5.5 Start Up Procedure

Refer to the appropriate Operator Manual for important safety precautions and recommended procedures for starting the genset and verifying proper operation. Start the generator set and verify all engine and generator menus are displaying the correct values.

## 5.6 Emissions Requirements

### WARNING

*It is the owner/operator's responsibility to complete site specific emission requirements to ensure compliance with the US EPA SI NSPS.*

Emissions on this Generator Set must be dialed-in at the job-site per the following requirements before operation:

GTA855E refer to manual 4325956 and AEB 10.124 and 24.52

KTA19SLB and QSK19 refer to AEB 28.07

## 5.7 Fuel Pressure and Mixture Adjustments

### WARNING

*Gaseous fuels are flammable and explosive and can cause severe personal injury or death. Do not allow cigarettes, flame, pilot lights, arcing switches or equipment in area or areas sharing ventilation. Keep a type ABC fire extinguisher nearby.*

### WARNING

*Natural gas is lighter than air, and will tend to gather under hoods. LPG is heavier than air, and will tend to gather in sumps or low areas. NFPA Standard No. 58 requires all persons handling and operating LPG to be trained in proper handling and operating procedures.*

### WARNING

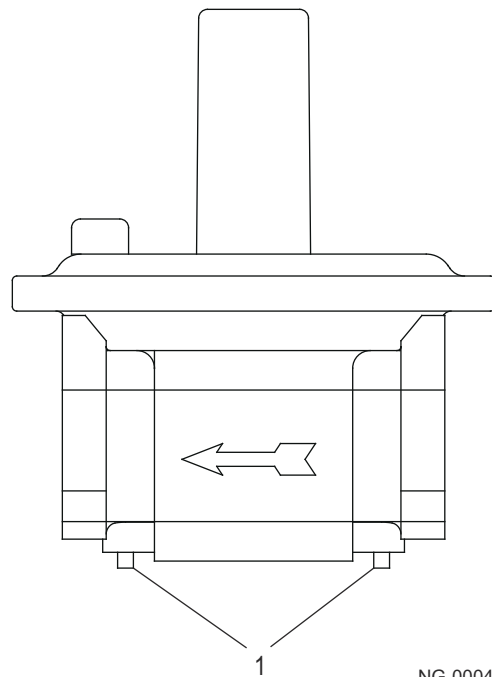
*Do not attempt to correct power by adjusting fuel system before determining that the engine and*

*the ignition system are functioning properly. Especially check air cleaner restriction due to dirt accumulation.*

**IMPORTANT:** Read the warranty statement provided with the genset for US Environmental Protection Agency (EPA) restrictions on servicing specific components.

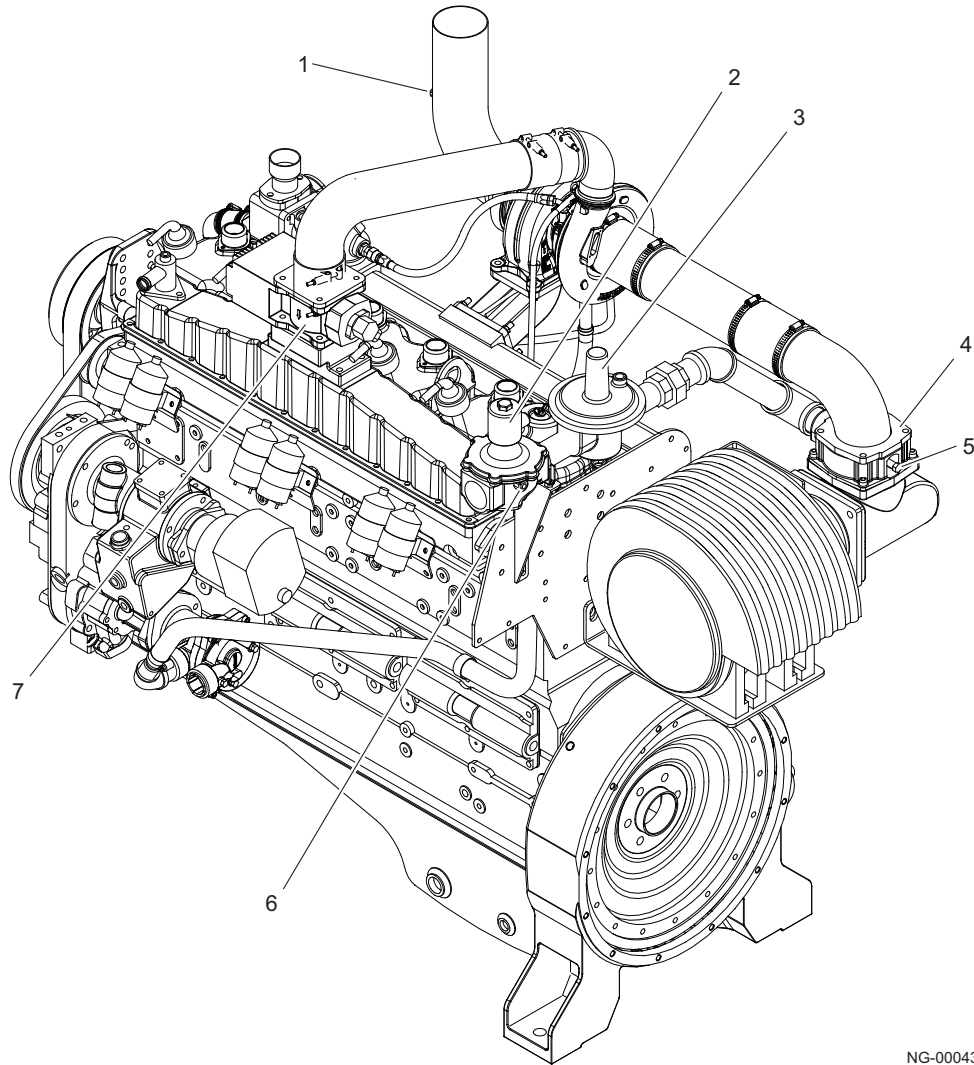
### 5.7.1 Fuel Supply Pressure

The fuel supply pressure must be 3.75-5 kPa (15-20 inches WC) under full-load operation not to exceed 5.0 kPa (20 inches WC) under any condition. See Figure 5-1 for the pressure test ports.



1. Pressure Test Port (2)

**Figure 5-1 Demand Regulator (Natural Gas)**



NG-00043

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Air-Fuel Mixture Test Port</li> <li>2. Solenoid Valve</li> <li>3. Demand Regulator</li> <li>4. Carburetor</li> </ol> | <ol style="list-style-type: none"> <li>5. Fuel Mixture Adjuster</li> <li>6. Natural Gas Supply Pressure Test Port</li> <li>7. Throttle Body/Governor Actuator</li> </ol> |
|--|--|

**Figure 5-2 Natural Gas Fuel System (Typical)**

### 5.7.2 Fuel System Components

Engine is equipped with one shut-off solenoid valve and a demand pressure regulator. Gensets for optional liquid withdrawal of propane are equipped with a converter that vaporizes the fuel with hot engine coolant. See Figure 5-2 for a typical fuel system. A genset equipped for dual fuel, natural gas and propane, has a gas mixer that serves both fuels. A fuel pressure switch to detect loss of natural gas pressure is provided for automatic changeover to propane while the engine is running. Manual shut-off

valves are provided in each supply line for manual changeover systems.

### 5.7.3 Fuel System Operation

During normal operation, the engine fuel/air ratio is determined by the fuel trim valve operating in conjunction with the oxygen sensor and the air/fuel control module. Your authorized Cummins distributor can monitor fuel system/oxygen sensor operation using the service tool.

---

## 5.7.4 Fuel Mixture Adjustments

**IMPORTANT:** Always use Nox and CO test equipment to set emission levels.

1. Check for recommended fuel supply pressure 3.7-5.0 kpa (15-20 inches WC) at engine mounted regulator
2. Check the operation of fuel shut-off solenoids.

### 5.7.4.1 Electronic Engines

For electronic engines:

- Model GTA855E see Cummins AEB 24.51.
- Model KTA19 SLB and QSK19, see Cummins AEB 28.07. Model 150 GFPA, GFMC, and GCDC are self adjusting per engine manufacturer. Visit [www.psiengines.com](http://www.psiengines.com) for additional information and updates.

### 5.7.4.2 Non-Electronic Engines

Some engines are site compliant capable. Generator set certification is per local, regional and national codes and may require frequent site testing. A summary of the testing procedure is listed here. For non-electric engines, apply 100% load.

1. Install the emission tester in the exhaust post catalyst. The emission tester needs to read Nox and CO in grams per break horsepower (g/bhp). Install an O<sub>2</sub> meter per catalyst in port on turbo exhaust elbow.
2. Connect the laptop to RS232 connection at the Gill air-fuel ratio controller module. Start the engine. Click on the Gill icon when connected, click on View, then click on Fuel Valve Control. (The engine has to be running for the laptop to connect to the air-fuel ratio controller.)
3. On the screen, go to the Mode column, and click on Open Loop. The air-fuel valve will go to the closed position.
4. Apply full generator name plate load.
5. All adjustments and emission readings need to be at full load of the generator rating.
6. Run at full load for 5 minutes. Check O<sub>2</sub> at the turbo exhaust elbow. It should be at 0.5. If O<sub>2</sub> is not at 0.5, proceed to step 7. If at 0.5, proceed to

step 10. THIS READING NEEDS TO BE WITH AFR IN OPEN LOOP.

7. Adjust the carburetor air-fuel mixing screw. If O<sub>2</sub> is above 0.5, turn screw out. This will lower the O<sub>2</sub> setting. If O<sub>2</sub> is below 0.5, adjust the carburetor screw in, this will raise the O<sub>2</sub>.
8. Run the engine for 5 minutes and check the O<sub>2</sub> setting. Repeat adjustment until O<sub>2</sub> is at 0.5.
9. Under the Mode column, click on Close Loop, and the fuel valve will open.
10. Run the engine for 5 minutes. Check the exhaust emissions. Emission should be under 4 g/hp for CO and under 2 g/hp for Nox. O<sub>2</sub> reading, post catalyst should be 0.0 to -0.3.
11. O<sub>2</sub> reading at the turbo exhaust elbow should drop to about 0.1.
12. If the emission readings are not correct, the air-fuel ratio controller will need to be adjusted.
13. Under the Control column, record the number in the set point box. (This is in case you need to go back and start from the beginning).
14. Double click on the set point box. It will turn red. Now you can change the set point value.
15. Change the set point value in small increments (sample if the set point is -0.1550, change to -0.1750), click Enter on the laptop. This will save the new set point and the box will change back to white.
16. Wait 5 to 10 minutes after every adjustment before taking the emission readings. Be very patient doing this part of the set up. Making a change to the setting before emissions have stabilized will make it very difficult to get AFR adjusted correctly.
17. As the set point value goes up, the valve will open more.
18. Under output, you will see % Open and Steps. This is the amount the valve is open. The maximum opening is 200 steps.
19. The CO and NOx reading will fluctuate.



## Section 6 - Installation Checklist

### 6.1 General

- Generator set wattage capacity is sufficient to handle maximum anticipated load.
- At least .91 m (3 ft) of clearance (or greater for housing door) is provided around entire generator set for servicing and ventilation.
- Generator set is located in an area not subject to flooding.
- All operating personnel have read and are familiar with Operator Manual.
- All operators have been thoroughly briefed on preventive maintenance procedures.
- All operators have read and understand all Important Safety Instructions in Operator Manual.

### 6.2 Generator Set Support

- Floor, roof or earth on which the generator set rests is strong enough and will not allow shifting or movement. Observe local codes on soil bearing capacity due to freezing and thawing.
- Generator set is properly supported and retained to approved base.
- Supporting base is large enough and is of non-combustible materials.

### 6.3 Cooling Air Flow

- Generator set air inlet is faced into direction of strongest, prevailing winds.
- Air inlet openings are unrestricted and at least 1-1/2 times larger than air outlet area.
- Cooling air outlet is on downwind side of building (if not, wind barrier is constructed).
- Proper ducting material (sheet metal, canvas) is used between radiator and air outlet.

### 6.4 Fuel System

- Fuel tanks meet or exceed all Local, State or National codes.
- Fuel lines are properly installed, supported and protected against damage.
- Approved flexible fuel line is installed between main fuel supply line and generator set's fuel system, near the generator set, to protect the fuel system from damage caused by vibration, expansion and contraction.
- Fuel supply line shutoff valve is installed to prevent fuel flow in case of leaks.
- No fuel leaks are found in supply line or engine fuel system.

---

## 6.5 Exhaust System

- Operators are thoroughly briefed on the dangers of carbon monoxide gas.
- Areas around set are well ventilated. No possibility of exhaust fumes entering building doors, windows, or intake fans.
- Exhaust gases are piped safely outside and away from building.
- The correct length of approved rigid pipe is connected to the generator set flexible pipe using approved securing methods with no weight resting on engine exhaust components. There are no bends in flex section.
- Condensation drain is provided in lowest section of exhaust piping.
- Exhaust piping is insulated to guard against burns to personnel.
- Exhaust piping passing through walls or ceilings have approved fire-proof materials and are in compliance with all codes.
- Exhaust piping is large enough in diameter to prevent excessive back pressure on engine.
- For model GTA855E, verify O<sub>2</sub> and temperature sensors are installed pre and post catalyst.

## 6.6 AC And DC Wiring

- Wire sizes, insulation, conduits and connection methods all meet applicable codes.
- AC and DC wires are separated in their own conduit to prevent electrical induction.
- All load, line and generator connections are proper and correct.
- Flexible conduit between generator set and building or surrounding structure.

## 6.7 Generator Set Pre-Start

- Generator set engine is properly serviced with oil and coolant.
- E-Stop is depressed.
- Batteries are properly installed, serviced and charged.
- Battery charger and engine coolant heater are connected and operational.
- All generator set covers and safety shields are installed properly.



---

## Section 7 - Wiring Diagrams

### 7.1 General

This section consists of the schematic and connection wiring diagrams referenced in the text. The following drawings are included.

#### Wiring Diagrams - Electronic Engines

Drawing Title	Drawing No.	Rev.
Schematic, Controls Interface GFBC GTA855E w/ PCC 1302	GFBC-PCC1.3-Wiring	B
Schematic, Controls Interface GFBC GTA855E w/ PCC 2300	GFBC-PCC 2.3-Wiring	B
Schematic, Controls Interface GFBC GTA855E w/ PCC 3300	GFBC-PCC 3.3-Wiring	B
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 1302	GFEB-PCC1.3-Wiring	A
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 2300	GFEB-PCC 2.3-Wiring	A
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 3300	GFEB-PCC 3.3-Wiring	A
Schematic, Overall GFPA Model 150 w/PCC 1.1/PCC 2.2	22726	-

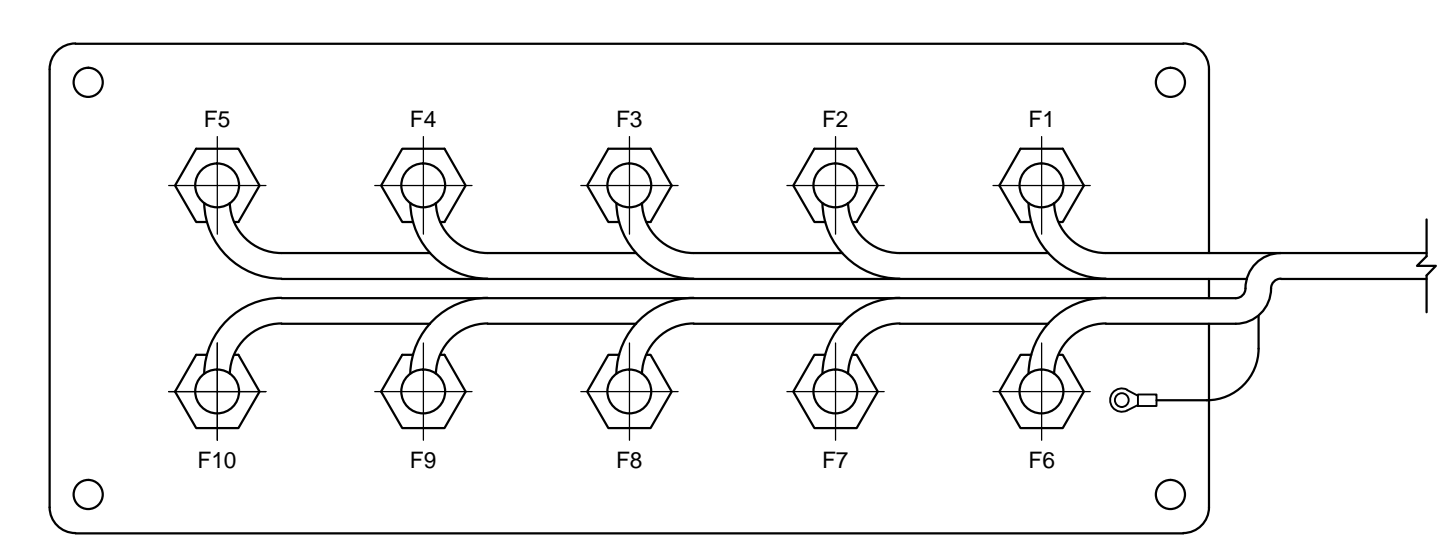
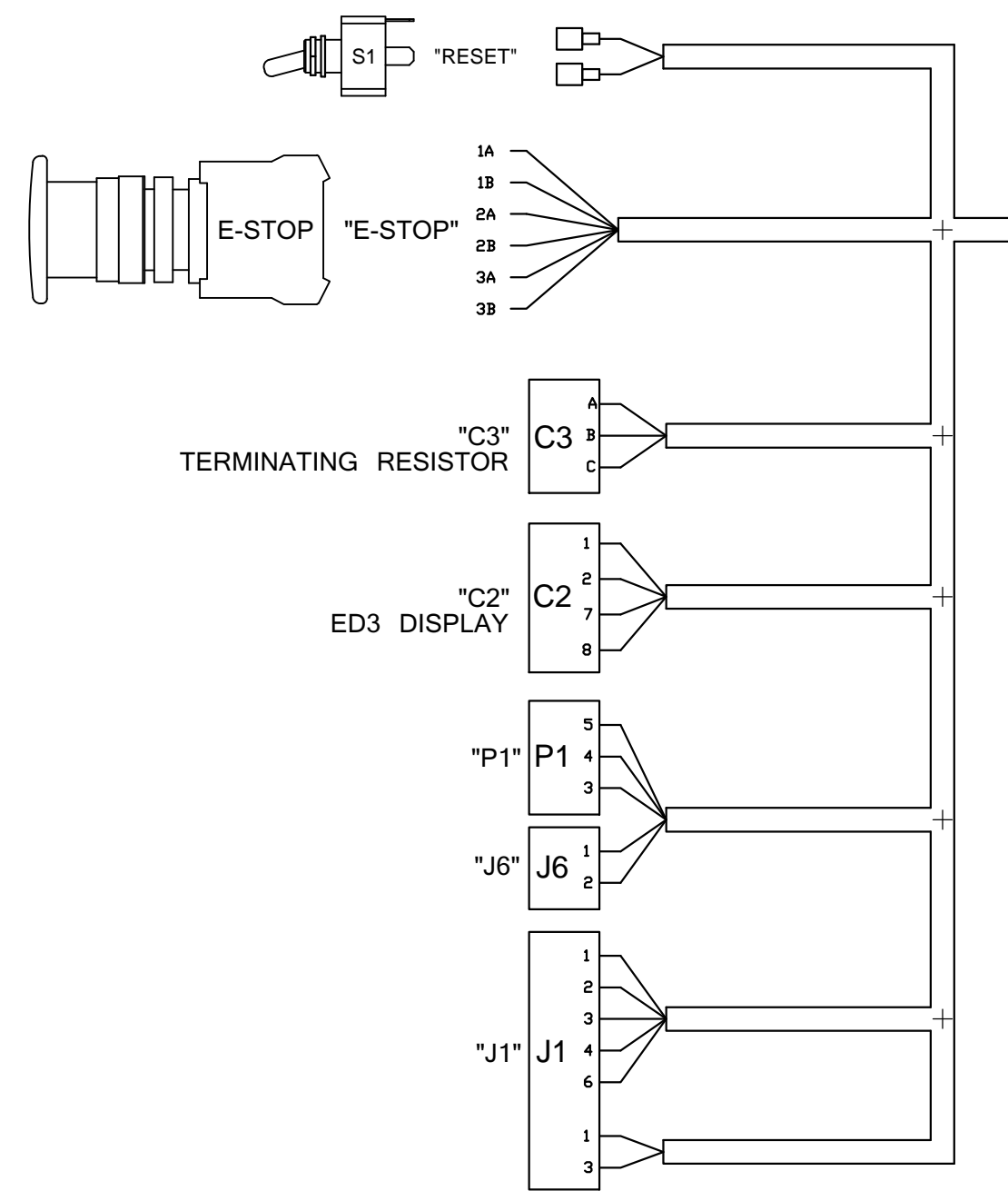
#### Wiring Diagrams - Hydro-Mechanical Engines

Drawing Title	Drawing No.	Rev.
Schematic, Controls Interface HM ENG w/PCC 1302	25538	-
Schematic, Controls Interface HM ENG w/PCC 3300	25539	-

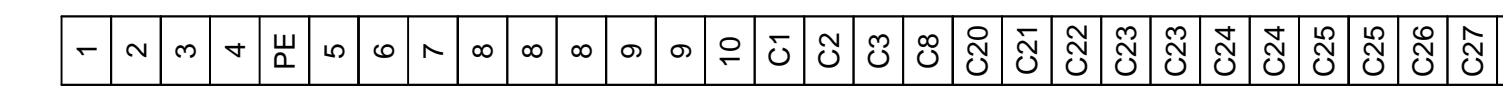
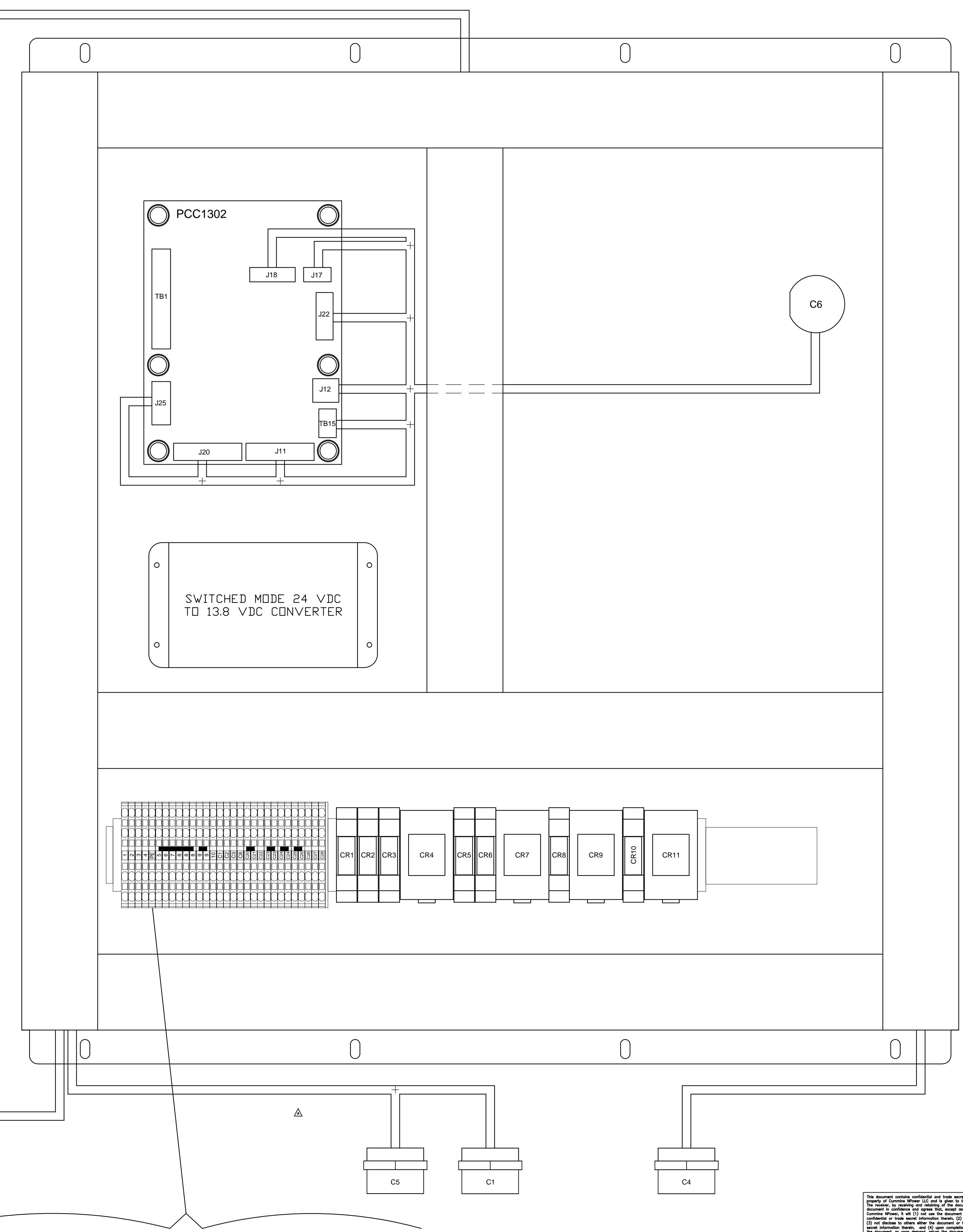
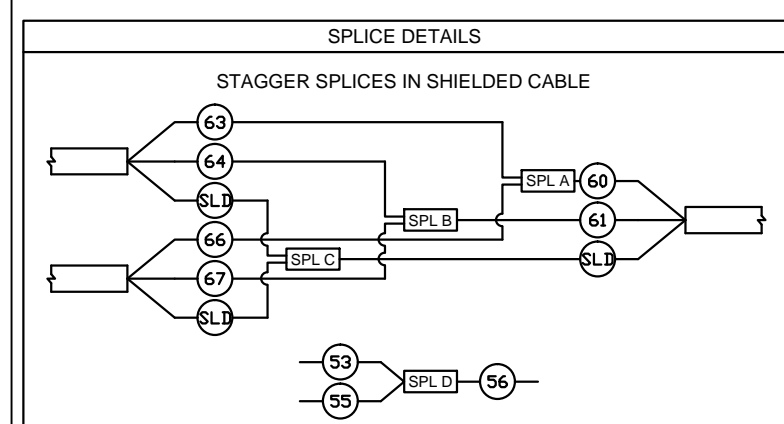
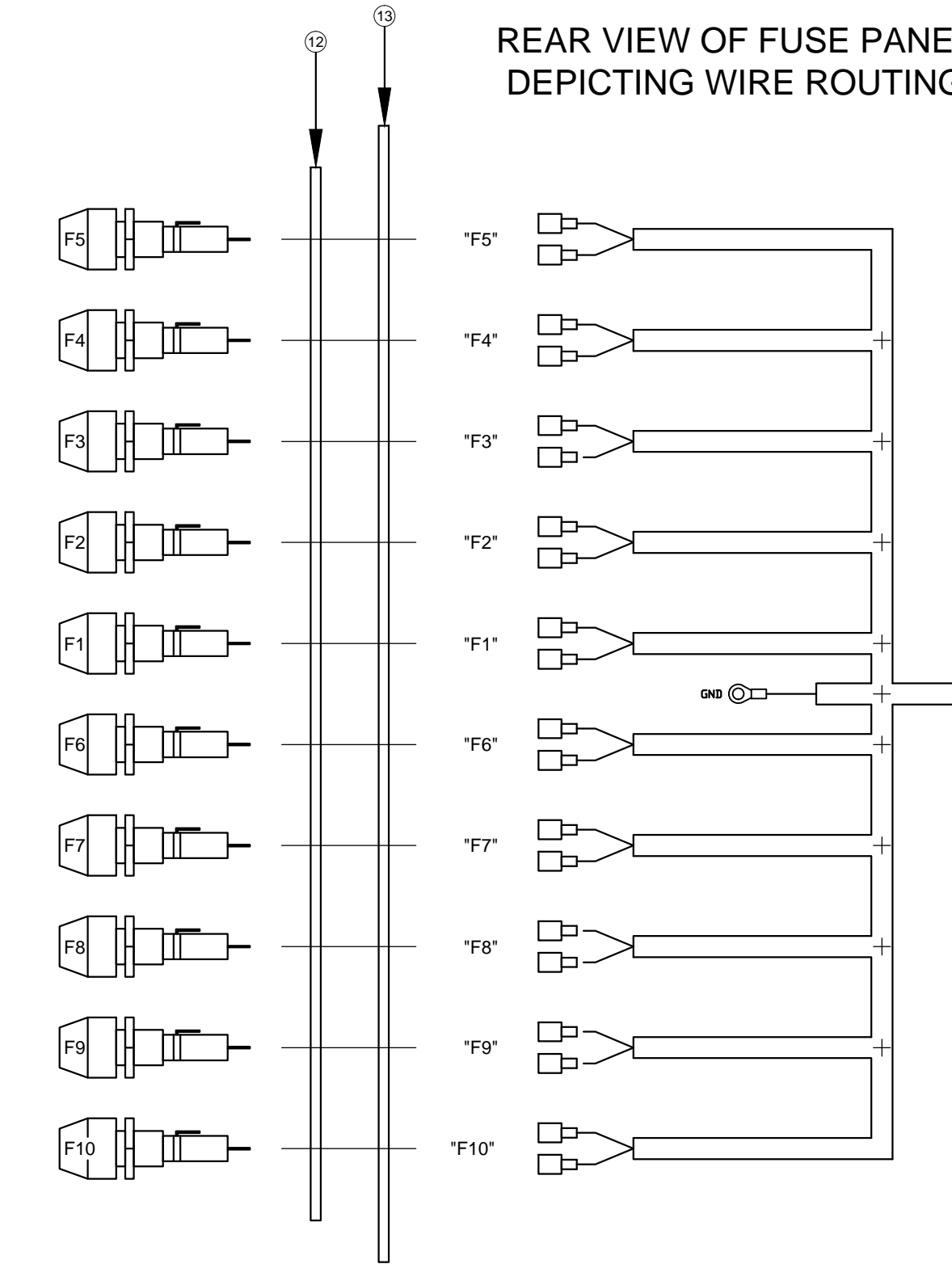








REAR VIEW OF FUSE PANEL DEPICTING WIRE ROUTING



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± 0.020	± 0.0020	± 0.1016
± 0.050	± 0.0050	± 0.2540

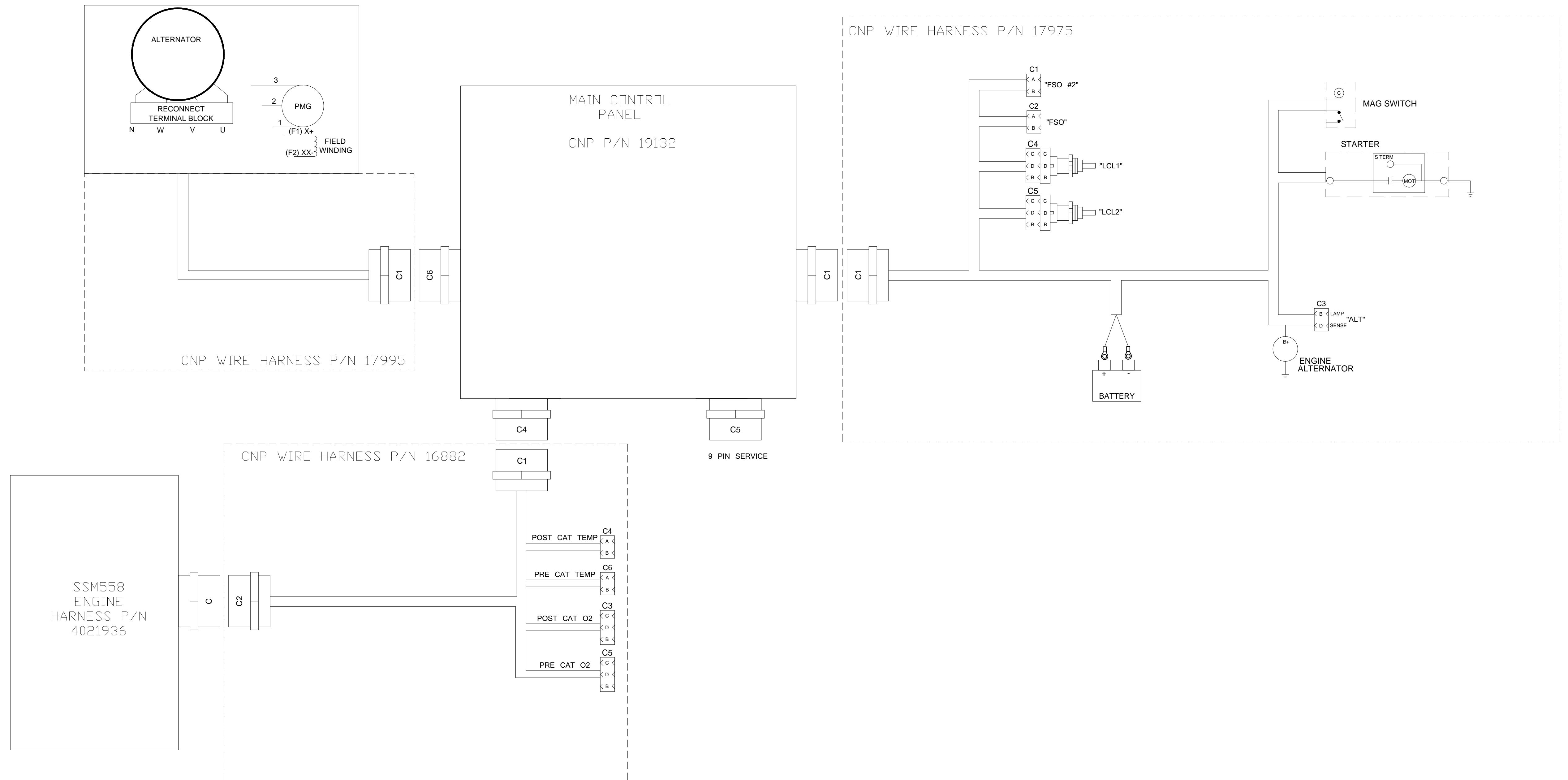
THIRD ANGLE PROJECTION

**SCHEMATIC, CONTROLS INTERFACE**  
GTAB55E w/ PCC1302

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SCALE: 1:1	<b>AUTO CAD</b>	INIT: ECO
EST WEIGHT:	SHEET 20F3	DRAWING NO: GFBC-PCC1.3-WIRING

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CUSTOM DESIGN AND  
UPFIT CENTER  
875 LAURITZ DRIVE  
DEPERE, WISCONSIN



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± 0.003	± 0.010	± 0.025
± 0.002	± 0.008	± 0.020

THIRD ANGLE PROJECTION

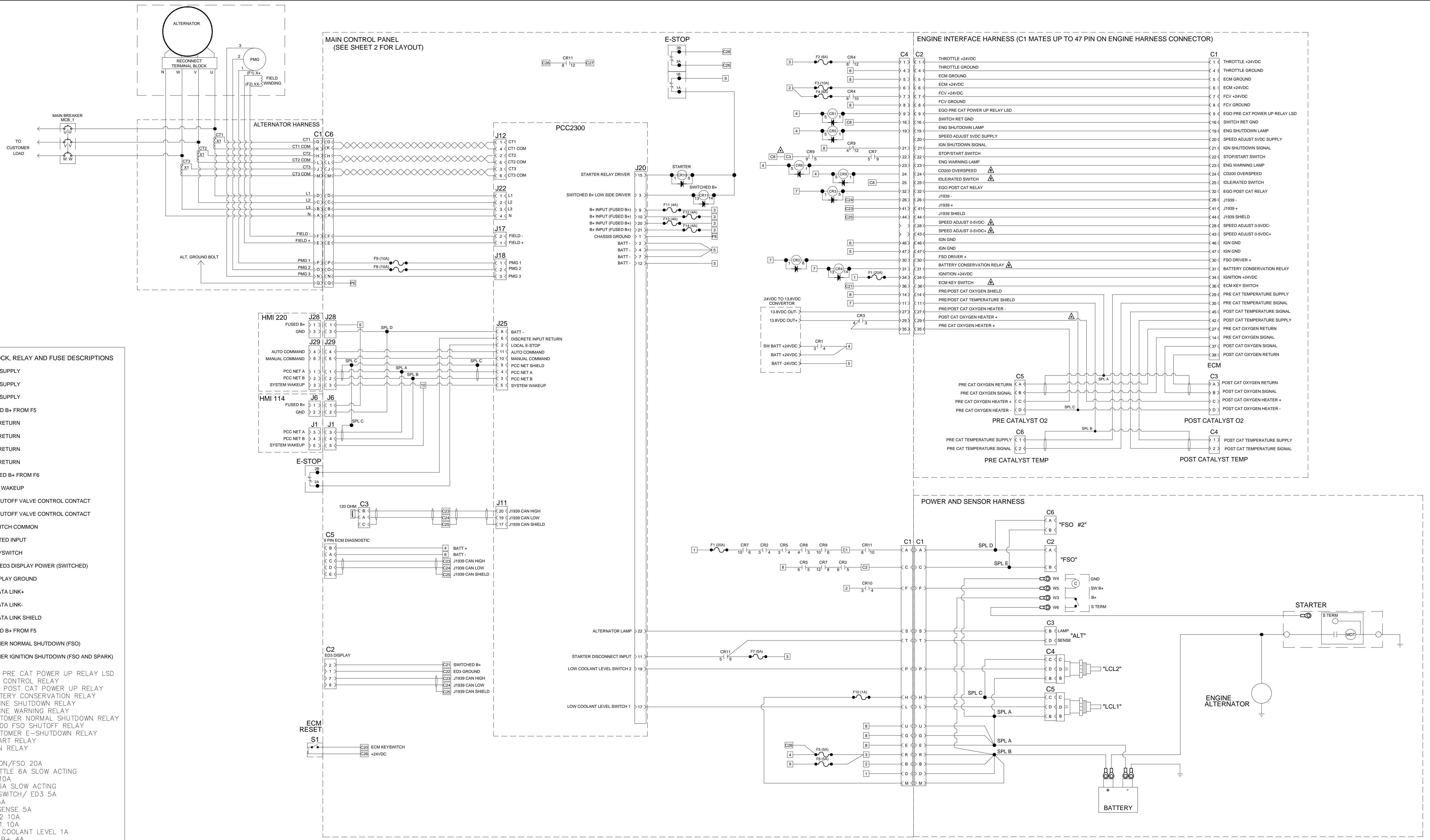
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A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE

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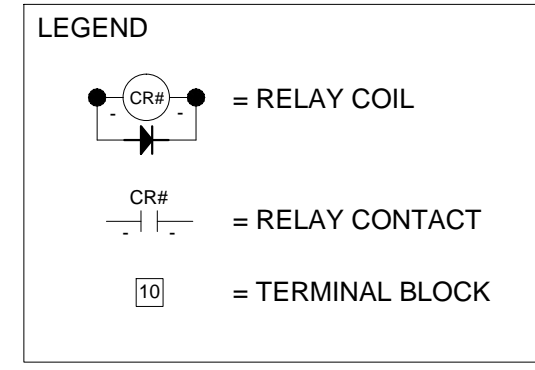
CUSTOM DESIGN AND  
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 DEPERE, WISCONSIN

**SCHEMATIC, CONTROLS INTERFACE**  
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DRAWN BY: KAK  
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 DATE: 02 SEPT 2011  
 INIT ECO:  
 DRAWING NO: GFBC-PCC1.3-WIRING



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLE/RATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 ED3 DISPLAY GROUND
  - C23 J1939 DATA LINK+
  - C24 J1939 DATA LINK-
  - C25 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (F50)
  - C28 CUSTOMER IGNITION SHUTDOWN (F50 AND SPARK)
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = RUN RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021936-02 FOR ENGINE SIDE WIRING AND INTERFACE

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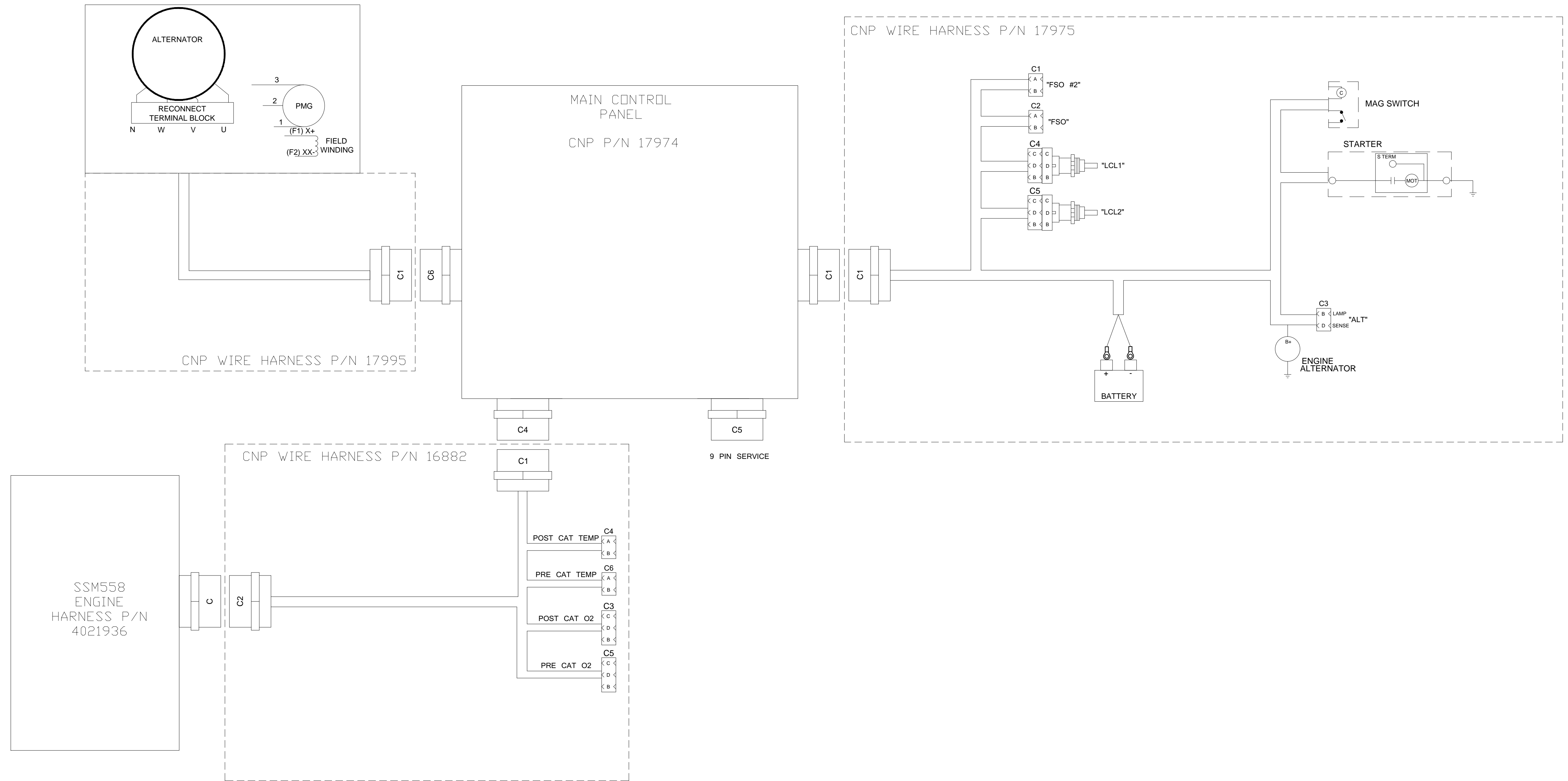
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0.009	0.009	0.009
0.010	0.010	0.010

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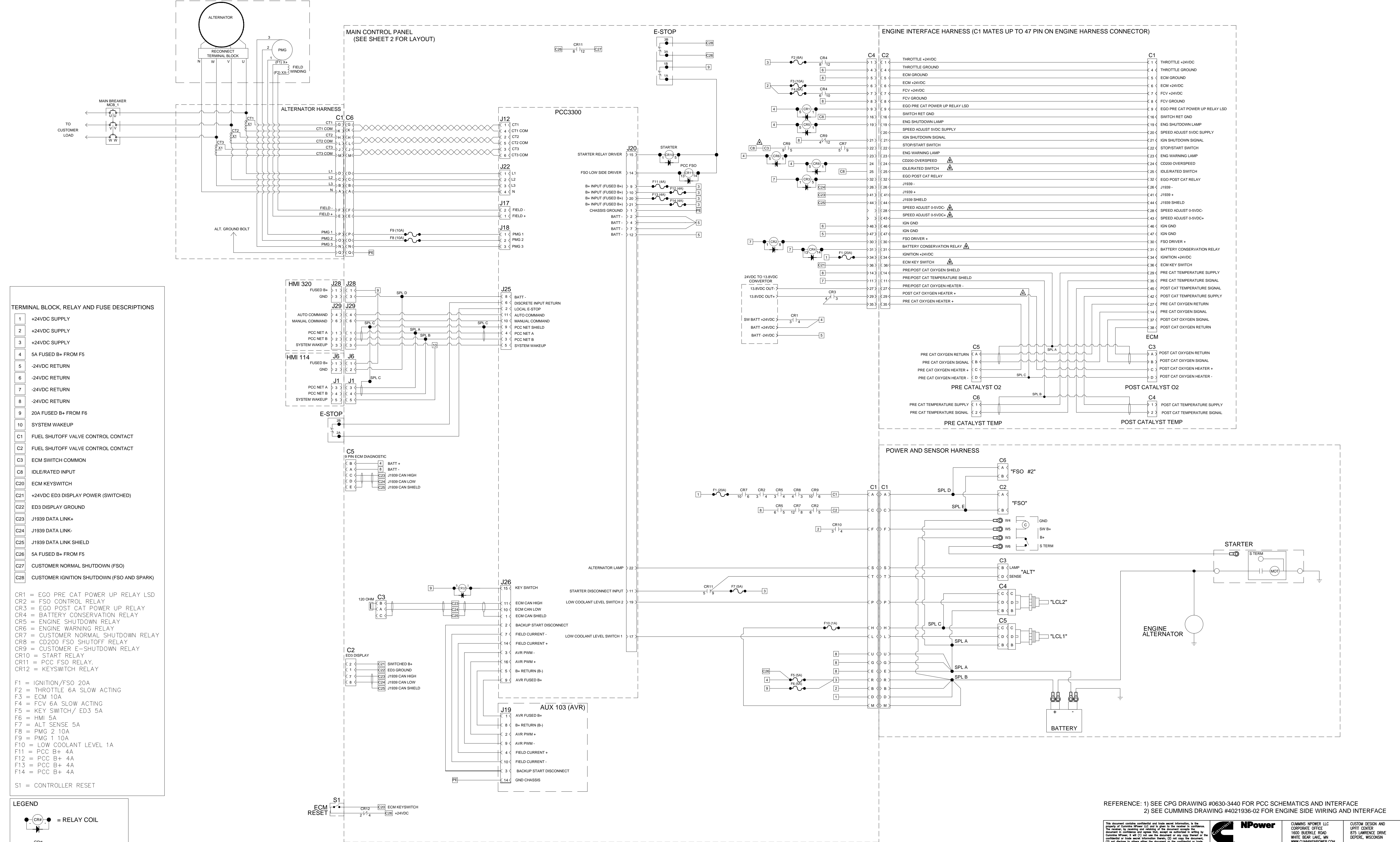
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EST WEIGHT:	AUTO CAD	

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
B	2014-109	CORRECTED PINOUTS BETWEEN C1 & C2.	RMJ	25FEB2014
A	2013-721	REMOVED C7, FIXED O2 WIRING, ADDED SHEET 3.	KAK	25NOV2013



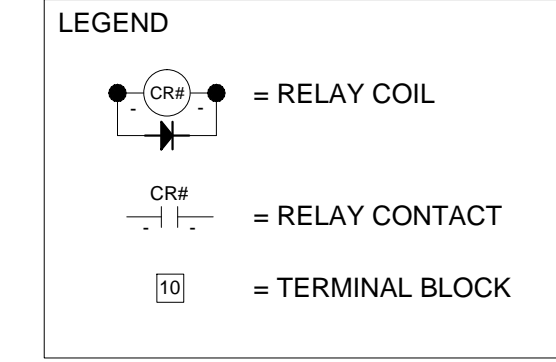


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- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
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  - CR2 = F5O CONTROL RELAY
  - CR3 = EGO POST CAT POWER UP RELAY
  - CR4 = BATTERY CONSERVATION RELAY
  - CR5 = ENGINE SHUTDOWN RELAY
  - CR6 = ENGINE WARNING RELAY
  - CR7 = CUSTOMER NORMAL SHUTDOWN RELAY
  - CR8 = CD200 F5O SHUTOFF RELAY
  - CR9 = CUSTOMER E-SHUTDOWN RELAY
  - CR10 = START RELAY
  - CR11 = PCC F5O RELAY
  - CR12 = KEYSWITCH RELAY
- F1 = IGNITION/F5O 20A
  - F2 = THROTTLE 6A SLOW ACTING
  - F3 = ECM 10A
  - F4 = FCV 6A SLOW ACTING
  - F5 = KEY SWITCH/ ED3 5A
  - F6 = HMI 5A
  - F7 = ALT SENSE 5A
  - F8 = PMG 2 10A
  - F9 = PMG 1 10A
  - F10 = LOW COOLANT LEVEL 1A
  - F11 = PCC B+ 4A
  - F12 = PCC B+ 4A
  - F13 = PCC B+ 4A
  - F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



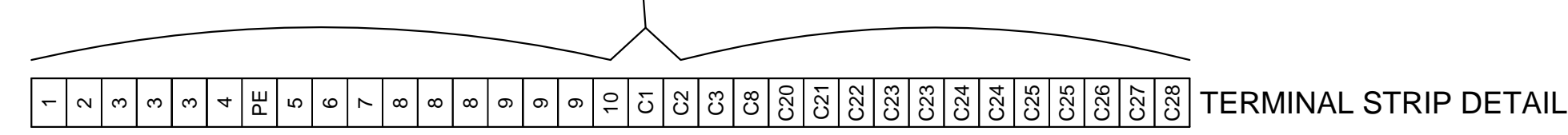
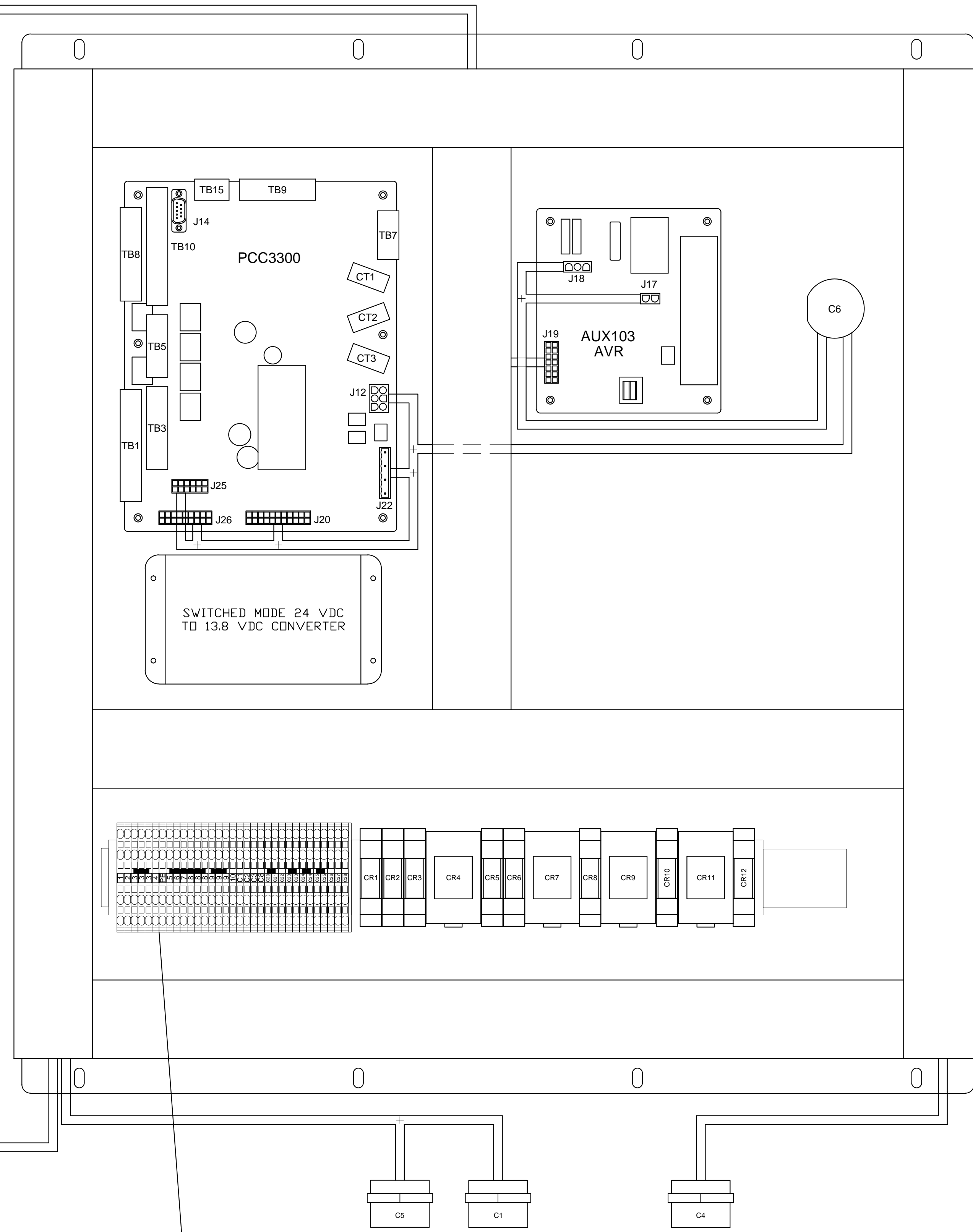
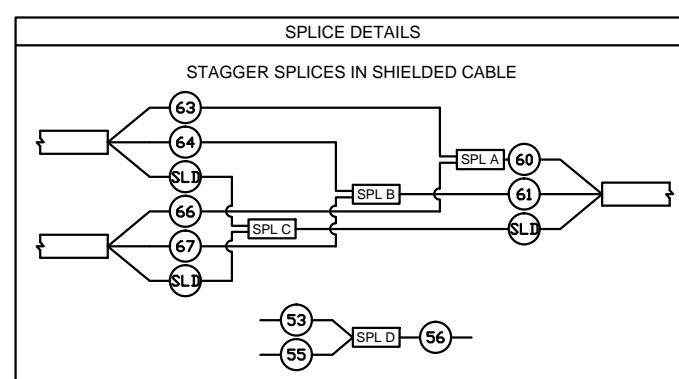
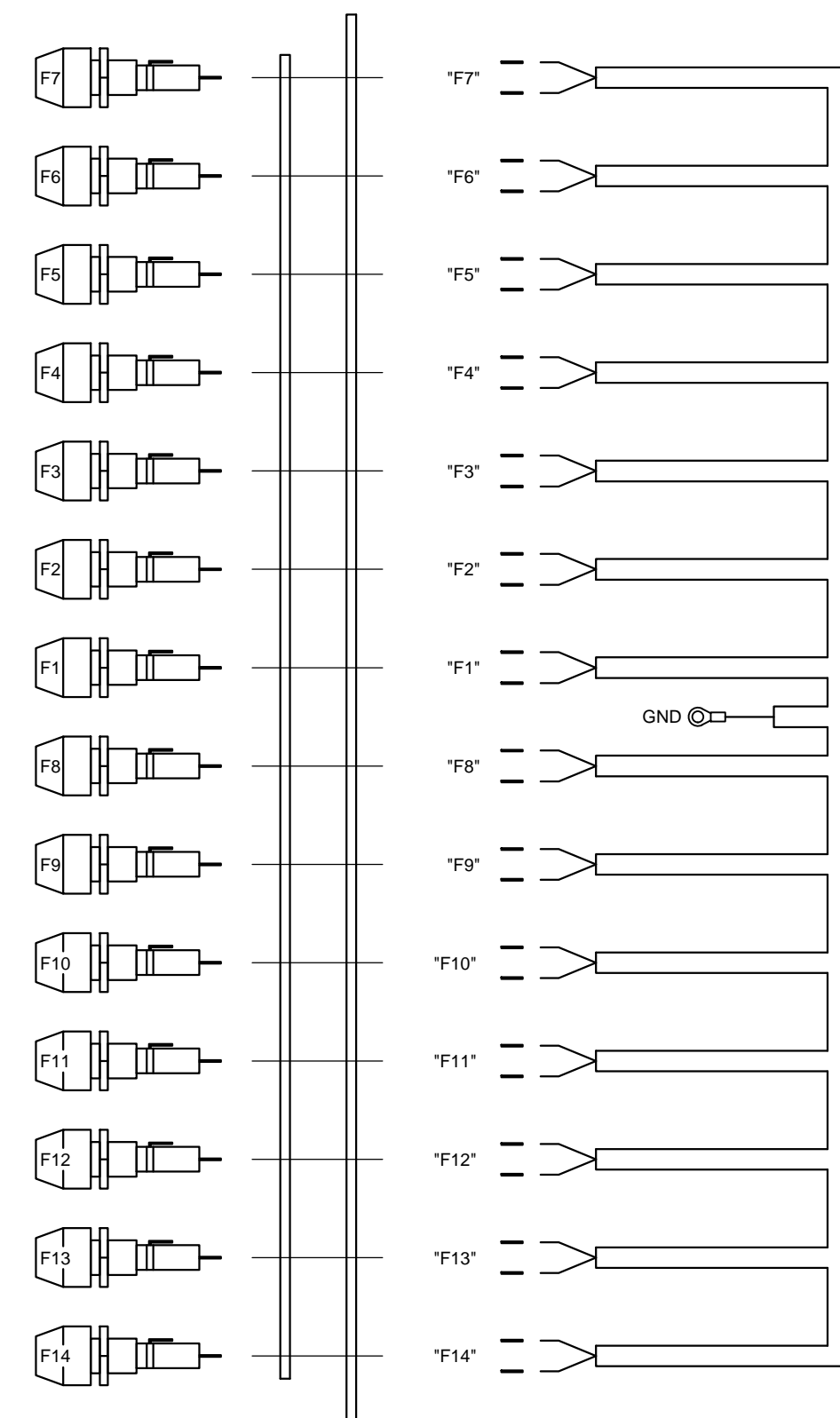
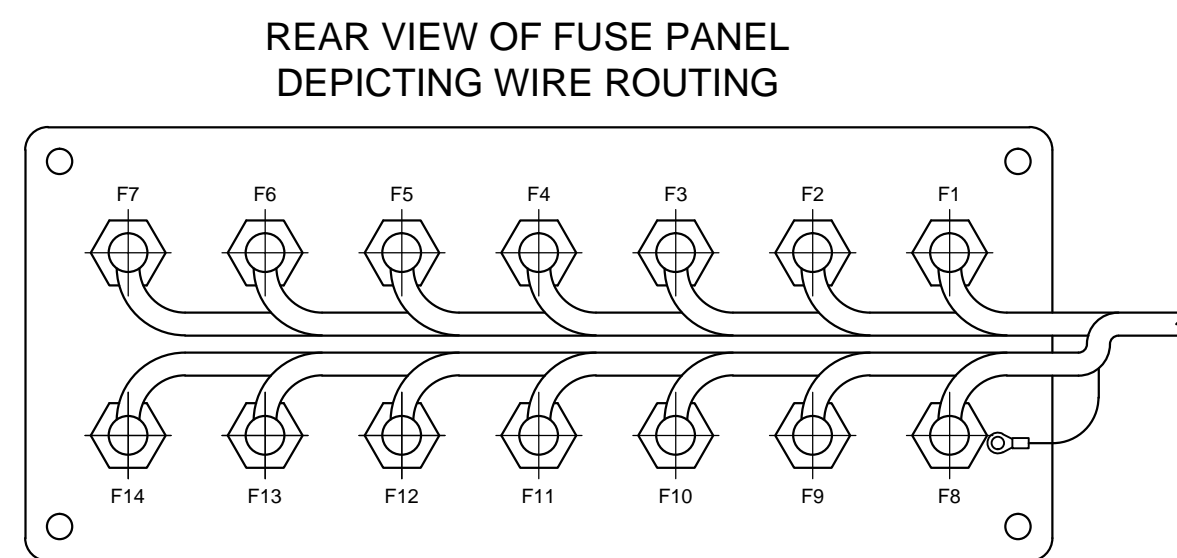
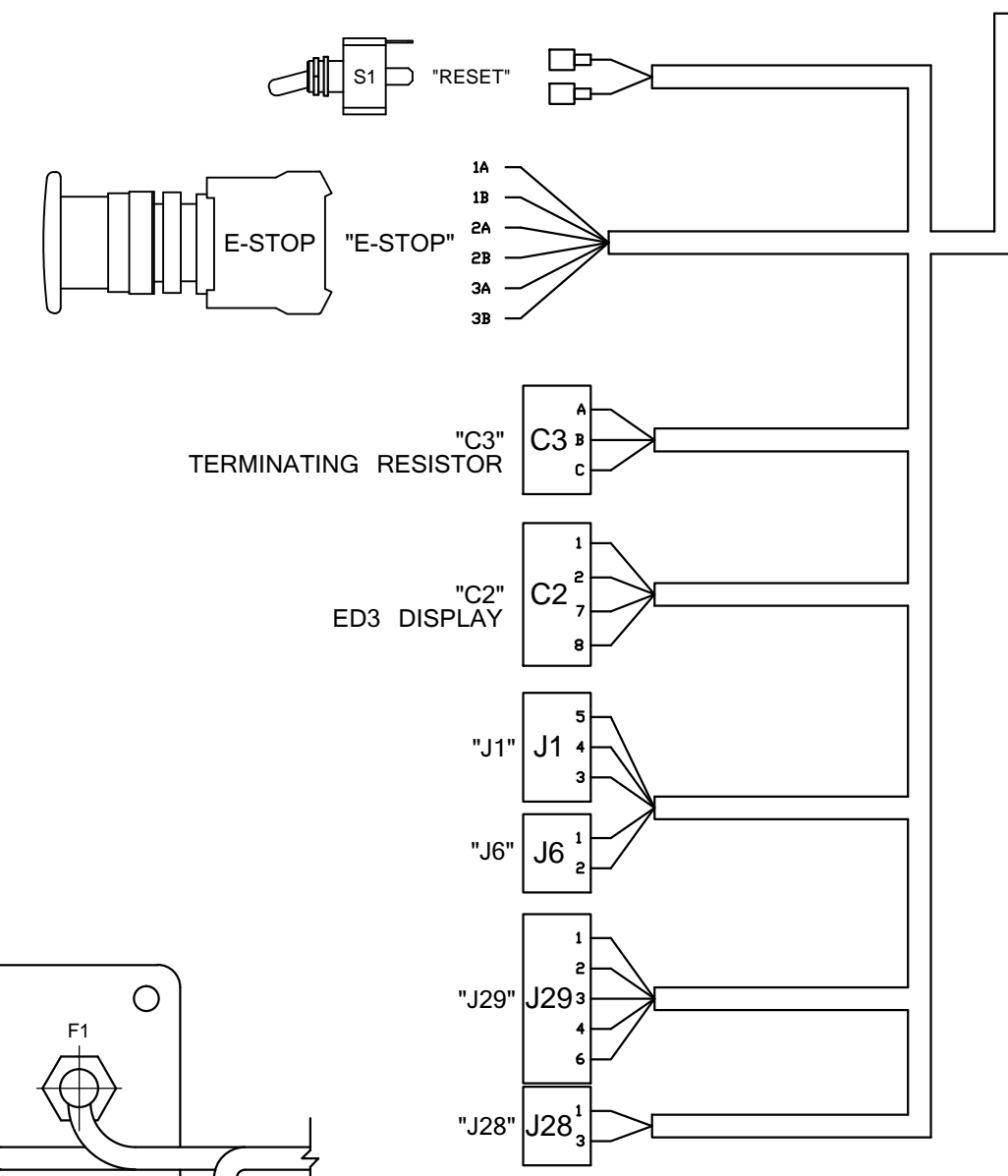
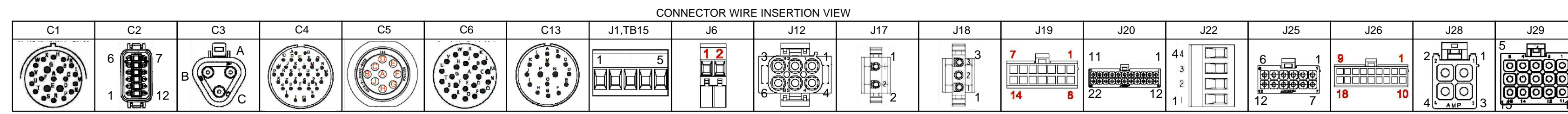
REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021936-02 FOR ENGINE SIDE WIRING AND INTERFACE

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SCHEMATIC, CONTROLS INTERFACE GTA855E w/ PCC3300			DRAWN BY: KAK DATE: 23 AUG 2011		UNIT ECO:
DWG UNITS: INCH/LB/S SCALE:			SHEET 10F3 DRAWING NO: GFBC-PCC3.3-WIRING		EST WEIGHT:

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
B	2014-109	CORRECTED PINOUTS BETWEEN C1 & C2.	RMJ	25FEB2014
A	2013-721	ADDED JUMPER BETWEEN TERMINALS C3 & C8. FIXED O2 WIRING. ADDED SHEET 3.	KAK	25NOV2013





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0.050	0.0050	0.1270
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0.080	0.0080	0.2032
0.090	0.0090	0.2286
0.100	0.0100	0.2540

THIRD ANGLE PROJECTION

SCHEMATIC, CONTROLS INTERFACE  
GTAB55E w/ PCC3300

B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014		
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013		
REV	ECO	DESCRIPTION OF REVISION	BY	DATE		

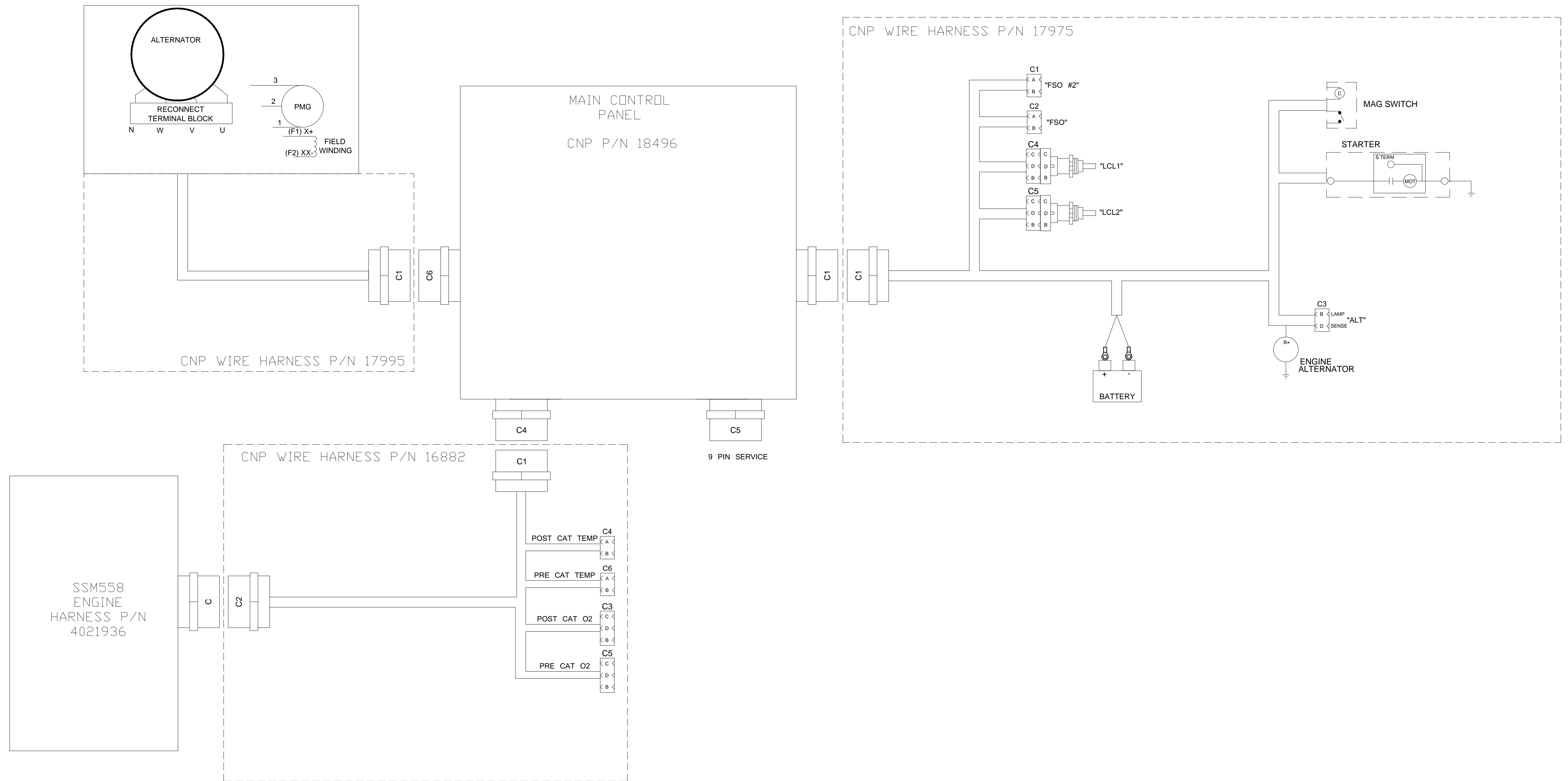
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DRAWN BY: KAK  
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DATE: 23 AUG 2011  
DRAWING NO: GFBC-PCC3.3-WIRING

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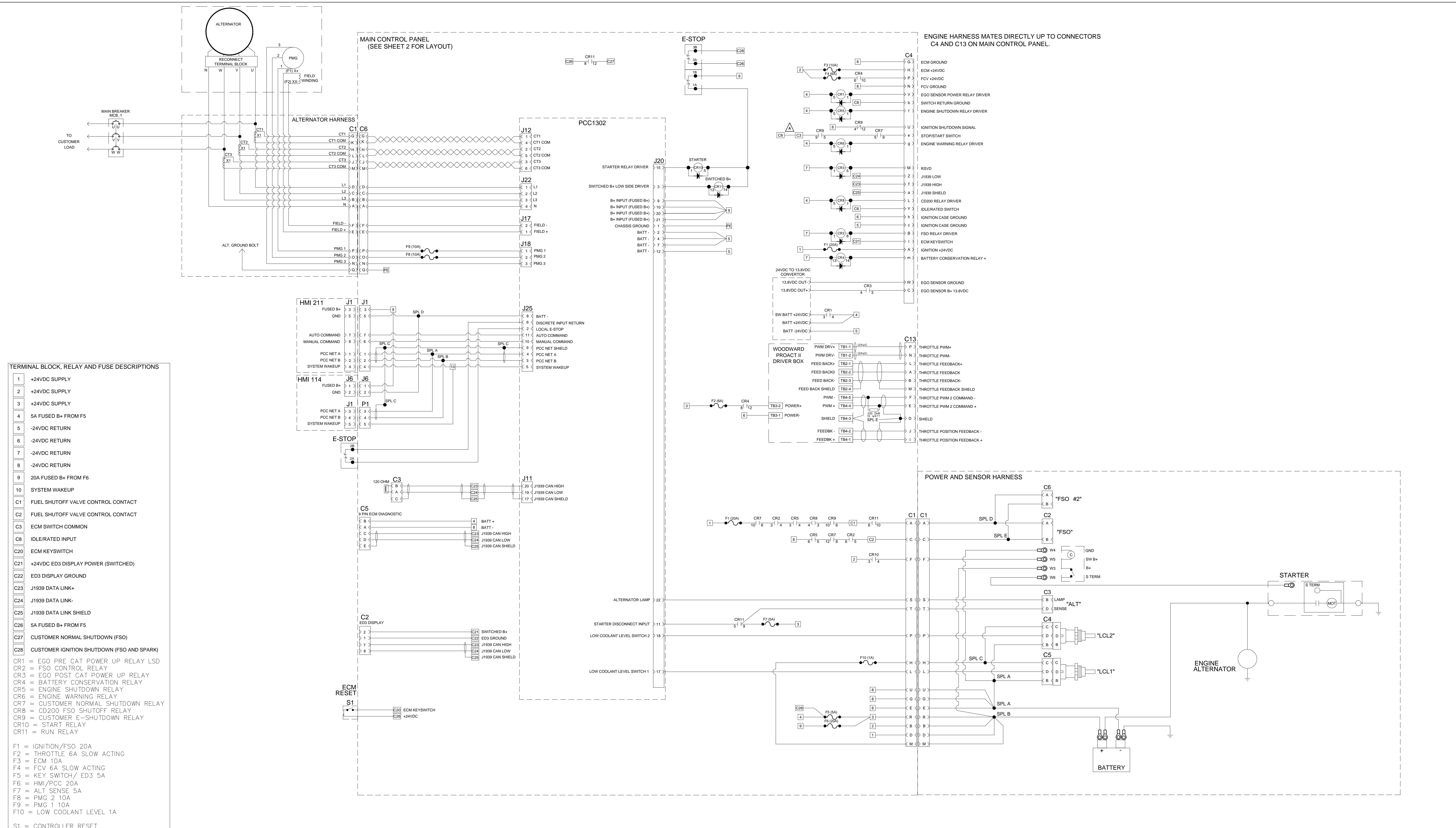
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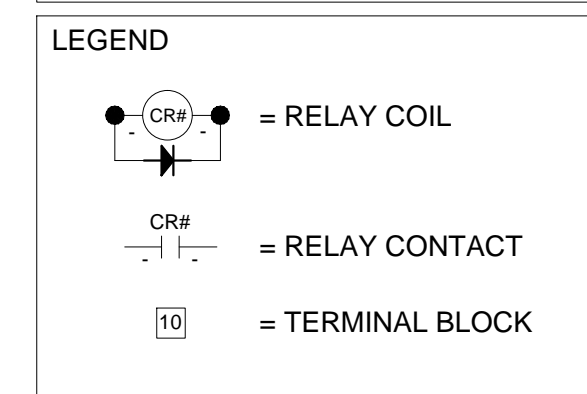
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	± 0.010	± 0.30
	± 0.015	± 0.45
	± 0.030	± 0.90
	± 0.060	± 1.50

B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014		
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013		
REV	ECO	DESCRIPTION OF REVISION	BY	DATE		

SCHEMATIC, CONTROLS INTERFACE GTA855E W/ PCC3300	DWG UNITS: INCH/LB/S	DRAWN BY: KAK	DATE: 23 AUG 2011
SCALE: EST WEIGHT:	SHEET 30F3	DRAWING NO: GFBC-PCC3.3-WIRING	INIT: ECO



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- |     |  |
|-----|--|
| 1   | +24VDC SUPPLY                              |
| 2   | +24VDC SUPPLY                              |
| 3   | +24VDC SUPPLY                              |
| 4   | 5A FUSED B+ FROM F5                        |
| 5   | -24VDC RETURN                              |
| 6   | -24VDC RETURN                              |
| 7   | -24VDC RETURN                              |
| 8   | -24VDC RETURN                              |
| 9   | 20A FUSED B+ FROM F6                       |
| 10  | SYSTEM WAKEUP                              |
| C1  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C2  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C3  | ECM SWITCH COMMON                          |
| C8  | IDLE/RATED INPUT                           |
| C20 | ECM KEYSWITCH                              |
| C21 | +24VDC ED3 DISPLAY POWER (SWITCHED)        |
| C22 | ED3 DISPLAY GROUND                         |
| C23 | J1939 DATA LINK+                           |
| C24 | J1939 DATA LINK-                           |
| C25 | J1939 DATA LINK SHIELD                     |
| C26 | 5A FUSED B+ FROM F5                        |
| C27 | CUSTOMER NORMAL SHUTDOWN (FSO)             |
| C28 | CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK) |
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = RUN RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI/PCC 20A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A
- S1 = CONTROLLER RESET



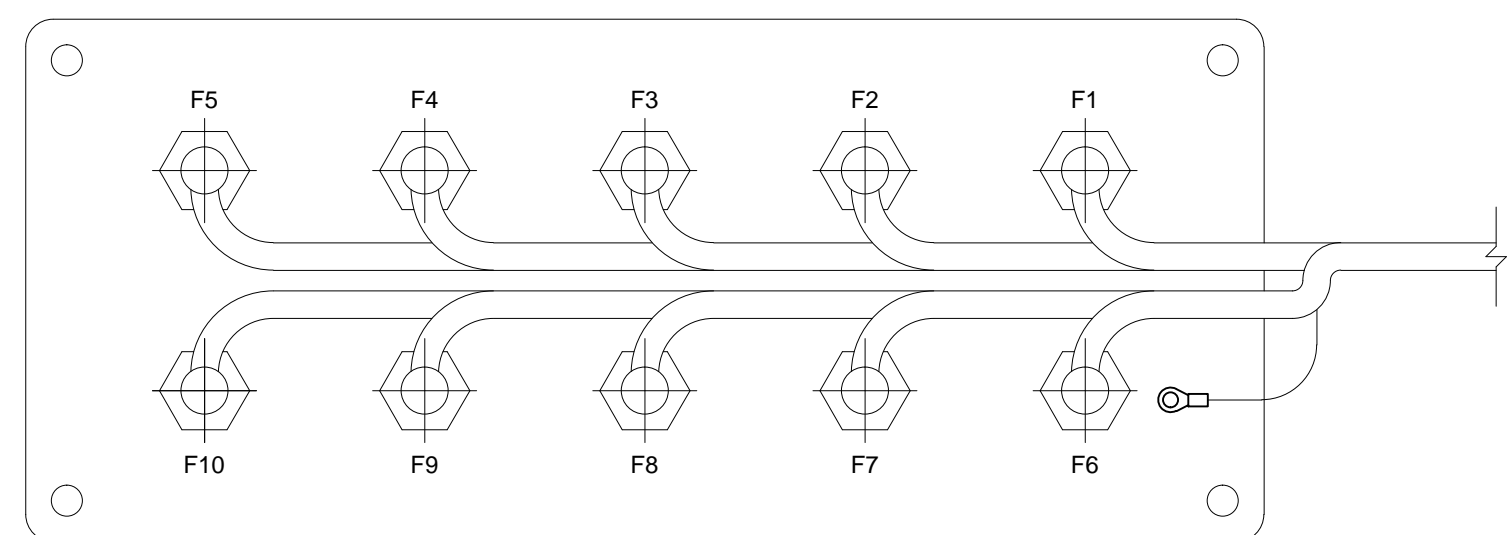
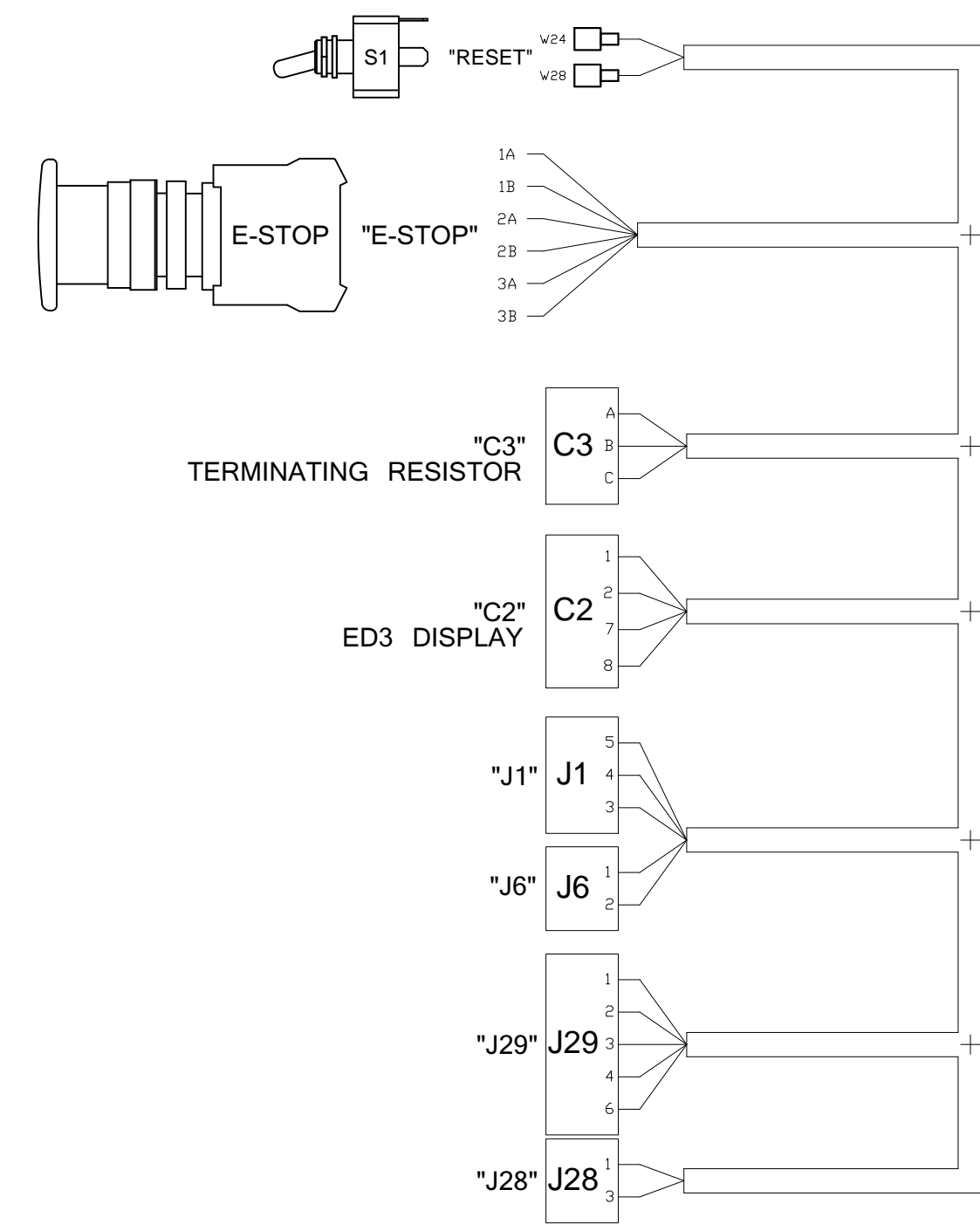
REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

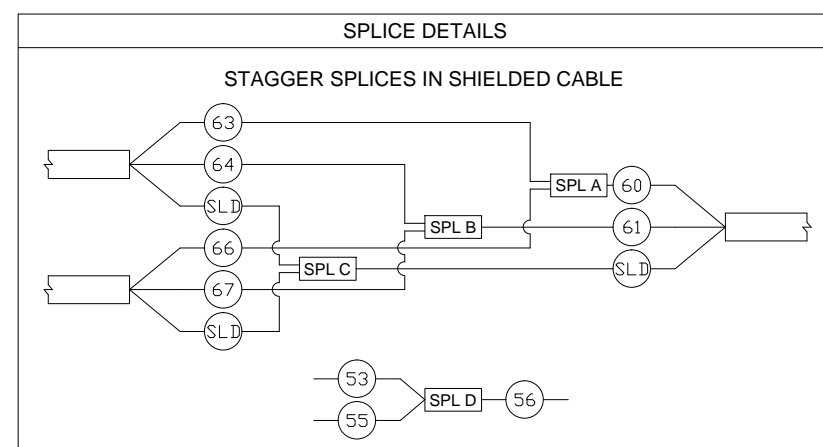
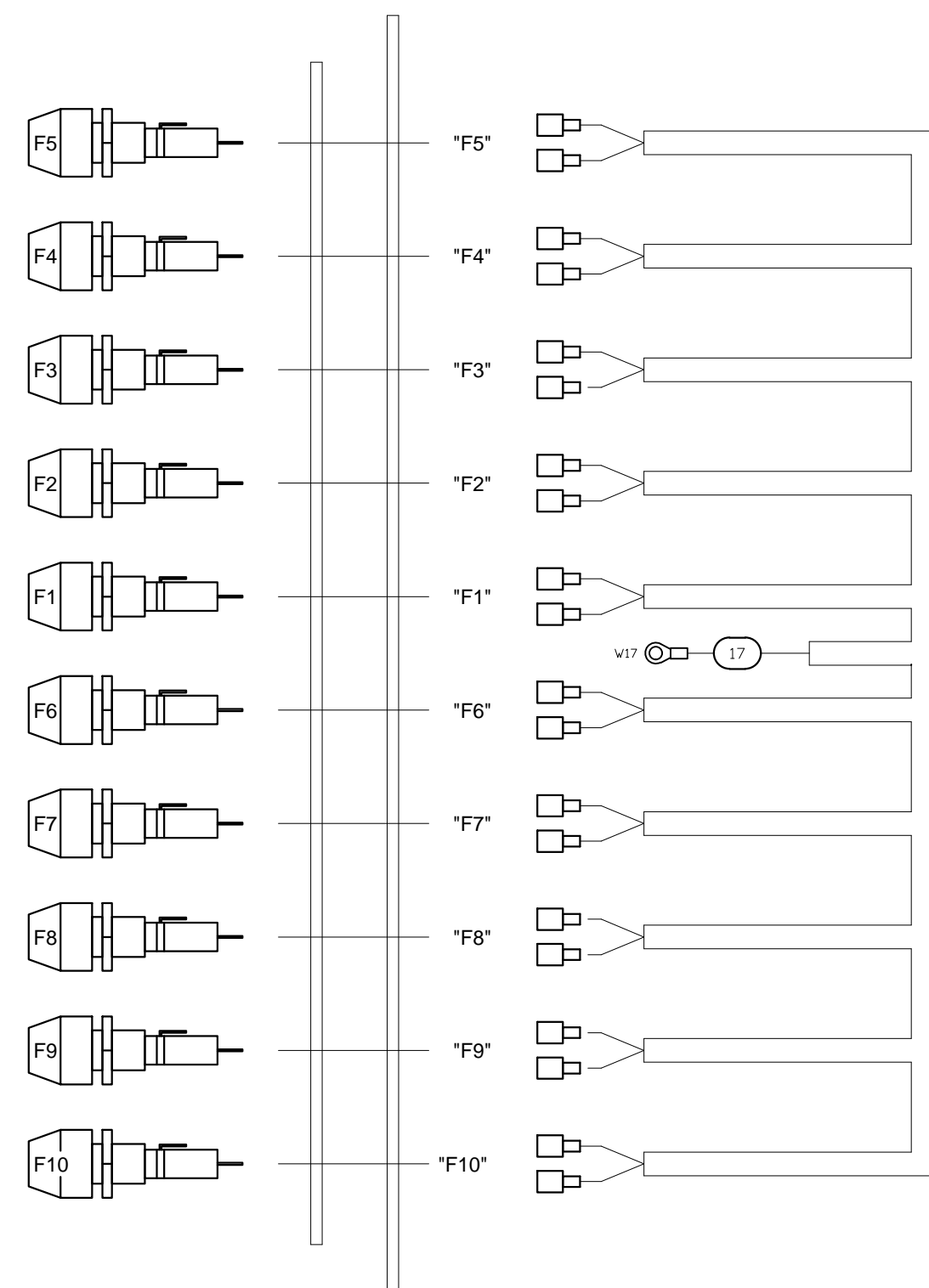
ANGULAR DIMENSIONS ±	IMPERIAL UNITS	METRIC UNITS
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15°	±0.005	±0.127
30°	±0.005	±0.127
45°	±0.005	±0.127
60°	±0.005	±0.127
75°	±0.005	±0.127
90°	±0.005	±0.127

DWG UNITS: INCH/LB/S	SCALE: 1:1	EST WEIGHT: 10F3
DRAWN BY: KAK	DATE: 25NOV2013	DATE: 2 SEPT 2011
INIT ECO:		
DRAWING NO: GFEB-PCC1.3-WIRING		

REV	DATE	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	ADDED JUMPER BETWEEN TERMINALS C3 & C8. REMOVED C7. ADDED SHEET 3.	KAK	25NOV2013
ECO				

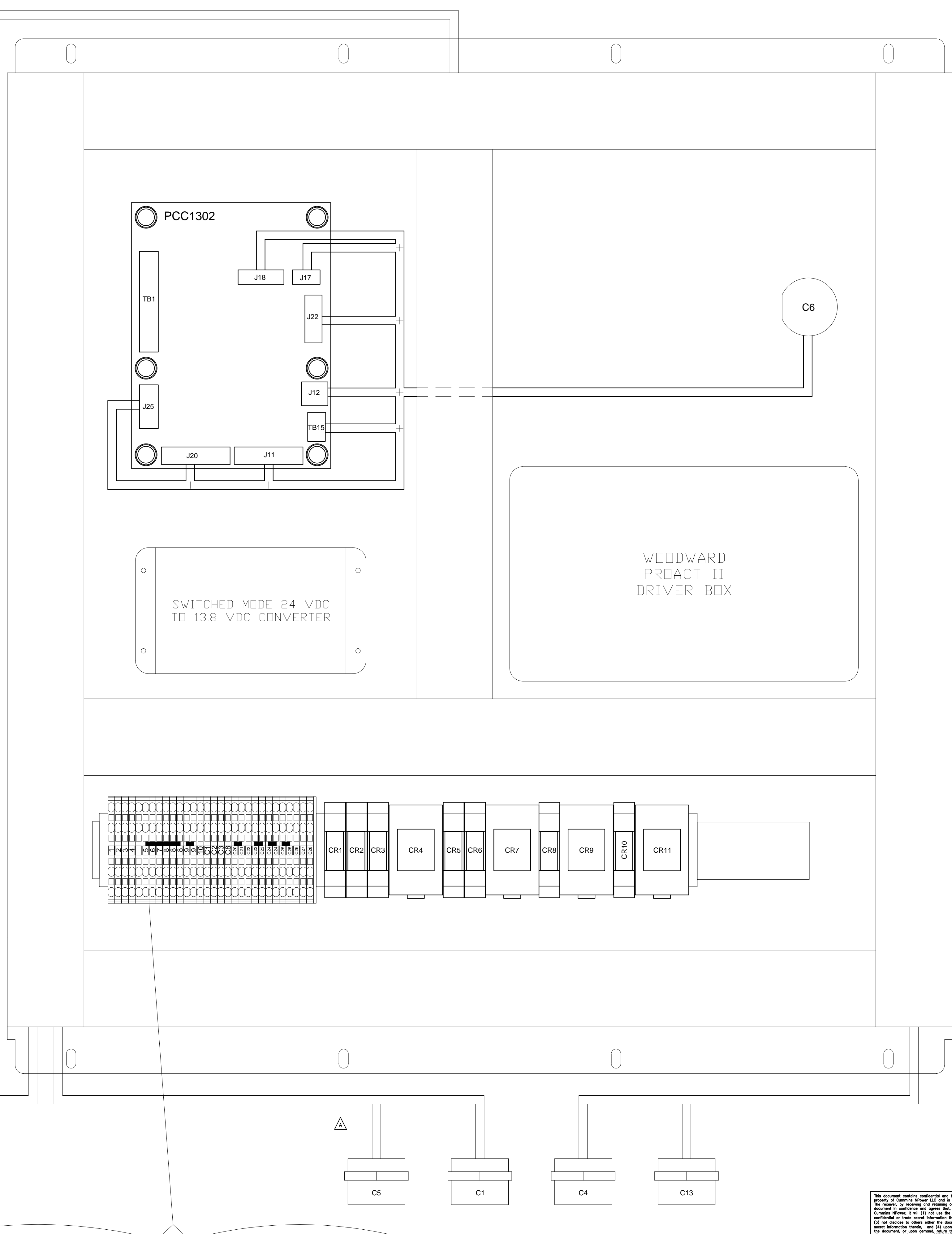


REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING



1	2	3	4	5	6	7	8	9	10	C1	C2	C3	C8	C20	C21	C22	C23	C24	C25	C26	C27	C28
---	---	---	---	---	---	---	---	---	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----

TERMINAL STRIP DETAIL



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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
± 0.005	± 0.005	± 0.15
± 0.010	± 0.010	± 0.30
± 0.020	± 0.020	± 0.60
± 0.050	± 0.050	± 1.50

THIRD ANGLE PROJECTION

DATE: 2 SEPT 2011

INIT ECO:

DWG UNITS: INCH/LB/S

SCALE: 1:1

EST WEIGHT:

DRAWN BY: KAK

AUTO CAD

SHEET 20F3

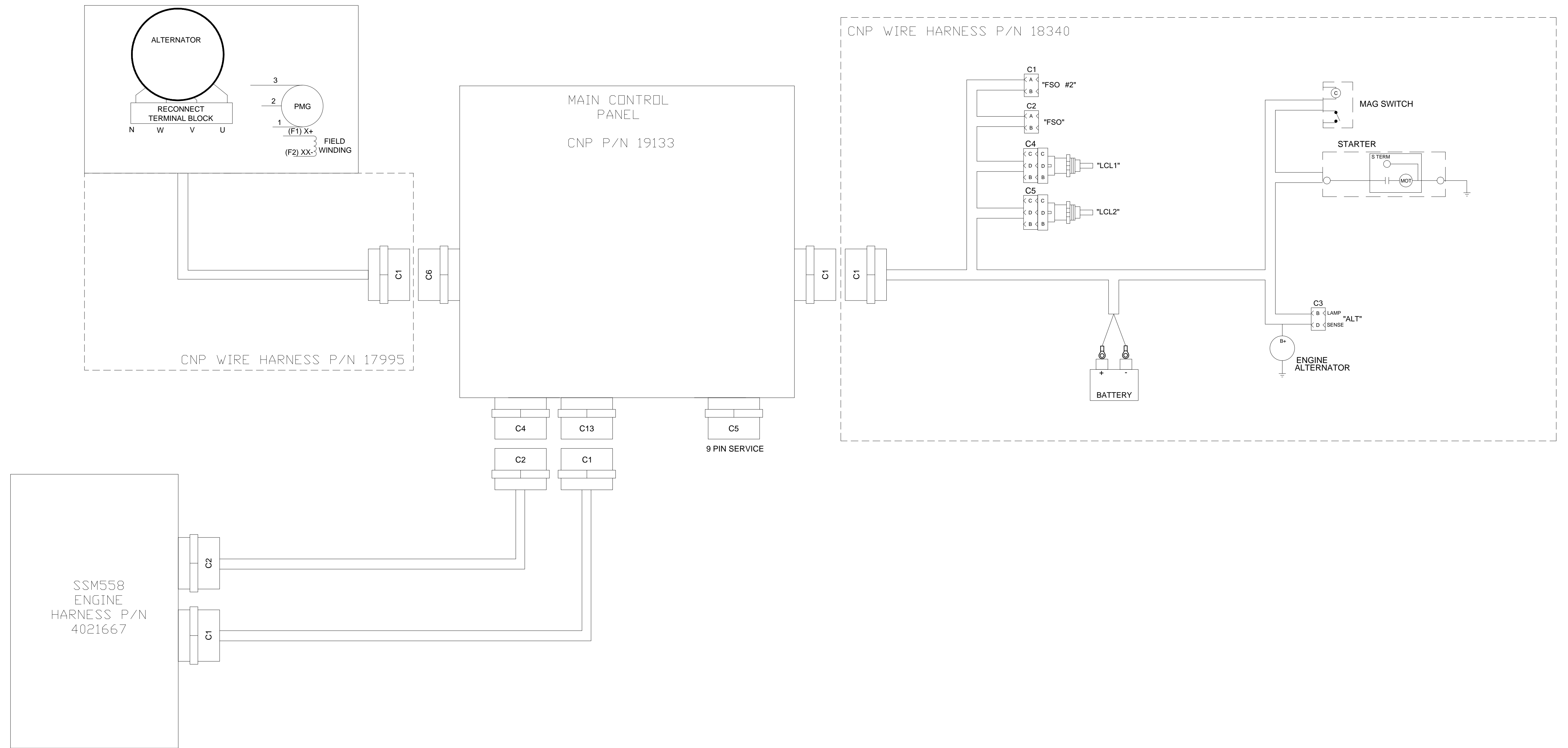
DRAWING NO: GFEB-PCC1.3-WIRING

SCHEMATIC, CONTROLS INTERFACE  
KTA19SLB w/ PCC1302

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WWW.CUMMINSNPOWER.COM

CUSTOM DESIGN AND  
UPFIT CENTER  
875 LAURANCE DRIVE  
DEPERE, WISCONSIN

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



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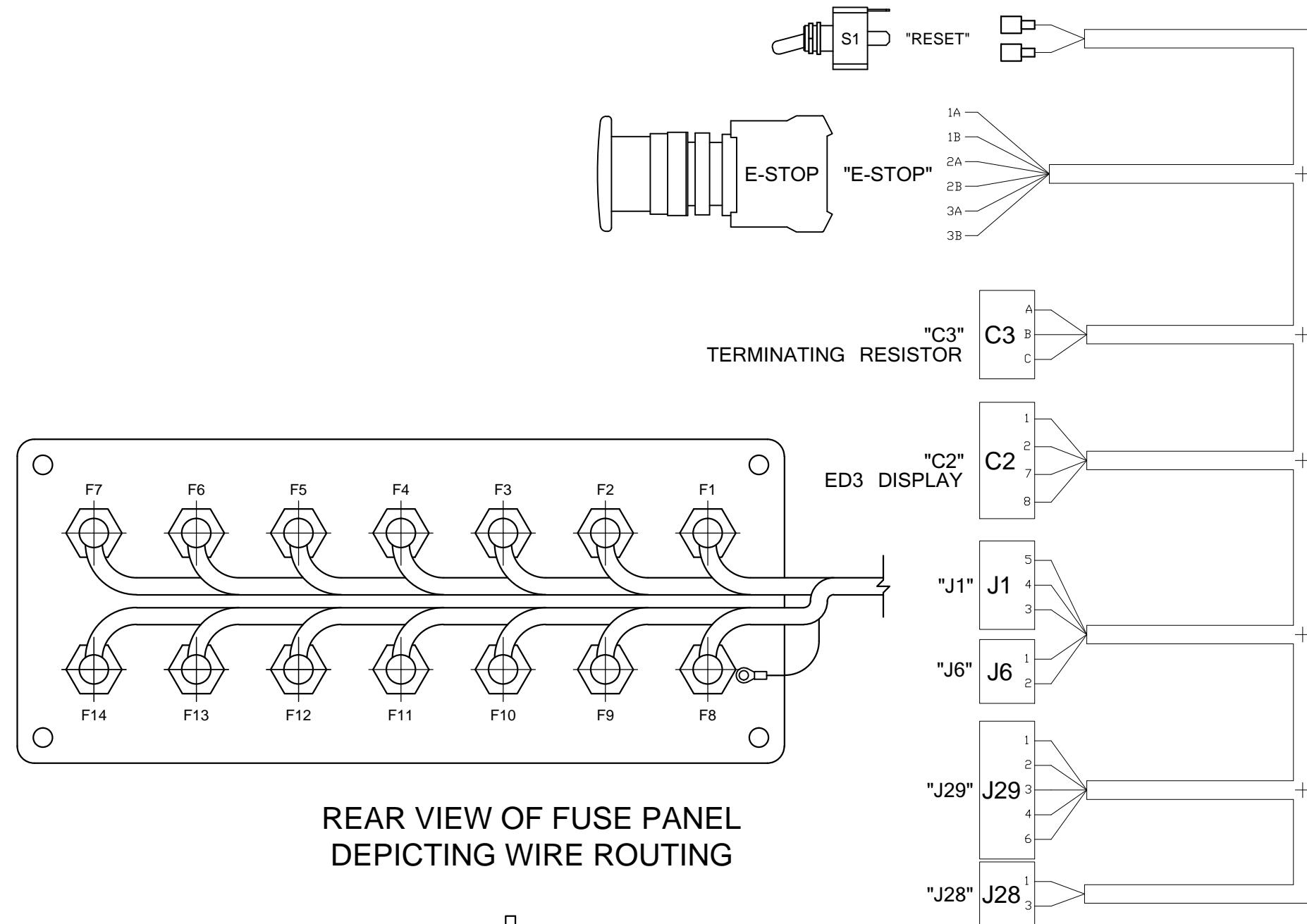
**SCHEMATIC, CONTROLS INTERFACE**  
 KTA19SLB W/ PCC1302

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:  
 ANGULAR DIMENSIONS ± 1°  
 DIMENSIONAL UNITS: IMPERIAL UNITS: METRIC UNITS  
 DWG UNITS: INCH/LB/S  
 SCALE: 1:1  
 EST WEIGHT: SHEET 30F3 DRAWING NO: GFEB-PCC1.3-WIRING

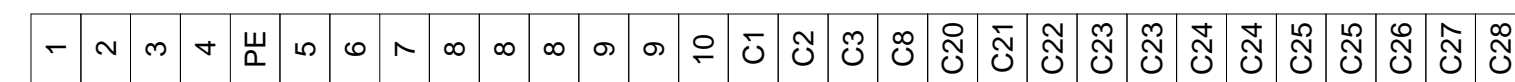
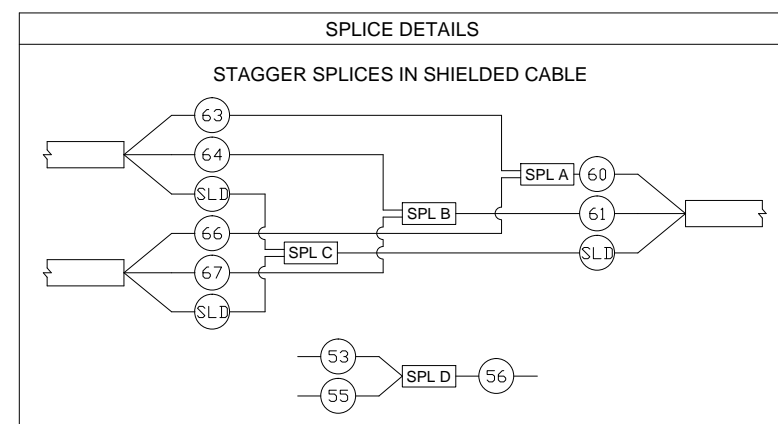
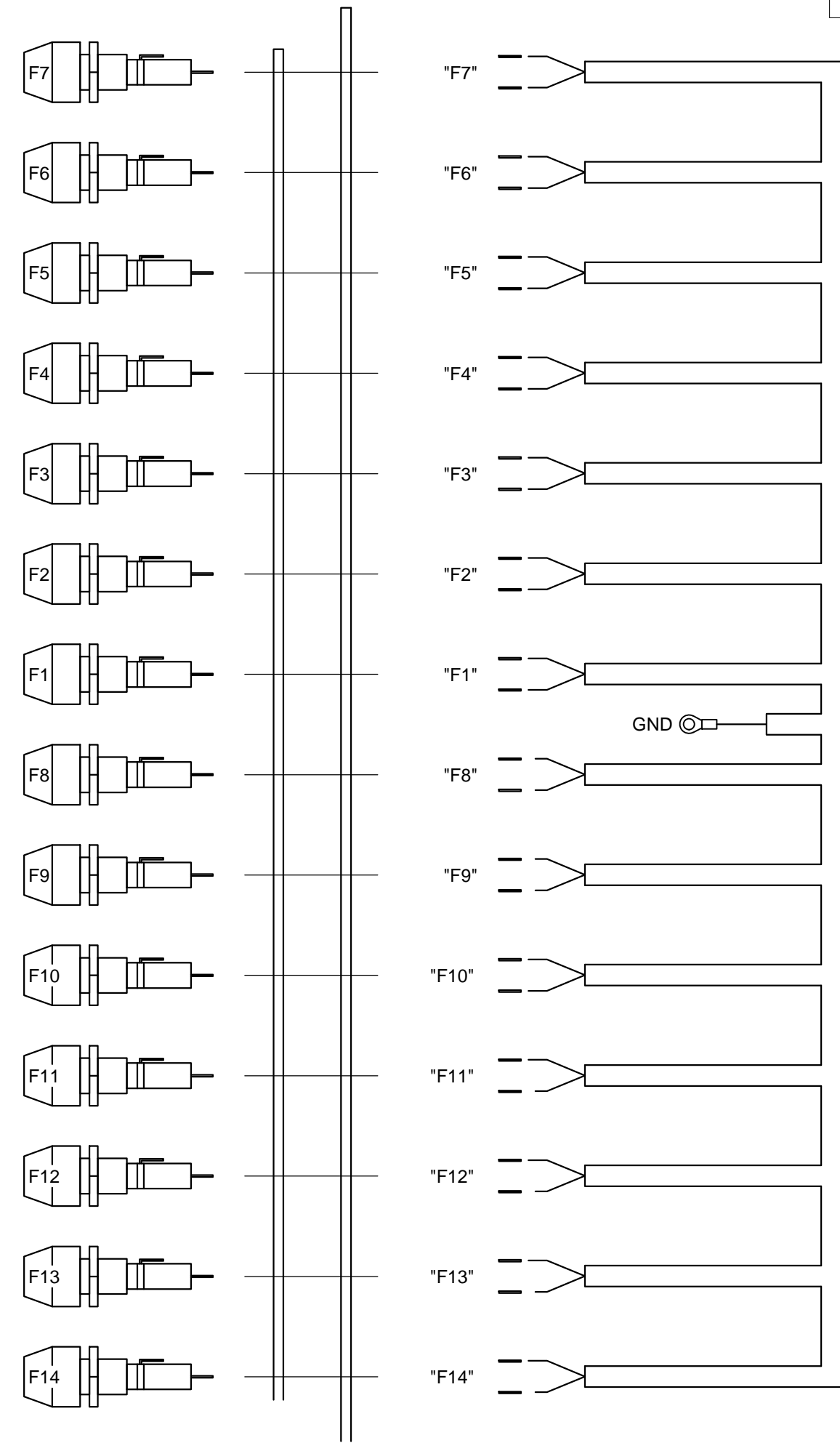
DATE: 02 SEPT 2011  
 INIT: ECO

REV	DATE	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
ECO				

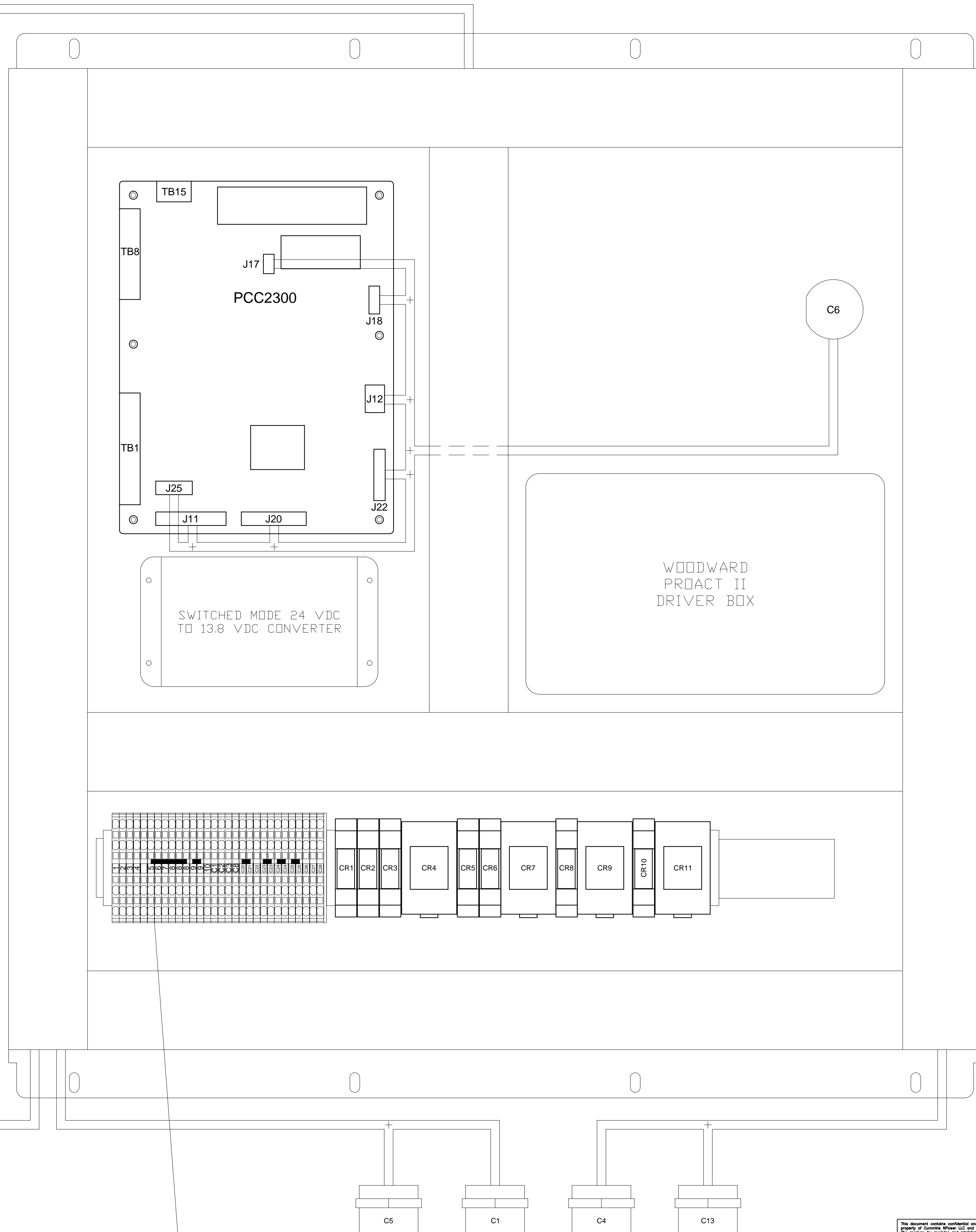




REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING



TERMINAL STRIP DETAIL



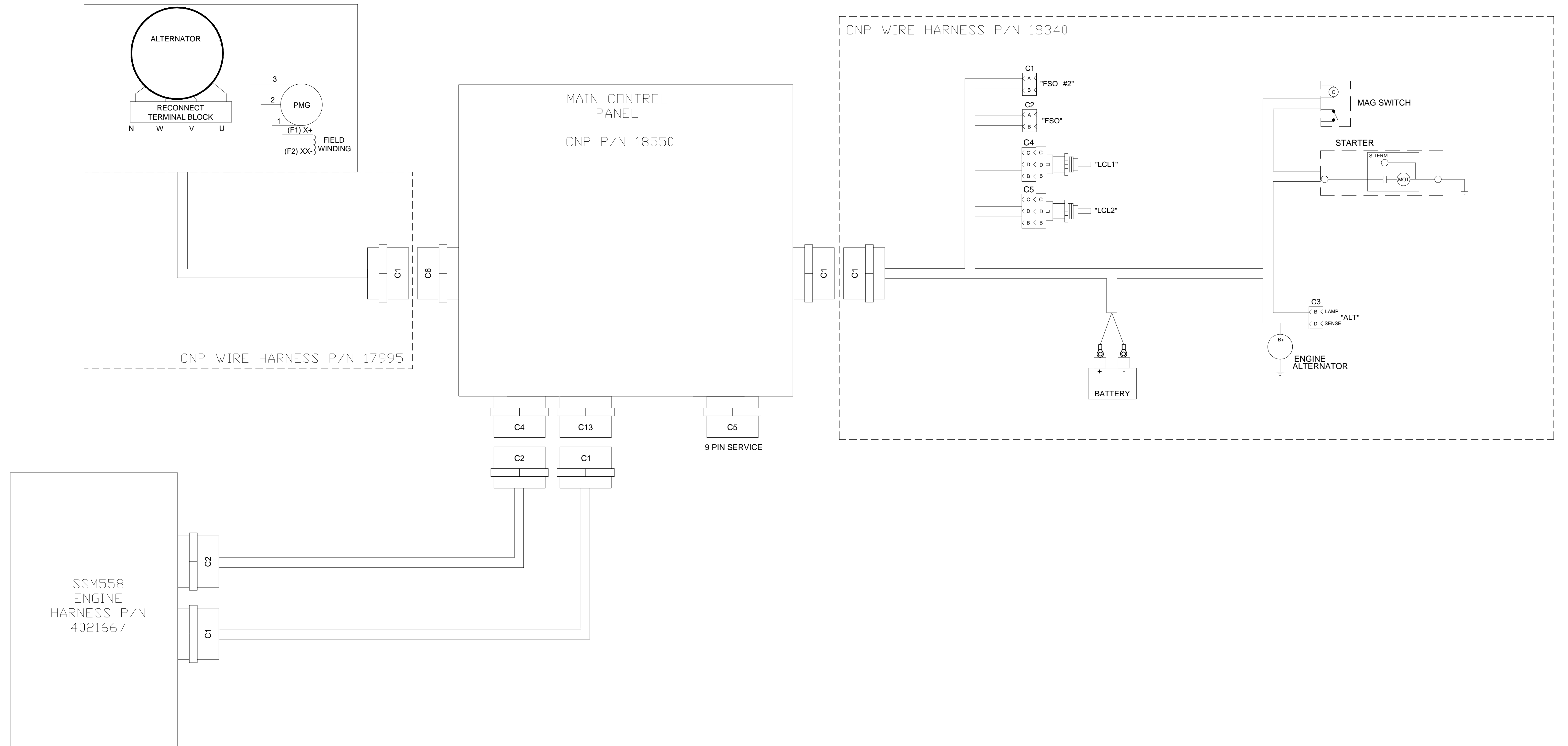
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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
0.005	0.005	0.15
0.010	0.010	0.25
0.015	0.015	0.38
0.020	0.020	0.51
0.030	0.030	0.76
0.040	0.040	1.02
0.050	0.050	1.27

SCHEMATIC, CONTROLS INTERFACE KTA19SLB w/ PCC2300		CUMINS NPOWER LLC CORPORATE OFFICE 1600 BUEKLE ROAD WHITE BEAR LAKE, MN WWW.CUMINSNPOWER.COM	CUSTOM DESIGN AND LIFT CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN
DWG UNITS: INCH/LB/S	DRAWN BY: KAK	DATE: 23 AUG 2011	INIT ECO:
SCALE:	<b>AUTO CAD</b>		
EST WEIGHT:	SHEET 20F3	DRAWING NO: GFEB-PCC2.3-WIRING	

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



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 WWW.CUMMINSPOWER.COM

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 UPRIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

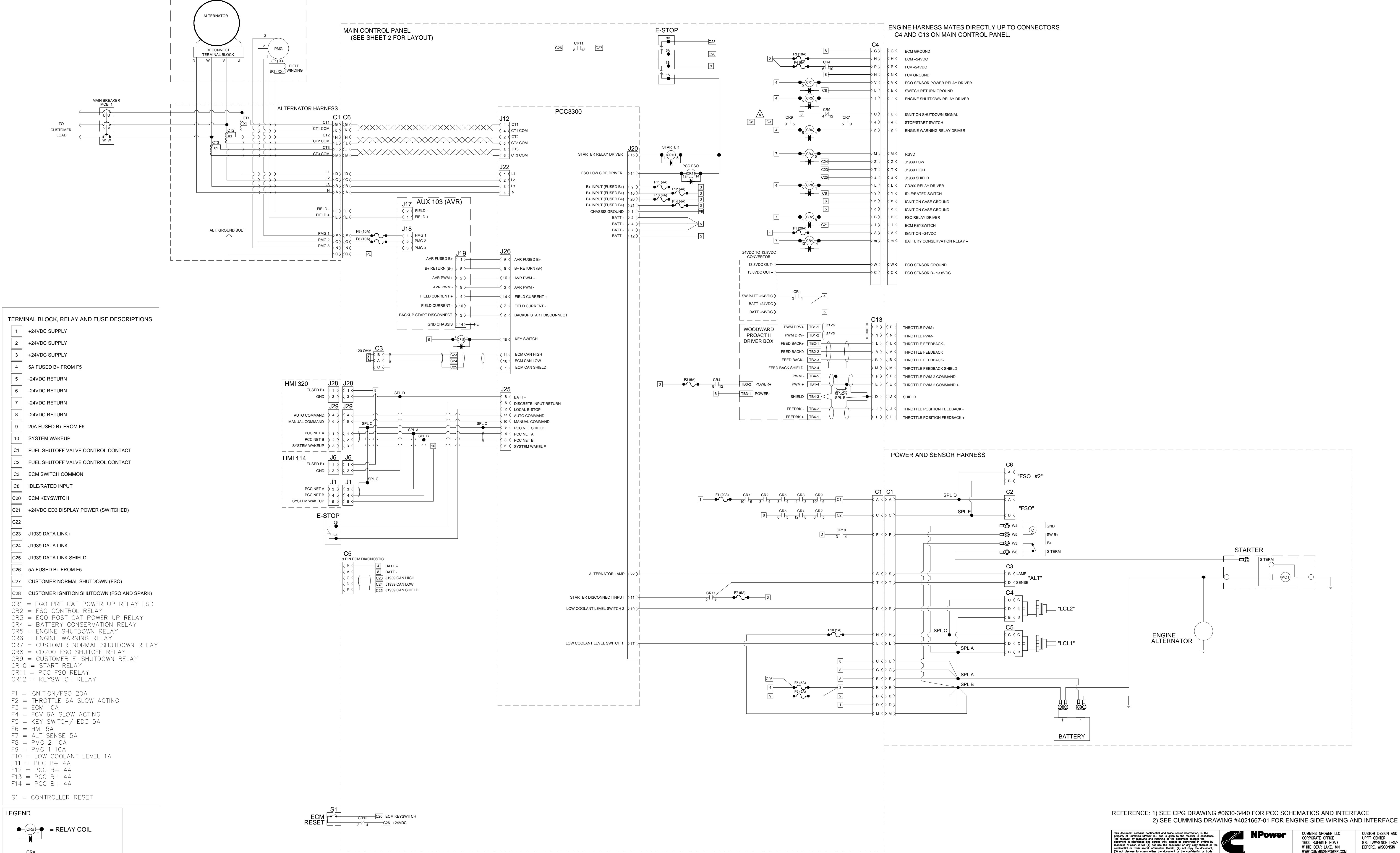
**SCHMATIC, CONTROLS INTERFACE**  
 KTA19SLB W/ PCC2300

DWG UNITS: INCH/LB/S  
 SCALE: EST WEIGHT: SHEET 30F3 DRAWING NO: GFEB-PCC2.3-WIRING

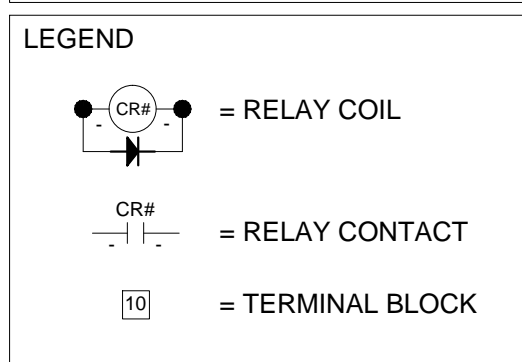
DATE: 23 AUG 2011  
 INIT ECO:

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:  
 ANGULAR DIMENSIONS ± 1°  
 THIRD ANGLE PROJECTION

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLERATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 J1939 DATA LINK+
  - C23 J1939 DATA LINK-
  - C24 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (FSO)
  - C28 CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK)
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = PCC FSO RELAY  
 CR12 = KEYSWITCH RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

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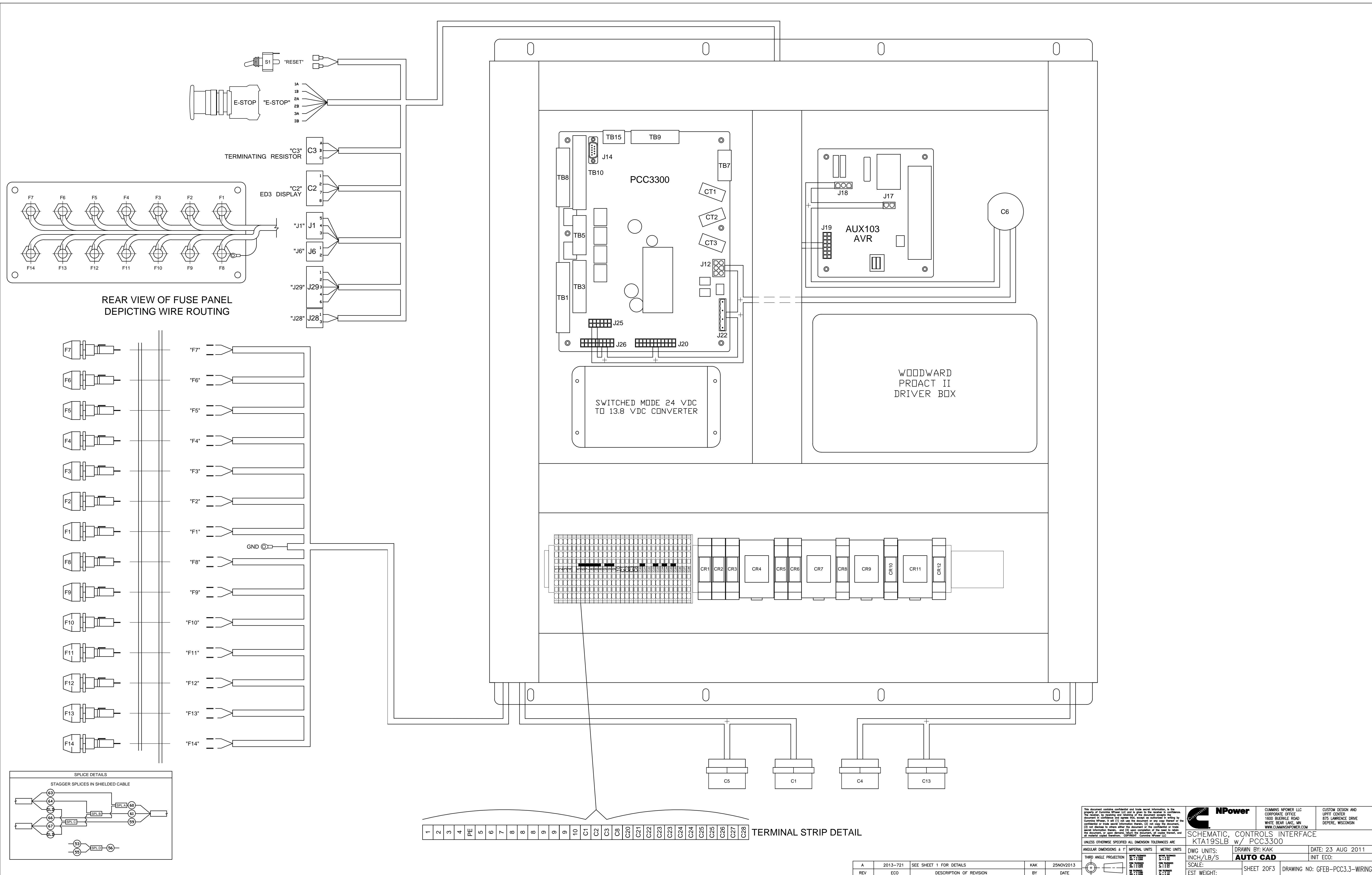
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0.0010	0.0010	0.0254
0.0015	0.0015	0.0381
0.0020	0.0020	0.0508
0.0030	0.0030	0.0762
0.0040	0.0040	0.1016
0.0050	0.0050	0.1270
0.0060	0.0060	0.1524
0.0070	0.0070	0.1778
0.0080	0.0080	0.2032
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 DRAWING NO: GFEB-PCC3.3-WIRING

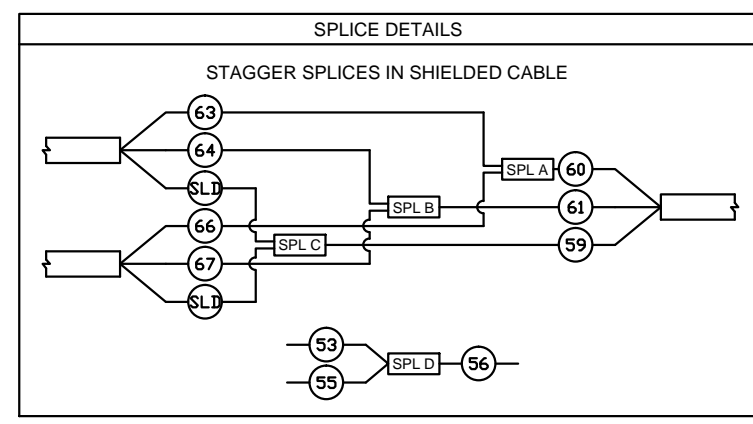
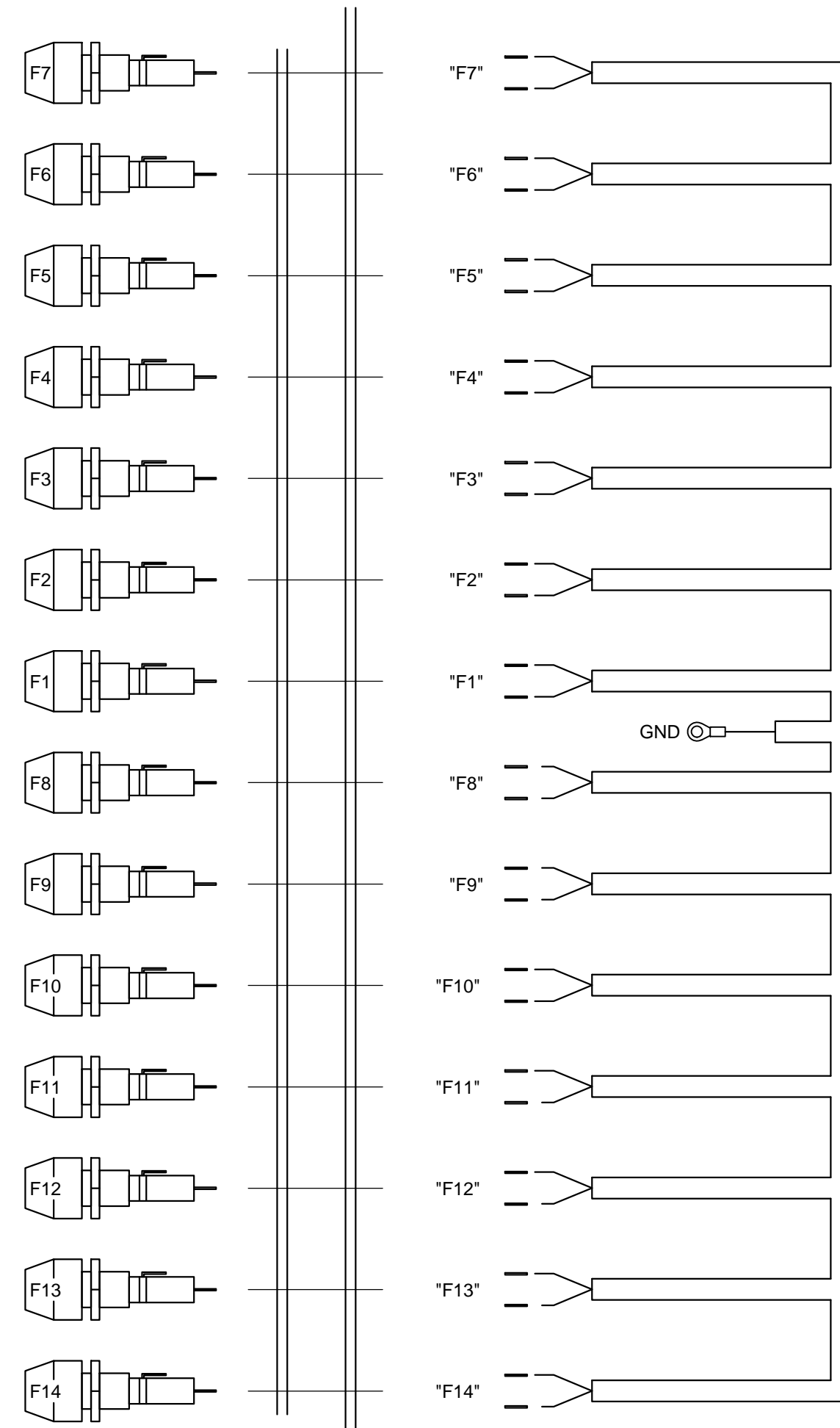
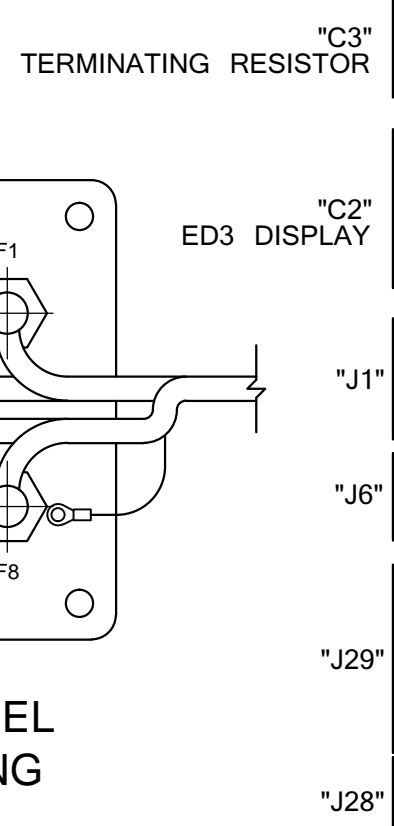
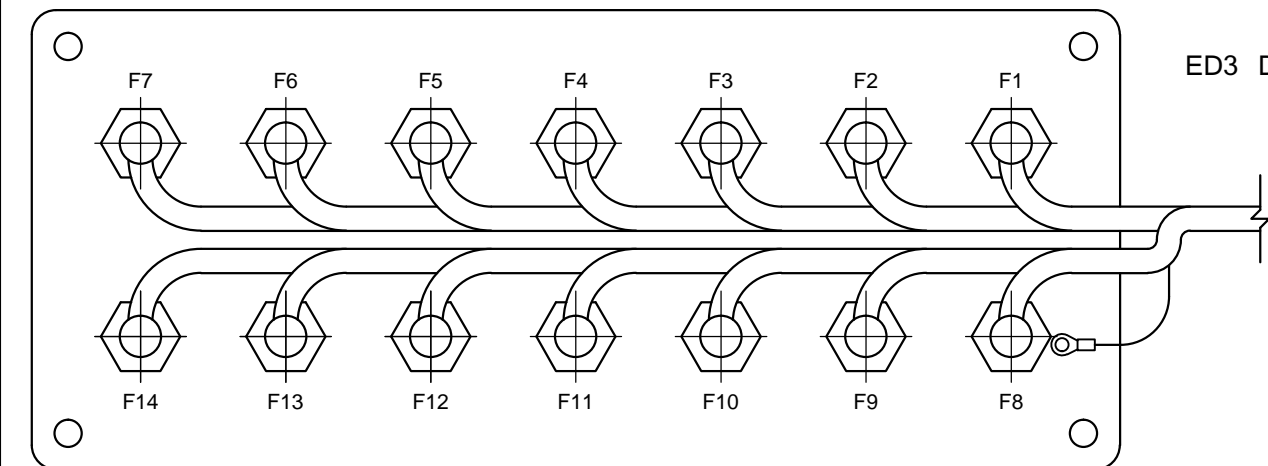
DATE: 23 AUG 2011  
 INIT ECO:  
 DATE: 23 AUG 2011

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	REMOVED C7. ADDED SHEET 3. ADDED JUMPER BETWEEN TERMINALS C3 & C8.	KAK	25NOV2013





REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING



1 2 3 PE 4 5 6 7 8 9 10 C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28

TERMINAL STRIP DETAIL

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE

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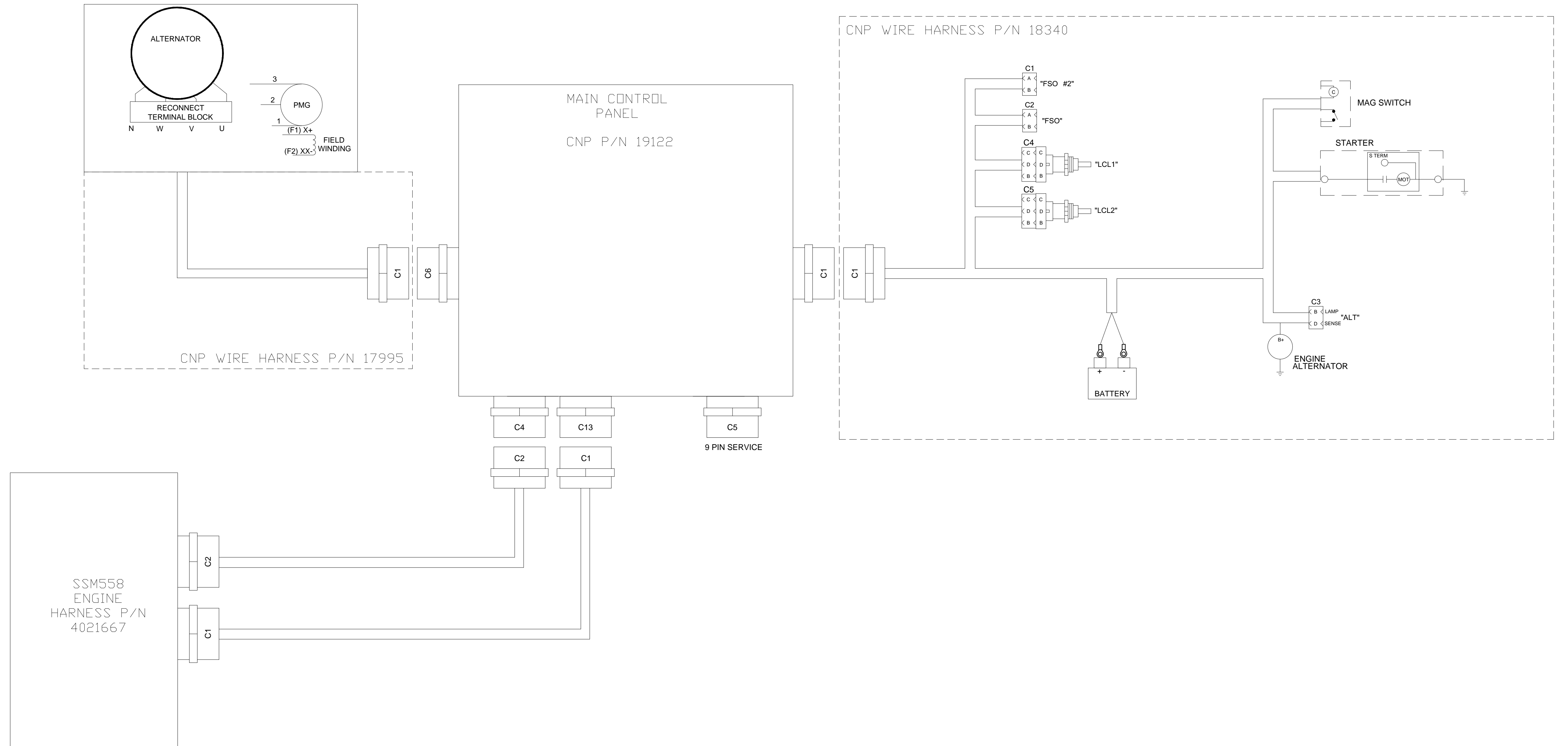
CUSTOM DESIGN AND  
LIFT CENTER  
875 LAWRENCE DRIVE  
DEPERE, WISCONSIN

SCHEMATIC, CONTROLS INTERFACE  
KTA19SLB w/ PCC3300

DWG UNITS: INCH/LB/S  
SCALE: 1:1  
EST WEIGHT: SHEET 20F3

DRAWN BY: KAK  
DATE: 23 AUG 2011  
INIT ECO:  
DRAWING NO: GFEB-PCC3.3-WIRING

ANGULAR DIMENSIONS ± 1°  
THIRD ANGLE PROJECTION  
IMPERIAL UNITS  
METRIC UNITS



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 875 LAWRENCE DRIVE  
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**SCHMATIC, CONTROLS INTERFACE**  
 KTA19SLB W/ PCC3300

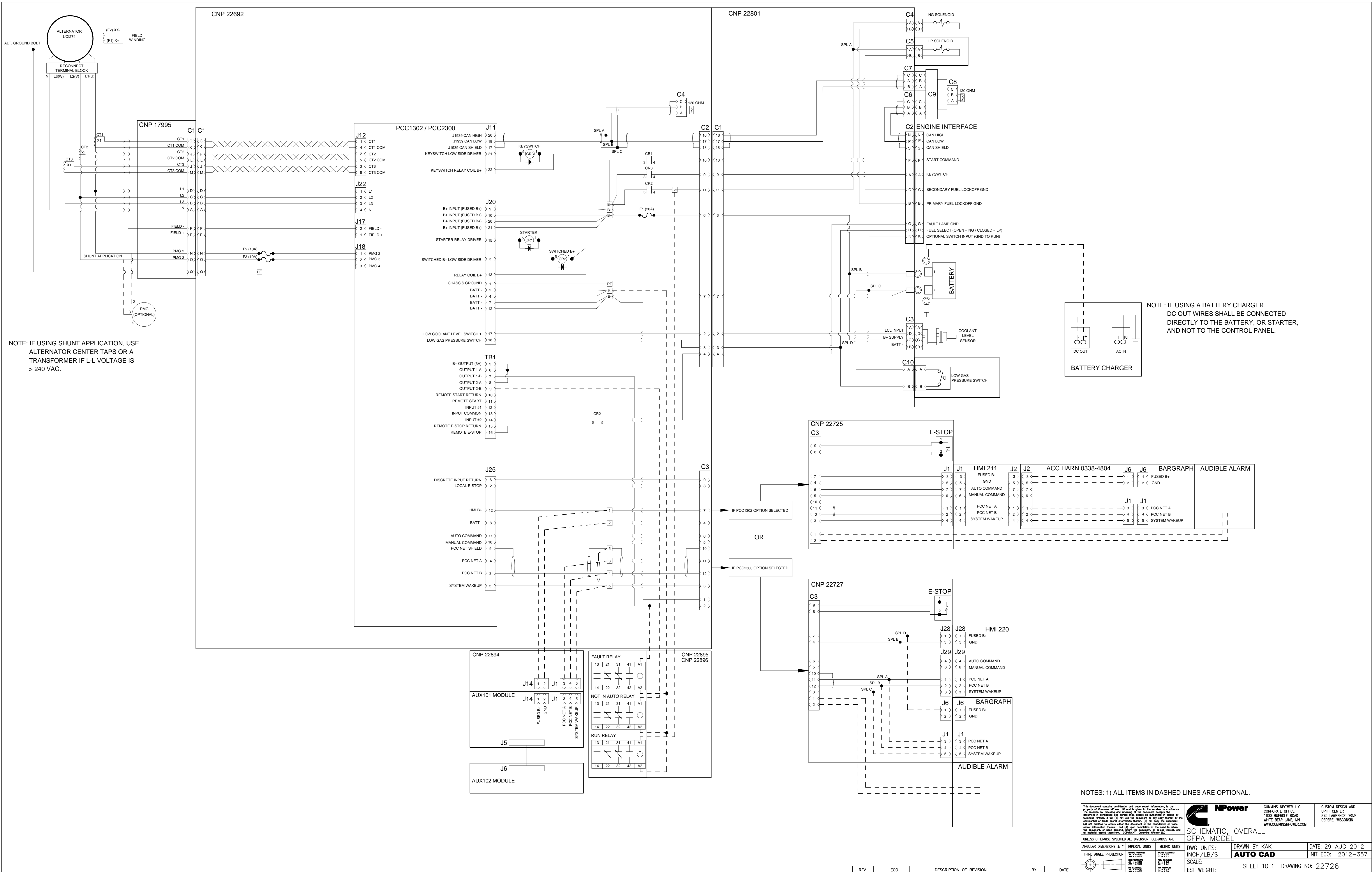
DWG UNITS: INCH/LB/S  
 SCALE: EST WEIGHT: SHEET 30F3 DRAWING NO: GFEB-PCC3.3-WIRING

DATE: 23 AUG 2011  
 INIT ECO:

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	AS SHOWN	AS SHOWN

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013



NOTE: IF USING SHUNT APPLICATION, USE ALTERNATOR CENTER TAPS OR A TRANSFORMER IF L-L VOLTAGE IS > 240 VAC.

NOTE: IF USING A BATTERY CHARGER, DC OUT WIRES SHALL BE CONNECTED DIRECTLY TO THE BATTERY, OR STARTER, AND NOT TO THE CONTROL PANEL.

NOTES: 1) ALL ITEMS IN DASHED LINES ARE OPTIONAL.

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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	INCH/LB/S	MM/KG

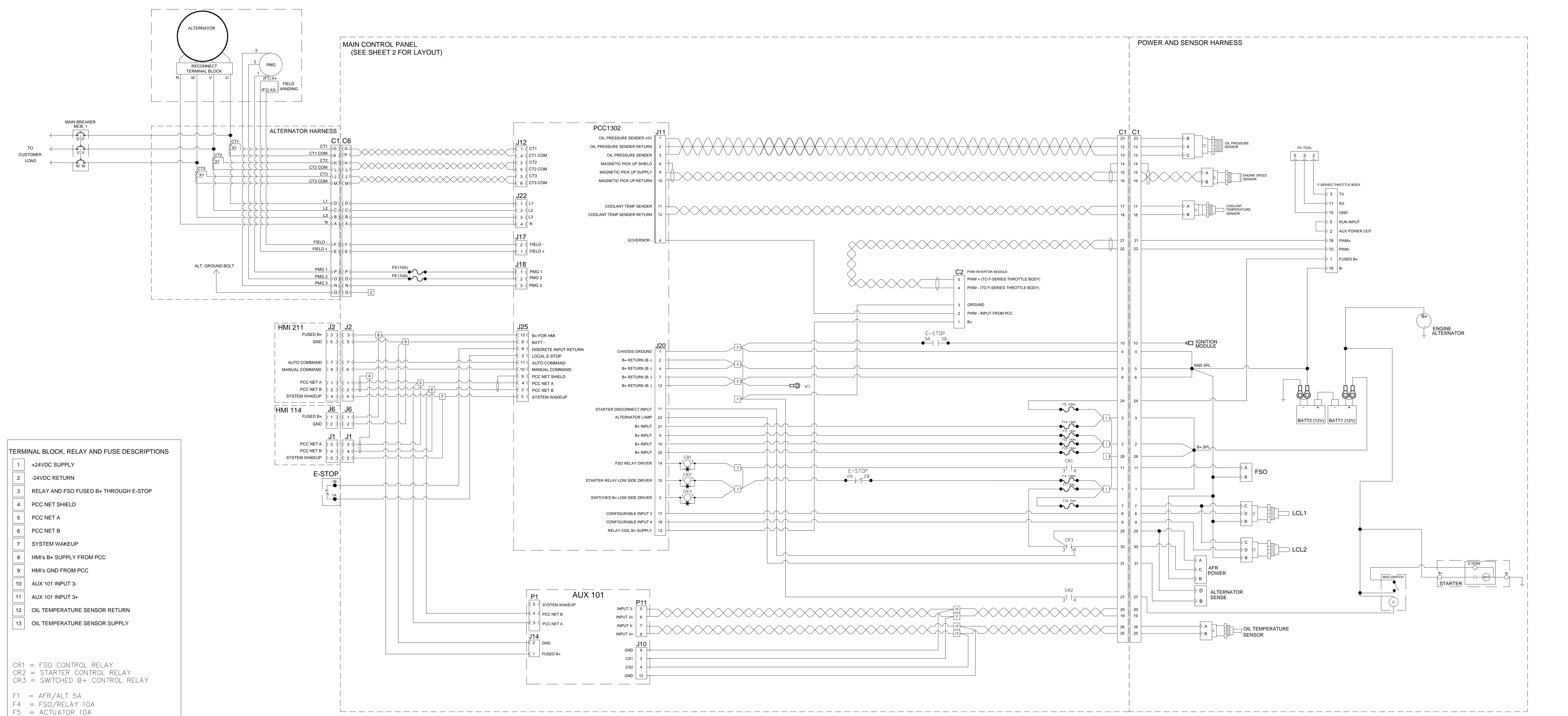
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 SCALE: 1:1  
 EST WEIGHT: SHEET 10F1 DRAWING NO: 22726

DRAWN BY: KAK  
 DATE: 29 AUG 2012  
 INIT ECO: 2012-357

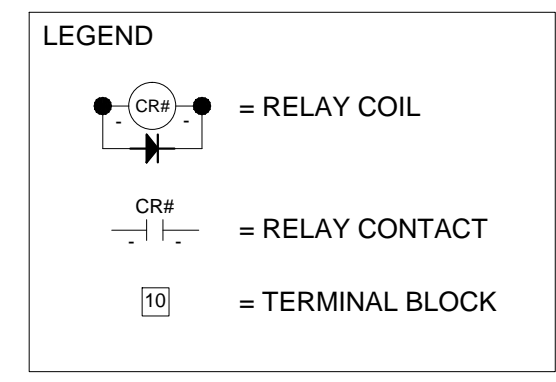
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CUSTOM DESIGN AND  
 UPRIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

REV	ECO	DESCRIPTION OF REVISION	BY	DATE



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 -24VDC RETURN
  - 3 RELAY AND FSO FUSED B+ THROUGH E-STOP
  - 4 PCC NET SHIELD
  - 5 PCC NET A
  - 6 PCC NET B
  - 7 SYSTEM WAKEUP
  - 8 HMI's B+ SUPPLY FROM PCC
  - 9 HMI's GND FROM PCC
  - 10 AUX 101 INPUT 3-
  - 11 AUX 101 INPUT 3+
  - 12 OIL TEMPERATURE SENSOR RETURN
  - 13 OIL TEMPERATURE SENSOR SUPPLY
- CR1 = FSO CONTROL RELAY  
 CR2 = STARTER CONTROL RELAY  
 CR3 = SWITCHED B+ CONTROL RELAY
- F1 = AFR/ALT 5A  
 F4 = FSO/RELAY 10A  
 F5 = ACTUATOR 10A  
 F8 = PMG 1 10A  
 F9 = PMG 2 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC 4A  
 F12 = PCC 4A  
 F13 = PCC 4A  
 F14 = PCC 4A



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE

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	± 0.005	± 0.13
	± 0.010	± 0.25
	± 0.015	± 0.38
	± 0.030	± 0.76

**SCHEMATIC, CONTROLS INTERFACE**  
 HM ENG W/ PCC1302

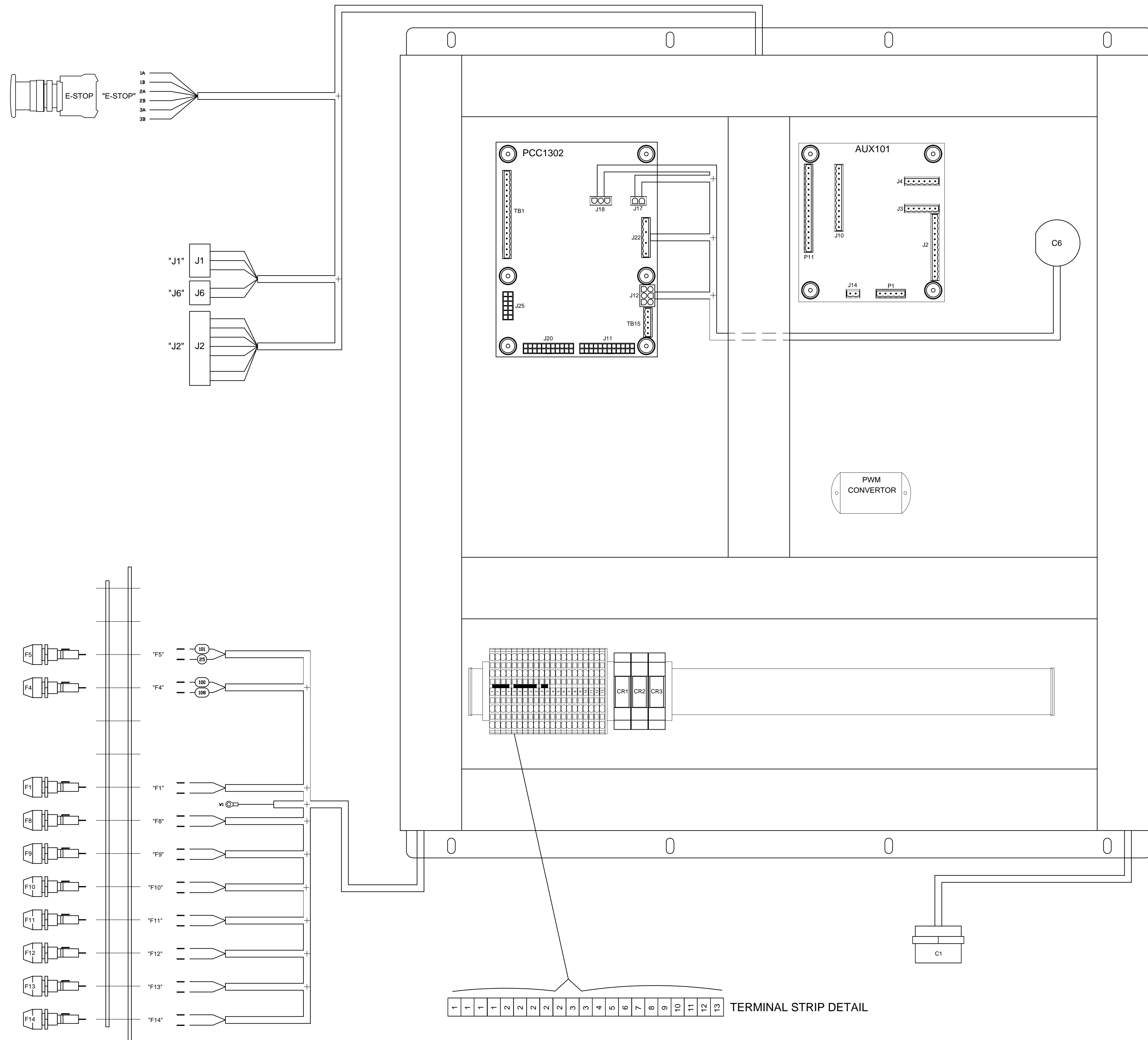
DWG UNITS: INCH/LB/S  
 SCALE: **AUTO CAD**  
 EST WEIGHT: SHEET 10F2 DRAWING NO: 25538

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 WHITE BEAR LAKE, MN  
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CUSTOM DESIGN AND  
 UPRIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

DATE: 31 MAY 2013  
 INIT ECO:  
 DRAWN BY: KAK

REV	ECO	DESCRIPTION OF REVISION	BY	DATE



1 1 1 2 2 2 3 3 4 5 6 7 8 9 10 11 12 13 **TERMINAL STRIP DETAIL**

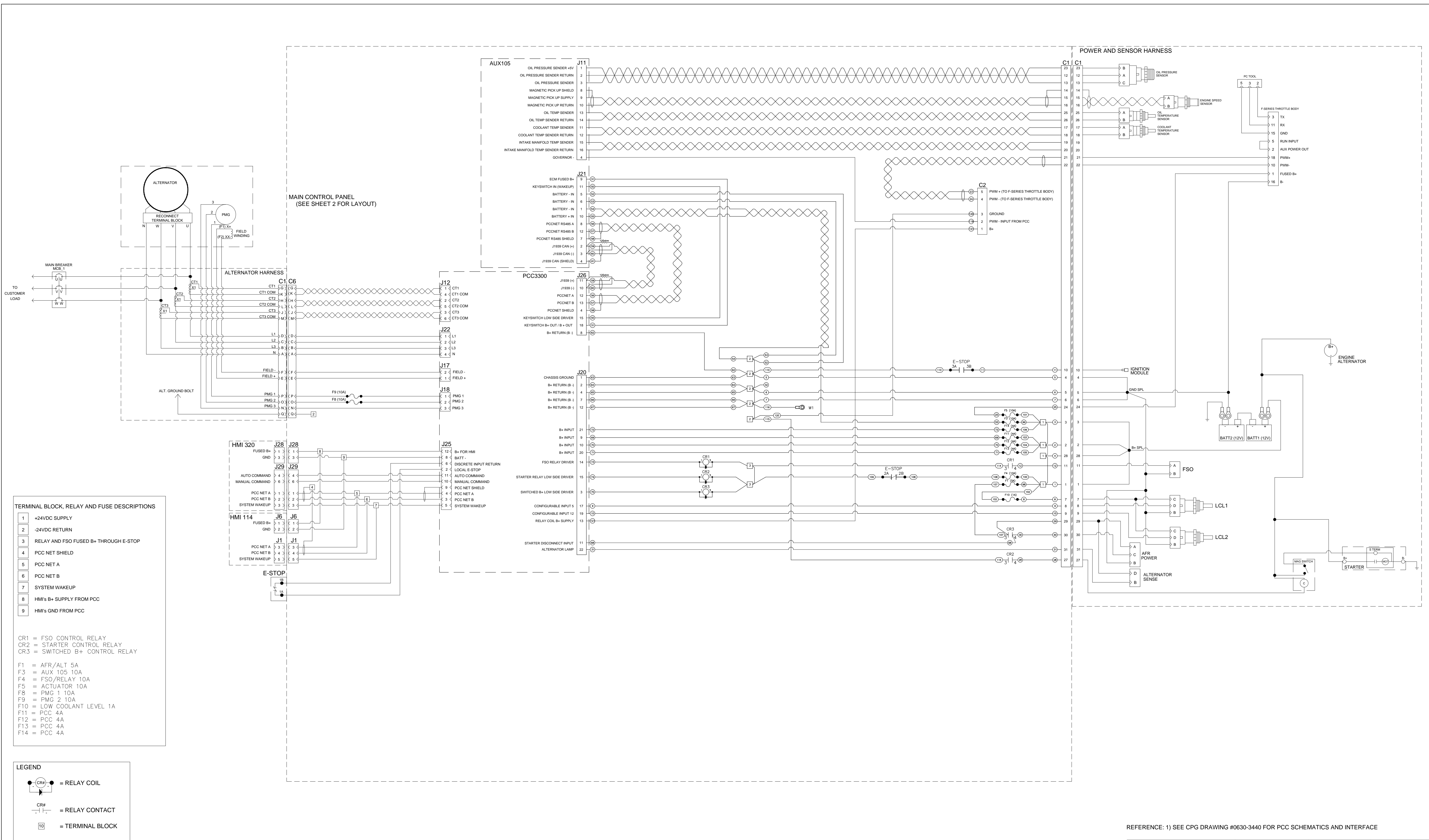
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	0.0010" (0.0254mm)	0.0508mm (0.0020")
	0.0020" (0.0508mm)	0.1016mm (0.0040")
	0.0050" (0.1270mm)	0.2540mm (0.0100")

<p><b>CONROLS, INTERFACE BOX</b> HM ENG W/ PCC1302</p>	<p><b>Cummins NPower</b> CORPORATE OFFICE 1600 BLUEKLE ROAD WHITE BEAR LAKE, WI WWW.CUMMINSPOWER.COM</p>	<p>CUMMINS NPOWER LLC CORPORATE OFFICE 1600 BLUEKLE ROAD WHITE BEAR LAKE, WI WWW.CUMMINSPOWER.COM</p>	<p>CUSTOM DESIGN AND LIFT CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN</p>
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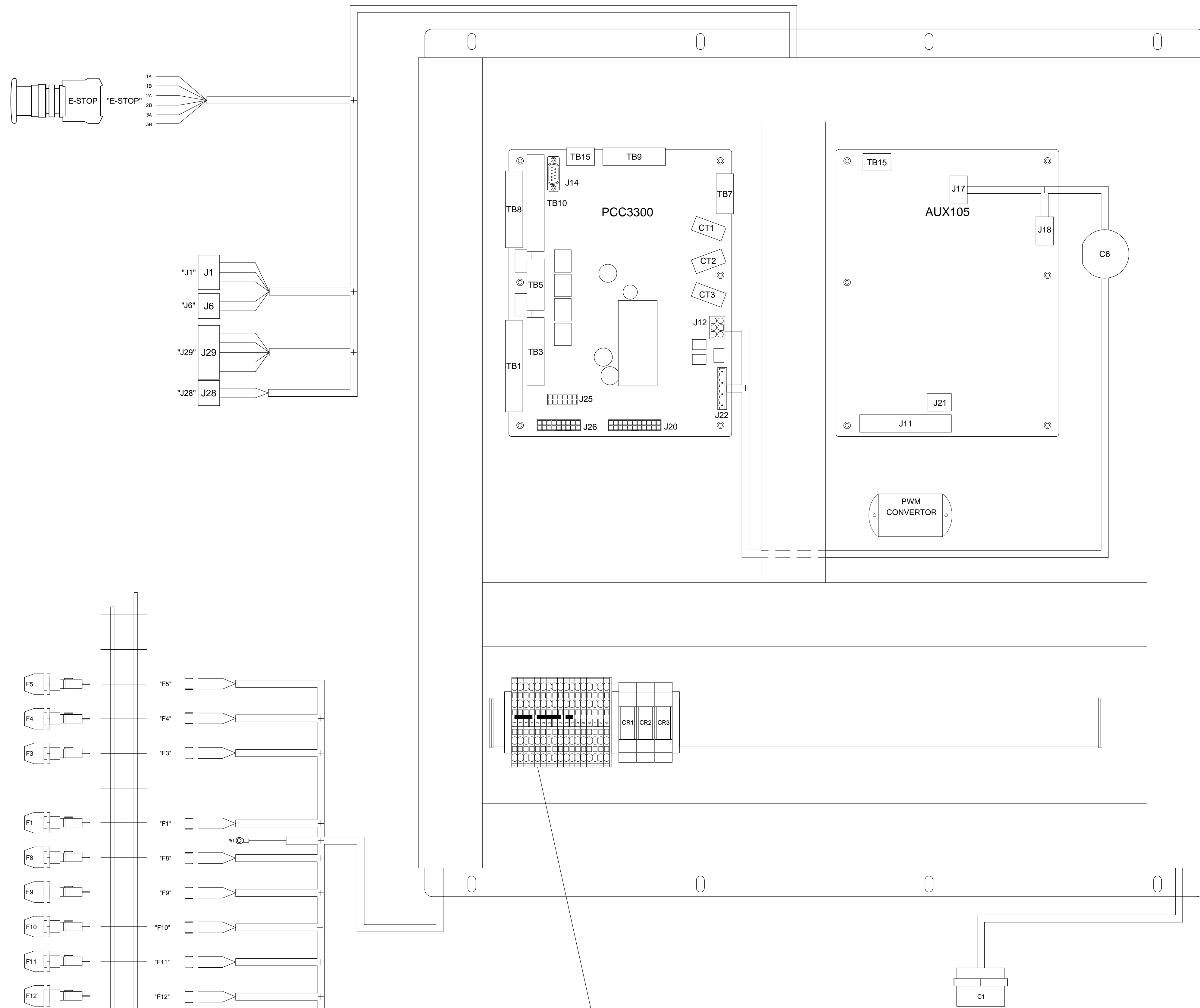
**SCHEMATIC, CONTROLS INTERFACE**  
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**CONTROLS, INTERFACE BOX**  
 HM ENG W/ PCC3300

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	0.010" (0.254mm)	0.200mm
	0.015" (0.381mm)	0.300mm
	0.030" (0.762mm)	0.600mm
	0.060" (1.524mm)	1.200mm
	0.125" (3.175mm)	2.500mm

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Cummins NPower, LLC  
1600 Buerkle Rd  
White Bear Lake, MN 55110  
Customer Assistance Center: 1 866 831 7620  
[www.cumminsnpower.com](http://www.cumminsnpower.com)



# Operator Manual



## **Generator Set**

### Cummins NPower GF Series



This manual contains proprietary information to equipment produced by Cummins NPower LLC and Cummins Inc. and is being supplied solely for the purpose of operating, maintaining, and servicing the natural gas generator set purchased from Cummins NPower LLC.

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## Cummins NPower LLC Generator Sets Limited Warranty

### Commercial Generating Set

This limited warranty applies to all Cummins NPower LLC (hereinafter referred to as "Cummins NPower" branded commercial generating sets and associated accessories (hereinafter referred to as "Product"). This warranty covers any failures of the Product, under normal use and service, which result from a defect in material or factory workmanship.

### Warranty Period:

The warranty start date for stationary Product is the date of initial start up, demonstration or 18 months after factory ship date, whichever is sooner. The warranty start date for rental or oil and gas products is the date of receipt of Product by the end customer. See table for details.

#### Base Warranty Duration (Whichever occurs first)

Rating	Months	Maximum Hours
Emergency Standby Power (ESP)	12	500
Prime Power (PRP)	12	Unlimited

**Emergency Standby Power (ESP)** is defined as the maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a reliable utility power outage. The permissible average power output over 24 hours of operation shall not exceed 70% of the ESP. For applications supporting an unreliable utility service, the Prime Power (PRP) rating should be used.

**Prime Power (PRP)** is defined as being the maximum power which a generating set is capable of delivering continuously while supplying a variable electrical load. The permissible average power output over 24 hours of operation shall not exceed 70% of the PRP.

### Cummins NPower Responsibilities:

In the event of a failure of the Product during the warranty period due to defects in material or workmanship, Cummins NPower will only be responsible for the following costs:

- All parts and labor required to repair the Product.
- Reasonable travel expenses to and from the Product site location.
- Maintenance items that are contaminated or damaged by a warrantable failure.

### Owner Responsibilities:

The owner will be responsible for the following:

- Notifying Cummins NPower distributor or dealer within 30 days of the discovery of failure.
- Installing, operating, commissioning and maintaining the Product in accordance with Cummins NPower's published policies and guidelines.
- Providing evidence for date of commissioning.
- Providing sufficient access to and reasonable ability to remove the Product from the installation in the event of a warrantable failure.

In addition, the owner will be responsible for:

- Incremental costs and expenses associated with Product removal and reinstallation resulting from difficult or non-standard installations.
- Costs associated with rental of generating sets used to replace the Product being repaired.
- Costs associated with labor overtime and premium shipping requested by the owner.
- All downtime expenses, fines, all applicable taxes, and other losses resulting from a warrantable failure.



### **Limitations:**

This limited warranty does not cover Product failures resulting from:

- Inappropriate use relative to designated power rating or application guidelines.
- Normal wear and tear, negligence, accidents or misuse.
- Improper and/or unauthorized installation.
- Lack of maintenance or unauthorized repair.
- Noncompliance with any Cummins NPower published guideline or policy.
- Use of improper or contaminated fuels, coolants or lubricants.
- Improper storage before and after commissioning.
- Owner's delay in making Product available after notification of potential Product problem.
- Replacement parts and accessories not authorized by Cummins NPower.
- Use of Battle Short Mode.
- Owner or operator abuse or neglect such as: operation without adequate coolant or lubricants; over-fueling; over-speeding; lack of maintenance to lubricating, cooling or air intake systems; late servicing and maintenance; improper storage, starting, warm-up, run-in or shutdown practices, or for progressive damage resulting from a defective shutdown or warning device.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the generating set.

This limited warranty does not apply to:

- Costs of maintenance, adjustments, installation, commissioning or start-up.
- Starting batteries, heating elements, trailers and enclosures.
- Components added to the Product after shipment from Cummins NPower.

Please contact your local Cummins NPower Distributor for clarification concerning these limitations.

### **Extended Warranty**

Cummins NPower offers the Cummins ENCOMPASS Extended Coverage program for parts and labor as listed in Cummins Bulletin # 3624424 for a period of 5 years or 2000 hours.

### **Cummins NPower Right to Failed Components:**

Failed components claimed under warranty remain the property of Cummins NPower. Cummins NPower has the right to reclaim any failed component that has been replaced under warranty.

**THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS NPOWER IN REGARD TO THE PRODUCT. CUMMINS NPOWER MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT IS CUMMINS NPOWER LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

This limited warranty shall be enforced to the maximum extent permitted by applicable law. This limited warranty gives the owner specific rights that may vary from state to state or from jurisdiction to jurisdiction.



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# Section 1 - Safety

IMPORTANT SAFETY INSTRUCTIONS - This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries. SAVE THESE INSTRUCTIONS.

Before operating the generator set (genset), read the Operator Manual, become familiar with it and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

## 1.1 Advisory and Cautionary Statements

Advisory and Cautionary Statements are used throughout this manual to call attention to special information, correct operating procedures, and safety precautions.

**NOTE:** *A general advisory statement relating to equipment operation and maintenance procedures.*

**IMPORTANT:** *A specific advisory statement intended to prevent damage to the equipment or associated components.*

Cautionary Statements consist of three levels:



**This symbol warns of immediate hazards which will result in severe personal injury or death.**



**This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.**



**CAUTION**  
***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***



**CAUTION**  
***Fuel And Fumes Are Flammable.***

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while the engine is running unless the tanks are outside the engine compartment. Fuel contact with the hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. The fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Natural gas is lighter than air, and will tend to gather under hoods. Propane is heavier than air, and will tend to gather in sumps or low areas. NFPA code requires all persons handling propane to be trained and qualified.
- Be sure all fuel supplies have a positive shut-off valve.
- Be sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.



**WARNING**  
***Exhaust Gases Are Deadly.***

---

## **WARNING**

***The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.***

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

## **WARNING**

***Moving Parts Can Cause Severe Personal Injury or Death.***

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, depress the E-stop, then disconnect the starting batteries, negative (-) cable first. This will prevent accidental starting.

**NOTE:** *ECM Engines can sustain damage if not Keyed Off when battery is disconnected. E-stop depress with Key Off control.*

- Make sure that fasteners on the generator set are secure. Tighten supports and clamps. Keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

## **WARNING**

***Electrical Shock Can Cause Severe Personal Injury or Death.***

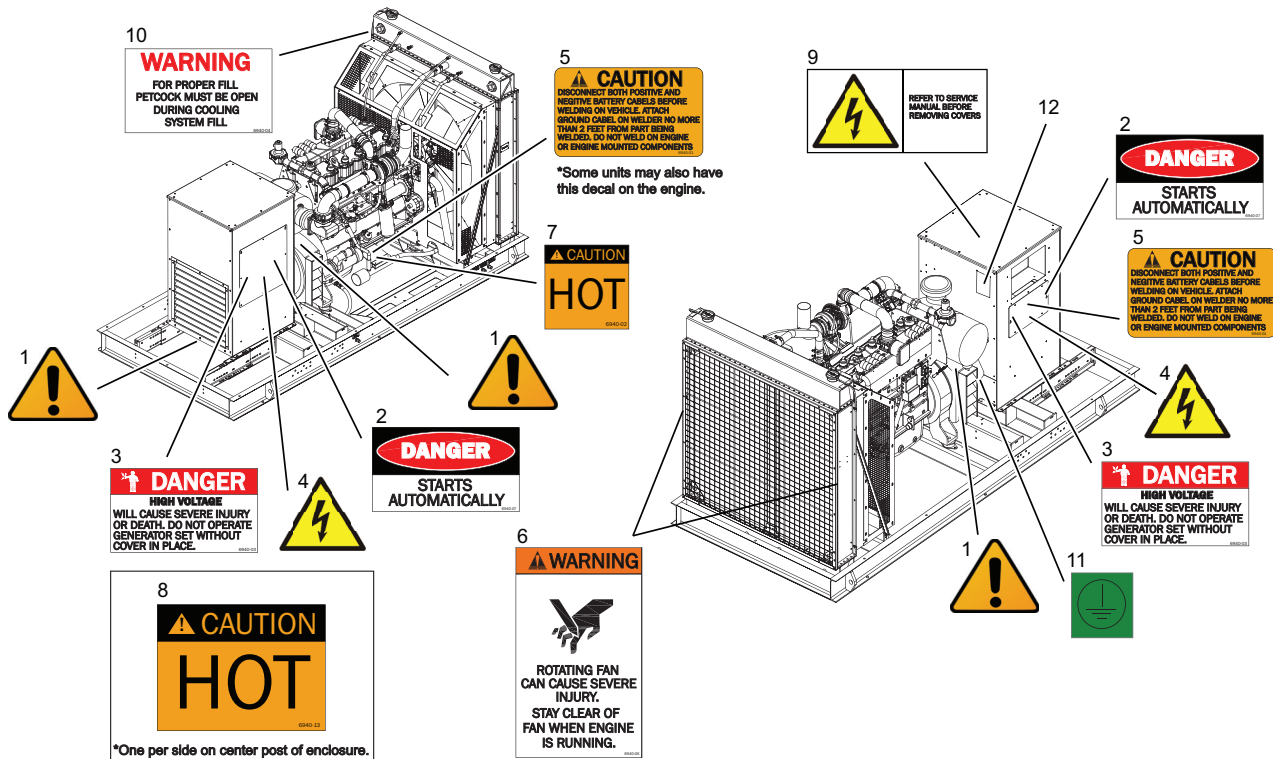
- Disconnect electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

## **General Safety Precautions**

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires involve combustible and flammable liquid fuels and gaseous fuels; Class C fires involve live electrical equipment. (Ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.

- Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breathe or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, turbo charger, and exhaust system.

## 1.2 Safety/Data Labels



- |  |   |
|--|---|
| 1. Decal, Caution                            | 8. Decal, Caution Hot, Lg (P/N 6940-13) (Enclosed Units Only) |
| 2. Decal, Danger Auto Start (P/N 6940-07)    | 9. Decal, Caution Cover                                       |
| 3. Decal, Danger High Voltage (P/N 6940-03)  | 10. Decal, Warning Petcock (P/N 6940-04) (KTA19 Only)         |
| 4. Decal, Caution Shock Hazard               | 11. Decal, Ground   |
| 5. Decal, Caution Welding (P/N 6940-01)      | 12. Data Tag, Genset (P/N 24588)                              |
| 6. Decal, Warning Rotating Fan (P/N 6940-06) |   |
| 7. Decal, Caution Hot, Sm (P/N 6940-02)      |   |

Figure 1-1 Generator Decal Locations (typical)

---

**KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE**



## Section 2 - Introduction

Each operator should read this manual before operating the generator set for the first time. A generator set (genset) must be operated and maintained properly if you are to expect safe and reliable operation. This manual includes a troubleshooting guide and a maintenance schedule.

### **WARNING**

*Improper operation and maintenance can lead to severe personal injury or loss of life and property by fire, electrocution, mechanical breakdown, or exhaust gas asphyxiation. Read and follow the safety precautions in [Section 1](#) and carefully observe all instructions and precautions in this manual.*

### **2.1 How to Obtain Service**

When the generator set requires servicing, contact your nearest Authorized Cummins Distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

To contact your local Authorized Cummins Distributor in the United States or Canada, call 1-800-DIESELS (this automated service utilizes touch-tone phones only). By selecting Option 1 (press 1), you will be automatically connected to the nearest distributor.

If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS-ELECTRIC or  
ELECTRICAL PRODUCTS

For outside North America, call your nearest Authorized Cummins Distributor, or visit our website at [www.cummins.com](http://www.cummins.com) for distributor information.

When contacting your distributor, always supply the complete Model, Specification, and Serial Number as shown on the generator set nameplate.

### **WARNING**

*Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and /or mechanical service.*

### **2.1.1 Engine Related Inquiries (Model 150GFPA)**

For engine related inquiries please contact PSI department technical service support representative at 1-888-331-5764, or e-mail [service@powergreat-lakes.com](mailto:service@powergreat-lakes.com) for more information. For questions about generator controls on this model please contact Npower service at 1-866-831-7620.

### **2.2 Product Modifications**

Agency certified products purchased from Cummins NPower comply only with those specific requirements and as noted on company product specification sheets. Subsequent modifications must meet commonly accepted engineering practices and/or local, state and national codes and standards. Product modifications must be submitted to the local authority having jurisdiction for approval.

The information, specifications, and recommended guidelines in this manual are based on information in effect at the time of printing. Cummins Npower, LLC. and Cummins, Inc. reserves the right to make changes at any time without obligation. If you find differences between your engine and the information in this manual, contact your local Cummins Authorized Repair Location or call 1-800-DIESEL (1-800-343-7357) toll free in the U.S. and Canada.





## Section 3 - Operation

The following describes the function and operation of the PowerCommand® Control (PCC).

The PCC controls the starting and stopping sequence of the engine through the ECM (mounted on the engine). Referenced in separate manuals as indicated in [Figure 3-1](#). The function and operation of the Electronic Control Module (ECM) and how it interfaces with PCC control is also identified in the manuals.

This section covers pre-start checks, starting and stopping and operating the generator set. Each operator should read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set and the PCC control. Refer to [Section 6](#) for operating recommendations.

### **WARNING**

***Before operating the generator set become familiar with the equipment and how it is operated (including all controls, manually operated valves and alarm devices). Safe and efficient operation can only be achieved if the unit is operated correctly.***

Before starting, be sure the following checks have been made and the unit is ready for operation.

### **WARNING**

***It is the owner/operator's responsibility to complete site specific emission requirements to ensure compliance with the US EPA SI NSPS.***

Emissions on this Generator Set must be dialed-in at the job-site per the following requirements before operation:

GTA855E refer to manual 4325956 and AEB 10.124 and 24.52

KTA19SLB refer to AEB 28.07

### 3.1 Operator's Pre-Start Checks

#### 3.1.1 Lubrication

Check the engine oil level. Keep the oil level as near as possible to the dipstick high mark without overfilling.

**NOTE:** *Generator sets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check oil level before initial start. Failure to fill to the recommended level can result in equipment damage.*

#### 3.1.2 Coolant

Check the engine coolant level and ensure that the level is always maintained at the coolant expansion tank. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check while the engine is hot.

#### 3.1.3 Fuel

Make sure that the fuel tank is filled to the normal level and that the fuel system is primed and all the valves required for operation are open. Make sure that there are no leaks and that all fittings are tight.

#### 3.1.4 Ventilation

Make sure the generator set cooling inlet/outlet and exhaust ventilation openings are unobstructed and operational.

Remove all loose debris from the surrounding area of the generator set. Air flow from the radiator fan can blow loose items around and into ventilation openings.

#### 3.1.5 Exhaust Outlet

Make sure that exhaust components are secured and not warped; that not combustible materials are near the system, and gases are discharged away from building openings. Make sure that there are no leaks and that all fittings are tight.





## WARNING

**Exhaust gas is deadly! Exhaust gasses contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:**

- Dizziness
- Nausea
- Headache
- Weakness and sleepiness
- Throbbing in temples
- Muscular twitching
- Vomiting
- Inability to think coherently

If you, or anyone else, experience any of these symptoms, get out into the fresh air immediately! If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspection of the complete exhaust system.

### 3.1.6 Batteries

Make sure that the batteries are charged, that the electrolyte is at the correct level and that all connections are correct.

### 3.1.7 Emergency Stop Button

Push this button in for emergency shutdown of the generator set. This will stop the generator set immediately and prevent starting of the set from any location (local and remote).

To reset:

1. Pull the button and allow it to pop out.
2. Turn the **Off/Manual/Auto** switch to **O (Off)**.
3. Press the front panel Fault Acknowledge/Reset button.
4. Return **Off/Manual/Auto** switch to desired position.

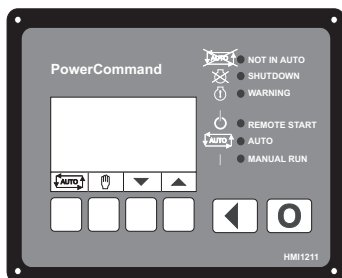
**IMPORTANT:** *Emergency Stop shutdown can be reset only at the PCC front panel.*

## 3.2 Control Panel

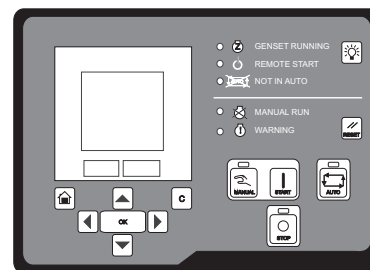
There are several PowerCommand® Control options available. For more information on a specific option model, refer to the PowerCommand® Control manual shipped with the unit. The following chart lists each option available and shows a figure depicting the option's configuration.

**Table 3-1 PowerCommand® Control Options**

Description	Part Numbers	Figure Number
PCC 1.1 (1302) Owner Manual	900-0661	Figure 3-1
PCC 2.2 (2300) Operator Manual	900-0665	Figure 3-2
PCC 3.3 (3300) Owner Manual	A029M414	Figure 3-3

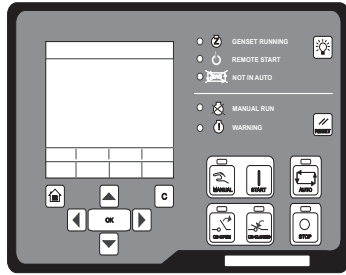


**Figure 3-1 PCC 1.1 (1302)**



**Figure 3-2 PCC 2.2 (2200)**





**Figure 3-3 PCC3.2 (3200)**

**NOTE:** 1302 Control with HMI211 [Figure 3-1](#) is provided on GTA855 and GTA19 Mechanical Engines as standard. 1302 Control with HMI220 [Figure 3-2](#) is provided on GTA28, 38, 50 Mechanical Engines as standard.

**! WARNING**

**Contacting high voltage components can cause severe personal injury or death by electrocution. Do not open the generator output box while the generator set is running. Read and observe all warning and cautions in your generator set manuals.**

**! CAUTION**

**Only technically qualified personnel should open the control housing. Voltages are present which can cause electrical shock, resulting in personal injury. Even with the power removed, improper handling of components can cause electrostatic discharge and damage circuit board components.**

**3.3 Electronic Control Module (ECM)**

The PCC controls the starting and stopping sequence of the engine. On electrical engines the ECM drives and monitors engine functions and energizes the starter solenoid through start relay K4 and disconnects the starter. The ECM governs engine speed and performs all engine control, monitoring, and diagnostic functions.

**NOTE:** The PCC displays engine oil pressure, coolant temperature, coolant level and speed. The ECM also monitors engine coolant temperature using a different sensor.

If the ECM shuts down the engine, it will send a signal to the PCC, which will display, ENGINE WARNING (Code 1311). Each digit of the three digit numerical

fault code will be displayed as flashes. There will be a brief pause between digits and a longer pause before the repetition.

**NOTE:** Code 123 may be indicating higher than expected engine coolant temperature. If overheating is suspected, measure coolant temperature with a gauge while the engine is warming up. If the temperature exceeds 107° C (225° F) service the cooling system as necessary. If temperature is not higher than expected but shutdown recurs, the coolant sensor may be faulty.

**NOTE:** Refer to the troubleshooting instructions for each model specific Genset Controls manual as outlined in [Table 3-1](#).

See your Authorized Cummins Distributor regarding the wiring harness and software required for performing engine diagnostics using a PC (laptop).

**3.4 Sequence of Operation**

The generator set is run Automatically using a Remote Start signal or Manually using the generator set control panel buttons. LEDs are provided on the operator panel to indicate the operating Run mode of the generator set. The PowerCommand® controls initiate a starter cranking signal and will perform an automatically sequenced manual start; all under a complete engine protection system combined with full monitoring capability. If a fault is sensed at Start-up, the engine is locked out and will not start.

The choice of Auto or Manual Run mode is decided by authorized personnel during the generator set initial setup. An access code is required to switch between the Auto, Manual Run, or Off modes, and this facility may be permitted or denied by the authorized personnel during the initial setup of the generator set.

**3.5 Starting the Generator Set**

**! CAUTION**

**One operator should be in complete charge, or working under the direction of someone who is in complete charge. Remember that, upon starting the generator set, cables and switchgear will become energized, possibly for the first time. Furthermore, equipment that does not form part of the generator set installation may become electronically charged. Only authorized and competent personnel should carry out this work.**

---

 **CAUTION**

**Do not use the Emergency Stop switch to shut down the generator set unless a serious fault develops. The Emergency Stop push-switch must not be used for a normal shut-down as this will prevent a cooling down run in which the lubricating oil and engine coolant carry the heat away from the engine combustion chamber and bearings in a safe manner.**

 **CAUTION**

**Avoid off-load running for other than short periods. A minimum loading of 30% is recommended. This loading will help to prevent the build up of carbon deposits in the injectors, do to unburnt fuel, and reduce the risk of fuel dilution of the engine lubricating oil. The engine must be shut down as soon as possible after the appropriate functions have been checked.**

Before attempting to start the generator set, the operator should read through this entire manual, together with the Health and Safety manual and the specific engine manual provided as part of the documentation package supplied with the generator set. It is essential that the operator be completely familiar with the generator set and the PowerCommand® controls.

The following sub-sections cover the systems used to start and stop the generator set. Before starting the generator set, make sure that exhaust and fuel fittings are tight and properly positioned, and proper maintenance and pre-start checks have been performed.

During starting, automatic checks are carried out for the integrity of various protection systems. The PowerCommand® control will not allow the generator set to continue the starting sequence if the integrity of a sensor is considered to be in doubt.

The generator set can be configured for a number of starting cycles (one to seven) with set times for crank and rest periods for all starting modes (manual/ remote). The default setting is for three start cycles, composed of fifteen seconds of cranking and 30 seconds of rest.

**NOTE:** *The number of starting cycles, and the crank and rest times are set from within the Setup menu. Trained and experienced service personnel are*

*required to change the default setting. Contact your authorized distributor.*

**NOTE:** *Generator sets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check oil levels before initial start. Failure to fill to the recommended level can result in equipment damage.*

**NOTE:** *Check the coolant level and ensure the level is always maintained at the coolant expansion tank. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check when the engine is hot.*

 **CAUTION**

**It is essential that Cummins Power Generation's recommendations for the correct type and concentration of anti-freeze and DCA inhibitor are complied with. Warranty claims for damage will be rejected if the incorrect mix has been used. Consult your authorized distributor for the correct anti-freeze specifications and concentration for your operating conditions.**

**NOTE:** *Some radiators have two fill necks, both of which must be filled after the cooling system has been drained.*

 **CAUTION**

**Do not attempt to remove a radiator pressure cap while the generator set is running, or is still hot. Hot coolant is under pressure in the radiator system. Contact with hot coolant can result in severe burns. Always allow it to cool before releasing the pressure and removing the cap.**

### 3.5.1 Starting at Operator Panel (Manual Run Mode)

 **WARNING**

**Make sure that all Pre-start Checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.**

To start the generator set in the Manual Run mode, press the Manual button on the Operator Panel, and then press the Start button within ten seconds. Failure to press the Start button within this time will result in the generator set changing to the Off mode.

---

(Refer also to Selecting Manual Run Mode in the appropriate controls manual. See [Table 3-1](#) to determine the unit's control manual.)

The PowerCommand® control will initiate a starter cranking signal and will perform an automatically sequenced manual start, under a complete engine protection system combined with full monitoring capability. This will activate the engine control system and the starting procedure. The starter will begin cranking, and after a few seconds the engine will start and the starter will disconnect.

Should the engine fail to start, the starter will disengage after a specified period of time and the control will indicate a Fail to Start shutdown.

To clear a Fail to Start shutdown, press the Stop button and then press the Reset button. Before attempting to re-start, wait a minimum of two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt, refer to the Troubleshooting Section of this manual and the appropriate controls manual. See [Table 3-1](#) to determine the unit's control manual.

To disable Manual mode, change to Auto or Off mode. If the generator set is running when it leaves Manual mode, it will continue to run if Auto mode has been selected and the remote start signal is active. If there is no active remote start signal, the generator set will stop.

### 3.5.2 Starting from Remote Location (Auto Mode)

#### **WARNING**

***Make sure that all Pre-start Checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator is about to start.***

To start the generator set in the Auto Run mode, select the Auto button from the Operator Panel. (Refer also to the Selecting Manual Run mode in the appropriate manual. See [Table 3-1](#).)

Only on receipt of a Remote Start signal, and after a Time Delay to Start, will the PowerCommand® control initiate the starting sequence as above.

The Remote Start LED will be illuminated.

There are two start modes that are selectable for the Remote Start input; one for non-emergency start and the other for emergency start. In the non-emergency start, the control will complete the warm-up at idle. In the emergency mode, the generator set will omit the warm-up stage and proceed directly to rated speed and voltage.

In response to the Remote Start signal, if the control detects the loss of Utility voltage, the control illuminates the Remote Start indicator and initiates the starting sequence as described in Starting at Operator Panel (Manual Run Mode), except for the following:

- In Auto position, the control will complete the Time Delay to Start (0 to 300 seconds) for a non-emergency start signal only.

**NOTE:** *If the mode change access code feature has been enabled, enter the access code when prompted. For more on Entering the Mode Change Access Code see the appropriate control manual. See [Table 3-1](#) to determine the unit's control manual.*

To disable Auto mode, change to Manual or Stop mode. Refer to Stopping.

## 3.6 Cold Starting with Loads

### **WARNING**

***Make sure that all Pre-start Checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.***

Use an oil pan heater and a coolant heater if a separate source of power is available. The optional heater will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

Cummins recommends equipping diesel standby generator sets (life safety systems) with engine water jacket coolant heaters to maintain the coolant at a minimum of 32 °C (90 °F) and, for most applications, accept the emergency load in ten seconds or less. Although most Cummins generator sets will start in temperatures down to -32 °C (-25 °F) when equipped with engine water jacket coolant heaters, it might take more than ten seconds to warm the engine up before a load can be applied when ambient temperatures are below 4 °C (40°F).

---

To advise the Operator of a possible delay in accepting the load, the Low Coolant Temp (code 1435) message, in conjunction with illumination of the Warning LED, is provided. The engine cold sensing logic initiates a warning when the engine water jacket coolant temperature falls below 21°C (70 °F). In applications where the ambient temperature falls below 4°C (40°F), a cold engine may be indicated even though the coolant heaters are connected and functioning correctly. Under these conditions, although the generator set may start, it may not be able to accept load within ten seconds. When this condition occurs, check the coolant heaters for correct operation. If the coolant heaters are operating correctly, other precautions may be necessary to warm the engine before applying a load.

### 3.7 Stopping the Generator Set

**NOTE:** *The access code may be required before initiating the Off button sequence. Refer to Entering the Mode Change Access Code in the appropriate controls manual. See Table 3-1 to determine the unit's control manual.*

#### CAUTION

**Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.**

#### 3.7.1 Stopping at Operator Panel (Manual Mode)

If the generator set was started at the Operator Panel in Manual mode, Press the Stop button once to put the generator set into a Cooldown run, after which the set will enter the Off mode.

Pressing the Stop button twice will stop the generator set immediately, without a Cooldown run, after which the set will enter the Off mode.

**NOTE:** *If possible, hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a Hot Shutdown Warning.*

#### 3.7.2 Stopping from Operator Panel (Auto Mode)

If the Generator set was started in Auto mode, press the Stop button once to stop the generator set immediately, without a Cooldown run, after which the generator set will enter the Off mode.

If possible re-start the generator set in Manual mode with the circuit breaker open, and allow to stop with a Cooldown run.

**NOTE:** *If possible, hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a Hot Shutdown Warning.*

#### 3.7.3 Stopping from Remote Location (Auto Mode)

If the control received a remote stop signal, the generator set completes its normal shutdown sequence incorporating a Cooldown run. (The remote stop signal is actually the removal of the remote start signal to the control).

The generator set will stop after completing the following Cooldown sequence:

- Time Delay to Stop function (zero to 600 seconds)
- Cooldown at Idle 0 to 10 minutes or longer, if necessary to obtain normal operating temperature before shutdown.

The set will remain in Auto mode, and subject to a remote start signal, unless the Stop button is pressed. If the Stop button is pressed the set will enter the Off mode.

**NOTE:** *The InPower service tool or access to the Setup menu is required to enable and change the time delay start/stop settings. Contact your authorized distributor for assistance.*

#### 3.7.4 Emergency Stop (Code 1433 or 1434)

The Local Emergency Stop button is located on the front of the Operator Panel. This is a mechanically latched switch that will unconditionally stop the engine when pressed, bypassing any time delay to stop. Push this button in for Emergency Shutdown of the engine.

**NOTE:** *If the engine is not running, pushing the button in will prevent the starting of the engine, regardless of the start signal source (Manual or Auto - remote).*

When the Stop button is pressed, the display panel will indicate the Shutdown condition by illuminating the red Shutdown status LED and displaying the following message on the graphical LCD display:

---

**Fault Number: 1433 LOCAL EMERGENCY STOP**

A Remote Emergency Stop button may be incorporated within the installation. If this Remote Emergency Stop button is activated the following message will be displayed:

**Fault Number: 1434 REMOTE EMERGENCY STOP**

To reset:

1. Pull, or twist and pull, the button out.
2. Press the Stop button on the Operator Panel to acknowledge this action.
3. Press the Reset button
4. Press the Auto or Manual Run button, as previously determined. (See Selecting Operating Modes in the appropriate controls manual.)

**CAUTION**

***Do not use an Emergency Stop button to shut down an engine unless a serious fault develops. The Emergency Stop button must not be used for***

***a normal shutdown as this will prevent a Cooldown run in which the lubricating oil and engine coolant carry away heat from the engine combustion chamber and bearings in a safe manner.***

**NOTE:** *Make sure the remote start control is not active or, when the Emergency Stop is reset, the generator set could start running.*

**CAUTION**

***Make sure the cause of the Emergency Stop is fully investigated and remedied before a fault reset and generator start are attempted.***

**NOTE:** *An external Emergency button is located in close proximity to the Operator Panel viewing window.*

**3.8 Paralleling Operation**

Available with control PCC 3.3. Refer to PCC 3.3 control manual for further instruction. See [Table 3-1](#) for controls manual number.







## Section 4 - Troubleshooting

Fault code information together with Warning and Shutdown information is provided in this section to assist in locating and identifying the possible causes of faults in the generator set system. Refer also to the engine specific operator manual. This latter manual will contain further information regarding the running and care of the generator set and also specific equipment instructions that may differ from the standard generator set.

The PCC continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will display a yellow warning lamp or a red shutdown lamp and display a message on the digital display.

**NOTE:** This section lists the warning and shutdown codes/messages (Table 4-1), and suggests troubleshooting procedures.

**NOTE:** Refer to the troubleshooting instructions for each model specific Genset Controls manual as outlined in Figure 3-1.

**NOTE:** Displayed error codes on the PCC that are not listed in the Table generally require an authorized service representative to correct the fault. Before contacting an authorized service center for assistance, however, look up the previous fault in PCC Fault History to determine whether the real reason for generator set shutdown was ENGINE SHUTDOWN (PCC Code 1311). If engine shutdown is the cause, follow Code 1311 corrective procedures in Table 4-1. The corrective procedure could be as simple as adding engine oil or coolant.

### 4.1 Safety Considerations

#### **WARNING**

**Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Keep the output box covers in place during troubleshooting.**

#### **CAUTION**

**High voltages are present when the set is running. Do not open the generator output box while the set is running.**

#### **WARNING**

**Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switches, or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.**

**Ventilate battery area before working on or near battery. Wear goggles. Stop genset and disconnect charger before disconnecting battery cables. Disconnect negative (-) cable first and reconnect last.**

#### **CAUTION**

**Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes which are damaging to DC control circuits of the generator set.**

#### **WARNING**

**Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.**

When troubleshooting a set that is shut down, make certain the generator set cannot be accidentally restarted as follows:

1. Move the **Off/Manual/Auto** switch on the control panel to the **O** (off) position.
2. Turn off or remove AC power from the battery charger.
3. Depress E-stop.
4. Remove the negative (-) battery cable from the generator set starting battery.

---

## 4.2 Fault Finding

Should a fault condition occur during operation, follow the procedures in the following tables to locate and correct the problem. For any symptom not listed, contact your authorized distributor for assistance.

Before starting any fault finding actions, ensure that the following basic checks are carried out:

- All switches and controls are in their correct positions.
- The fuel oil level is correct.
- The lubricating oil is correct.
- The coolant level is correct.
- The area around the radiator and the radiator core are free from obstruction.
- The battery charge condition is satisfactory and connections are secure.
- The generator set electronics and alternator connections are secure.
- The panel connections are secure.
- The protection circuits have been replaced.
- Blown fuses have been replaced.
- Tripped contactors or circuit breakers have been reset.

## 4.3 Status Indicators

### 4.3.1 Not in Auto

The red lamp is illuminated when the control is NOT in Auto.

### 4.3.2 Remote Start

The green lamp indicates the control is receiving a Remote Run signal. The Remote Run signal has no effect unless the generator set is in Auto.

### 4.3.3 Warning

The yellow lamp is illuminated whenever the control detects a Warning condition. This lamp is automatically shut off when the warning condition no longer exists.

### 4.3.4 Shutdown Status

The red lamp is illuminated when the control detects a Shutdown condition. The generator set cannot be

started when this lamp is on. After the condition has been corrected, the lamp can be reset by first pressing the stop button and then the release button.

### 4.3.5 Generating Set Running

The green lamp is illuminated when the generator set is running at, or near, rated speed and voltage. This is not illuminated when the generator set is warming up or cooling down.

## 4.4 Fault/Status Codes



### WARNING

*Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery leads (negative [-] first).*

### 4.4.1 Fault Messages

A fault message is an indicator of a warning or shutdown condition. It includes the fault type (warning or shutdown) fault number, and a short description. It also includes where the fault occurred if the generator set control did not detect the fault and is simply reporting the fault.

### 4.4.2 Fault Acknowledgement

Shutdown faults must be acknowledged after the fault has been corrected. If in Auto or Manual mode, the control must be set to Stop mode (off). Faults are cleared from the control panel display by pressing the reset button.

Faults are also acknowledged when in Auto mode and the remote start command is removed.

Faults are re-announced if they are detected again after being acknowledged.

**NOTE:** *Gaps in the code numbers are for codes that do not apply to this generator set. Some of the codes listed are feature dependent and will not be displayed by this control.*

**NOTE:** *Some warnings remain active after the condition is corrected and the control reset button is pressed. This will require the genset to be shutdown to reset the warning indicator.*



---

## 4.5 Line Circuit Breaker

The optional line circuit breaker mounts on the generator output box. If the load exceeds the circuit breaker rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breakers trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator.

## 4.6 Control and Diagnostic Via Network or PC (laptop)

See your authorized Cummins Power Generation dealer regarding software, hardware and network requirements for control and diagnostics via network or PC.

## 4.7 Fault Codes

The fault codes have been divided into five categories to help you determine which corrective action to take for safe operation of the generator set. Use [Table 4-1](#) to find the category and fault description for all codes. Gaps in the code numbers are for codes that do not apply to these gensets.

*Refer to the troubleshooting instructions for each model specific Genset Controls manual as outlined in [Figure 3-1](#) (same graphic as the installation manual).*

**Table 4-1 Fault codes**

CODE	LAMP	DISPLAYED MESSAGE
111	Shutdown	Internal ECM Failure
115	Shutdown	Eng Crank Sensor Error
122	Warning	Manifold 1 Press High
123	Warning	Manifold 1 Press Low
124	Warning	Manifold 1 Press High
135	Warning	High Oil Rifle 1 Pressure
141	Warning	Low Oil Rifle 1 Pressure
143	Warning	Low Oil Rifle Pressure
144	Warning	High Coolant 1 Temp
145	Warning	Low Coolant 1 Temp
146	Derate	Pre-High Engine Coolant Temperature
151	Shutdown	High Coolant Temp
153	Warning	High Intake Manf 1 Temp
154	Warning	Low Intake Manf 1 Temp

---

## 4.8 Troubleshooting

The following information is intended as a guide to troubleshooting some common non-technical equipment problems. Many problems can be resolved using corrective maintenance, adjustment, or minor repair. Refer to the vendor supplied literature, electrical schematics, and mechanical prints for additional information. For engine related issues, refer to the Operation and Maintenance Manual or contact the Cummins Customer Assistance Center at 1-866-831-7620.



### WARNING

*The status checks should be performed ONLY by a qualified technician. Contact with exposed electrical components could cause extreme personal injury or death.*



### WARNING

*Before equipment operation, ALL guards, covers, and protective devices MUST BE in place and securely fastened. Serious personal injury could result from contact with exposed or moving components.*



### CAUTION

*AVOID SERVICING complex components such as: printed circuit boards, programmable controllers and ECM's not specifically authorized by Cummins Inc. Contact your local Cummins NPower Generator distributor before performing any extensive maintenance. In the United States or Canada, call 1-800-888-6626 (this automated service utilizes touch-tone phones only). By selecting Option 1 (press 1) you will be automatically connected to the nearest distributor.*



### CAUTION

*Never climb or stand on the equipment frame, guards, or enclosures. Contact with exposed or moving components can cause personal injury or equipment damage.*

**Table 4-2 Troubleshooting Chart**

PROBLEM	POSSIBLE CAUSE	SOLUTION
<p><b>4.8.1 Engine will not Start</b></p>	<p>Low gas pressure.</p> <p>No voltage at gas solenoid.</p> <p>Low water level after gas regulator.</p> <p>Air cleaner plugged or restricted.</p> <p>Governor actuator not opening.</p>	<p>Check gas pressure on utility side of gas regulator.</p> <p>Have gas regulator tested by gas company.</p> <p>Have gas company turn on gas.</p> <p>Check if there is 14 inches of water pressure at the engine solenoid. If not, check for gas pressure on utility side of gas regulator.</p> <p>Check if gas is turned off.</p> <p>Check for 24 volts to gas solenoid. If voltage is present, replace the gas solenoid.</p> <p>Test gauge panel for no voltage to gas solenoid.</p> <p>Check that there is 7 inches of water pressure after engine mounted gas regulator when engine is cranking.</p> <p>Check if vent is blocked and clear blockage.</p> <p>Check regulator diaphragm for leaks.</p> <p>Check piping and inlet for restriction.</p> <p>Change air filter.</p> <p>Check if there is switched battery voltage at governor controller.</p> <p>If no voltage, test gauge panel for switched battery voltage.</p> <p>If switched battery voltage is present at governor controller, check for mag pickup voltage of at least 25 A/C volts.</p> <p>If no mag pickup voltage, check mag pickup adjustment to flywheel 1/2 to 3/4 turn out from flywheel.</p>





**Table 4-2 Troubleshooting Chart (Continued)**

PROBLEM	POSSIBLE CAUSE	SOLUTION
<p><b>4.8.3 Gill AFR Controller Module Flashing</b></p>	<p>Insufficient battery voltage.</p>	<p>Check for voltage at pin 1 of AFR plug.</p> <p>Check for voltage in PCC panel to TB-1-17 B and TB1-20 and. If voltage to panel is present, replace the gill module.</p> <p>Check switched battery voltage on pin 11 of AFR plug.</p> <p>Check for switched battery voltage in gauge panel TB1-19 and TB1-20.</p> <p>Check battery negative on pin 2 of AFR module. If good, replace AFR module.</p> <p>Check for battery negative at gauge panel TB1-20. If panel is not functioning properly, replace the PCC panel.</p>
<p><b>4.8.4 Gill AFR Center LED Illuminated</b></p>	<p>Module in closed loop.</p>	<p>Put AFR module in closed loop.</p> <p>Check if sensor temperature box is red. If box is red, replace the O<sub>2</sub> sensor.</p> <p>Check if fuel valve is out of range or not responding. If so, replace the fuel valve. If not, replace the AFR module.</p>
<p><b>4.8.5 Gill AFR Control Module not Communicating with Laptop</b></p>	<p>Laptop has faulty connections or cable.</p>	<p>Check connections and cable. If faulty, replace cable.</p>
<p><b>4.8.6 PCC Controls Fault Codes</b></p>	<p>Fault Code error</p>	<p>See applicable manual per <a href="#">Table 3-1</a></p>



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## Section 5 - Maintenance

Engine and Generator set are to be operated in accordance with all manufacture’s guidelines and recommendations.

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. The recommended service intervals for a generator set on STANDBY power service is covered in [Table 5-1](#) and for PRIME power service [Table 5-2](#). If the set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are the following:

- Extremes in ambient temperature
- Exposure to weather
- Exposure to salt water
- Exposure to dust, sand, or other airborne contaminants

Consult with your local Authorized Cummins Distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use [Table 5-1](#) (Standby) or [Table 5-2](#). (Prime) to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

### 5.1 Owner/Operator Unit Compliance

Owner/Operator unit engine certification must be monitored and documented to remain in compliance with the EPA. Reference to the EPA SI NSPS final ruling can be found under Title 40 CFR 60.4243.

**NOTE:** *For complete information, the owner/operator should review entire Code of Federal Regulation.*

In general, the guidelines are as follows:

#### 5.1.1 Base Drains (Optional)

Some units are equipped with drain extensions that allow for oil or coolant (or both) drains to be brought out to the base edge for convenient maintenance. These drains have an in-line ball valve or Fumoto valve installed for control. Remove the cap and open the valve to drain. Close the valve and restore the cap before refilling. Maintenance – Check end of drain line/valve for obstructions. Check all connections for leaks or worn parts.

**5.1.2** If you operate and maintain the certified stationary SI internal combustion engine and control device according to the manufacturer’s emission-related written instructions, you must keep records of conducted maintenance to demonstrate compliance, but no performance testing is required if you are an owner or operator.

**5.1.3** If you Do Not operate and maintain the certified stationary SI internal combustion engine and control device according to the manufacturer’s emission-related written instructions, your engine will be considered a non-certified engine, and you must demonstrate compliance according to 5.1.2.1 through 5.1.2.3 of this section, as appropriate.

**5.1.3.1** If you are an owner or operator of a stationary SI internal combustion engine less than 100 HP, you must keep a maintenance plan and records of conducted maintenance to demonstrate compliance and must, to extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions, but no performance testing is required if you are an owner or operator.

**5.1.3.2** If you are an owner or operator of a stationary SI internal combustion engine greater than or equal to 100 HP and less than or equal to 500 HP, you must keep a maintenance plan and records of conducted maintenance and must, to extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions. In addition, you must conduct and initial

performance test within 1 year of engine startup to demonstrate compliance.

**5.1.3.3** If you are an owner or operator of a stationary SI internal combustion engine greater than 500 HP, you must keep a maintenance plan and records of conducted maintenance and must, to extent practica-

ble, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions. In addition, you must conduct and initial performance test within 1 year of engine startup and conduct subsequent performance testing every 8,760 hours or 3 years, whichever comes first, thereafter to demonstrate compliance.

**Table 5-1 Periodic Maintenance Schedule For Standby Power Gensets**

MAINTENANCE ITEMS	SERVICE TIME						
	*After First 24 Hours or 1 Year	Daily or after 8 Hours	*Monthly or after 100 Hours	After 150 Hours	*6 Months or after 250 Hours	*Yearly or after 500 Hours	After 1000 Hours
General set inspection		X <sup>1</sup>					
Oil pan heater		X					
Check engine oil level and reservoir (optional)		X					
Check coolant level		X					
Check coolant heater(s)		X					
Fuel heater		X					
Battery heater		X					
Control heater		X					
Breather heater		X					
Check air cleaner			X <sup>2,3</sup>				
Check all hardware (fittings, clamps, fasteners, etc.)			X				
Check battery electrolyte level			X				
Check generator air outlet			X				
Change engine oil and filter	X			X <sup>2,8</sup>			
Check radiator hoses for wear and cracks					X <sup>4</sup>		
Check drive belt					X <sup>5</sup>		
Check antifreeze concentration					X		
Check AC generator and controls					X <sup>7</sup>		
Clean cooling systems						X	
Replace spark plugs						X <sup>6</sup>	
Inspect or replace oxygen sensor						X <sup>7,9</sup>	
Overhaul cylinder heads							X
Periodic Emissions Testing							X <sup>10</sup>



**Table 5-1 Periodic Maintenance Schedule For Standby Power Gensets**

MAINTENANCE ITEMS	SERVICE TIME						
	*After First 24 Hours or 1 Year	Daily or after 8 Hours	*Monthly or after 100 Hours	After 150 Hours	*6 Months or after 250 Hours	*Yearly or after 500 Hours	After 1000 Hours
<p>X<sup>1</sup> - Check for oil, fuel, cooling, and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately.</p> <p>X<sup>2</sup> - Perform more often in extremely dusty conditions.</p> <p>X<sup>3</sup> - Replace element after 500 hours.</p> <p>X<sup>4</sup> - Replace if hard or brittle.</p> <p>X<sup>5</sup> - Visually check belt for evidence of warping or slippage. Replace if hard or brittle.</p> <p>X<sup>6</sup> - Replace every 1000 hours.</p> <p>X<sup>7</sup> - Must be performed by a qualified mechanic. Contact your authorized service center.</p> <p>X<sup>8</sup> - Perform at least once a year.</p> <p>X<sup>9</sup> - Replace every 1500 hours (recommended).</p> <p>X<sup>10</sup> - Retesting onsite is required on capable compliant generator sets per local, regional and national codes.</p> <p>*Whichever comes first.</p>							

**Table 5-2. Periodic Maintenance Schedule For Prime Power Gensets**

MAINTENANCE ITEMS	SERVICE TIME					
	After First 24 Hours	24 Hours	100 Hours	250 Hours	500 Hours	1000 Hours
General set inspection		X <sup>1</sup>				
Oil pan heater		X				
Check fuel		X				X
Check battery		X				X
Check control		X				X
Check breather heater		X				X
Check engine oil level and reservoir (optional)		X				
Check coolant level		X				
Check coolant heater(s)		X				
Check air cleaner (heavy duty filter)			X <sup>2,3</sup>			
Check all hardware (fittings, clamps, fasteners, etc.)				X		
Check battery electrolyte level				X		
Check generator air outlet				X		
Change engine oil and filter	X			X <sup>2</sup>		
Check fuel filter element	X			X <sup>2</sup>		
Check radiator hoses for wear and cracks					X <sup>4</sup>	
Check drive belt					X <sup>5</sup>	
Check antifreeze concentration				X		
Check AC generator and controls					X <sup>6</sup>	
Clean cooling systems					X	
Replace spark plugs						X <sup>3</sup>
Inspect or replace oxygen sensor					X <sup>6,8</sup>	
Overhaul cylinder heads						X
Periodic Emissions Testing						X <sup>9</sup>

**Table 5-2. Periodic Maintenance Schedule For Prime Power Gensets**

MAINTENANCE ITEMS	SERVICE TIME					
	After First 24 Hours	24 Hours	100 Hours	250 Hours	500 Hours	1000 Hours
<p>X<sup>1</sup> - Check for oil, fuel, cooling, and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately.</p> <p>X<sup>2</sup> - Perform more often in extremely dusty conditions.</p> <p>X<sup>3</sup> - Replace every 2000 hours.</p> <p>X<sup>4</sup> - Replace if hard or brittle.</p> <p>X<sup>5</sup> - Visually check belt for evidence of warping or slippage. Replace if hard or brittle.</p> <p>X<sup>6</sup> - Must be performed by a qualified mechanic. Contact your authorized service center.</p> <p>X<sup>7</sup> - Replace every 1000 hours.</p> <p>X<sup>8</sup> - Replace every 1500 hours (recommended)</p> <p>X<sup>9</sup> - Retesting onsite is required on capable compliant generator sets per local, regional and national codes.</p>						

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## 5.2 Generator Set Inspection

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected for continued safe operation.

With the generator set stopped, E-stop depressed, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately.

### 5.2.1 Catalyst-Removable Elements (Only available on some models)

Some Gensets require a 3-way or Oxidation catalyst to meet emission requirements. There is a precious metals element inside the housing of the catalyst that converts exhaust to EPA requirements. Some catalysts have a removable body that can be replaced with a new element when required. Check with your distributor or service technician for details on your product. Maintenance – Check manufacturer's recommended maintenance or replacement schedule.

## 5.3 Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly, including the exhaust manifold, muffler, and exhaust pipe. Check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the generator set and have leaks corrected immediately.

### WARNING

*Inhalation of exhaust gases can result in severe personal injury or death. Be sure deadly exhaust gas is piped outside and away from any windows, doors, vents or other inlets to building and not allowed to accumulate in inhabitable areas.*

### 5.3.1 Fuel Filters (Optional-MOH models only)

Our in-line fuel filters are designed for optimal performance of the generator set. They provide the best

choice for Customers who want to extend service intervals and increase Genset uptime. Optional pressure indicators and automatic drains are available on some models. Check the installation and service manuals for your specific filter (models vary by unit) for details. Maintenance – Check pressure differential across the filter to ensure restriction is within operating range. If pressure loss is out of range, see owners manual to change filter.

### 5.3.2 Fuel Heater (Optional-MOH models only)

Fuel heaters are available on some MOH models. They are designed to provide heating of engine fuel for optimal performance of the Genset. The Fuel Heater is designed to provide uninterrupted fuel flow in cold temperature environments when it is needed most. Maintenance – Check heater for fuel flow to ensure minimal pressure loss during operation. See Owner's manual for regular maintenance schedule.

### 5.3.3 Regulator (Optional)

Prime regulators are available on some models for fuel pressure reduction from source. Regulators vary by manufacturer and model. Check with your distributor or service technician for details on use and settings of your Regulator. Maintenance – Check manufacturer's recommended maintenance schedule.

## 5.4 Fuel System

With the generator set operating, inspect the fuel supply lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, shut off fuel supply valves, shut down generator set and have them corrected immediately.

### WARNING

*Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, arcing switch or equipment, pilot light, or other igniter near the fuel system or in areas sharing ventilation.*

---

## 5.5 AC Electric System

Check the following while the genset is operating. Frequency/RPM (Alternator/Engine Menu): The generator frequency should be stable under load and the reading should be the same as the genset name plate rating (60 Hz/1800 RPM).

**AC Voltmeter (Alternator Menu):** At no load, the line-to-line or line-to-neutral voltage(s) should be the same as the genset nameplate rating.

**AC Ammeter (Alternator Menu):** At no load the current ratings should be zero. With a load applied, each line current should be about the same.

**Panel Lamp/Lamp Test Button:** Press and hold this button to test all front panel LEDs and meters. The meters will light one bar at a time. Make sure that all LEDs and meters are operating and then release the button.

### 5.5.1 Battery Heater (Optional)

Battery heaters ensure the batteries are ready for starting the engine in cold standby conditions. They also protect against condensation during standby and prevent corrosive damage of electrical components in high humidity environments. Maintenance – Check to ensure wiring is intact (no shorts or frayed wires) and there are no obstructions around heater or batteries.

### 5.5.2 Control Heater (Optional)

Control heaters protect the control cabinet components from condensation during standby and prevent corrosive damage of electrical and mechanical components in high humidity environments. Maintenance – Check to ensure wiring is intact (no shorts or frayed wires) and there are no obstructions around heater.

### 5.5.3 Breather Heater (Optional)

This heater is designed to prevent crankcase breather freezing. The heater has a set point of 50° F. If the ambient temperature inside the enclosure drops below 50° F, the heater will automatically switch on. Maintenance – check to ensure wiring is intact (no shorts or frayed wires) and there are no obstructions around heater.

## 5.6 DC Electrical System


Check the terminals on the batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Refer to BATTERIES later in this section for cleaning and safety precautions.

## 5.7 Engine

Monitor fluid levels and oil pressure and coolant temperatures frequently. Most engine problems give an early warning. Look and listen for changes in engine performance, sound, or appearance that can indicate service or repair is needed. Some engine changes to look for are as follows:

- Misfire
- Vibration
- Unusual noises
- Sudden changes in engine operating temperatures or pressures
- Excessive exhaust smoke
- Loss of power
- An increase in oil consumption
- An increase in fuel consumption
- Fuel, oil, or coolant leaks

## 5.8 Generator Set Maintenance (Battery Disconnected)

 **WARNING**  
*Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.*

## CAUTION

**Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.**

## CAUTION

**Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.**

## WARNING

**Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal before beginning maintenance procedures.**

When performing the following maintenance procedures, make certain the generator set cannot be accidentally restarted as follows:

1. Move the Off/Manual/Auto switch on the control panel to the O (off) position.
2. Turn off or remove AC power from the battery charger.
3. Depress E-stop.
4. Remove the negative (-) battery cable from the generator set starting battery

## 5.9 Lubrication System

Before the initial start, check dipstick to be sure crankcase is filled with oil. See Specifications for lubricating oil specifications and capacity in model specific engine manual.

## CAUTION

**Do not use 5W-30 engine oil in ambients above 0° C (32° F) because it may not provide adequate lubrication in this application.**

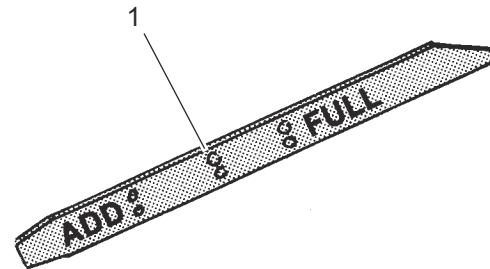
### 5.9.1 Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance

Table. The dipstick is stamped with FULL and ADD to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the engine oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

## WARNING

**Crankcase pressure can blow out hot oil and cause severe burns. DO NOT check oil while the generator set is operating.**



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1. Normal Oil Level

**Figure 5-1 Oil Level Dipstick**

Keep the oil level between the FULL and ADD marks on the dipstick, see [Figure 5-1](#). Remove the oil fill cap and add oil of the same quality and brand when necessary.

## CAUTION

**Do not operate the engine with the oil level below the ADD mark or above the FULL mark. Overfilling can lead to oil foaming and expulsion from the breather cap. Operation below the ADD mark can cause loss of oil pressure.**

### 5.9.2 Engine Oil Change

**NOTE:** Disconnect oil pan heater and coolant heater (if equipped) prior to changing oil. Reconnect heaters once oil change is complete.

## WARNING

**State or federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Do not contact oil or breathe vapors. Use rubber gloves and wash exposed skin.**

## WARNING

**Used oil and filters must be disposed of properly to avoid environmental damage and clean-up liability. Check all federal, state and local regulations for disposal requirements.**

Run the engine until thoroughly warm before draining the oil. Stop the set, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill to proper level with oil of the correct API viscosity grade and type for the temperature conditions. Refer to engine manual for model specification information.

## WARNING

**Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.**

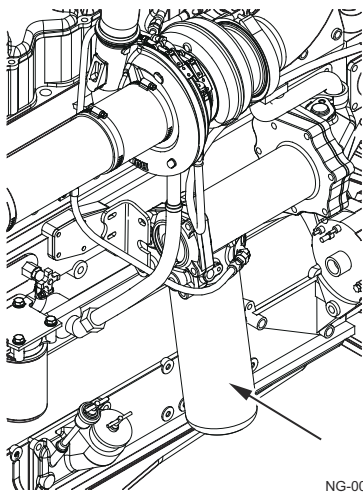


Figure 5-2 Oil Filter

### 5.9.3 Oil Filter Change

Spin off the oil filter and discard it in accordance with local environmental regulations. Thoroughly clean filter mounting surface.

Fill the oil filter with clean lubricating oil. To fill, pour the oil into the center hole of the filter.

Apply a thin film of oil to filter gasket and install new element. Spin element on by hand until gasket just touches mounting pad and then turn an additional 1/2

to 3/4 turn. Do not overtighten. Please see [Figure 5-2](#) for location.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks but do not overtighten.

### 5.9.4 Oil Reservoir (Optional)

5 or 10 gallon Oil Tanks are optional on some units to allow for extended service intervals between maintenance. These tanks are typically plumbed to an Oil Maintainer Switch that controls the flow into the engine oil pan. It is imperative the switch is functioning properly without obstruction and if the switch is vented, the vent is not obstructed as well. The tank should be filled with oil per Engine Manufacturer guidelines. Maintenance – Check all connections for leaks or worn parts.

## 5.10 Cooling System

The cooling system capacity of a standard unit with set mounted radiator is shown in Specifications section. **Gensets are normally shipped with coolant added. Be sure to check coolant level before initial start.**

### 5.10.1 Coolant Requirements

Satisfactory engine coolant inhibits corrosion and if necessary protects against freezing. Use a 50/50 coolant solution (50% pure water and 50% anti-freeze). If temperatures below -38° C (-37° F) are possible, use a mixture of 65% antifreeze and 35% water. Do not use an antifreeze that contains anti-leak additives.

The water used for engine coolant should be clean, low in mineral content and free of any corrosive chemicals such as chloride, sulfate or acid. Use soft water. Well water often contains lime and other materials which eventually can clog the radiator core and reduce the cooling efficiency and can also cause heater element failure.

Table 5-3.

Ethylene-Glycol	Propylene-Glycol
40% = -23° C (-10° F)	40% = -21° C (-6° F)
50% = -37° C (-34° F)	50% = -33° C (-27° F)
60% = -54° C (-65° F)	60% = -54° C (-65° F)
68% = -71° C (-90° F)	68% = -63° C (-82° F)

### 5.10.2 Filling the Cooling System

#### **! CAUTION**

***The engine can overheat and be damaged if coolant is filled improperly.***

Check to make sure that all drain cocks are closed and all hose clamps secure. Remove the pressure cap (Figure 5-3) and slowly fill the cooling system with the recommended coolant.

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50° C (120° F) before adding coolant. When the engine is first started monitor the coolant level. As trapped air is expelled from the system, the coolant level may drop and additional coolant must be added. Replace the pressure cap after coolant has been added.

### 5.10.3 Coolant Level

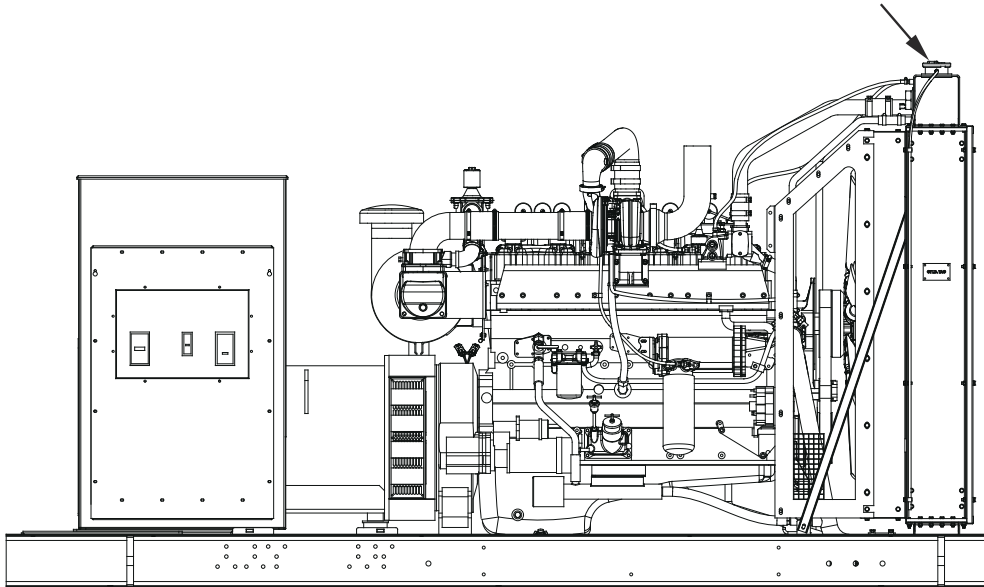
Check the coolant level during shutdown periods at the intervals shown in Table 5-1. Remove the pressure cap after allowing the engine to cool and add coolant as necessary to keep the fluid level visible in the sight glass.

#### **! WARNING**

***To prevent severe scalding, let engine cool down before removing coolant pressure cap. Turn cap slowly, and do not open it fully until the pressure has been relieved.***

#### **! CAUTION**

***Loss of coolant can allow engine to overheat without protection of shutdown device and cause severe damage to the engine. Maintain coolant level for proper operation of the high engine temperature shutdown system.***



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**Figure 5-3 Coolant Pressure Cap (Typical)**

### 5.10.4 Draining and Flushing

#### **! WARNING**

***Some coolant is toxic. Keep away from children and animals. Follow local environmental regulations for disposal.***

To maintain adequate corrosion protection and remove rust and scale deposits, drain and flush radiator at the recommended interval.

#### **! CAUTION**

***The heater element will burn out if engine coolant is removed with heater connected to power source.***



1. Disconnect engine coolant heater from power source (if equipped).
2. Allow the engine to cool and then remove radiator pressure cap.
3. Open the radiator drain cock and remove the water drain plugs (one on each side of engine). When the coolant is drained, place the end of a water hose into the radiator fill port and turn on water supply.
4. Regulate the flow of water into the radiator until it is equal to the outflow from drain openings.
5. Continue flushing until outflow from drains is clear of rust sediment.

**NOTE:** *If engine is equipped with engine coolant heater, drain coolant by removing hose and clamp from bottom of heater.*

6. Replace the water drain plugs and close the radiator drain cock when flushing is complete.
7. Refill the cooling system with the recommended coolant (refer to Filling the Cooling System 5.9.2).
8. With cooling system properly filled and the engine has been run, connect heater plug to receptacle.

### CAUTION

***The heater element will burn out if power is connected before it is filled with coolant or if straight antifreeze solution is used for coolant. Before connecting power, fill the engine with coolant and run it for a while to circulate coolant through the heater.***

#### 5.10.5 Radiator

Inspect the exterior of the radiator for obstructions. Remove all dirt or foreign material with a soft brush or cloth. Use care to avoid damaging the fins. If available, use low pressure compressed air or stream of water (maximum of 242 kPa [35 psi]), in the opposite direction of normal air flow to clean radiator. If using water, protect the engine and the generator from over spray.

#### 5.10.6 Coolant Heater

Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet

hose. **Do not touch outlet hose** - if heater is operational, radiant heat should be felt with hand held close to outlet hose.

### WARNING

***Contact with cooling system or engine can result in serious burns. Do not touch cooling system or engine during genset maintenance until they are cool.***

#### 5.11 Air Filter

Clean air filter every 100 hours of operational time, more often in extremely dusty conditions. Replace air filter as needed.

The following procedure should be followed when cleaning or replacing the element.

1. Remove cover and filter. Tap filter on a flat surface to remove dirt.
2. Place a light source inside filter and inspect for air passage. If necessary, apply a low pressure air source (207 kPa [30 psi]) to the inside of filter to remove as much dirt as possible.
3. Install air filter, then cover and secure.

#### 5.12 Belt Replacement

This section identifies how to install replacement belts. Refer to [Figure 5-4](#).

##### 5.12.1 Belt Removal - Spring Tensioner

1. Depress E-Stop.
2. Disconnect the negative (-) cable from the battery to prevent accidental starting.
3. Remove belt guard or side fan guard (between engine and radiator) to gain access to the belt.
4. Using a socket wrench, rotate the tensioner pulley arm away from the belt and remove the belt(s).

### WARNING

***The belt idler is under tension. Do not allow your hands to get between the belt and pulley. Personal injury will result.***

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### 5.12.2 Belt Installation - Spring Tensioner

1. Slip the belt onto all but one pulley.



#### WARNING

***The belt idler is under tension. Do not allow your hands to get between the belt and pulley. Personal injury will result.***

2. Rotate the tensioner pulley arm away from the belt and position the belt over the alternator pulley. Slowly release the belt tensioner pulley arm onto belt.

**NOTE:** *The spring-loaded idler used on this design maintains the correct belt tension.*

3. Install belt guard or fan guard.
4. Connect the negative (-) cable to the battery.
5. Clear the E-Stop.
6. Start genset and visually check belt for proper alignment with engine running.

**NOTE:** *Always wear proper PPE when starting and checking genset.*

### 5.12.3 Belt Removal - Manual Tensioner

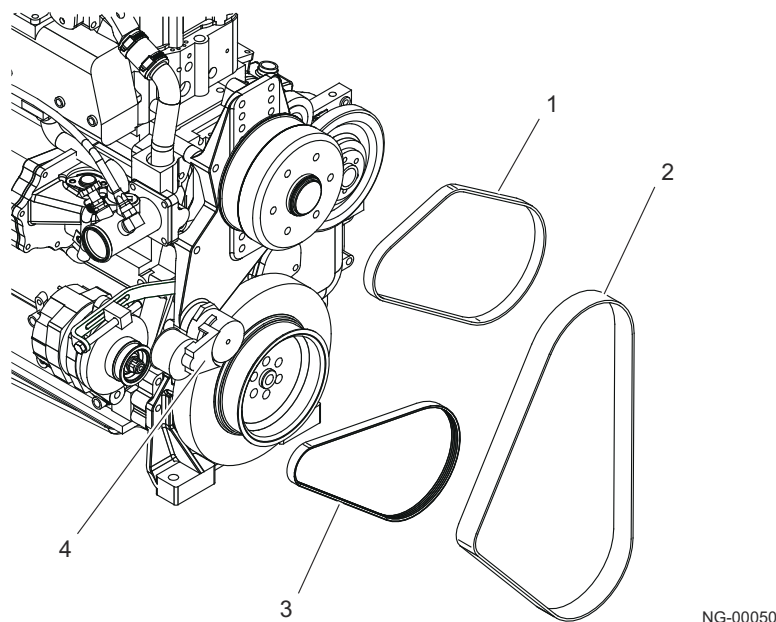
1. Depress E-Stop.
2. Disconnect the negative (-) cable from the battery to prevent accidental starting.

3. Remove belt guard or fan guard (between engine and radiator) to gain access to the belt
4. Loosen the jam nut on the sliding pulley assembly.
5. Loosen the tightener bolt to allow the sliding pulley to move releasing belt tension and remove the belt(s).

### 5.12.4 Belt Installation - Manual Tensioner

**NOTE:** *Always wear proper PPE when starting and checking genset.*

1. Slip belt(s) onto all pulleys
2. Tighten the tensioner bolt to the correct amount of belt tension. Measure tension on belt(s) using Cummins ST1138 belt tension gauge. Refer to [Table 7-1 Drive Belt Tension Table](#) in [Section 7](#).
3. Tighten jam nut on sliding pulley assembly. Torque to appropriate value based on the [Table 7-2 Torque Table](#) in [Section 7](#).
4. Re-check belt tension using belt tension gauge, Cummins ST1138, to verify tension from step 2.
5. Install belt guard or fan guard.
6. Connect the negative (-) battery cable to the battery.
7. Clear the E-Stop.
8. Start genset and visually check belt for proper alignment with engine running.



- |                                       |                             |
|---------------------------------------|-----------------------------|
| 1. Auxiliary Drive Belt (if equipped) | 3. Alternator Drive Belt(s) |
| 2. Fan Drive Belt(s)                  | 4. Tensioner Arm            |

**Figure 5-4 Belt Replacement (Typical)**

## 5.13 Ignition System

The ignition system consists of the ignition module, ignition coil packs, high tension wires and spark plugs. Maintenance consists of periodic inspections to detect possible problems and replacement of worn or deteriorated parts. The ignition system must be completely functional or the set may run poorly or be unable to carry full load. Perform the following inspections at recommended intervals.

### 5.13.1 Spark Plugs

Replace the spark plugs at the intervals specified in the Maintenance Table. If the spark plugs show any of the following conditions, the engine may require additional service. Contact your authorized service distributor for help.

- Carbon Fouled - Overly Rich Mixture
- Oil Fouled - High oil consumption
- Burned - Excessive engine temperature

Before installing new spark plugs:

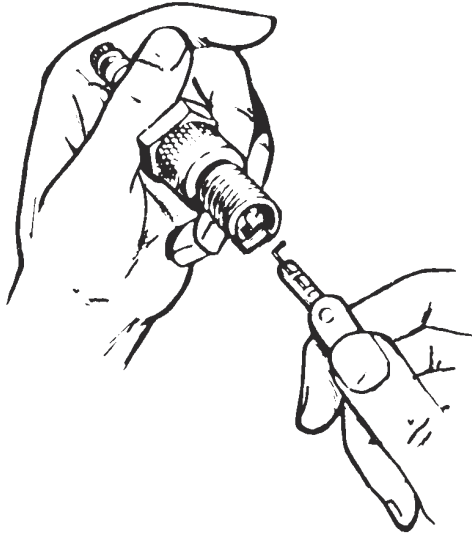
- Clean all dirt and grit away from the spark plug seats.
- Check each spark plug gap and reset as necessary to 0.076 cm (0.030 in). Refer to [Figure 5-5](#) and model specification for part information. See also [Section 7](#) for information on ordering replacement parts.
- Lightly lubricate spark plug threads with high temp anti-seize compound.

### 5.13.2 High Tension Wires

Check the spark plug wires for good contact at the ignition coil pack and spark plugs. Terminal connections should be tight and fully seated. All spark plug covers and cable end boots should be in good condition and fit tightly. There should be no breaks or cracks in the insulation. Replace the wire if any of these conditions are noted.

### 5.13.3 Ignition Coil Packs

Check for cracks, carbon tracks or corrosion on the ignition coil packs. Replace a coil pack if any of these conditions are noted.



NG-00051

Figure 5-5 Gapping Spark Plugs

## 5.14 Batteries

### **! WARNING**

**Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.**

### **! CAUTION**

**Ventilate battery area before working on or near battery—Wear goggles—E-Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.**

### **! CAUTION**

**Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.**

Check the condition of the starting batteries at the interval specified in the Maintenance Table. To prevent dangerous arcing, always E-stop then disconnect the negative ground cable from the battery

before working on any part of the electrical system or the engine. If using a maintenance free battery disregard this sections On Checking Specific Gravity and Checking Electrolyte Level if using a "maintenance-free" battery.

### 5.14.1 Cleaning Batteries

#### **! WARNING**

**Electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. Do not get the substance in your eyes or contact with skin. Wear goggles and protective, rubber gloves and apron when servicing batteries.**

#### **! WARNING**

**In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN.**

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with a solution consisting of 1/4 pound (11 Kg) of baking soda added to 1 quart (.94 Liters) of water. (This solution is also used for washing down spilled electrolyte.)

Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery and surrounding areas with clean water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

### 5.14.2 Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every ten degrees the electrolyte temperature is above 27° C (80° F). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

---

### 5.14.3 Checking Electrolyte Level

#### CAUTION

**Do not add water in freezing weather unless the engine will run long enough (two to three hours) to assure a thorough mixing of water and electrolyte.**

Check the level of the electrolyte (acid and water solution) in the batteries at least every 200 hours of operation.

If necessary, fill the battery cells to the bottom of the filler neck with distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

### 5.14.4 Battery Replacement

Always replace the starting battery with the same number and type (vented, lead acid). Properly dispose of battery in accordance with local environmental agency requirements.

#### WARNING

**Electrolyte or explosion of battery can cause severe personal injury or death. Do not burn the battery in a fire for disposal.**

**Damage to case will release electrolyte which is harmful to the skin and eyes and is also toxic. Burning of battery may cause an explosion.**

### 5.14.5 NiCad Batteries

NiCad (nickel-cadmium) battery systems are often specified where extreme high or low ambient temperature is expected because their performance is less affected by temperature extremes than that of lead-acid batteries.

NiCad batteries require special battery chargers in order to bring them to the full-charge level. These chargers must be provided with filter to reduce “charge ripple” which can disrupt engine and generator control systems.

## 5.15 Out-of-Service Protection

When the set will be stored or removed from operation for an extended period of time, take the following precautions to prevent rust accumulation, corrosion of bearing surfaces within the engine and gum formation in the fuel system. Perform the following procedures as outlined in this manual.

### 5.15.1 Preparing Set for Storage

1. For engine start up, follow operation steps as described in [Section 3](#) until the engine is up to operating temperature.
2. Shut down the engine.
3. Depress E-stop.
4. Turn off and disconnect the battery charger (if equipped).
5. Disconnect the battery (negative [-] first) and store in a cool, dry place. Connect the battery to the charger every 30 days to maintain it at full charge.
6. Drain the engine oil while still warm and refill with new oil recommended for the set. Attach a tag indicating the type of oil used.
7. Remove the spark plugs and pour two ounces of rust preventative oil into each spark plug opening. Barr engine over to complete three to four rotations of the crank shaft to distribute the oil on the cylinder walls and then reinstall the spark plugs.
8. Disconnect the engine coolant heater from the power source (if equipped).
9. Drain the cooling system, including the engine block.
10. Remove the air cleaner and seal off the carburetor air inlet opening and PVC hose.
11. Plug the exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
12. Disconnect oil pan heater and engine coolant heater from power source (if equipped).
13. Clean and wipe the entire unit. Coat parts susceptible to rust with a light coat of oil. Cover the entire set loosely after the engine has cooled down.

### 5.15.2 Returning Set to Service

**NOTE:** *Always wear proper PPE before starting genset.*

1. Remove the protective cover.
2. Remove exhaust plugs, seal from carburetor and PVC hose, and replace air cleaner.
3. Check the oil dipstick to make sure the crankcase is full.

- 
4. Refill the cooling system per model specifications provided with the unit. See model specific engine manual or specification sheet for model specification information.
  5. Reconnect the battery (positive [+] cable first) and check specific gravity.
  6. Connect the battery charger (if applicable).
  7. Connect the oil pan heater and engine coolant heater to the power supply (if equipped).
  8. Clear the E-stop.
  9. Remove all loads before starting the set.
  10. Start the set and apply load of at least 50% of data plate rating.
  11. Check the display for normal readings. The set is now ready for service.



## Section 6 - Operating Recommendations

### 6.1 No-Load Operation

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, the best engine performance will be obtained by connecting a load bank of at least 30 percent of nameplate rating.

### 6.2 Exercise Period

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting.

Exercise the generator set at least once a month for a minimum of 30 minutes, under not less than 30 percent of the nameplate rating.

### 6.3 Low Operating Temperature

Use an oil pan heater and/or coolant heater if a separate source of power is available. The optional heater(s) will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.



### CAUTION

**To avoid damage to heater(s), be sure that oil and coolant systems are full before applying power to the heater(s).**

### 6.4 High Operating Temperature

Refer to the model specification information provided with the unit (refer to [Section 7](#) for instructions on finding model specific information) for the maximum ambient operating temperature, if applicable.

### 6.5 Natural Gas Engine Guidelines for Low -Load operation.

#### 6.5.1 Low- Load Operations

Cummins natural gas engines can be operated at low loads as long as the time at low loads does not exceed Cummins recommendations. Operating at low loads causes low intake manifold pressures which can result in higher-than-normal oil lubrications of the valves, rings and liners. Excess oil consumption over long periods of time causes carbon deposits that will result in a misfire condition due to spark plug fouling or excessive carbon build up on the valves, head and rings

#### 6.5.2 Recommended Hours of Operation at Low Loads

[Table 6-1](#) details the maximum length of time that Cummins engines should be run at various load conditions. For example, Cummins natural gas engines should not be run for more than 4 hours at a 10% load. % load = Ratio of actual load to rated load X100 during a specified time period of operation. After a period of low-load operation the engine should be operated at higher loads as described in the next section.

As additional examples, an engine should not be run for more than 24 hours at a 40% load or 8 hours at a 20% load. The hours at a low-load are cumulative, i.e. stopping an engine after 2 hours at 10% load does not mean that an additional 4 hours at 10% load is available.

**NOTE:** *At a load of > 70% the engines can be run continuously without excessive oil consumption or excessive carbon deposits.*



**Table 6-1 Low-Load Time Limits**

Maximum Engine Run Times at Low-Load Conditions		
Percent Load (%)	Maximum Low-Load Hours	Hours of Operation at >70% Load After a Period of Low-Load
Low Idle (no load)	1	2
High Idle (no load)	2	4
10	4	8
20	8	16
30	12	24
40	24	48
50	50	100
60	100	200
70	continuous	n/a
80	continuous	n/a
90	continuous	n/a
100	continuous	n/a

**6.5.3 Recommended Operation After Maximum Low-Load Time Limit Reached**

Once the engine has reached the maximum time limit at any operation load the engine should be run at greater than 70% load. The engine should be run at a minimum of 70% load for at least twice the length of time that it was run at the low-load level before oper-

ating again at a low-load level. (refer to the last column of [Table 6-1](#)).

For example, if the engine has been running 12 hours at 30% load, it should be run for at least 24 hours at a >70% rated load before a light load is applied. Running the engine for at least twice the length of time at the low-load levels allows the engine to burn the excess oil deposits of the spark plugs, valves, heads and rings.



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## Section 7 - Component Parts and Specifications

### 7.1 Part Ordering Information

Replacement parts for the Cummins Inc. equipment are manufactured to the same quality standards and specifications as the original equipment. Unapproved substitution may result in poor performance, reduced service life, lost production, or unsafe operation.

Cummins Inc. relies on the best and most cost effective shipping methods, unless specific instructions or requirements are requested by the customer. When ordering parts, please be prepared to provide the following information.

#### PARTS REQUESTS REQUIRE:

1. Model and serial number.
2. Part description by name or number.
3. Quantity required.
4. Purchase order number.

**NOTE:** *A purchase order number is desirable, even if the part(s) are supplied on a Returned Goods Authorization (RGA) issue number. A purchase order number helps Cummins NPower, LLC and its customers track the parts and necessary credits.*

### 7.2 Routine Service and Parts

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your engine. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support.

Check the telephone directory yellow pages or refer to the directory in this section for the nearest Cummins Authorized Repair Location.

### 7.3 Emergency Repairs and Technical Service

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can not be reached or is unable to resolve an issue with a Cummins product.

If assistance is required, call Toll-Free: 1-800-DIESELS (1-800-343-7357). Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.

Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.

Refer also to the Cummins Inc. web site at [www.cummins.com](http://www.cummins.com).

### 7.4 Recommended Spares Inventory

To minimize downtime and increase productivity, Cummins Inc. recommends maintaining a stock of spare parts critical to uninterrupted engine operation. Shipping costs can be lower using ground transportation rather than overnight or next day air freight. For this reason Cummins Inc. can provide a list of recommended spare parts. Contact the Cummins Authorized Repair Location for additional information.

### 7.5 Specifications

For model specific information see the specification data sheet provided with the genset. You can also view the specifications sheet and genset drawings by visiting our website at [www.cumminsnpower.com](http://www.cumminsnpower.com).

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**Table 7-1 Drive Belt Tension Table**

<b>SAE Belt Size</b>	<b>Belt Tension New</b>		<b>Belt Tension Range Used</b>	
	<b>N</b>	<b>lbf</b>	<b>N</b>	<b>lbf</b>
0.380 in	620	140	270 to 490	60 to 110
0.440 in	620	140	270 to 490	60 to 110
1/2 in	620	140	270 to 490	60 to 110
11/16 in	620	140	270 to 490	60 to 110
3/4 in	620	140	270 to 490	60 to 110
7/8 in	620	140	270 to 490	60 to 110
4 rib	620	140	270 to 490	60 to 110
5 rib	670	150	270 to 530	60 to 120
6 rib	710	160	290 to 580	65 to 130
8 rib	890	200	360 to 710	80 to 160
10 rib	1110	250	440 to 890	100 to 200
12 rib	1330	300	530 to 1070	120 to 240
12 rib K section	1330	300	890 to 1070	200 to 240
31 rib	1668	375	1330 to 1560	300 to 350

Table 7-2 Torque Table

### Cap Screw Markings and Torque Values



**Always use a cap screw of the same measurement and strength as the cap screw being replaced. Using the wrong cap screws can result in engine damage.**

Always use the torque values listed in the following tables when specific torque values are not available.

When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

#### Metric Cap Screw Identification

<b>Sample:</b>	<b>M8-1.25 x 25</b>		
<b>Value:</b>	<b>M8</b>	<b>1.25</b>	<b>X 25</b>
<b>Meaning:</b>	Major thread diameter in millimeters	Distance between threads in millimeters	Length in millimeters

#### Metric Cap Screw Head Markings

Metric cap screws and nuts are identified by the grade number stamped on the head of the cap screw or on the surface of the nuts.

<b>Commercial Steel Class</b>	<b>8.8</b>	<b>10.9</b>	<b>12.9</b>
<b>Cap Screw Head Markings</b>			

#### US Customary Cap Screw Identification

<b>Sample:</b>	<b>5/16 x 18 x 1-1/2</b>		
<b>Value:</b>	<b>5/16</b>	<b>18</b>	<b>1-1/2</b>
<b>Meaning:</b>	Major thread diameter in inches	Number of threads per inch	Length in inches

#### U.S. Customary Cap Screw Head Markings

U.S. Customary cap screws are identified by radial lines stamped on the head of the cap screw.

<b>SAE Grade 5 w/ three lines</b>	<b>SAE Grade 8</b>

**Table 7-2 Torque Table (Continued)**

**Metric Cap Screw Torque Values (lubricated threads)**

<b>Class:</b>	<b>8.8</b>				<b>10.9</b>				<b>12.9</b>			
<b>Diameter</b>	<b>Cast Iron</b>		<b>Aluminum</b>		<b>Cast Iron</b>		<b>Aluminum</b>		<b>Cast Iron</b>		<b>Aluminum</b>	
<b>mm</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

**U.S. Customary Cap Screw Torque Values (lubricated threads)**

<b>Grade:</b>	<b>SAE Grade 5</b>				<b>SAE Grade 8</b>			
<b>Cap Screw Body Size</b>	<b>Cast Iron</b>		<b>Aluminum</b>		<b>Cast Iron</b>		<b>Aluminum</b>	
	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>	<b>N•m</b>	<b>ft-lb</b>
1/4-20	9	7	8	6	15	11	8	6
1/4-28	12	9	9	7	18	13	9	7
5/16-18	20	15	16	12	30	22	16	12
5/16-24	23	17	19	14	33	24	19	14
3/8-16	40	30	25	20	55	40	25	20
3/8-24	40	30	35	25	60	45	35	25
7/16-14	60	45	45	35	90	65	45	35
7/16-20	65	50	55	40	95	70	55	40
1/2-13	95	70	75	55	130	95	75	55
1/2-20	100	75	80	60	150	110	80	60
9/16-12	135	100	110	80	190	140	110	80
9/16-18	150	110	115	85	210	155	115	85
5/8-11	180	135	150	110	255	190	150	110
5/8-18	210	155	160	120	290	215	160	120
3/4-10	325	240	255	190	460	340	255	190
3/4-16	365	270	285	210	515	380	285	210
7/8-9	490	360	380	280	745	550	380	280
7/8-14	530	390	420	310	825	610	420	310
1-8	720	530	570	420	1100	820	570	420
1-14	800	590	650	480	1200	890	650	480



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## Section 8 - Wiring Diagrams

### 8.1 General

This section consists of the schematic and connection wiring diagrams referenced in the text. The following drawings are included.

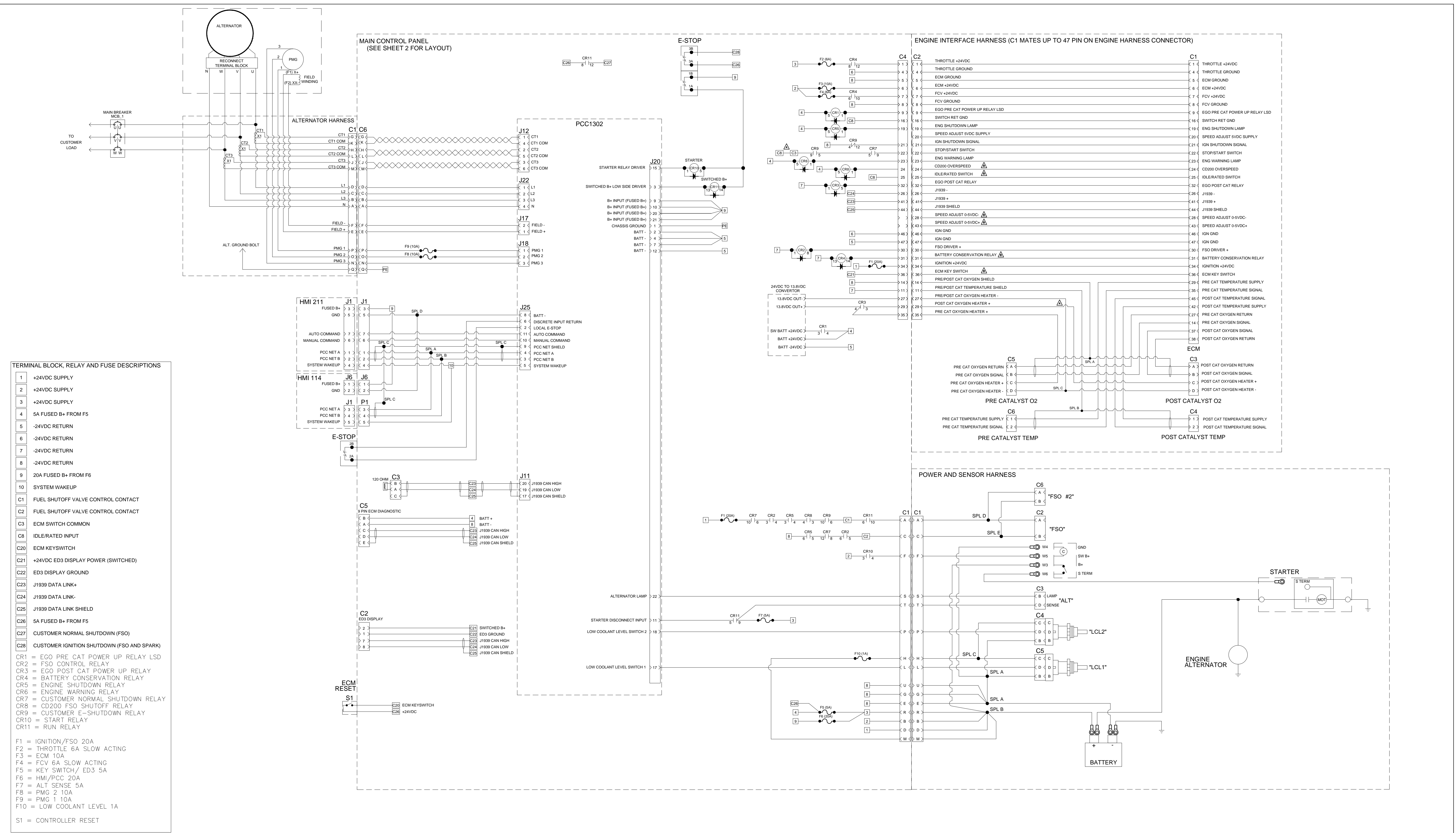
#### Wiring Diagrams - Electronic Engines

Drawing Title	Drawing No.	Rev.
Schematic, Controls Interface GFBC GTA855E w/ PCC 1302	GFBC-PCC 1.3 Wiring	B
Schematic, Controls Interface GFBC GTA855E w/ PCC 2300	GFBC-PCC 2.3-Wiring	B
Schematic, Controls Interface GFBC GTA855E w/ PCC 3300	GFBC-PCC 3.3-Wiring	B
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 1302	GFEB-PCC 1.3 Wiring	A
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 2300	GFEB-PCC 2.3-Wiring	A
Schematic, Controls Interface GFEB KTA19SLB w/ PCC 3300	GFEB-PCC 3.3-Wiring	A
Schematic, Overall GFPA Model 150 w/PCC 1.1/PCC 2.2	22726	-

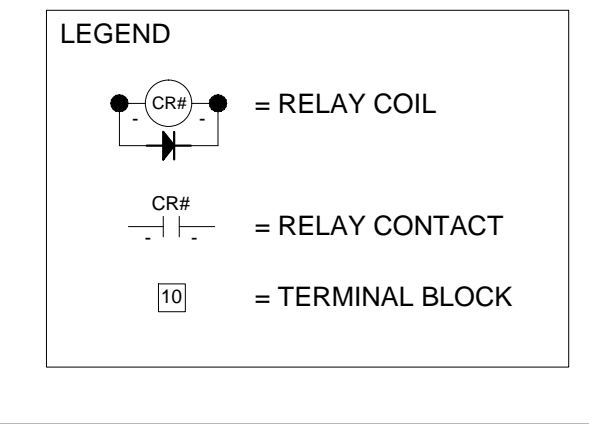
#### Wiring Diagrams - Hydro-Mechanical Engines

Drawing Title	Drawing No.	Rev.
Schematic, Controls Interface HM ENG w/PCC 1302	25538	-
Schematic, Controls Interface HM ENG w/PCC 3300	25539	-





- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLERATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 ED3 DISPLAY GROUND
  - C23 J1939 DATA LINK+
  - C24 J1939 DATA LINK-
  - C25 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (FSO)
  - C28 CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK)
  - CR1 = EGO PRE CAT POWER UP RELAY LSD
  - CR2 = FSO CONTROL RELAY
  - CR3 = EGO POST CAT POWER UP RELAY
  - CR4 = BATTERY CONSERVATION RELAY
  - CR5 = ENGINE SHUTDOWN RELAY
  - CR6 = ENGINE WARNING RELAY
  - CR7 = CUSTOMER NORMAL SHUTDOWN RELAY
  - CR8 = CD200 FSO SHUTOFF RELAY
  - CR9 = CUSTOMER E-SHUTDOWN RELAY
  - CR10 = START RELAY
  - CR11 = RUN RELAY
  - F1 = IGNITION/FSO 20A
  - F2 = THROTTLE 6A SLOW ACTING
  - F3 = ECM 10A
  - F4 = FCV 6A SLOW ACTING
  - F5 = KEY SWITCH/ ED3 5A
  - F6 = HMI/PCC 20A
  - F7 = ALT SENSE 5A
  - F8 = PMG 2 10A
  - F9 = PMG 1 10A
  - F10 = LOW COOLANT LEVEL 1A
  - S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021936-02 FOR ENGINE SIDE WIRING AND INTERFACE

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**SCHEMATIC, CONTROLS INTERFACE  
 GTA855E w/ PCC1302**

ANGULAR DIMENSIONS ± 1°  
 THIRD ANGLE PROJECTION

DWG UNITS: INCH/ LB/S  
 SCALE: 1:1  
 EST WEIGHT:

CUMMINS POWER LLC  
 CORPORATE OFFICE  
 1600 BERKLEY ROAD  
 WHITE BEAR LAKE, MN  
 WWW.CUMMINSPOWER.COM

CUSTOM DESIGN AND  
 UPTIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

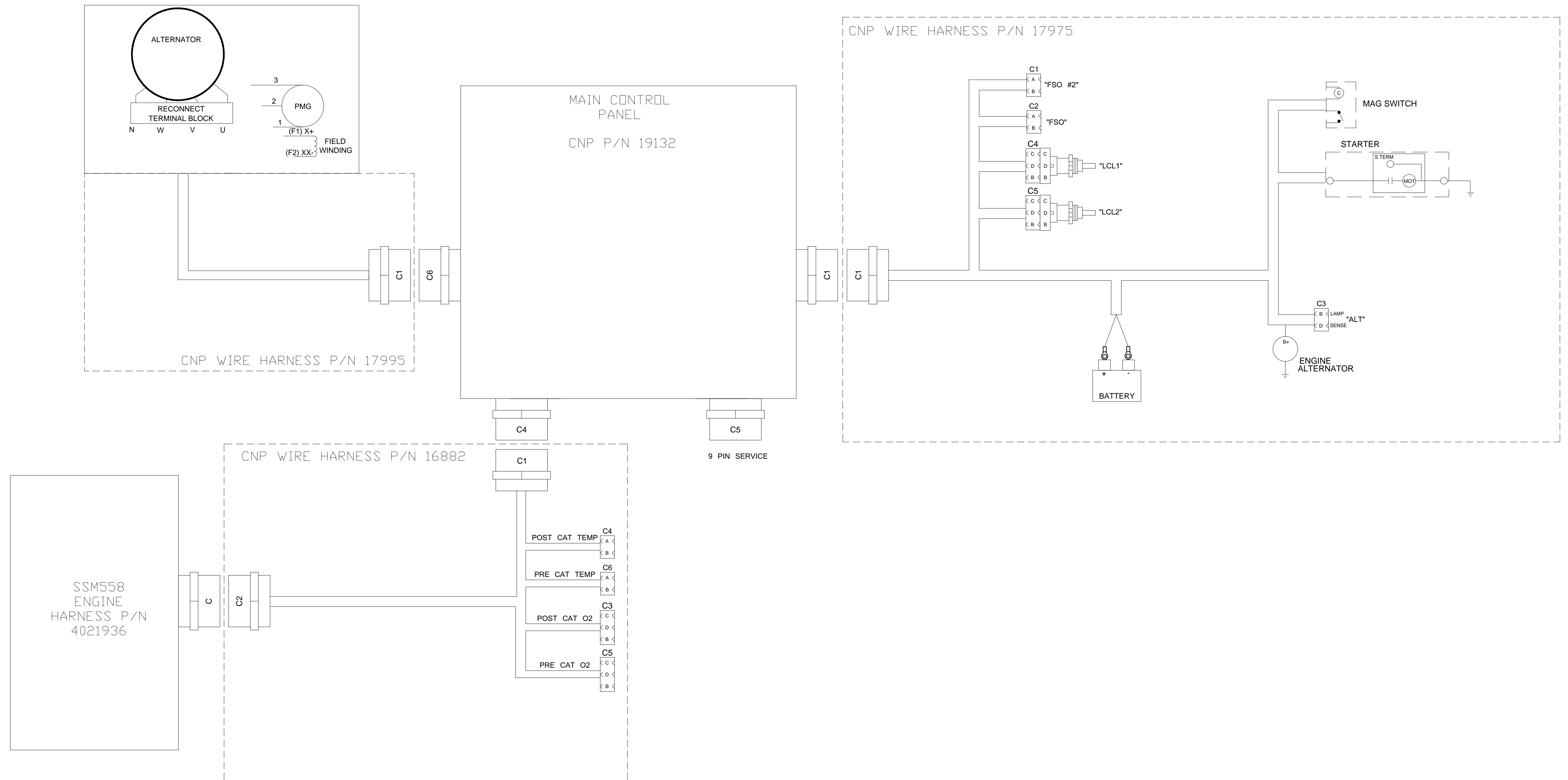
DRAWN BY: KAK  
 DATE: 2 SEPT 2011  
 INIT ECO:

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
B	2014-109	CORRECTED PINOUTS BETWEEN C1 & C2.	RMJ	25FEB2014
A	2013-721	ADDED JUMPER WIRE BETWEEN TERMINALS C3 & C8. REMOVED C7. FIXED O2 WIRING. ADDED SHEET 3.	KAK	25NOV2013

SHEET 10F3 DRAWING NO: GFBC-PCC1.3-WIRING







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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:  
 ANGULAR DIMENSIONS ± 1°  
 IMPERIAL UNITS: INCH/LB/S  
 METRIC UNITS: MM/KG

**Cummins InPower**  
 CUMMINS INPOWER LLC  
 CORPORATE OFFICE  
 1500 BUCKLE ROAD  
 WHITE BEAR LAKE, MN  
 WWW.CUMMINSINPOWER.COM

CUSTOM DESIGN AND  
 UPTIT CENTER  
 875 LAURITZKE DRIVE  
 DEPERE, WISCONSIN

**SCHEMATIC, CONTROLS INTERFACE  
 GT4855E W/ PCC1302**

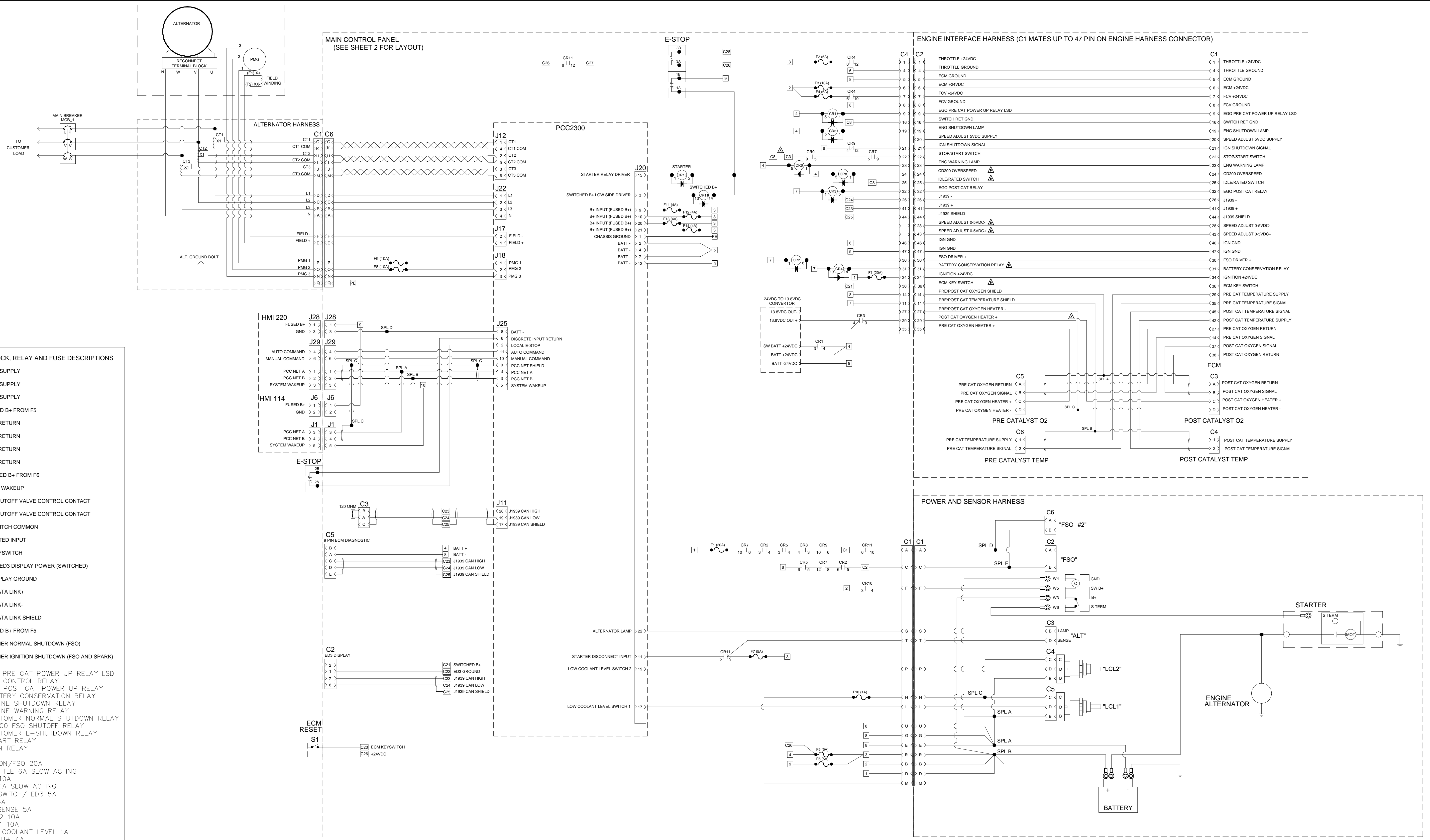
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 SCALE: SHEET 30F.3  
 EST WEIGHT:

DRAWN BY: KAK  
**AUTO CAD**

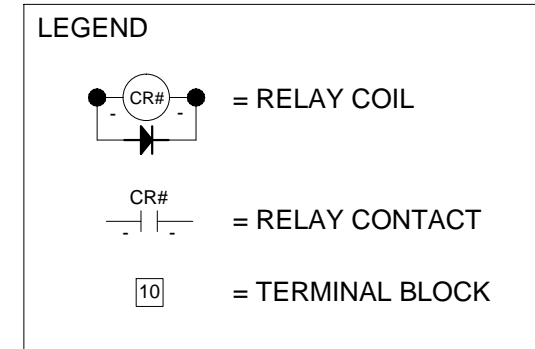
DATE: 02 SEPT 2011  
 INIT: ECO

DRAWING NO: GFBC-PCC1.3-WIRING

REV	DATE	DESCRIPTION OF REVISION	BY	DATE
B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLE/RATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 ED3 DISPLAY GROUND
  - C23 J1939 DATA LINK+
  - C24 J1939 DATA LINK-
  - C25 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (F50)
  - C28 CUSTOMER IGNITION SHUTDOWN (F50 AND SPARK)
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = RUN RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021936-02 FOR ENGINE SIDE WIRING AND INTERFACE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

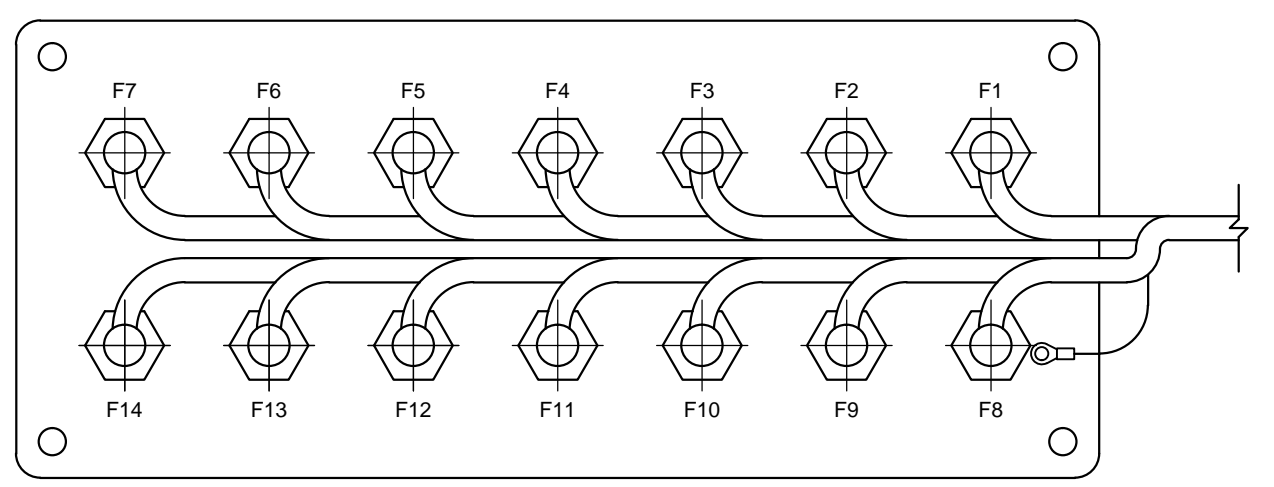
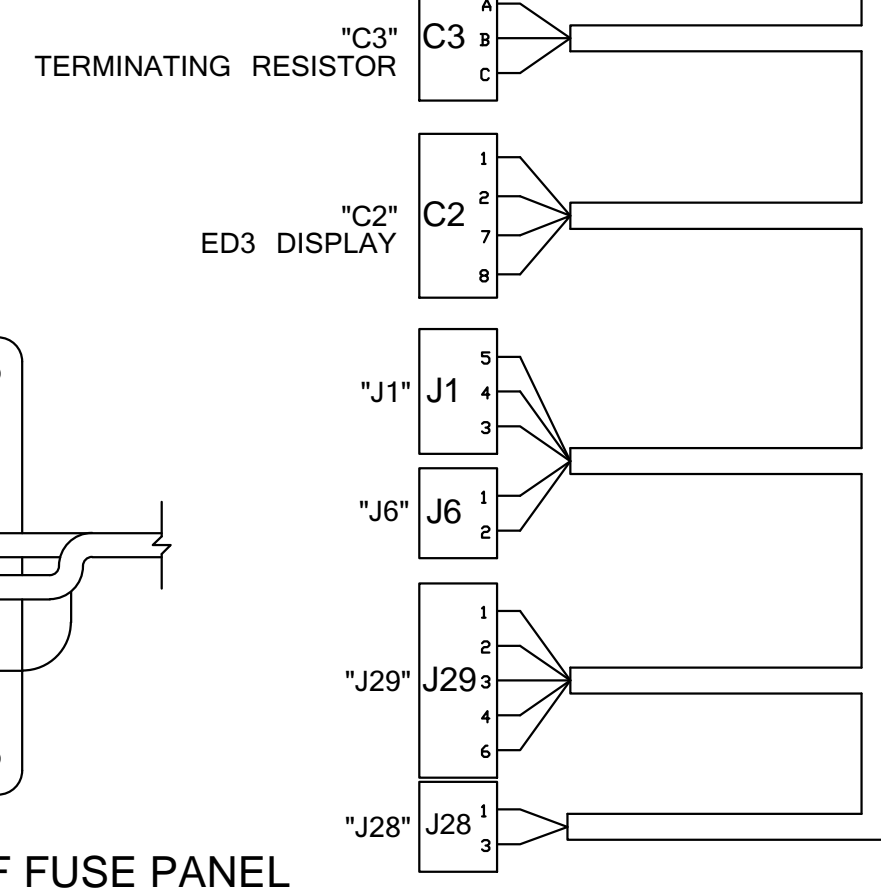
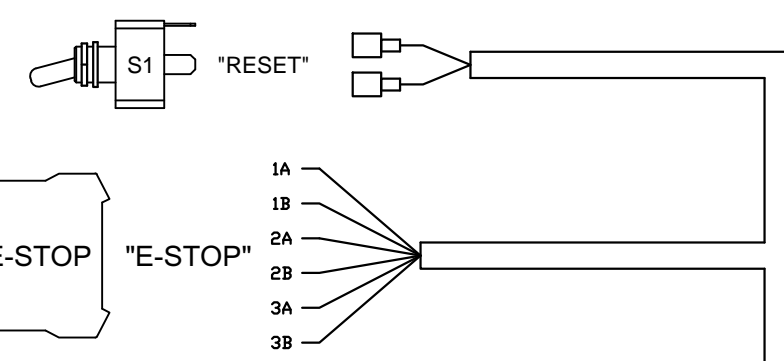
ANGULAR DIMENSIONS ±	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	±.005	±.15
	±.010	±.25
	±.015	±.38
	±.030	±.76

**SCHEMATIC, CONTROLS INTERFACE**  
 GTA855E w/ PCC2300

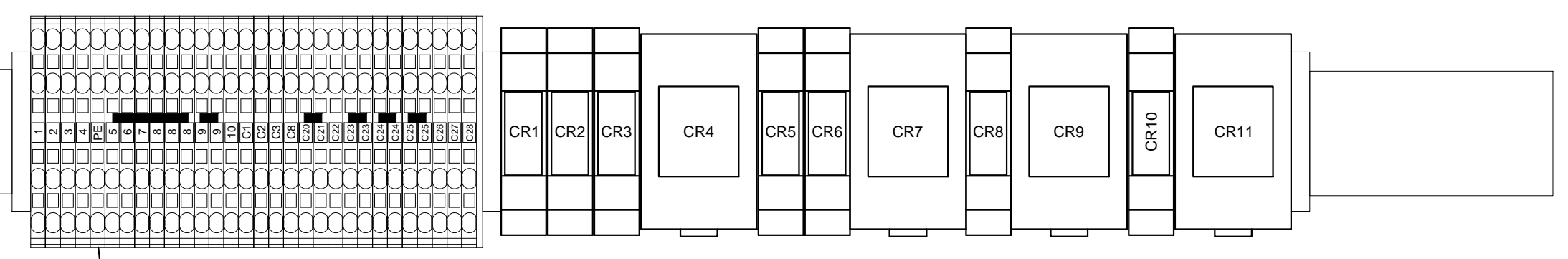
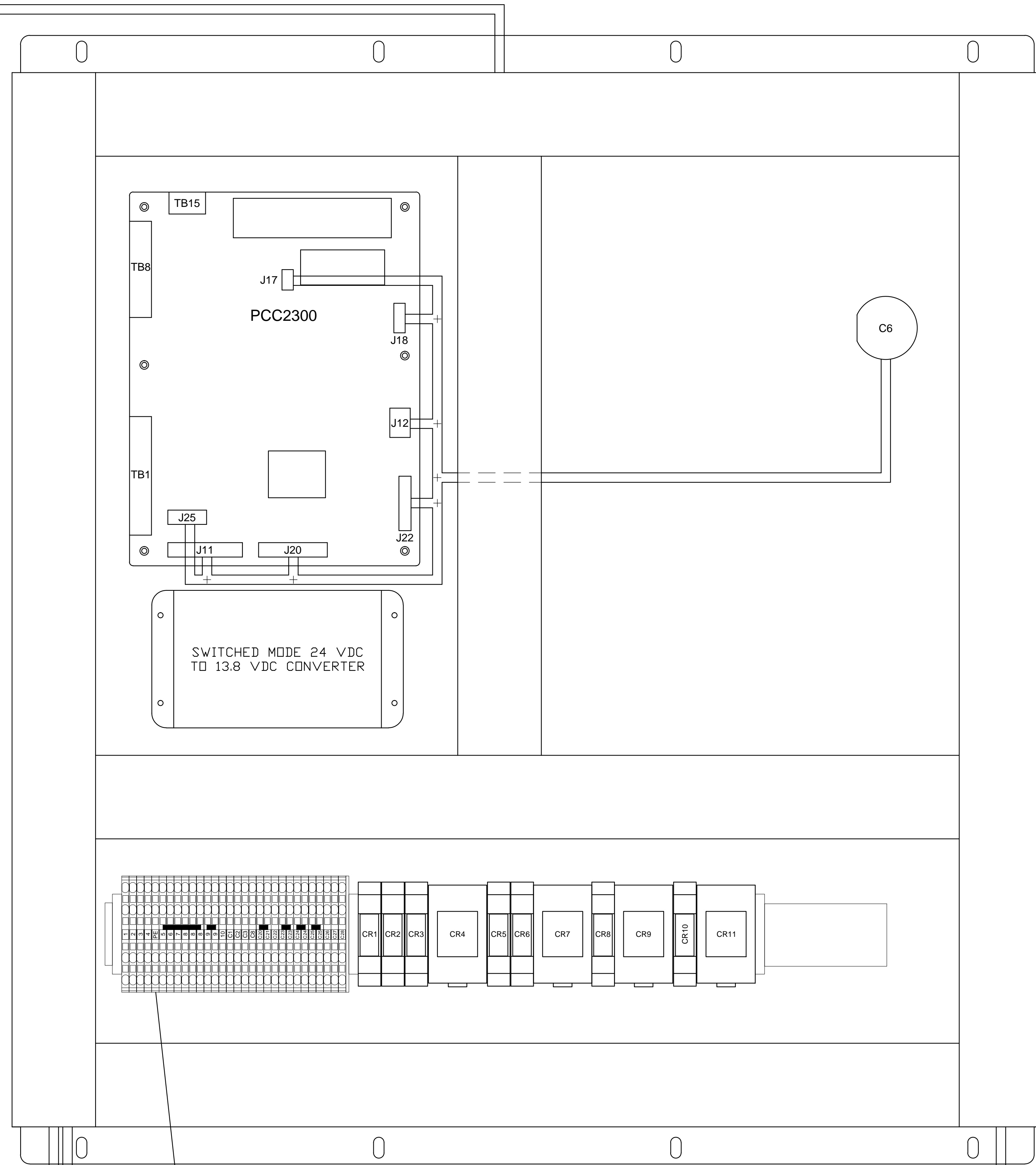
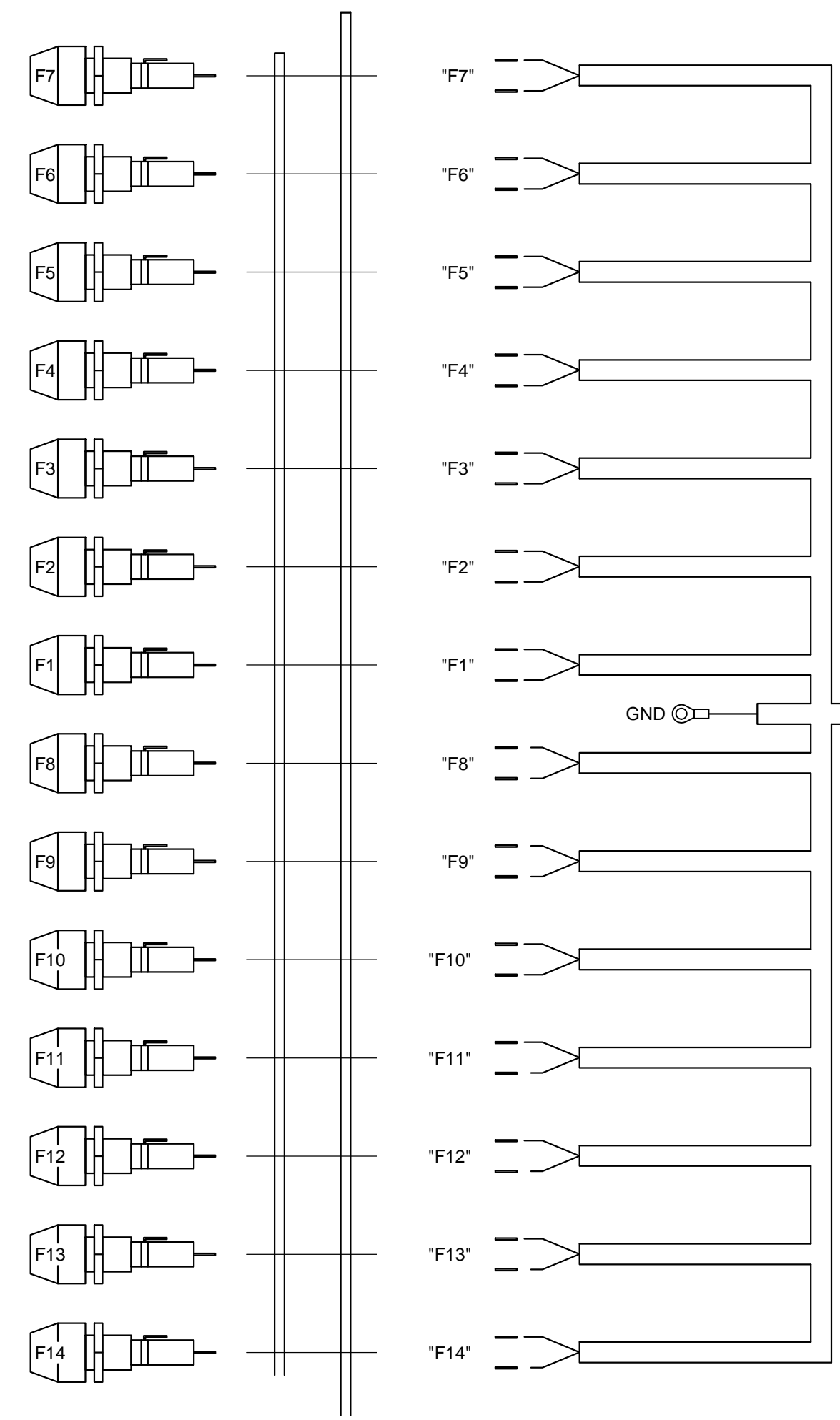
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 SCALE: SHEET 10F3  
 EST WEIGHT:

DRAWN BY: KAK  
**AUTO CAD**  
 DATE: 23 AUG 2011  
 INIT EGO:  
 DRAWING NO: CFBC-PCC2.3-WIRING

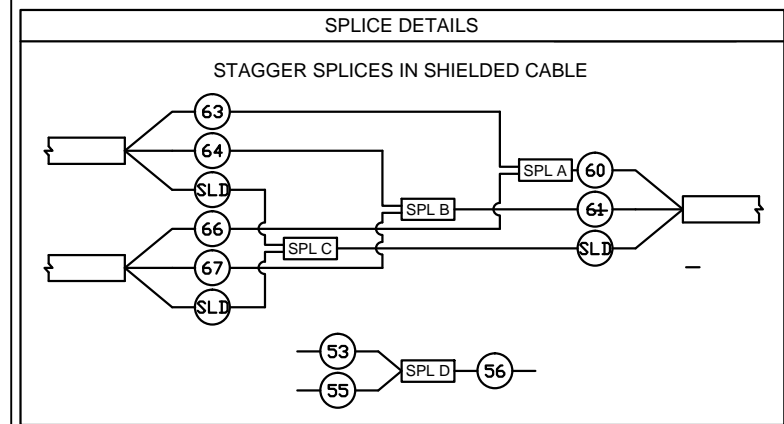
REV	ECO	DESCRIPTION OF REVISION	BY	DATE
B	2014-109	CORRECTED PINOUTS BETWEEN C1 & C2.	RMJ	25FEB2014
A	2013-721	REMOVED C7, FIXED O2 WIRING, ADDED SHEET 3. ADDED JUMPER BETWEEN TERMINALS C3 & C8.	KAK	25NOV2013



REAR VIEW OF FUSE PANEL DEPICTING WIRE ROUTING



1 2 3 4 PE 5 6 7 8 8 9 9 10 C1 C2 C3 C8 C20 C21 C22 C23 C24 C25 C26 C27 C28 TERMINAL STRIP DETAIL



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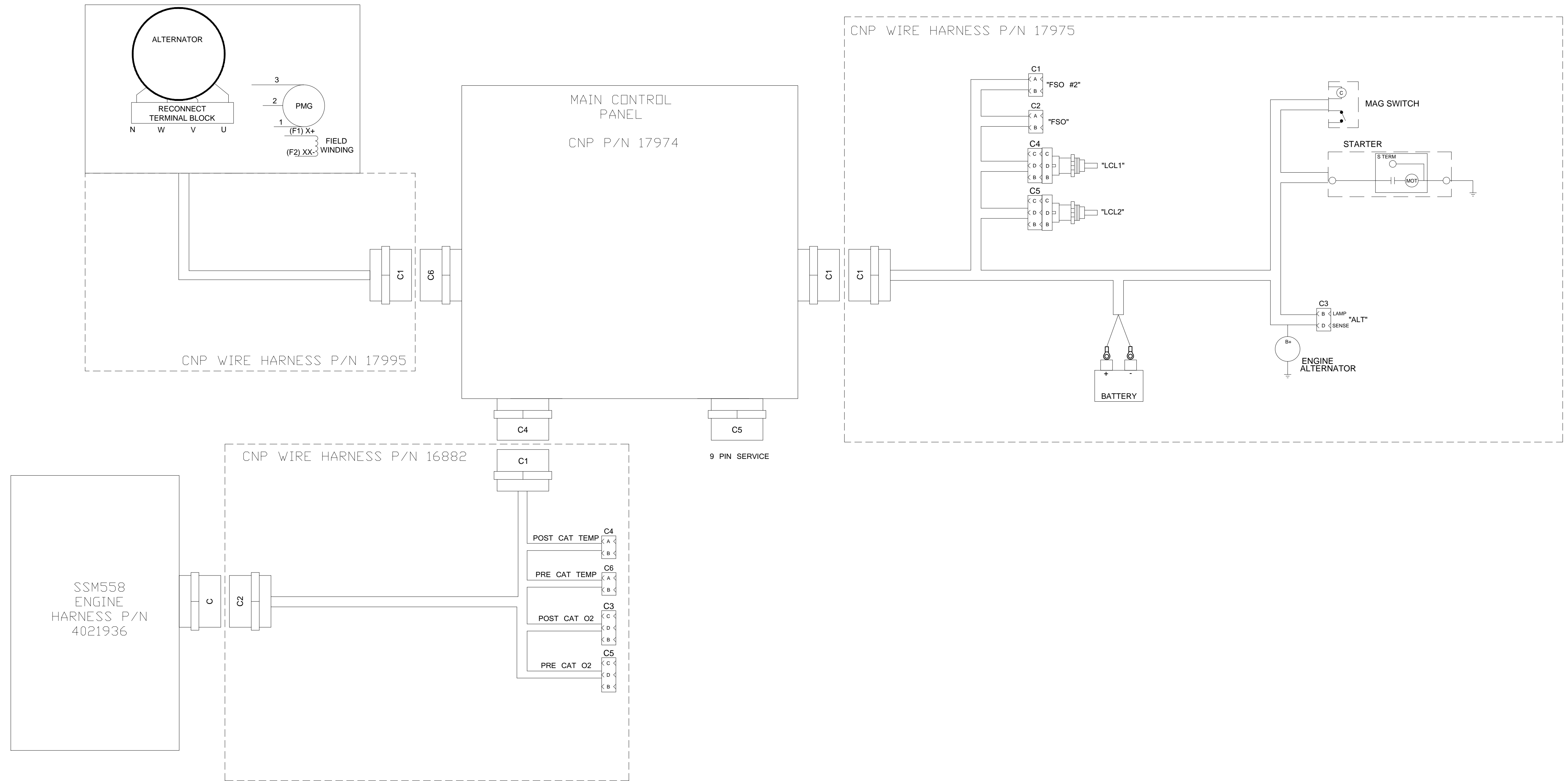
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
0.005	0.005	0.125
0.010	0.010	0.250
0.015	0.015	0.375
0.020	0.020	0.500

SCHEMATIC, CONTROLS INTERFACE  
 GTA855E w/ PCC2300

DWG UNITS: INCH/LB/S	DRAWN BY: KAK	DATE: 23 AUG 2011
SCALE: SHEET 20F3	INIT: ECO	
EST WEIGHT:	DRAWING NO: QFBC-PCC2.3-WIRING	

B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



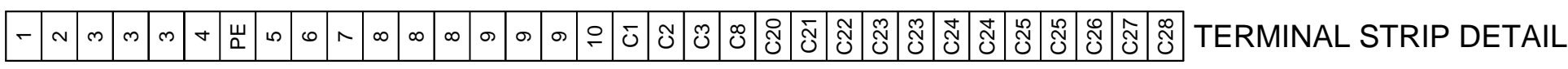
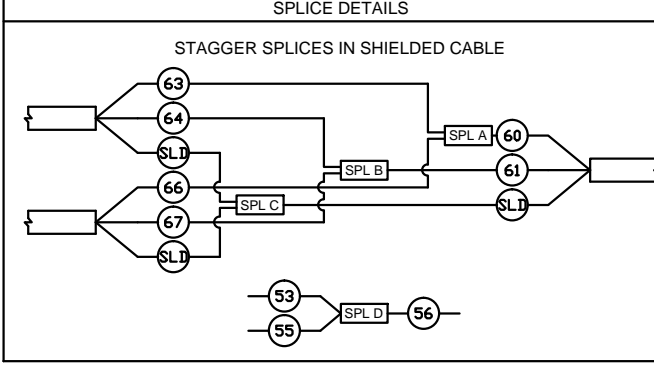
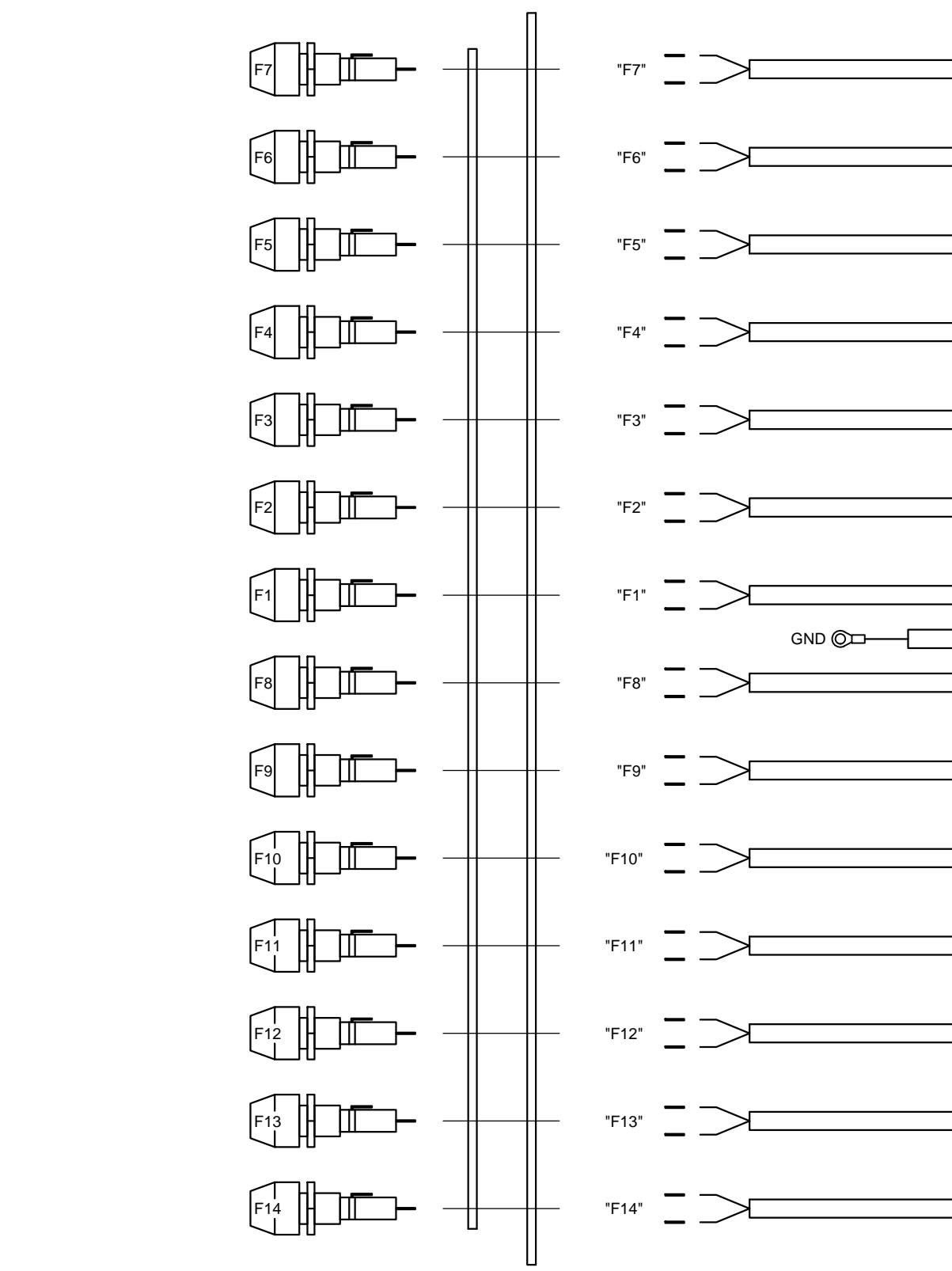
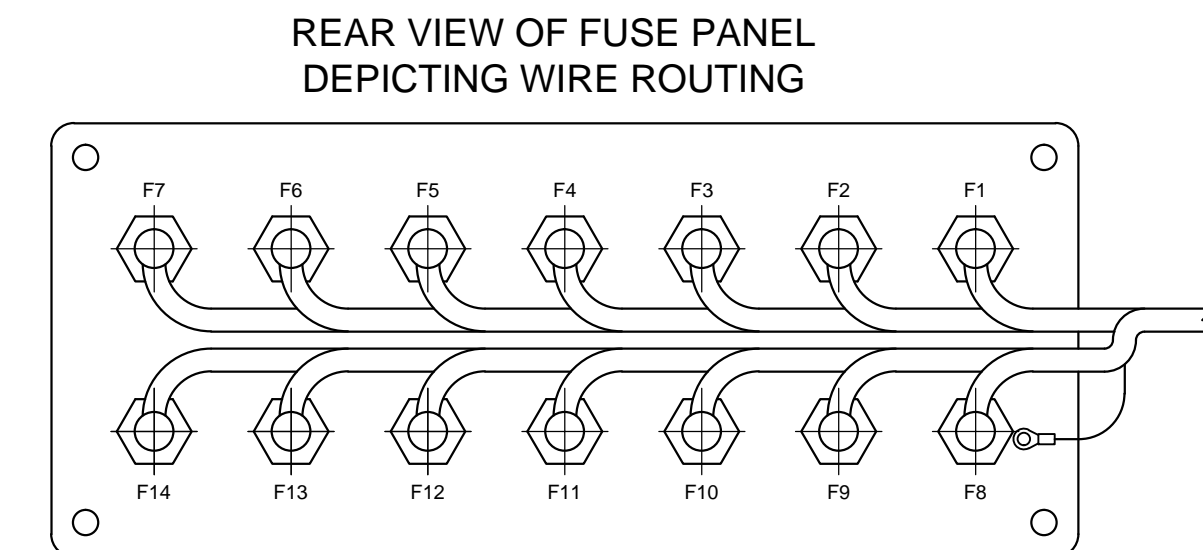
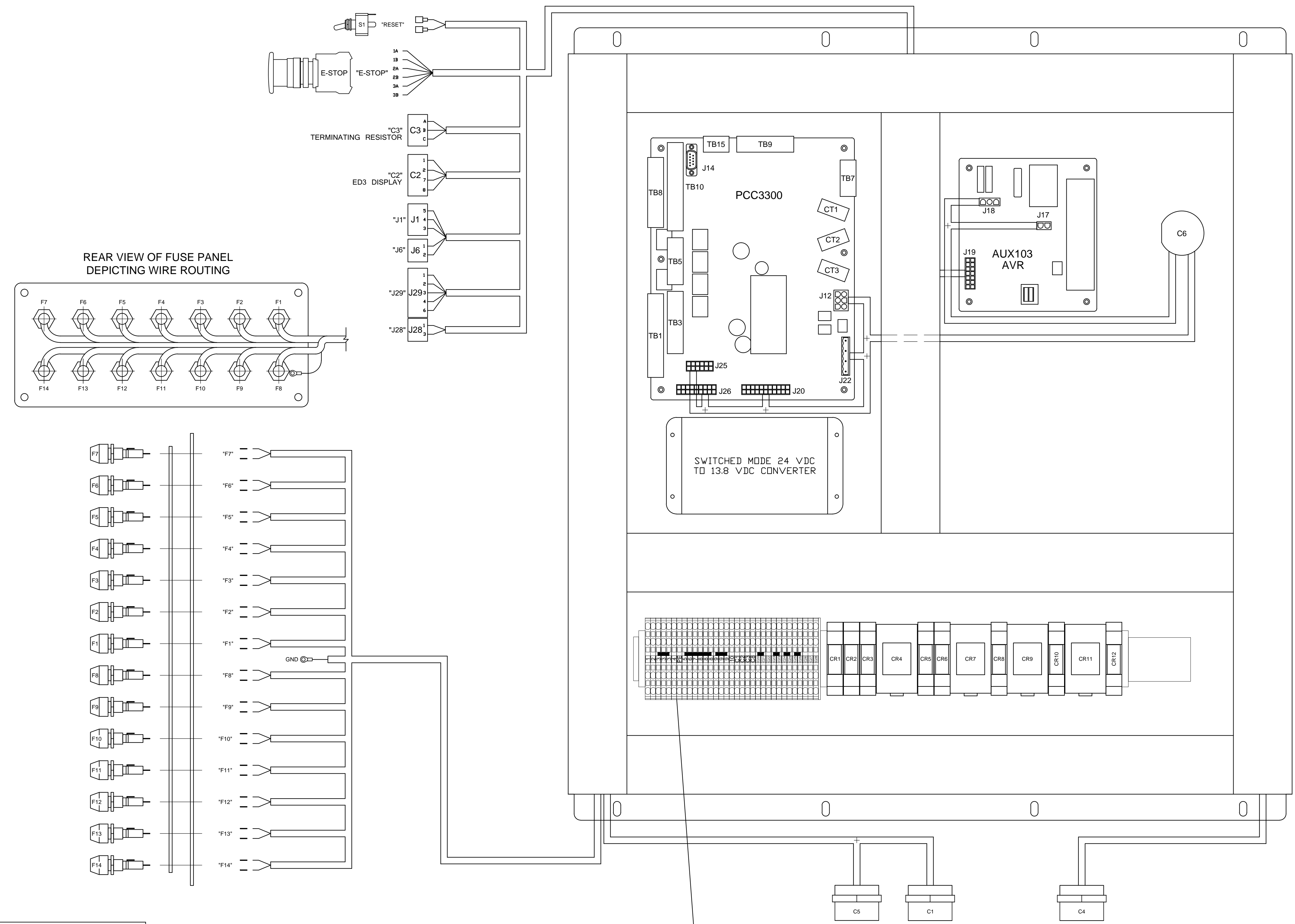
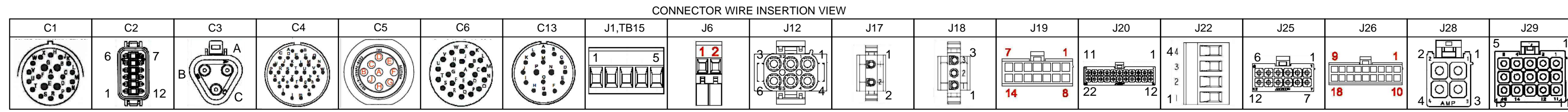
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ANGULAR DIMENSIONS ± 1°  
 THIRD ANGLE PROJECTION  
 IMPERIAL UNITS: 1/16, 1/8, 3/16, 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, 1  
 METRIC UNITS: 1.5, 3, 4.5, 6, 7.5, 9, 10.5, 12, 13.5, 15, 16.5, 18, 19.5, 21, 22.5, 24, 25.5, 27, 28.5, 30, 31.5, 33, 34.5, 36, 37.5, 39, 40.5, 42, 43.5, 45, 46.5, 48, 49.5, 51, 52.5, 54, 55.5, 57, 58.5, 60, 61.5, 63, 64.5, 66, 67.5, 69, 70.5, 72, 73.5, 75, 76.5, 78, 79.5, 81, 82.5, 84, 85.5, 87, 88.5, 90, 91.5, 93, 94.5, 96, 97.5, 99, 100.5, 102, 103.5, 105, 106.5, 108, 109.5, 111, 112.5, 114, 115.5, 117, 118.5, 120, 121.5, 123, 124.5, 126, 127.5, 129, 130.5, 132, 133.5, 135, 136.5, 138, 139.5, 141, 142.5, 144, 145.5, 147, 148.5, 150, 151.5, 153, 154.5, 156, 157.5, 159, 160.5, 162, 163.5, 165, 166.5, 168, 169.5, 171, 172.5, 174, 175.5, 177, 178.5, 180, 181.5, 183, 184.5, 186, 187.5, 189, 190.5, 192, 193.5, 195, 196.5, 198, 199.5, 201, 202.5, 204, 205.5, 207, 208.5, 210, 211.5, 213, 214.5, 216, 217.5, 219, 220.5, 222, 223.5, 225, 226.5, 228, 229.5, 231, 232.5, 234, 235.5, 237, 238.5, 240, 241.5, 243, 244.5, 246, 247.5, 249, 250.5, 252, 253.5, 255, 256.5, 258, 259.5, 261, 262.5, 264, 265.5, 267, 268.5, 270, 271.5, 273, 274.5, 276, 277.5, 279, 280.5, 282, 283.5, 285, 286.5, 288, 289.5, 291, 292.5, 294, 295.5, 297, 298.5, 300

B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE

SCHEMATIC, CONTROLS INTERFACE  
 GT855E w/ PCC2300  
 DWG UNITS: INCH/LB/S  
 SCALE: 1:1  
 EST WEIGHT: SHEET 30F3  
 DRAWING NO: GFBC-PCC2.3-WIRING  
 DATE: 23 AUG 2011  
 DRAWN BY: KAK  
 AUTO CAD  
 INIT ECO:





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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
0.005	0.0005	0.0127
0.010	0.0010	0.0254
0.015	0.0015	0.0381
0.020	0.0020	0.0508
0.030	0.0030	0.0762
0.040	0.0040	0.1016
0.050	0.0050	0.1270
0.060	0.0060	0.1524
0.070	0.0070	0.1778
0.080	0.0080	0.2032
0.090	0.0090	0.2286
0.100	0.0100	0.2540

THIRD ANGLE PROJECTION

SCHEMATIC, CONTROLS INTERFACE  
GTAB55E w/ PCC3300

B	2013-109	SEE SHEET 1 FOR DETAILS	RMJ	25FEB2014		
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013		
REV	ECO	DESCRIPTION OF REVISION	BY	DATE		

DWG UNITS: INCH/LB/S  
SCALE: SHEET 20F3  
EST WEIGHT:

DRAWN BY: KAK  
INIT ECO:  
AUTO CAD

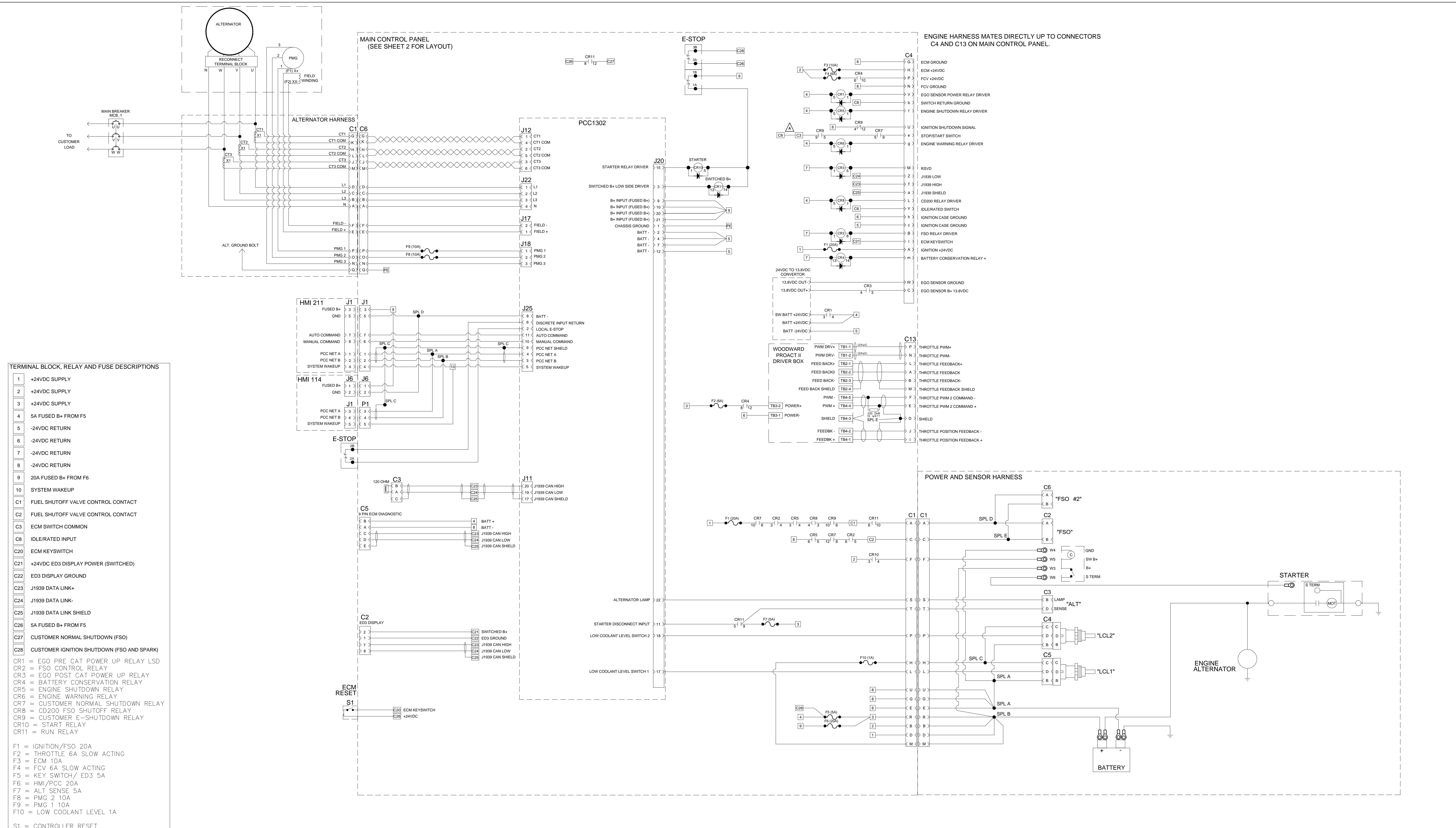
CUSTOM DESIGN AND UPLIFT CENTER  
875 LAWRENCE DRIVE  
DEPERE, WISCONSIN

CUMMINS NPOWER LLC  
CORPORATE OFFICE  
1500 BUCKLE ROAD  
WHITE BEAR LAKE, MN  
WWW.CUMMINSNPOWER.COM

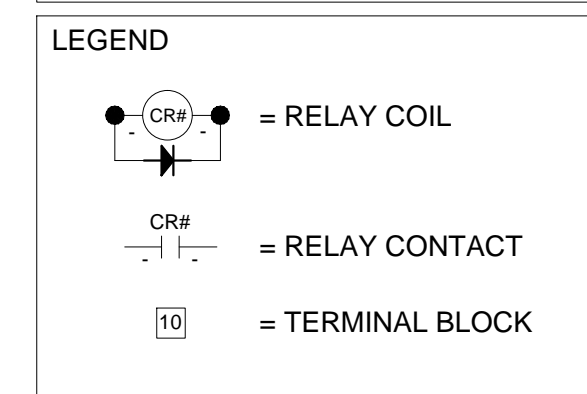
DATE: 23 AUG 2011







- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- |     |  |
|-----|--|
| 1   | +24VDC SUPPLY                              |
| 2   | +24VDC SUPPLY                              |
| 3   | +24VDC SUPPLY                              |
| 4   | 5A FUSED B+ FROM F5                        |
| 5   | -24VDC RETURN                              |
| 6   | -24VDC RETURN                              |
| 7   | -24VDC RETURN                              |
| 8   | -24VDC RETURN                              |
| 9   | 20A FUSED B+ FROM F6                       |
| 10  | SYSTEM WAKEUP                              |
| C1  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C2  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C3  | ECM SWITCH COMMON                          |
| C8  | IDLE/RATED INPUT                           |
| C20 | ECM KEYSWITCH                              |
| C21 | +24VDC ED3 DISPLAY POWER (SWITCHED)        |
| C22 | ED3 DISPLAY GROUND                         |
| C23 | J1939 DATA LINK+                           |
| C24 | J1939 DATA LINK-                           |
| C25 | J1939 DATA LINK SHIELD                     |
| C26 | 5A FUSED B+ FROM F5                        |
| C27 | CUSTOMER NORMAL SHUTDOWN (FSO)             |
| C28 | CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK) |
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = RUN RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI/PCC 20A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

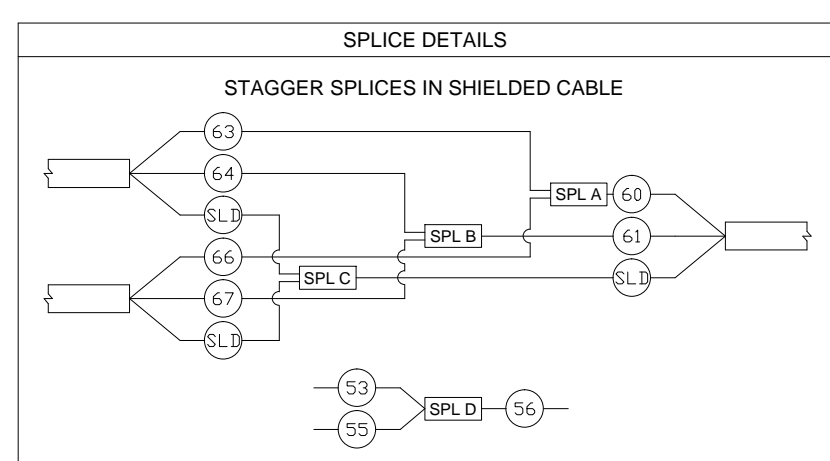
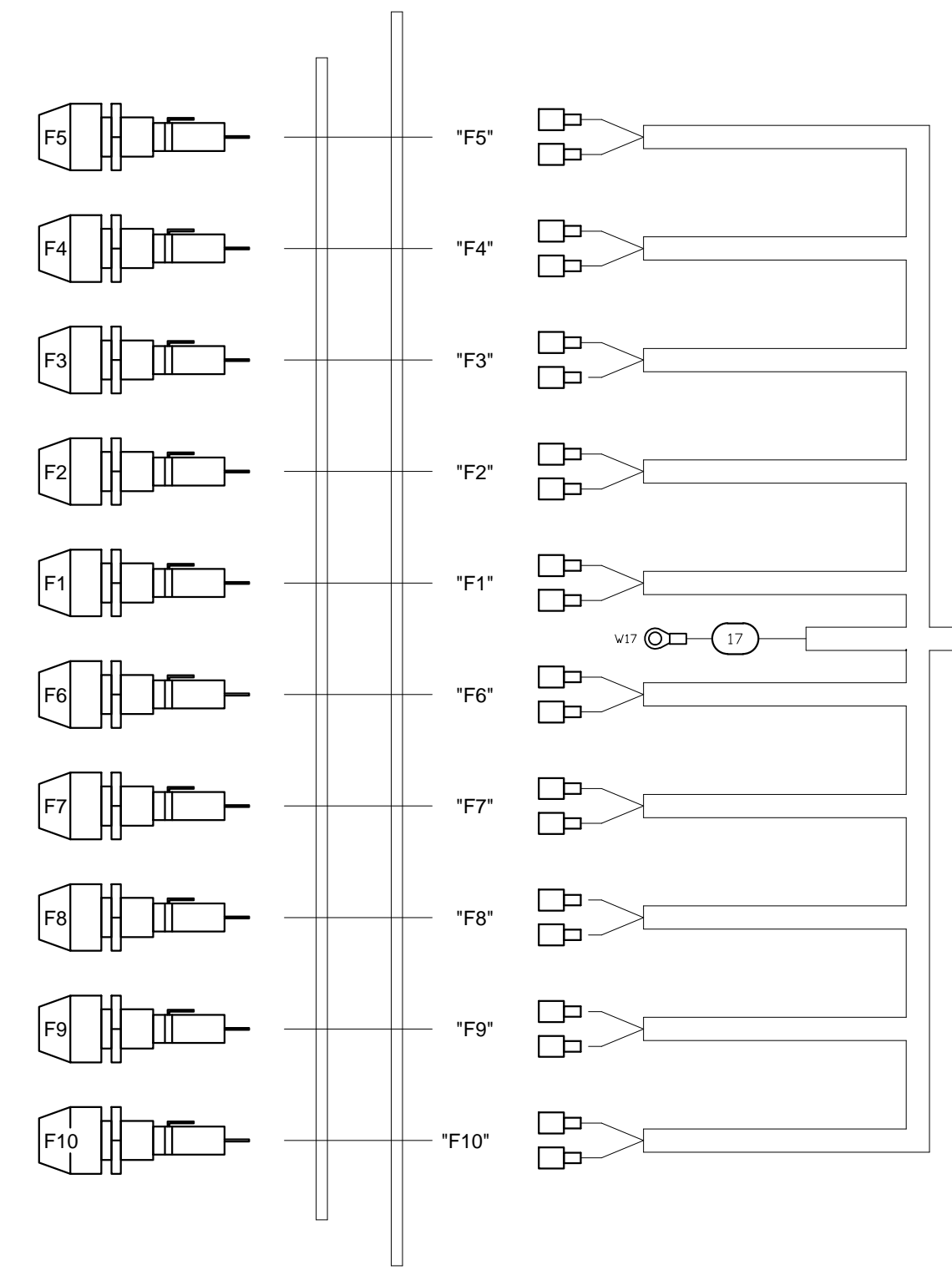
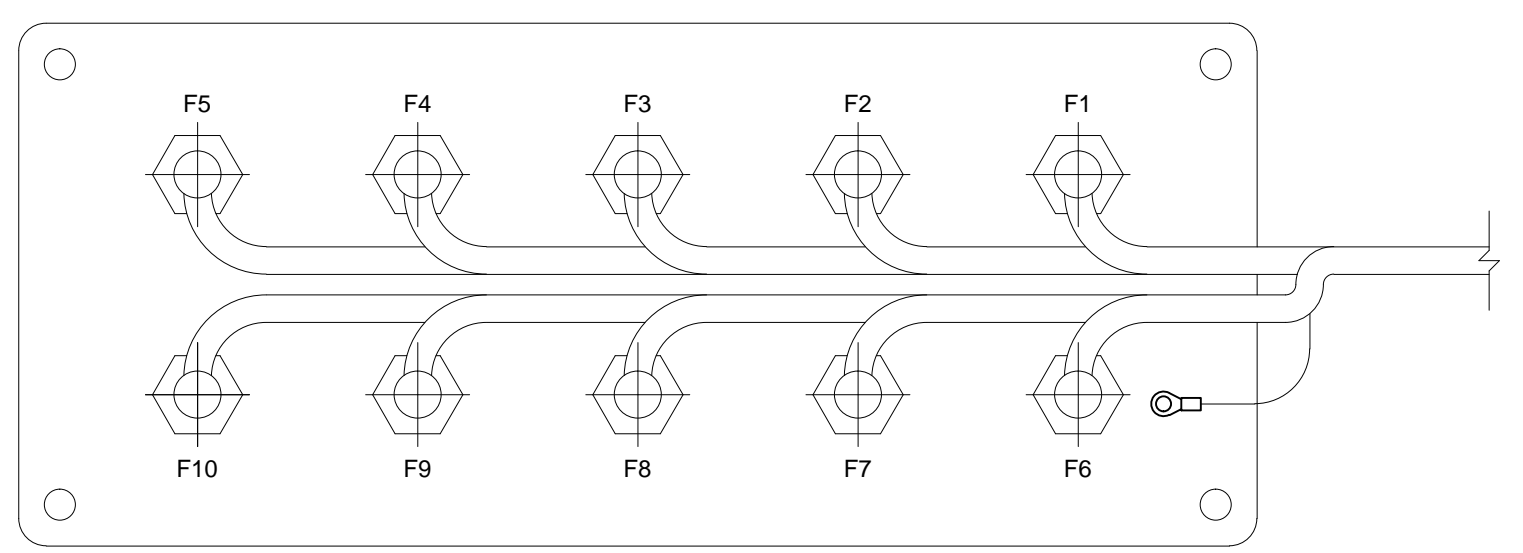
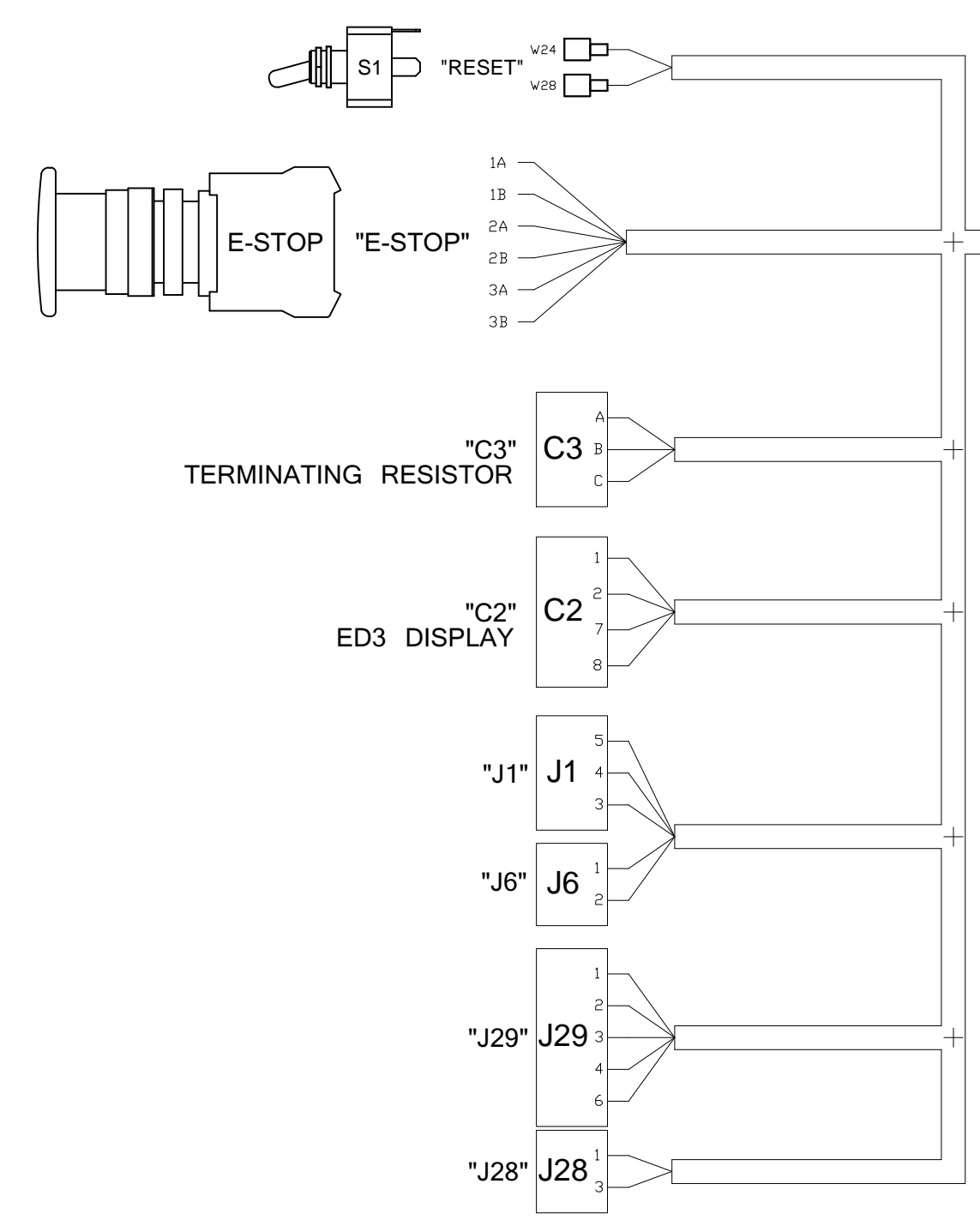
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

ANGULAR DIMENSIONS ±	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	1/16, 1/32, 1/64	0.015, 0.03, 0.075

DWG UNITS: INCH/LB/S  
 SCALE: AS SHOWN  
 EST WEIGHT: SHEET 10F3 DRAWING NO: GFEB-PCC1.3-WIRING

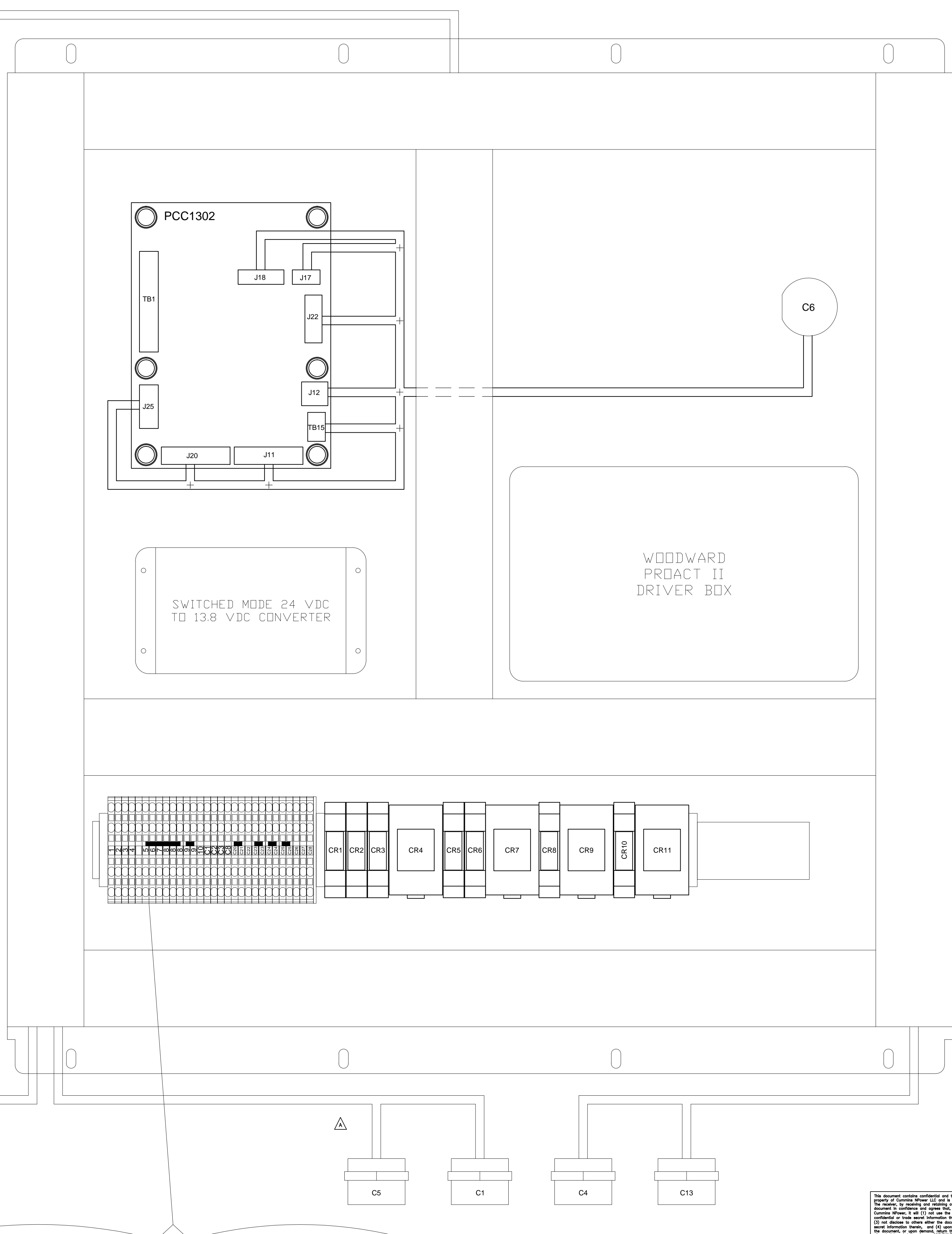
A	2013-721	ADDED JUMPER BETWEEN TERMINALS C3 & C8. REMOVED C7. ADDED SHEET 3.	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE





1	2	3	4	5	6	7	8	9	10	C1	C2	C3	C8	C20	C21	C22	C23	C24	C25	C26	C27	C28
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TERMINAL STRIP DETAIL



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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
0.005	0.005	0.15
0.010	0.010	0.25
0.020	0.020	0.50
0.050	0.050	1.25

THIRD ANGLE PROJECTION

SCALE: 1" = 1"

EST WEIGHT: SHEET 20F3

DWG UNITS: INCH/LB/S

SCALE: 1" = 1"

EST WEIGHT: SHEET 20F3

DRAWN BY: KAK

DATE: 2 SEPT 2011

INIT ECO:

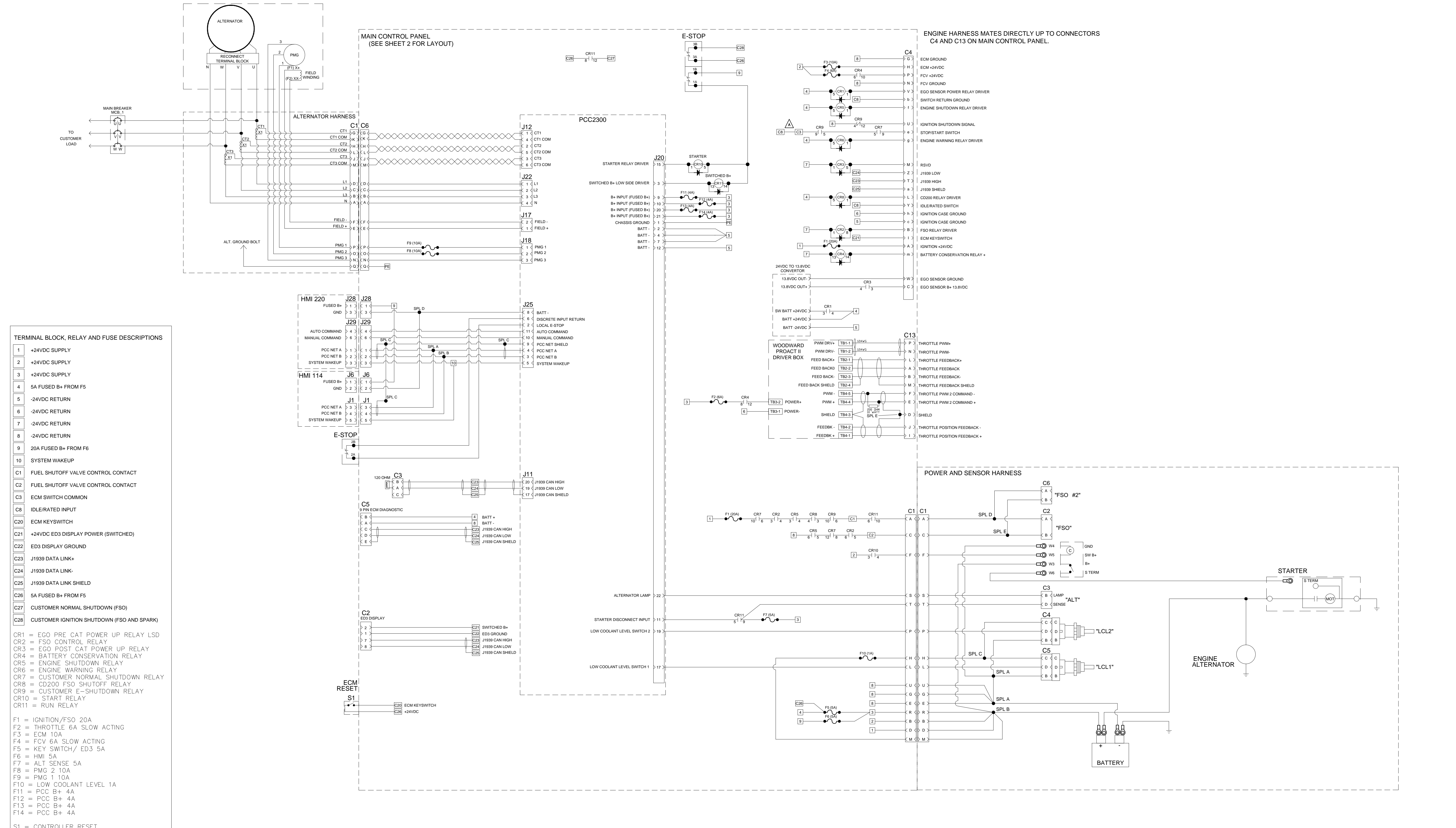
SCHEMATIC, CONTROLS INTERFACE  
KTA19SLB w/ PCC1302

CUMMINS NPOWER LLC  
CORPORATE OFFICE  
1000 SUBSILE ROAD  
WHITE BEAR LAKE, MN  
WWW.CUMMINSNPOWER.COM

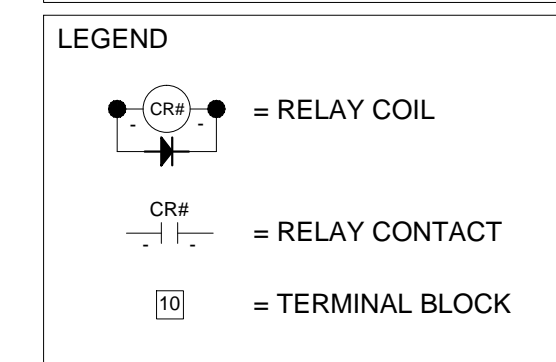
CUSTOM DESIGN AND  
UPFIT CENTER  
875 LAURANCE DRIVE  
DEPERE, WISCONSIN

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE





- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- |     |  |
|-----|--|
| 1   | +24VDC SUPPLY                              |
| 2   | +24VDC SUPPLY                              |
| 3   | +24VDC SUPPLY                              |
| 4   | 5A FUSED B+ FROM F5                        |
| 5   | -24VDC RETURN                              |
| 6   | -24VDC RETURN                              |
| 7   | -24VDC RETURN                              |
| 8   | -24VDC RETURN                              |
| 9   | 20A FUSED B+ FROM F6                       |
| 10  | SYSTEM WAKEUP                              |
| C1  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C2  | FUEL SHUTOFF VALVE CONTROL CONTACT         |
| C3  | ECM SWITCH COMMON                          |
| C8  | IDLE/RATED INPUT                           |
| C20 | ECM KEYSWITCH                              |
| C21 | +24VDC ED3 DISPLAY POWER (SWITCHED)        |
| C22 | ED3 DISPLAY GROUND                         |
| C23 | J1939 DATA LINK+                           |
| C24 | J1939 DATA LINK-                           |
| C25 | J1939 DATA LINK SHIELD                     |
| C26 | 5A FUSED B+ FROM F5                        |
| C27 | CUSTOMER NORMAL SHUTDOWN (FSO)             |
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 CR6 = ENGINE WARNING RELAY  
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 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



ENGINE HARNESS MATES DIRECTLY UP TO CONNECTORS C4 AND C13 ON MAIN CONTROL PANEL.

REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

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**ANGULAR DIMENSIONS ± 1°**  
**THIRD ANGLE PROJECTION**

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
1/8" = 3.175mm	1/16" = 1.5875mm	1/32" = 0.79375mm
3/16" = 4.7625mm	1/4" = 6.35mm	5/16" = 7.9375mm
1/2" = 12.7mm	5/8" = 15.875mm	3/4" = 19.05mm
7/8" = 22.225mm	1" = 25.4mm	

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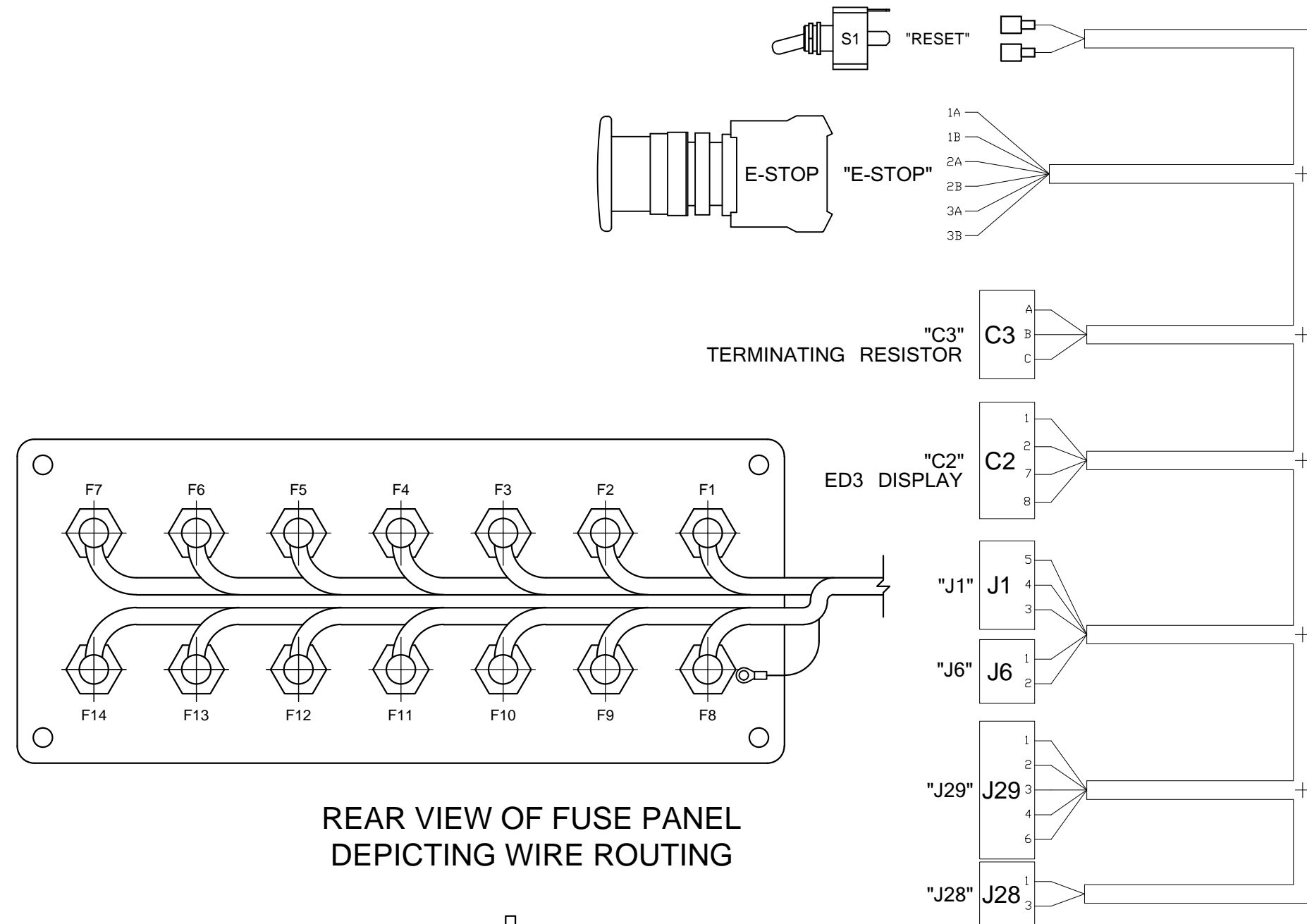
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**SCHEMATIC, CONTROLS INTERFACE**  
**KTA19SLB w/ PCC2300**

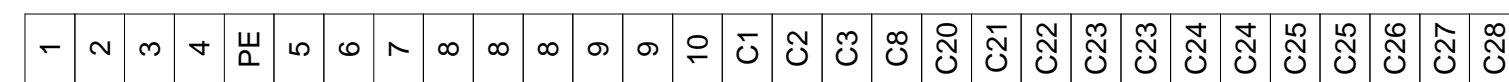
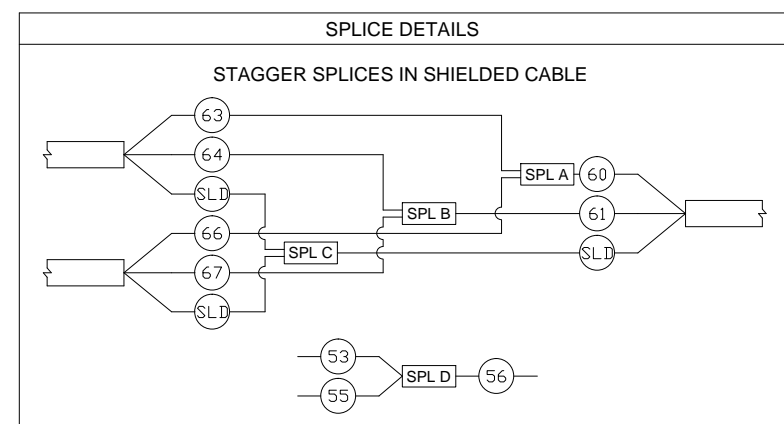
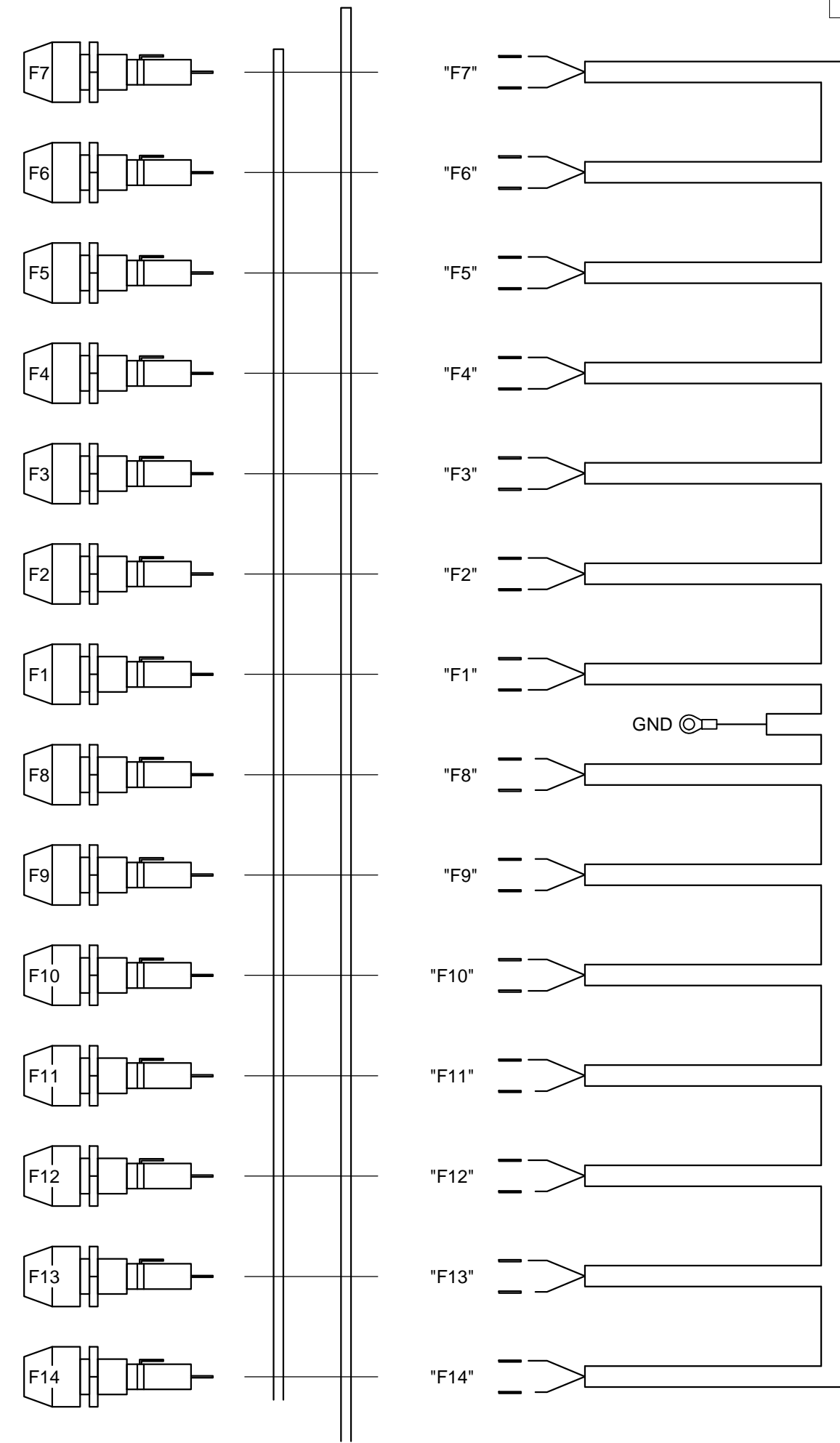
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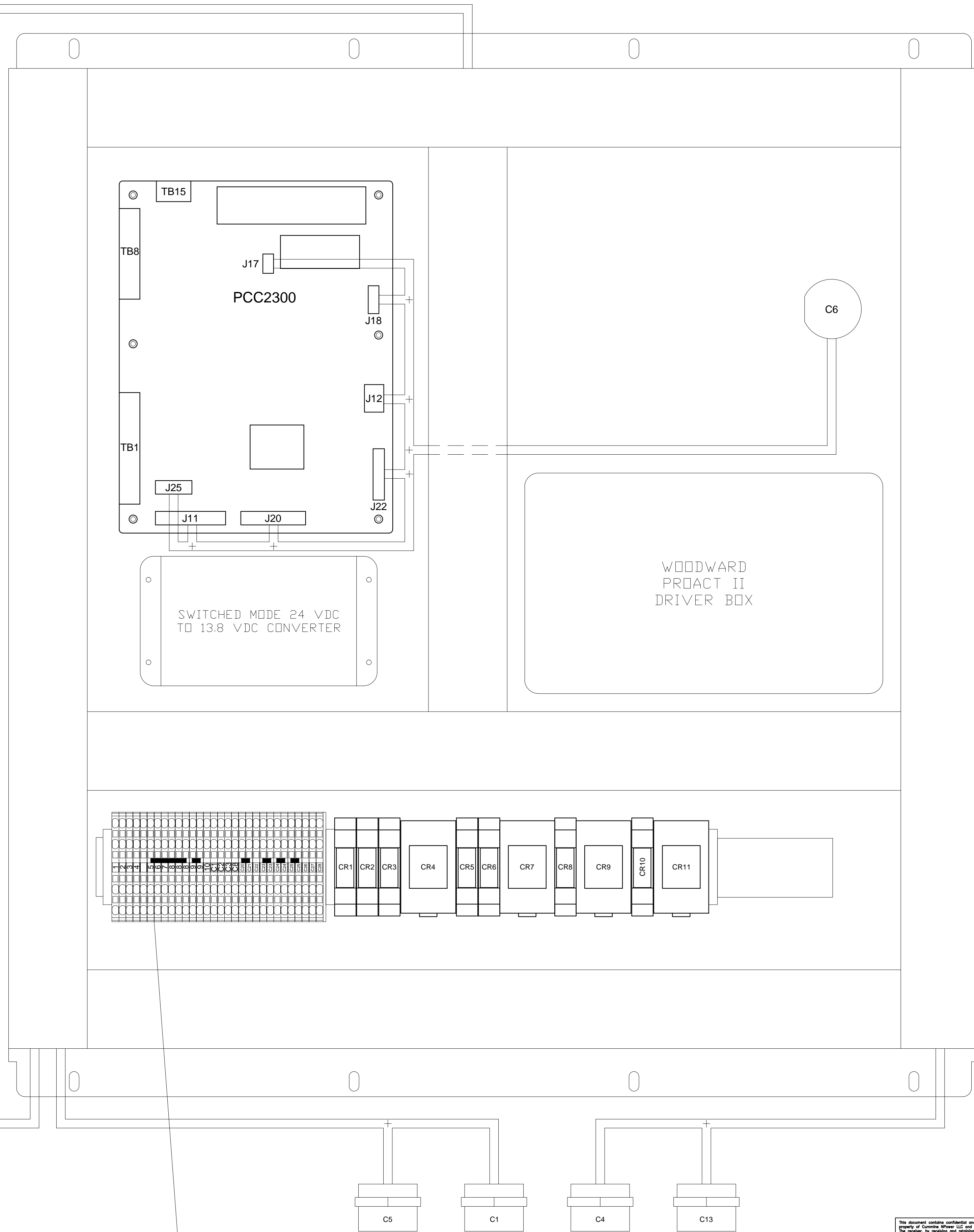
A	2013-721	REMOVED C7, ADDED SHEET 3, ADDED JUMPER BETWEEN TERMINALS C3 & C8.	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING



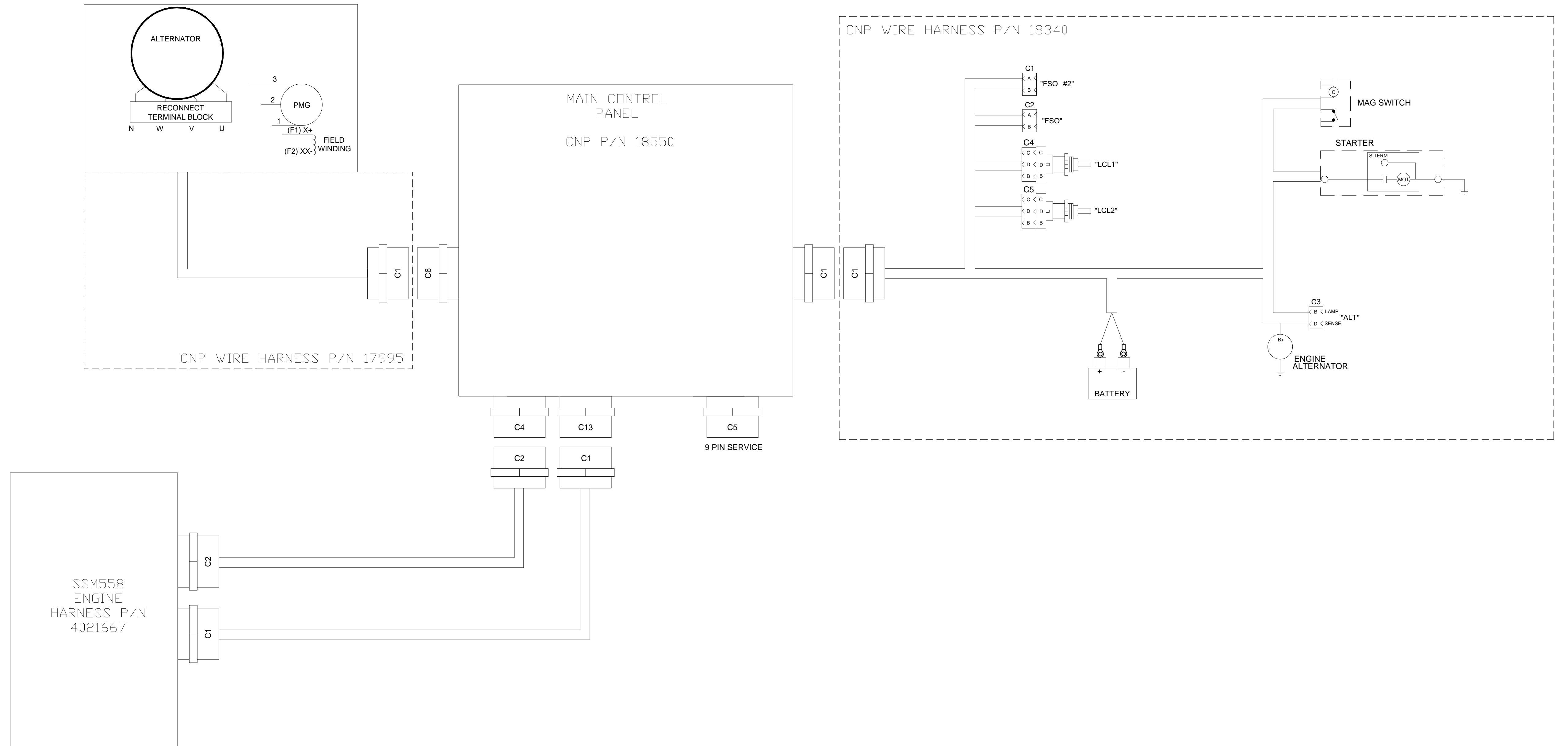
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	SCHEMATIC, CONTROLS INTERFACE KTA19SLB w/ PCC2300	
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SCALE: EST WEIGHT:	SHEET 20F3	DRAWING NO: GFEB-PCC2.3-WIRING

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 KTA19SLB W/ PCC2300

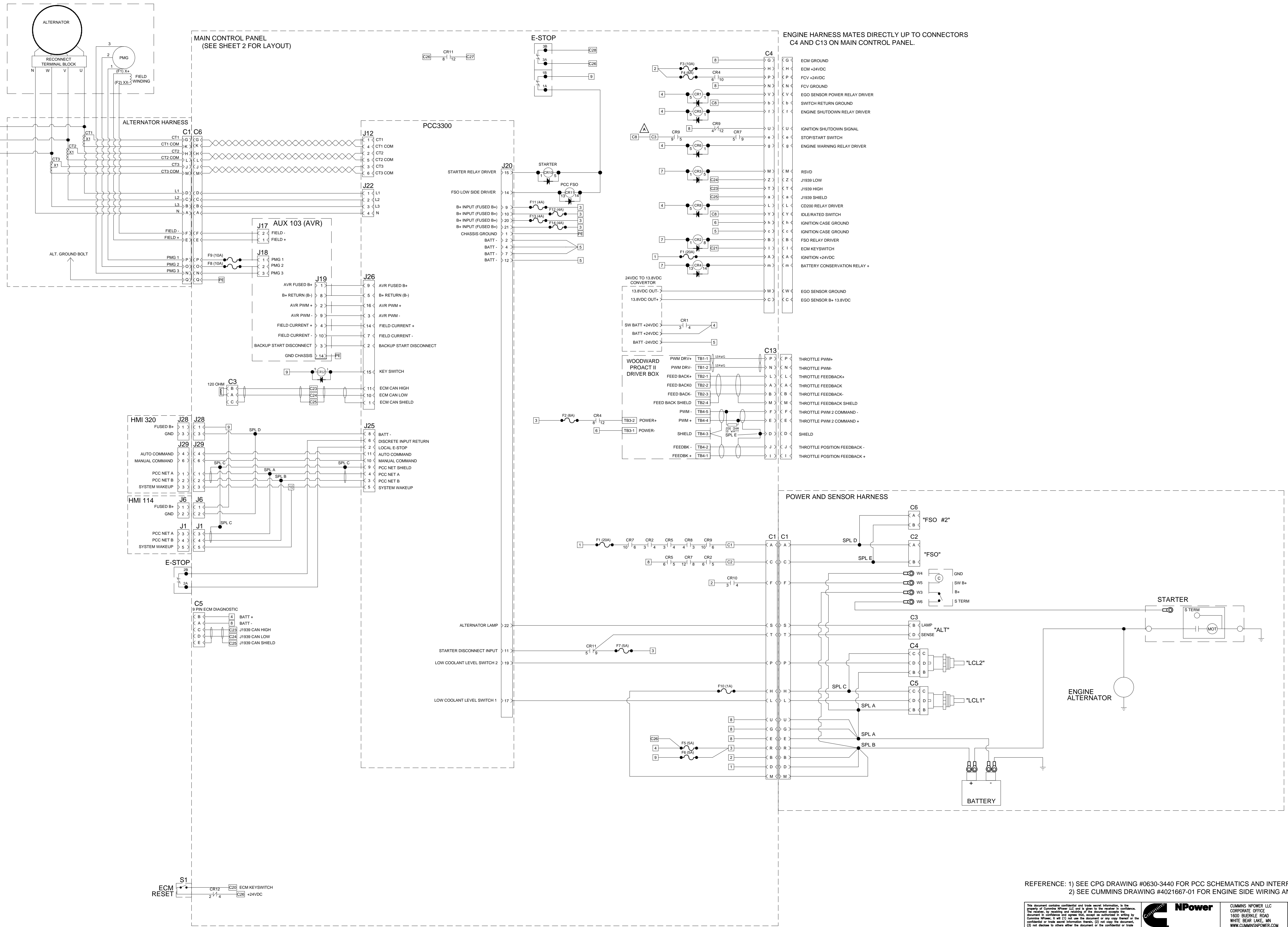
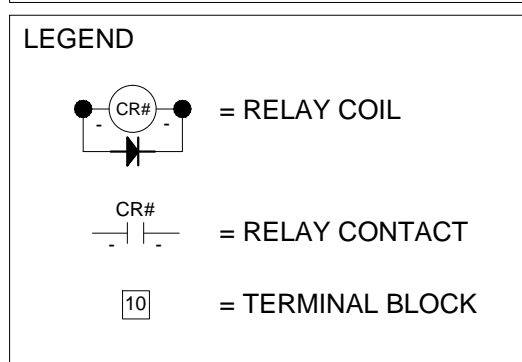
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 THIRD ANGLE PROJECTION

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
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- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLERATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 J1939 DATA LINK+
  - C23 J1939 DATA LINK-
  - C24 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (FSO)
  - C28 CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK)
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = PCC FSO RELAY  
 CR12 = KEYSWITCH RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

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0.0005	0.0005	0.0127
0.0010	0.0010	0.0254
0.0015	0.0015	0.0381
0.0020	0.0020	0.0508
0.0030	0.0030	0.0762
0.0040	0.0040	0.1016
0.0050	0.0050	0.1270
0.0060	0.0060	0.1524
0.0070	0.0070	0.1778
0.0080	0.0080	0.2032
0.0090	0.0090	0.2286
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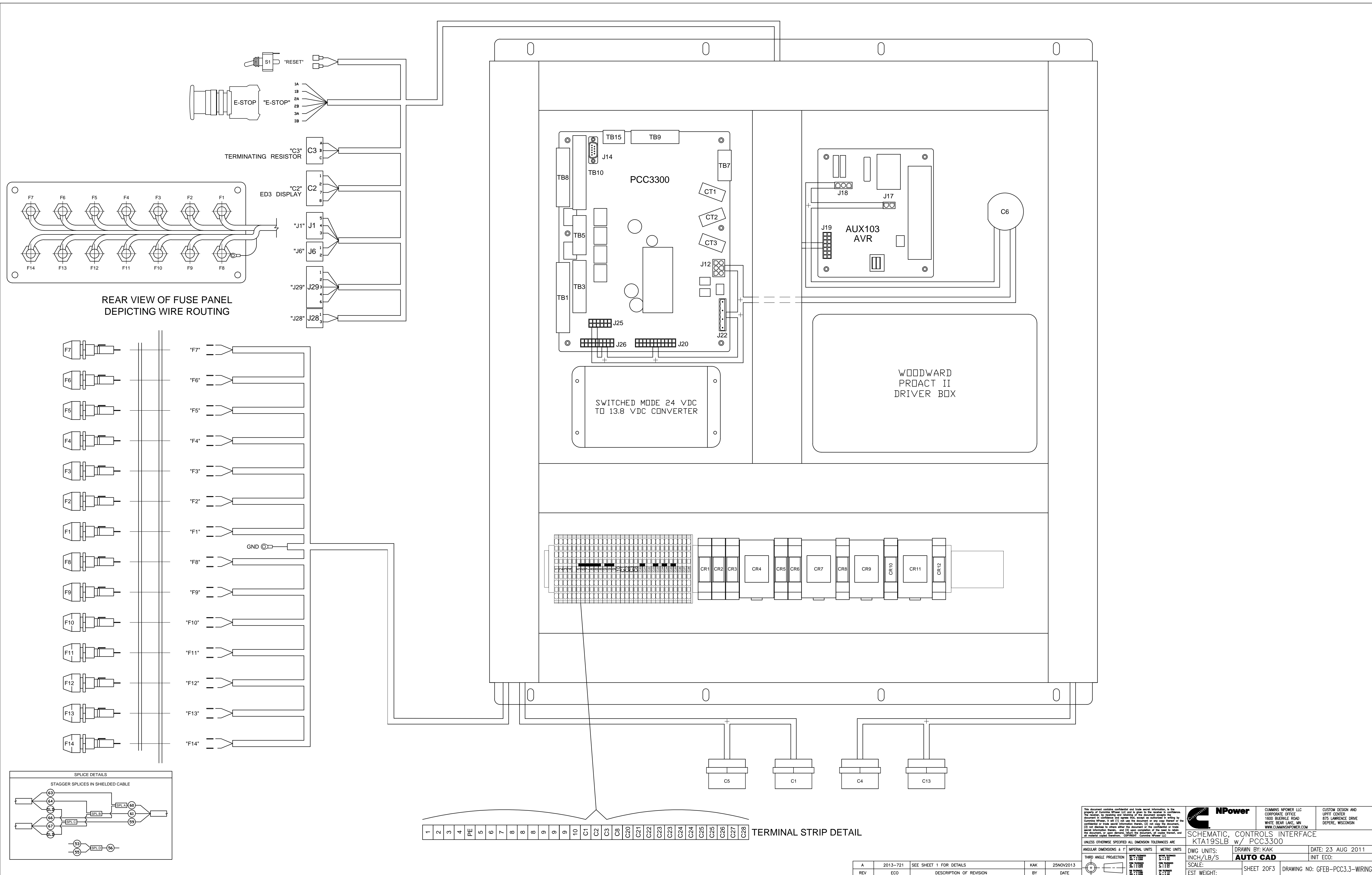
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REV	ECO	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	REMOVED C7. ADDED SHEET 3. ADDED JUMPER BETWEEN TERMINALS C3 & C8.	KAK	25NOV2013



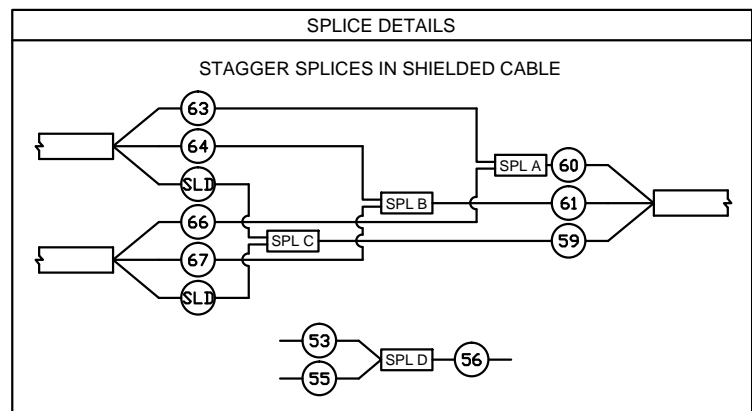
REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING

SWITCHED MODE 24 VDC  
TO 13.8 VDC CONVERTER

WOODWARD  
PROACT II  
DRIVER BOX

TERMINAL STRIP DETAIL

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- C1
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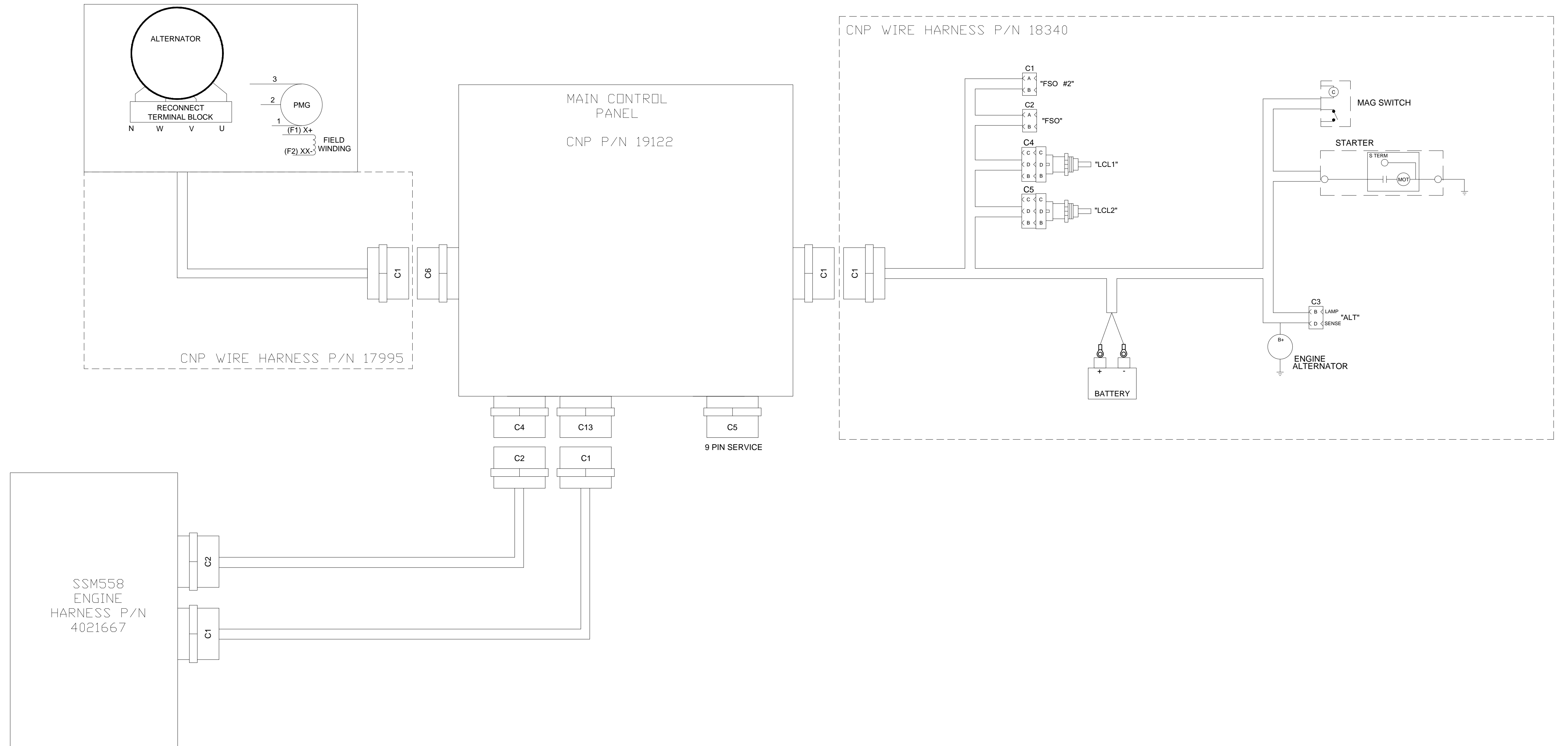
SCHEMATIC, CONTROLS INTERFACE  
KTA19SLB w/ PCC3300

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DRAWN BY: KAK  
**AUTO CAD**  
SHEET 20F3

DATE: 23 AUG 2011  
INIT ECO:  
DRAWING NO: GFEB-PCC3.3-WIRING

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	± 0.010	± 0.25
	± 0.015	± 0.38
	± 0.030	± 0.76

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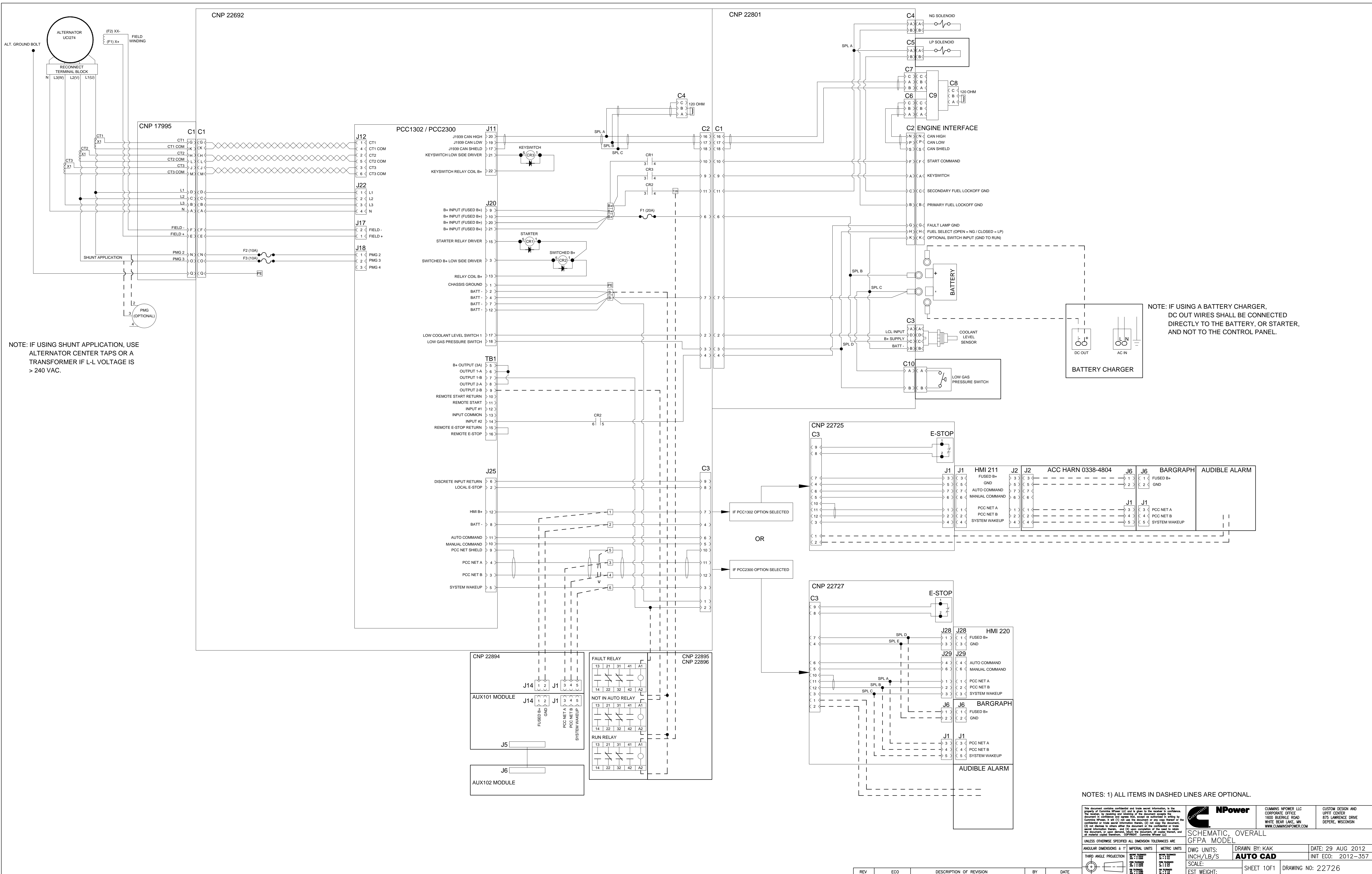
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**SCHMATIC, CONTROLS INTERFACE**  
**KTA19SLB W/ PCC3300**

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SCALE:	SHEET 30F3	INIT ECO:
EST WEIGHT:	DRAWING NO: GFEB-PCC3.3-WIRING	

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
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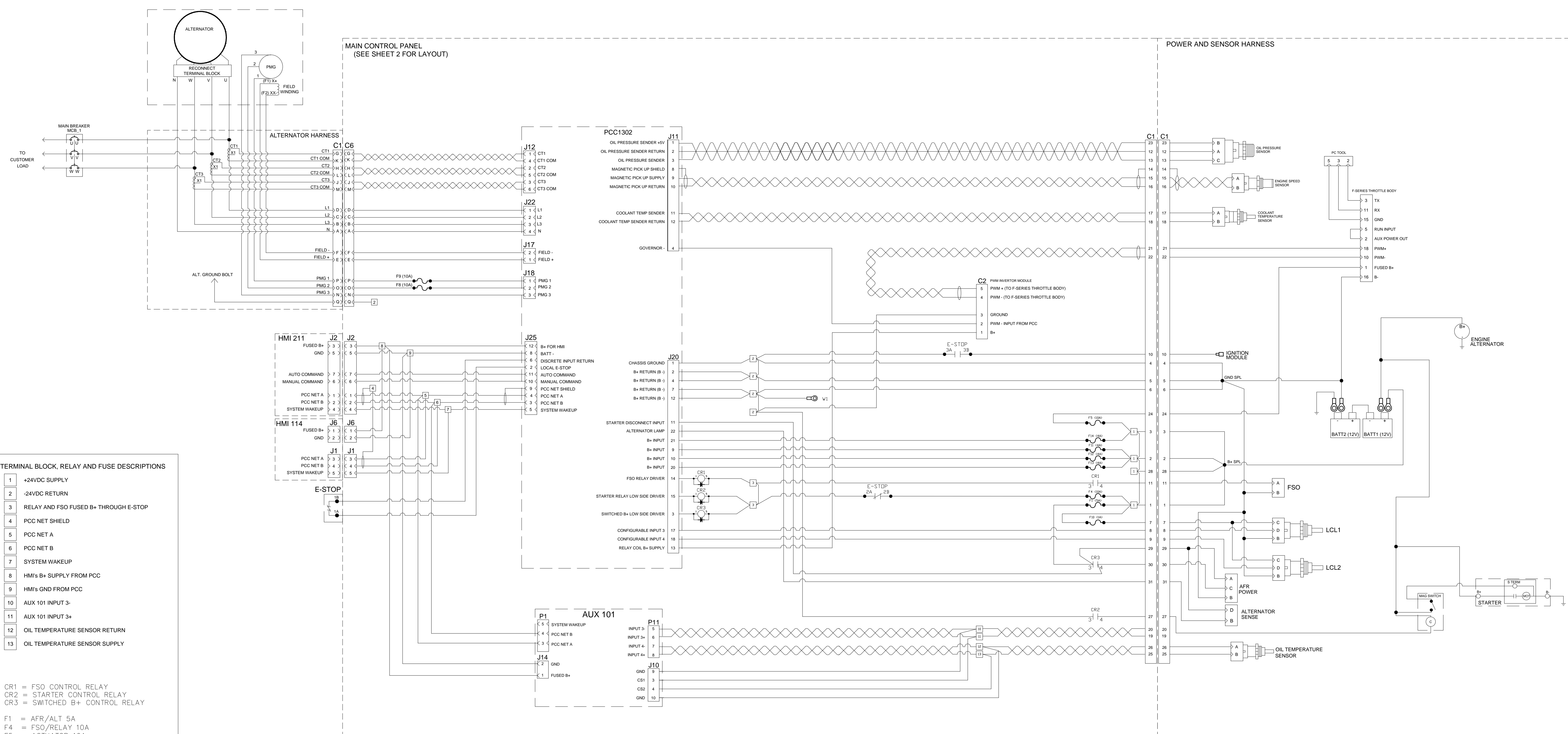
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THIRD ANGLE PROJECTION	INCH/LB/S	MM/KG

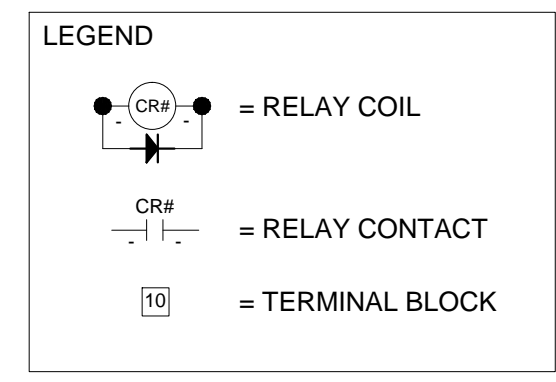
SCHEMATIC, OVERALL GFPA MODEL

DWG UNITS: INCH/LB/S	DRAWN BY: KAK	DATE: 29 AUG 2012
SCALE:	AUTO CAD	INIT ECO: 2012-357
EST WEIGHT:	SHEET 10F1	DRAWING NO: 22726

REV ECO DESCRIPTION OF REVISION BY DATE



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 -24VDC RETURN
  - 3 RELAY AND FSO FUSED B+ THROUGH E-STOP
  - 4 PCC NET SHIELD
  - 5 PCC NET A
  - 6 PCC NET B
  - 7 SYSTEM WAKEUP
  - 8 HMI's B+ SUPPLY FROM PCC
  - 9 HMI's GND FROM PCC
  - 10 AUX 101 INPUT 3-
  - 11 AUX 101 INPUT 3+
  - 12 OIL TEMPERATURE SENSOR RETURN
  - 13 OIL TEMPERATURE SENSOR SUPPLY
- CR1 = FSO CONTROL RELAY  
 CR2 = STARTER CONTROL RELAY  
 CR3 = SWITCHED B+ CONTROL RELAY
- F1 = AFR/ALT 5A  
 F4 = FSO/RELAY 10A  
 F5 = ACTUATOR 10A  
 F8 = PMG 1 10A  
 F9 = PMG 2 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC 4A  
 F12 = PCC 4A  
 F13 = PCC 4A  
 F14 = PCC 4A



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE

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	0.005	0.127
	0.002	0.051
	0.001	0.025

THIRD ANGLE PROJECTION

**SCHEMATIC, CONTROLS INTERFACE**  
 HM ENG W/ PCC1302

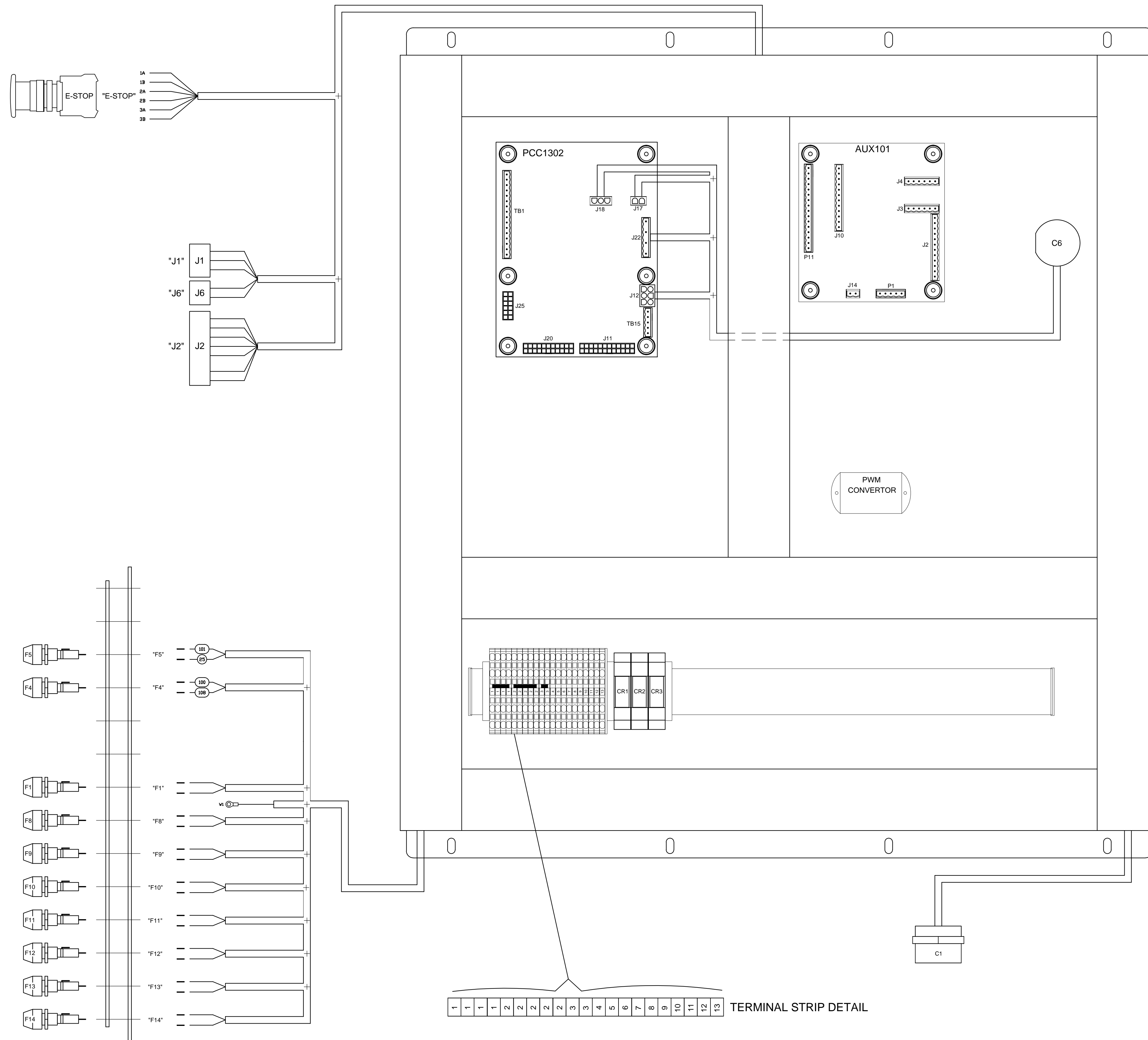
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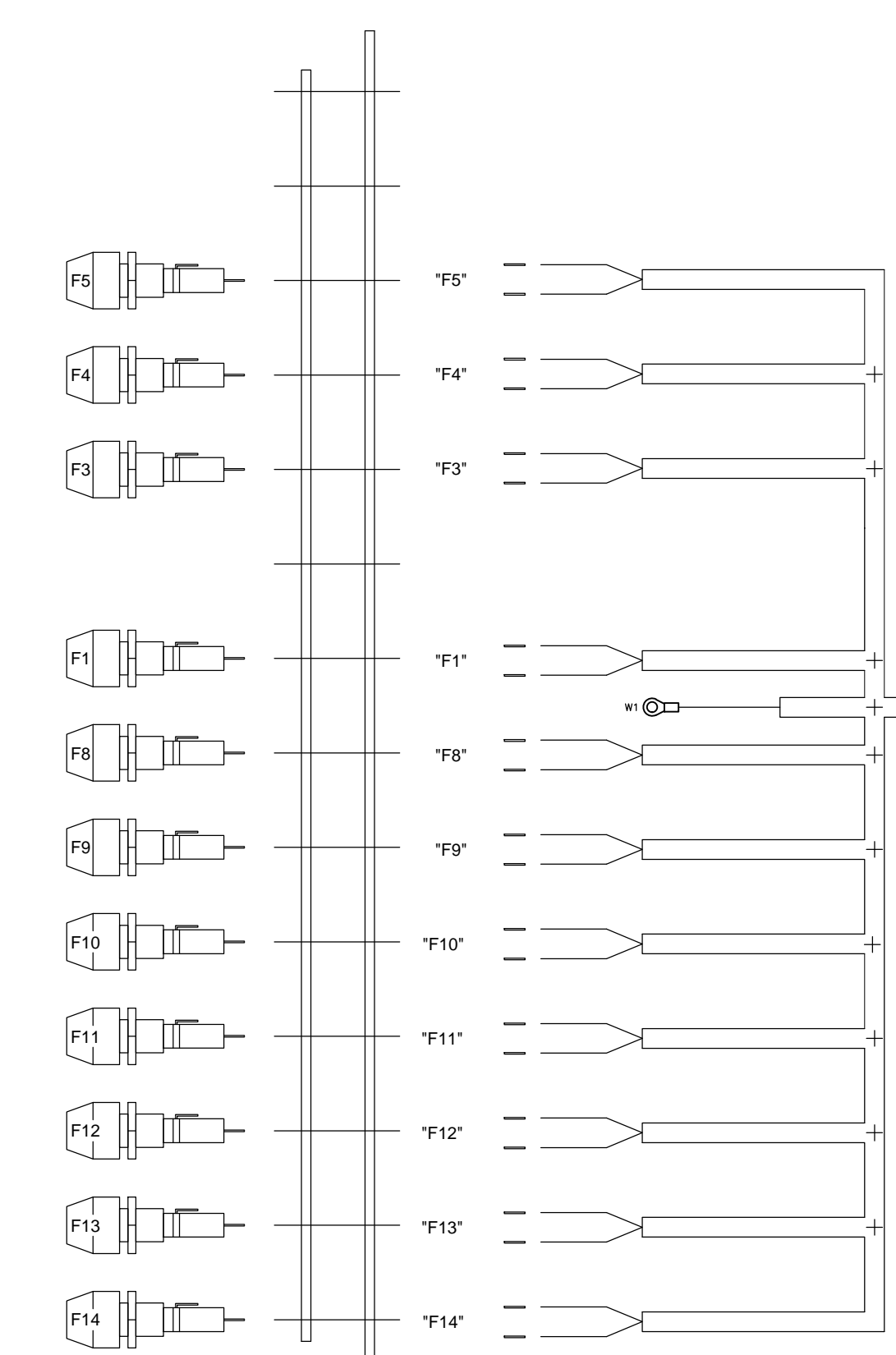
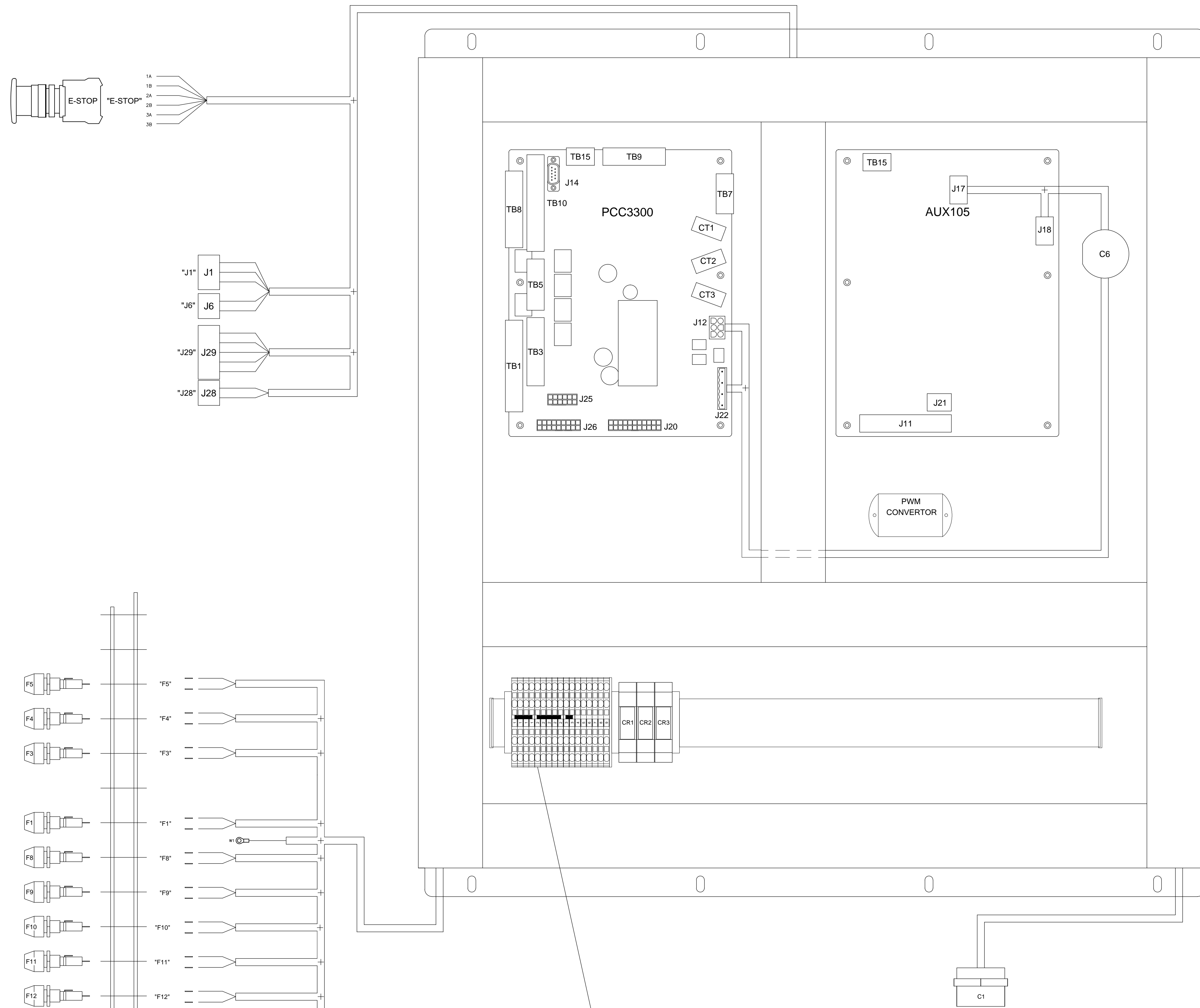
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	0.0010	0.0508
	0.0020	0.1016
	0.0050	0.2540

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INCH/LB/S	<b>AUTO CAD</b>	INIT ECO:	
SCALE:	SHEET 20F2	DRAWING NO: 25538	
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**Rocky  
Mountain**

**Tab #3**

# **Transfer Switch Manuals**





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# Installation Manual

## Transfer Switch

**40-4000 Amps**

OTPCA (Spec A)  
OTPCB (Spec A)  
OTPCC (Spec A)  
OTPCD (Spec A)  
OTPCE (Spec A-C)  
OTPCF (Spec A-B)  
OTPCG (Spec A-B)  
OTPCH (Spec A-B)  
OTPCJ (Spec A)



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# Safety Precautions

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This manual includes the following symbols to indicate potentially dangerous conditions. Read the manual carefully and know when these conditions exist. Then take the necessary steps to protect personnel and the equipment.

## **DANGER**

*This symbol warns of immediate hazards that will result in severe personal injury or death.*

## **WARNING**

*This symbol refers to a hazard or unsafe practice that can result in severe personal injury or death.*

## **CAUTION**

*This symbol refers to a hazard or unsafe practice that can result in personal injury or product or property damage.*

### **ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH**

High voltage in transfer switch components presents serious shock hazards that can result in severe personal injury or death. Read and follow these suggestions.

Keep the transfer switch cabinet closed and locked. Make sure only authorized personnel have the cabinet and operational keys.

Due to the serious shock hazard from high voltages within the cabinet, all service and adjustments to the transfer switch must be performed only by an electrician or authorized service representative.

Whenever closed transition is used, approval in parallel with the local electric utility must be obtained.

### **GENERAL PRECAUTIONS**

Place rubber insulative mats on dry wood platforms over metal or concrete floors when working on any electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling any electrical equipment.

Jewelry is a good conductor of electricity and should be removed when working on the electrical equipment.

Wear safety glasses whenever servicing the transfer switch and do not smoke near the batteries.

Do not work on this equipment when mentally or physically fatigued, or after consuming alcohol or any drug that makes the operation of equipment unsafe.

### **UTILITY-TO-GENSET OR GENSET TO GENSET APPLICATIONS**

If the cabinet must be opened for any reason:

1. Move the operation selector switch on the generator set to Stop.
2. Disconnect the battery charger.
3. Disconnect the starting batteries of the generator set or sets (remove the ground [-] lead first).
4. Remove AC power to the automatic transfer switch. If the instructions require otherwise, use extreme caution due to the danger of shock hazard.



**UTILITY-TO-UTILITY APPLICATIONS**

If the cabinet must be opened for any reason, remove AC power to the automatic transfer switch. If the instructions require otherwise, use extreme caution due to the danger of shock hazard.

** WARNING**

***INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN DEATH, SEVERE PERSONAL INJURY, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.***

# 1 Introduction

---

## 1.1 Installation Manual

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

This manual provides information necessary for installation of an OTPC transfer switch. This is an open transition (OT) transfer switch with a PowerCommand (PC) control. It is capable of executing Open Transition with Sync Check, Programmed Transition, and Closed Transition transfer modes.

An **Open Transition with Sync Check** executes an OT when both sources of power are within specified tolerances of frequency, voltage, and relative phase difference. If both sources meet the tolerances, a fast transfer occurs.

A **Programmed Transition** executes an OT by disconnecting the load from the source of power, pausing in the neutral position of the transfer switch (between switched positions) to allow transient currents from the load to diminish, and then the load is switched to the other source.

A **Closed Transition** executes a load transfer by momentarily paralleling both sources (a maximum of 100ms) before switching sources.

## 1.2 Transfer Switch Application

Transfer switches are an essential part of a building's standby or emergency power system. Power Source 1 (Normal), commonly the utility line, is backed up by Power Source 2 (Emergency), often a generating set. The transfer switch automatically switches the electrical load from one source to the other.

The load is connected to the common of the transfer switch ([Figure 1](#)). Under normal conditions, the load is supplied with power from Source 1 (as illustrated). If Source 1 is interrupted, the load is transferred to Source 2. When Source 1 returns, the load is retransferred to Source 1. The transfer and retransfer of the load are the two most basic functions of a transfer switch.

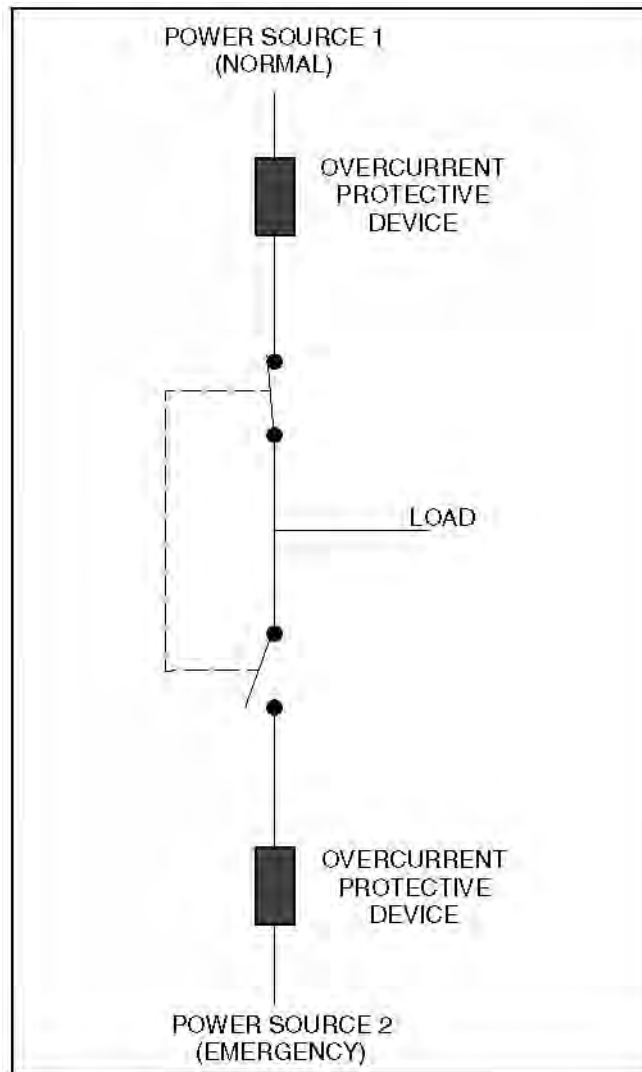


FIGURE 1. LOAD TRANSFER SWITCH (TYPICAL FUNCTION)

## 1.3 Transfer Switch Function

Automatic transfer switches, capable of automatic operation without operator intervention, perform the basic function of transferring the load to the available source. The controller monitors each source for allowable voltage and frequency range. Transfer switches may interact with any of the Lon-Mark™ devices.

- Genset
- Master Controller
- Annunciator Panel
- Circuit Breaker

## 1.4 Utility-to-Genset Operation

In utility-to-genset applications, the transfer switch performs the following functions:

1. Senses the interruption of the Source 1 power.
2. Sends a start signal to the generator set (Source 2).
3. Transfers the load to the Source 2.
4. Senses the return of Source 1.
5. Retransfers the load to Source 1.
6. Sends a stop signal to the generator set.

## 1.5 Utility-to-Utility Operation

In utility-to-utility applications, the transfer switch performs the following functions:

1. Senses the interruption of the Source 1 power.
2. Transfers the load to the Source 2.
3. Senses the return of Source 1.
4. Retransfers the load to Source 1.

Level 2 controllers can control a two-utility configuration for prime power. One utility is designated the preferred source. The control automatically transfers the load between the two utilities and detects alarm conditions. The exercise routine is not available in this configuration.

The operator can select either source as the preferred source. See the Digital Display Menu System section.

## 1.6 Generator-to-Generator Operation

In genset-to-genset applications, there are two possible configurations, as shown in [Figure 3](#).

- Prime Power - Two gensets provide all of the power (utility power is not available).
- Dual Standby - Two gensets are used to back up utility power.

### 1.6.1 Prime Power (Plant to Plant) Operation

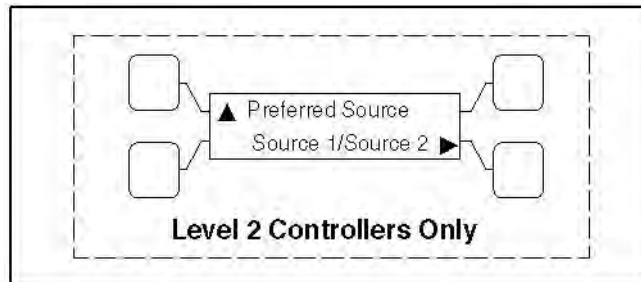
In prime power applications, utility power is not available. The system includes one transfer switch and two gensets (see [Figure 3](#)). One genset is always running and supplying power to the load while the other genset is the backup genset. An external power supply is not needed in this application.

#### 1.6.1.1 Preferred Source Selection

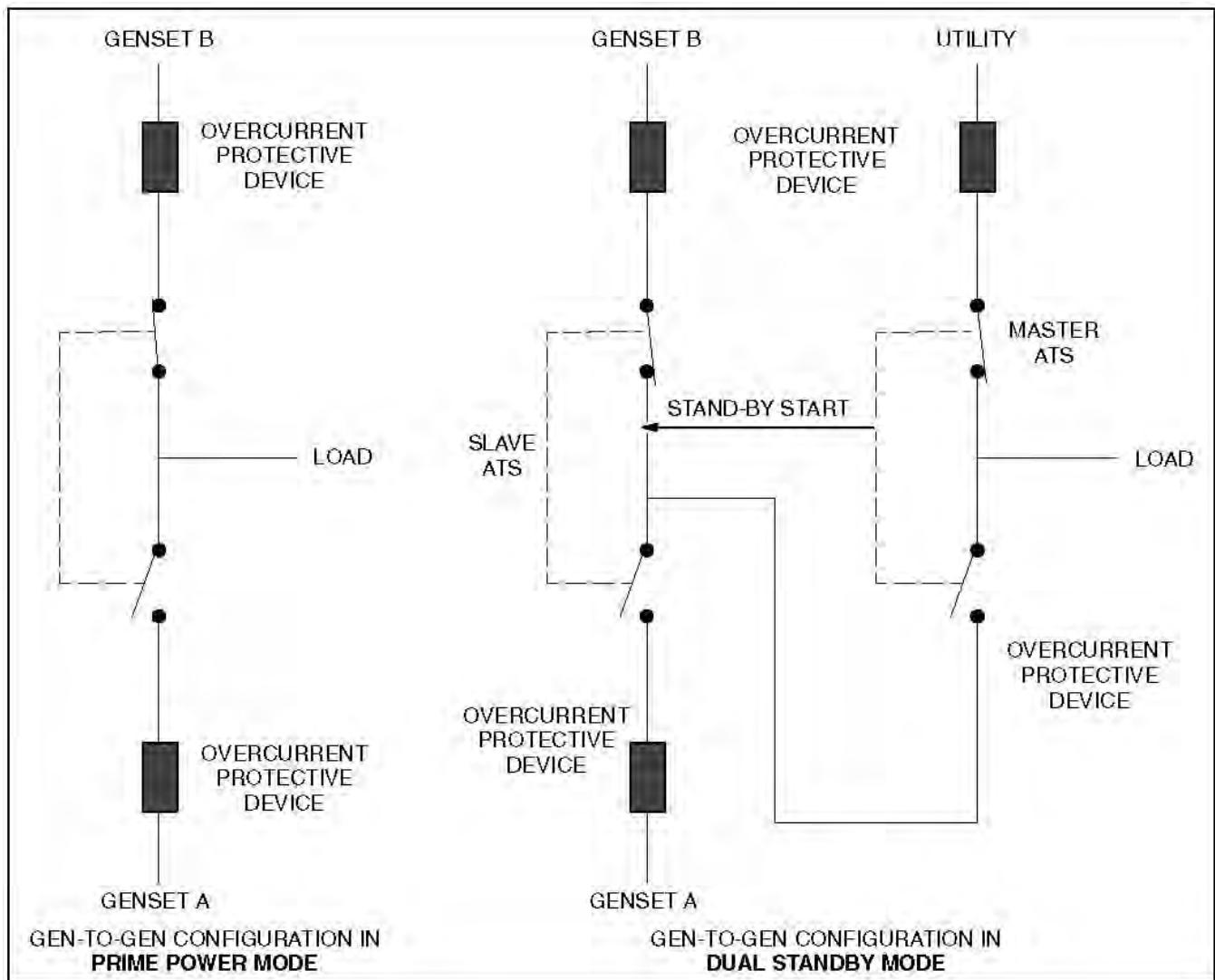
Under normal operation, one genset is designated as the preferred source and supplies power to the load. The second genset is the backup power source. If the preferred genset fails, the backup genset starts and the transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu (see [Figure 2](#)) can be used to designate either genset (Source 1 or Source 2) as the preferred genset. The Preferred Source menu is included in the Test submenus (see [Figure 57](#)).

If the user manually changes the preferred source setting so that the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset when it becomes available. The unit that is carrying the load is always considered the preferred source. The control doesn't automatically select which source is considered preferred.



**FIGURE 2. PREFERRED SOURCE SUBMENU**



**FIGURE 3. GENERATOR-TO-GENERATOR CONFIGURATION IN PRIME POWER AND DUAL STANDBY MODES**

### 1.6.1.2 Automatic Changeover

The transfer switch can be set up to change the preferred source automatically by enabling the changeover timer. The Time Delay submenus under Setup or the PC service tool can be used to enable the changeover timer and specify a changeover delay time period (see [Figure 4](#)). The Changeover menus are included in the Time Delay submenus (see [Figure 53](#) through [Figure 56](#)).

The automatic changeover timer automatically changes the preferred source and transfers the load to the new preferred genset after a TDEN time delay. After the transfer is complete, the control initiates a cool-down period (TDEC) on the old preferred genset before shutting it down. The old preferred genset is now the new backup genset. The changeover timer is now timing for the next changeover and the cycle continues as long as the changeover timer is enabled.

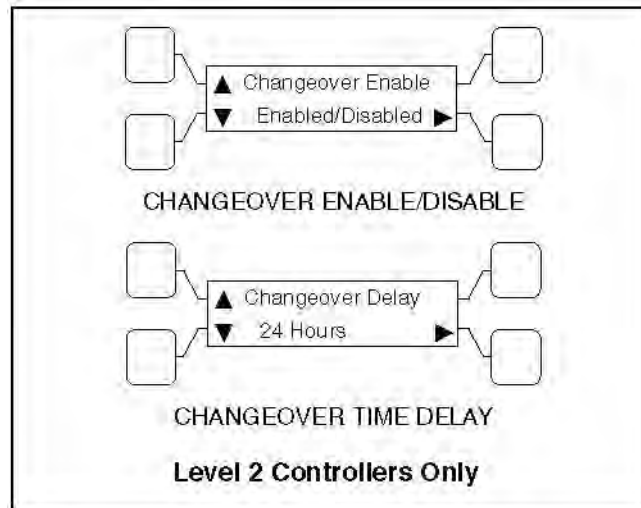


FIGURE 4. CHANGEOVER SUBMENUS

### 1.6.1.3 Prime Power Wiring

A permanent start jumper is installed in the transfer switch and is shipped from the factory in the prime power mode. Verify that the jumper (TB3-57 to TB3-59) is installed (see [Appendix A](#)).

### 1.6.1.4 System Startup

To set up a system for prime power operation:

1. Place the motor disconnect switch in the Off position, and both generator selector switches into the OFF position.
2. Place the transfer switch in the Source 1 position.
3. Place the Off-Manual-Auto selector switch on the Source 1 genset control in the Auto position. The genset will start and supply power to the load (the load will be energized and TDECa may be timing).
4. Use the PC Service tool or the Test sub-menu to set this genset as the preferred source.
5. Wait for TDECa to finish timing.
6. Place the Off-Manual-Auto selector switch on the Source 2 genset control in the Auto position.
7. Place the motor disconnect switch in the Auto position.

8. If desired, use the Time Delay sub-menus under Setup or use the PC Service tool to enable the changeover timer and specify a changeover delay time period.

### 1.6.1.5 Testing the System by Turning Off the Preferred Source

1. With the preferred source genset running and supplying power to the load, place the genset control Off-Manual-Auto selector switch in the Off position. The backup genset should start and run.

After the voltage and frequency are at acceptable levels, the transfer switch should transfer the load to the backup genset.

2. Place the genset control Off-Manual-Auto selector switch on the preferred genset back in the Auto position. The preferred genset should start and run.

After the voltage and frequency levels are at acceptable levels, the transfer switch should transfer the load back to the preferred genset.

After the transfer is complete, the control initiates a cool-down period (TDEC) on the backup genset and it should stop.

### 1.6.1.6 Testing the System by Changing the Designated Preferred Source

1. With the preferred source genset running and supplying power to the load, use the PC Service tool or the Test sub-menu to change the preferred source. The new preferred source should start and run.

After the voltage and frequency are at acceptable levels, the transfer switch should transfer the load to the new preferred source.

After the transfer is complete, the control initiates a cool-down period (TDEC) on the old preferred source and it should stop.

2. Use the PC Service tool or the Test sub-menu to change the preferred source back to the original genset. The original genset should start and run.

After the voltage and frequency levels are at acceptable levels, the transfer switch should transfer the load back to the original genset.

After the transfer is complete, the control initiates a cool-down period (TDEC) on the backup genset and it should stop.

## 1.6.2 Dual Stand-By Operation

In dual stand-by applications, utility power is available. The system includes two transfer switches (a Master ATS and a Slave ATS) and two gensets (see [Figure 3](#)). Utility power supplies power to the load and both gensets are backup gensets.

Under normal operation, the utility is supplying power to the load through the lead transfer switch. The lead transfer switch is a utility-to-genset switch. The two gensets are connected to the genset-to-genset transfer switch. The load side of this switch is connected to the genset side of the lead transfer switch.

Upon loss of utility power to the lead transfer switch, a signal is sent to the genset-to-genset transfer switch to start the preferred genset. When the lead transfer switch senses generator voltage, it transfers the load to that genset. If the preferred genset fails to start, a signal is sent to the backup genset to start. The PC Service tool or the Test sub-menu on the genset-to-genset transfer switch can be used to set the preferred source.

If the Stand-By Start is inactive, upon initial power-up (or reset), or during software initialization, the transfer switch control will not start either genset. When a Stand-By Start command is received by the Slave ATS from a Master ATS (or other device), the preferred genset immediately starts. If the preferred genset does not start, a time delay engine start (TDES) is initiated and the control starts the backup genset. The load is connected to the genset when it becomes available.

If the preferred genset becomes available while the backup genset is active, a time delay retransfer (TDEN) period is initiated and the load is retransferred back to the preferred genset. A time delay cool-down (TDEC) period is initiated before turning off the backup genset. When the Stand-By Start becomes deactivated, a TDEC period is initiated and the active generator is turned off.

### **1.6.2.1 Preferred Source Selection**

Under normal operation, one genset is designated as the preferred source and the second genset is designated as the backup power source. If both the utility power and the preferred genset fails, the backup genset starts and the genset-to-genset transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu (see [Figure 57](#)) on the genset-to-genset transfer switch can be used to designate either genset (Source 1 or Source 2) as the preferred genset. If the preferred genset is changed and the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset if it is needed and when it becomes available.

### **1.6.2.2 Alternating Preferred Source**

In an attempt to keep the running time equally distributed between both gensets, the control can be set to alternate between the gensets when utility power fails. The selected preferred genset starts with the first power outage. The second power outage starts the backup genset, which now becomes the preferred genset. Upon subsequent outages, the preferred genset alternates.

If the preferred genset becomes available while the backup genset is active, a time delay retransfer (TDEN) period is initiated and the load is retransferred back to the preferred genset. A time delay cool-down (TDEC) period is initiated before turning off the backup genset. When the Stand-By Start becomes deactivated, a TDEC period is initiated and the active generator is turned off.

Only utility outages and tests or exercises initiated at the lead transfer switch result in the gensets being alternated. The designated preferred genset will not change if it fails and the backup genset takes over the load. This alternating preferred source can only be enabled with the PC Service tool. When enabled, a genset can be designated as the preferred source for a maximum of two weeks. Time adjustments can be made in one-hour increments.

### **1.6.2.3 Control Voltage**

A dual stand-by configuration requires an external 12-24 VDC power supply to keep the genset-to-genset control active. An optional Battery Kit is available, or the genset starting batteries can be used. See drawing 630-2024 for connection details.

### **1.6.2.4 Dual Stand-By Wiring**

For dual stand-by applications, the jumper (TB3-57 to TB3-59) must be removed.



---

### 1.6.2.5 System Startup

To set up a system for dual stand-by operation:

1. Place the motor disconnect switch on both transfer switches in the Off position.
2. Connect both transfer switches to the Source 1 side.
3. Make sure the Off-Manual-Auto selector switch on both gensets is in the Off position.
4. Make sure the genset-to-genset transfer switch is being powered by an external DC supply.
5. Press the Lamp Test/Reset button on the genset-to-genset transfer switch. If all of the front panel lights come on, the control is running properly.
6. Use the PC Service tool or the Test sub-menu on the genset-to-genset transfer switch to set the Source 1 genset as the preferred source.
7. Energize utility power to the lead transfer switch. The load is energized and a time delay (TDECa) begins.
8. Wait for TDECa to finish timing.
9. Set the time delay engine start (TDESa) to zero on the lead transfer switch.
10. Set the time delay engine stop (TDECa) to zero on the lead transfer switch.
11. If desired, use the PC Service tool to enable the alternating preferred source.
12. Place the motor disconnect switch in the Auto position on both transfer switches.

### 1.6.2.6 Testing the System by Removing Utility Power and Turning Off the Preferred Genset

1. With the utility supplying power to the load and neither genset running, turn off the utility circuit breaker feeding the load transfer switch. The preferred genset should start and run.  
After the voltage and frequency are at acceptable levels, the lead transfer switch should transfer the load to the preferred genset.
2. Place the Off-Manual-Auto selector of the preferred genset (running) control in the Off position.  
The preferred genset should stop and the backup genset should start and run.  
After the voltage and frequency are at acceptable levels, the genset-to-genset transfer switch should transfer the load to the backup genset.
3. Place the Off-Manual-Auto selector switch on the preferred genset back to the Auto position. The preferred genset should start and run.  
After the voltage and frequency are at acceptable levels, the genset-to-genset transfer switch should transfer the load to the preferred genset. The backup genset should stop after the time delay engine cool-down (TDECa) is completed.
4. Turn on the utility circuit breaker feeding the lead transfer switch.  
After the voltage and frequency are at acceptable levels, the lead transfer switch should transfer the load back to the utility. The preferred genset should stop after the time delay engine cool-down (TDECb) is completed.

### 1.6.2.7 Testing the System with Alternating Preferred Source Enabled:

1. With the utility supplying power to the load and neither genset running, turn off the utility circuit breaker feeding the lead transfer switch. The preferred genset should start and run.

After the voltage and frequency are at acceptable levels, the lead transfer switch should transfer the load to the preferred genset.

2. Restore utility power.

After the voltage and frequency are at acceptable levels, the lead transfer switch should transfer the load back to the utility. The preferred genset should stop after the time delay engine cool-down is completed.

3. Turn off utility power. The backup genset should now be the preferred genset and should start and run.

After the voltage and frequency are at acceptable levels, the genset-to-genset transfer switch should transfer to the new primary genset.

After the lead transfer switch senses the proper voltage and frequency levels, the lead transfer switch should transfer the load to the genset.

4. Restore utility power.

After the voltage and frequency are at acceptable levels, the lead transfer switch should transfer the load back to the utility. The new preferred genset should stop after the time delay engine cool-down is completed.

The gensets will alternately start upon subsequent power outages, system tests, or exercises initiated by the lead transfer switch.

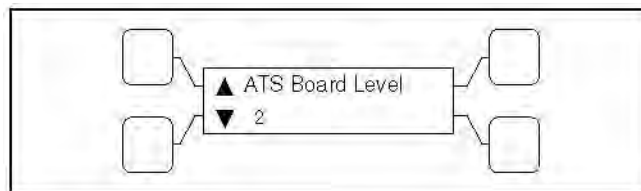
## 1.7 Control Level 1 and Level 2

Two controls are available. The type of power source switched and the desired features determine the control levels available. The [Table 1](#) lists the applications that are available with each control.

**TABLE 1. AVAILABLE CONTROL LEVELS**

Power Sources	Level 1	Level 2
Genset-to-Utility	X	X
Genset-to-Genset		X
Utility-to-Utility		X

The control board level can be viewed, using the digital display (see [Figure 5](#)). This menu is included in the About submenus (see [Figure 76](#) through [Figure 79](#)).



**FIGURE 5. CONTROL LEVEL SUBMENU**

---

## 1.8 Installation Overview

These installation recommendations apply to typical installations. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your nearest Cummins/Onan distributor for assistance.

### 1.8.1 Application and Installation

Installations must be carefully planned and correctly installed for proper operation. This involves two essential elements: application and installation.

**Application** refers to the design of the complete standby power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, cooling exhaust, and fuel systems. Each component must be correctly designed so the complete system functions as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers are normally responsible for the design of the complete standby system and for selecting the materials and products required.

**Installation** refers to the actual set-up and assembly of the standby power system. The installers set up and connect the various components of the system as specified in the system design plan. The complexity of the standby system normally requires the special skills of qualified electricians, plumbers, sheetmetal workers, etc. to complete the various segments of the installation. This is necessary so all components are assembled using standard methods and practices.

### 1.8.2 Safety Considerations

The transfer switch has been carefully designed to provide safe and efficient service when properly installed, maintained, and operated. However, the overall safety and reliability of the complete system depends on many factors outside the control of the manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the transfer switch exactly as specified in this manual. All systems external to the transfer switch must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

## 1.9 Model Identification

Identify your model by referring to the Model and Specification number as shown on the nameplate. Electrical characteristics are shown on the lower portion of the nameplate, which is located on the cabinet door.

If it is necessary to contact a dealer or distributor regarding the transfer switch, always give the complete Model, Specification, and Serial number as listed on the nameplate. This information is necessary to properly identify your unit among the many types manufactured.

OTPCA	00000	Spec.A
1	2	3
		4

1. OTPC - Open Transition PowerCommand® Control.
2. Ampere Rating:
  - A = 40, 70, 125
  - B = 150, 225, 260
  - C = 300, 400, 600
  - D = 800, 1000
  - E = 1200
  - F = 1600
  - G = 2000
  - H = 3000
  - J = 4000
3. Assigned spec number - issued for each specific combination of accessories, voltages, frequency and standards codes. This number is only repeated for standard product.
4. Specification letter - advances with production modification.

## 1.10 How to Obtain Service

When the transfer switch requires servicing, contact your nearest Cummins Power Generation distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

To contact your local Cummins Power Generation distributor in the United States or Canada, call 1-800-888-6626 (this automated service utilizes touch-tone phones only). By selecting Option 1 (press 1), you will be automatically connected to the distributor nearest you.

If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, our distributors are listed under:

Generators-Electric,  
Engines-Gasoline or  
Engines-Diesel, or Recreational Vehicles-Equipment,  
Parts and Service.

For outside North America, call Cummins Power Generation, 1-763-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Cummins Power Generation using the fax number 1-763-574-8087.

When contacting your distributor, always supply the complete Model, Specification, and Serial Number as shown on the generator set nameplate.

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# 2 Mounting

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## 2.1 Location

The location of the transfer switch in the existing electrical circuit varies with the application and the type of entrance switch. The location and wiring must comply with the contract drawings.

There must be a service disconnect in the commercial power line ahead of the transfer switch.

A typical installation is shown in [Figure 6](#). Cabinet dimensions and weights are listed in [Table 2](#) and [Table 2](#).

Choose a vibration-free mounting surface that supports the weight of the switch. Avoid locations that are near flammable liquids or gases, or are hot, moist, or dusty.

### WARNING

*An electrical arc occurs during transfer that can ignite a flammable atmosphere, resulting in severe personal injury or death. The switch must not be located near batteries, fuel tanks, solvents, or other sources of flammable liquids or gases, or in areas sharing ventilation with such sources.*

## 2.2 Wall Mounting

1. Make sure that the wall where the ATS switch is to be mounted is suitable to hold firmly the weight and size of the transfer switch, within a reasonable safety factor.
2. Check the location to be sure no wires or plumbing, gas, or exhaust lines run behind the wall.
3. Make sure that all anchorage fasteners used to bolt the switch to wall are strong enough to withstand the switch weight and its vibration during operation, within a reasonable safety factor.
4. Install two mounting bolts in the wall for the top cabinet mounting keyholes.
5. With the shipping box standing so that the cabinet is upright, carefully remove the top and sides of the box.

### WARNING

*Improper lifting can cause severe personal injury. Have sufficient manpower for lifting and mounting the cabinet.*

6. Raise the cabinet and mount it on the two mounting bolts in the wall.
7. Install two bottom mounting bolts, but do not tighten them. (**Do not remove the cabinet support until all bolts are installed**).
8. Push the cabinet against the wall. If the cabinet does not align flush against the wall, shim the mounting bosses as required.
9. When the switch is installed on the wall, the switch cabinet should be squared up before final fastener tightening. Make sure the installed ATS is square, level, and plumb upon completion of the installation.

10. Tighten all mounting bolts.

**TABLE 2. APPROXIMATE NEMA 1 CABINET DIMENSIONS**

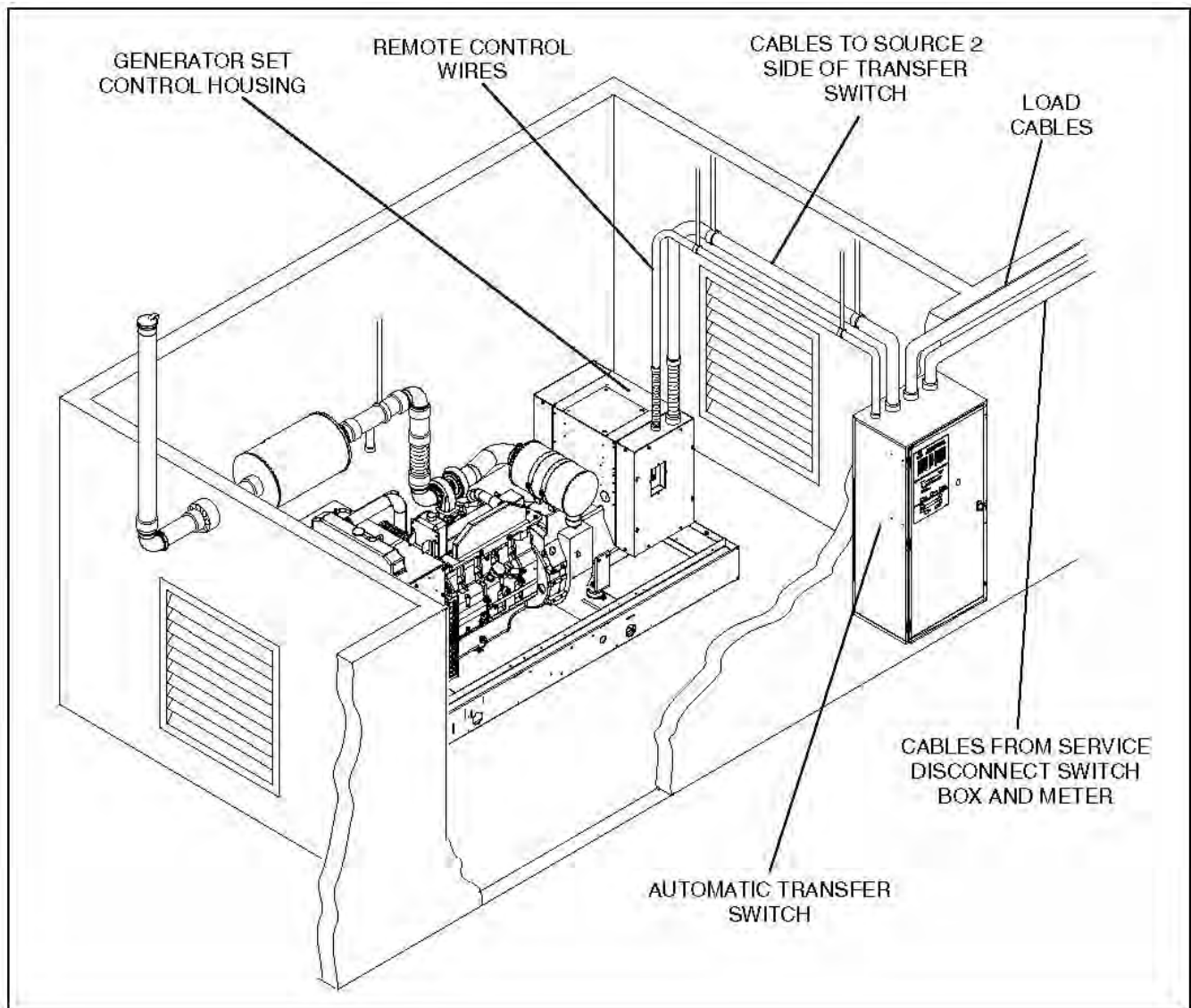
Switch Current Rating	Height	Width	Depth With Door		Weight
			Closed	Open	
40, 70, & 125 (Three Pole Switches Only)	27 in 686 mm	20.5 in 521 mm	12 in 305 mm	31.5 800 mm	82 lb 37 kg
40, 70 & 125 (Four Pole Switches) and 150 & 225 (Three and Four Pole Switches)	35.5 in 902 mm	26 in 660 mm	16 in 406 mm	41 in 1042 mm	165 lb 75 kg
260	43.5 in 1105 mm	28.5 in 724 mm	16 in 406 mm	43 in 1093 mm	170 lb 77 kg
300, 400, & 600	54 in 1372 mm	25.5 in 648 mm	18 in 457 mm	42 in 1067mm	225 lb 102 kg
800 (Open and Programmed Transition) & 1000 (Open and Programmed Transition) - Spec A	68 in 1727 mm	30 in 762 mm	19.5 in 495 mm	48.5 in 1232 mm	360 lb 163 kg
1000 (Closed Transition) & 1200 - Spec C	75 in 1905 mm	36 in 915 mm	21.5 in 546 mm	54 in 1372 mm	450 lb 204 kg
1000 (Closed Transition) & 1200 (Closed Transition) - Spec D	75 in 1905 mm	36 in 915 mm	21.5 in 546 mm	54 in 1372 mm	450 lb 204 kg
1200 (Open and Programmed Transition) - Spec D	90 in 2286 mm	39 in 991 mm	27.5 in 698 mm	65 in 1644 mm	730 lb 331 kg
1600 & 2000	90.0 in 2286 mm	36.0 in 915 mm	48 in 1219 mm	84 in 2134 mm	1100 lb 499 kg
3000	90.0 in 2286 mm	36.0 in 915 mm	48 in 1219 mm	84 in 2134 mm	1250 lb 567 kg
4000	90.0 in 2286 mm	47.0 in 1193.8	60 in 1524 mm	106 in 2692.4 mm	1870 lb 848 kg

**TABLE 3. APPROXIMATE NEMA 3R AND 4 CABINET DIMENSIONS**

Switch Current Rating	Height	Width	Depth with Door		Weight
			Closed	Open	
40, 70, & 125 (Three Pole Switches Only)	34 in 864 mm	26.5 in 673 mm	12.5 in 318 mm	36.5 in 927 mm	125 lb 57 kg
40, 70 & 125 (Four Pole Switches) and 150 & 225 (Three and Four Pole Switches)	42.5 in 1080 mm	30.5 in 775 mm	16 in 406 mm	44 in 1118 mm	215 lb 97 kg

Switch Current Rating	Height	Width	Depth with Door		Weight
			Closed	Open	
260	46 in 1168 mm	32 in 813 mm	16 in 406 mm	46 in 1168 mm	225 lb 102 kg
300, 400, & 600	59 in 1499 mm	27.5 in 699 mm	16.5 in 419 mm	41.5 in 1054 mm	275 lb 125 kg
800 (Open and Programmed Transition & 1000 (Open and Programmed Transition) - Spec A	73.5 in 1867 mm	32.5 in 826 mm	19.5 in 495 mm	49.5 in 1257 mm	410 lb 186 kg
1000 (Closed Transition) & 1200 - Spec C	75 in 1905 mm	36 in 915 mm	19.5 in 495 mm	55 in 1397 mm	450 lb 204 kg
1000 (Closed Transition) & 1200 (Closed Transition) - Spec D	75 in 1905 mm	36 in 915 mm	19.5 in 495 mm	55 in 1397 mm	450 lb 204 kg
1200 (Open and Programmed Transition) - Spec D	90 in 2286 mm	39 in 991 mm	27.5 in 698 mm	65 in 1644 mm	730 lb 331 kg
1600 & 2000	90 in 2286 mm	32.5 in 826 mm	51.0 in 1295 mm	79 in 2007 mm	1100 lb 499 kg
3000	90 in 2286 mm	38.0 965 mm	51.0 in 1296 mm	84.5 in 2146 mm	1250 lb 567 kg
4000	90.0 in 2286 mm	47.0 in 1193.8	61.25 in 1555.75 mm	107.25 in 2724 mm	1870 lb 848 kg





**FIGURE 6. TYPICAL WALL-MOUNT INSTALLATION**

## 2.3 Open Construction

Use a cabinet of the required NEMA type. The door should be secured and have safety warnings required to meet all applicable codes. The minimum cabinet size is 90 in (H) x 39 in (W) x 25 in (D).

The outline drawings supplied with the transfer switch provide outline dimensions for mounting the transfer switch components inside the cabinet. Page one of the outline drawing shows the dimensions of the control plate typically mounted on the back side of the front door. Page two shows the cutout needed and proper mounting so the touch pad and optional key switch are visible through the front of the door.

Refer to the Wiring Section for electrical connections.

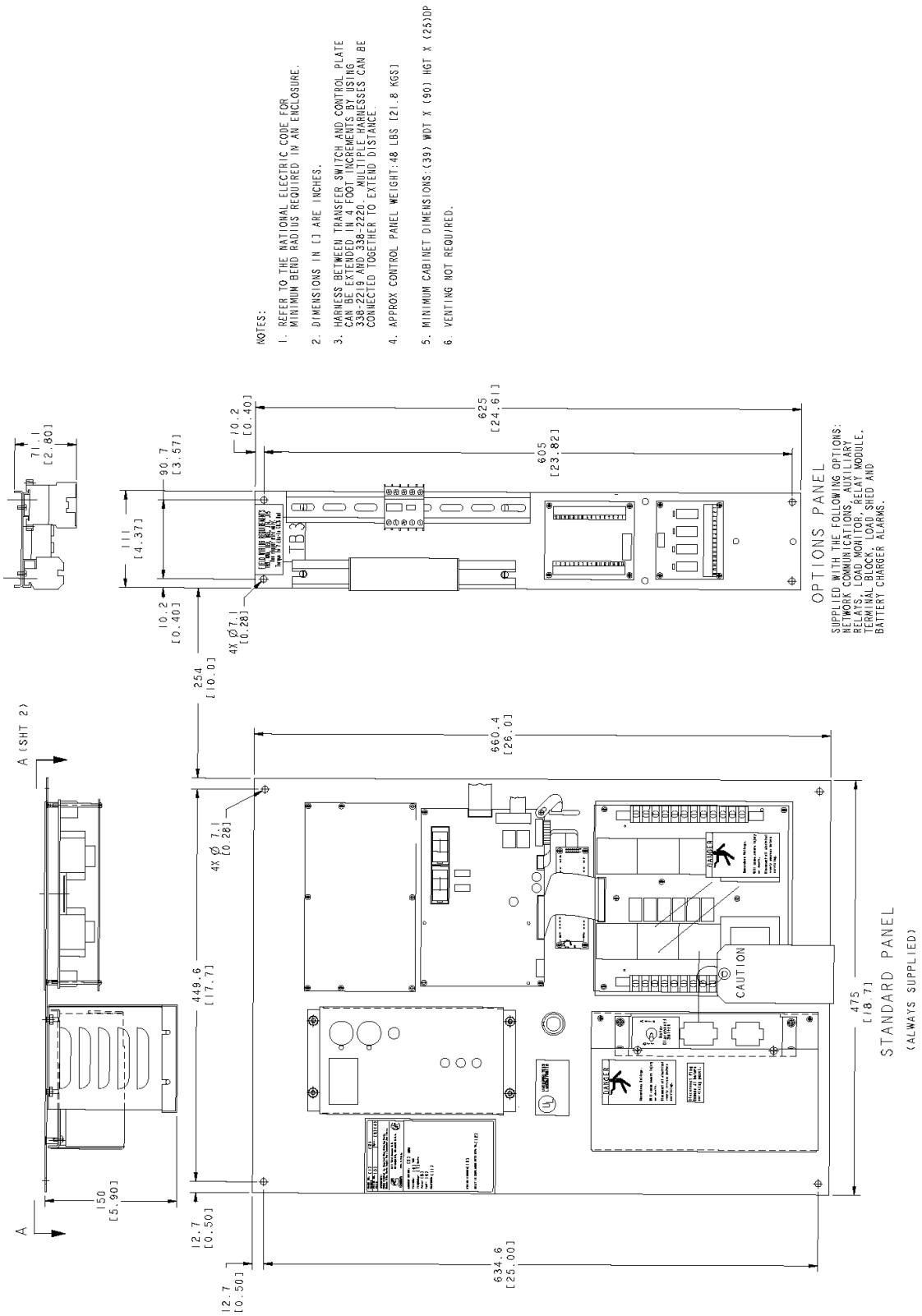


FIGURE 7. TYPICAL OPEN CONSTRUCTION

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## 2.4 Seismically Certified Installations

Seismically certified transfer switch installations (feature code A080-7) have special requirements, as defined by IAA-VMC (Independent Approval Agency, the VMC Group).

1. The design of post-installed anchors in concrete used for the component anchorage is prequalified for seismic applications in accordance with ACI 355.2 and documented in a report by a reputable testing agency (for example, the Evaluation Service Report issued by the international Code Council).
2. Anchors must be installed to an embedment depth, as recommended in the prequalification test report defined in Note 1. For IBC 2000 and IBC 2003 applications, the minimum embedment must be 8 times the anchor diameter.
3. Anchors must be installed in a minimum of 4000 PSI compressive strength normal weight concrete. Concrete aggregate must comply with ASTM C33. Installation in structural lightweight concrete is not permitted unless otherwise approved by the structural engineer of record.
4. Anchors must be installed to the maximum torque specification, as recommended by the anchor manufacturer.
5. Anchors must be installed in the locations specified on the Installation Outline Drawings or on Seismic Requirements Installation Drawing 0179-5288.
6. Wide washers must be installed at each anchor location between the anchor head and the equipment for tension load distribution. Wide steel washers must be Series W of American National Standard Type A plain washers (low carbon steel washers), ANSI B18.22.1- 1965, R1975, with the washer sizes specified on drawing 0179-5288 (Switch Installation, Seismic Requirements, sheet 2 of 3).
7. Concrete floor slab and concrete housekeeping pads must be designed and rebar-reinforced for seismic applications, in accordance with ACI 318.
8. All housekeeping pad thicknesses must be designed in accordance with the prequalification test report, as defined in Note 1 or a minimum of 1.5 times the anchor embedment depth, whichever is largest.
9. All housekeeping pads must be dowelled or cast into the building structural floor slab and designed for seismic application, as per SCI 318 and as approved by the structural engineer of record.
10. Wall mounting equipment must be installed to a rebar-reinforced structural concrete wall that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the wall.
11. Floor mounted equipment (with or without a housekeeping pad) must be installed to a rebar-reinforced structural concrete floor that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the floor.
12. When installing to a floor or wall, rebar interference must be considered.
13. Attaching seismic certified equipment to any floor or wall, other than those constructed of structural concrete and designed to accept the seismic loads from said equipment, is not permitted by this specification.
14. Attaching seismic certified equipment to any floor constructed of light weight concrete over steel decking is not permitted by this specification.

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15. Attaching seismic certified equipment to any concrete block walls or cinder block walls is not permitted by this specification.

**For special switch installation requirements, see written and tabulated seismic requirements listed on drawing 0179-5288.**

The installation of the seismically certified switch should be overseen by the installation project structural engineer of record.

The Site Specific Requirements listed on page one of the "Seismic Certificate of Compliance" should be filled out by the installation project structural engineer of record.

Drawing 0179-5288 and the Seismic Certificate of Compliance for transfer switch and seismic installation requirements are included in the literature package of each seismically certified switch with feature code A080-7.

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# 3 Wiring

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Refer to [Figure 28](#) thru [Figure 32](#) for component locations.

**⚠ WARNING**

*AC voltages and currents present an electrical shock hazard that can cause severe personal injury or death. Only qualified personnel are to perform the following procedures.*

When installing conduit, observe the following precautions:

1. Before beginning conduit installation, cover the transfer switch to prevent accidental entry of metal chips.
2. Install at least 2 feet (610 mm) of flexible conduit between the rigid conduit and generator set to absorb vibration.
3. Run control circuit wiring in separate conduit from the AC wiring; otherwise, induced currents could cause operational problems within the switch. If using non-metallic conduits, be sure to use shielded cable. Cutouts can be made through the top, bottom, or sides of the cabinet. (Refer to the switch outline drawings in [Appendix A](#).)

**⚠ CAUTION**

*Installation debris can cause equipment failure and damage. Use extreme care to keep drill chips and filings out of the relays, contacts, and other parts of the automatic transfer switch when mounting or connecting conduit. Screwdrivers should be used carefully to prevent damage to components.*

## 3.1 Dual Standby System - Genset-To-Genset Installations

Genset-to-genset installations that include a dual standby system are typically installed with a control battery and battery charger. Refer to the interconnection drawings included with your transfer switch. A typical interconnection drawing for this type of installation is included at the back of this manual.

## 3.2 Prime Power (Plant to Plant) System - Genset-To-Genset Installations

**Prime Power Wiring** - A permanent start jumper is installed in the transfer switch and is shipped from the factory in the prime power mode. Verify that the jumper (TB3-57 to TB3-59) is installed.

### 3.3 Dual Standby System - Genset-To-Genset Installations

Genset-to-genset installations that include a dual standby system are typically installed with a control battery and battery charger. A DC power supply is required for dual standby systems. Refer to the interconnection drawings included with your transfer switch. A typical interconnection drawing for this type of installation is included at the back of this manual.

**Control Voltage** - A dual stand-by configuration requires an external 12-24 VDC power supply to keep the genset-to-genset control active. An optional Battery Kit is available, or the genset starting batteries can be used. See [Appendix A](#) for connection details.

**Dual Stand-By Wiring** - For dual stand-by applications, the jumper (TB3-57 to TB3-59) must be removed (see [Appendix A](#)).

### 3.4 Recommended Compression Lugs (OTPCE Spec D)

Tables [Table 4](#) through [Table 7](#) list recommended compression lugs in sizes 500, 600, and 750 MCM for the OTPCE Spec D switch.

**TABLE 4. COMPRESSION LUGS FROM ILSCO**

750 MCM	600 MCM	500 MCM
CRA-750L2	CRA-600L2	CRA-500L2
2ACL-750	2ACL-600	2ACL-500
2IACL-750	2IACL-600	2IACL-500
CRA-xxxL2 represents long barrel copper compression lugs. 2ACL-xxx represents aluminum compression lugs. 2IACL-xxx represents narrow tang aluminum compression lugs.		

**TABLE 5. COMPRESSION LUGS FROM THOMAS & BETTS (COLOR-KEYED)**

750 MCM	600 MCM	500 MCM
54223	54289	54286
60278	60275	60273
60278N	60278N	60278N
54xxx represents short barrel two hole lugs. 60xxx represents two hole lugs - 90° C. 60xxxN represents range taking narrow tongue single barrel lugs. The 60278N lug is from 500 to 750 MCM.		

**TABLE 6. COMPRESSION LUGS FROM THOMAS & BETTS (BLACKBURN)**

750 MCM	600 MCM	500 MCM
LCN75	LCN600	LCN500
ATL502	ATL6002	ATL5002

LCN represents long barrel 2-hole mount copper lugs.  
ATL represents 2-hole aluminum lugs.

**TABLE 7. COMPRESSION LUGS FROM BURNDY**

750 MCM	600 MCM	500 MCM
YA39-2LN	YA36-2LN	YA34-2LN
YA39-2N	YA36-2N	YA34-2N
YA44L-2NTC-FX	-	YA38L-2NTC-FX
YAG44L-2NTC-LD	-	YAG38L-2NTC-LD
YA44-2N-FXB	-	YA38-2N-FXB
YA39A5 and YA39AM2	YA36A3	YA34A3

YAx-2LN represents standard length barrel copper compression terminal.  
YAx-2N represents long barrel uninsulated copper compression terminal.  
YAxL-2NTC-FX represents standard length barrel copper compression terminal for flexible and extra flexible copper cables.  
YAGxL-2NTC-LD represents standard length barrel lead plated copper compression terminal.  
YAGx-2N-FXB represents long barrel copper compression terminal belled entry for flexible and extra flexible copper cables.  
YAxAx and YAxAMx represent 2-hole and 4-hole uninsulated aluminum compression terminal.

## 3.5 AC Connections

Perform wiring in the following sequence:

1. Test the operation of the generator set from its own controls.
2. Stop the generator set and remove the negative lead from the cranking battery to prevent starting.

### WARNING

***Failure to prevent the generator set from starting before wiring procedures are performed presents a shock hazard that can cause severe personal injury or death. Disconnect generator set battery (negative (-) terminal first) before proceeding.***

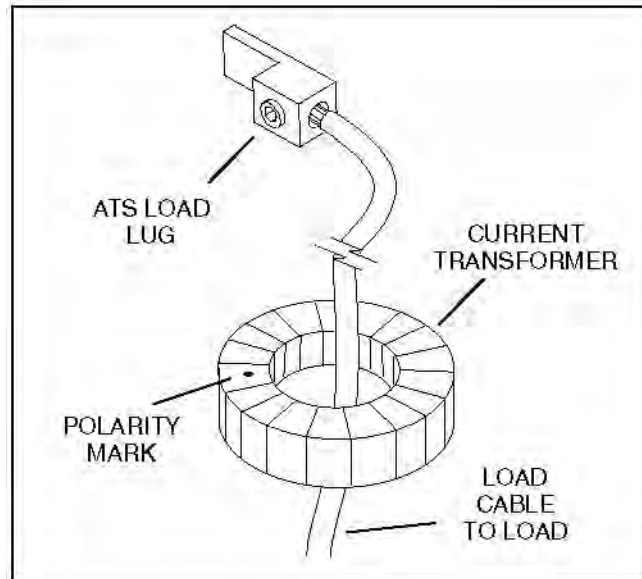
3. Connect conductors of sufficient size (see contract drawings) to carry rated current from the line, load, and generator set directly to the transfer switch terminals, which are marked A, B, and C (A, B, C, and N on 4-pole switches). A neutral bar with lugs is standard on 3-pole switches.

On transfer switches with a bar graph display, in order to measure the current, the load cables must each pass through a current transformer ([Figure 8](#)). Transfer switches are shipped with current transformer (CT) wires (white wire = X1, black wire = X2) connected to the terminal block (TB4) with the polarity mark facing the transfer switch. When wiring the power cables to the transfer switch, be sure the cables pass thru the CTs, and **make sure all CTs are facing the same direction with the polarity marks facing the transfer switch.**

[Table 9](#) gives the type and maximum conductor size the transfer switch accepts. [Figure 10](#) through [Figure 13](#) show transfer switch source and load connections.



**TABLE 8.**



**FIGURE 8. CURRENT TRANSFORMER WIRING**

**TABLE 9. TERMINAL LUG CAPACITY FOR COPPER OR ALUMINUM CONDUCTORS**

Switch Current Rating	Wires per Phase	Size Range of Wires
40/70/125 Source	1	12 AWG-2/0 Cu-Al
40/70/125 Load & Neutral	1	14 AWG-2/0 Cu-Al
150/225	1	6 AWG-300 MCM Cu-Al
260	1	6 AWG-400 MCM Cu-Al
300/400	2 1	3/0 AWG-250 MCM Cu-Al 3/0 AWG-600 MCM Cu-Al
600	2	250-500 MCM Cu-Al
800 (Open and Programmed Transition)/1000 (Open and Programmed Transition) - Spec A	4	250-500 MCM Cu-Al
1000 (Closed Transition)/1200 Spec C	4	2 AWG-600 MCM Cu-Al
1000 (Closed Transition)/1200 (Closed Transition) Spec D	4	2 AWG-600 MCM Cu-Al
1200 (Open and Programmed Transition) - Spec D	4	2 AWG-600 MCM Cu-Al (standard - mechanical lugs) 4-1/0-750 MCM Cu-Al (optional - mechanical lugs) 500 MCM Cu-Al (optional - mechanical lugs) 600 MCM Cu-Al (optional - compression lugs) 750 MCM Cu-Al (optional - compression lugs)

Switch Current Rating	Wires per Phase	Size Range of Wires
1600/2000	8	2 AWG-600 MCM Cu-Al (lugs optional)
1600/2000	8	2 AWG-750 MCM Cu-Al (lugs optional)
3000	8	2 AWG-600 MCM Cu-Al (lugs optional)
3000	8	2 AWG-750 MCM Cu-Al (lugs optional)
4000	12	2 AWG-600 MCM Cu-Al (lugs optional)
4000	12	2 AWG-750 MCM Cu-Al (lugs optional)

4. On 120-volt switches, connect the hot side to the (A) lug and the neutral side to the Neutral lug. On 240-volt single phase switches, connect the two hot lines to the A- and C-lugs and the Neutral line to the Neutral lug.
5. Connect power cables to the load terminals. Tighten the lugs as indicated in [Table 10](#).

**TABLE 10. LUG TORQUES**

Set Screw Socket Size (Across Flats)	Minimum Torque For Proper Operation
3/16 In	80 In-lbs (9 N•m)
1/4 In	200 In-lbs (23 N•m)
5/16 In	275 In-lbs (31 N•m)
3/8 In	375 In-lbs (43 N•m)
1/2 In	500 In-lbs (57 N•m)
9/16 In	600 In-lbs (68 N•m)

6. Make sure that both AC power sources are disconnected.

**⚠ WARNING**

***AC voltages and currents present an electrical shock hazard that can cause severe personal injury or death. Make sure that both AC power sources are disconnected.***

7. For 800-1000 amp transfer switches used on a circuit capable of delivering 50,000 amps @ 600 volts, wrap the line cables together with nominal 1/2-inch nylon rope, or rope having a minimum tensile strength of 4200 pounds, at five inches from the line terminals with four wraps (see [Figure 9](#)). This is not required for 1000 amp Closed Transition switches.

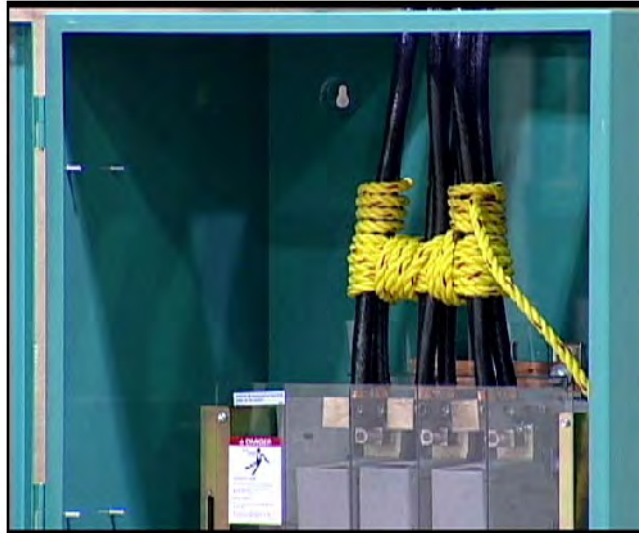


FIGURE 9. SECURING THE POWER CABLES

### 3.5.1 Converting Transfer Switch Phase Setting

Converting a transfer switch from single-phase to three-phase operation or from three-phase to single-phase operation is a three-step procedure:

#### ⚠ CAUTION

*Incorrect placement of transformer jumper wires can cause damage to the control when power is applied. To perform this conversion procedure correctly, refer to and comply with the schematics and wiring diagrams that were shipped with the transfer switch.*

1. Disconnect both AC power sources.

#### ⚠ WARNING

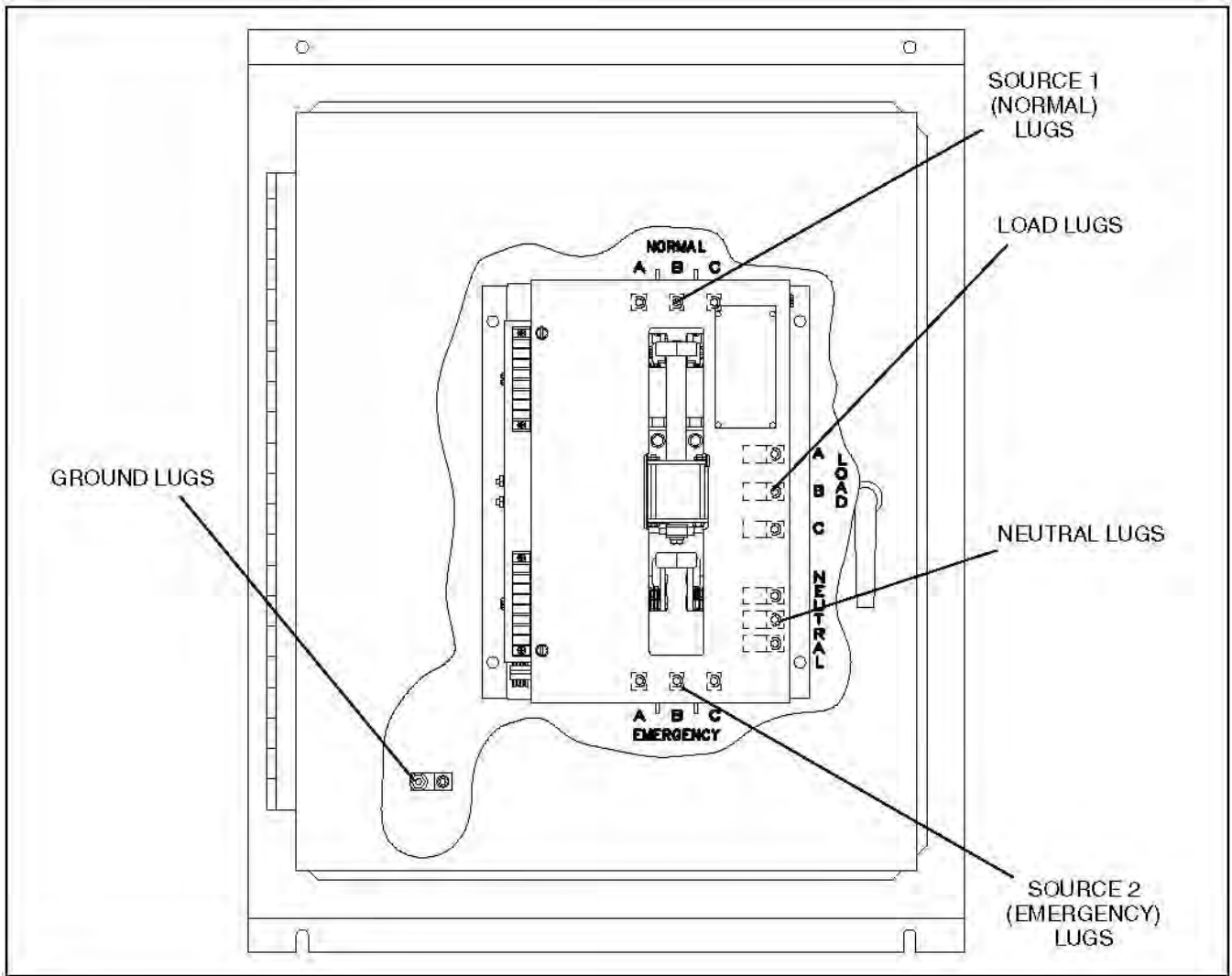
*AC voltages and currents present an electrical shock hazard that can cause severe personal injury or death. Make sure that both AC power sources are disconnected.*

2. Stop the generator set and remove the negative lead from the cranking battery to prevent starting.

#### ⚠ WARNING

*Failure to prevent the generator set from starting before wiring procedures are performed presents a shock hazard that can cause severe personal injury or death. Disconnect generator set battery (negative (-) terminal first) before proceeding.*

3. Place the transformer jumper wires (on the Power Module board) in the appropriate configuration. See [Figure 10](#) through [Figure 13](#). Refer to the service manual and to the schematic and wiring diagram package.
4. Set the appropriate Phase parameter with the digital menu system (see Section [Chapter 4](#)) when it is available or the PC service tool.



**FIGURE 10. 40- TO 125-AMPERE TRANSFER SWITCH TERMINAL ACCESS**

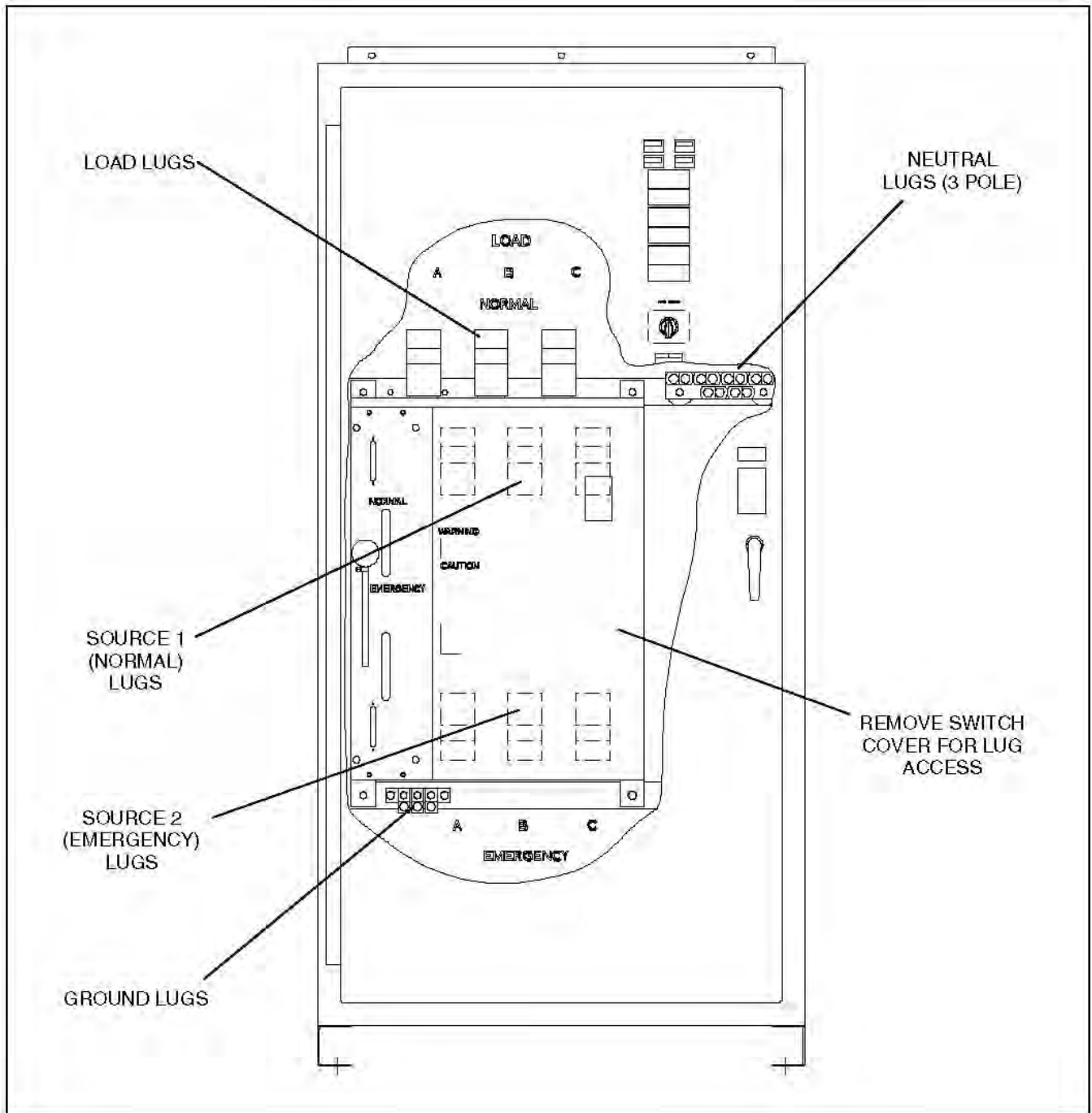
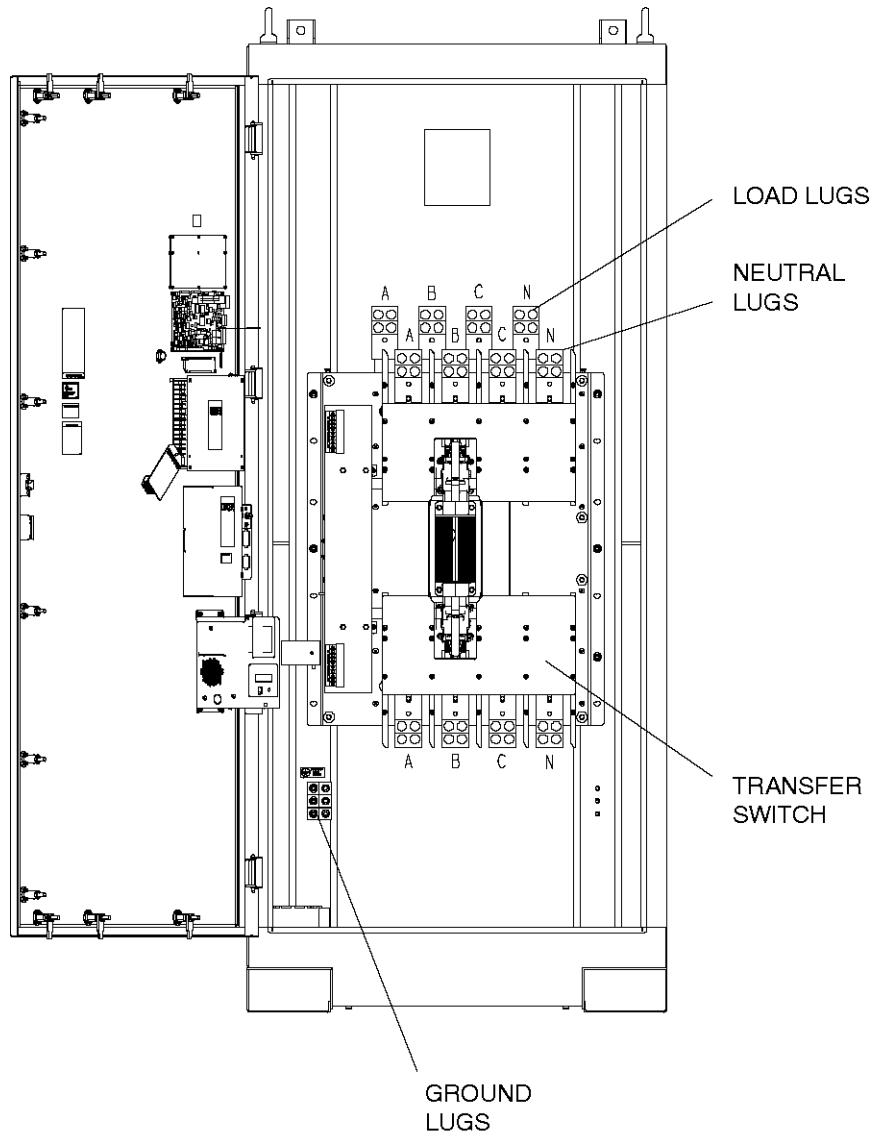
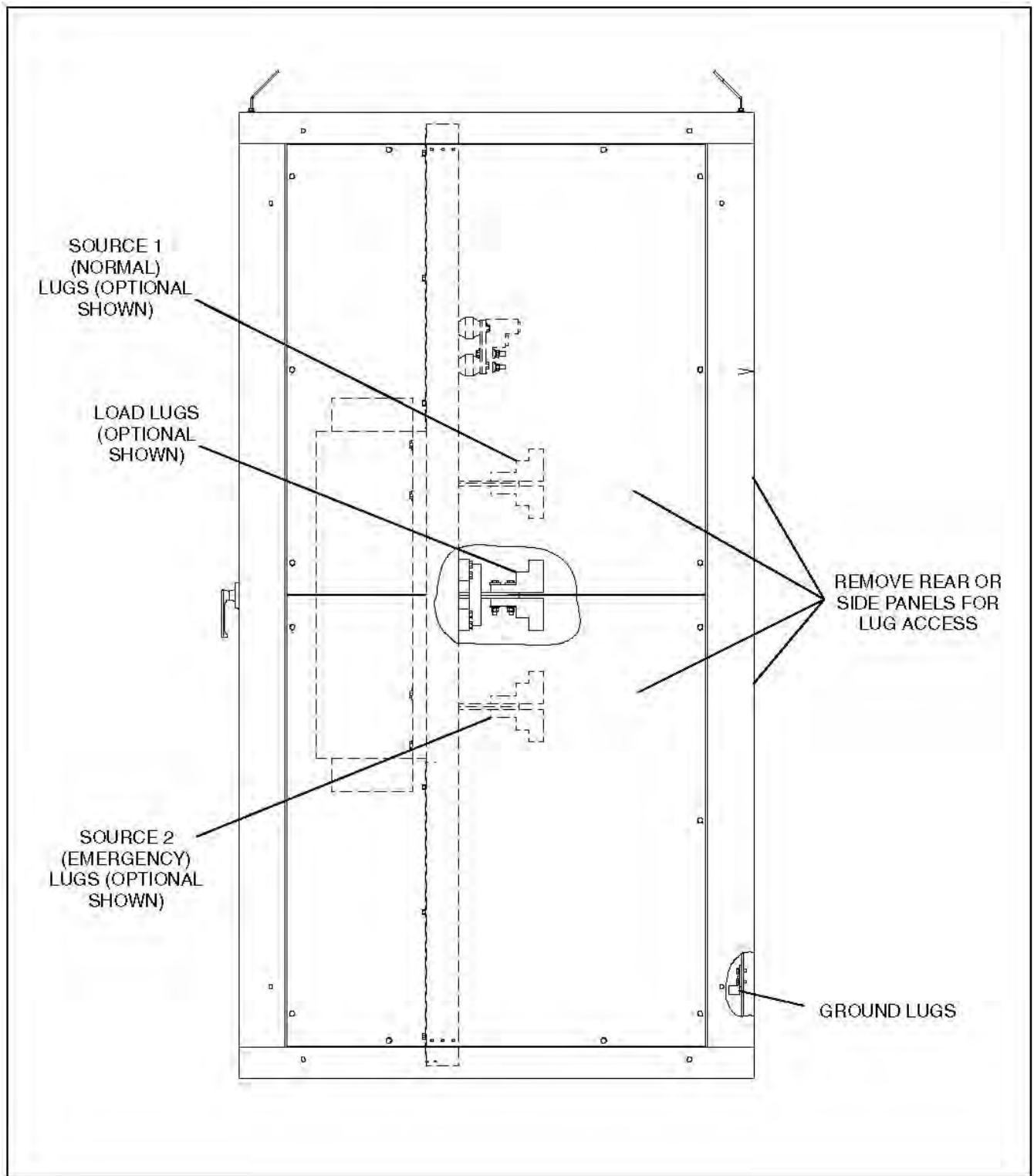


FIGURE 11. 1200-AMPERE TRANSFER SWITCH TERMINAL LUG ACCESS (CLOSED TRANSITION)



**FIGURE 12. 1200-AMPERE TRANSFER SWITCH TERMINAL LUG ACCESS (OPEN AND PROGRAMMED TRANSITION)**

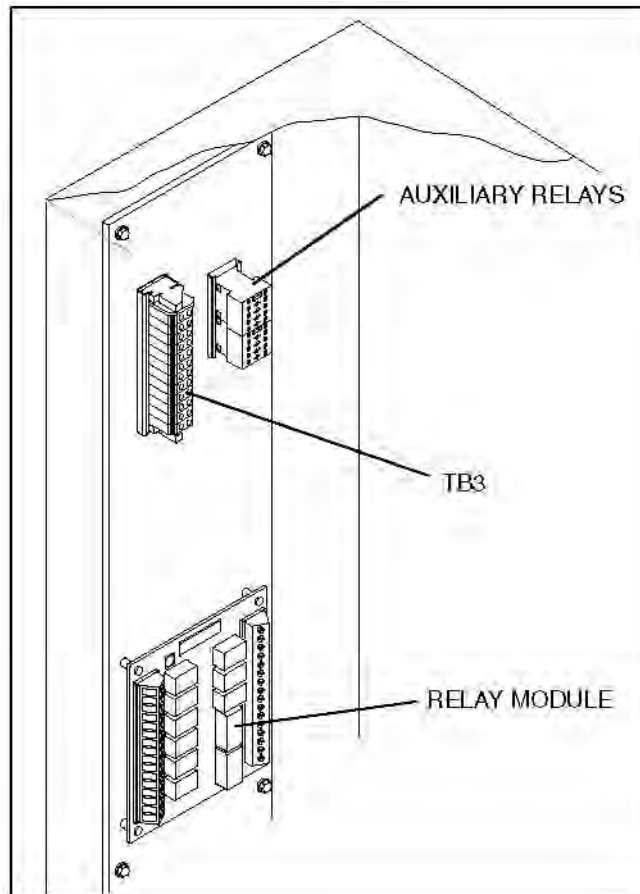


**FIGURE 13. 1600- TO 3000-AMPERE TRANSFER SWITCH TERMINAL LUG ACCESS**

## 3.6 Control Connections

Connections of standard and optional control wiring are made at terminal blocks TB1, TB2, TB3, and Relay Module; and directly at the (optional) auxiliary relays ([Figure 14](#)).

TB1 is located near the top left side on the front of the transfer switch. TB2 is located below TB1, near the bottom left side of the transfer switch. TB3 and auxiliary relays are located inside the cabinet on the DIN rail (see [Table 11](#)).



**FIGURE 14. CONTROL WIRING CONNECTIONS**

**TABLE 11. DIN RAIL LOCATIONS**

Model (Amps)	Cabinet Type	Location
OTPC 40-1000 A	All Types	Inside, upper left wall
OTPC 1200 Amps	All Types	Upper left side
OTPC 1600-4000 A	Type 1	Left side of cabinet
OTPC 1600-4000 A	Type 3R, 4, 12	Right side of cabinet



### 3.6.1 Connecting the Transfer Switch to a Genset

**⚠ WARNING**

***AC voltages and currents present an electrical shock hazard that can cause severe personal injury or death. Disconnect the AC power source.***

Wire size depends on the distance and the type of battery charger installed. Refer to [Table 12](#) to determine the wire size required.

- All leads to TB2 use Column A.
- If the transfer switch is not equipped with a battery charger, use Column A for all wires.
- If the transfer switch is equipped with a 2-Amp charger, use Column B for B+ and GND. Use Column A for all other wires.
- If the transfer switch is equipped with a 10-Amp charger, use Column C for B+ and GND. Use Column A for all other wires.
- If the genset is equipped with an annunciator, use Column A for wires to the annunciator.

**TABLE 12. WIRE SPECIFICATIONS**

Wire Size (AWG)	Distance in Feet, One Way (Multiply by 0.3 for Meters)		
	Column A	Column B	Column C
16	1000	125	25
14	1600	200	40
12	2400	300	60
10	4000	500	100

Wire resistance must not exceed 0.5 ohm per line. Use stranded wire only. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

Remote starting (for Cummins Power Generation water-cooled generator sets only) uses terminals B+, GND (ground), and RMT of terminal block TB2 ([Figure 16](#)). Connect these terminals to like terminals on the generator set. Refer to Interconnect Wiring diagram shipped with the switch. A jumper is shipped with the transfer switch and is in a small envelope attached to TB2.

- For PCC 3100 and PCC 2100 genset controls, install a jumper between TB2-1 and TB2-2 for ground-to-start connection.
- For Detector 12 genset controls, install a jumper between TB2-2 and TB2-3 for B+ start.
- For PCC 3200 and PCC 1301 genset controls requiring a dry contact start, do not install a jumper.

Be sure to check the Interconnect Wiring diagram shipped with the transfer switch.

For network wiring instructions, refer to the *PowerCommand Network and Operator's Manual* (PN 900-0366 for TP-78 networks or 900-0529 for FT-10 networks).

### 3.6.2 Auxiliary Contacts

Auxiliary contacts, used for external alarm or control circuitry, are available for the Source 1 (Normal) and Source 2 (Emergency) sides of the transfer switch. Connections for the auxiliary contacts can be made on terminal block TB1 ([Figure 15](#)). The contacts have ratings of 10 amperes at 250 VAC. [Figure 15](#) shows the normally open and normally closed positions of the auxiliary contacts with the transfer switch in the neutral position. Moving the transfer switch to Normal or Emergency actuates the corresponding auxiliary contacts.

Use number 22 to number 12 AWG stranded wire. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

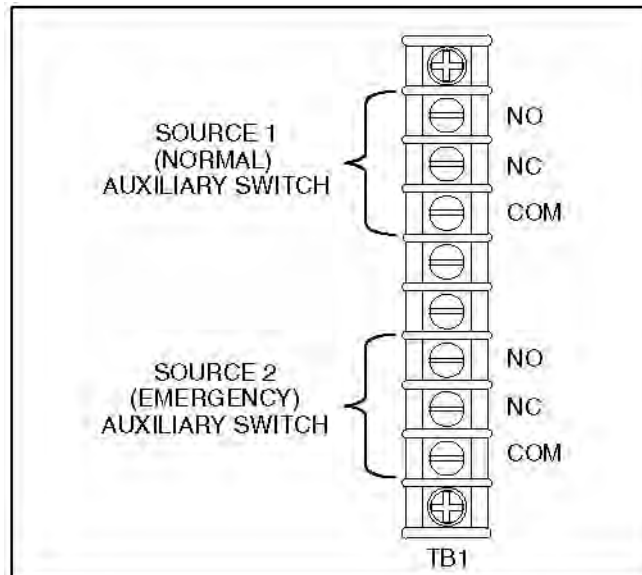


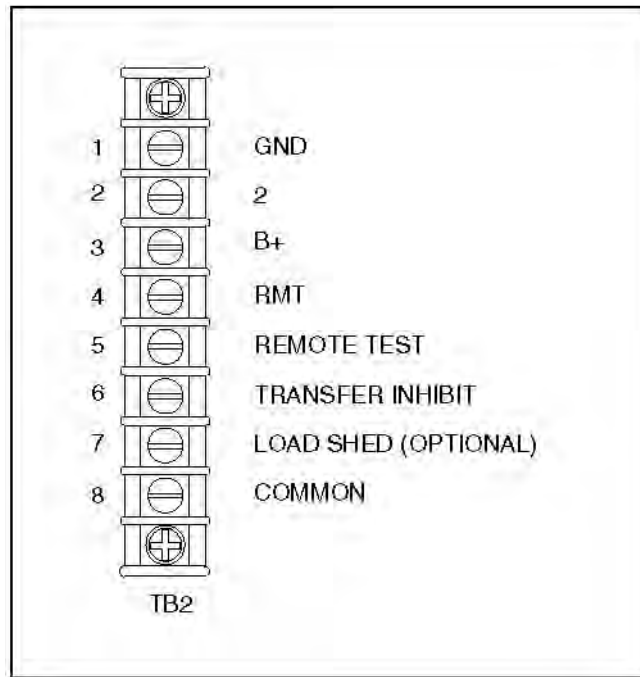
FIGURE 15. TERMINAL BLOCK TB1

### 3.6.3 Remote Start-Stop Connections

Use number 18 to number 12 AWG stranded wire. Resistance must not exceed 0.5 ohm per line. Stranded wire is recommended. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

Remote starting (for Onan water-cooled generator sets only) uses terminals B+, GND (ground), and RMT of terminal block TB2 ([Figure 16](#)). Connect these terminals to like terminals on the generator set. Refer to your generator set wiring diagrams.

Connect the supplied jumper between terminals 1 and 2 for PowerCommand control systems. Connect the jumper between terminals 2 and 3 for Detector Control systems. Do not use the jumper for all other systems.



**FIGURE 16. TB2: START CONNECTIONS, REMOTE TEST, AND TRANSFER INHIBIT**

### 3.6.4 Remote Test Feature

The transfer switch can be remotely activated by using an external switch. Closure of a set of contacts (switch) across the remote test transfer input and common causes the transfer switch to sense a (simulated) utility power failure and send a start/run signal to the generator set. The load is transferred to the generator set when generator set power becomes available. (Refer to the Service manual.)

To a remote test switch, connect normally open contacts (from a test switch) to terminals 5 and 8 of TB2 ([Figure 16](#)).

Use number 22 to number 12 AWG stranded wire (maximum resistance of 4 ohms per line). For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

### 3.6.5 Transfer Inhibit

To add transfer inhibit, connect normally open contacts to terminals 6 and 8 of TB2 ([Figure 16](#)).

In systems that have multiple closed transition transfer switches the transfer inhibit function should be used to make sure that multiple switches don't transfer at the same time. Refer to the section on closed transition ATS considerations.

In systems that have multiple closed transition transfer switches the retransfer inhibit function should be used to make sure that multiple switches don't transfer at the same time. Refer to the section on closed transition ATS considerations.

Use number 22 to number 12 AWG stranded wire. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

### 3.6.6 Load Shed Option

To add a load shed control, connect normally open contacts across terminals 7 and 8 of TB2.

Load shed is initiated by the closing of contacts across terminals 7 and 8 of TB2. When the load shed function is initiated, the switch is moved from the Source 2 position to the neutral position. When load shedding is in effect, a return of Source 1 utility power causes immediate retransfer to Source 1. If the load shed signal is removed before Source 1 returns, the switch transfers back to Source 2 if the Source 2 is available.

**NOTICE**

**TB1 and TB2 will accept 22 AWG - 12 AWG wire with 3/8 inch (10 mm) strip. Torque to 9 in-lbs.**

### 3.6.7 Auxiliary Relays Option

Connections to the auxiliary relays are made directly to the relay terminals. [Figure 14](#) shows the location of the Auxiliary Relays on the options panel. The terminals accept wire sizes from one number 18 AWG stranded wire to two number 12 AWG stranded wires. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

There are two types of auxiliary relay coils (12 VDC and 24 VDC).

[Table 13](#) lists several auxiliary relay options.

All relays have two normally open and two normally closed contacts that are rated for 6 amperes at 600 VAC ([Figure 17](#)).

**TABLE 13. AUXILIARY RELAY**

24 Vdc Coil	Installed, Not Wired
24 Vdc Coil	Emergency Relay
24 Vdc Coil	Normal Relay
24 Vdc Coil	Genset Run Relay
12 Vdc Coil	Installed, Not Wired
12 Vdc Coil	Emergency Relay
12 Vdc Coil	Normal Relay
12 Vdc Coil	Genset Run Relay

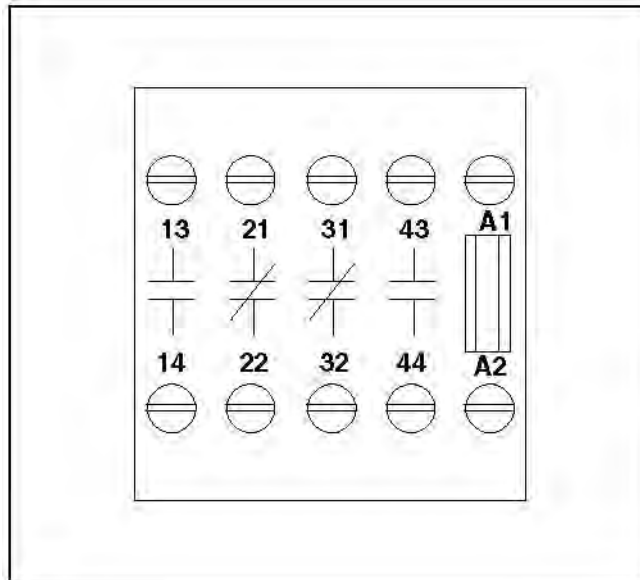


FIGURE 17. AUXILIARY RELAY TERMINALS

### 3.6.8 Relay Module Option

The Relay Module provides nine sets of form C contacts and two sets of normally open contacts that are rated for 2 Amps at 30 VDC or 0.60 Amps at 120 VAC. Two sets of form C contacts and one set of normally open contacts is reserved for future use. Connections to these relays are made at J14 and J15 on the Relay Module. The Relay Module is located on the left inside wall of the transfer switch enclosure.

The Source 1 and Source 2 Connected relays are energized when their respective power sources are available, ready to produce power, and connected to the load.

#### NOTICE

**The following image shows all relay contacts as de-energized.**

The Source 1 and Source 2 Available relays are energized when their respective power sources are producing power.

The Test/Exercise relay is energized when the system is in test or exercise mode.

The Elevator Pre-Transfer relay is energized during the elevator signal time delay. The relay contacts are used to provide a warning that a transfer or retransfer is about to occur.

The ATS Not-In-Auto relay is energized when any one of the following is active:

- Motor Disconnect Switch in OFF position
- Transfer Inhibit
- Retransfer Inhibit
- Load Shed
- P12 is disconnected from Power Module

The Load Shed relay is active when a load shed signal is given between TB2-7 and TB2-8.

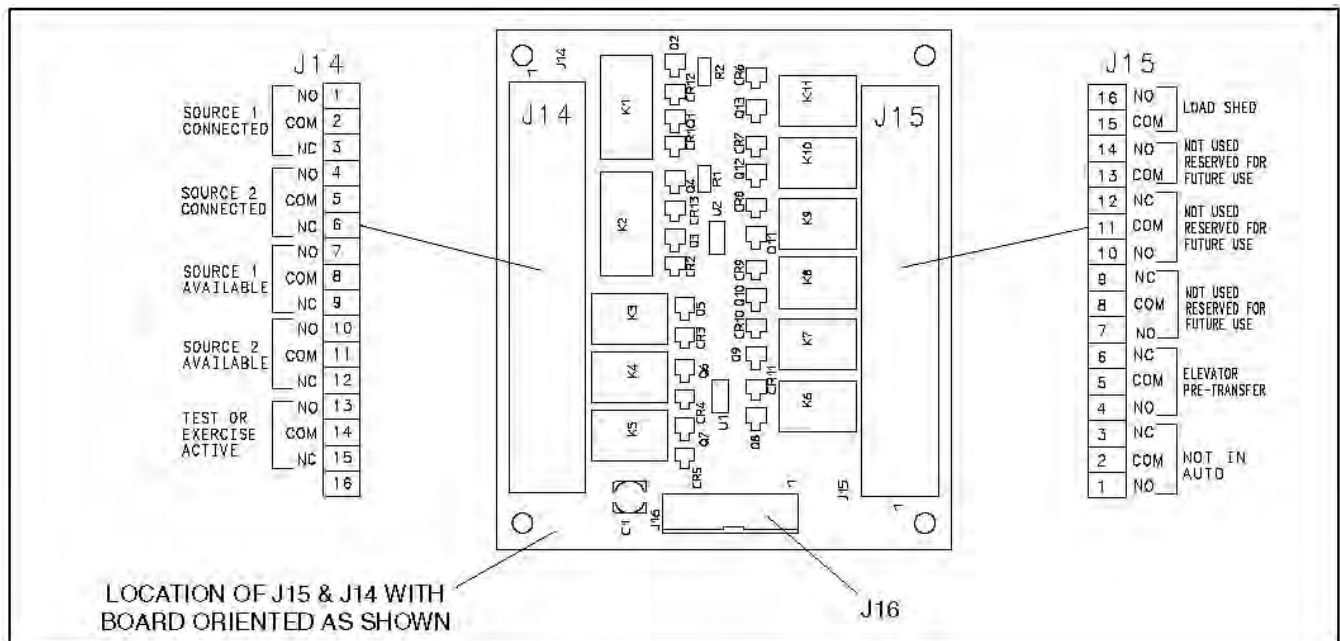
The Fail to Disconnect relay is active when the transfer switch remains connected to both sources for more than 100 msec during a closed transition transfer. It should be wired to the shunt trip of the breaker feeding the ATS on either the normal or the emergency side. Refer to the section on closed transition ATS wiring considerations.

**NOTICE**

**TB1 and TB2 will accept 22 AWG - 12 AWG wire with 3/8 inch (10 mm) strip. Torque to 9 in-lbs.**

**TABLE 14. RELAY MODULE CONTACTS (ALL SHOWN AS DE-ENERGIZED)**

Relay	NO	COM	NC
Source 1 Connected	J14-1	J14-2	J14-3
Source 2 Connected	J14-4	J14-5	J14-6
Source 1 Available	J14-7	J14-8	J14-9
Source 2 Available	J14-10	J14-11	J14-12
Test/Exercise Active	J14-13	J14-14	J14-15
ATS Not-In-Auto	J15-1	J15-2	J15-3
Elevator Pre-Transfer	J15-4	J15-5	J15-6
Not Used	J15-7	J15-8	J15-9
Not Used	J15-10	J15-11	J15-12
Not Used	J15-13	J15-14	X
Load Shed	J15-15	J15-16	X



**FIGURE 18. OPTIONAL RELAY MODULE**

## 3.6.9 Battery Charger Options

Battery chargers are used with utility-to-genset and genset-to-genset applications. When so equipped, a battery charger can be used for charging genset starting and control batteries. These chargers are current limiting and supply automatic constant voltages.

When the battery approaches the full charge preset voltage, the charging current automatically tapers to zero amperes or to a steady-state load on the battery.

A float-charge battery charger regulates its charge voltage to continuously charge without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery.

Two battery chargers are available (see [Figure 19](#)). One battery charger is rated for 2 amperes at 12 or 24 VDC. The other battery charger is rated for 15 amperes at 12 VDC or 12 amperes at 24 VDC.

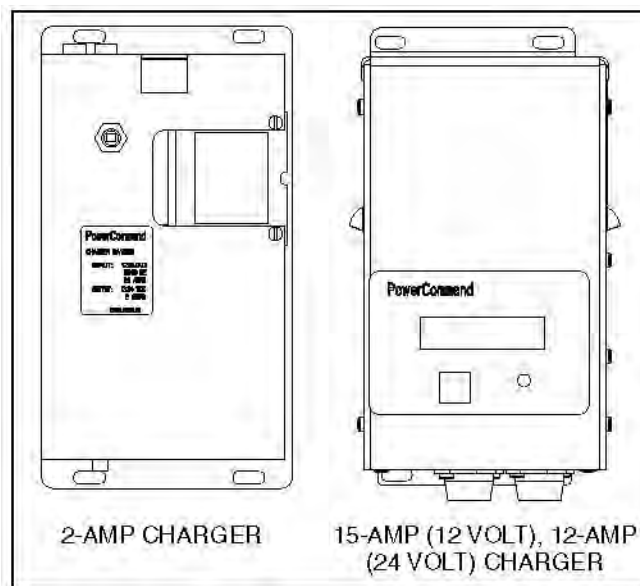


FIGURE 19. CURRENT BATTERY CHARGERS

### 3.6.9.1 2-Amp Battery Charger

The 2-ampere battery charger (see [Figure 20](#)) has a 5 amp DC output circuit breaker switch on the front of the battery charger. The charger also includes a 5 amp AC fuse to protect the battery charger circuit.

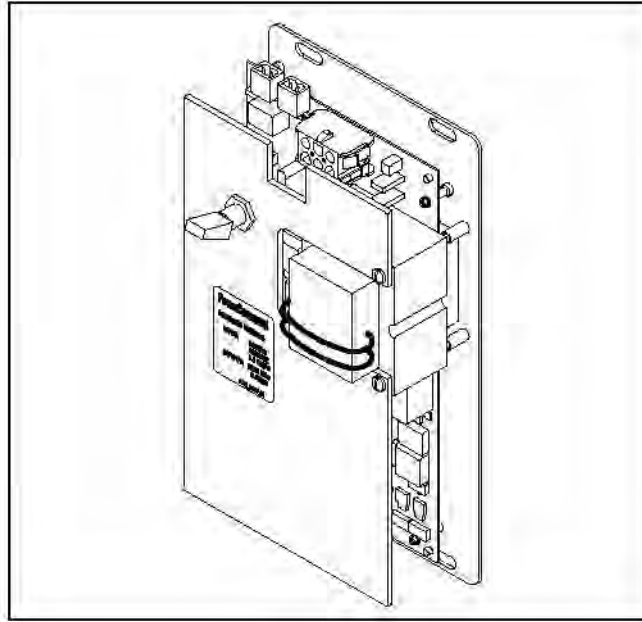
Under normal operating conditions, the Low Bat and AC Fail relays are energized and the High Bat relay is de-energized. In response to a Low Bat or AC Fail condition, the appropriate normally energized relay (Low Bat or AC Fail) drops out. In response to a High Bat condition, the normally de-energized High Bat relay is energized.

*Control Panel* - The 2-amp charger control panel includes a digital display, a RESET button, and an LED status indicator (see [Figure 21](#)).

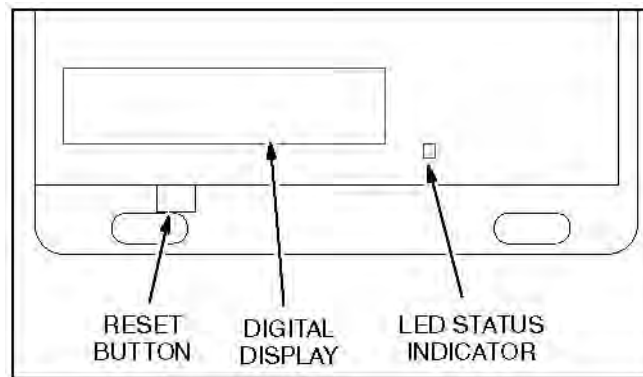
- The 2-line x 16-character digital display displays menus and faults.
- The RESET button is used to select menu options and to clear fault messages.
- The status LED displays the appropriate color for the following conditions.
  - **Green** - Onsolid indicates unit is charging

- **Red** - On solid indicates a fault condition. The fault number is shown on the digital display.

*Battery Charger Configuration* - The **RESET** button on the control panel (see [Figure 21](#)) is used to configure the battery charger for the correct battery voltage. (More information on Setup menus is included in the Battery Charger Operator's Manual.)



**FIGURE 20. 2-AMP POWERCOMMAND BATTERY CHARGER**



**FIGURE 21. 2-AMP CHARGER CONTROL PANEL**

### 3.6.9.2 15/12-Amp Battery Charger

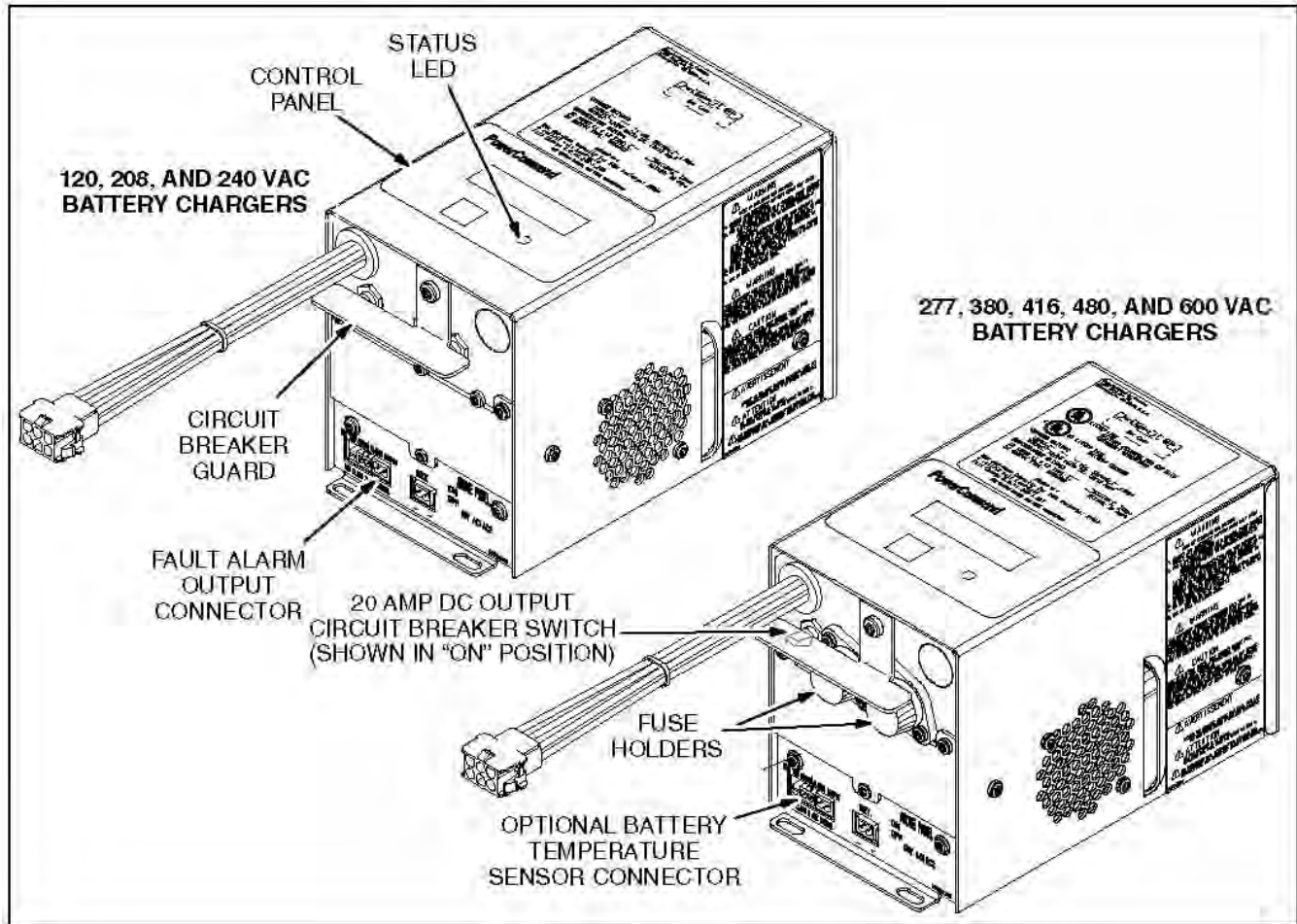
There are two types of 15/12-amp PowerCommand battery chargers (see [Figure 22](#)). All 15/12-amp battery chargers have a 20 amp DC circuit breaker switch on the front of the battery charger. The 120, 208, and 240 VAC battery chargers include two 10 amp AC circuit breaker switches and a circuit breaker guard, while the 277, 380, 416, and 600 VAC battery chargers include two AC fuse holders.

*Control Panel* - The 15/12-amp charger control panel includes a digital display, a Reset button, and an LED status indicator (see [Figure 23](#)).

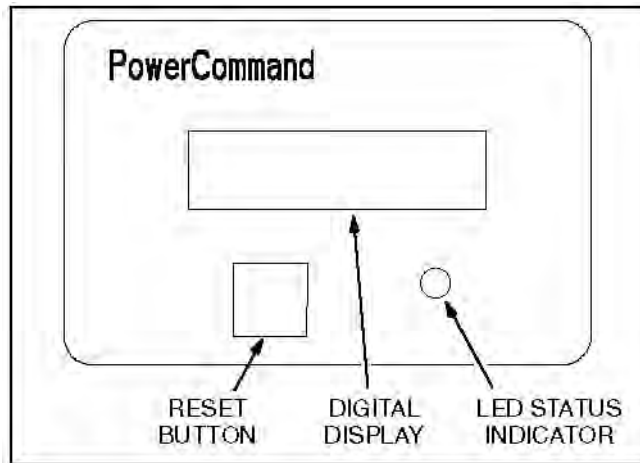
- The 2-line x 16-character digital display displays menus and faults.



- The Reset button is used to select menu options and to clear fault messages.
- The status LED displays the appropriate color for the following conditions.
  - **Green** - On solid indicates unit is charging
  - **Amber** - On solid indicates Equalizing
  - **Red** - On solid indicates a fault condition. The fault number is shown on the digital display.



**FIGURE 22. 15/12-AMP POWERCOMMAND BATTERY CHARGERS**



**FIGURE 23. 15/12-AMP CHARGER CONTROL PANEL**

### 3.6.9.2.1 Optional Battery Temperature Sensor

*Optional Battery Charger Sensor* - A connector for an optional battery temperature sensor is located on the front of the battery charger. When used to monitor battery temperature, the optional battery temperature sensor is connected from the battery charger to the positive terminal of the battery. A fault message (fault code 2263) is displayed if the battery temperature is too high (reaches 131 degrees F (55 degrees C)).

*Battery Charger Configuration* - The **RESET** button on the control panel (see [Figure 23](#)) is used to configure the battery charger. (More information on Setup menus is included in the Battery Charger Operator's Manual.)

- **Battery Voltage and Type** - The battery charger must be correctly configured, using the Setup menus, for the correct battery voltage and type before it is connected to the battery. The battery voltage can be set for 12 or 24 VDC (default = 12 VDC). The battery type can be set for Lead-Acid, Gel, or AGM batteries (default = Lead-Acid).

#### NOTICE

A factory installed battery charger is set up for the proper DC battery voltage requested on the production order, with the Lead-Acid battery type selected as the default.

- **Battery Equalization** - Battery equalization is available for lead-acid batteries that are completely charged, using the Equalize Battery screen in the Setup menus. When battery equalization is in process, the LED status indicator turns amber.

## 3.6.10 Battery Charger Alarm Contacts Option

The optional 10-ampere battery charger can include three sets of form C relay contacts, as an additional option.

Under normal operating conditions, the Low Bat and AC Fail relays are energized and the High Bat relay is de-energized. In response to a Low Bat or AC Fail condition, the appropriate normally energized relay (Low Bat or AC Fail) drops out. In response to a High Bat condition, the normally de-energized High Bat relay is energized.

The contacts are rated for 4 amperes at 120 VAC or 30 VDC. Connections to these contacts are made at terminals 41-42-43 (AC failure), 44-45-46 (high battery voltage), and 47-48-49 (low battery voltage) of TB3 ([Figure 24](#)). See [Figure 14](#) for the location of TB3 on the option panel.

Use number 22 to number 12 AWG stranded wire. For connection to the screw terminal, strip the insulation back 3/8 inch (10 mm).

The Level 1 and Level 2 Digital Modules have an input dedicated to monitor the AC Line failure on the battery charger. This input is located at J27-23 and activated when grounded. (As of this printing, this input is only available at J27-23.)

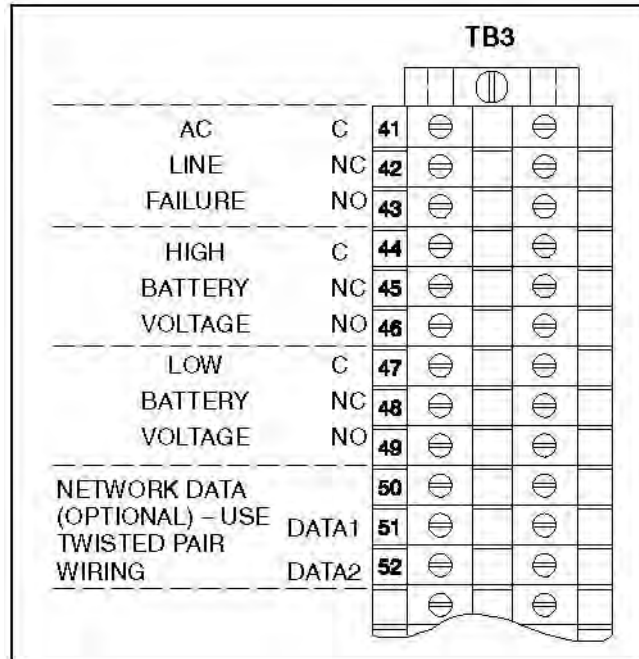


FIGURE 24. BATTERY CHARGER ALARM CONTACTS AND NETWORK CONNECTIONS

### 3.6.11 Network Connections

For installations that include a PowerCommand network module, connect stranded twisted pair network cable to the left side of terminals 51 and 52 on TB3. The network module is located on the left side of the digital module.

## 3.7 Voltage Sensing Wiring (Level 2 Control Only)

The transfer switch is wired at the factory for a 4-wire, 3-phase Wye configuration with grounded neutral. If this transfer switch is being connected to a Delta power system or a Wye *without* a grounded neutral, modify the wiring as follows:

1. Disconnect the neutral sensing wires marked TB12-7 and TB14-7.

#### NOTICE

**Leave the short jumpers as they are.**

2. Insulate the terminals and secure them to the harness with a wire tie.

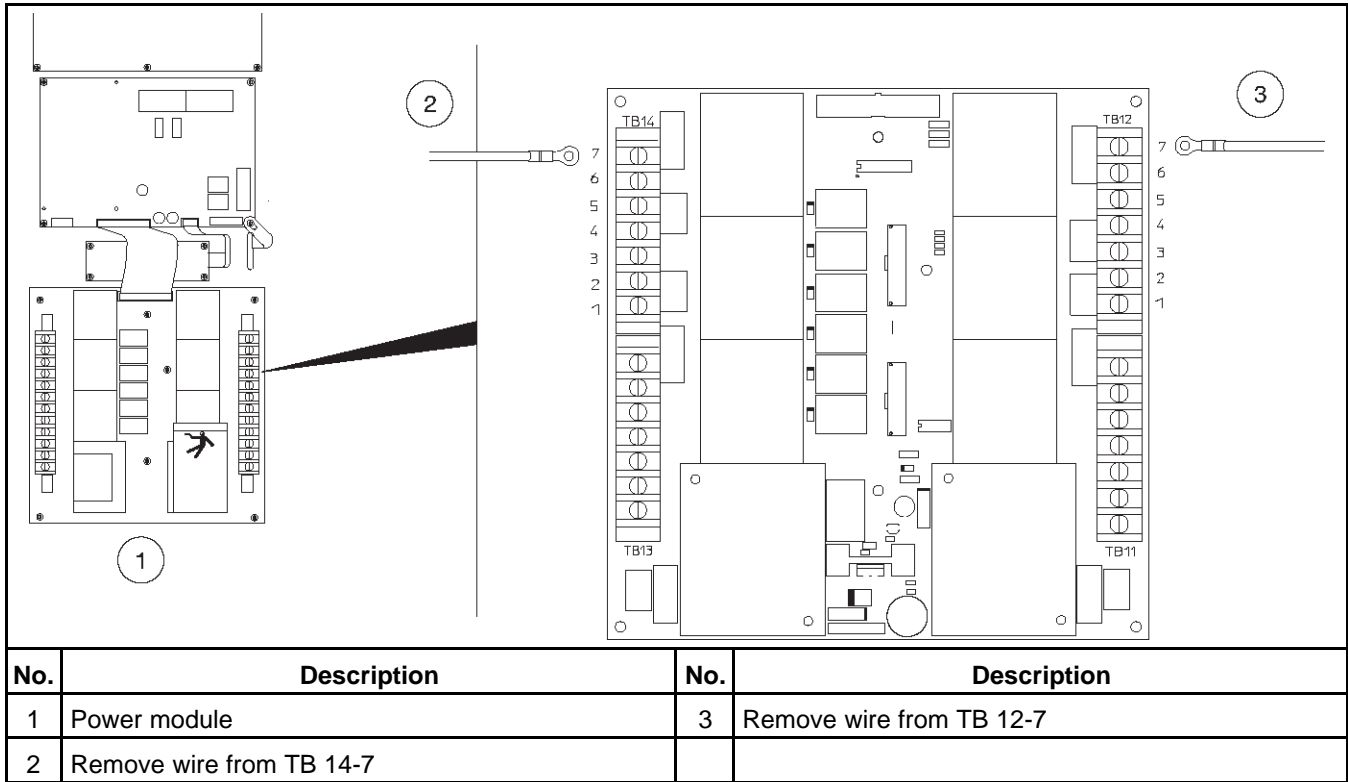
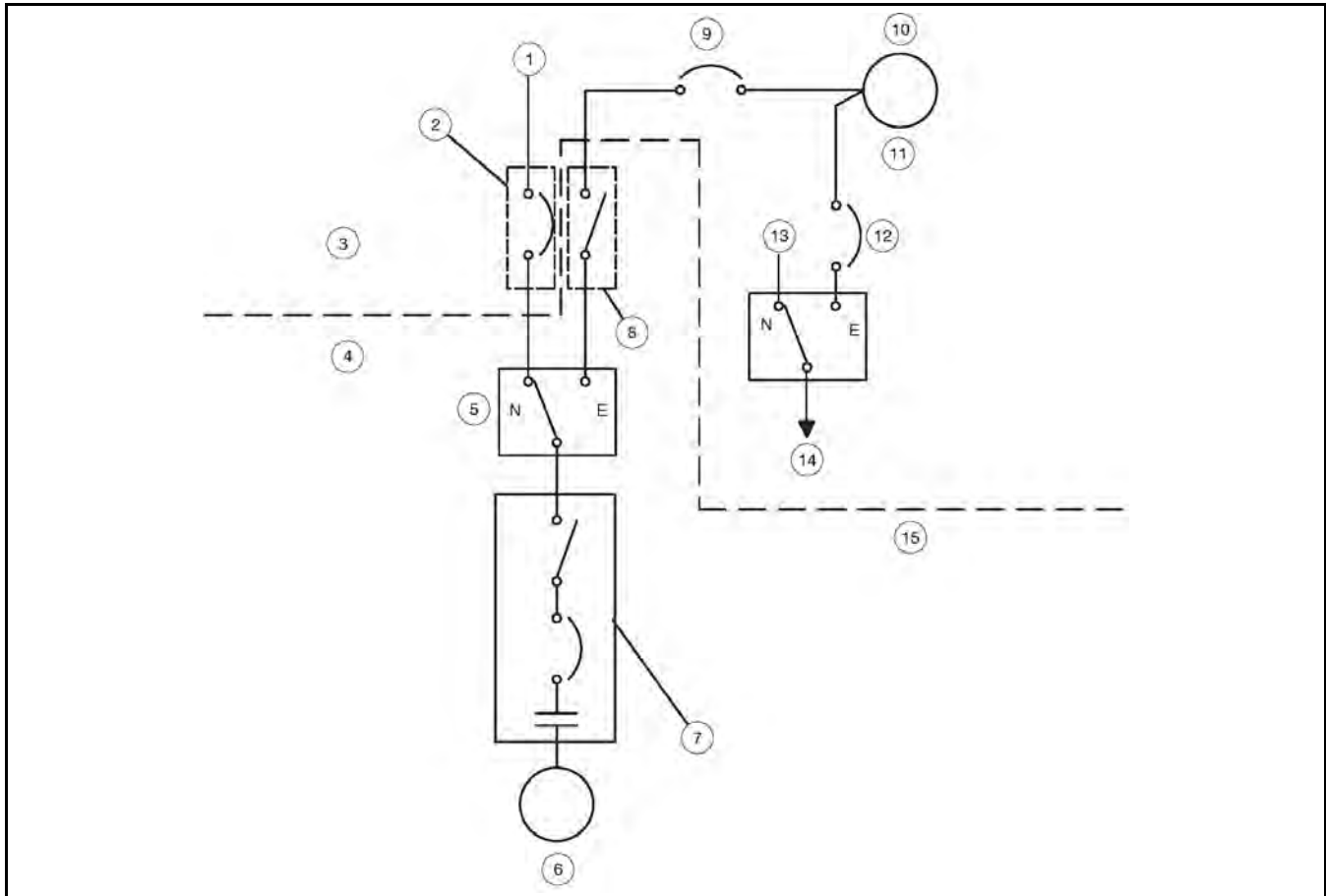


FIGURE 25. OPTIONAL DELTA CONFIGURATION JUMPER

### 3.8 Transfer Switches in Fire Pump Circuit Applications

The following image shows the typical fire pump controller/transfer switch arrangement for transfer switches in the range of 40 to 1000 Amp.



No.	Description	No.	Description
1	Source 1 (normal)	9	Fire pump feeder breaker
2	Fire pump service disconnect	10	Source 2 (generator)
3	Upstream overcurrent device (fuse or circuit breaker)	11	Alternate source
4	Pump room	12	Generator feeder breaker
5	Transfer switch	13	Normal source
6	Fire pump motor	14	To other loads
7	Fire pump controller	15	Pump room
8	Isolating switch		

**FIGURE 26. TYPICAL FIRE PUMP CONTROLLER AND TRANSFER SWITCH ARRANGEMENT**

### 3.8.1 Required Transfer Switch Features

1. An OTPC with Level 2 control (one ATS per fire pump)
2. Programmed transition
3. Phase sequence monitor
4. Momentary Test Switch (on cabinet door)
5. UL type 4 or 12 cabinet

### **3.8.2 Location**

The transfer switch and Source 2 (generator) isolating switch must be located in the fire pump room.

### **3.8.3 Isolating Switch**

The contractor must furnish and install a lockable isolating switch, with auxiliary contacts, on the Source 2 (generator) side of the ATS.

### **3.8.4 Supervision**

The isolating switch auxiliary contacts must be connected to the ATS controls to prevent generator set starting when the isolating switch is open. Refer to the site interconnection drawing.

### **3.8.5 Separate ATS for Auxiliaries**

A separate ATS must supply all pump room auxiliaries.

## **3.9 Shorting Bar Removal**

The current transformers are shorted during shipment. The shorting bar in terminal block TB4 connects all outputs to ground. The shorting bar must be removed in order for current metering to function. To remove the shorting bar from the center of TB4:

1. Remove the protective cover.
2. Loosen all the the shorting bar screws and lift it out of the terminal block.
3. Reinstall the protective cover. Save the shorting bar for reuse.

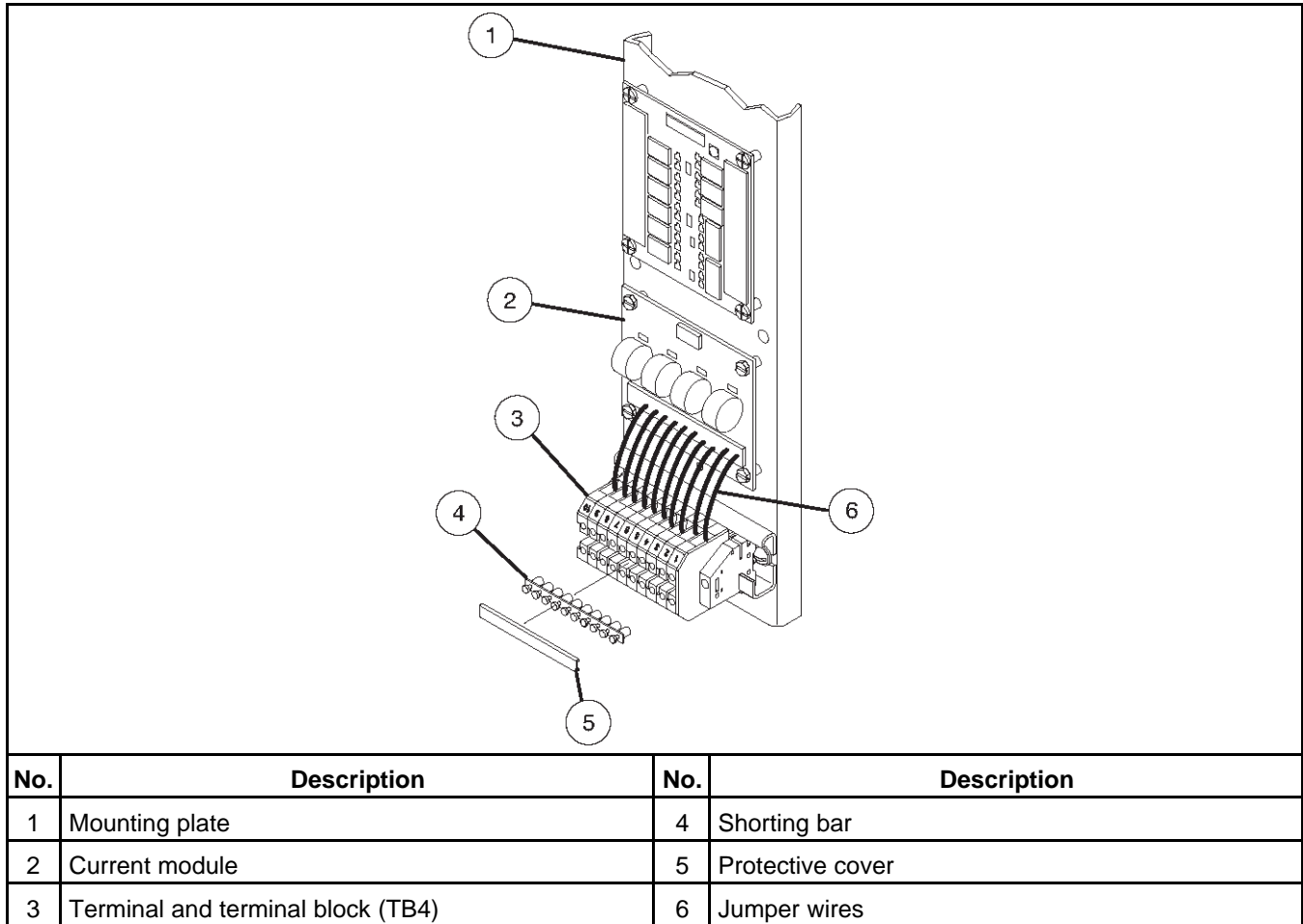


FIGURE 27. SHORTING BAR REMOVAL

### 3.10 Inspection and Cleanup

Inspect all wiring to be certain that:

- Wiring does not interfere with switch operation.
- Wiring is not damaged as door opens and closes.
- Wiring does not contact sharp or abrasive surfaces.
- No wiring is left loose and unconnected.

After mounting and wiring the cabinet, clean the interior with a vacuum cleaner to remove any chips, filings, or dirt from the cabinet interior and components.

The installation is not yet complete.

**Do not energize the transfer switch until instructed to do so in Sections 4 and 5.**

# 4 Setup and Adjustments

---

After the transfer switch is installed, the control settings can be adjusted. Setup and adjustment procedures can be performed using the Digital Display. If the transfer switch is not equipped with the Digital Display you must use the PC service tool to view and change parameters. Refer to the InPower™ User's Guide for details on using the PC service tool.

## 4.1 Before Adjusting

### 4.1.1 Install J1 and J2

**⚠ WARNING**

*AC power in the cabinet and the rear side of the cabinet door presents a shock hazard that can cause severe personal injury or death. Use extreme caution to avoid touching electrical contacts when the cabinet door is open. Do not wear long hair, damp clothing, or jewelry.*

Install connectors J1 and J2 when all wiring is complete.

### 4.1.2 Install Digital Module and Network Communications Module Batteries

The digital module and the optional network communication module each require two batteries. These batteries are included with the transfer switch. Install the batteries in the two battery holders on the module(s). Orient batteries according to the polarity marks on the battery holders.

### 4.1.3 Connect the Battery (Utility to Genset and Genset to Genset Applications Only)

Make sure that the RUN switch on the generator is in the STOP position and connect the battery (negative [-] lead last). If applicable, reconnect the external battery charger.

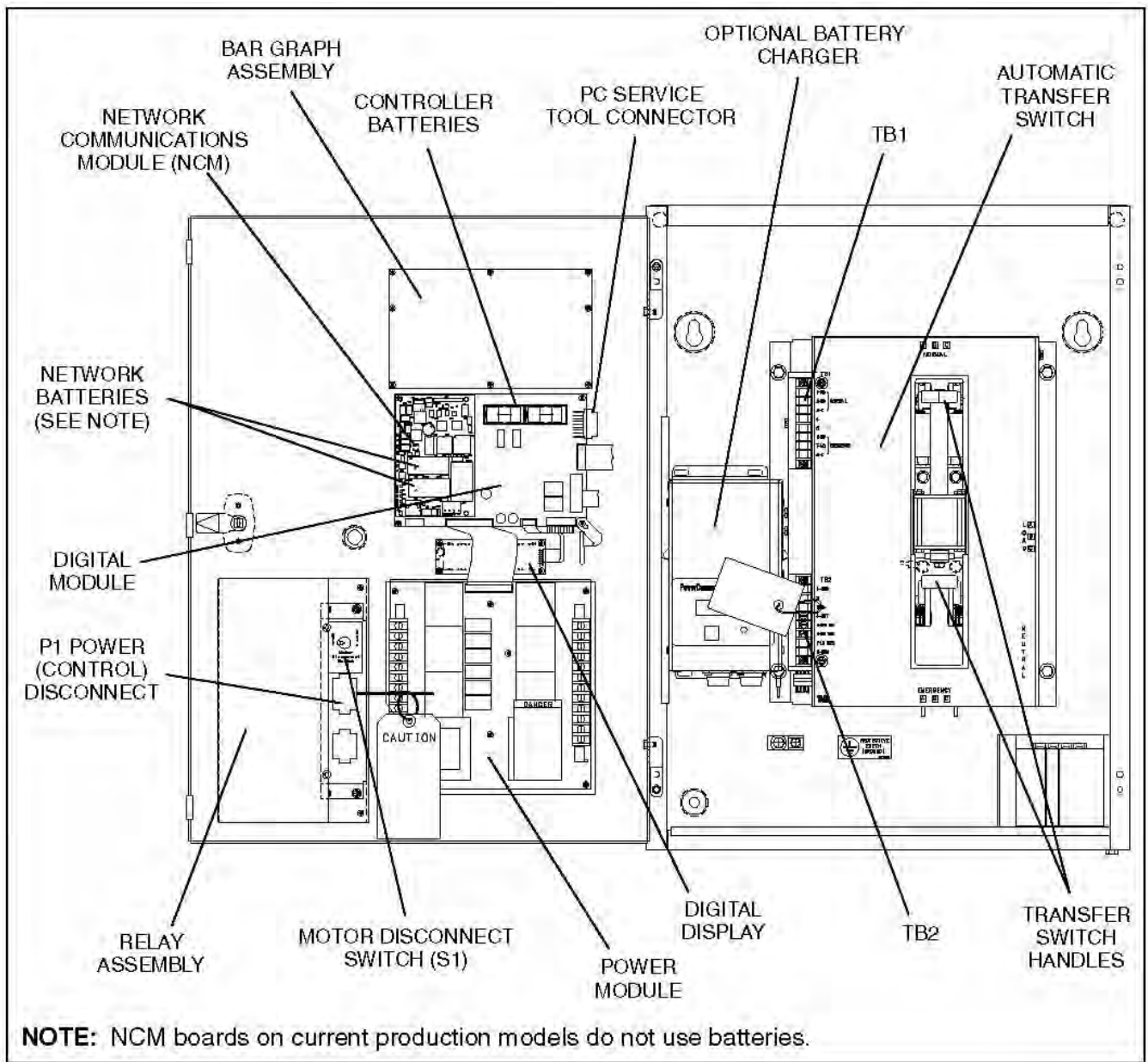
**⚠ WARNING**

*Ignition of explosive battery gases can cause severe personal injury. Do not smoke or cause any arc, spark, or flame while servicing batteries.*

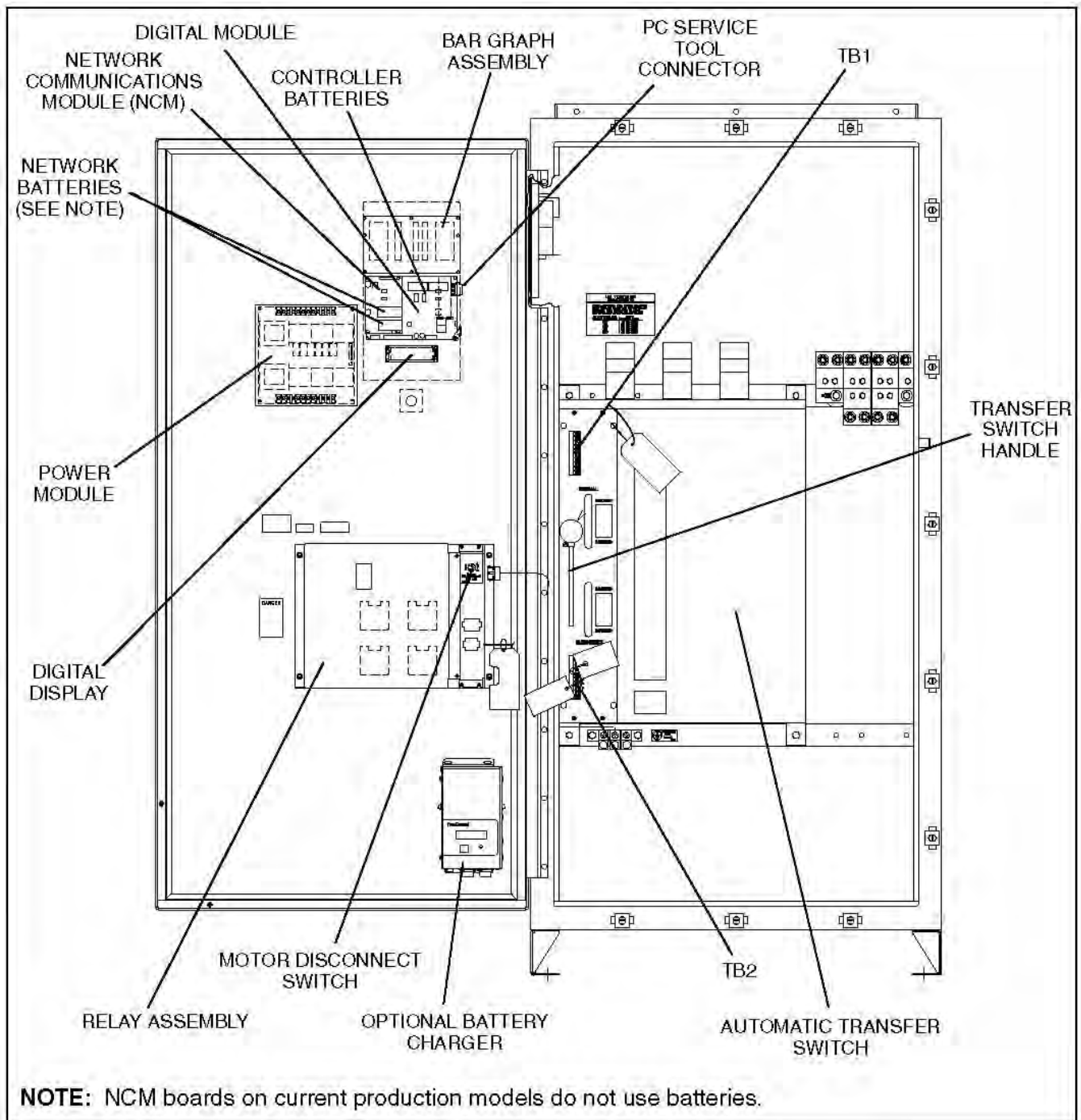
### 4.1.4 Connect AC Line Power

If the transfer switch main contacts are not closed to the Source 1 (Normal) power source side, manually close the transfer switch to the Source 1 side. Then connect AC line power to the automatic transfer switch. The Source 1 Available and Source 1 Connected lamps should light.

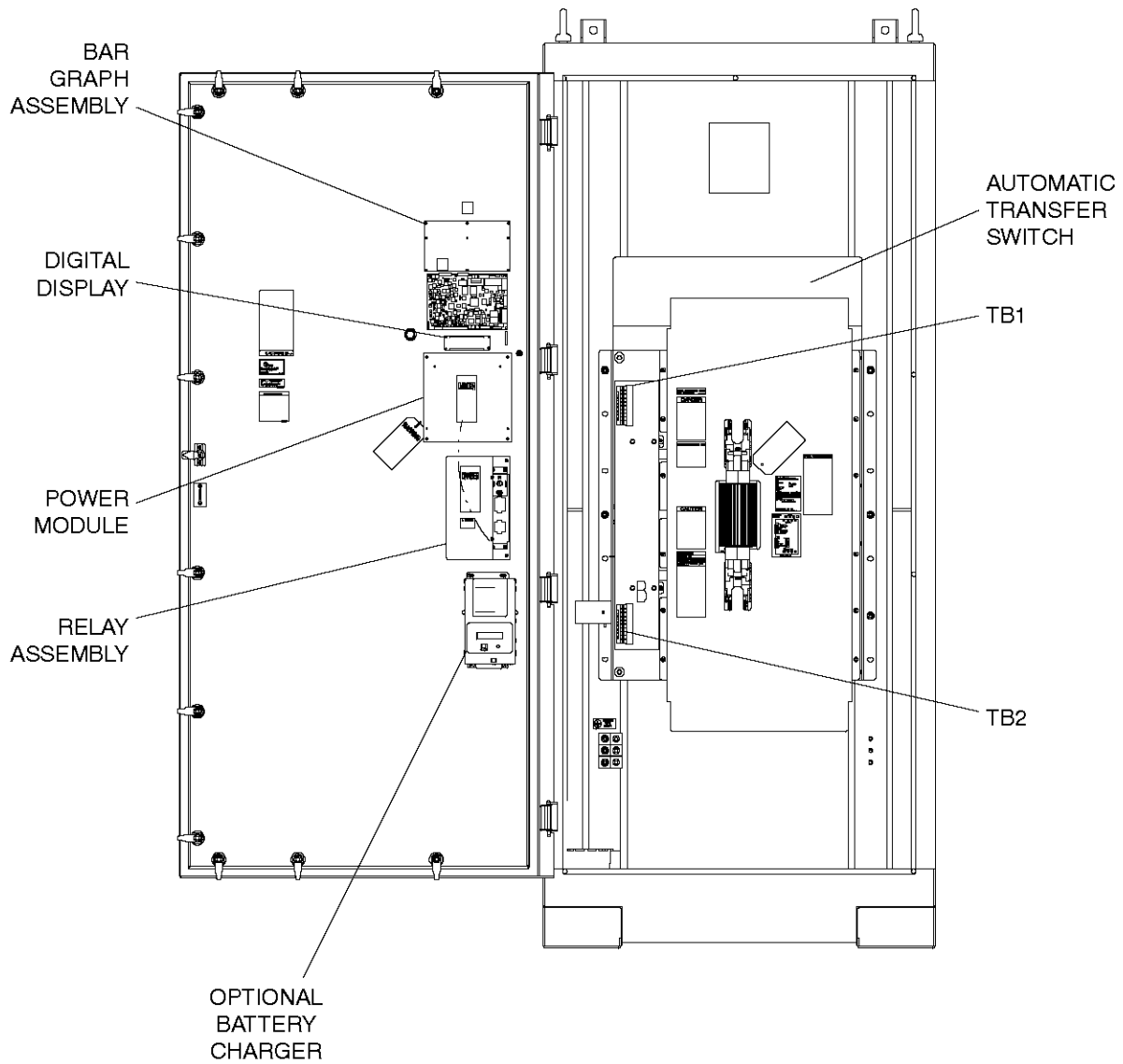




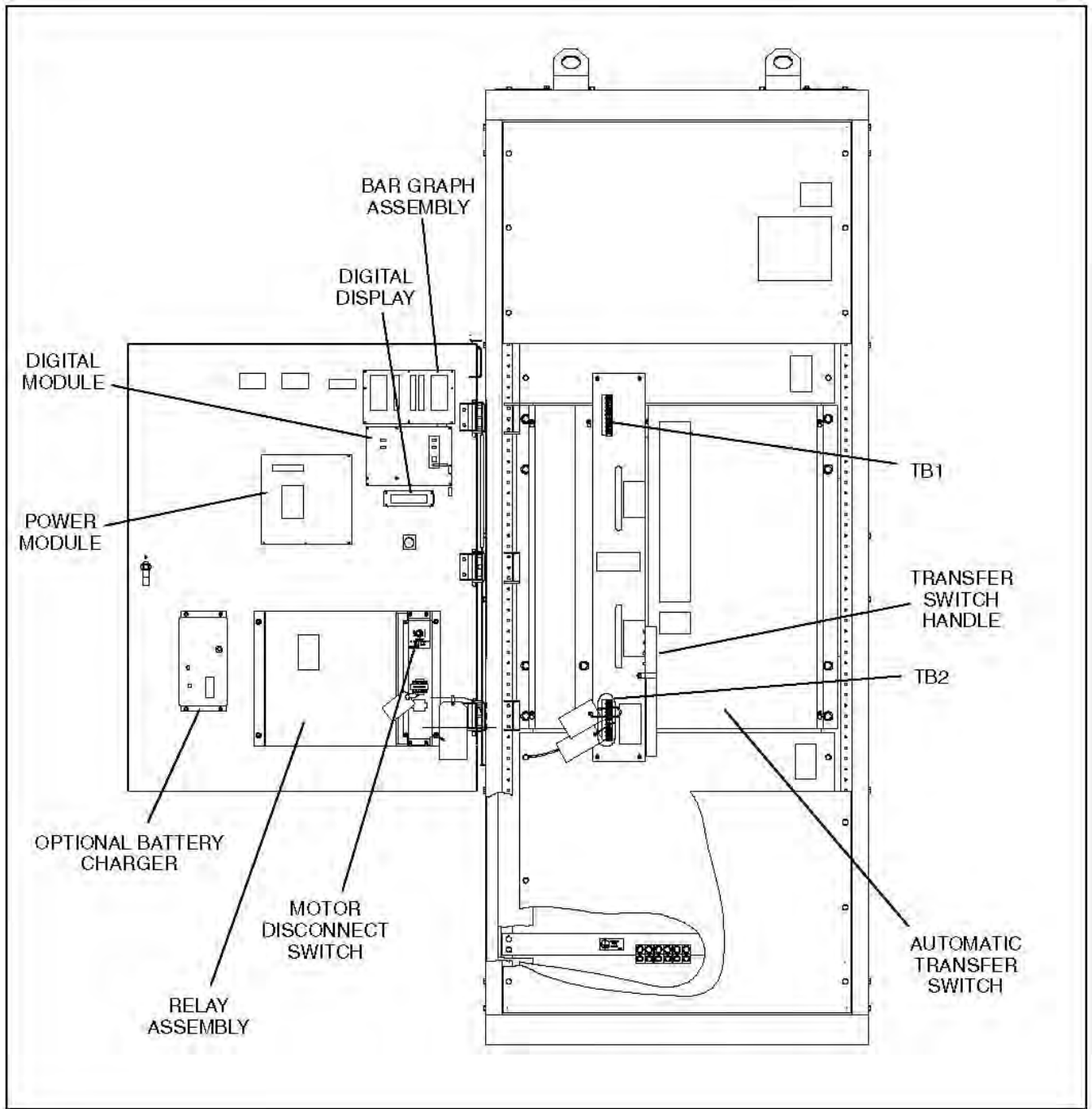
**FIGURE 28. INTERIOR/COMPONENTS: 40-125 AMP SWITCH**



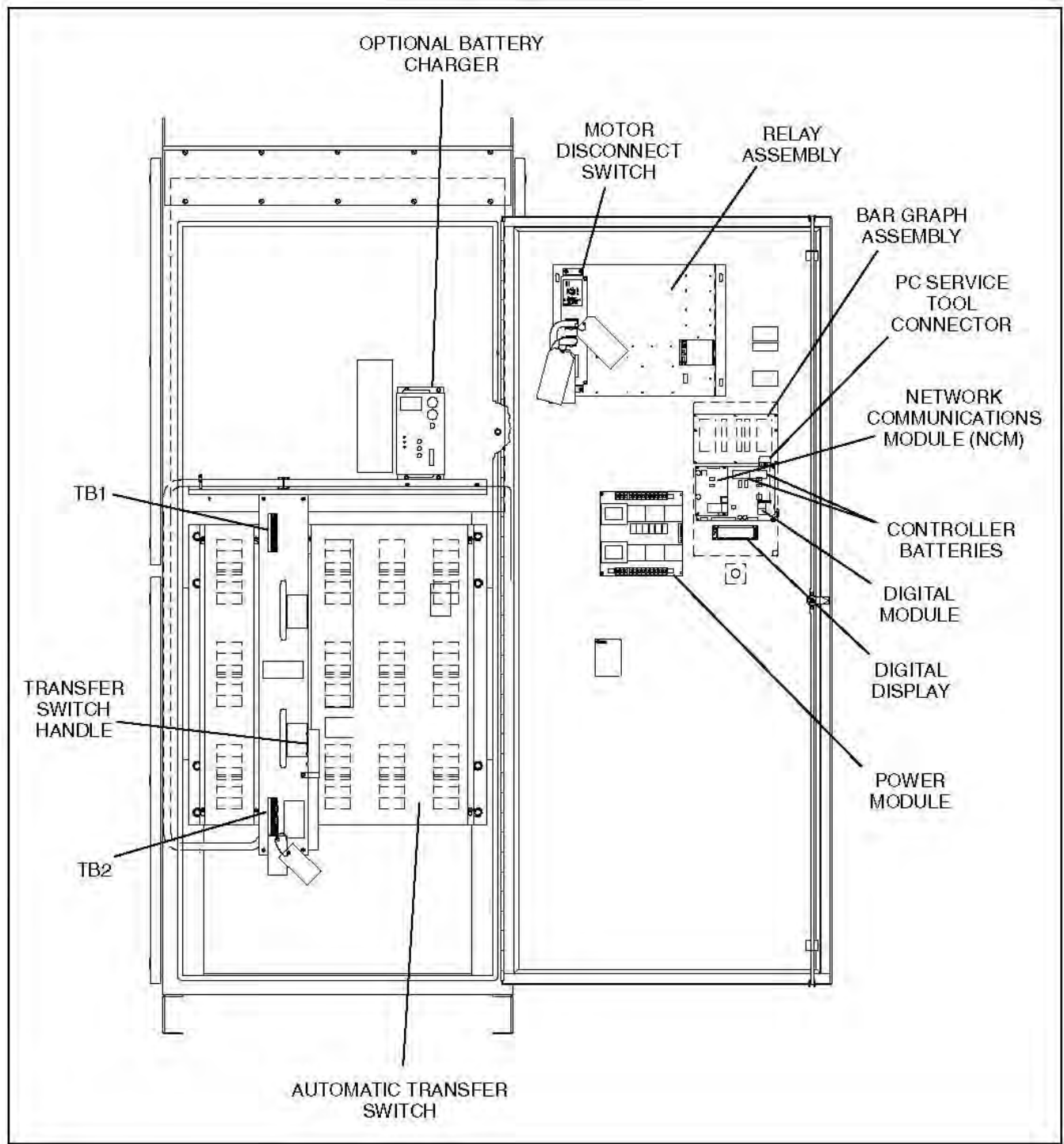
**FIGURE 29. INTERIOR/COMPONENTS: 1200 AMP SWITCH (CLOSED TRANSITION)**



**FIGURE 30. INTERIOR/COMPONENTS: 1200 AMP SWITCH (OPEN AND PROGRAMMED TRANSITION)**



**FIGURE 31. INTERIOR/COMPONENTS: 1600-4000 AMP SWITCH (TYPE 1 CABINET)**



**FIGURE 32. INTERIOR/COMPONENTS: 1600-4000 AMP SWITCH (TYPE 3R CABINET)**

## 4.2 Digital Display Menu

This section describes the Digital Display Menu System and navigation through the menus. The menus display status information, events, and setup menus. Setup menus contain parameters with adjustable values. The descriptions in this section include ranges for the parameters and default values. The Digital Display is an option with Level 1 controls and is standard with Level 2 controls. See [Figure 33](#).

The Digital Display Menu System is a 2-line by 20-character graphical display screen and six buttons. The screen or menu displays status information, parameters, events and messages. The buttons change screens and parameters. Two buttons have names: Home and Previous Menu. These buttons are used for navigation. Messages include navigational indicators for the other four buttons.

### 4.2.1 Main Menu

The main menu system consists of three top-level menus that list vertical menus (or sub-menus). The sub-menus display status information. This information cannot be changed in the main menus. The main menus contain eight sub-menus including the Setup Menu.

### 4.2.2 Setup Menu

To change setup parameters, you must enter a password (574); however, you can bypass the password and examine, but not change (read only), current parameter settings. When parameters are changed in any setup menu, you are prompted to either save the changes or restore the old values.

### 4.2.3 Navigation

Refer to [Figure 83](#) through [Figure 88](#) at the end of this section for an overview of menu navigation. These illustrations can also be used to locate a submenu and determine how to access it.

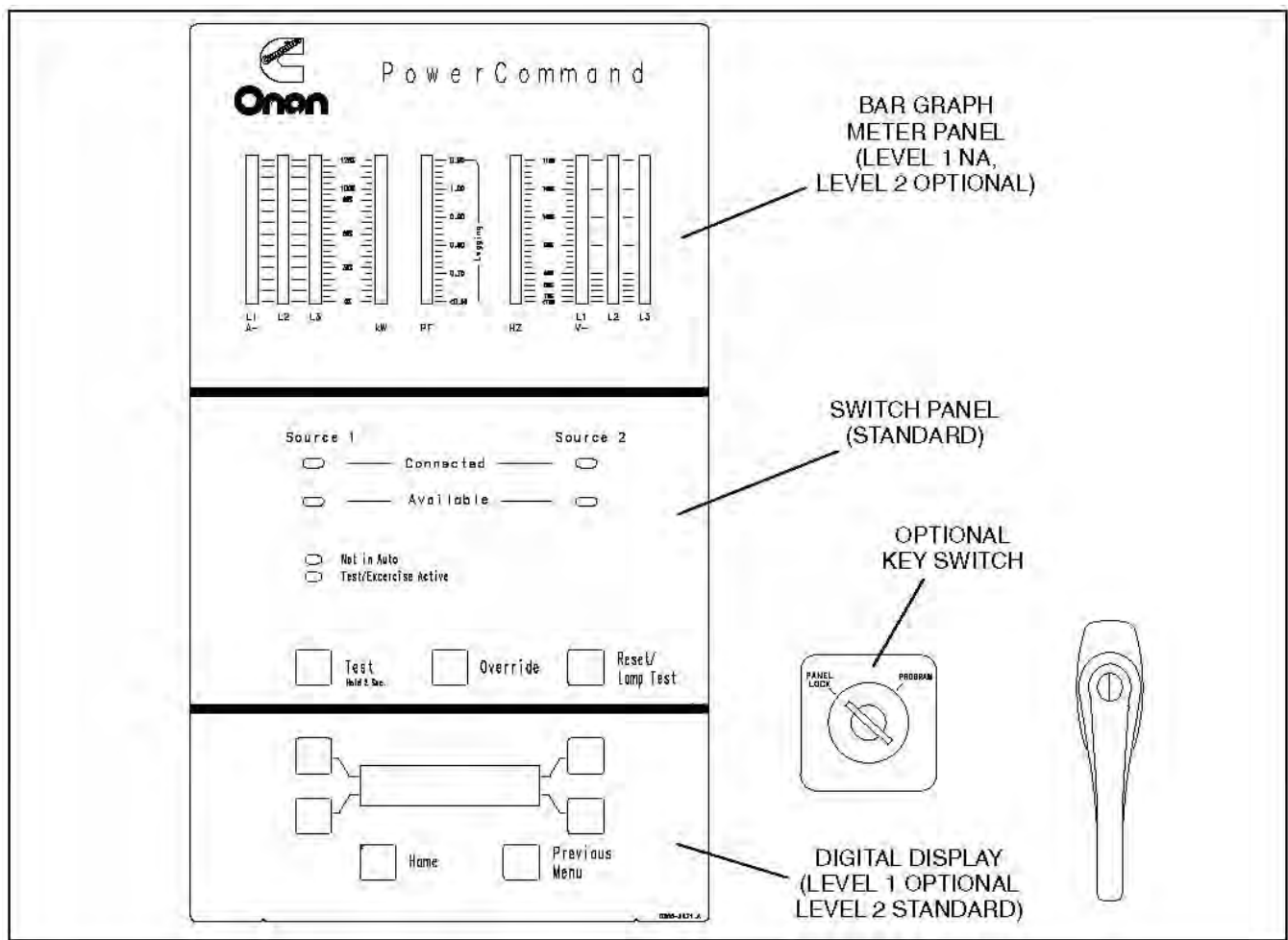
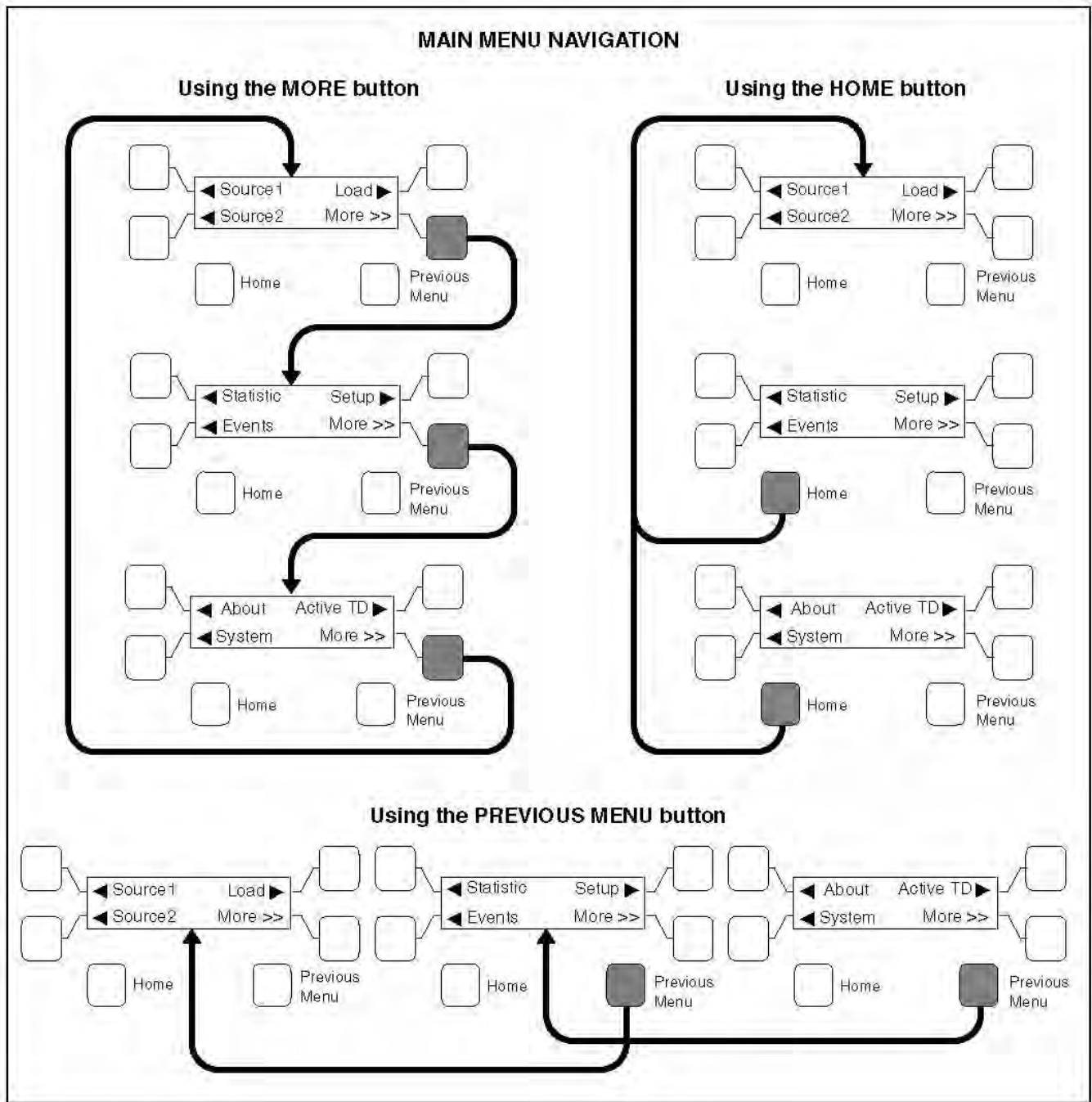


FIGURE 33. CABINET WITH OPTIONS



**FIGURE 34. NAVIGATION**



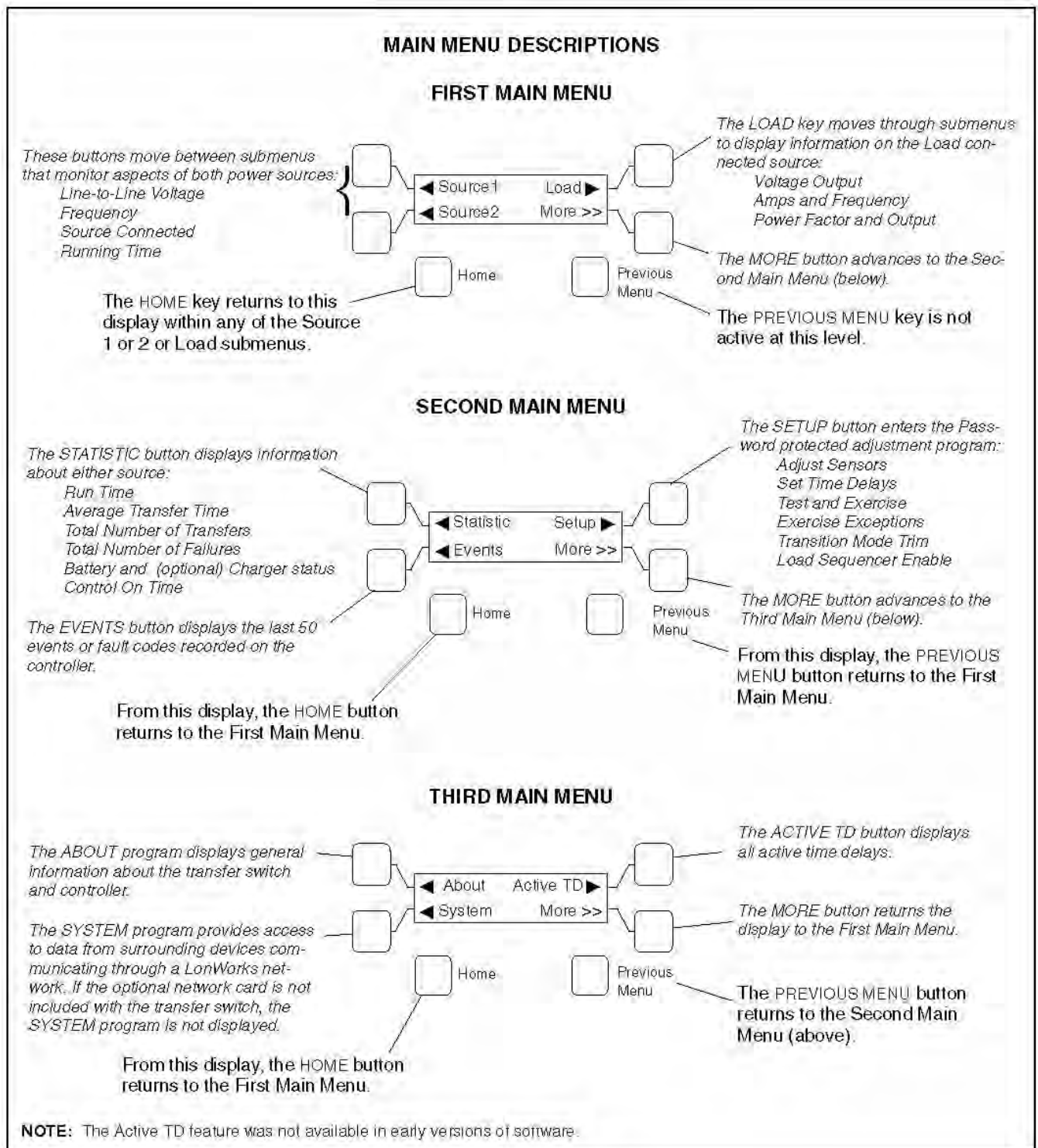
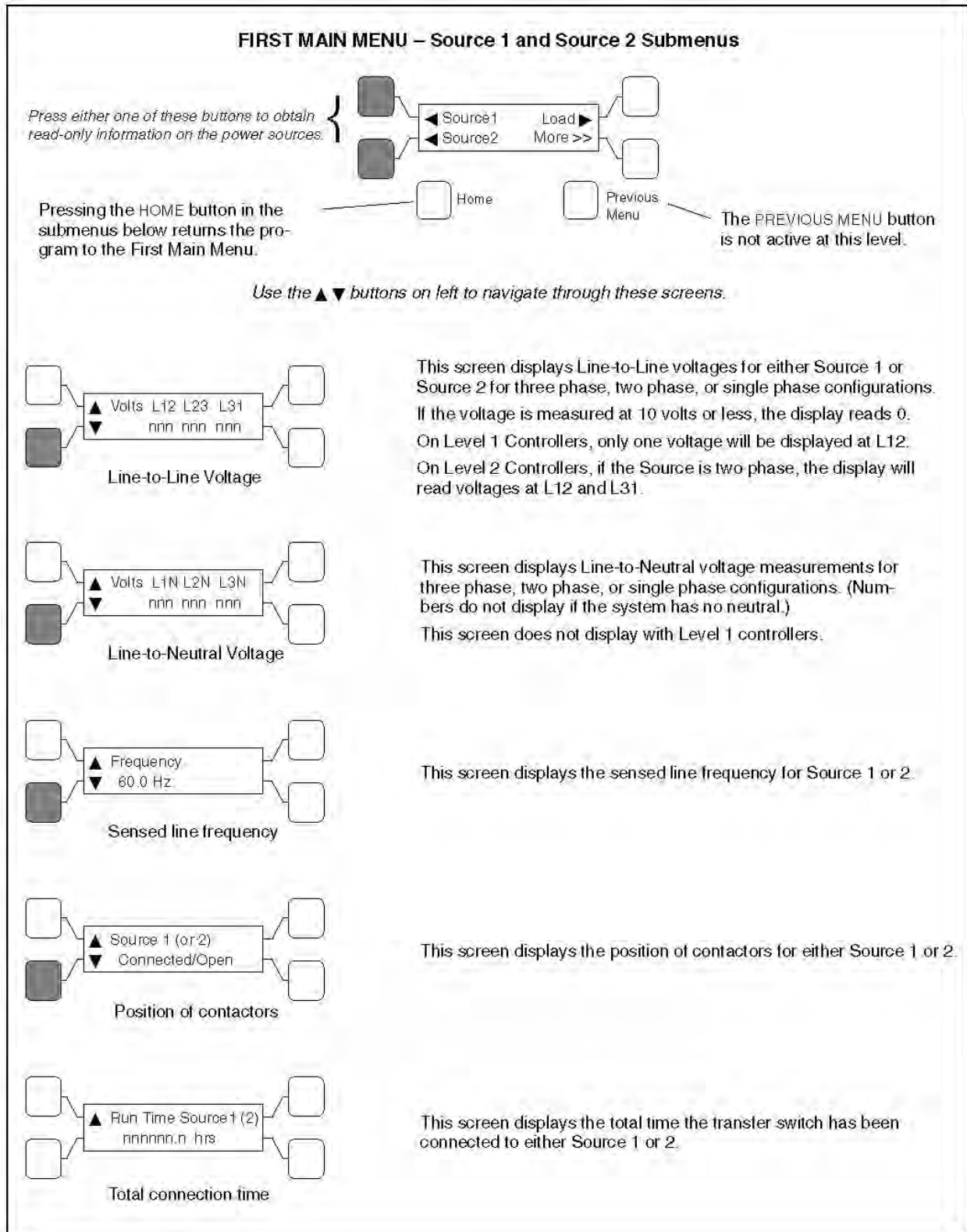
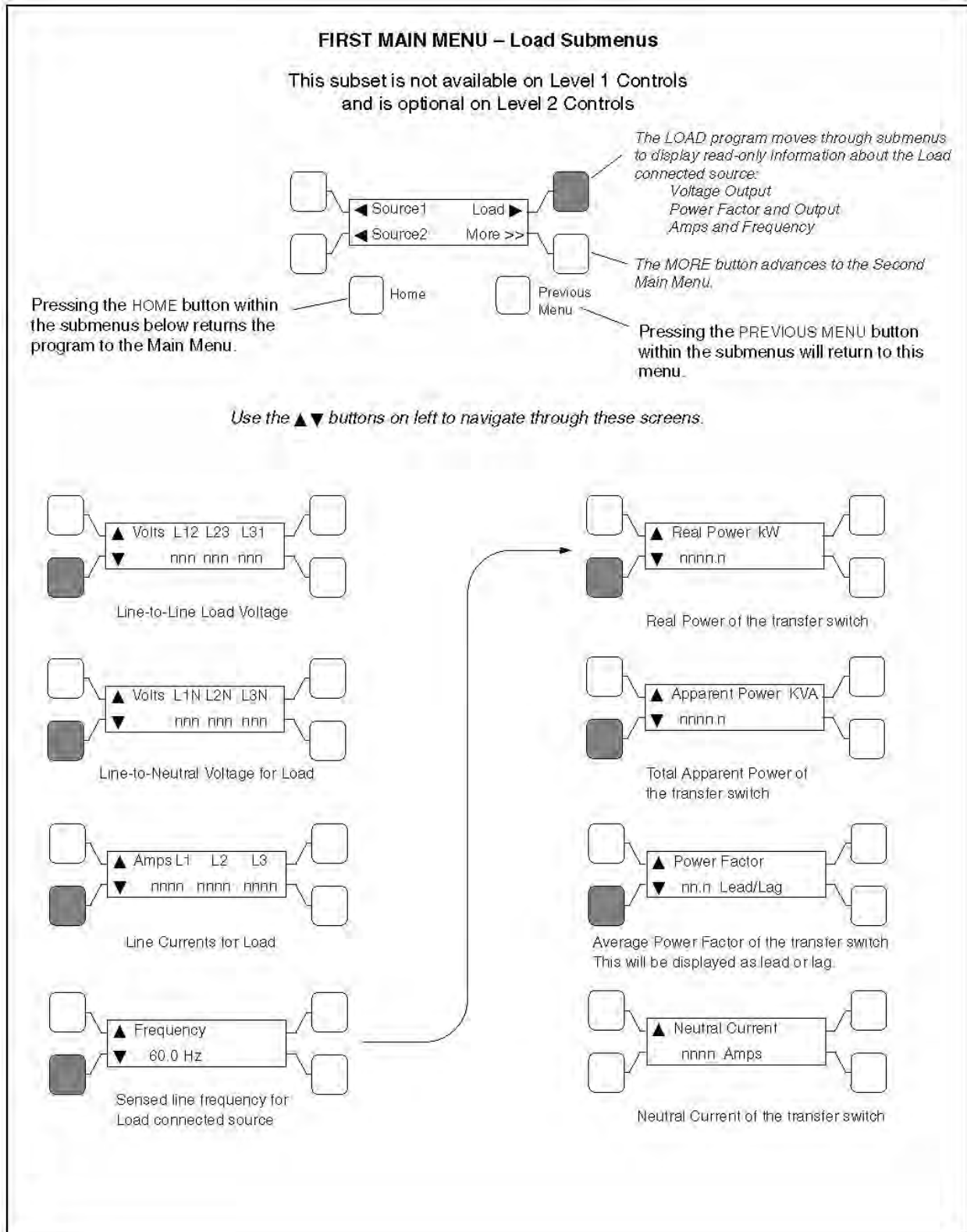


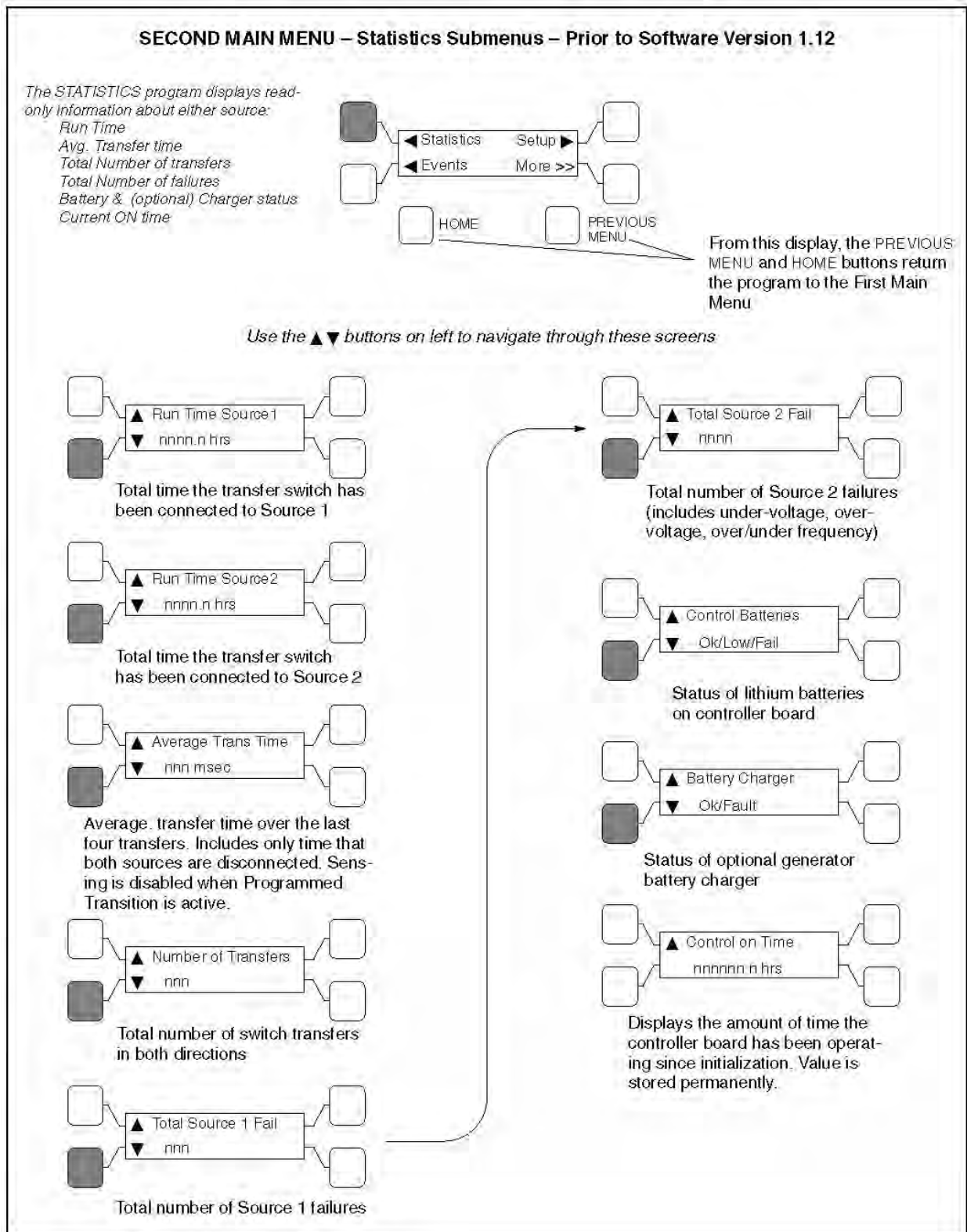
FIGURE 35. MAIN MENUS



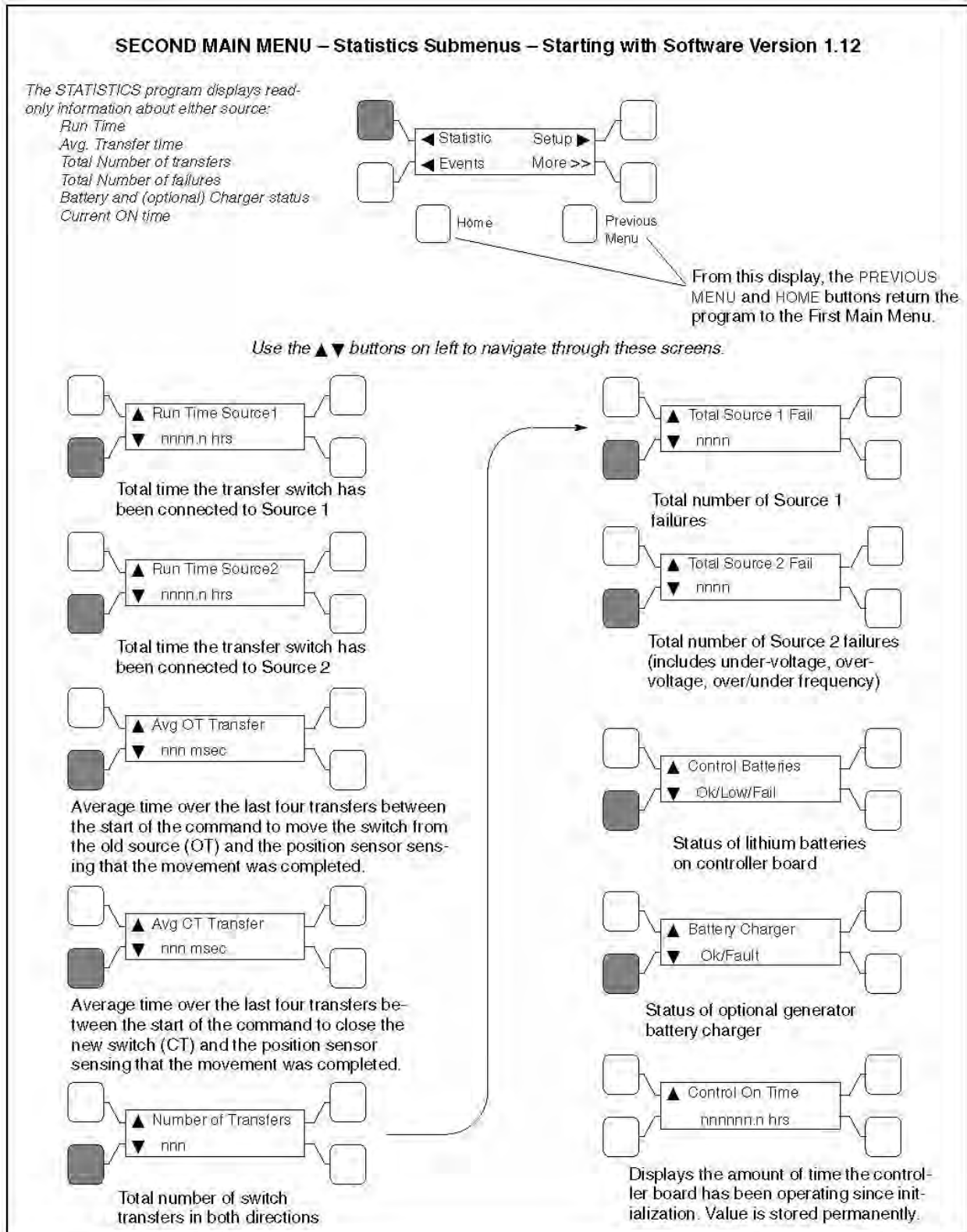
**FIGURE 36. SOURCE 1 AND 2 SUBMENUS**



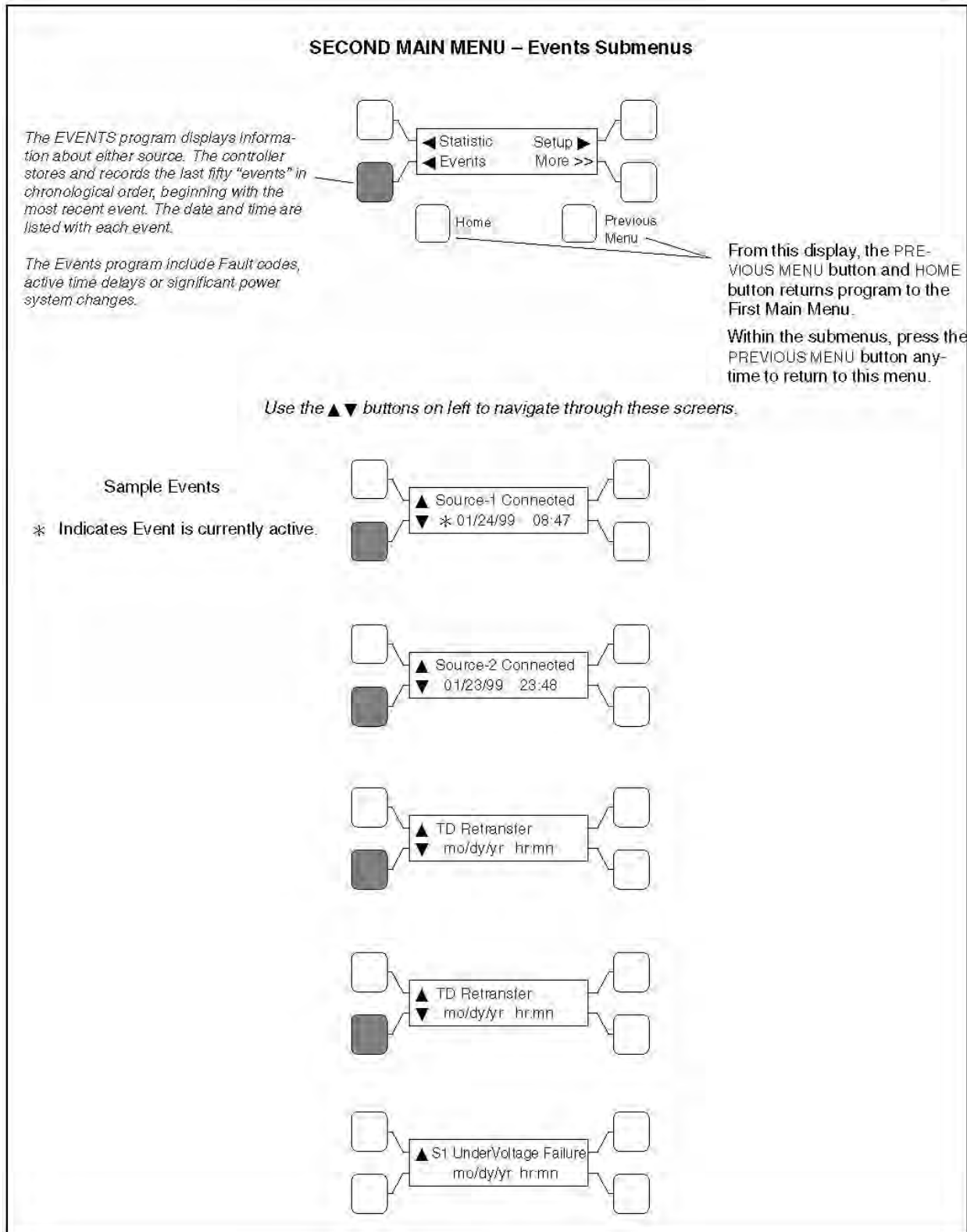
**FIGURE 37. LOAD SUBMENUS**



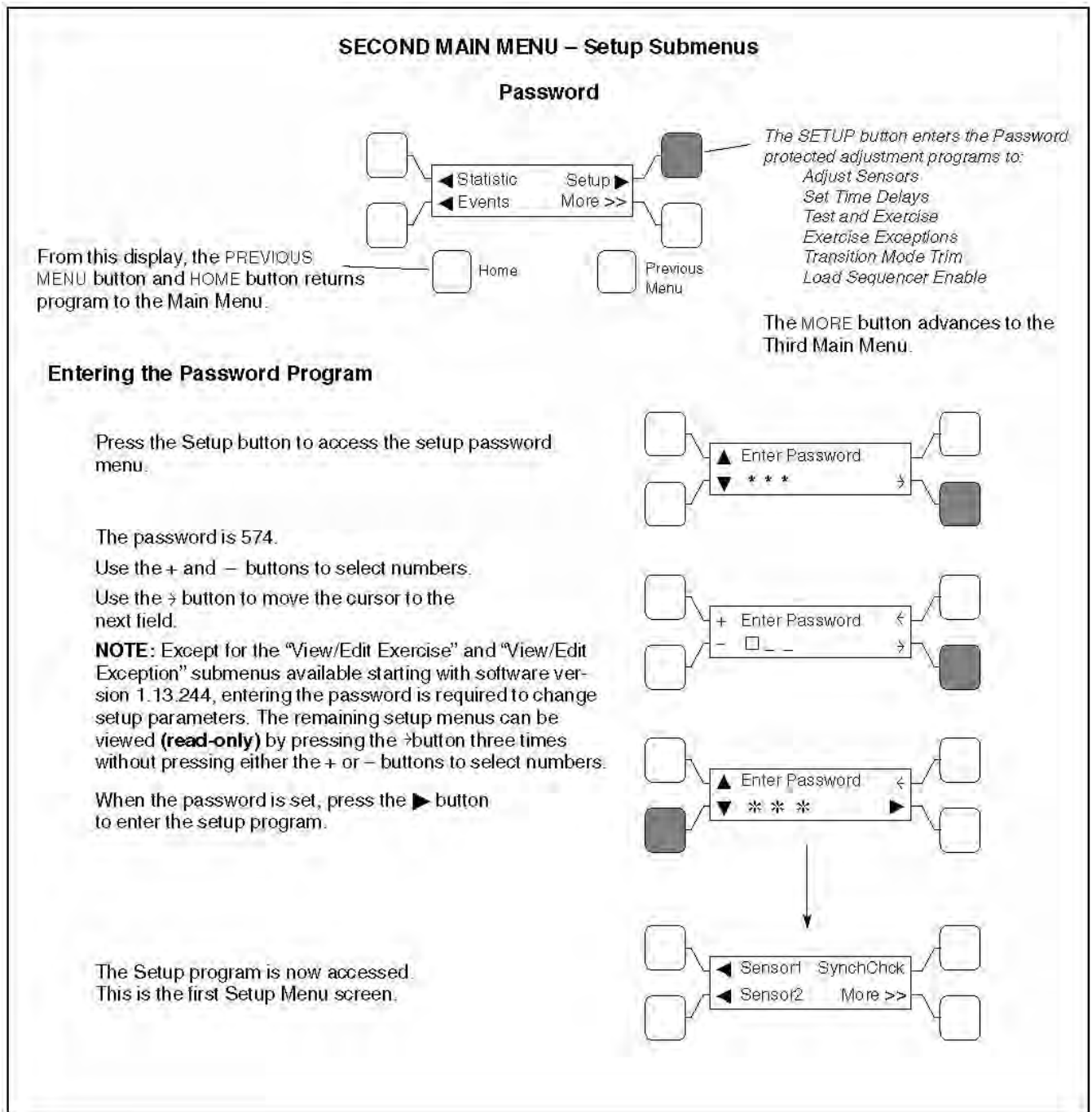
**FIGURE 38. STATISTICS SUBMENUS (PRIOR TO SOFTWARE VERSION 1.12)**



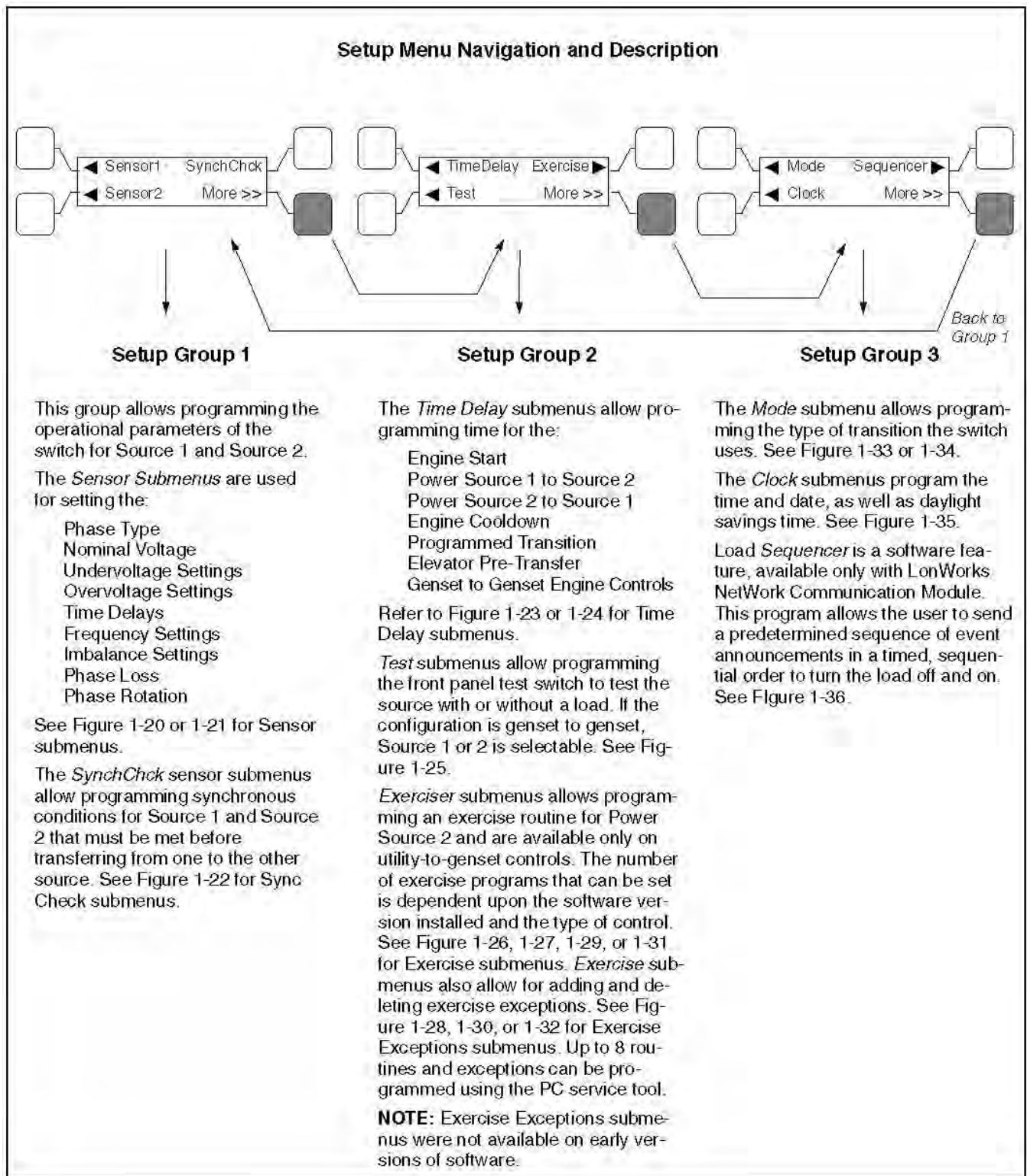
**FIGURE 39. STATISTICS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**



**FIGURE 40. EVENTS SUBMENU**

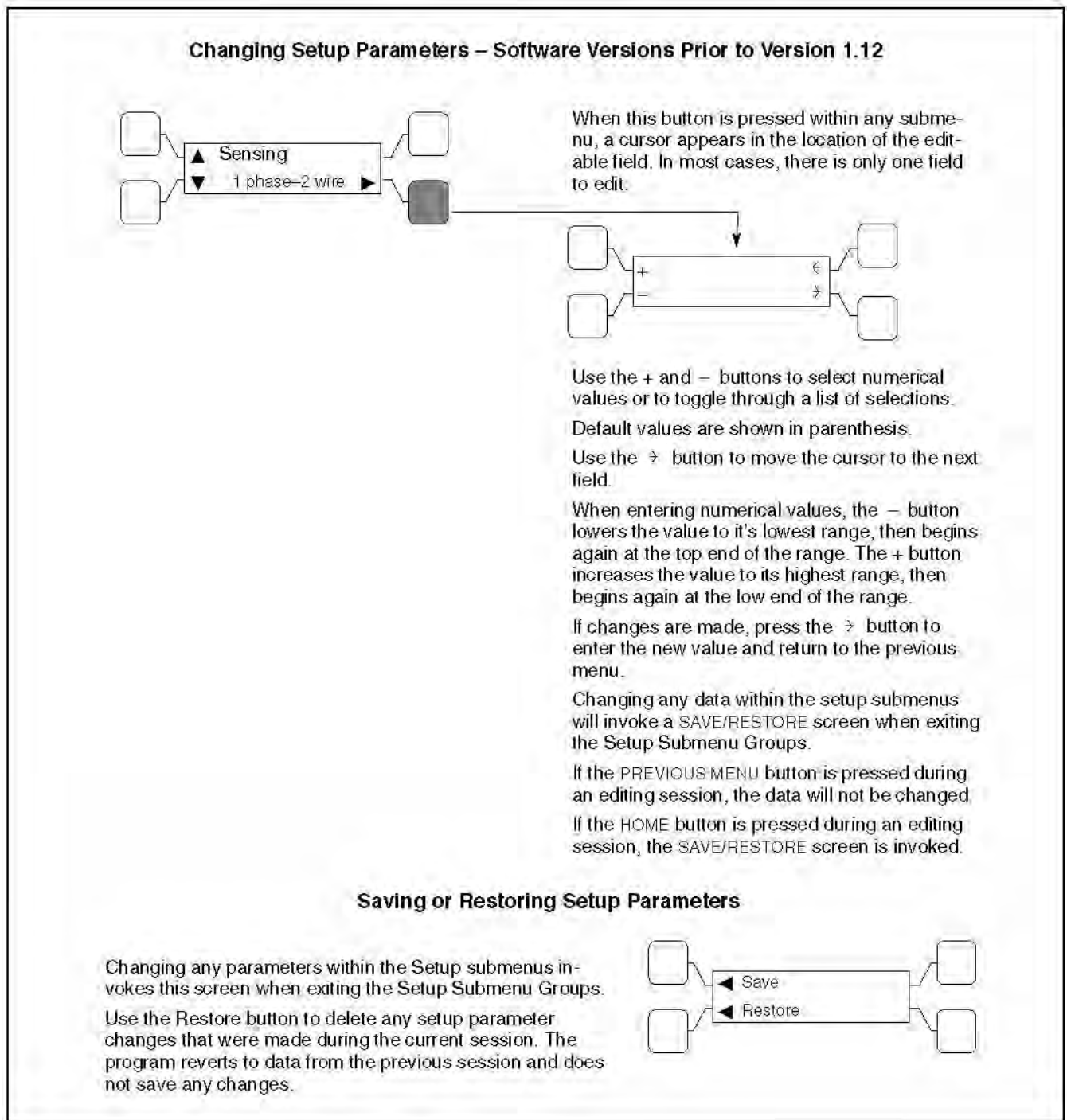


**FIGURE 41. PASSWORD SUBMENUS**

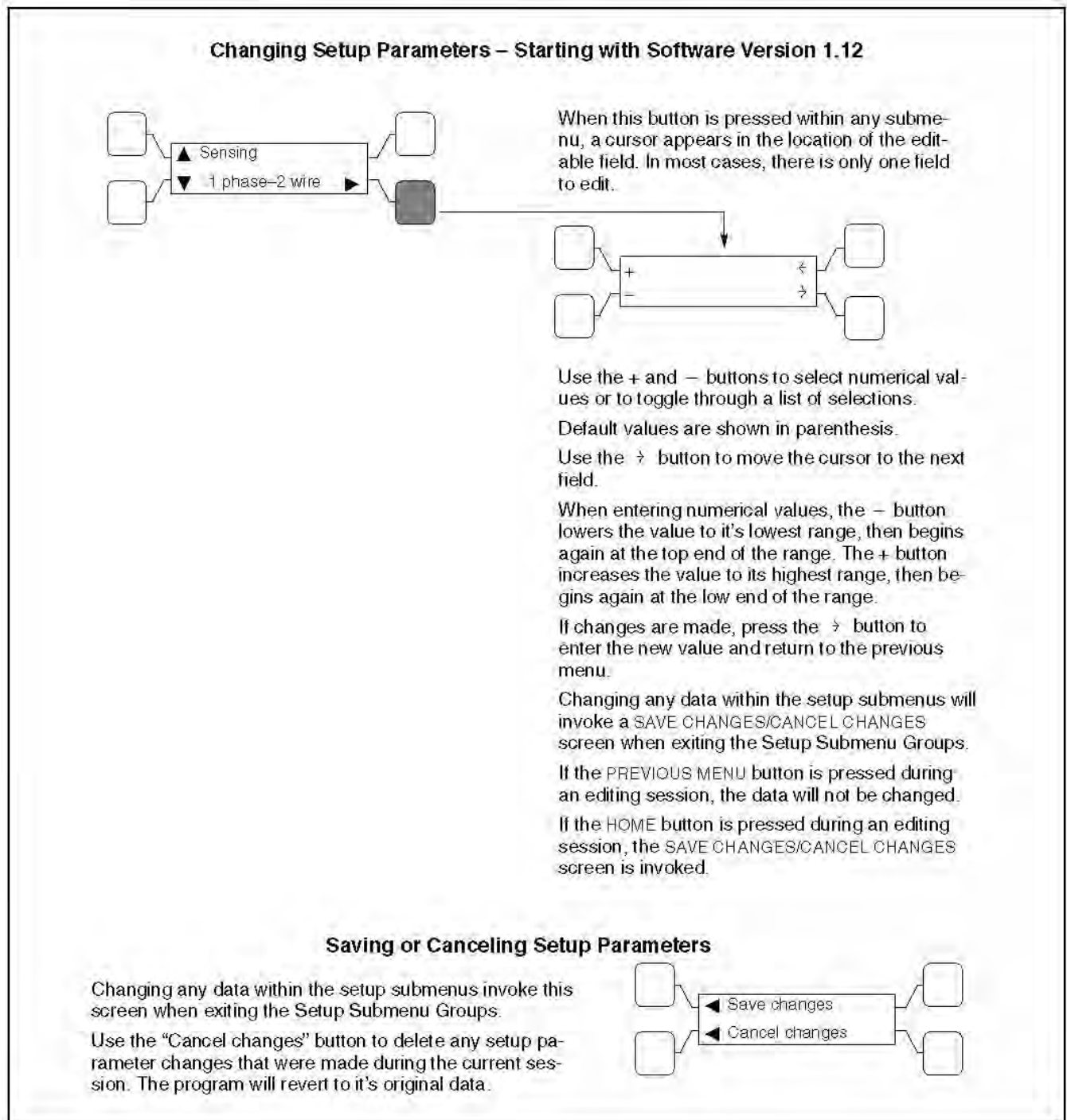


**FIGURE 42. SETUP DESCRIPTION**





**FIGURE 43. CHANGING SETUP PARAMETERS (SOFTWARE VERSIONS PRIOR TO 1.12)**



**FIGURE 44. CHANGING SETUP PARAMETERS (STARTING WITH SOFTWARE VERSION 1.12)**

## 4.3 Voltage and Frequency Sensing

### 4.3.1 Under-Voltage Sensing

All controls include under-voltage sensors for Source 1 and Source 2. When a sensor detects a low voltage condition over a specified time period, it initiates a transfer. When the source voltage returns to an acceptable value again, the sensor initiates a retransfer.

These parameters are adjustable. The under-voltage sensing range for a falling voltage (drop-out) is 75 to 98% of the pick-up voltage setting. The default value is 90%. The pick-up range for a rising voltage is 85 to 100% of the nominal voltage setpoint. The default value is 90%. The adjustable range for the time delay period is 0.1 to 1.0 seconds in 0.1 second increments. The default delay time is 0.5 second. These values are set with the PC service tool or the digital display. See [Figure 45](#) for an example using the default values. Refer to [Figure 48](#) through [Figure 51](#) for information on how to set up those values using the digital display.

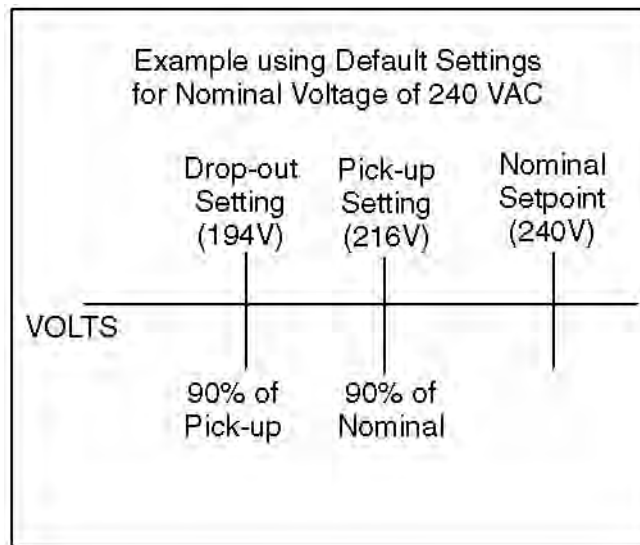
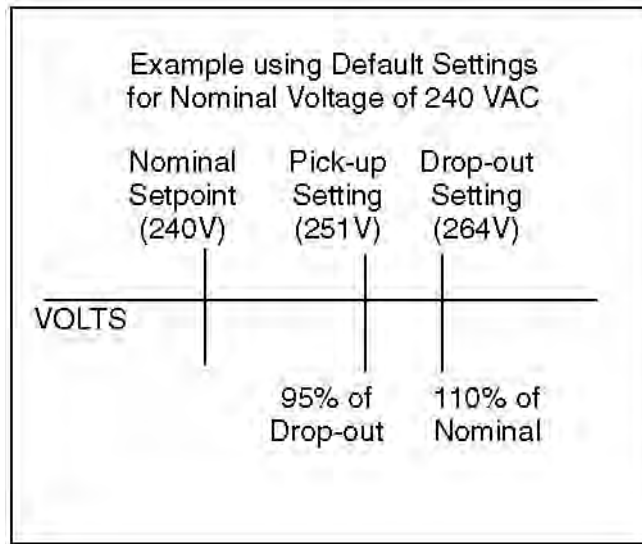


FIGURE 45. UNDER-VOLTAGE SENSING

### 4.3.2 Over-Voltage Sensing

All controls include over-voltage sensors for Source 1 and Source 2 that can be disabled and not used. When a sensor detects a high voltage condition over a specified time period (delay), it initiates a transfer. When the source voltage falls to an acceptable value again, the sensor initiates a retransfer.

These parameters are adjustable. The over-voltage sensing range (drop-out) for a rising voltage is 105 to 135% of the nominal voltage setpoint. The default value is 110%. The pick-up range for a falling voltage is 95 to 100% of the drop-out setting. The default value is 95%. The adjustable range for the delay time period is 0.5 to 120.0 seconds in 1 second intervals. The default delay time is 3.0 seconds. The over-voltage sensing feature is enabled by default. These values are set with the PC service tool or the digital display. See [Figure 46](#) for an example using the default values. Refer to [Figure 48](#) through [Figure 51](#) for information on how to set up those values using the digital display.

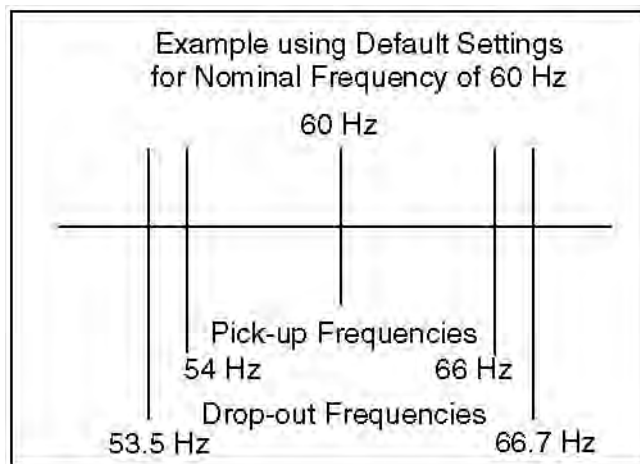


**FIGURE 46. OVER-VOLTAGE SENSING**

### 4.3.3 Frequency Sensing

All controls include frequency sensors for Source 1 and Source 2 that can be disabled and not used. When a sensor detects a high or low frequency condition over a specified delay time period, it initiates a transfer. When the frequency returns to an acceptable value again, the sensor initiates a retransfer.

These parameters are adjustable. The nominal frequency can be set between 45.0 and 60.0 Hz in 0.1 Hz increments. The default frequency is 60 Hz. The acceptable frequency bandwidth (pick-up) is  $\pm 5$  to  $\pm 20\%$  of the nominal frequency setpoint. The default value is 10%. The drop-out frequency is 1 to 5% beyond the pick-up. The default value is 1%. The range for the delay time period is 0.1 to 15 seconds. The default delay time is 1.0 second. The frequency sensing feature is enabled by default. These values are set with PC service tool or the digital display. See [Figure 47](#) for an example using the default values. Refer to [Figure 48](#) or [Figure 51](#) for information on how to set up those values using the digital display.



**FIGURE 47. FREQUENCY SETTING**

### 4.3.4 Voltage Imbalance Sensing

Three phase Level 2 controllers include a voltage imbalance sensor for both Source 1 and Source 2. This feature informs the operator when there is significant voltage imbalance between the phases of Source 1 or Source 2. This feature is used for equipment protection.

A voltage imbalance is typically caused by severe single phase loading. The sensor indicates a failure when the maximum deviation from the average voltage is greater than a user-specified value between 2 and 10 % (drop-out) of the average voltage in 1% increments. The pickup value is fixed at 10% of the drop-out. The time delay for the imbalance sensor drop-out is adjustable (2-20 seconds).

This sensor can be enabled using the PC service tool or the digital display Setup submenus. This sensor is inactive for single phase systems and indicates no failures. To prevent nuisance faults, the setting can be increased up to 10 % of the nominal voltage. Refer to [Figure 48](#) or [Figure 51](#) for information on how to set up those values using the digital display.

### 4.3.5 Phase Rotation Sensing

Three phase Level 2 controllers include a phase rotation sensor. This feature monitors the phase rotation of the source opposite from the connected source. When the alternate source is out of phase rotation with the connected source, transfer is inhibited. This generally occurs on new installations or after storm damage or generator rewiring. This feature protects against equipment damage by preventing transfer to a source that is out of phase. This feature is required in fire pump applications.

#### CAUTION

***Level 1 controls do not support three-phase sensing on Source 2. Do not select the three-phase option for the Source 2 Sensing adjustment with Level 1 controls, even if the system is three phase. This setting will prevent Source 2 from becoming available.***

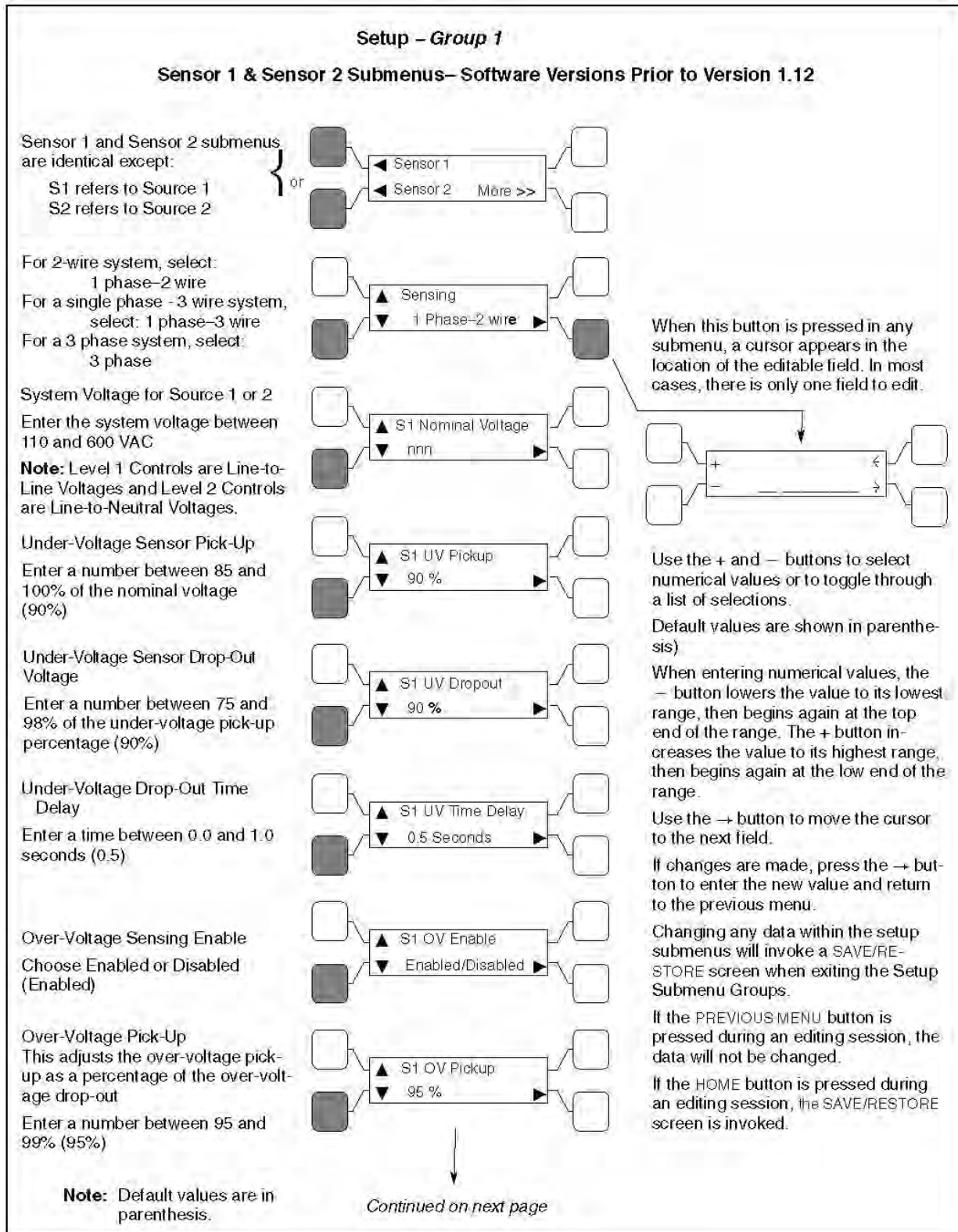
Both voltage sources have to be applied in order to check phase rotation. Generally, a power source may become out of phase rotation in new installations, after a storm, or when there is generator rewiring.

This feature is enabled by default. To disable it, see [Figure 48](#) or [Figure 48](#).

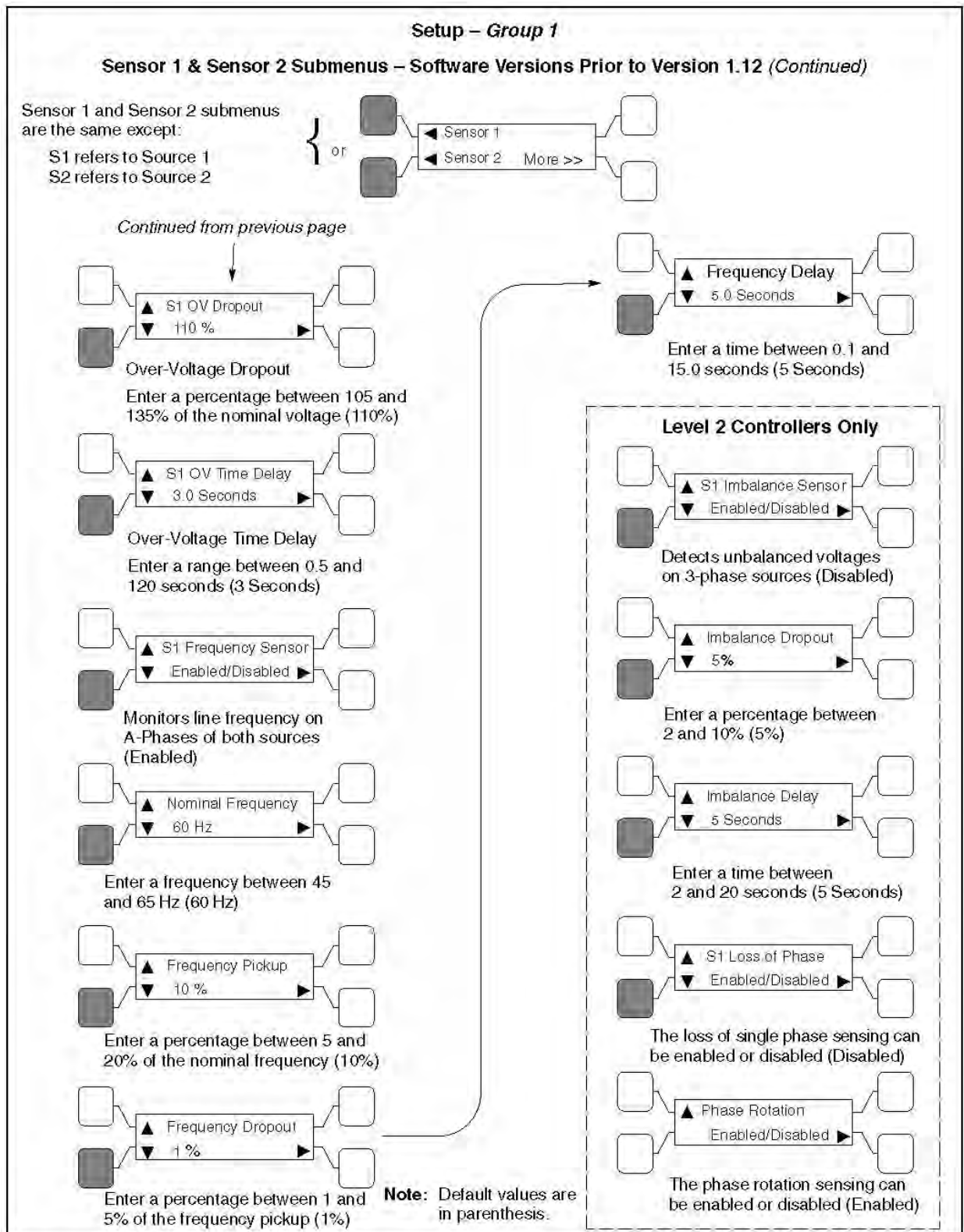
### 4.3.6 Loss of Single Phase Sensing

Three phase Level 2 controllers include a loss of single phase sensor. This feature initiates a transfer from a source that has lost a single phase and prevents a transfer to a source that has lost a single phase. This is generally caused by a single phase to line ground or open. The controller indicates a fault when the relative phase angle between any line-to-line phase angle drops to less than 90°. This feature is mainly used to protect three phase devices, such as motors.

To enable this sensor, see [Figure 48](#) or [Figure 50](#). This sensor is inactive for single phase systems and indicates no failures.

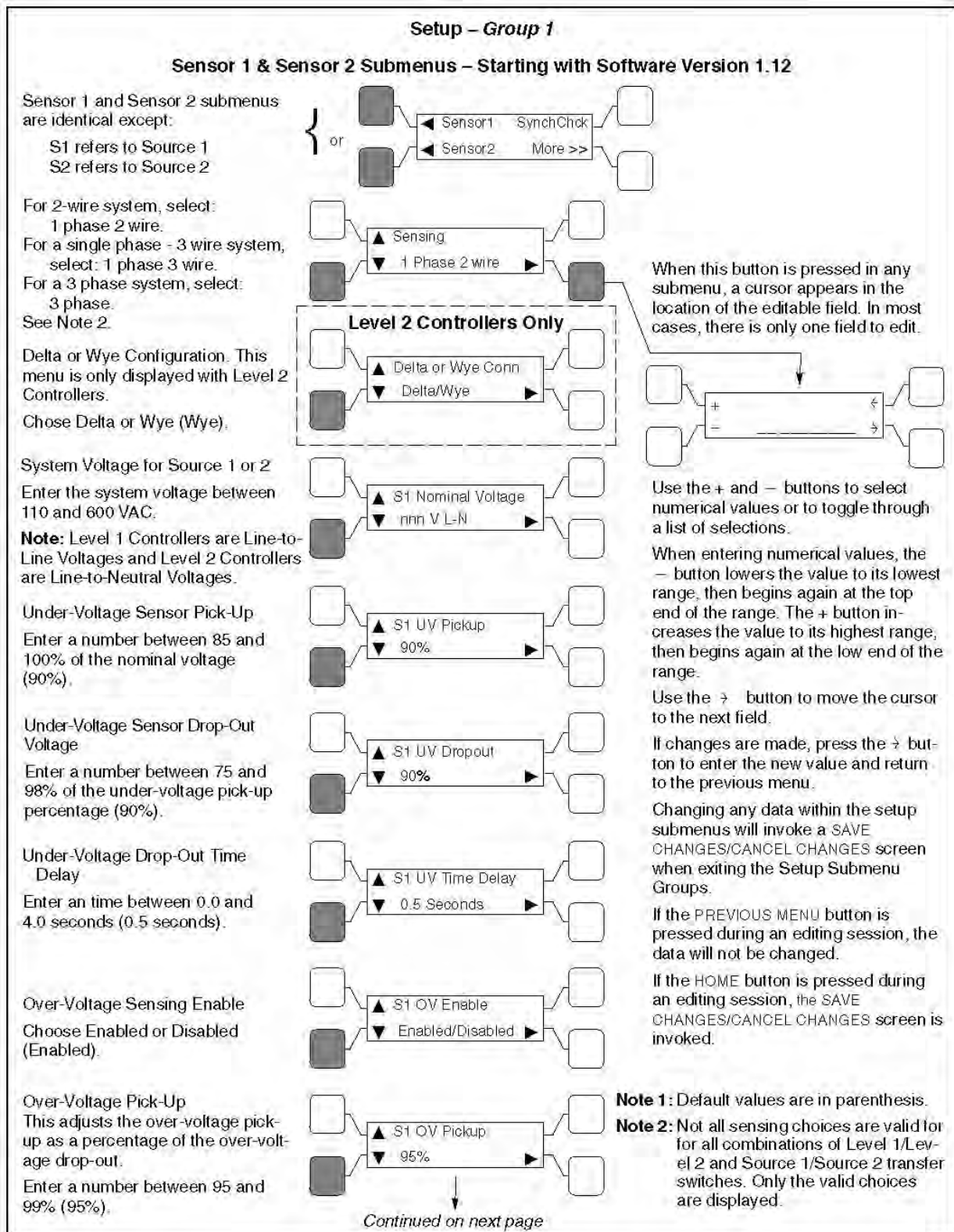


**FIGURE 48. SETUP GROUP 1 - SENSOR SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.12)**



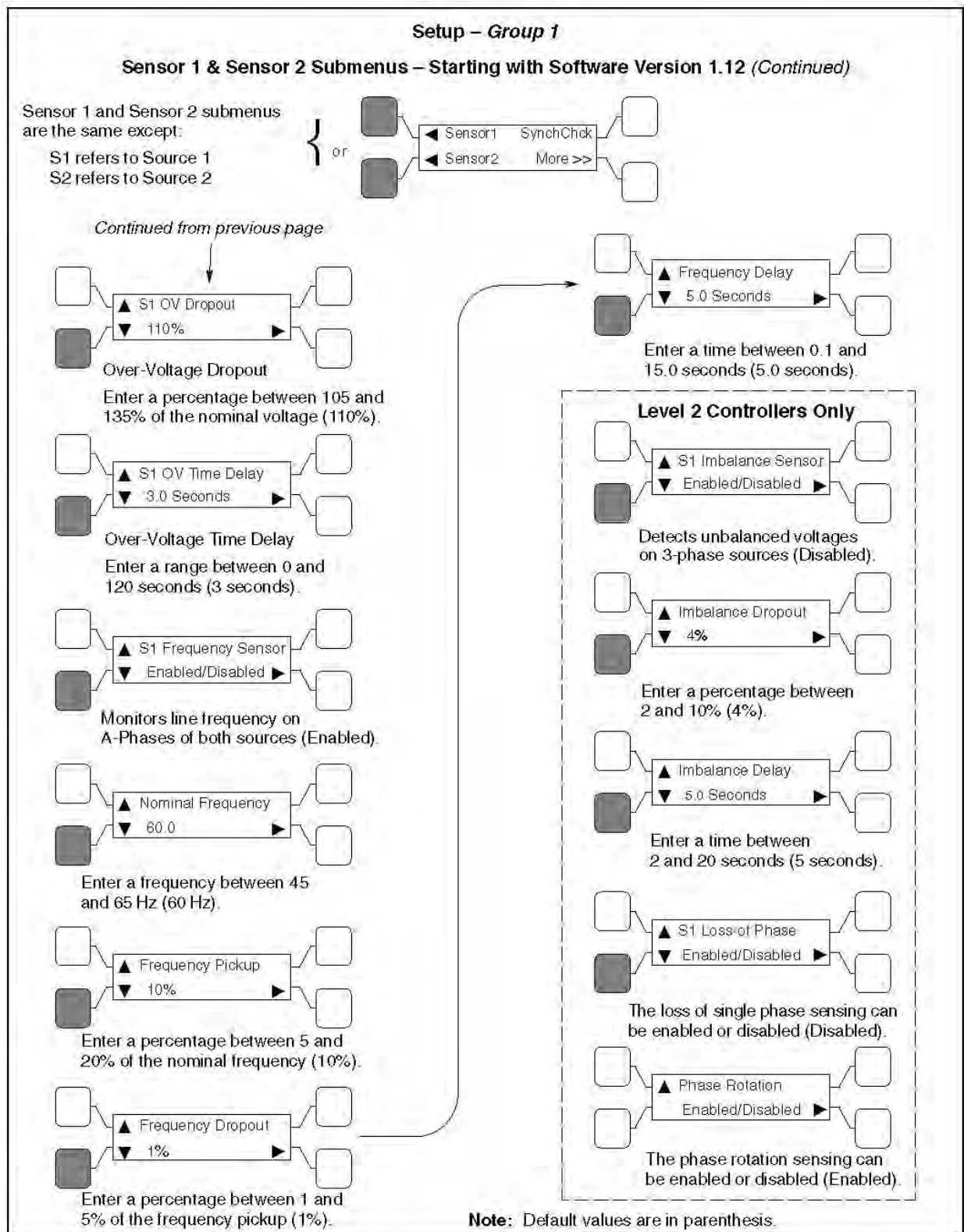
**FIGURE 49. SETUP GROUP 1 - SENSOR SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.12) (CONTINUED)**





**FIGURE 50. SETUP GROUP 1 - SENSOR SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**





**FIGURE 51. SETUP GROUP 1 - SENSOR SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12) (CONTINUED)**

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## 4.4 Sync Check Sensor

If enabled, the Sync Check sensor overrides programmed transition whenever transferring between two live sources. If only one power source is available, programmed transition overrides the Sync Check sensor.

The Sync Check sensor is disabled on BTPC transfer switches. The transfer switch mode setting can be changed with the InPower service tool or with the digital display (see [Figure 52](#)) when it is available.

Sync Check is used to determine when both sources of power are within specified tolerances of frequency, voltage, and relative phase difference. If both sources are within this range, a fast transfer occurs.

Synchronicity parameters are adjustable. The frequency bandwidth range is from 0.1 and 1.0 Hz. The default value is 1.0 Hz. The frequency difference between the sources must be equal to or less than the set value in order for transfer to occur. The voltage window is from 5 and 25 volts. The default value is 10 volts. The average voltage difference between the two sources must be equal to or less than the set value in order for transfer to occur. The manual offset range is from -25 to +25 milliseconds. The default value is 0 milliseconds. The transfer switch controller measures non-programmed transition transfer times from one source to another. It takes into account relay coils and solenoids energizing. These values can be set with the InPower service tool or with the digital display (see [Figure 52](#)) when it is available.

Another feature included with controls that have a Sync Check sensor is the Return to Programmed Transition. If the two sources fail to synchronize within two minutes, a Failed to Synchronize event occurs and the ATS will not transfer. However, if the Return to Programmed Transition feature is enabled, the control reverts the ATS to the programmed transition mode and executes an open transition. This feature is enabled by default and can be changed with the InPower service tool or with the digital display (see [Figure 52](#)) when it is available.

### 4.4.1 Active Sync Feature

When the transfer switch is configured to transfer in closed transition mode it is recommended to use the active sync feature. When the active sync feature is enabled,

the transfer switch control can send a Sync Enable command to the genset to synchronize with the utility. This command is activated just before the Sync Check sensor is activated. When the genset control receives a Sync Enable command and detects the Source 1 bus voltages, the genset control automatically synchronizes its speed and phase to match the Source 1 bus. The Sync Check sensor monitors both sources. When they are synchronized, a transfer or retransfer command is initiated.

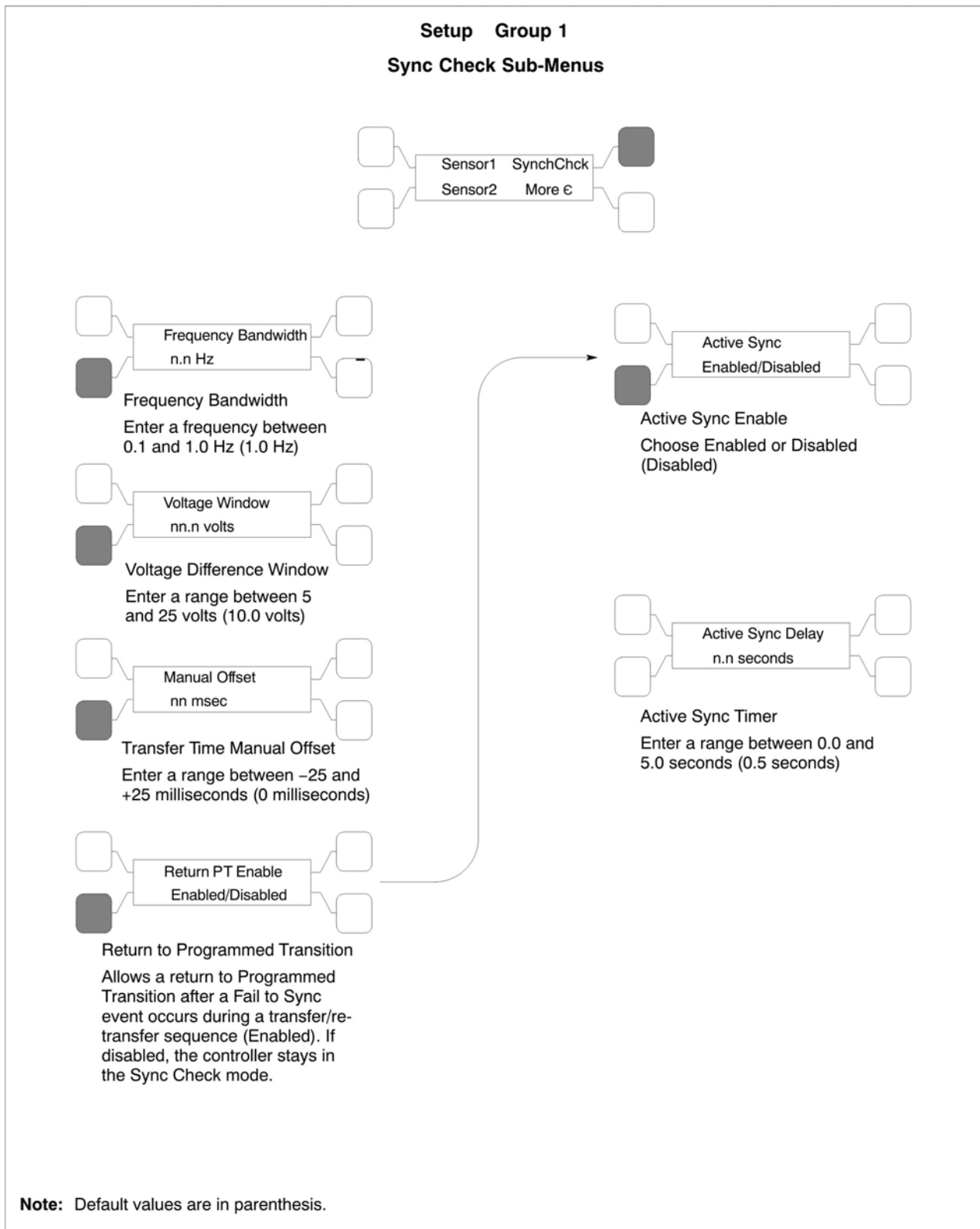
To use the Active Sync feature, it must first be enabled. The Active Sync feature can be enabled with the InPower service tool or the digital display (see the Active Sync sub-menu in [Figure 52](#)).

When the Active Sync feature is enabled, the control runs an Active Sync Time Delay (if greater than 0) and sends the Sync Enable command to the genset. The Active Sync Time Delay is used to check the stability of the system before transferring to the other source. The two sources must remain synchronized for this period of time period before a transfer command is given. The Active Sync Time Delay is adjustable from 0 to 5 seconds in 0.1 second increments (default = 0.5 seconds). The Active Sync Delay timer can be set with the InPower service tool or the digital display (see [Figure 52](#)). The active sync feature may be used with a non-paralleling genset control as well as a paralleling control. A non-paralleling genset control will not

synchronize the genset to the utility but enabling the active sync feature will impose the active sync time delay so that the two source must remain synchronized for the set time period maximizing the reliability of the transfer. When using a non-paralleling genset with this feature it is recommended to set the generator set frequency to 0.1 Hz higher than the utility to make sure that the generator set will come into sync with the utility.

#### 4.4.2 Speed Adjust

If a PowerCommand transfer switch and a non-paralleling genset are networked together, the transfer switch control can send a Speed Adjust command to the genset to increase its speed just enough to increase its frequency by 0.5 Hz. The command is activated just before the Sync Check sensor is activated. It is used when the genset takes a long time to drift in sync with the utility. This increases the number of "in-phase" opportunities to satisfy the Sync Check sensor. Speed Adjust is always enabled unless the Active Sync is enabled. **The genset must be capable of reacting to a Speed Adjust command. This feature is only available if a PowerCommand network is installed.**



**FIGURE 52. SYNC CHECK SUBMENUS (STARTING WITH SOFTWARE VERSION 1.20.250)**

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## **4.5 POWER COMMAND TIME DELAYS**

### **4.5.1 Start Time Delay (TDES, TDES-A, and TDES-B)**

This delay is adjustable from 0 to 15 seconds in 1 second increments on Level 1 controls and from 0 to 120 seconds in 1 second increments on Level-2 controls. The default value is 3 seconds for both. This brief time delay prevents generator set starting during short power interruptions. Timing starts the moment of Source 1 power interruption. If the duration of interruption exceeds the delay time, the control system signals the generator set to start. The value is set with PC service tool or the digital display.

For genset-to-genset applications, TDES-A is the start time delay to start Power Source 2 genset and TDES-B is the start time delay to start Source 1 genset.

### **4.5.2 Stop Time Delay (TDEC, TDEC-A, and TDEC-B)**

This delay is adjustable from 0 to 30 minutes in 1 minute increments. The default value is 10 minutes. It begins timing when the load is retransferred to Source 1. At the end of the delay, the stop signal is sent to the generator set. During this time delay, the generator set cools down at no load before stopping. The value is set with PC service tool or the digital display.

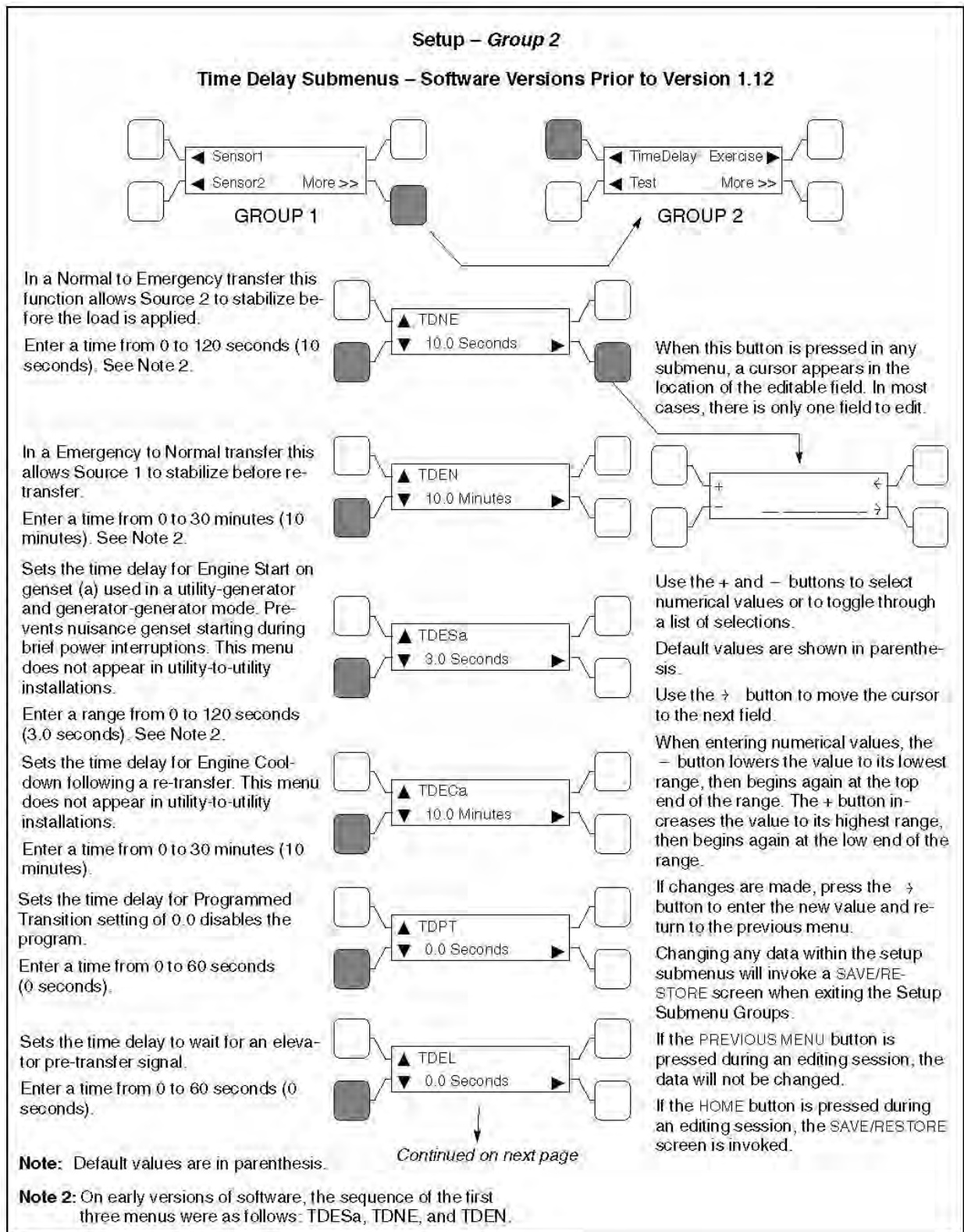
For genset-to-genset applications, TDEC-A is the stop time delay to stop Power Source 2 genset and TDEC-B is the stop time delay to stop Source 1 genset.

### **4.5.3 Transfer Time Delay (TDNE)**

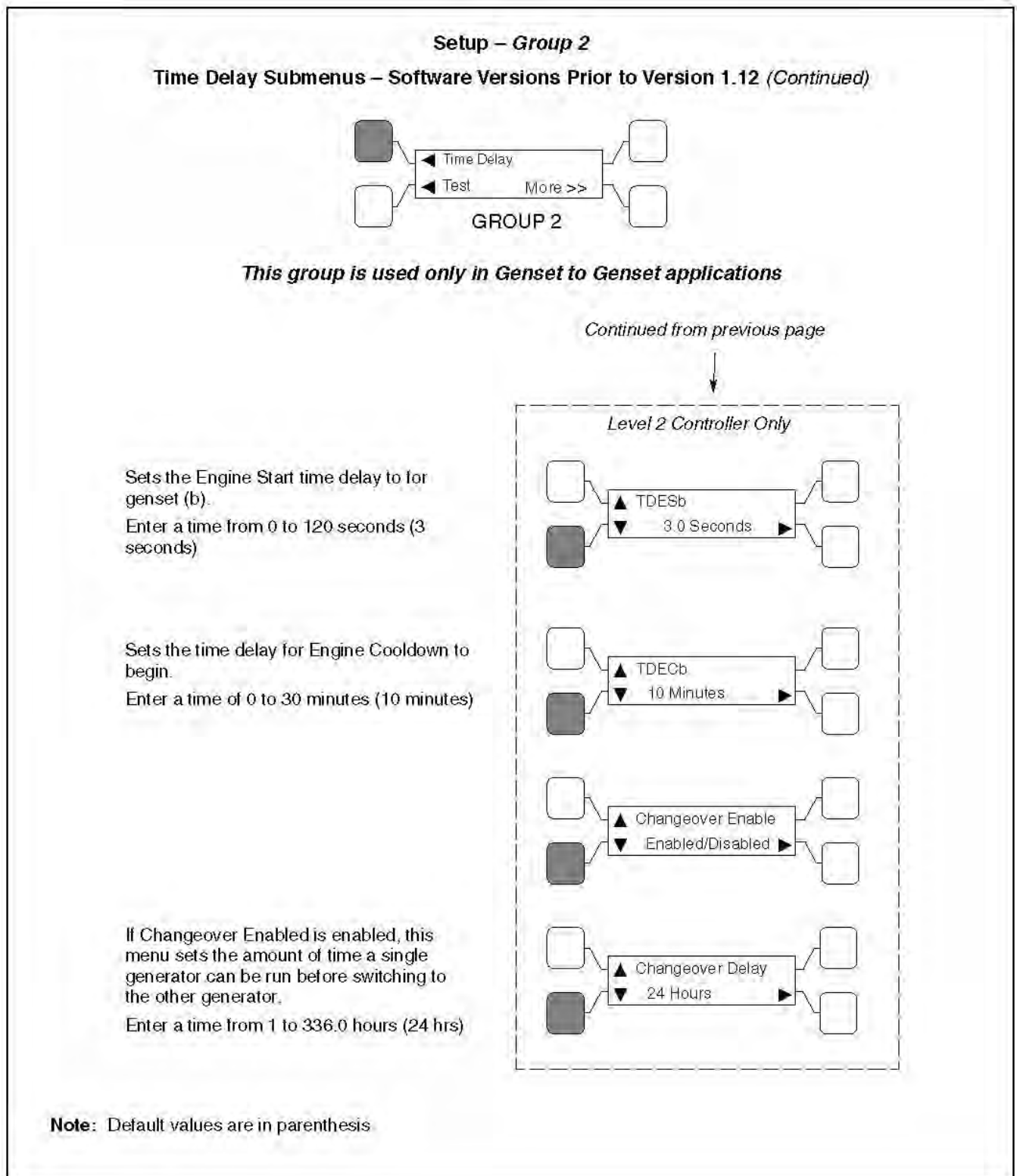
This delay begins when Source 2 (typically the generator) voltage and frequency reach the settings of the control. After the delay, the transfer switch transfers the load to Source 2. This brief time delay allows the generator set to stabilize before the load is applied. It has an adjustable range of 0 to 120 seconds in 1 second increments. The default value is 10 seconds. The value is set with the PC service tool or the digital display.

### **4.5.4 Retransfer Time Delay (TDEN)**

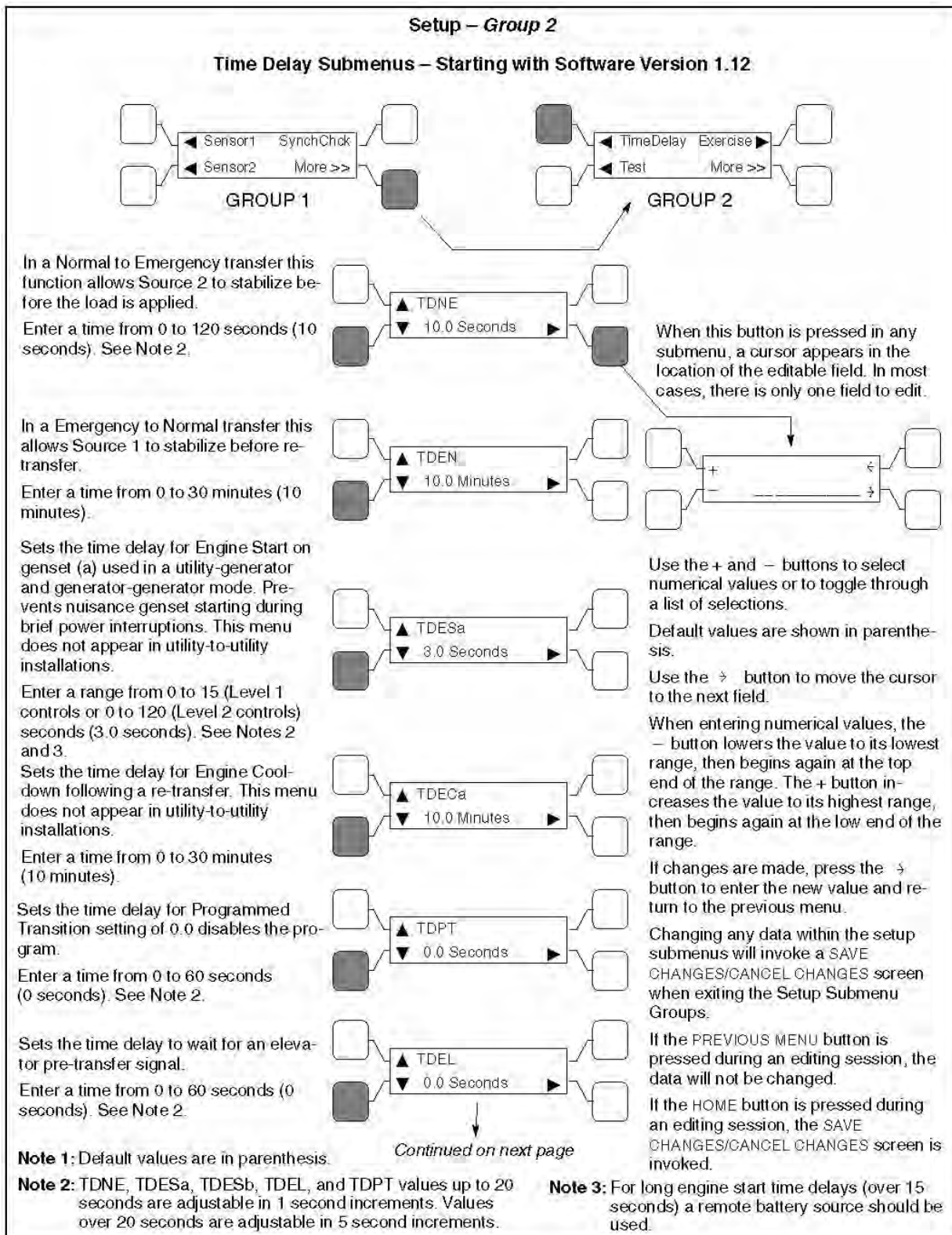
This delay begins the moment Source 1 line voltage and frequency return to specified values. After the delay, the transfer switch can retransfer the load to Source 1. The delay allows the Power Source 1 to stabilize before retransfer. It has an adjustable range of 0 to 30 minutes in 1 minute increments. The default value is 10 minutes. The value is set with PC service tool or the digital display.



**FIGURE 53. SETUP GROUP 2 - TIME DELAY SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.12)**

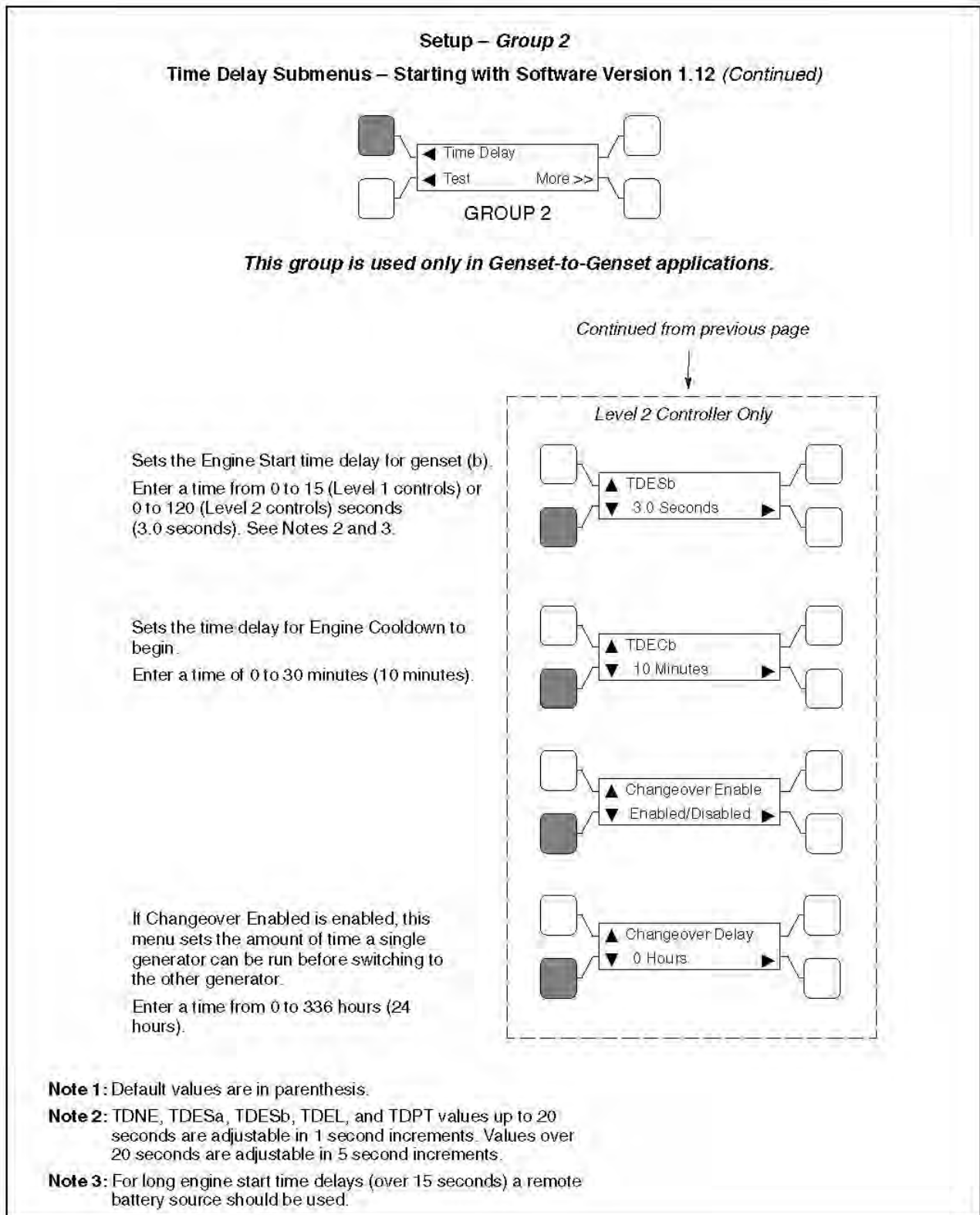


**FIGURE 54. SETUP GROUP 2 - TIME DELAY SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.12) (CONTINUED)**



**FIGURE 55. SETUP GROUP 2 - TIME DELAY SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**





**FIGURE 56. SETUP GROUP 2 - TIME DELAY SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12) (CONTINUED)**

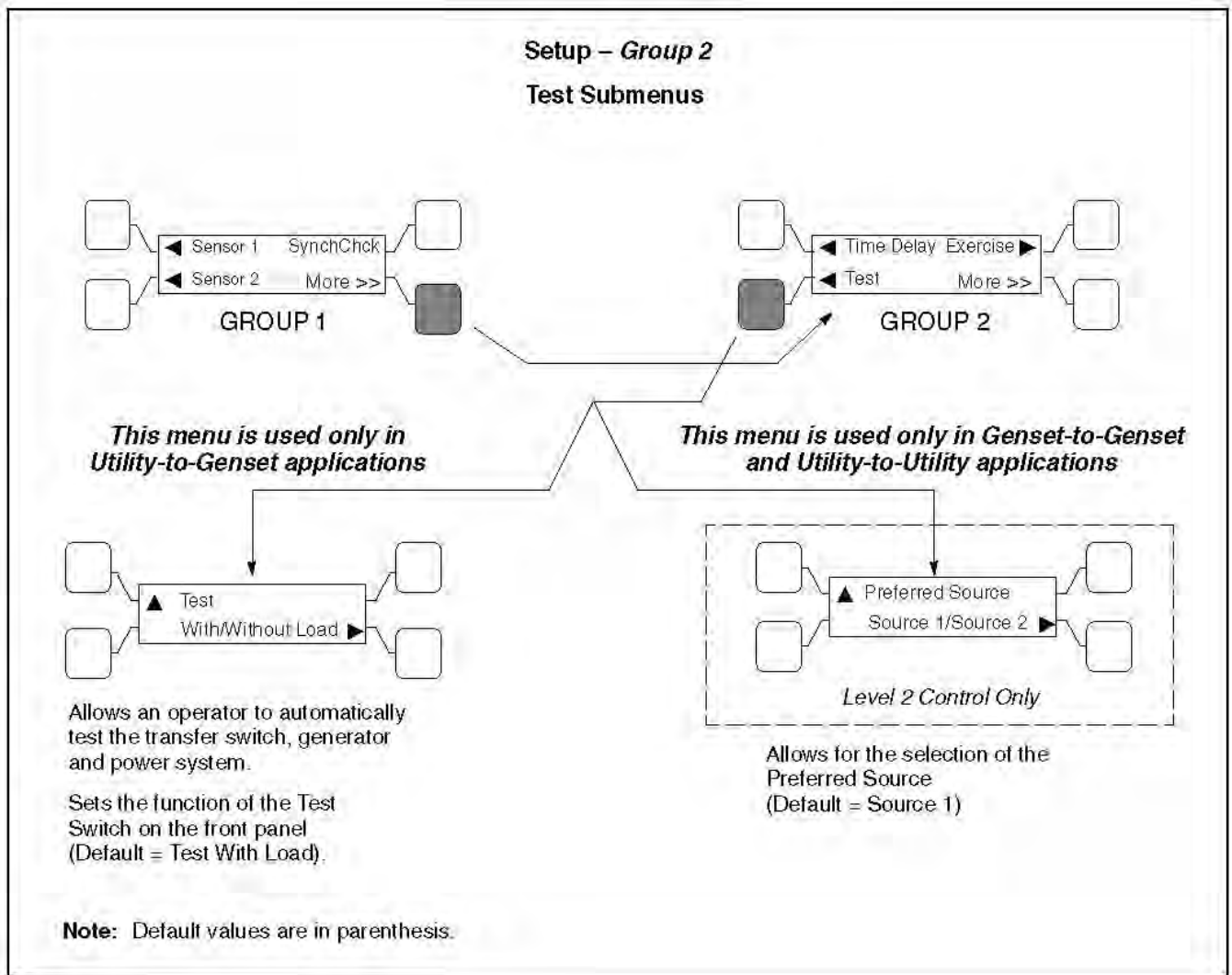
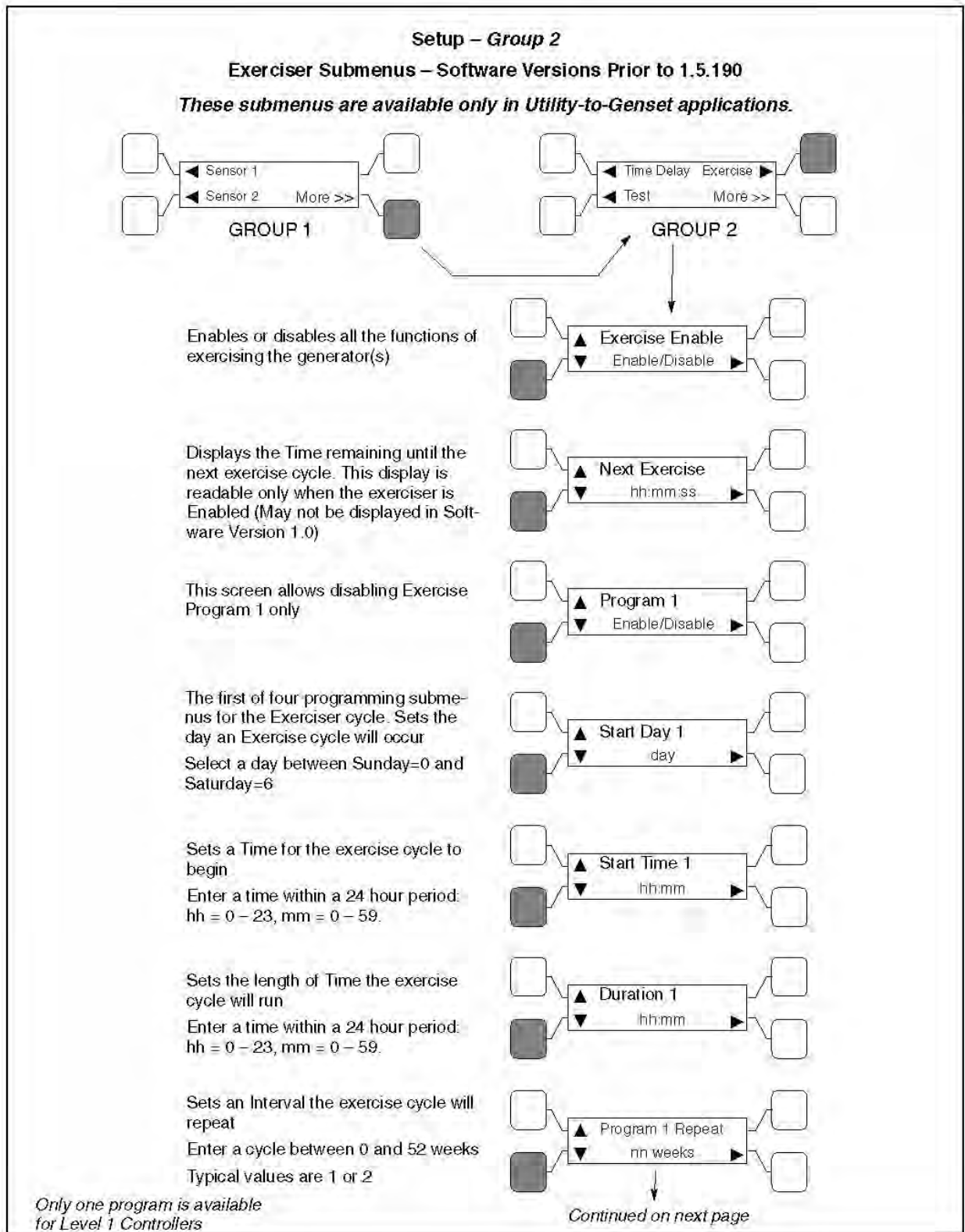


FIGURE 57. SETUP GROUP 2 - TEST SUBMENUS

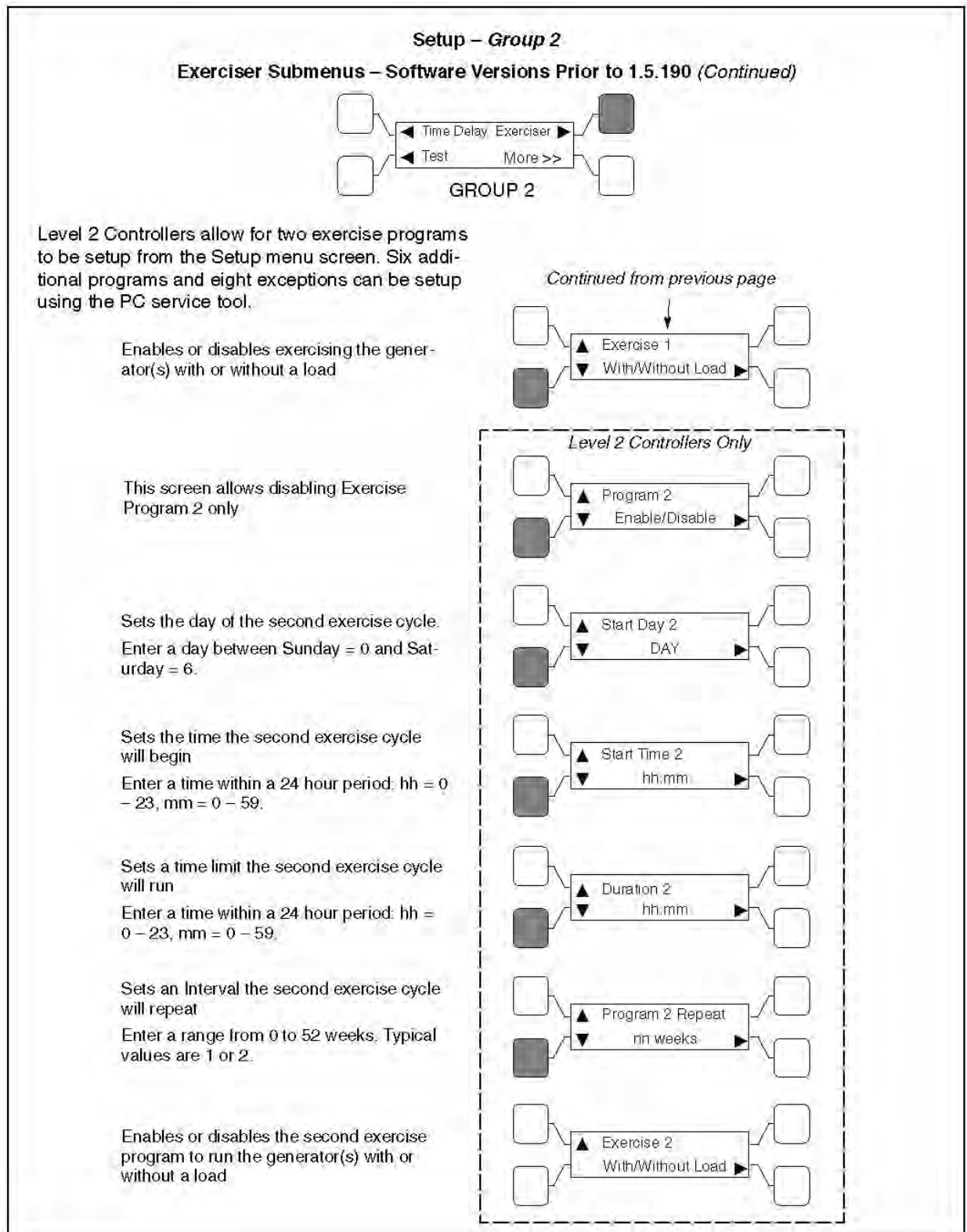
## 4.6 Programmable Generator Exerciser

Level 1 controllers include one programmable generator exercise event and Level 2 controllers include eight programmable generator events and eight programmable exceptions. These events are generally programmed to be recurring. They can be programmed from the PC service tool or the digital display. All controllers have a push-button switch on the digital module that enables and disables the exerciser clock. See the Digital Display Menu System section for details on setting the clock.

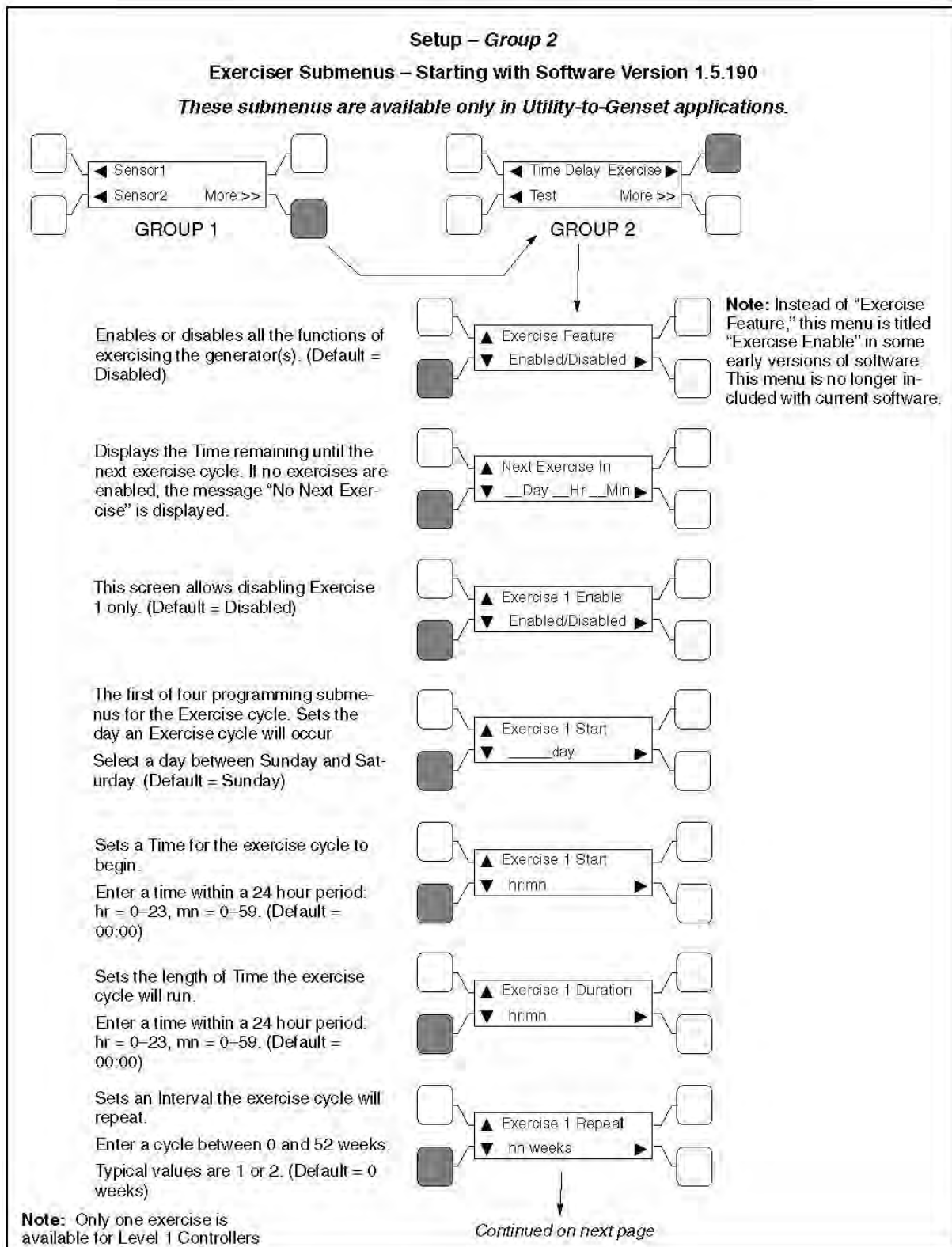
For utility-to-genset configurations, the exerciser clock initiates genset start and run cycles at specified intervals for specified durations. This clock is not used in utility-to-utility or genset-to-genset configurations.



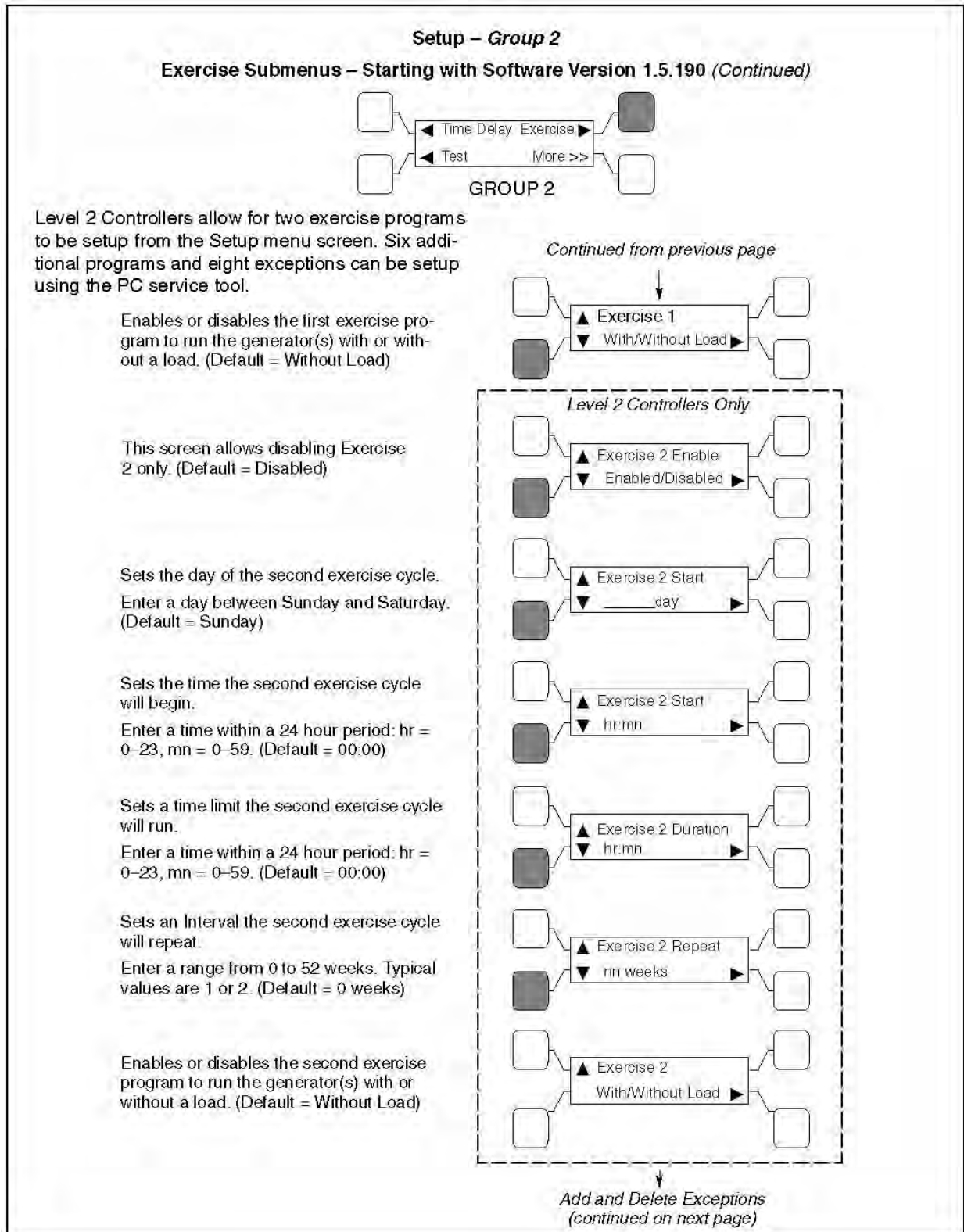
**FIGURE 58. SETUP GROUP 2 - EXERCISER SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.5.190)**



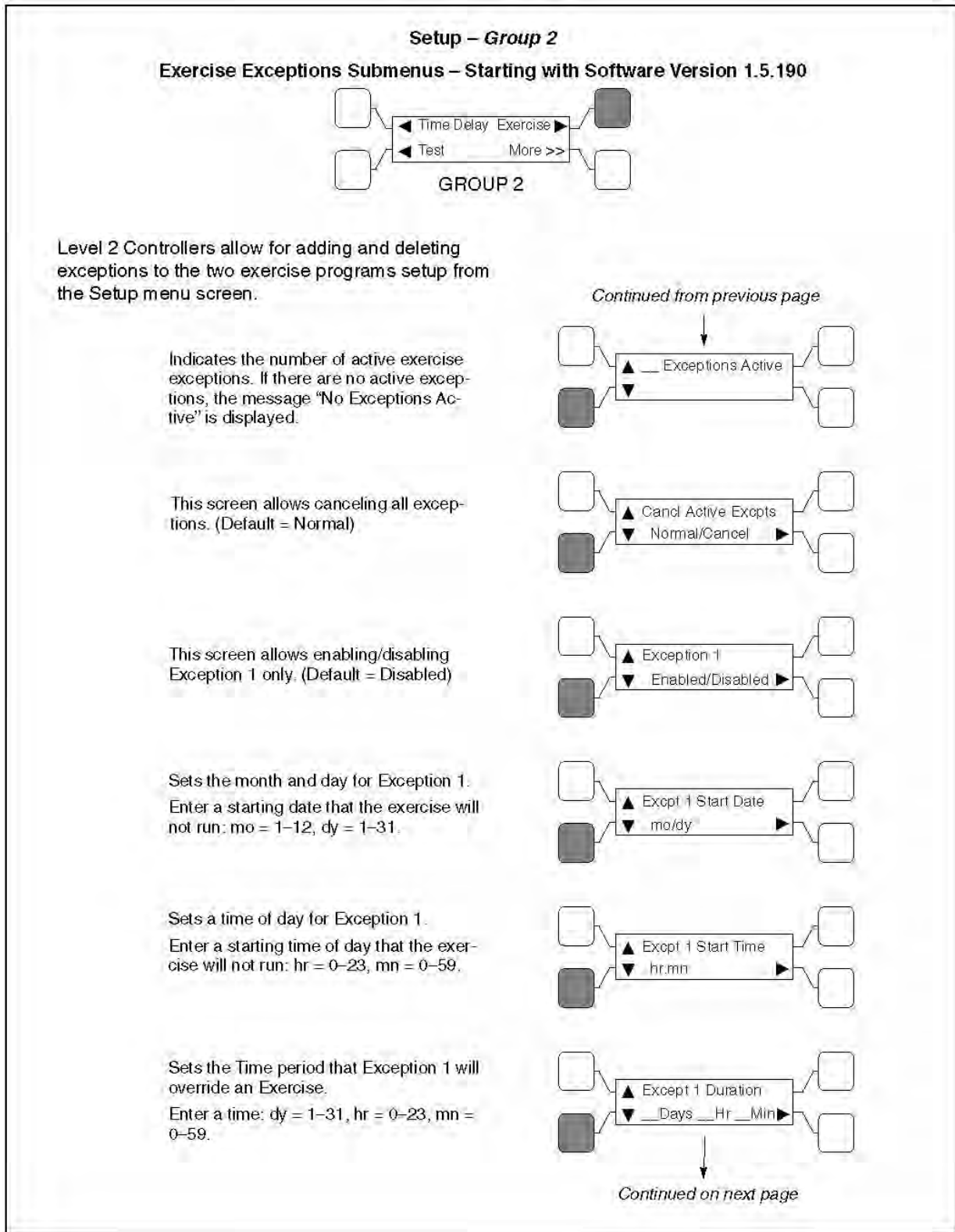
**FIGURE 59. SETUP GROUP 2 - EXERCISER SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.5.190) (CONTINUED)**



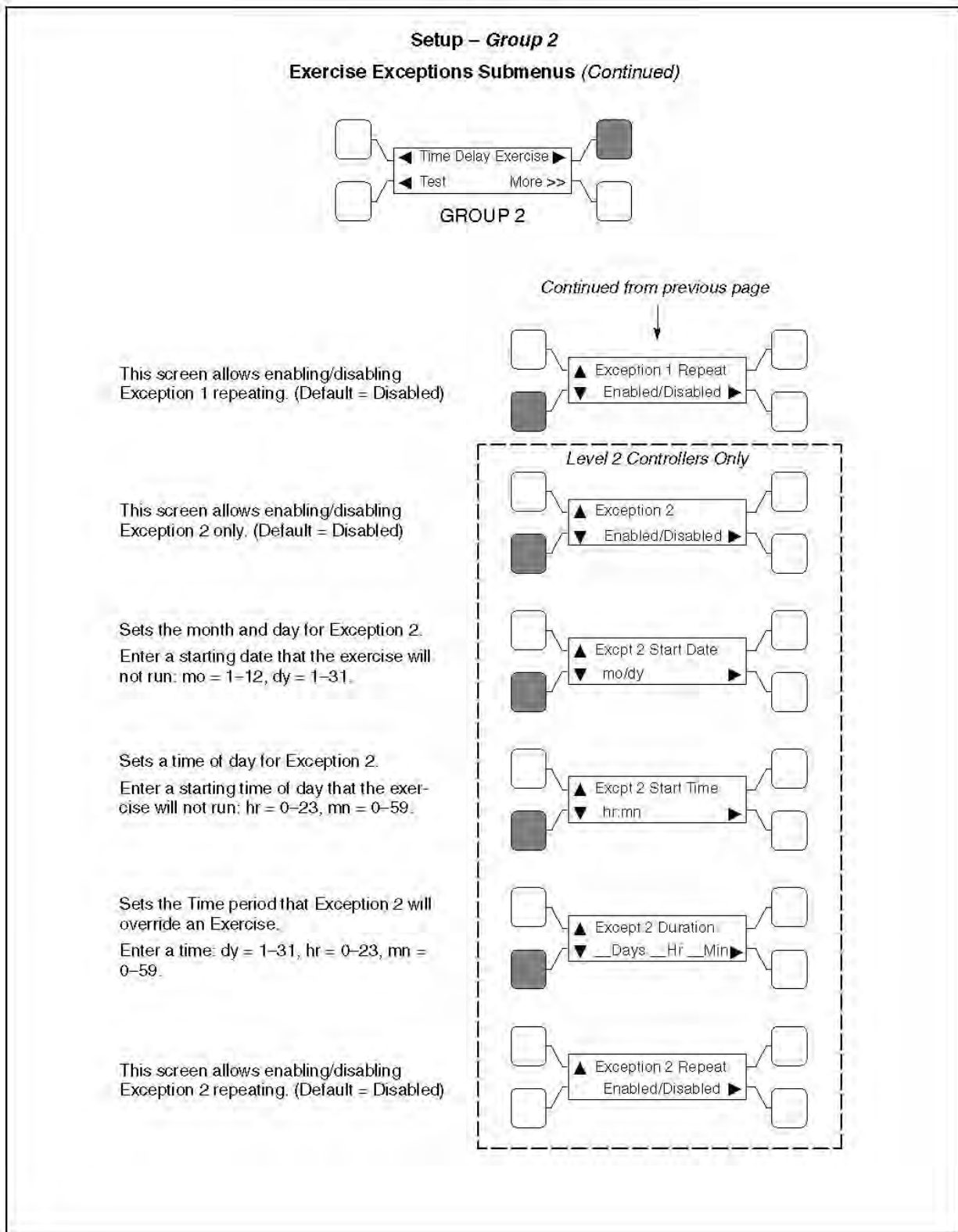
**FIGURE 60. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.5.190)**



**FIGURE 61. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.5.190) (CONTINUED)**

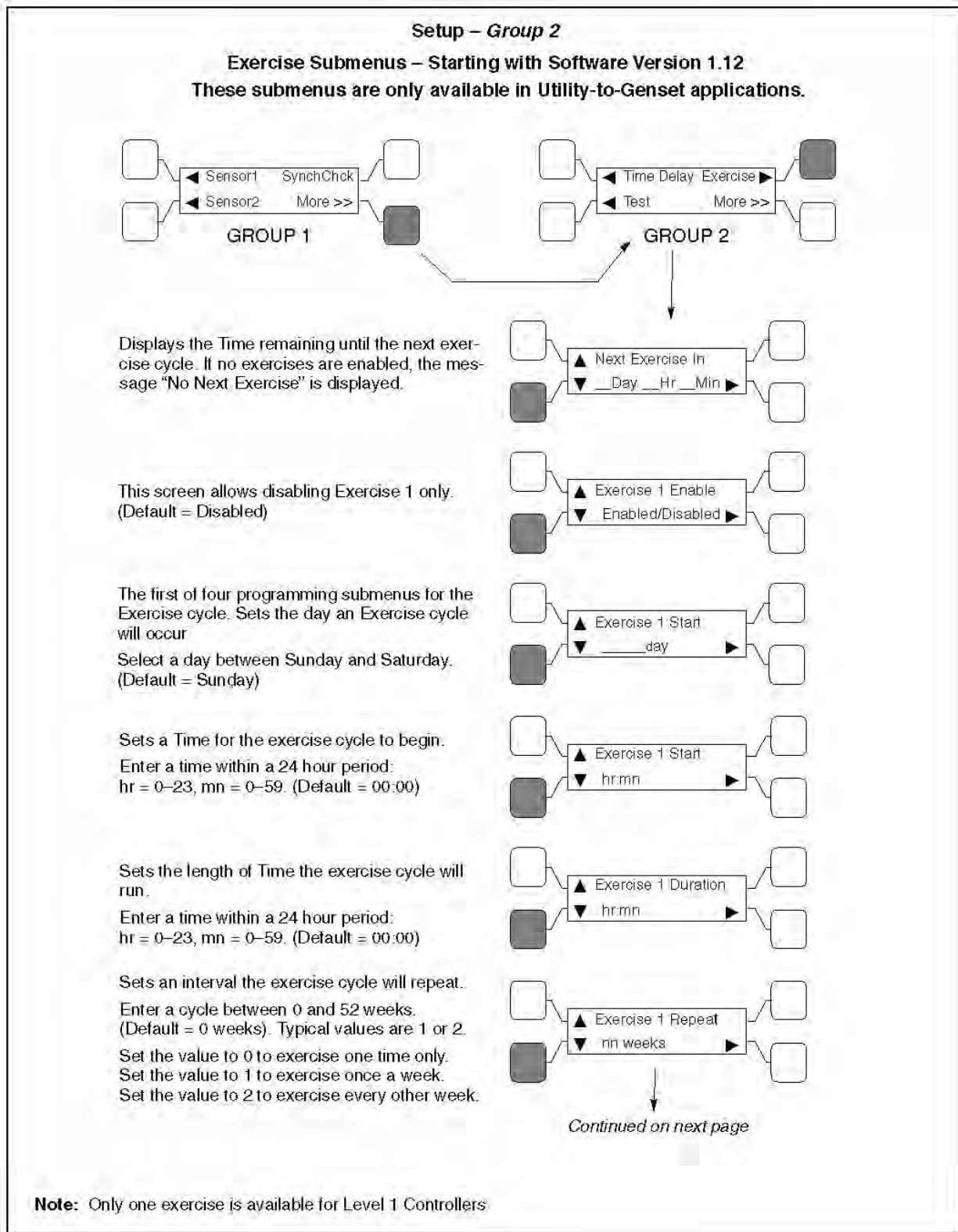


**FIGURE 62. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.5.190)**

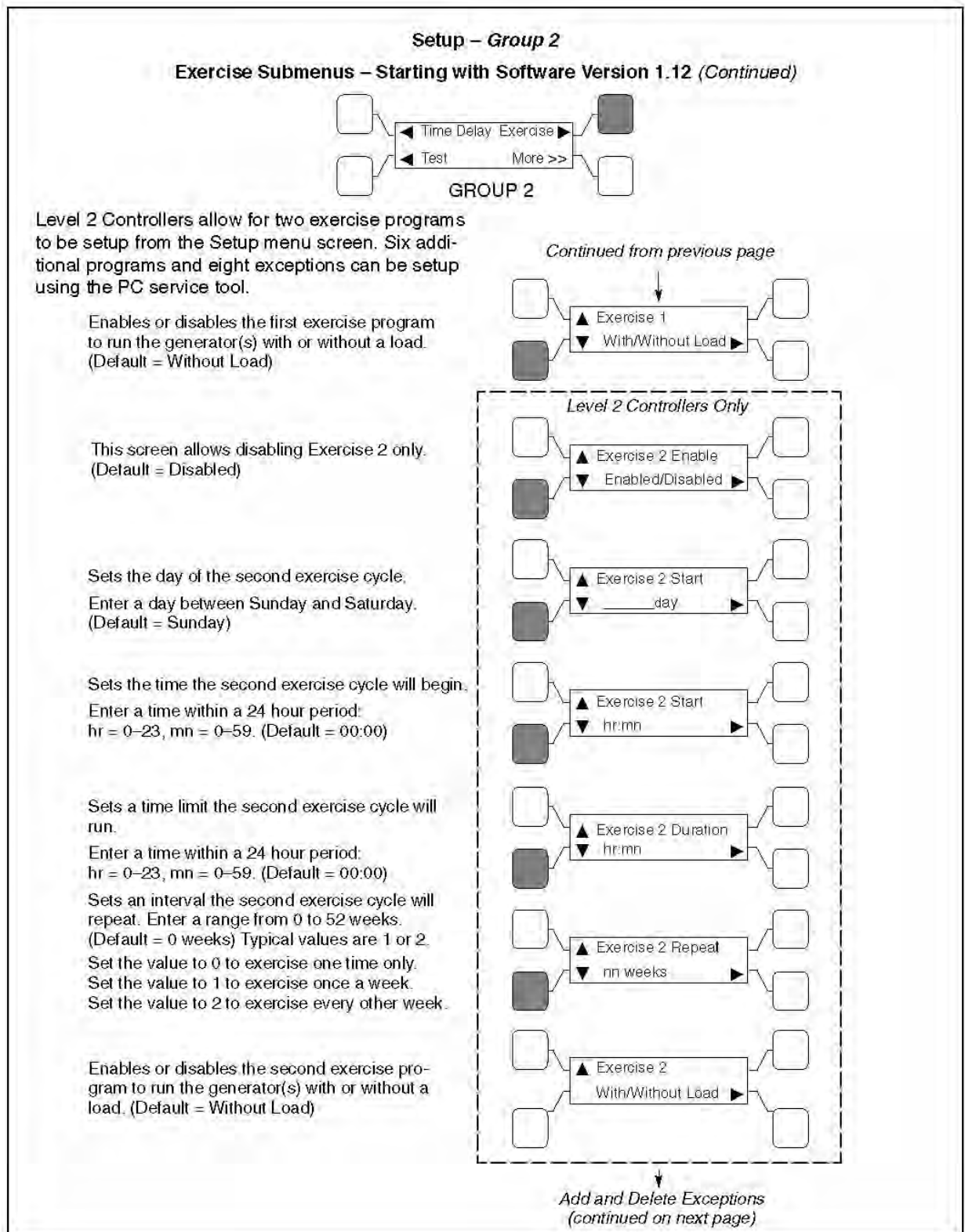


**FIGURE 63. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.5.190) (CONTINUED)**

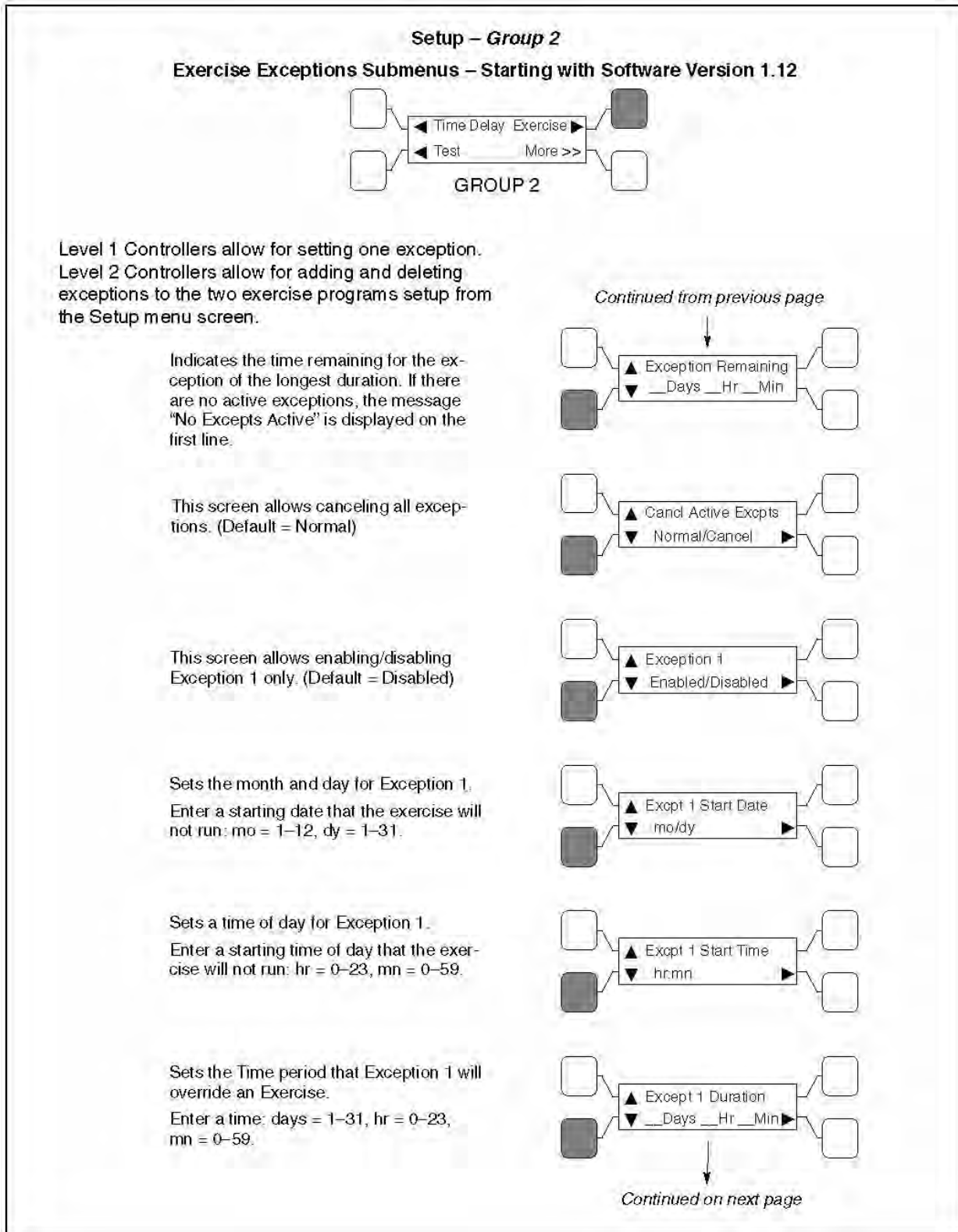




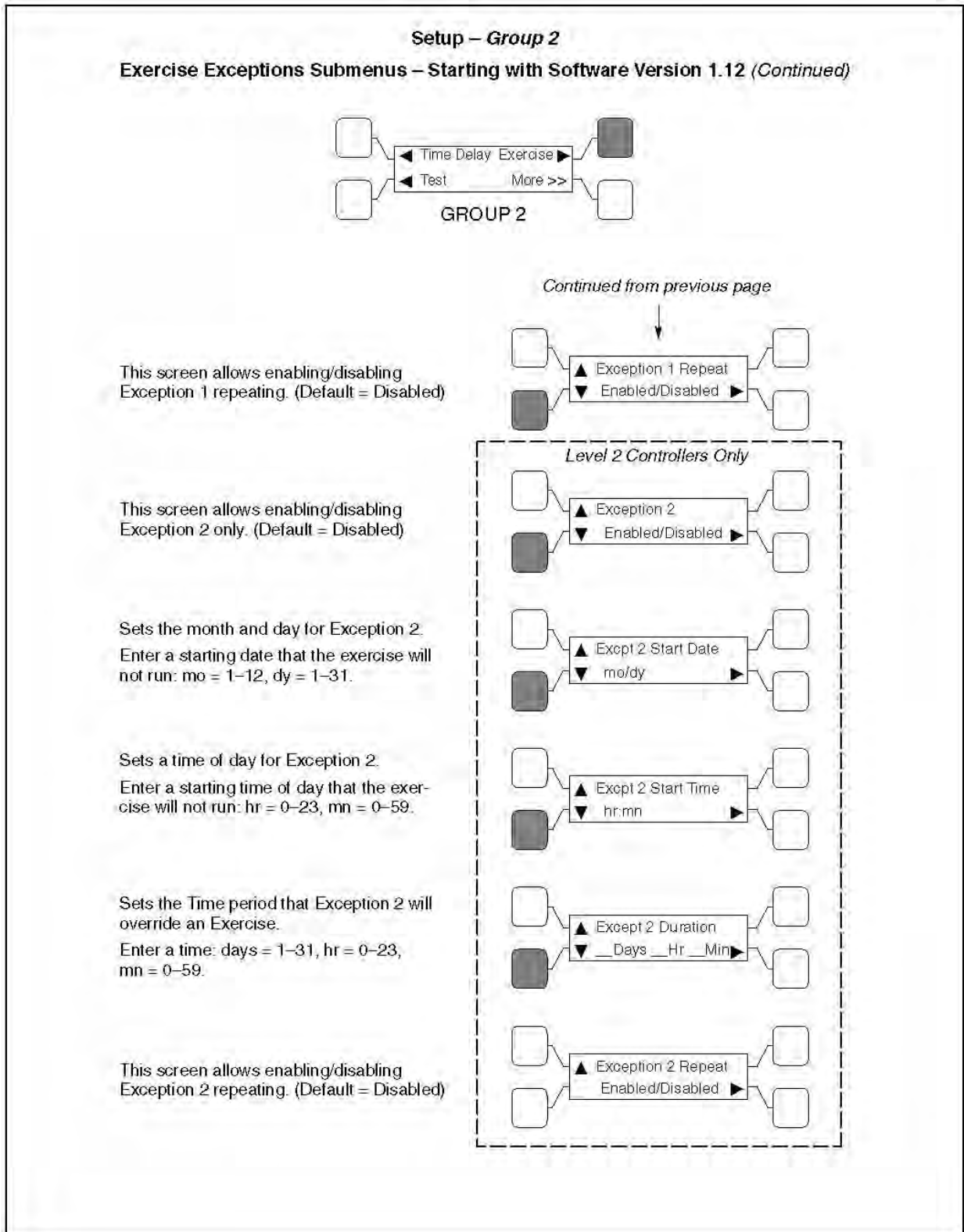
**FIGURE 64. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**



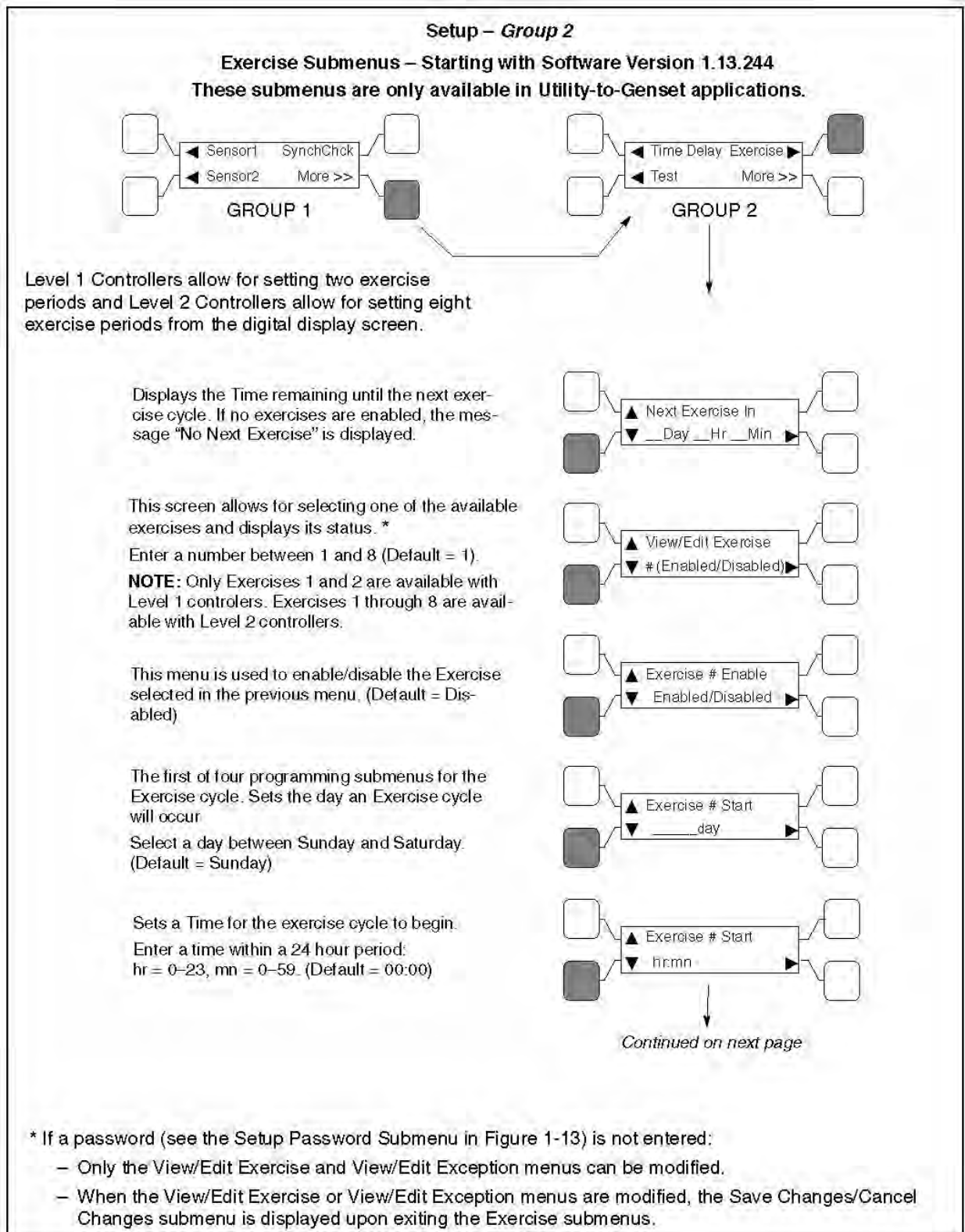
**FIGURE 65. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12) (CONTINUED)**



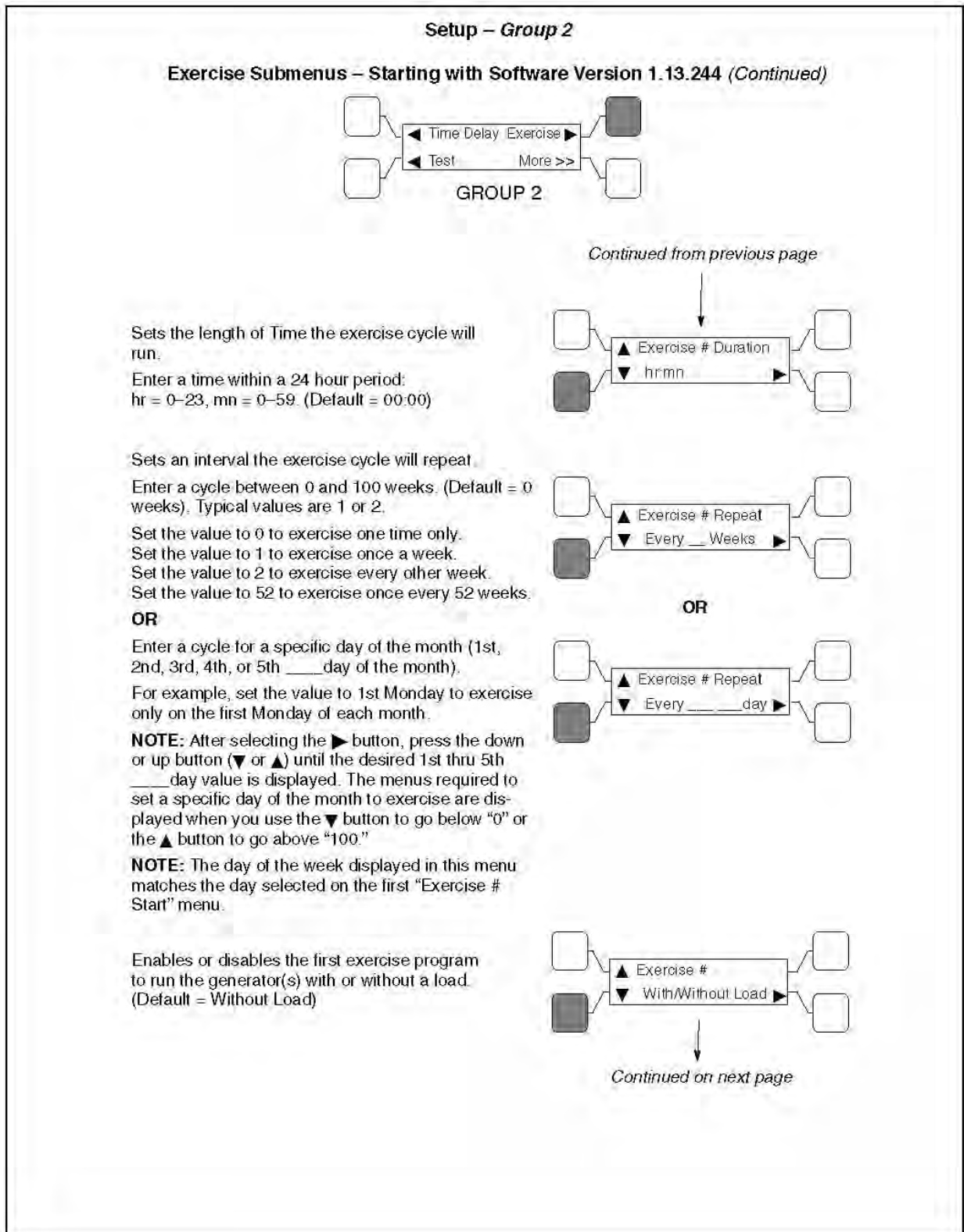
**FIGURE 66. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**



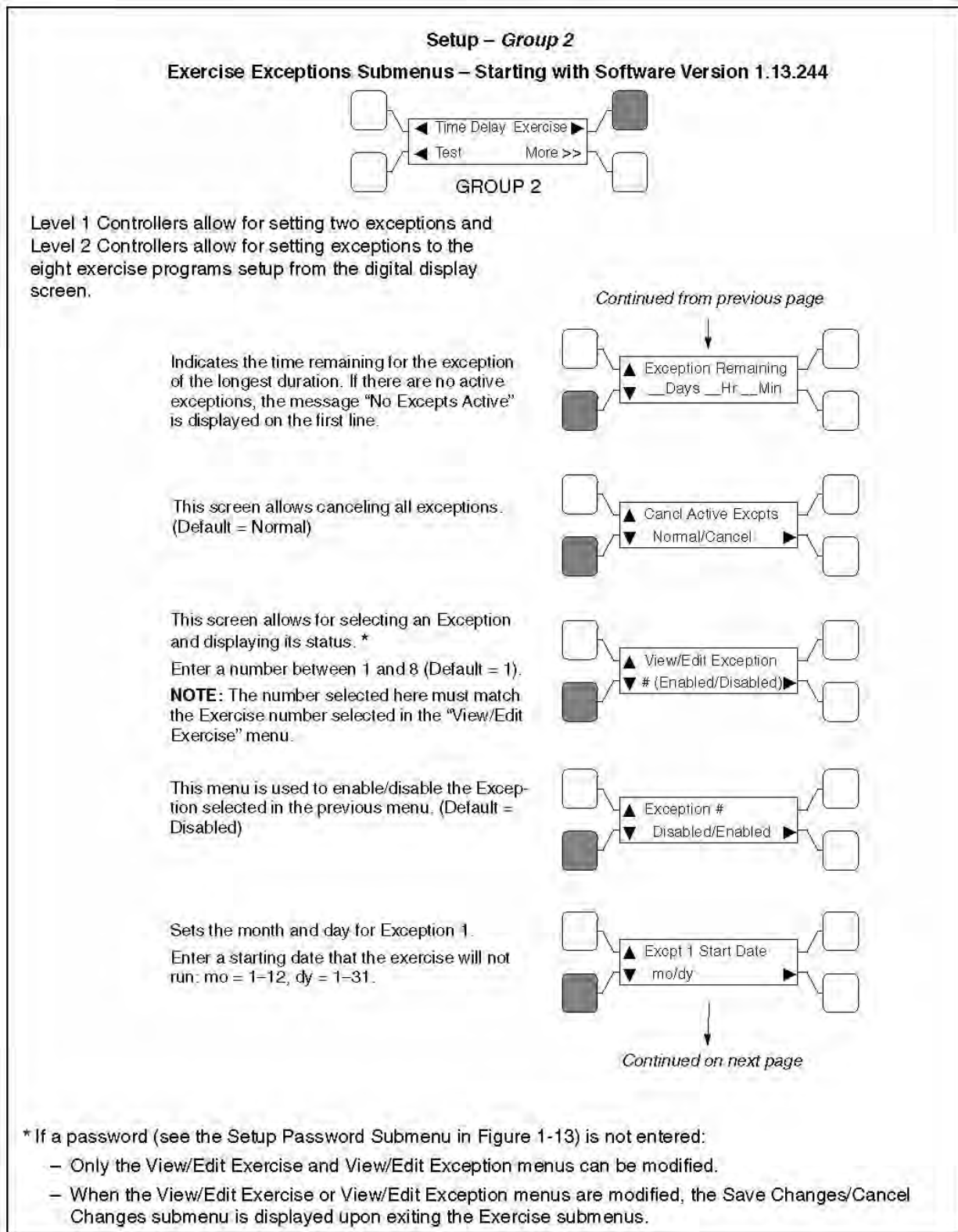
**FIGURE 67. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12) (CONTINUED)**



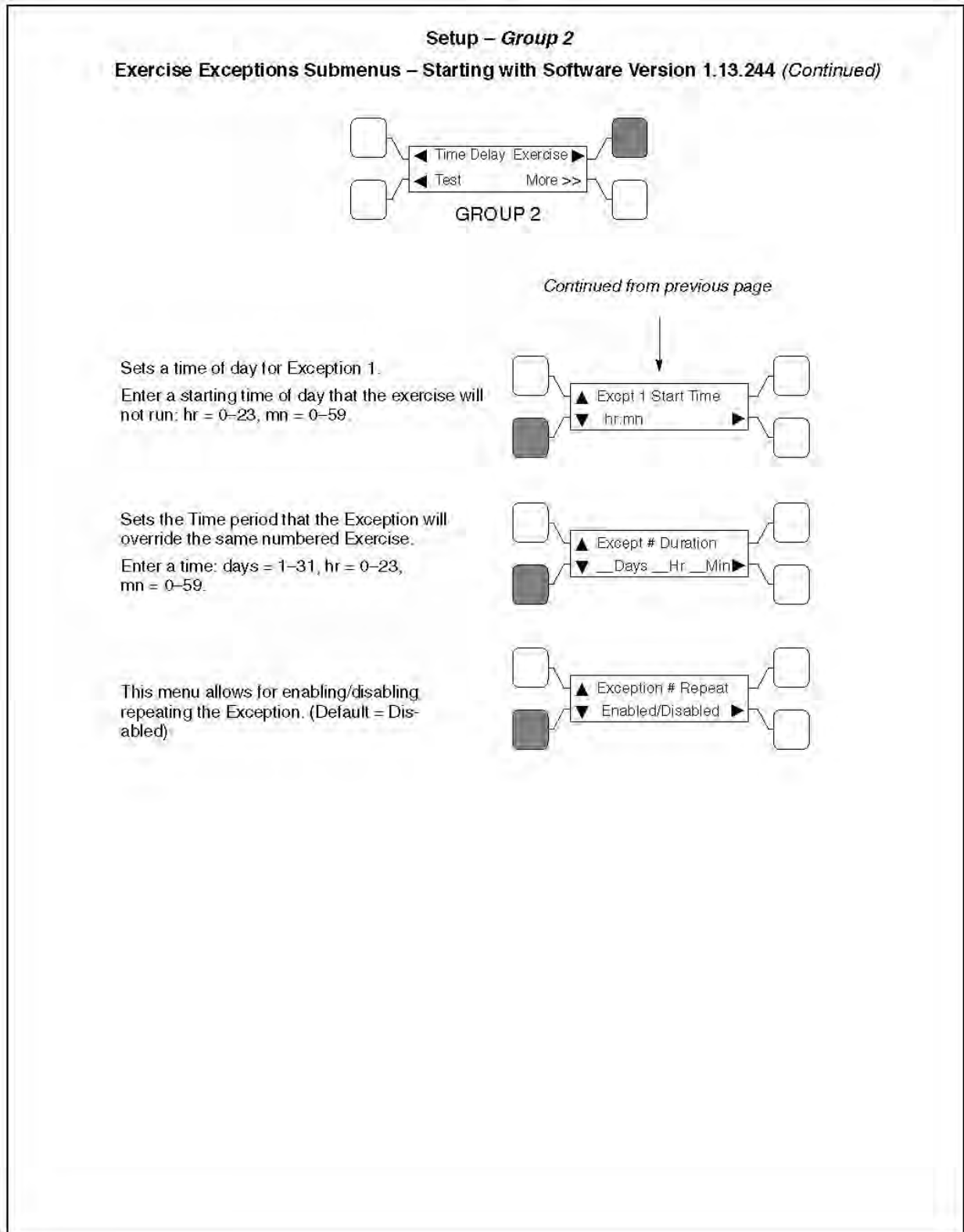
**FIGURE 68. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.13.244)**



**FIGURE 69. SETUP GROUP 2 - EXERCISE SUBMENUS (STARTING WITH SOFTWARE VERSION 1.13.244) (CONTINUED)**

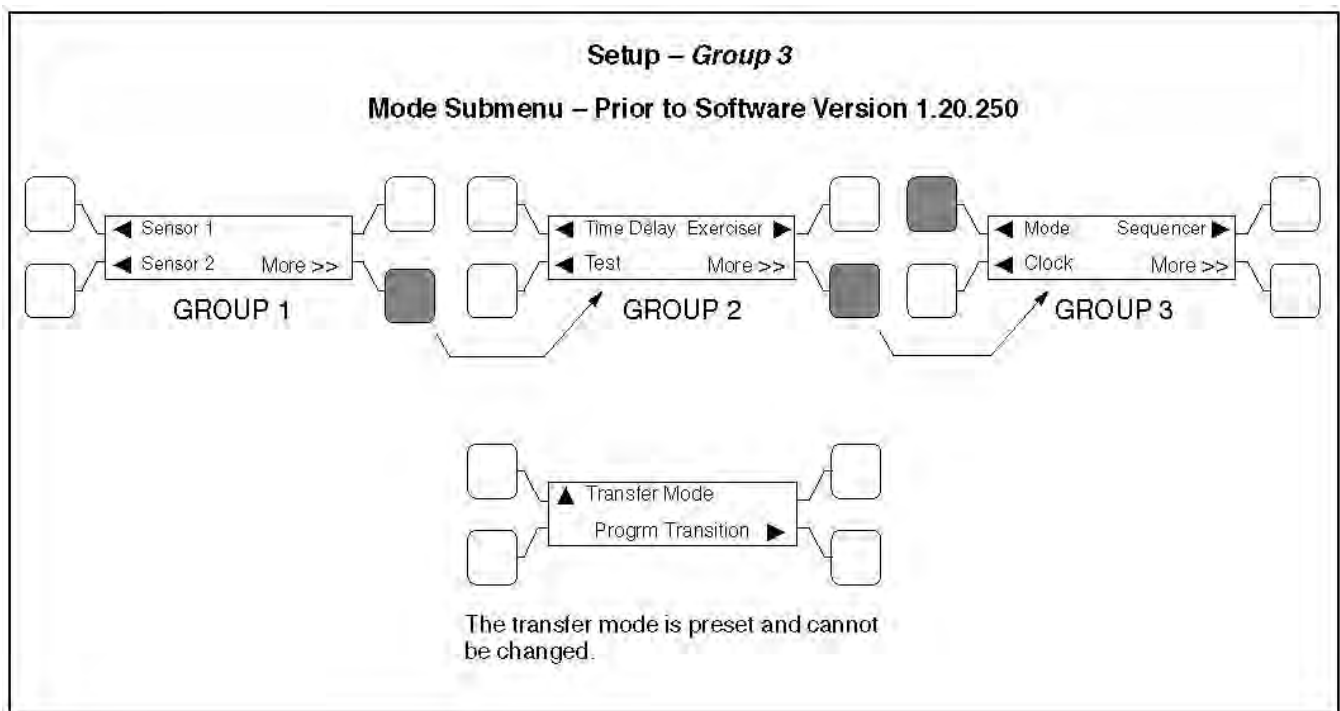


**FIGURE 70. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.13.244)**

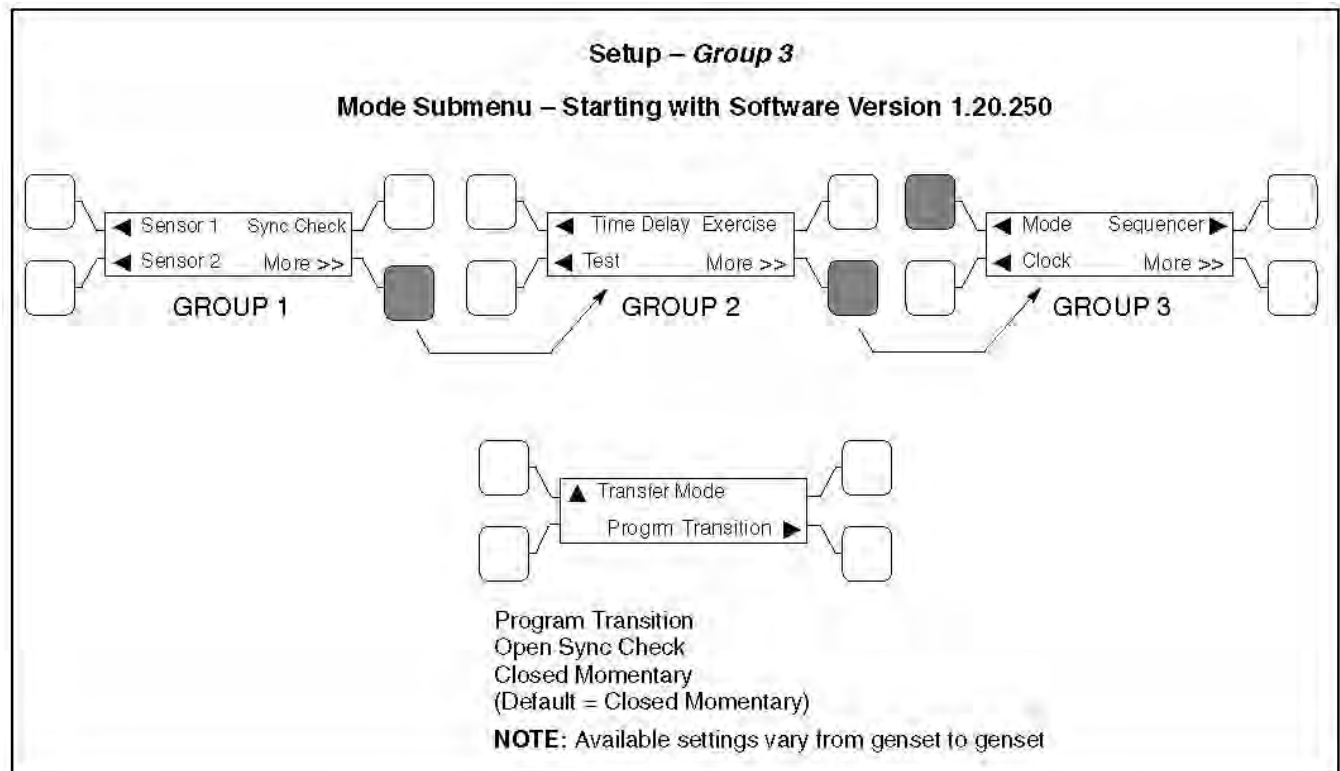


**FIGURE 71. SETUP GROUP 2 - EXERCISE EXCEPTIONS SUBMENUS (STARTING WITH SOFTWARE VERSION 1.13.244) (CONTINUED)**

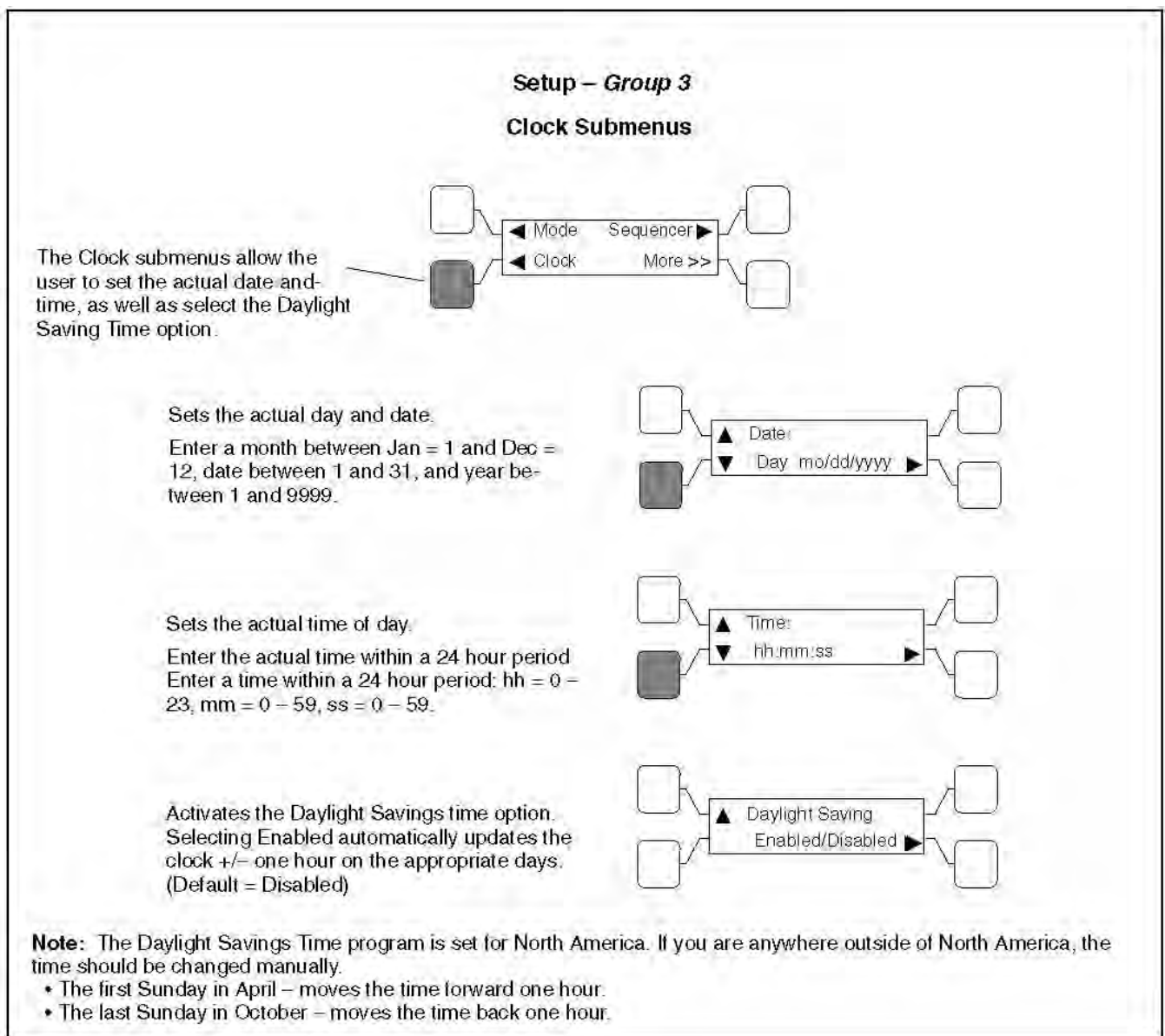




**FIGURE 72. SETUP GROUP 3 - MODE SUBMENU (PRIOR TO SOFTWARE VERSION 1.20.250)**



**FIGURE 73. SETUP GROUP 3 - MODE SUBMENU (STARTING WITH SOFTWARE VERSION 1.20.250)**



**FIGURE 74. SETUP GROUP 3 - CLOCK SUBMENUS**

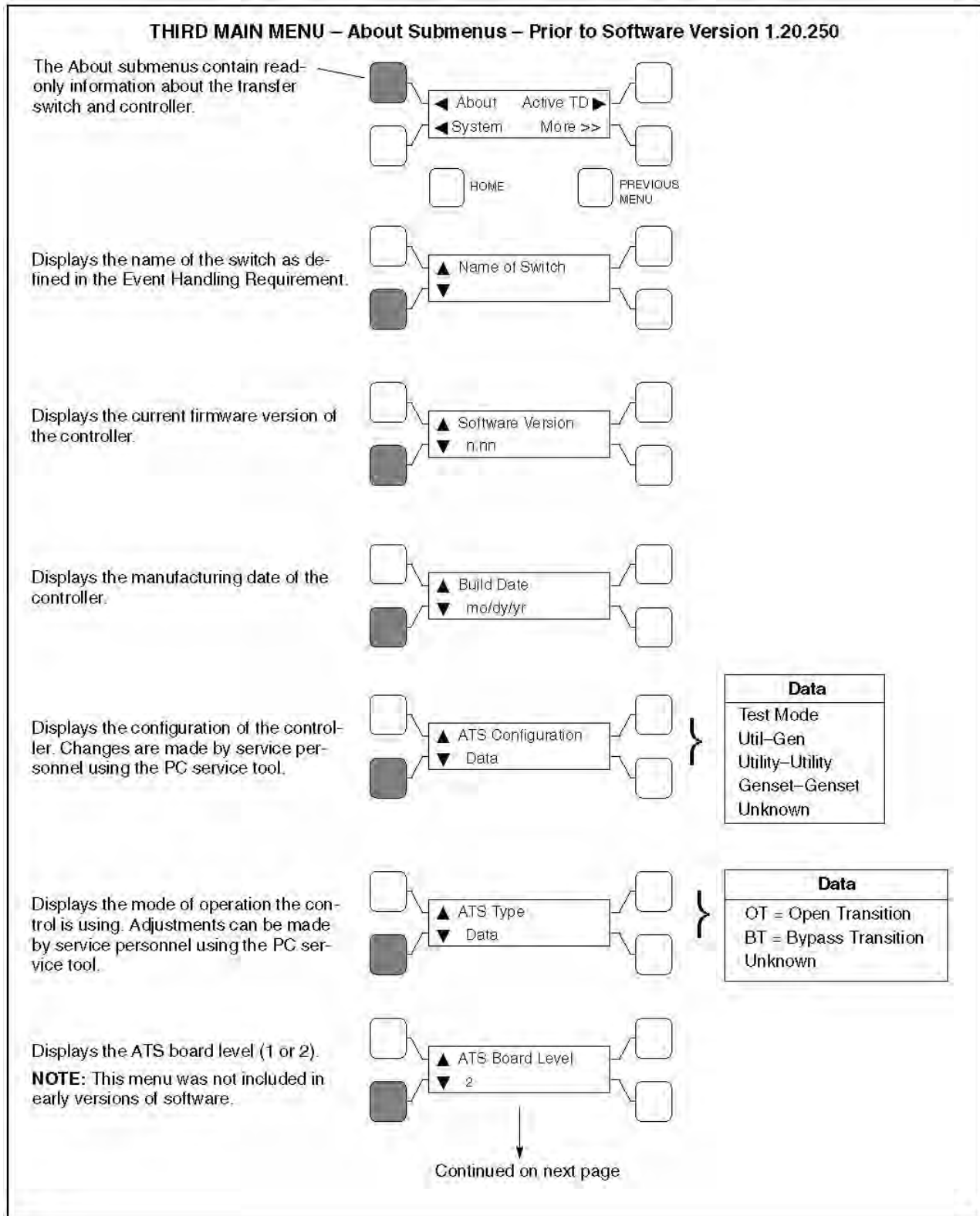
**Setup – Group 3**  
**Sequencer Submenus**

The Sequencer submenus are a software only feature allowing the user to send a predetermined sequence of network event announcements. The announcements are sent in a timed, sequential order and are used to turn ATS loads off and on. When used, a few seconds should be allowed between load steps to allow the generator voltage and frequency to stabilize.

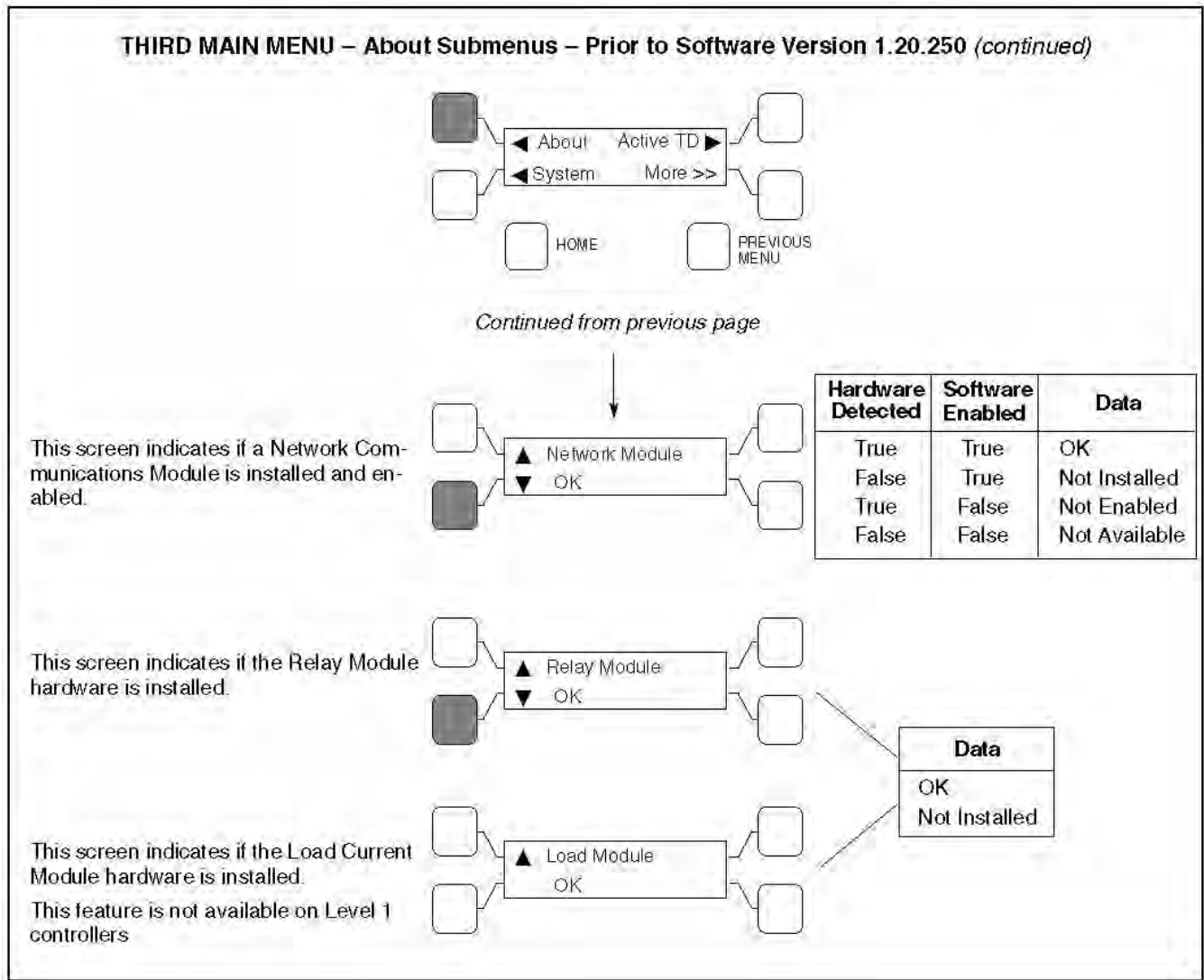
Sequencer is available only with the optional Network Communication Module. The module must be installed and enabled with the PC service tool before these screens are displayed.

<p>When Enabled, allows event announcements to be sent to the transfer switch.</p>	
<p>Sets activation for certain operational modes. Choose Transfer, Re-transfer, or All</p>	
<p>The control can activate a maximum of 8 relay output signals. Enter the number of relay output signals desired to activate: 1 thru 8.</p>	
<p>When Load Sequencer is triggered, the controller deactivates all remote relay output signals. Starting with Relay 1, the controller counts down the specified time delay, then activates Relay 1. Enter a time from 0 to 60 seconds.</p>	
<p>If the Sequence Length is greater than 1, the control counts down the specified Relay 2 time delay, then activates the Relay 2 signal. Enter a time from 0 to 60 seconds.</p>	
<p>The process repeats until all relay signals have been sequenced. The maximum time delay for all 8 signals is 8 minutes.</p>	<p style="text-align: right;"><i>Menus continue through Output 8, depending on the number of Sequence Lengths specified.</i></p>

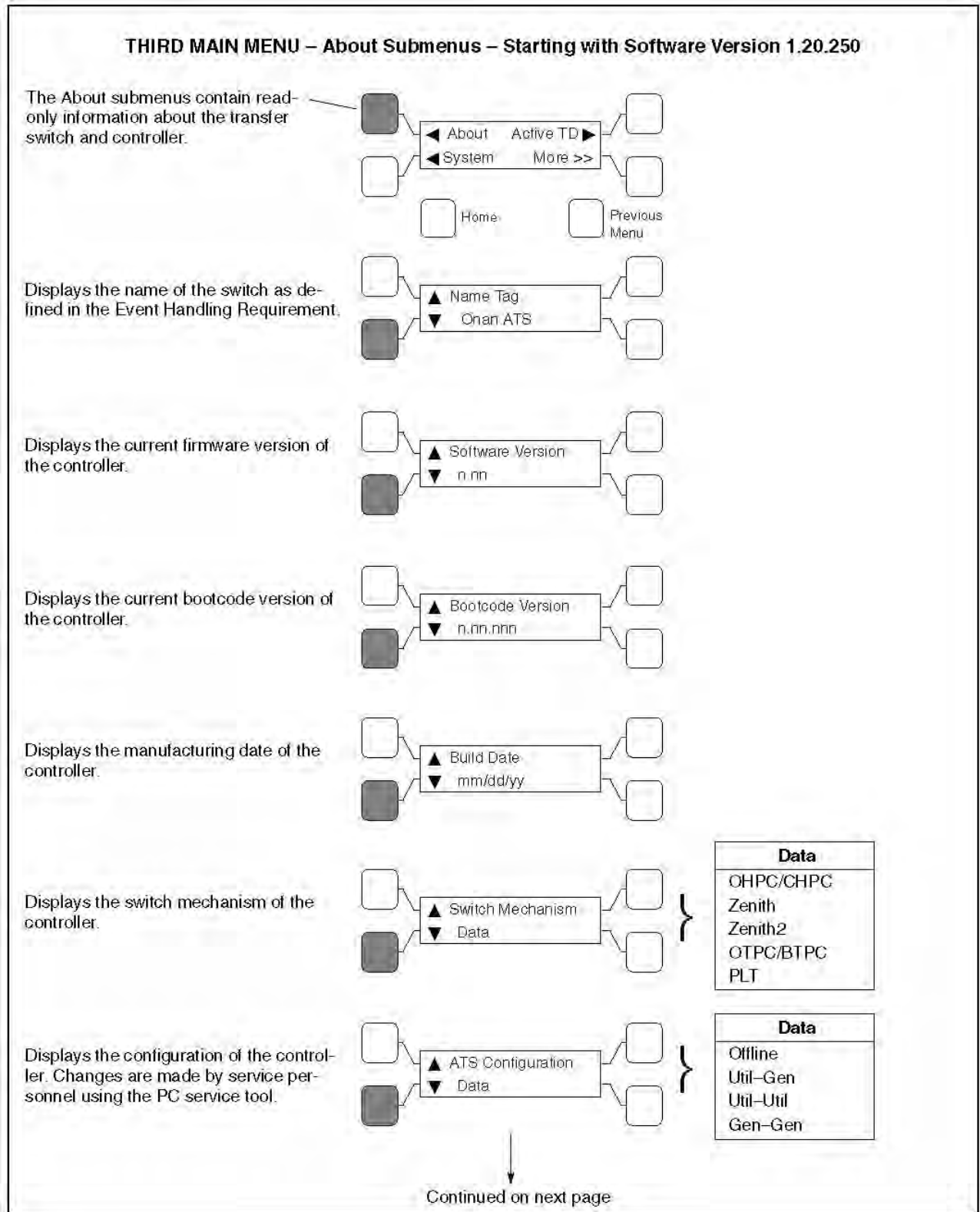
**FIGURE 75. SETUP GROUP 3 - SEQUENCER SUBMENUS**



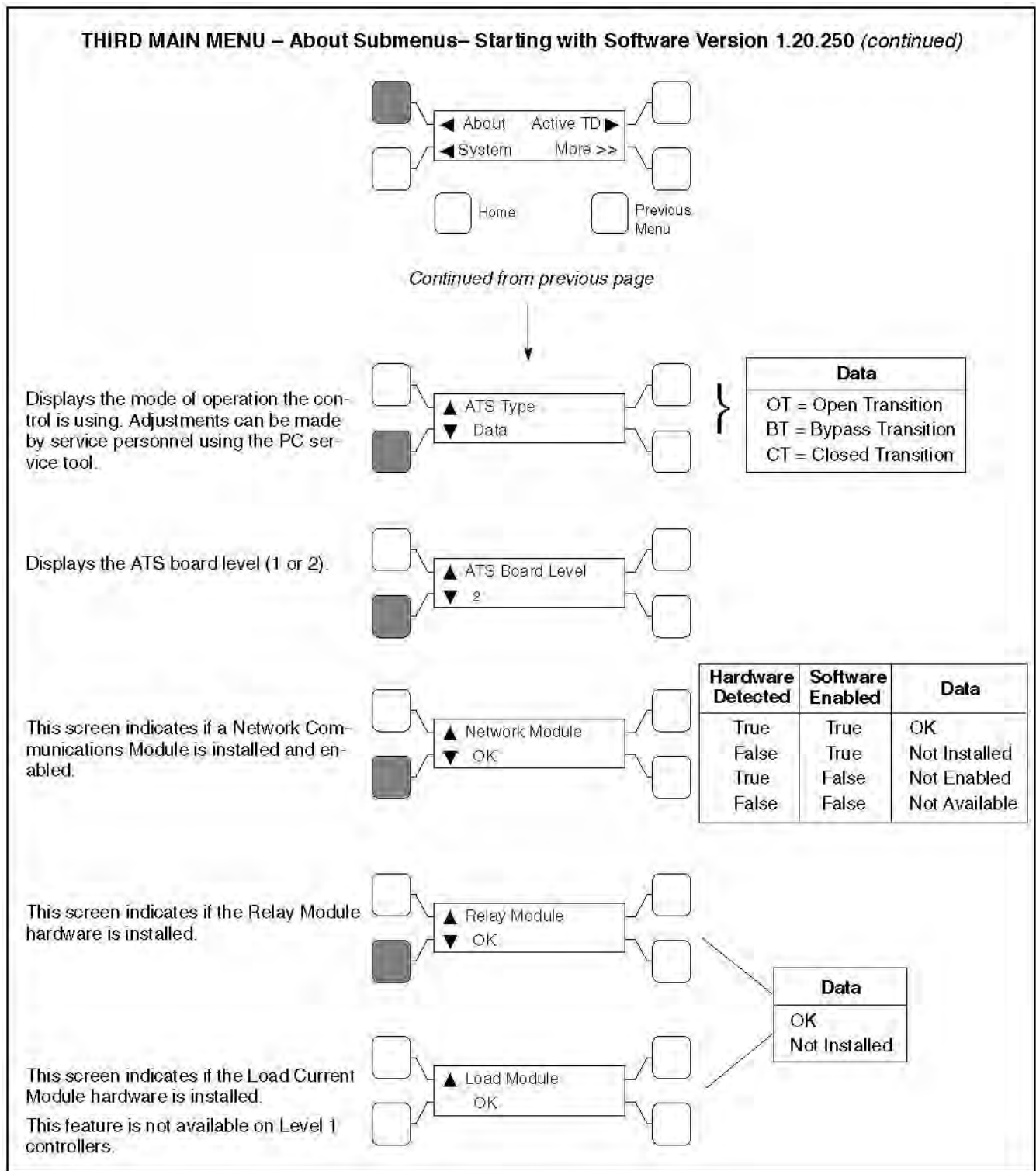
**FIGURE 76. THIRD MAIN MENU - ABOUT SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.20.250)**



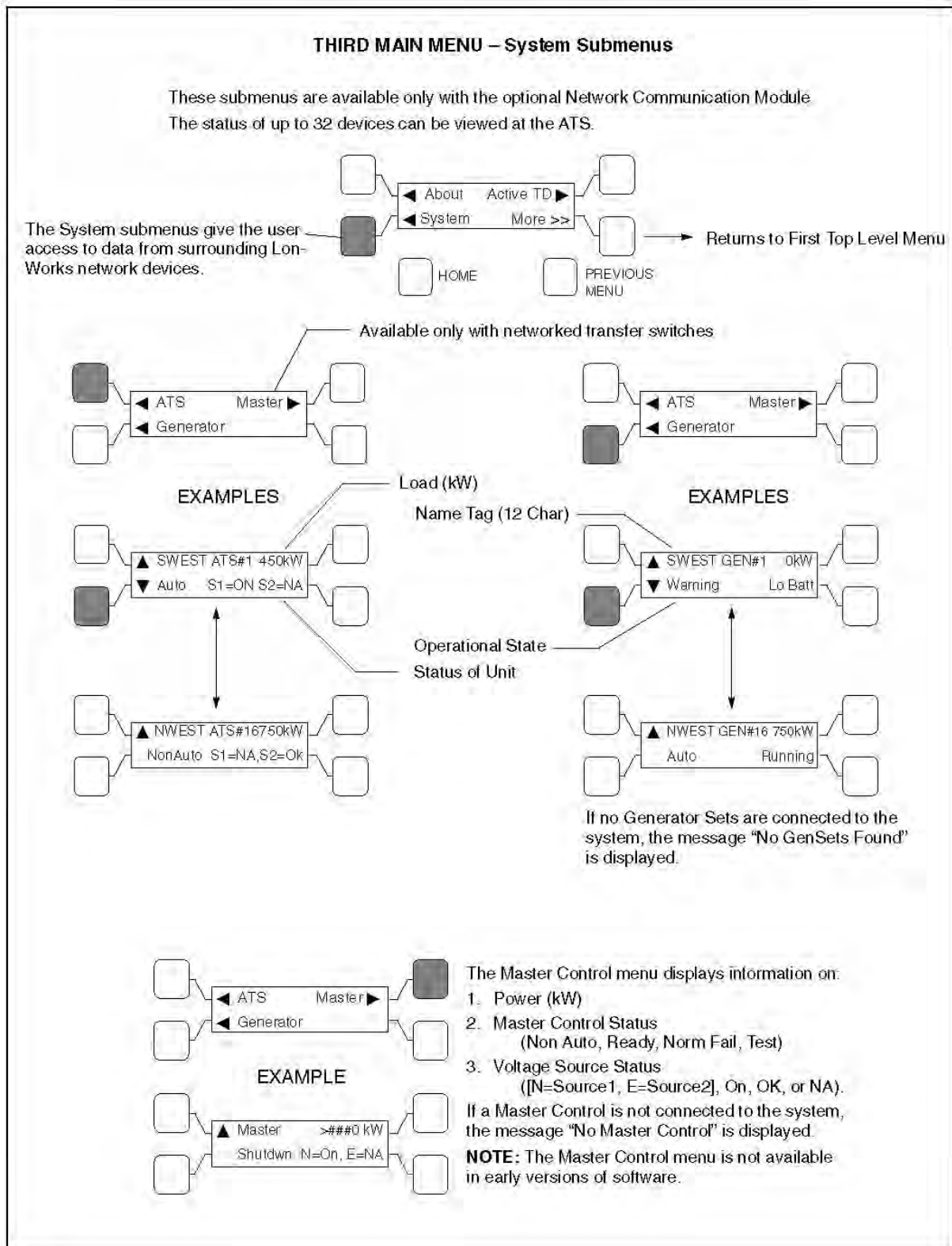
**FIGURE 77. THIRD MAIN MENU - ABOUT SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.20.250) (CONTINUED)**



**FIGURE 78. THIRD MAIN MENU - ABOUT SUBMENUS (STARTING WITH SOFTWARE VERSION 1.20.250)**

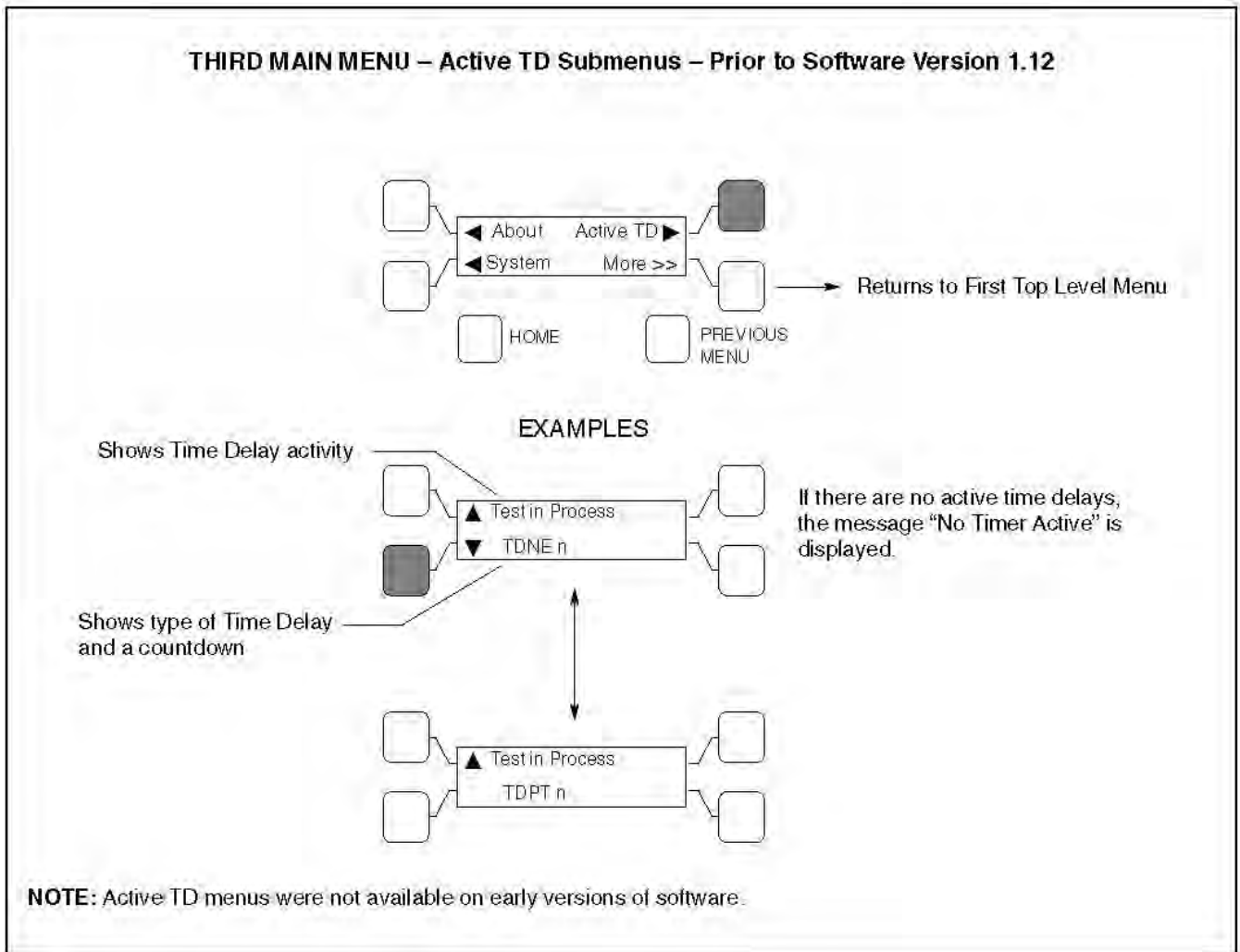


**FIGURE 79. THIRD MAIN MENU - ABOUT SUBMENUS (STARTING WITH SOFTWARE VERSION 1.20.250) (CONTINUED)**

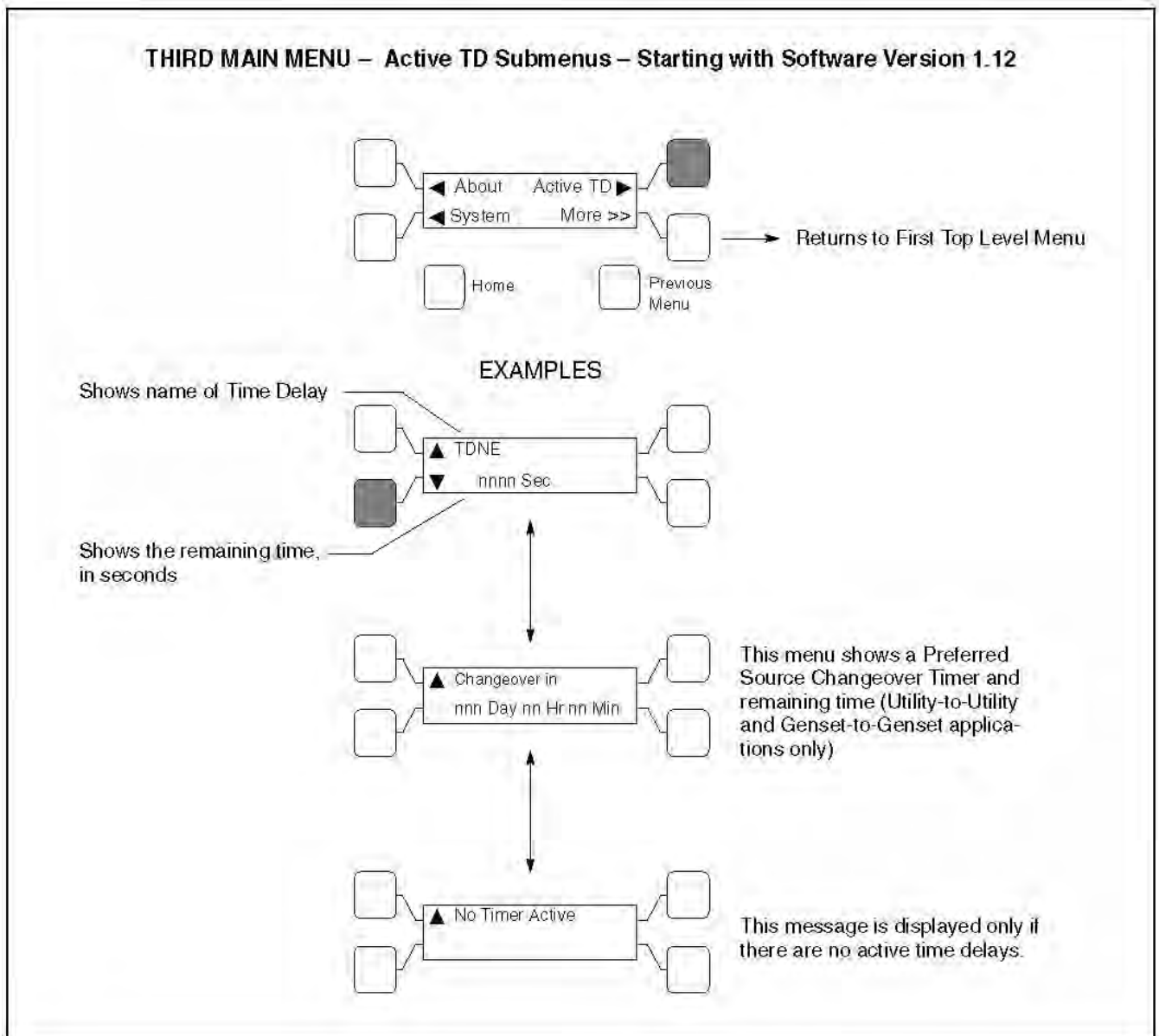


**FIGURE 80. THIRD MAIN MENU - SYSTEM SUBMENUS**





**FIGURE 81. THIRD MAIN MENU - ACTIVE TD SUBMENUS (SOFTWARE VERSIONS PRIOR TO 1.12)**



**FIGURE 82. THIRD MAIN MENU - ACTIVE TD SUBMENUS (STARTING WITH SOFTWARE VERSION 1.12)**

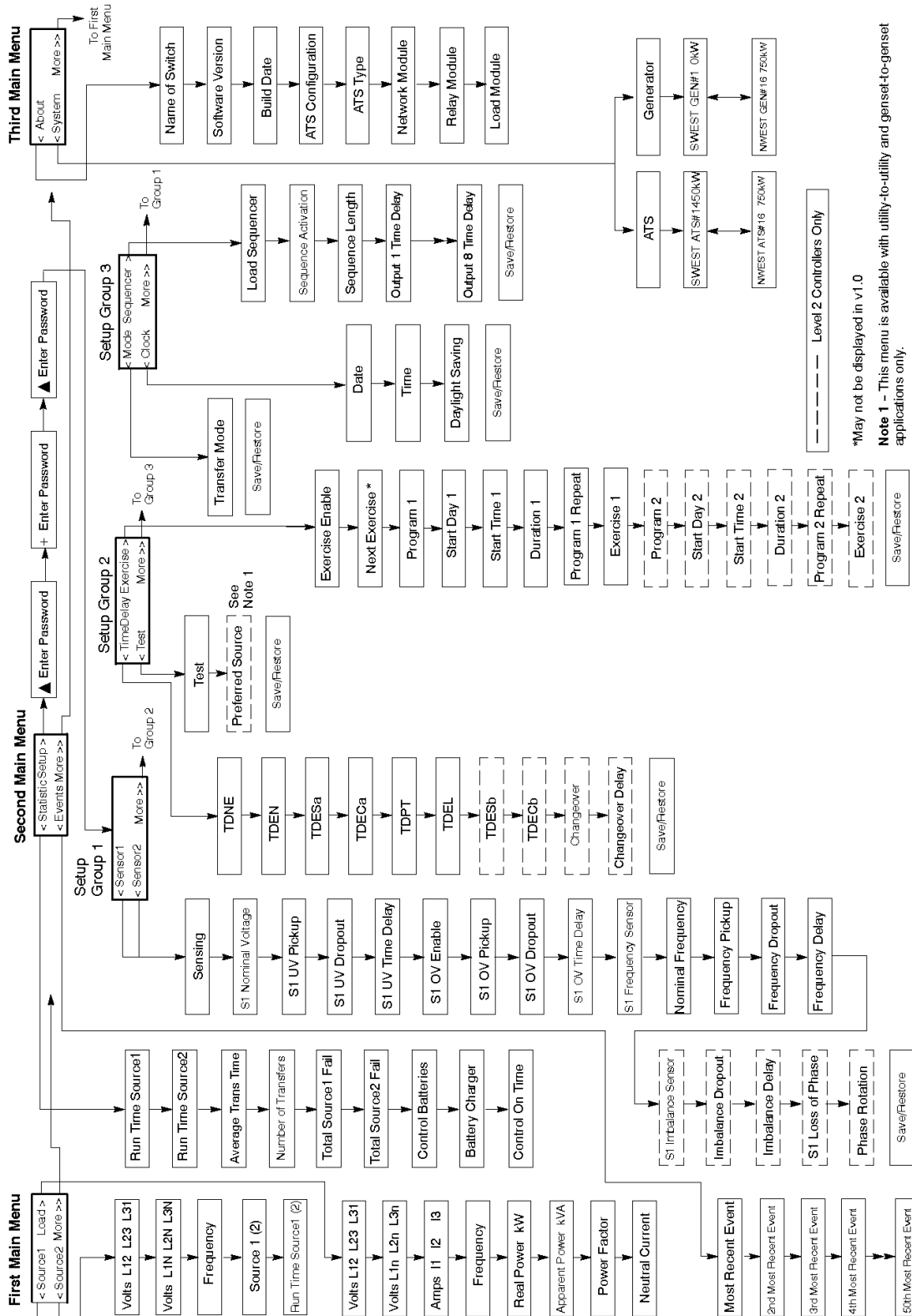


FIGURE 83. MENU SYSTEM MAP - PRIOR TO SOFTWARE VERSION 1.5.190

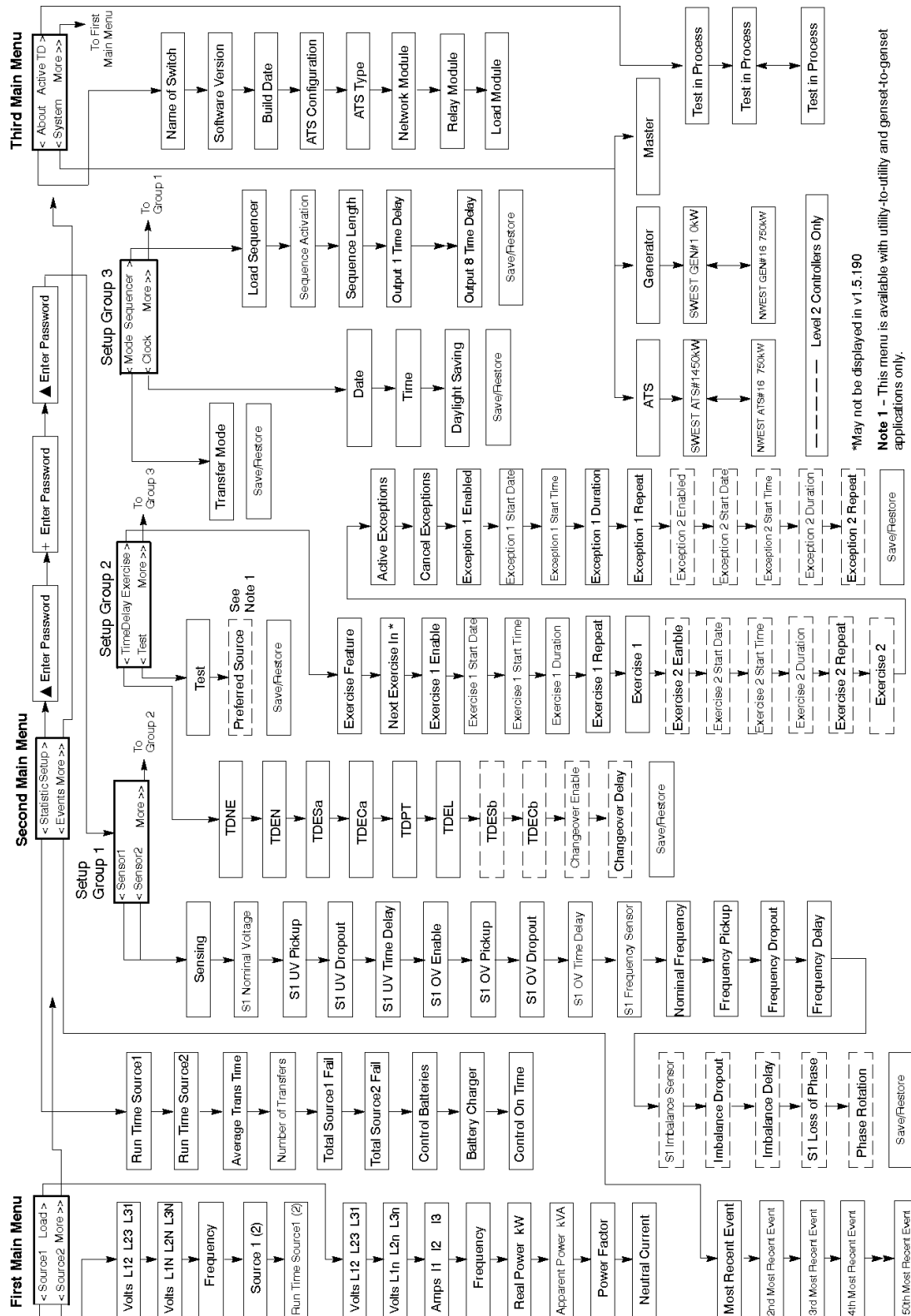


FIGURE 84. MENU SYSTEM MAP - STARTING WITH SOFTWARE VERSION 1.5.190





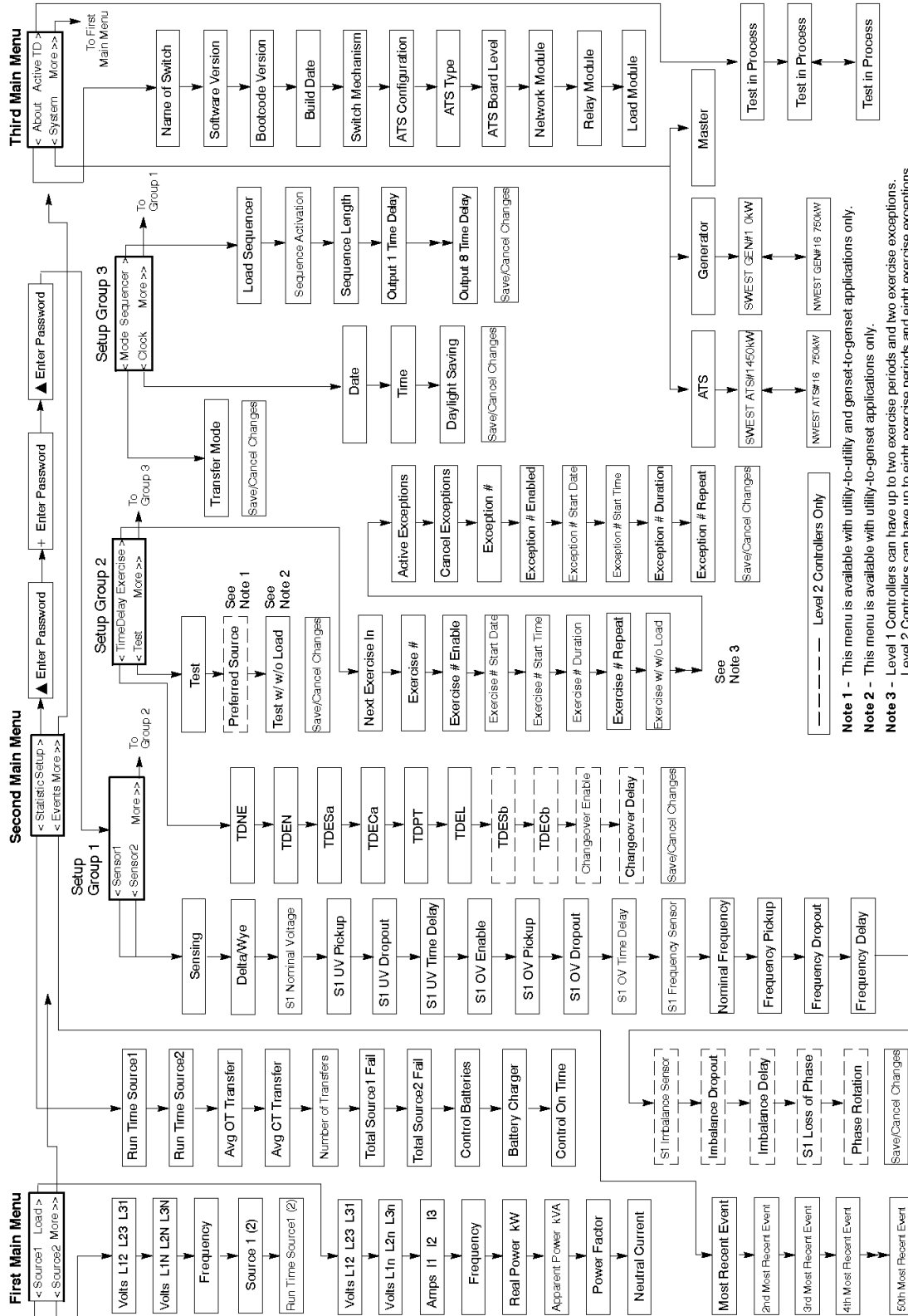


FIGURE 87. MENU SYSTEM MAP - STARTING WITH SOFTWARE VERSION 1.13.244

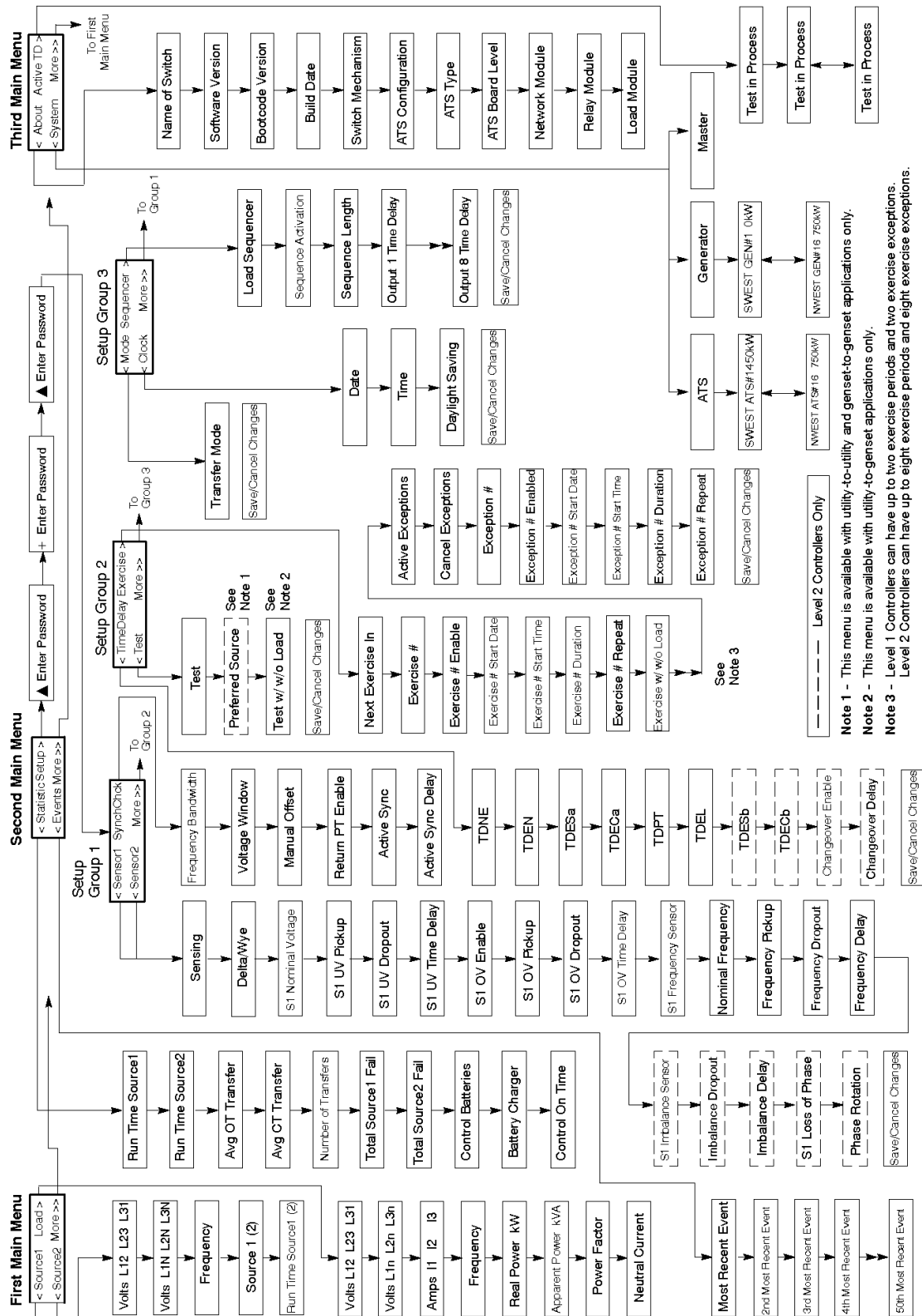


FIGURE 88. MENU SYSTEM MAP - STARTING WITH SOFTWARE VERSION 1.20.250



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# 5 Checkout

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If the transfer switch is equipped with a Digital Display, use it to checkout the switch. Refer to Section 4 for setup details. If the switch is not equipped with a Digital Display, use the the LED indicators located on the Digital Module mounted on the inside of the transfer switch enclosure door. See [Figure 89](#).

**⚠ WARNING**

*AC power within the cabinet and the rear side of the cabinet door presents a shock hazard that can cause severe personal injury or death. Use extreme caution to avoid touching electrical contacts whenever the cabinet door is open.*

**⚠ WARNING**

*Improper operation of the generator set presents a hazard that can cause severe personal injury or death. Observe all safety precautions in your generator set Operation and Installation manuals.*

## 5.1 STARTING TEST (UTILITY-TO-GENSET MODE)

1. Move the selector switch on the engine control to Run. The generator set should start and run.
2. Move the selector switch to Remote. The generator set should stop.

## 5.2 TEST TRANSFER WITH LOAD

1. Set the Test With/Without Load variable to the With Load value. Use the Digital Display Menu System or PC Service Tool.

**The Test With/Without Load variable must be set to the With Load value in order to test with load.**

2. Press and hold the Test switch for 2 seconds. With the appropriate time delays, the generator set should start and the load should be transferred to the generator. The Source 2 Available lamp lights when the generator output is sensed. The Source 2 Connected lamp lights to indicate that transfer has occurred.
3. Check the operation of the Bar Graph Meters (if equipped) on the cabinet door.
4. Press the Test switch. The transfer switch should retransfer load to Source 1 and stop the generator set after any time delays. The Source 1 Available lamp lights immediately. The Source 1 Connected lamp lights to indicate that retransfer has occurred.
5. Set the Test With/Without Load variable to the value you want to use for genset exercising.

## 5.3 CONTROL LED INDICATORS AND SWITCH

### 5.3.1 LED Indicators

The digital module located on the inside of the switch enclosure door contains ten LED indicators. The indicators provide some information about the current control status. These indicators may be helpful in troubleshooting the transfer switch when the Digital Display is not available. See [Figure 89](#) and [Table 15](#).

### 5.3.2 Exerciser Enable/Disable Switch

The Exerciser Enable/Disable switch ([Figure 89](#)) enables the control to exercise the genset during future scheduled exercise periods and lights the Exerciser Enabled indicator or disables the scheduled exercise period and turns the indicator off. The operator can also enable and disable the exerciser from the Digital Display, when it is available or from the PC Service Tool.

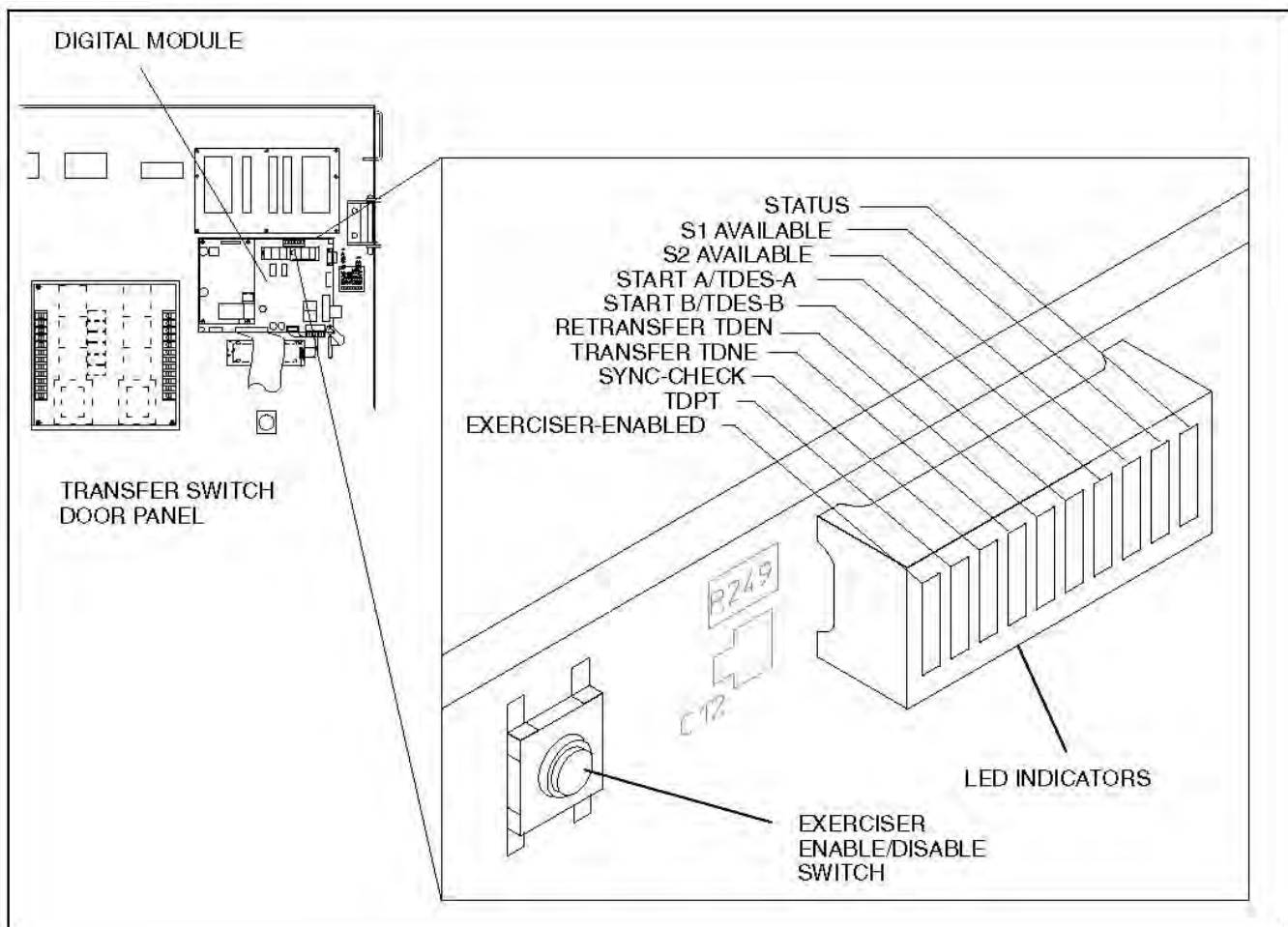


FIGURE 89. LED LOCATION ON DIGITAL MODULE (SHOWN ON THE 40 TO 125 AMP SWITCH)

**TABLE 15. DIGITAL MODULE LED INDICATORS**

<b>Indicator</b>	<b>Definition</b>
Status	Blinks at 1/2 Hz rate when the controller has power and the program is running without error. This indicator flashes the event code of an active event until the event is acknowledged with the Reset switch on the front panel. This indicator is sometimes referred to as the heart beat because it blinks constantly when the controller does not have an active event.
S1 Available	Lights when Power Source 1 has acceptable voltage and frequency limits. This indicator lights when the Source 1 Available indicator on the control panel lights.
S2 Available	Lights when Power Source 2 has acceptable voltage and frequency limits. This indicator lights when the Source 2 Available indicator on the control panel lights.
Start A/TDES-A	<ol style="list-style-type: none"> <li>1. Lights constantly when the control has commanded Source 2 to start</li> <li>2. Blinks at 1/2 Hz rate during the time delay to engine start (TDESa)</li> </ol>
Start B/TDES-B	<p>This indicator is only used for genset-to-genset applications when Source 1 is a generator not a utility.</p> <ol style="list-style-type: none"> <li>1. Lights constantly when the control has commanded Source 1 to start</li> <li>2. Blinks at 1/2 Hz rate during the time delay to engine start (TDESb)</li> </ol>
Retransfer/TDEN	<ol style="list-style-type: none"> <li>1. Lights when the control energizes the Retransfer relay</li> <li>2. Blinks at 1/2 Hz rate during the time delay to retransfer (TDEN)</li> </ol>
Transfer/TDNE	<ol style="list-style-type: none"> <li>1. Lights when the control energizes the Transfer relay</li> <li>2. Blinks at 1/2 Hz rate during the time delay to transfer (TDNE)</li> </ol>
Sync-Check	Blinks at 1-second rate when the in-phase sensor is active (maximum of 120 seconds).
TDPT	<p>Time Delay Programmed Transition</p> <p>Blinks at 1/2 Hz rate during the programmed transition time delay</p>
Exerciser Enabled	Lights when the Exerciser clock is enabled and blinks during an exercise period. The small switch next to the indicator enables and disables the exerciser. The operator can also enable and disable the exerciser from the Digital Display when it is available.

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# 6 Start-up Checklist

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## NOTICE

**Power must be available to the unit in order to perform this checklist.**

This start-up checklist provides the steps necessary to complete a typical setup. It also includes information on setting up a programmed exercise.

The transfer switch control is programmed at the factory with the voltage, frequency, and options listed on the nameplate. Make sure the application matches the nameplate values. Check the remote start connections before powering up the transfer switch.

- Verify that the remote start connections are correct for your application. For more information on jumper placement, refer to the interconnection diagram shipped with the unit.
- For Level 2 controls with 3-wire, 3-phase Delta applications, refer to the interconnection diagram shipped with the unit.

The transfer switch is released with the appropriate calibration and settings that allow the unit to function properly without any additional adjustments.

The clock must be set in order to maintain an accurate log of events and exercises. In addition, you may wish to set exercise periods and set the transfer switch to test with or without load (default = Without Load).

A setup can be done using the digital display or InPower™.

## 6.1 SETUP USING THE DIGITAL DISPLAY

- If the unit is equipped with a security key switch on the front door, place the switch in the Program position.

## NOTICE

**No changes can be made unless this key switch is in the Program position.**

- Using the digital display, navigate to the Setup sub-menu and enter the password (574).

### 6.1.1 Setting Exercise(s)

- Navigate to the Exercise sub-menus and set exercise(s):
  - [ ] Select "Enabled" to enable the exercise feature.
  - [ ] Select "Enabled" to enable an exercise.
  - [ ] Select a day between Sunday and Saturday.
  - [ ] Enter the time of day the exercise cycle is to begin (hr = 0-23, mn = 0-59).
  - [ ] Set the duration the exercise cycle will run (hr = 0-23, mn = 0-59).
  - [ ] Enter the number of weeks between each exercise (interval) (0 = one time only, 1 = once a week, 2 = once every two weeks, 52 = once every 52 weeks).

- [ ] Select whether or not you want the exercise to run the generator(s) with or without a load. The default is "Without Load."

#### NOTICE

**Exercise exceptions are also available through the digital display menus. For more information, see the *Operator's Manual*. Exercise exceptions can be cancelled in the "Cancel Active Excppts" sub-menu (change from "Normal" to "Cancel").**

## 6.1.2 Setting the Unit to Test With or Without Load

- Navigate to the Test sub-menu and set the Test Switch to Test With or Without Load:
  - [ ] Select whether or not you want your transfer switch to test "With" or "Without Load." The default is "Without Load."

## 6.1.3 Saving the Settings and System Verification

- Before exiting the Setup sub-menus, save the changes made to the control settings by pressing the Home button, then selecting Save on the menu.
- Next, verify that the transfer switch is operating properly.
  - [ ] Check to make sure the correct time is displayed.
  - [ ] View the "Next Exercise In" sub-menu to verify that a time is displayed.
  - [ ] Do a complete system check, including simulating a power outage. For more information about operation, see the Operator Manual.

## 6.1.4 Features

Loss of phase detection and voltage imbalance sensing are disabled at the factory. Before enabling them, see the *Operator's Manual* to review the feature descriptions.

#### ⚠ CAUTION

***Level 1 controls do not support three-phase sensing on Source 2. Do not select the three-phase option for the Source 2 Sensing adjustment with Level 1 controls, even if the system is three phase. This setting will prevent Source 2 from becoming available.***

## 6.2 SETUP USING INPOWER

### 6.2.1 Setting Exercise(s)

- Navigate to the Adjustments → Feature Enable folder.
  - [ ] Select "Enabled" to enable an exercise.
  - [ ] Select the "Save Adjustments" icon.
- Navigate to the Adjustments → Exerciser Clock folder.
  - [ ] Enable Program 1.
  - [ ] Select a start day between Sunday and Saturday.

- Set the time the exercise cycle is to begin (hr = 0-23, mn = 0-59).
- Set the duration of the exercise cycle (hr = 0-23, mn = 0-59).
- Enter an interval that the exercise cycle will repeat (0 = one time only, 1 = once a week, 2 = once every two weeks, 52 = once every 52 weeks).
- Select whether or not you want the exercise to run the generator(s) with or without a load. The default is "Without Load."
- Select the "Save Adjustments" icon.

#### NOTICE

The Reset Exerciser Repeat Count feature, in the Controller Mode folder, can be used to change a repeat interval. Switch the setting from "False" to "True" for the new interval to take effect. The setting will automatically switch back to "False" again.

#### NOTICE

Exercise exceptions are available through the Adjustments → Exceptions folder. Refer to the InPower *User's Guide* for more information.

## 6.2.2 Setting the Unit to Test With or Without Load

- Navigate to the Test → Setup folder.
  - Set the Test Switch to test "With" or "Without Load." The default is "Without Load."
  - Select the "Save Adjustments" icon.

## 6.2.3 Saving the Settings and System Verification

- To store your settings in a capture file, select the Device" pull-down menu and select "Capture to file."
- Next, verify that the transfer switch is operating properly.
  - Do a complete system check, including simulating a power outage. For more information about the operation, see the Operator Manual.
  - Review settings.

## 6.2.4 Features

Loss of phase detection and voltage imbalance sensing are disabled at the factory. Before enabling them, see the *Operator's Manual* to review the feature descriptions.

#### ⚠ CAUTION

***Level 1 controls do not support three-phase sensing on Source 2. Do not select the three-phase option for the Source 2 Sensing adjustment with Level 1 controls, even if the system is three phase. This setting will prevent Source 2 from becoming available.***



## **6.2.5 About InPower Service Tool**

The InPower service tool can be used to test the transfer switch using functions, including Remote Test, Transfer Inhibit, Retransfer Inhibit, etc. InPower, when used improperly, can cause symptoms like warnings and shutdowns that appear to be a defective control. When these problems occur, always verify that a Test feature was not left enabled with InPower. Always disable test features before disconnecting InPower.

## **6.2.6 About Network Applications and Customer Inputs**

In applications with networks and remote customer inputs, these inputs may cause unexpected genset or transfer switch operation. These symptoms may appear to be caused by the transfer switch control. Verify that the remote input is not causing the symptom or isolate the control from these inputs before troubleshooting the control.

# 7 Wiring Considerations for Closed Transition Transfer Switches

There are two functions that should be used with closed transition transfer switches: The transfer and re-transfer inhibit functions should be used to prevent two switches from transferring at the same time and the fail to disconnect output of the relay signal module should be wired to the shunt trip of one of the breakers feeding the ATS to prevent extended paralleling of the two sources.

## 7.1 Re-transfer and transfer inhibit functions

In applications with more than one closed transition ATS, the transfer and re-transfer inhibit functions should be used to prevent multiple transfer switches from transferring at the same time. For example to prevent two switches from re-transferring from the genset to the utility at the same time wire the normally closed contact that indicates the first ATS is connected to the normal source into the retransfer inhibit input of the transfer switch that is intended to transfer second. Ground the common aux contact on the first switch so that the re-transfer inhibit input on the second switch is grounded when the first transfer switch is not connected to the normal source. This will inhibit the second switch from beginning its retransfer sequence (including all time delays) until after the first transfer switch has transferred back to the normal source. A similar wiring scheme can be used when transferring to the emergency source so that only one switch transfers at a time. Switch position indicators are available on the relay signal module which is included with all Cummins closed transition ATS models. [Figure 90](#) and [Figure 91](#) illustrate how this can be done with all of Cummins' closed transition transfer switch models.

BTPC 1600 - 3000, CHPC

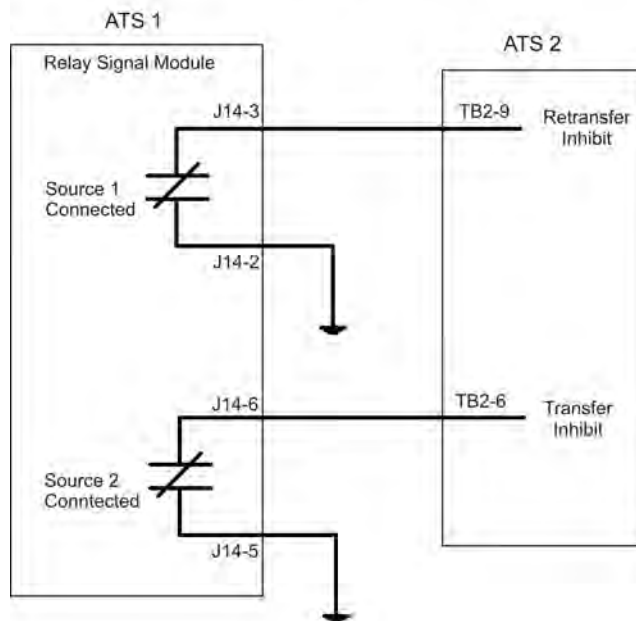


FIGURE 90. BTPC 1600-3000, CHPC

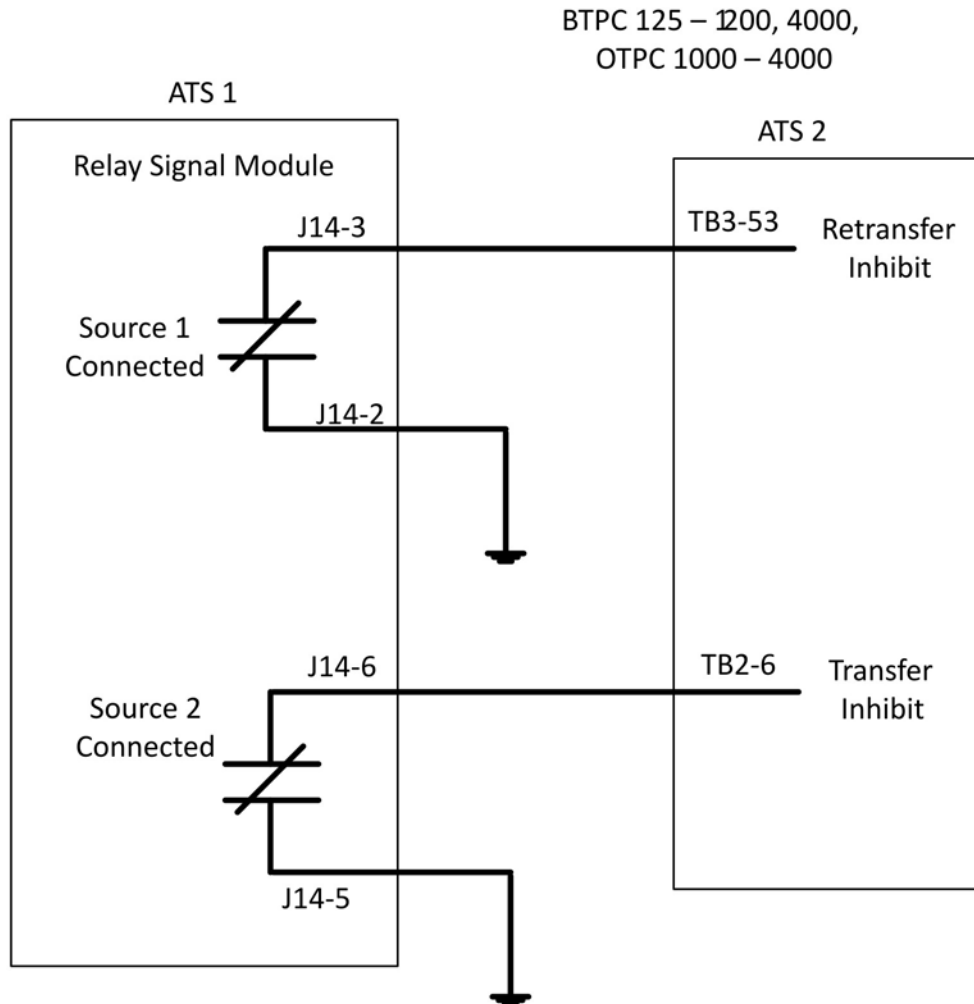
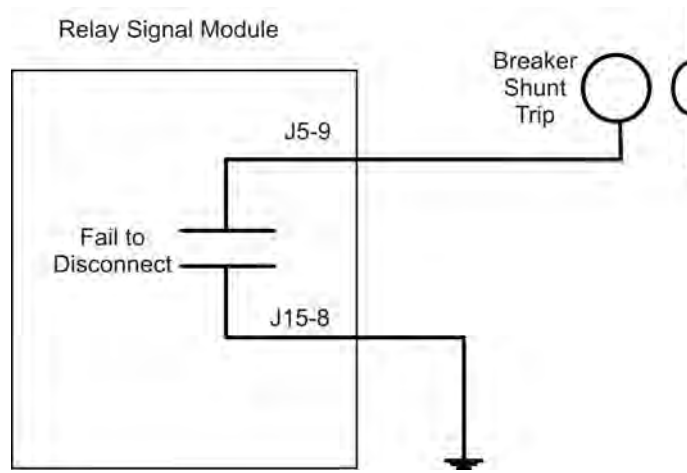


FIGURE 91. BTPC 125-1200, 4000, OTPC 1000-4000

## 7.2 Fail to disconnect

The Fail to Disconnect relay is active when the transfer switch remains connected to both sources for more than 100 msec during a closed transition transfer. It should be wired to the shunt trip of the breaker feeding the ATS on either the normal or the emergency side. The fail to disconnect relay is located on the relay signal module. See [Figure 92](#).



**FIGURE 92. BREAKER SHUNT TRIP**

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# Appendix A. Interconnect and Connection Diagrams

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This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

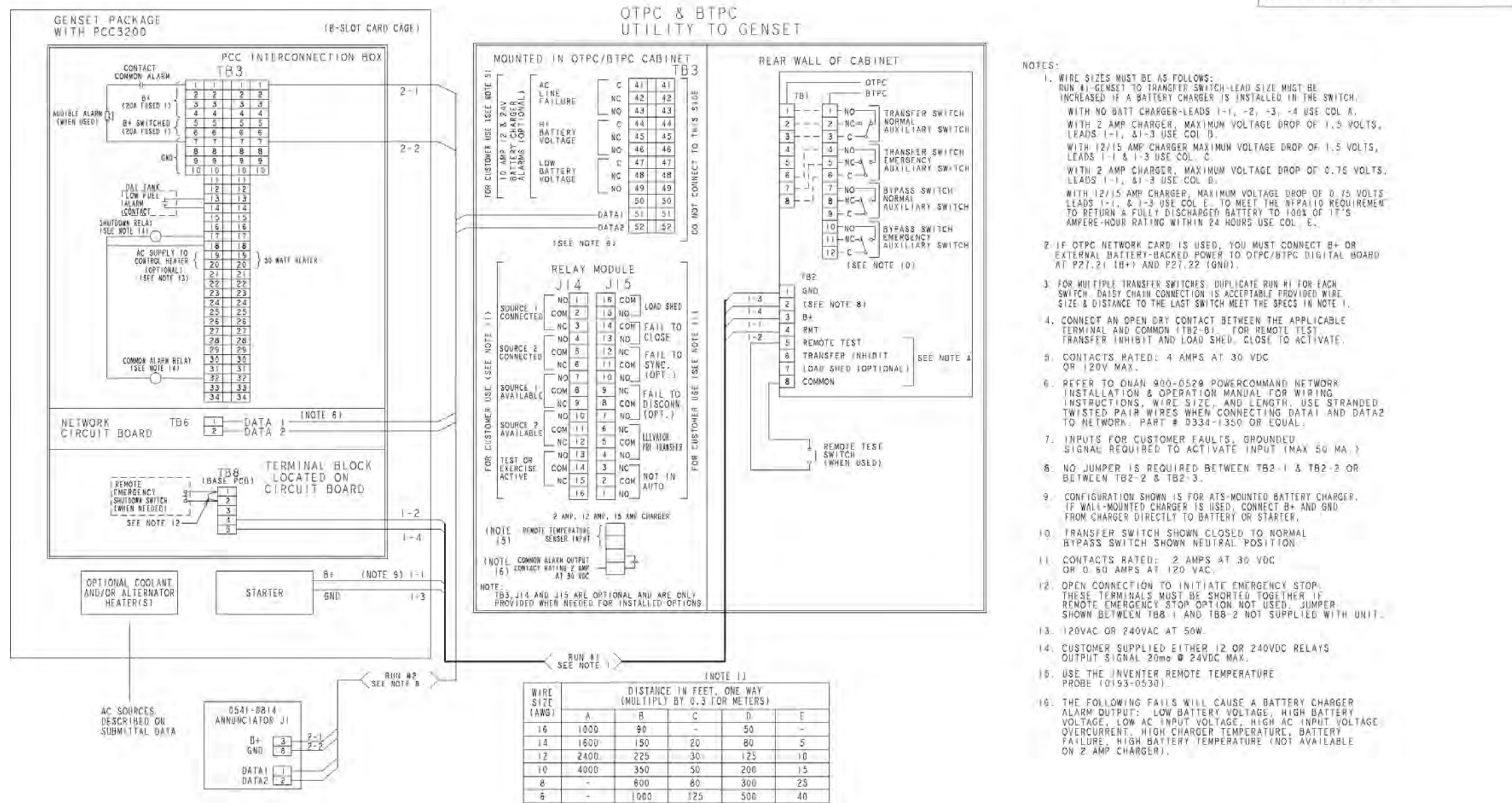
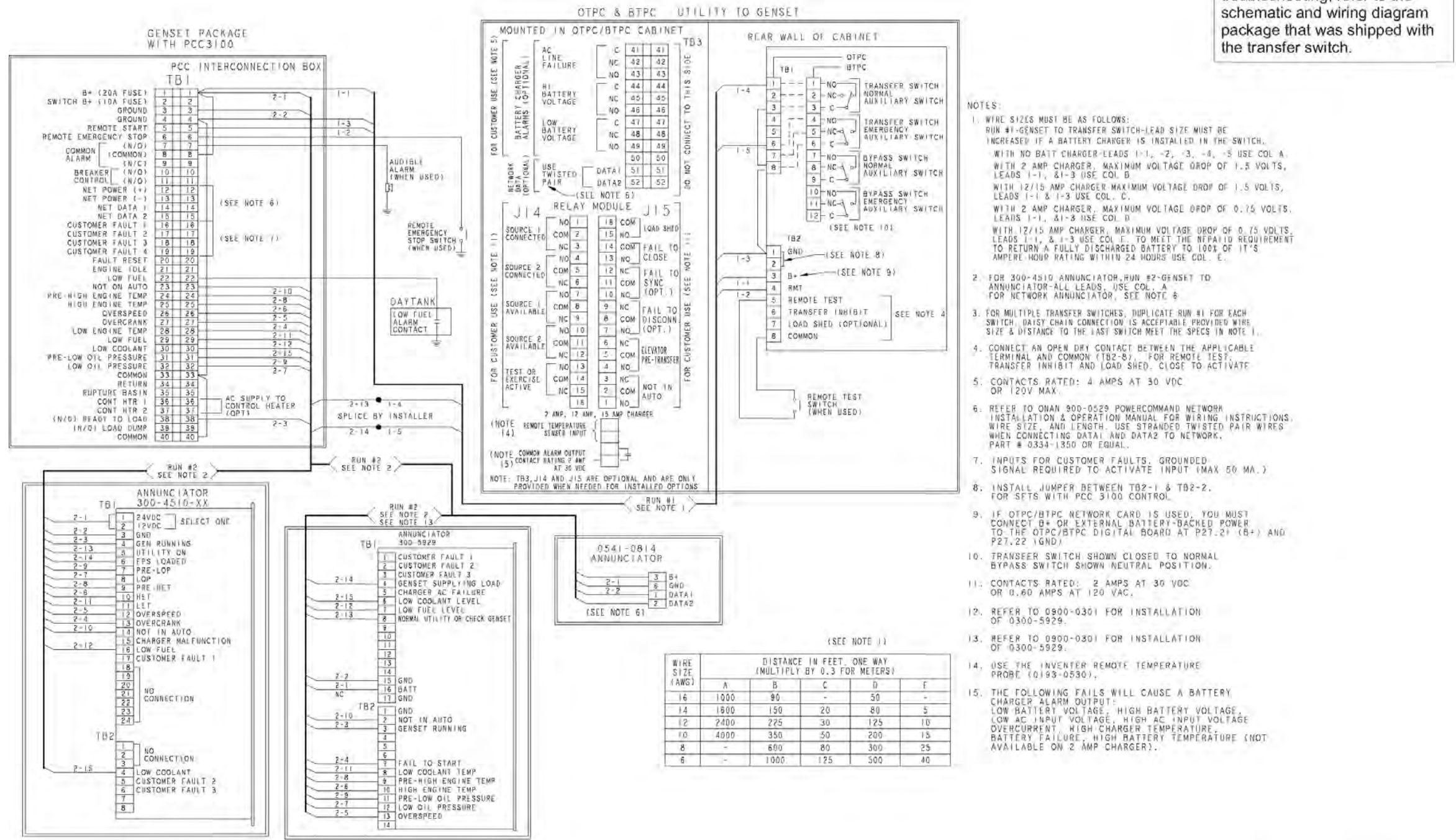


FIGURE 93. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 1 OF 10)

No. 0630-1974 sh 1 of 10  
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Modified 2/2011



This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.



- NOTES:**
1. WIRE SIZES MUST BE AS FOLLOWS:  
 RUN #1-GENSET TO TRANSFER SWITCH-LEAD SIZE MUST BE INCREASED IF A BATTERY CHARGER IS INSTALLED IN THE SWITCH.  
 WITH NO BATT CHARGER-LEADS 1-1, -2, -3, -4, -5 USE COL. A.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1, & 1-3 USE COL. B.  
 WITH 12/15 AMP CHARGER MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1 & 1-3 USE COL. C.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL. E. TO MEET THE NFPA10 REQUIREMENT TO RETURN A FULLY DISCHARGED BATTERY TO 100% OF IT'S AMPERE-HOUR RATING WITHIN 24 HOURS USE COL. E.
  2. FOR 300-4510 ANNUNCIATOR, RUN #2-GENSET TO ANNUNCIATOR-ALL LEADS, USE COL. A. FOR NETWORK ANNUNCIATOR, SEE NOTE 8.
  3. FOR MULTIPLE TRANSFER SWITCHES, DUPLICATE RUN #1 FOR EACH SWITCH, DAISY CHAIN CONNECTION IS ACCEPTABLE PROVIDED WIRE SIZE & DISTANCE TO THE LAST SWITCH MEET THE SPECS IN NOTE 1.
  4. CONNECT AN OPEN DRY CONTACT BETWEEN THE APPLICABLE TERMINAL AND COMMON (TB2-8) FOR REMOTE TEST, TRANSFER INHIBIT AND LOAD SHED, CLOSE TO ACTIVATE.
  5. CONTACTS RATED: 4 AMPS AT 30 VDC OR 120V MAX.
  6. REFER TO ONAN 900-0529 POWERCOMMAND NETWORK INSTALLATION & OPERATION MANUAL FOR WIRING INSTRUCTIONS, WIRE SIZE, AND LENGTH. USE STRANDED TWISTED PAIR WIRES WHEN CONNECTING DATA1 AND DATA2 TO NETWORK, PART # 0334-1350 OR EQUAL.
  7. INPUTS FOR CUSTOMER FAULTS, GROUNDED-SIGNAL REQUIRED TO ACTIVATE INPUT (MAX 50 MA.)
  8. INSTALL JUMPER BETWEEN TB2-1 & TB2-2. FOR SETS WITH PCC 3100 CONTROL.
  9. IF OTPC/BTPC NETWORK CARD IS USED, YOU MUST CONNECT B+ OR EXTERNAL BATTERY-BACKED POWER TO THE OTPC/BTPC DIGITAL BOARD AT P27-21 (B+) AND P27-22 (GND).
  10. TRANSFER SWITCH SHOWN CLOSED TO NORMAL BYPASS SWITCH SHOWN NEUTRAL POSITION.
  11. CONTACTS RATED: 2 AMPS AT 30 VDC OR 0.60 AMPS AT 120 VAC.
  12. REFER TO 0900-0301 FOR INSTALLATION OF 0300-5929.
  13. REFER TO 0900-0301 FOR INSTALLATION OF 0300-5929.
  14. USE THE INVENTER REMOTE TEMPERATURE PROBE (0193-0530).
  15. THE FOLLOWING FAILS WILL CAUSE A BATTERY CHARGER ALARM OUTPUT:  
 LOW BATTERY VOLTAGE, HIGH BATTERY VOLTAGE, LOW AC INPUT VOLTAGE, HIGH AC INPUT VOLTAGE, OVERCURRENT, HIGH CHARGER TEMPERATURE, BATTERY FAILURE, HIGH BATTERY TEMPERATURE (NOT AVAILABLE ON 2 AMP CHARGER).

FIGURE 94. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 2 OF 10)

No. 0630-1974 sh 2 of 10  
 Rev. N  
 Modified 2/2011

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

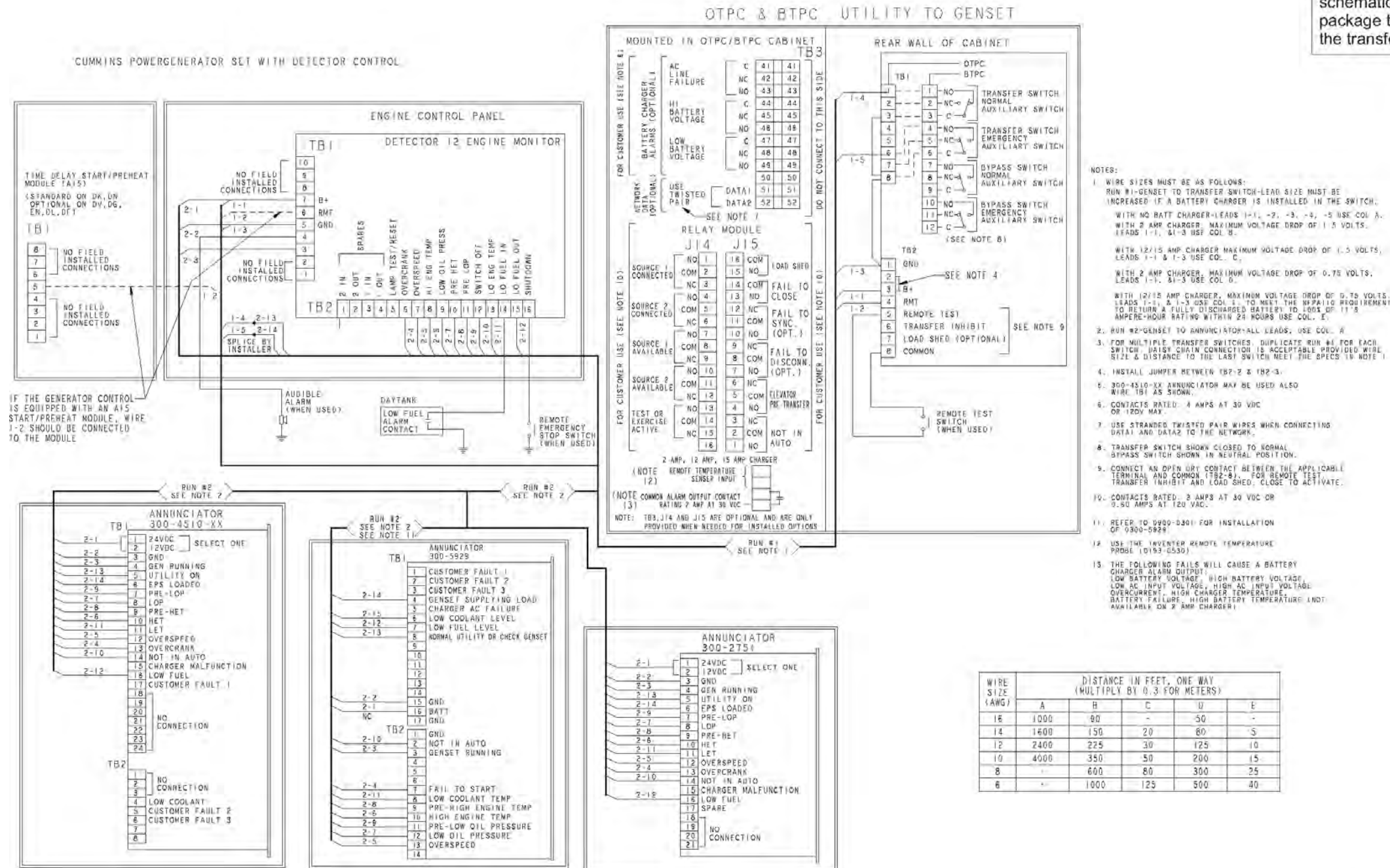
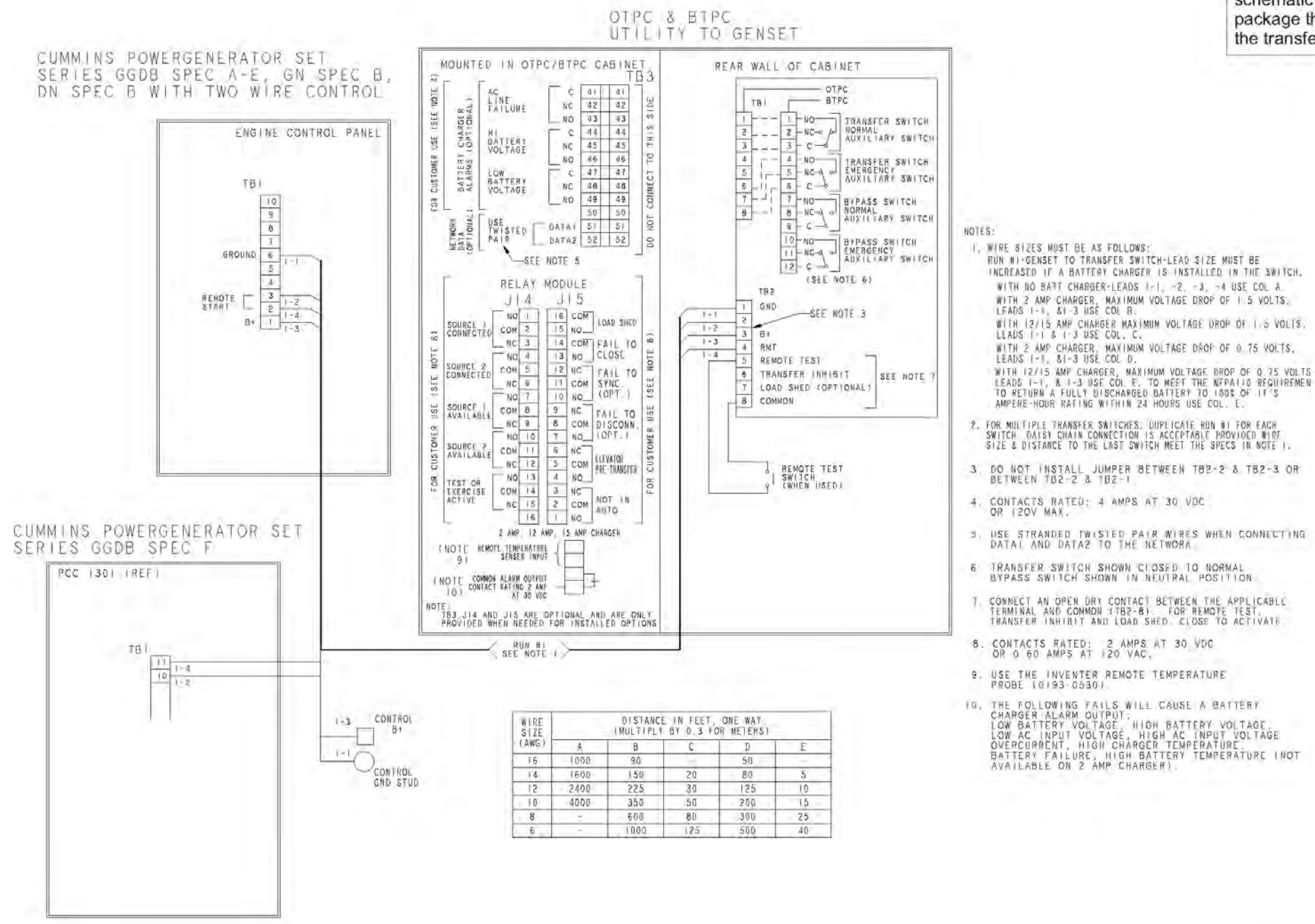


FIGURE 95. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 3 OF 10)

No. 0630-1974 sh 3 of 10  
Rev. N  
Modified 2/2011

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.



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FIGURE 96. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 4 OF 10)

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

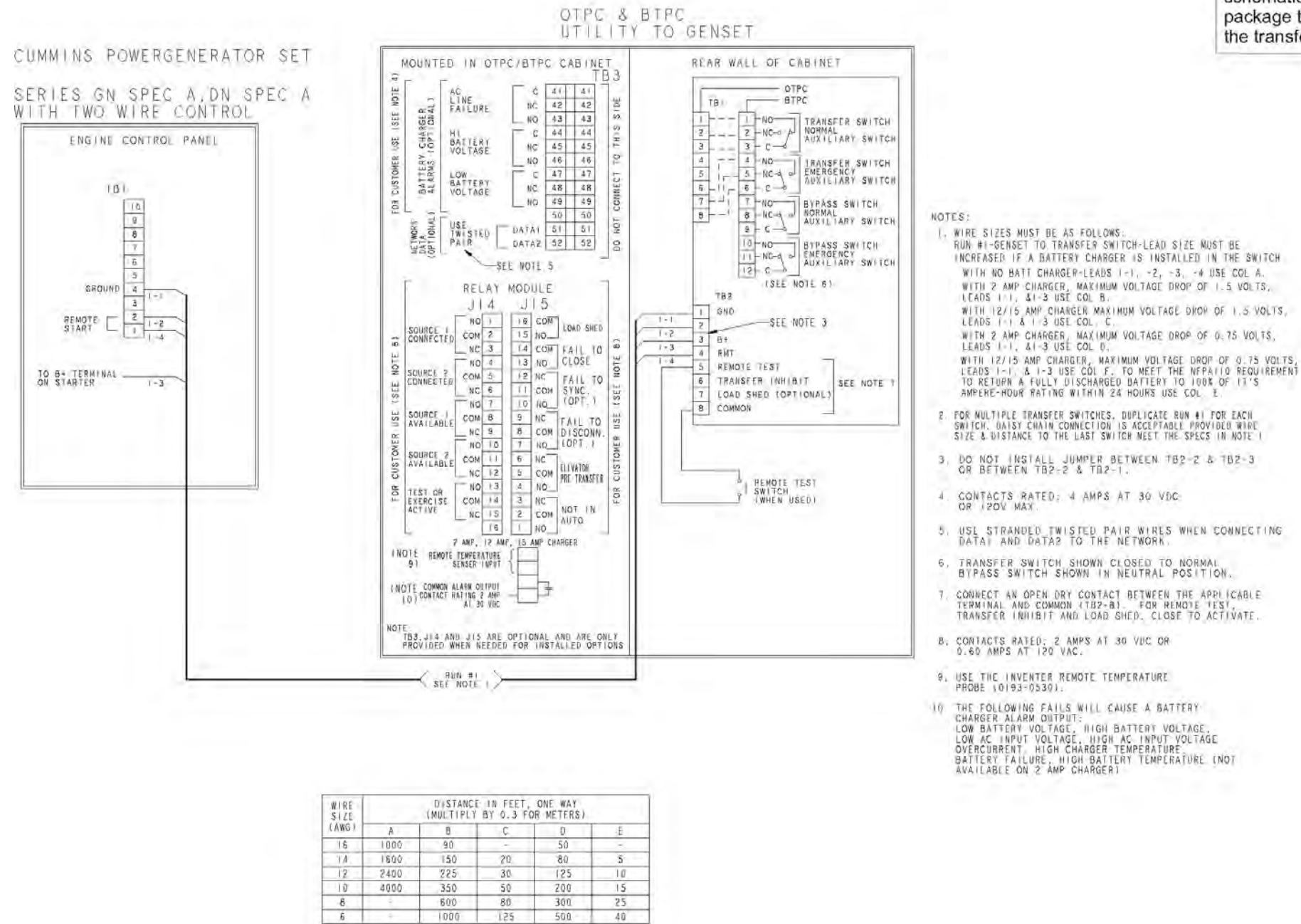


FIGURE 97. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 5 OF 10)

No. 0630-1974 sh 5 of 10  
Rev. N  
Modified 2/2011

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

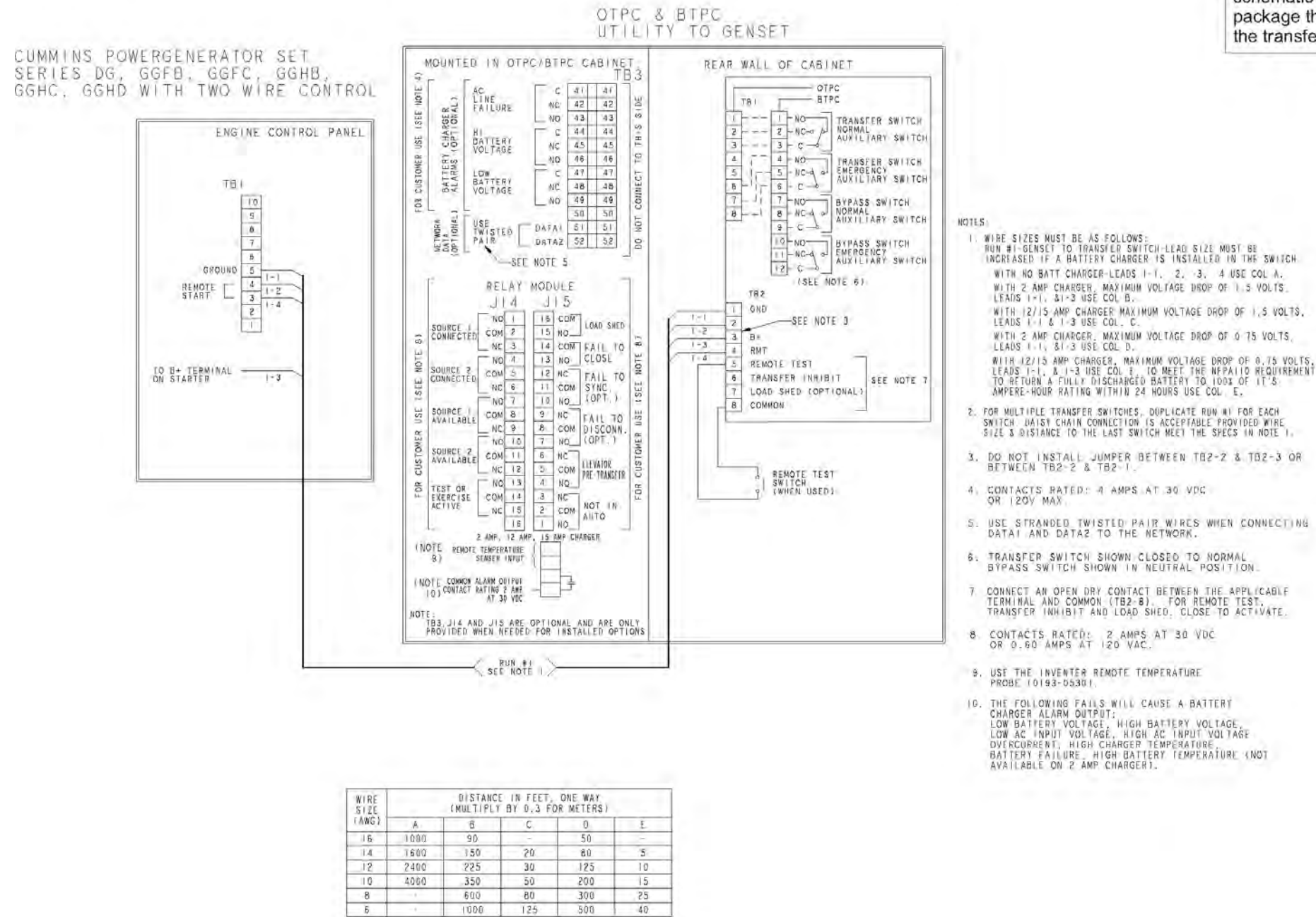


FIGURE 98. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 6 OF 10)

No. 0630-1974 sh 6 of 10  
 Rev. N  
 Modified 2/2011





This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

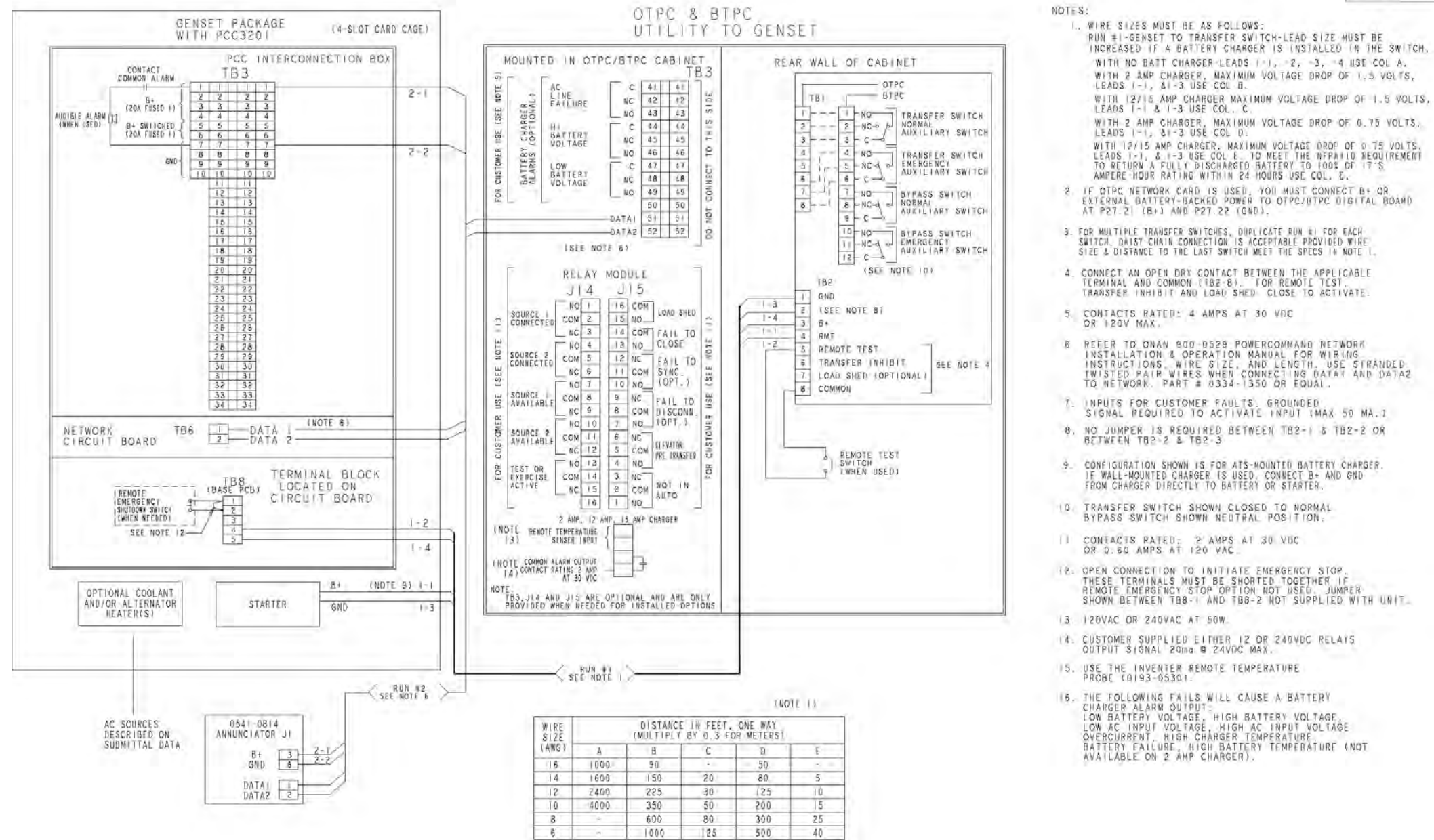
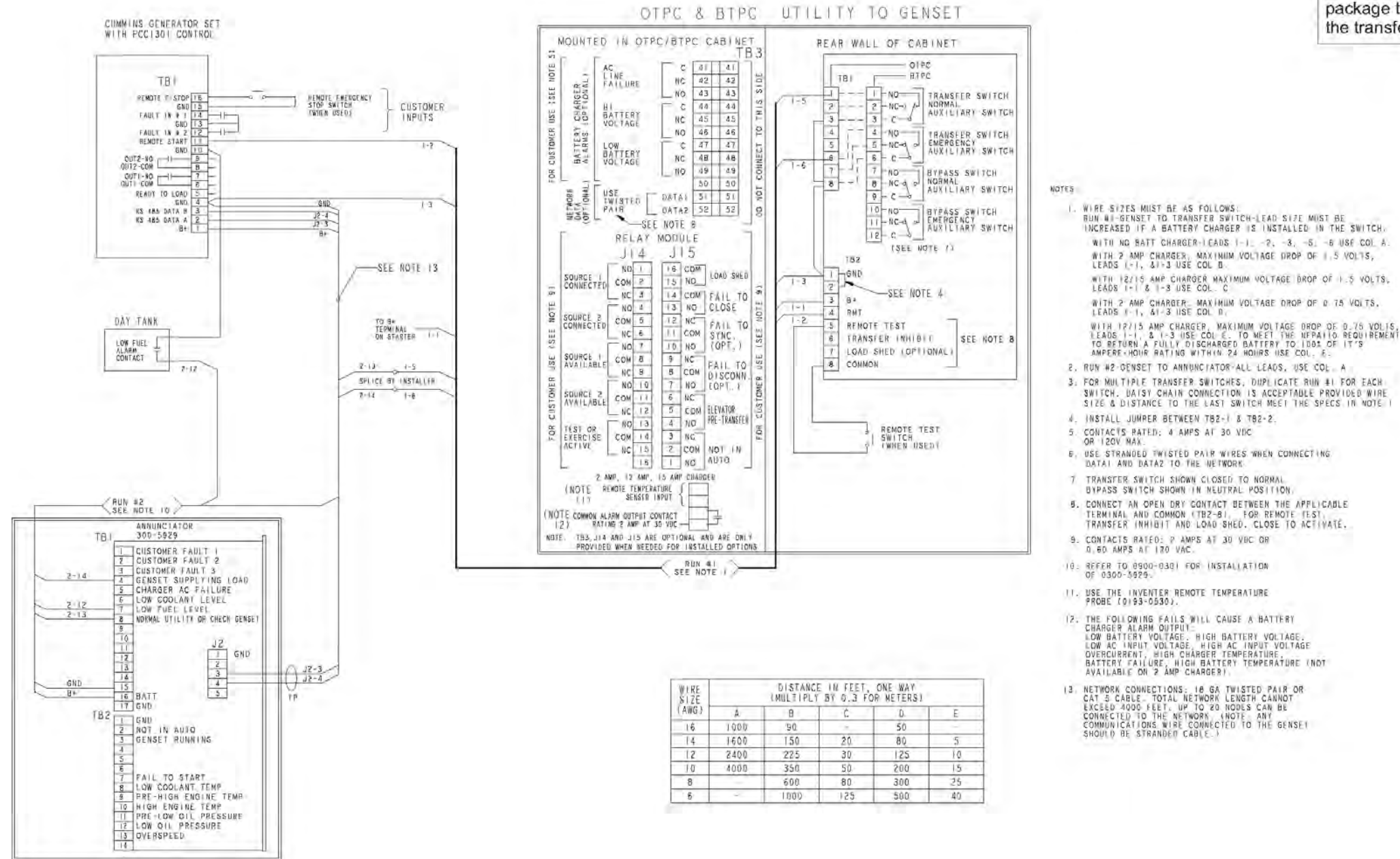


FIGURE 100. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 8 OF 10)

No. 0630-1974 sh 8 of 10  
 Rev. N  
 Modified 2/2011

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.



- NOTES**
- WIRE SIZES MUST BE AS FOLLOWS:  
 RUN #1-GENSET TO TRANSFER SWITCH-LEAD SIZE MUST BE INCREASED IF A BATTERY CHARGER IS INSTALLED IN THE SWITCH.  
 WITH NO BATT CHARGER-LEADS 1-1, 2, 3, 5, 6 USE COL. A.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1, & 1-3 USE COL. B.  
 WITH 12/15 AMP CHARGER MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1 & 1-3 USE COL. C.  
 WITH 2 AMP CHARGER- MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL. D.  
 WITH 12/15 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL. E. TO MEET THE NFPA110 REQUIREMENT TO RETURN A FULLY DISCHARGED BATTERY TO 100% OF IT'S AMPERE-HOUR RATING WITHIN 24 HOURS USE COL. E.
  - RUN #2-GENSET TO ANNUNCIATOR-ALL LEADS, USE COL. A
  - FOR MULTIPLE TRANSFER SWITCHES, DUPLICATE RUN #1 FOR EACH SWITCH. BAIST CHAIN CONNECTION IS ACCEPTABLE PROVIDED WIRE SIZE & DISTANCE TO THE LAST SWITCH MEET THE SPECS IN NOTE 1
  - INSTALL JUMPER BETWEEN TB2-1 & TB2-2.
  - CONTACTS RATED: 4 AMPS AT 30 VDC OR 120V MAX.
  - USE STRANDED TWISTED PAIR WIRES WHEN CONNECTING DATA1 AND DATA2 TO THE NETWORK.
  - TRANSFER SWITCH SHOWN CLOSED TO NORMAL. BYPASS SWITCH SHOWN IN NEUTRAL POSITION.
  - CONNECT AN OPEN DRY CONTACT BETWEEN THE APPLICABLE TERMINAL AND COMMON (TB2-8), FOR REMOTE TEST, TRANSFER INHIBIT AND LOAD SHED, CLOSE TO ACTIVATE.
  - CONTACTS RATED: 2 AMPS AT 30 VDC OR 0.60 AMPS AT 120 VAC
  - REFER TO 0900-0301 FOR INSTALLATION OF 0300-5929.
  - USE THE INVENTOR REMOTE TEMPERATURE PROBE (0193-0530).
  - THE FOLLOWING FAILS WILL CAUSE A BATTERY CHARGER ALARM OUTPUT:  
 LOW BATTERY VOLTAGE, HIGH BATTERY VOLTAGE, LOW AC INPUT VOLTAGE, HIGH AC INPUT VOLTAGE, OVERCURRENT, HIGH CHARGER TEMPERATURE, BATTERY FAILURE, HIGH BATTERY TEMPERATURE (NOT AVAILABLE ON 2 AMP CHARGER).
  - NETWORK CONNECTIONS: 16 GA TWISTED PAIR OR CAT 5 CABLE. TOTAL NETWORK LENGTH CANNOT EXCEED 4000 FEET. UP TO 20 NODES CAN BE CONNECTED TO THE NETWORK (NOTE: ANY COMMUNICATIONS WIRE CONNECTED TO THE GENSET SHOULD BE STRANDED CABLE.)

FIGURE 101. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 9 OF 10)

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 Rev. N  
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This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

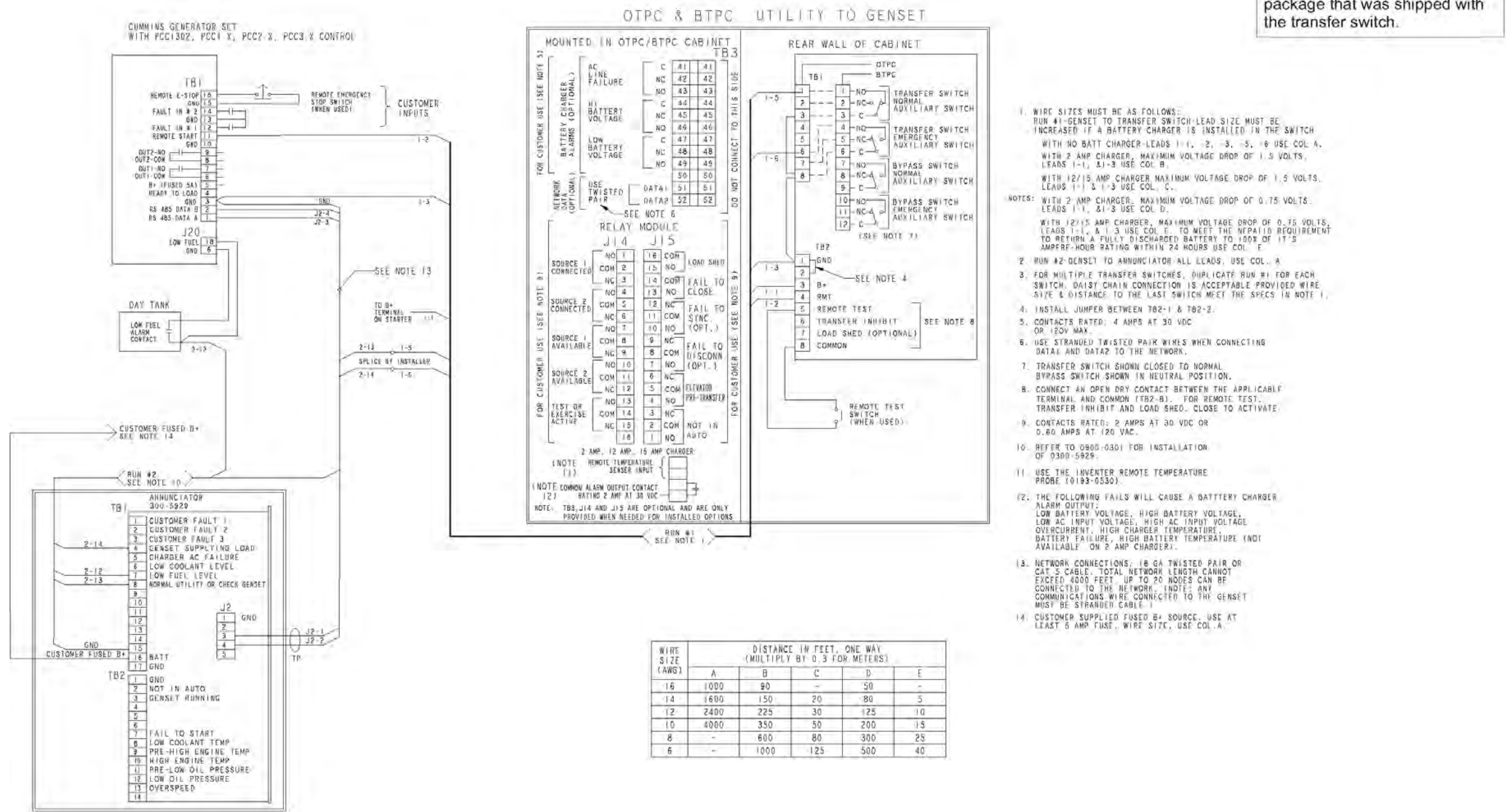
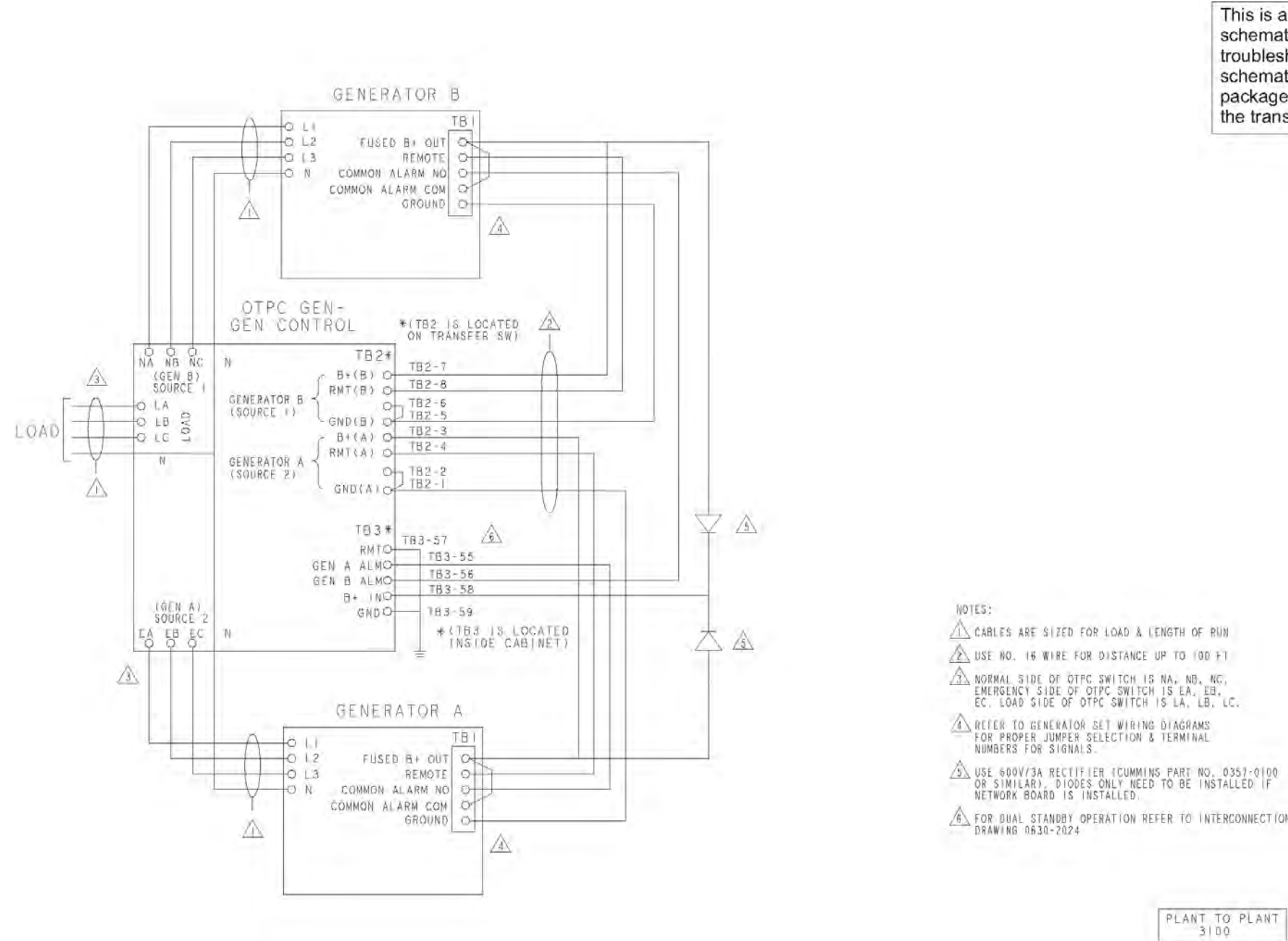


FIGURE 102. 1200 AMP TYPICAL INTERCONNECTION DIAGRAM (SHEET 10 OF 10)

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Rev. N  
Modified 2/2011

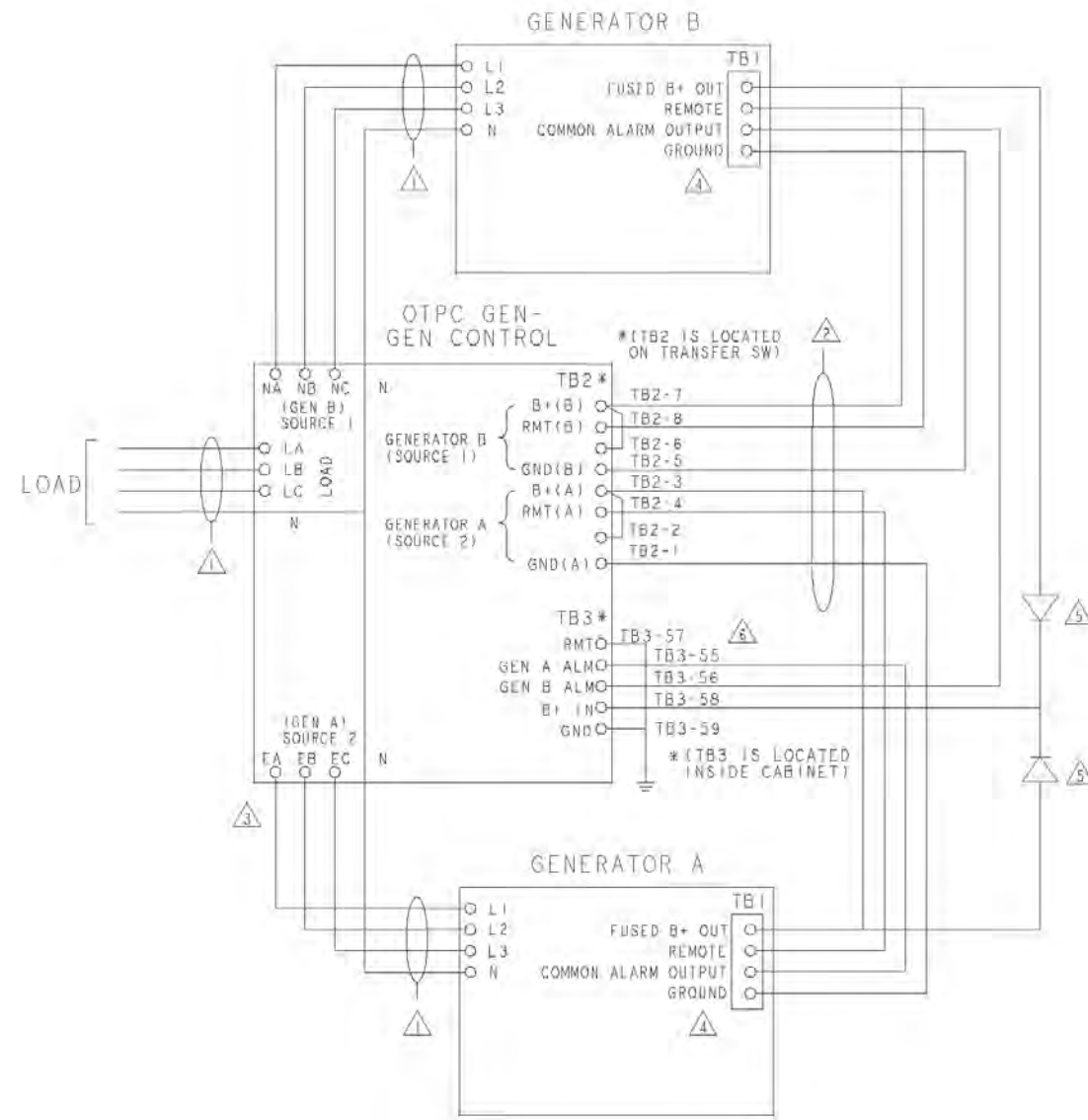


This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

- NOTES:
- 1 CABLES ARE SIZED FOR LOAD & LENGTH OF RUN
  - 2 USE NO. 16 WIRE FOR DISTANCE UP TO 100 FT
  - 3 NORMAL SIDE OF OTPC SWITCH IS NA, NB, NC, EMERGENCY SIDE OF OTPC SWITCH IS EA, EB, EC. LOAD SIDE OF OTPC SWITCH IS LA, LB, LC.
  - 4 REFER TO GENERATOR SET WIRING DIAGRAMS FOR PROPER JUMPER SELECTION & TERMINAL NUMBERS FOR SIGNALS.
  - 5 USE 600V/3A RECTIFIER (CUMMINS PART NO. 0357-0100 OR SIMILAR). DIODES ONLY NEED TO BE INSTALLED IF NETWORK BOARD IS INSTALLED.
  - 6 FOR DUAL STANDBY OPERATION REFER TO INTERCONNECTION DRAWING 0630-2024

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Rev. E  
Modified 1/2011

FIGURE 103. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, PLANT-TO-PLANT (SHEET 1 OF 4)



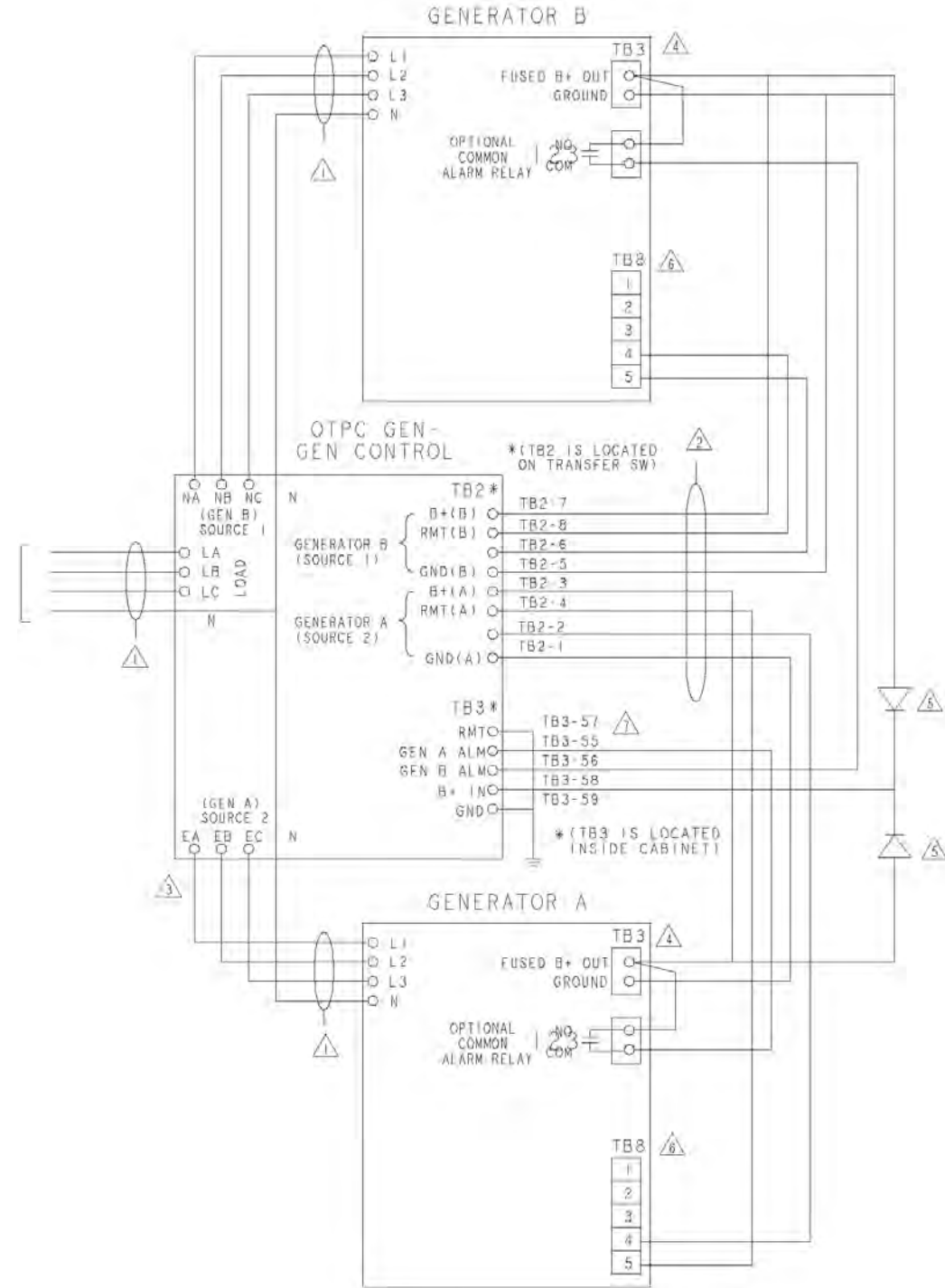
This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

- NOTES:
- ⚠ CABLES ARE SIZED FOR LOAD & LENGTH OF RUN.
  - ⚠ USE NO. 16 WIRE FOR DISTANCE UP TO 100 FT.
  - ⚠ NORMAL SIDE OF OTPC SWITCH IS NA, NB, NC. EMERGENCY SIDE OF OTPC SWITCH IS EA, EB, EC. LOAD SIDE OF OTPC SWITCH IS LA, LB, LC.
  - ⚠ REFER TO GENERATOR SET WIRING DIAGRAMS FOR PROPER JUMPER SELECTION & TERMINAL NUMBERS FOR SIGNALS.
  - ⚠ USE 600V/3A RECTIFIER (CUMMINS PART NO. 8357-0100 OR SIMILAR). DIODES ONLY NEED TO BE INSTALLED IF NETWORK BOARD IS INSTALLED.
  - ⚠ FOR DUAL STANDBY OPERATION REFER TO INTERCONNECTION DRAWING 0630-2024.

PLANT TO PLANT  
DETECTOR - 12

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FIGURE 104. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, PLANT-TO-PLANT (SHEET 2 OF 4)



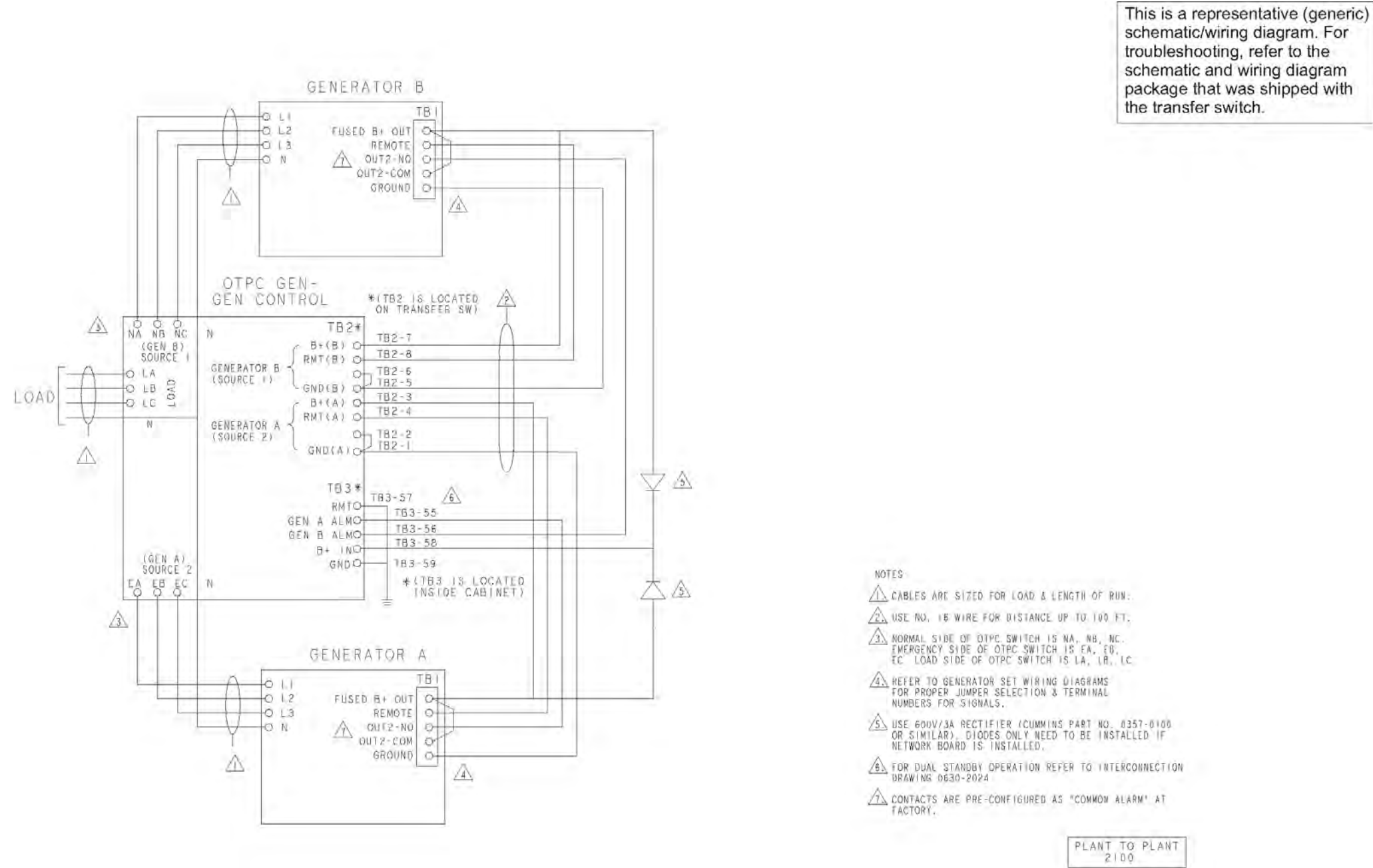
This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

- NOTES:
- ⚠️ CABLES ARE SIZED FOR LOAD & LENGTH OF RUN.
  - ⚠️ USE NO. 16 WIRE FOR DISTANCE UP TO 100 FT.
  - ⚠️ NORMAL SIDE OF OTPC SWITCH IS NA, NB, NC. EMERGENCY SIDE OF OTPC SWITCH IS EA, EB, EC. LOAD SIDE OF OTPC SWITCH IS LA, LB, LC.
  - ⚠️ REFER TO GENERATOR SET WIRING DIAGRAMS FOR PROPER JUMPER SELECTION & TERMINAL NUMBERS FOR SIGNALS.
  - ⚠️ USE 600V/3A RECTIFIER (CUMMINS PART NO. 0357-0100 OR SIMILAR). DIODES ONLY NEEDED TO BE INSTALLED IF NETWORK BOARD IS INSTALLED.
  - ⚠️ TERMINAL BLOCK LOCATED ON CIRCUIT BOARD.
  - ⚠️ FOR DUAL STANDBY OPERATION REFER TO INTERCONNECTION DRAWING 0630-2024.

PLANT TO PLANT  
3200

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Modified 1/2011

FIGURE 105. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, PLANT-TO-PLANT (SHEET 3 OF 4)

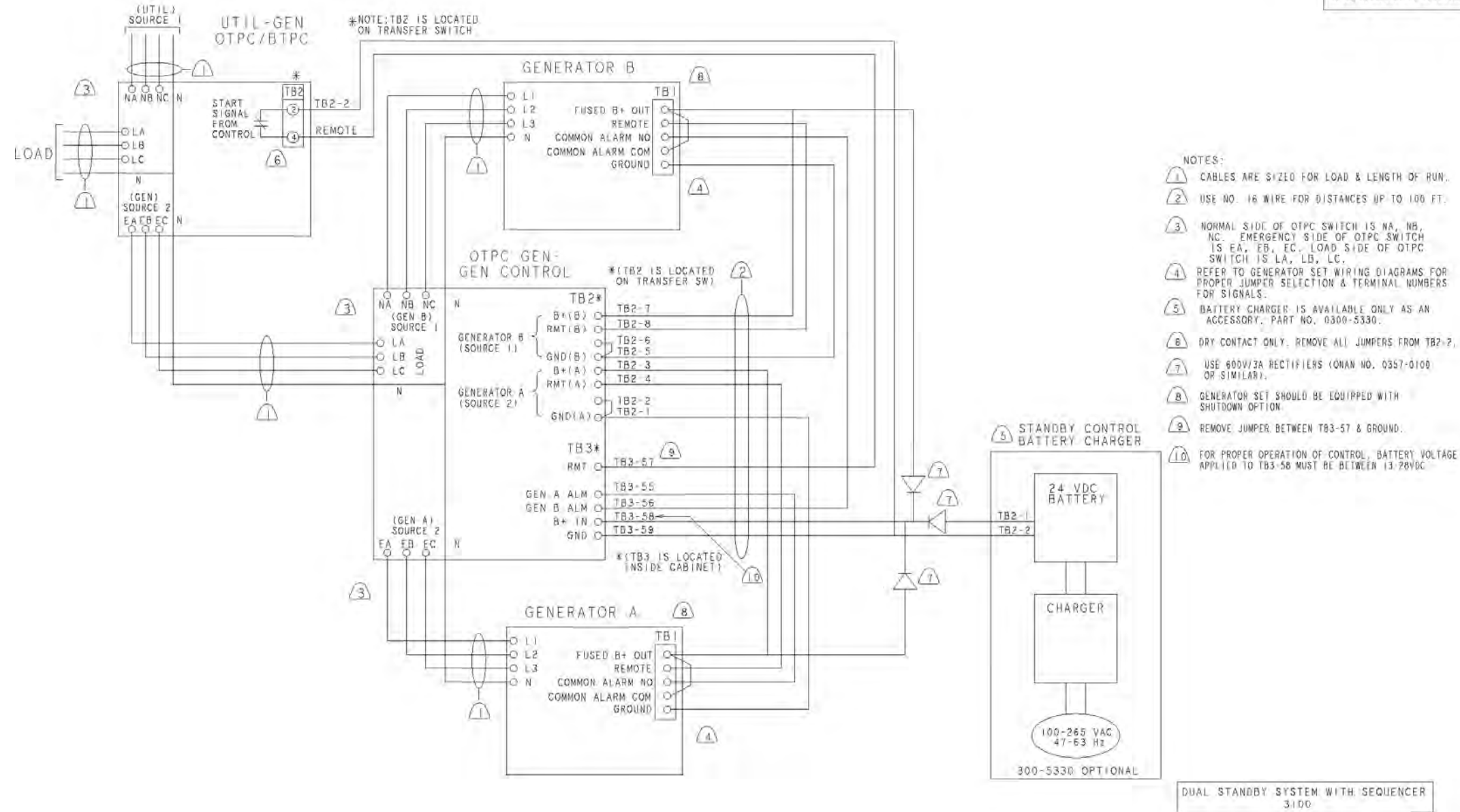


This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

FIGURE 106. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, PLANT-TO-PLANT (SHEET 4 OF 4)

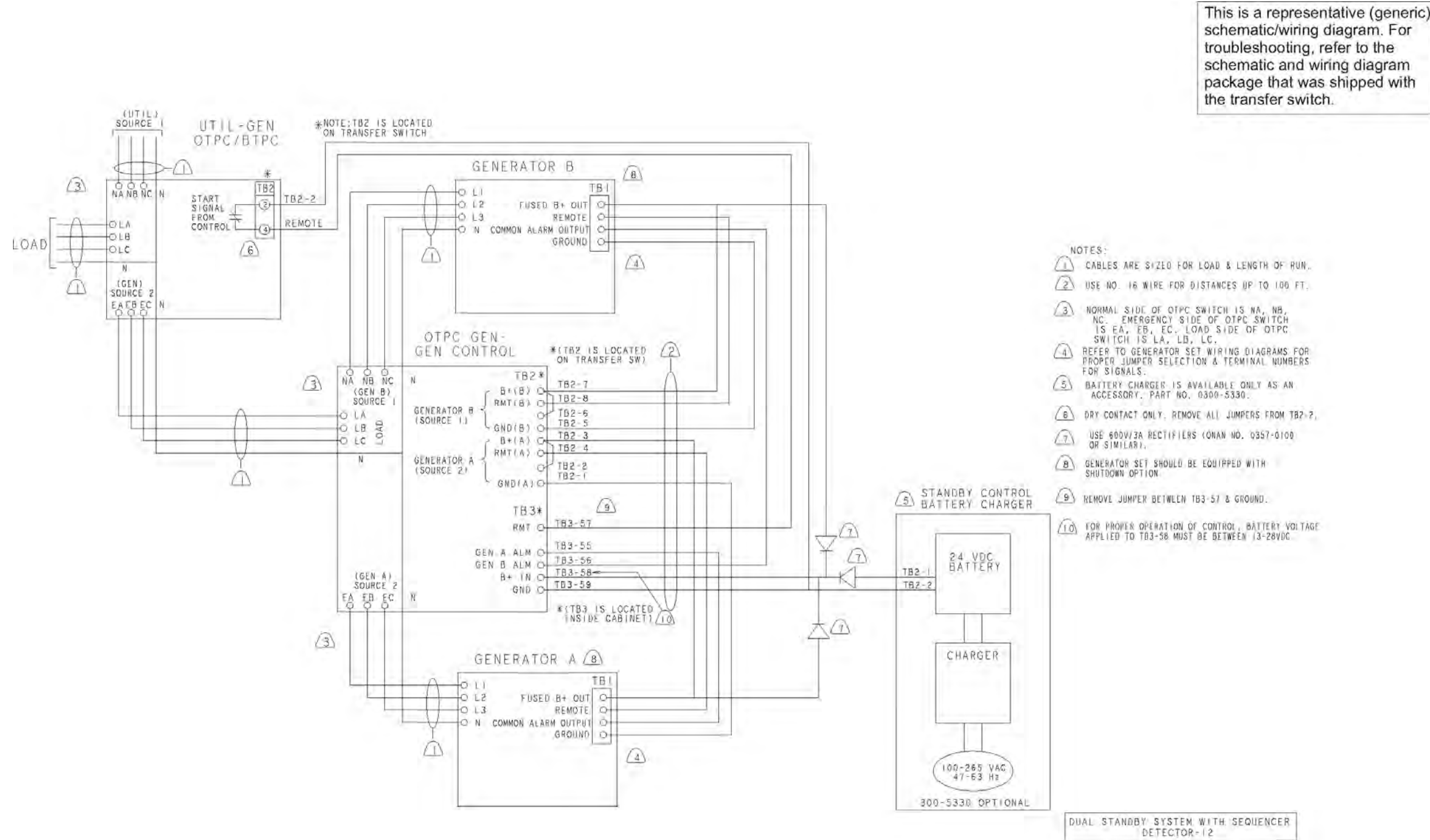
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Modified 1/2011

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.



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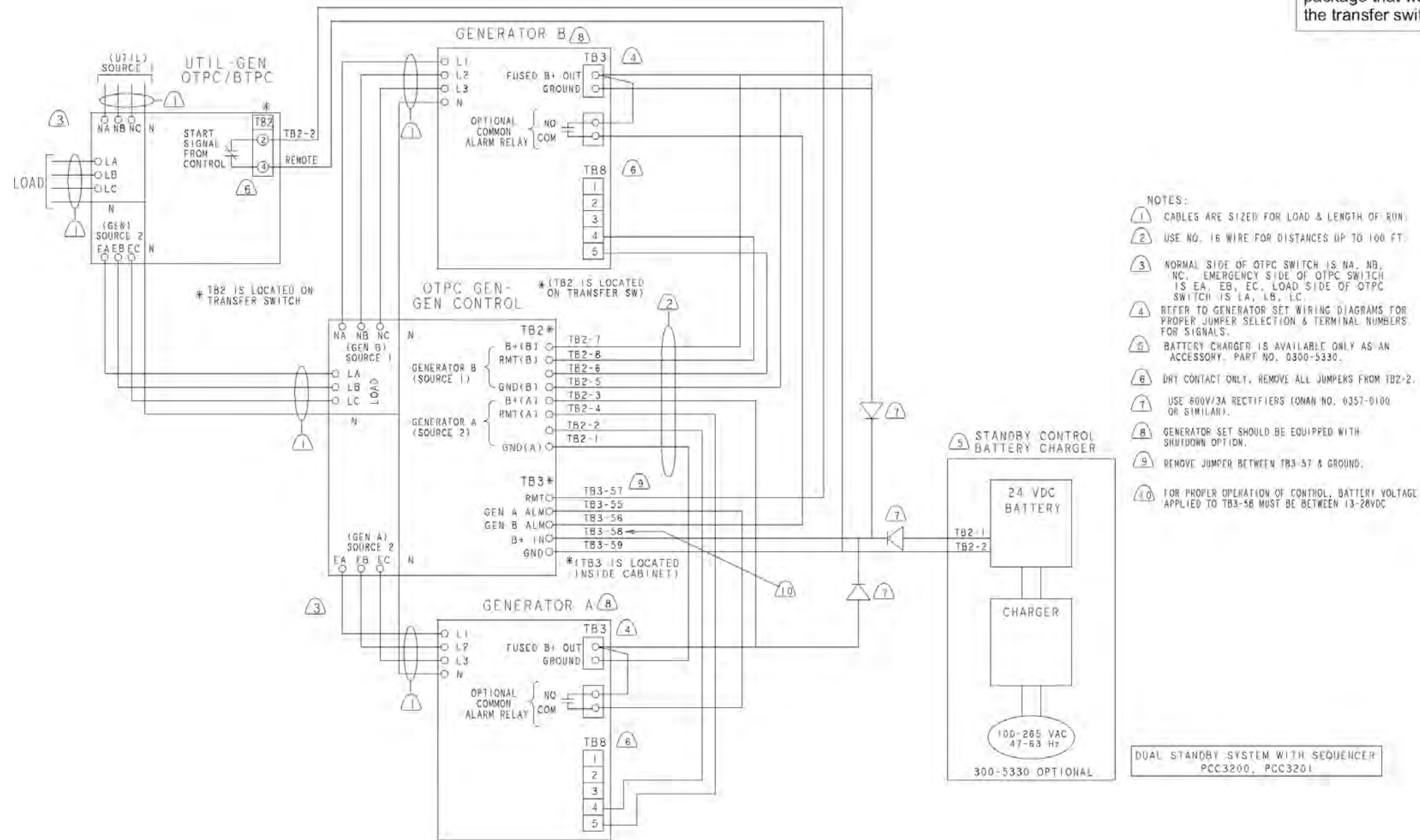
FIGURE 107. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, DUAL STANDBY SYSTEM (SHEET 1 OF 4)



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 Modified 2/2011

FIGURE 108. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, DUAL STANDBY SYSTEM (SHEET 2 OF 4)

This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.

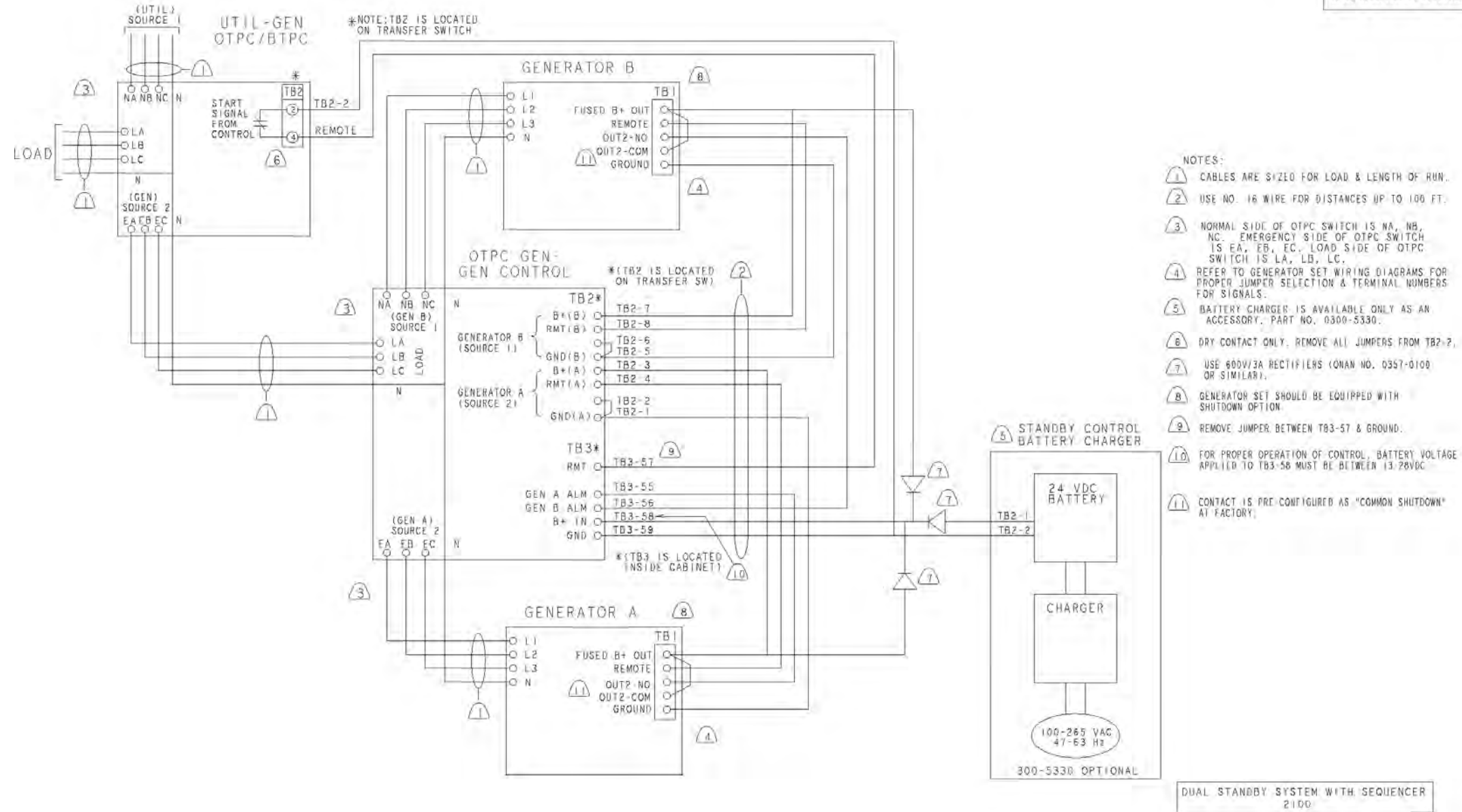


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FIGURE 109. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, DUAL STANDBY SYSTEM (SHEET 3 OF 4)



This is a representative (generic) schematic/wiring diagram. For troubleshooting, refer to the schematic and wiring diagram package that was shipped with the transfer switch.



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 Rev. F  
 Modified 2/2011

FIGURE 110. TYPICAL INTERCONNECTION DIAGRAM - GENERATOR-TO-GENERATOR, DUAL STANDBY SYSTEM (SHEET 4 OF 4)

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# Operator Manual

## **Transfer Switch**

**40-4000 Amps**

OTPCA (Spec A)

OTPCB (Spec A)

OTPCC (Spec A)

OTPCD (Spec A)

OTPCE (Spec A-C)

OTPCF (Spec A-B)

OTPCG (Spec A-B)

OTPCH (Spec A-B)

OTPCJ (Spec A)

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# 1 Safety Precautions

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This manual includes the following symbols to indicate potentially dangerous conditions. Read the manual carefully and know when these conditions exist. Then, take the necessary steps to protect personnel and the equipment.

## DANGER

*This symbol warns of immediate hazards that will result in severe personal injury or death.*

## WARNING

*This symbol refers to a hazard or unsafe practice that can result in severe personal injury or death.*

## CAUTION

*This symbol refers to a hazard or unsafe practice that can result in personal injury or product or property damage.*

## 1.1 Electrical Shock and Arc Flash Can Cause Severe Personal Injury or Death

High voltage in transfer switch components presents serious shock hazards that can result in severe personal injury or death. Read and follow these suggestions:

- The Operator **must** always keep the transfer switch cabinet closed and locked.
- Make sure only authorized personnel have the cabinet keys.
- All service and adjustments to the transfer switch **must** be performed only by an electrician or authorized service representative.

## NOTICE

**Whenever closed transition is used, approval to parallel with the local electric utility must be obtained.**

## 1.2 General Precautions

Refer to NFPA 70E Standard for Electrical Safety in the Workplace to be sure the proper personal protective equipment (PPE) is worn around this product.

Follow these guidelines while working on or around electrical equipment.

- Place rubber insulated mats on dry wood platforms over metal or concrete floors when working on any electrical equipment.
- Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling any electrical equipment.



- Remove all jewelry when working on electrical equipment.
- Wear safety glasses whenever servicing the transfer switch.
- Do not smoke near the batteries.
- Do not work on this equipment when mentally or physically fatigued, or after consuming alcohol or any drug that makes the operation of equipment unsafe.

** WARNING**

***Incorrect service or replacement of parts can result in death, severe personal injury, and/or equipment damage. Service personnel must be qualified to perform electrical and/or mechanical service.***

# 2 Introduction

---

## 2.1 Operator Manual

This manual covers models produced under the Cummins® and Cummins Power Generation (CPG) brand names.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that before commencing any work, they have the latest information available. The latest version of this manual is available on QuickServe Online (<https://qsol.cummins.com/info/index.html>).

This Operator Manual provides information necessary for the operation of the transfer switch(es) identified on the cover of this manual. The transition capabilities of the transfer switch(es) are identified in the following sections.

## 2.2 How to Obtain Service

When the transfer switch requires servicing, contact your nearest Cummins Power Generation distributor. Factory-trained Parts and Service representatives are ready to handle all of your service needs.

**To contact your local Cummins Power Generation distributor in the United States or Canada:**

- Call 1-800-888-6626 (this automated service utilizes touch-tone phones only).
- Select Option 1 (press 1) and you will be automatically connected to the distributor nearest you.

**If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, distributors are listed under one of the following:**

- Generators-Electric
- Engines-Gasoline
- Engines-Diesel
- Recreational Vehicles-Equipment
- Parts and Service

**For outside North America:**

- Call Cummins Power Generation at 1-763-574-5000, 7:30 AM to 4:00 PM Central Standard Time, Monday through Friday.

OR

- Send a fax to Cummins Power Generation using the fax number, 1-763-574-5298.

When contacting your distributor, always supply the complete model, specification and serial number as shown on the generator set nameplate.

## 2.3 Model Identification

If the transfer switch ever needs to be serviced, the distributor will need this information in order to properly identify your unit from the many types manufactured:

- Model No. (Product Model)
- Serial No. (Product Serial Number)
- Spec. (Product Specification Letter)


产品型号 Model No.
产品序列号 Serial No.
重要提示: 订购零件时请务必提供产品型号及序列号
符合标准 Comply with: 电器级别 Classification: 使用类别 Utilization category:
额定工作电压 Voltage:
额定频率 Operation Frequency:
额定工作电流 Nominal current:
额定短路接通能力 Rated short circuit making capacity:
额定短时耐受电流 Rated short-time withstand current:
额定冲击耐受电压 Rated impulse withstand voltage:
极数 Poles:
附件 Feature:
A030N966.B
 施耐德万高(天津)电气设备有限公司

FIGURE 1. CONTROL NAMEPLATE

## 2.4 Transfer Switch Application

Transfer switches are an essential part of a building's standby or emergency power system. The utility line (normal power), is backed up by a generator set (emergency power). The transfer switch automatically switches the electrical load from one source to the other.

If utility power is interrupted, the load is transferred to the generator set (genset). When utility power returns, the load is retransferred to the utility. The transfer and retransfer of the load are the two most basic functions of a transfer switch.

## 2.5 Specifications

### 2.5.1 Model OTPC

Transfer Switch Model OTPC Specifications:

Model	Amps	Cabinet Types	Util-to-Gen (Level 1 & 2)	Gen-to-Gen (Level 2)	Util-to-Gen & Util-to- Util (Level 1 & 2)	Dual Standby	Plant-to- Plant (Prime Power)	Transfer Modes
OTPCA	40 70 125	<b>All Amps:</b> 4, 3R, 1, 12, 4x	X	X		X	X	OT PT
OTPCB	150 225 260	<b>150-225 Amp (3 &amp; 4-Pole):</b> 1, 3R, 12, 4x <b>150-225 Amp (3 pole):</b> 4 <b>260 Amp (3 &amp; 4-Pole):</b> 1, 3R, 12, 4x <b>260 Amp (3 pole):</b> 4	X	X		X	X	OT PT
OTPCC	300 400 600	<b>All Amps:</b> 1, 3R, 12, 4, 4x	X	X		X	X	OT PT
OTPCD	800 1000	<b>All Amps (3 &amp; 4-Pole):</b> 1, 3R, 12, 4x <b>All Amps (3- Pole):</b> 4	X	X		X	X	OT PT
OTPCE	1000 1200	<b>All Amps:</b> 1, 3R, 12, 4, 4x	X	X	X	X	X	OT PT CT
OTPCF	1600	1, 3R, 12, 4	X	X	X	X	X	OT PT CT
OTPCG	2000	1, 3R, 12, 4	X	X	X	X	X	OT PT CT
OTPCH	3000	1, 3R	X	X	X	X	X	OT PT CT

OTPCJ	4000	1, 3R	X	X	X	X	X	OT PT CT
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## 2.6 Automatic Transfer Switch Typical Function

Automatic transfer switches perform the basic function of transferring the load to the available power source. The controller monitors each source for allowable voltage and frequency range.

The transfer switch(es) identified on the cover of this manual are designed for each, all or a combination of the following applications (If you are unsure which of these your transfer switch uses, refer to the Specifications section of this manual):

### 2.6.1 Open Transition with Sync Check

Open transition with sync check executes an open transition (OT) transfer when both sources of power are within specified tolerances of frequency, voltage and relative phase difference. If both sources meet the tolerances, a fast transfer occurs.

### 2.6.2 Programmed Transition

Programmed transition executes a programmed transition (PT) transfer by disconnecting the load from the source of power, pausing in the neutral position of the transfer switch (between switched positions) to allow transient voltages from the load to diminish, and then the load is switched to the other source.

### 2.6.3 Closed Transition

Closed transition executes a load transfer by momentarily paralleling both sources (a maximum of 100ms) before switching sources.

## 2.7 Utility-to-Generator Set Operation

In utility-to-generator set applications, the transfer switch performs the following functions:

1. Senses the interruption of the Source 1 power (Utility).
2. Sends a start signal to the generator set (Source 2).
3. Transfers the load to the Source 2 power.
4. Senses the return of Source 1 (Utility).
5. Retransfers the load to Source 1.
6. Sends a stop signal to the generator set.

## 2.8 Utility-to-Utility Operation

In utility-to-utility applications, the transfer switch performs the following functions:

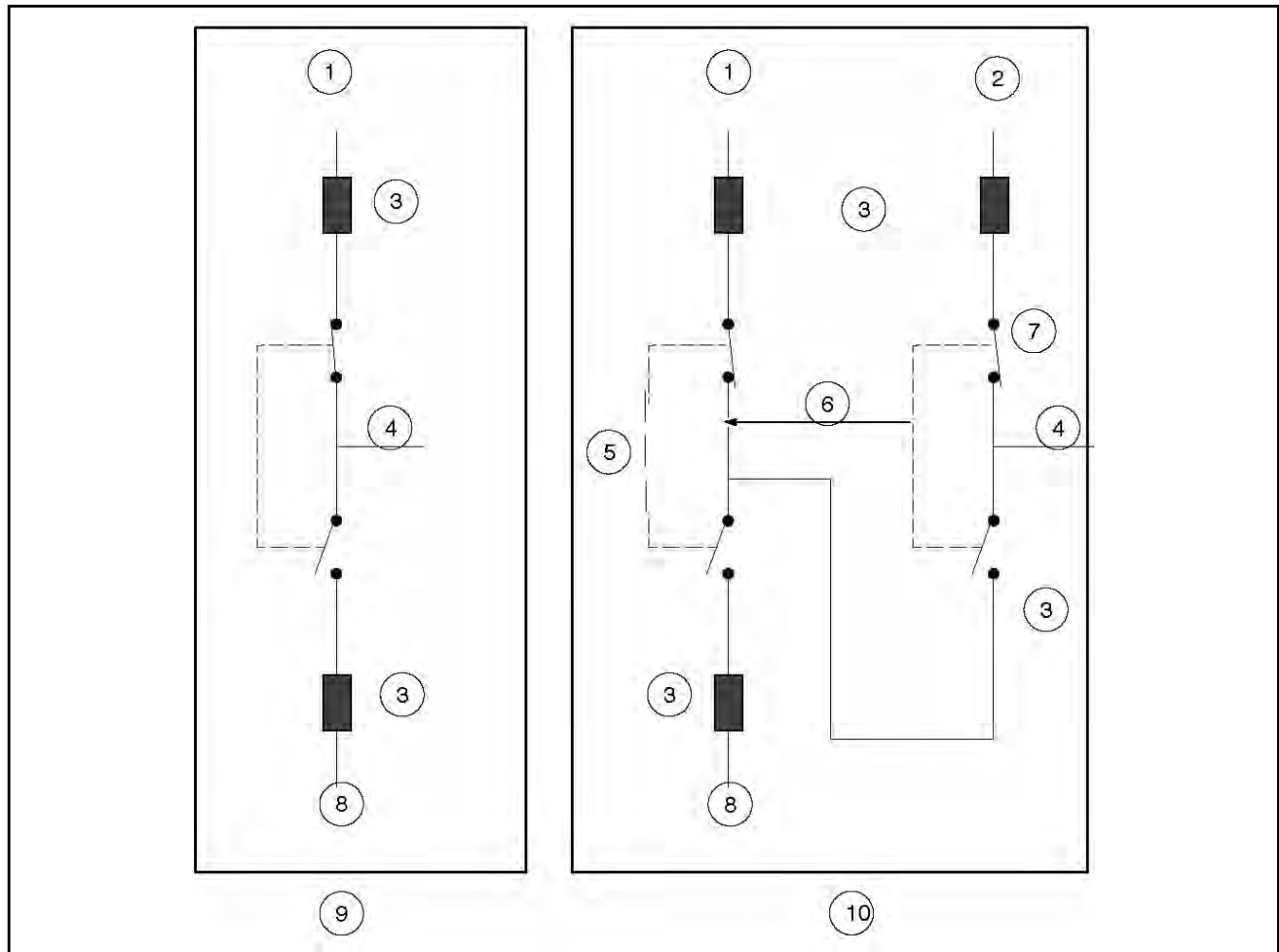
1. Senses the interruption of the Source 1 power (Utility).
2. Transfers the load to the Source 2.
3. Senses the return of Source 1 (Utility).

- 4. Retransfers the load to Source 1.

## 2.9 Generator-to-Generator Operation

In generator-to-generator applications, there are two possible configurations.

- Prime Power (Plant-to-Plant) Operation - Two generator sets provide all of the power (utility power is not available).
- Dual Standby - Two generator sets are used to back up utility power.



No.	Description	No.	Description
1	Generator set B	6	Standby start signal
2	Utility	7	Utility-to-Gen ATS
3	Over current protective device	8	Generator set A
4	Load	9	Gen-to-Gen configuration in Prime Power mode
5	Gen-to-Gen ATS	10	Gen-to-Gen configuration in Dual Standby mode

**FIGURE 2. GENERATOR-TO-GENERATOR CONFIGURATION IN PRIME POWER AND DUAL STANDBY MODES**

## 2.9.1 Prime Power (Plant-to-Plant) Operation

In prime power applications, utility power is not available. The system includes one transfer switch and two generator sets. One generator set is always running and supplying power to the load while the other generator set is the backup generator set. An external power supply is not needed in this application.

### 2.9.1.1 Preferred Source Selection

Under normal operation, one genset is designated as the preferred source and supplies power to the load. The second genset is the backup power source. If the preferred genset fails, the backup genset starts and the transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu can be used to designate either genset (Source 1 or Source 2) as the preferred genset. The Preferred Source menu is included in the Test submenus.

If the preferred genset is changed and the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset when it becomes available. The unit that is carrying the load is always considered the preferred source.

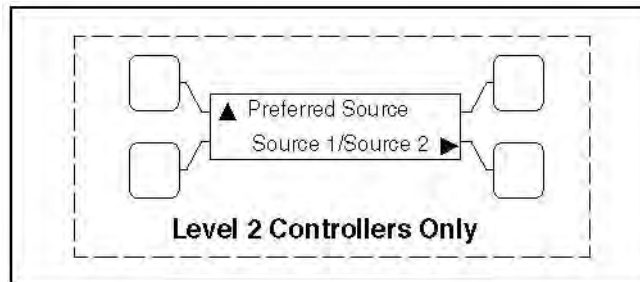
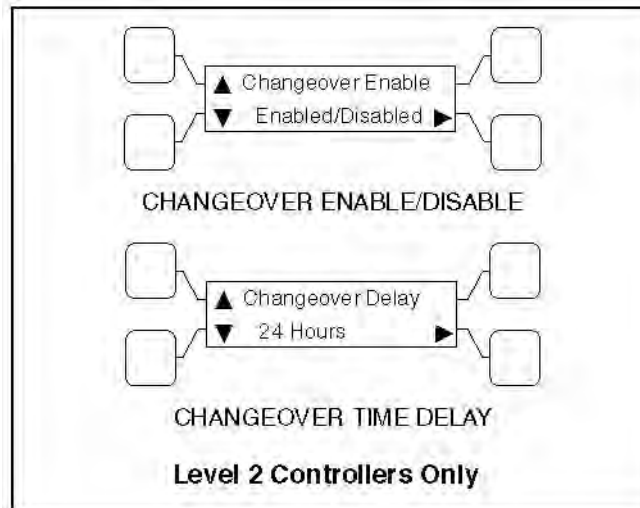


FIGURE 3. PREFERRED SOURCE SUBMENU

### 2.9.1.2 Automatic Changeover

The transfer switch can be set up to change the preferred source automatically by enabling the changeover timer. The Time Delay submenus under Setup or the PC service tool can be used to enable the changeover timer and specify a changeover delay time period. The Changeover menus are included in the Time Delay submenus.

The automatic changeover timer automatically changes the preferred source and transfers the load to the new preferred genset after a TDEN time delay. After the transfer is complete, the control initiates a cool-down period (TDEC) on the old preferred genset before shutting it down. The old preferred genset is now the new backup genset. The changeover timer is now timing for the next changeover and the cycle continues as long as the changeover timer is enabled.



**FIGURE 4. CHANGEOVER SUBMENUS**

## 2.9.2 Dual Stand-By Operation

In dual stand-by applications, utility power is available. The system includes two transfer switches (a Utility-to-Generator ATS and a Generator-to-Generator ATS) and two generator sets. Utility power supplies power to the load and both generator sets are backup generator sets.

Under normal operation, the utility is supplying power to the load through the lead transfer switch. The lead transfer switch is a utility-to-generator set switch. The two generator sets are connected to the generator set-to-generator set transfer switch. The load side of this switch is connected to the generator set side of the lead transfer switch.

Upon loss of utility power to the lead transfer switch, a standby start signal is sent to the generator set-to-generator set transfer switch to start the preferred generator set. When the lead transfer switch senses generator voltage, it transfers the load to that generator set. If the preferred generator set fails to start, a signal is sent to the backup generator set to start. The PC Service tool or the Test sub-menu on the generator set-to-generator set transfer switch can be used to set the preferred source.

If the Stand-By Start is inactive, upon initial power-up (or reset), or during software initialization, the transfer switch control will not start either generator set. When a Stand-By Start command is received by the Generator-to-Generator ATS from a Utility-to-Generator ATS (or other device), the preferred generator set immediately starts. If the preferred generator set does not start, the control starts the backup generator set. The load is connected to the generator set when it becomes available.

If the preferred generator set becomes available while the backup generator set is active, a time delay re-transfer (TDEN) period is initiated and the load is re-transferred back to the preferred generator set. A time delay cool-down (TDEC) period is initiated before turning off the backup generator set. When the Stand-By Start becomes deactivated, a TDEC period is initiated and the active generator is turned off.



### 2.9.2.1 Preferred Source Selection

Under normal operation, one genset is designated as the preferred source and the second genset is designated as the backup power source. If both the utility power and the preferred genset fails, the backup genset starts and the genset-to-genset transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu on the genset-to-genset transfer switch can be used to designate either genset (Source 1 or Source 2) as the preferred genset. If the preferred genset is changed and the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset if it is needed and when it becomes available.

### 2.9.2.2 Alternating Preferred Source

In an attempt to keep the running time equally distributed between both generator sets, the control can be set to alternate between the generator sets when utility power fails. The selected preferred generator set starts with the first power outage. The second power outage starts the backup generator set, which now becomes the preferred generator set. Upon subsequent outages, the preferred generator set alternates.

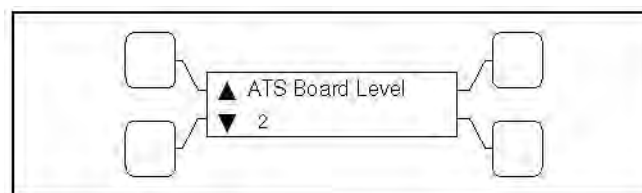
Only utility outages and tests or exercises initiated at the lead transfer switch result in the generator sets being alternated. The designated preferred generator set will not change if it fails and the backup generator set takes over the load. This alternating preferred source can only be enabled with the PC Service tool. When enabled, a generator set can be designated as the preferred source for a maximum of two weeks. Time adjustments can be made in one-hour increments with the Test submenu.

## 2.10 Control Level 1 and Level 2

Two controls are available. The type of power source switched and the desired features determine the control levels available.

The control board level can be viewed, using the digital display. This menu is included in the About submenus.

<b>NOTICE</b>
<b>The digital display comes standard with level 2 controls and is optional with level 1 controls.</b>



**FIGURE 5. CONTROL LEVEL SUBMENU**

# 3 Description

---

## 3.1 Cabinet

Cabinets are available in various configurations that meet UL and National Electrical Manufacturer's Association (NEMA) requirements. Each cabinet includes an identification label. The standard cabinet offerings are:

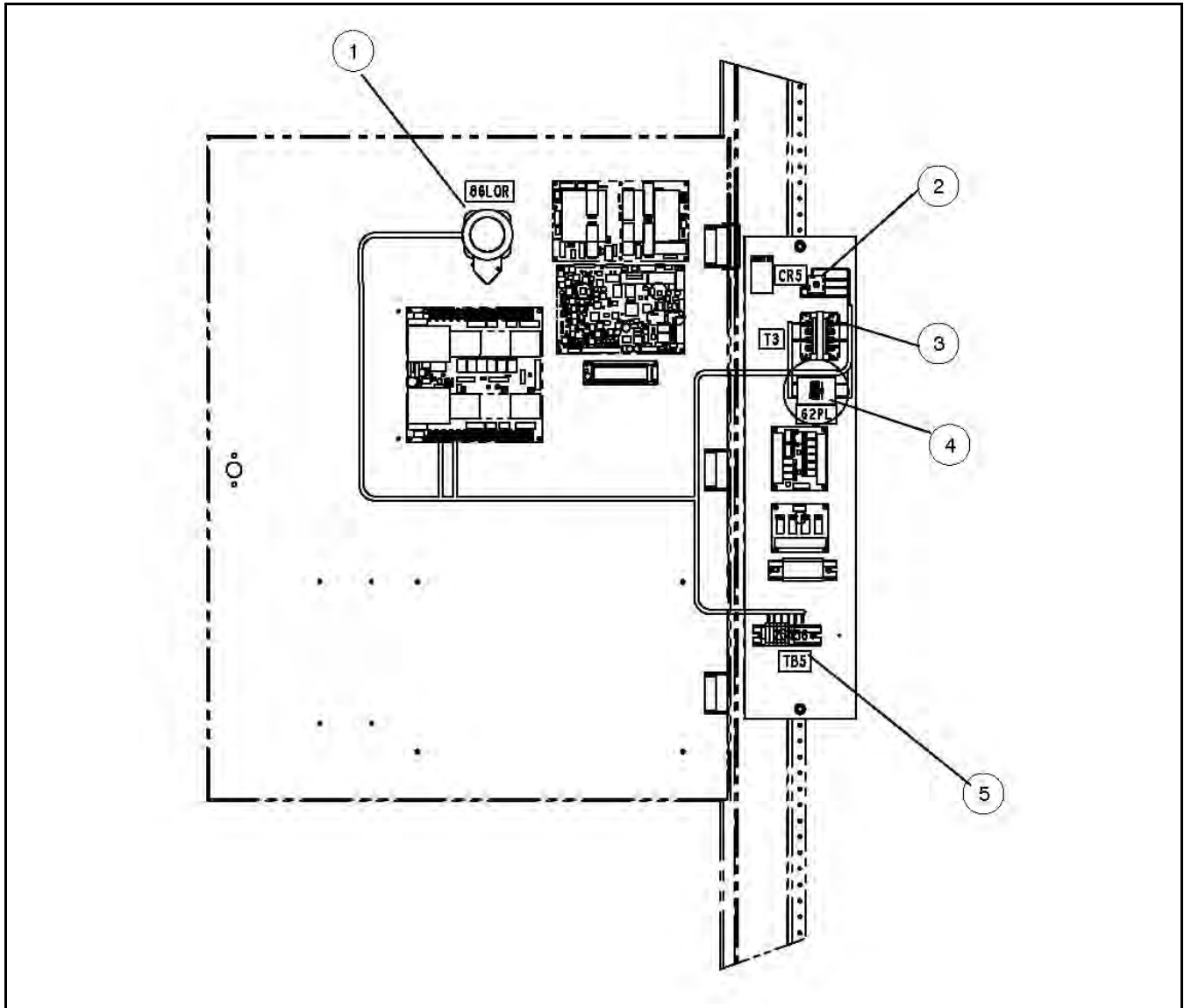
- Type 1 Indoor - general purpose
- Type 3R Outdoor - rainproof
- Type 4 Outdoor - watertight
- Type 4X Outdoor - watertight, stainless steel
- Type 12 Indoor - dust tight

## 3.2 Protective Relay

This section describes the solid state relays designed for use in single- or three-phase systems to protect equipment against overpower and/or under-power conditions.

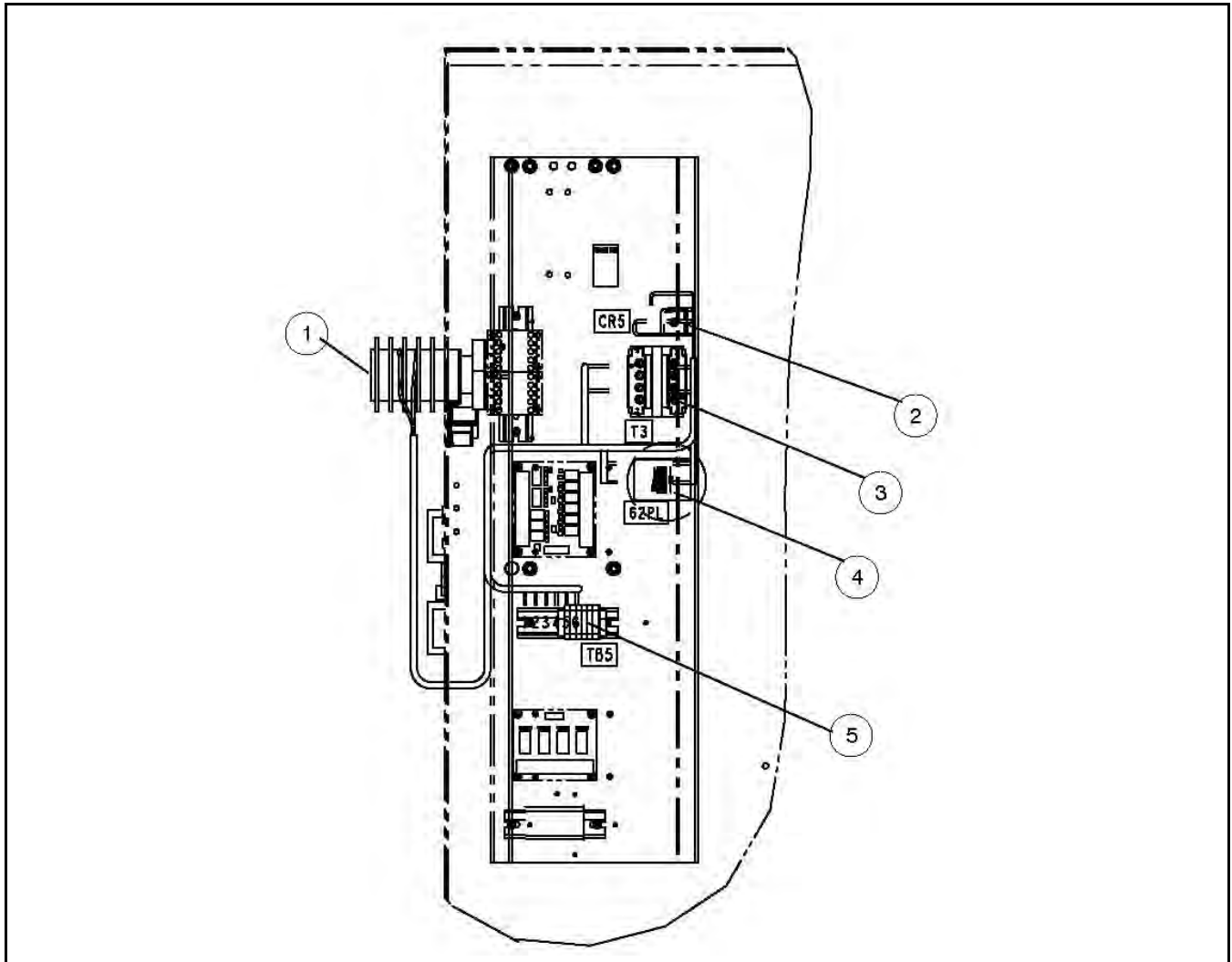
To increase the level of protection in our closed transition switches we have included a lock out relay (86) that can trip from two different signals. It can trip from the K32R directional relay when it senses reverse power is exported to utility or when the 62PL parallel timer has detected that two sources have been connected for more than the predefined time (not the same as "Maximum Parallel Timer" in the digital board).

The 86 lockout relay trips when the internal 24VDC relay coil is energized, and it is always required to manual reset the relay. NC and NO dry contacts are provided for customer wiring which are rated for 20A 600V. Factory settings for the 62PL are 1 and 3 closed (ON), 2 and 4-10 open (OFF), for 500mS delay.



No.	Description	No.	Description
1	Lockout relay	2	Rectifier
3	Transformer	4	Relay
5	Terminal blocks		

**FIGURE 6. RELAY INSTALLATION M036/M038**



No.	Description	No.	Description
1	Lockout relay	2	Rectifier
3	Transformer	4	Relay
5	Terminal Blocks		

**FIGURE 7. RELAY INSTALLATION M036/M038**

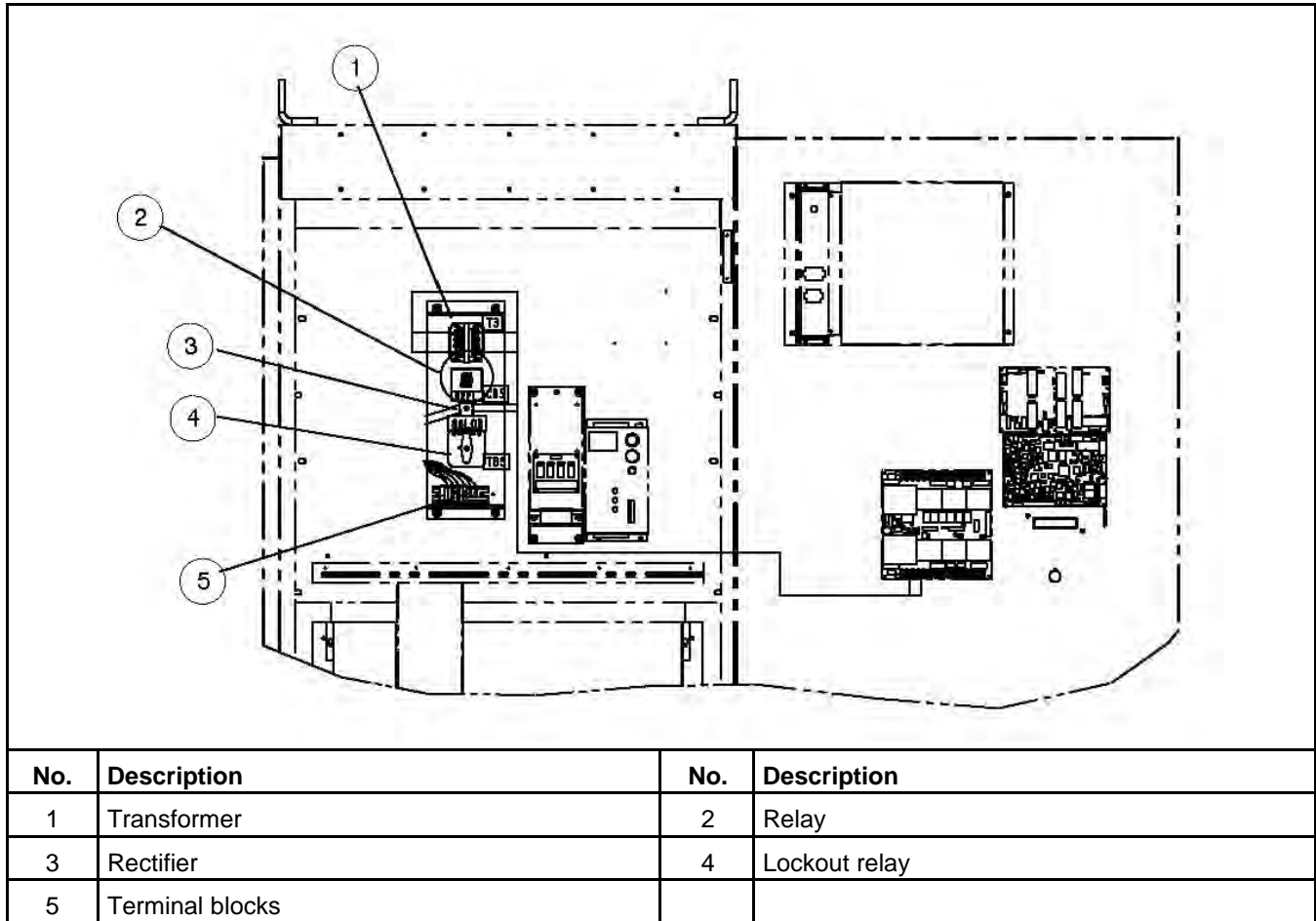


FIGURE 8. RELAY INSTALLATION M036/M038

### 3.3 Transfer Switch Components

The transfer switch opens and closes the contacts that transfer the load between the power sources (Source 1 and Source 2). The switch is mechanically interlocked to prevent simultaneous closing to both power sources (except in switches capable of closed transitions).

#### 3.3.1 Contact Assemblies

The automatic transfer switch has either three or four poles. Three pole transfer switches are provided with a neutral bar. The contact assemblies make and break the current flow. When closed to either power source the contacts are mechanically held. A mechanical interlock prevents them from closing to both power sources at the same time.

#### 3.3.2 Linear Actuator

The linear actuator moves the contact assemblies between the contacts of both power sources. Linear actuator operation is initiated automatically by the transfer switch control. Manual operation of the switch is also possible.

### 3.3.3 Motor Disconnect Switch (150-1000 Amp Switches)

Moving the Draw out lever to the Release position disables the linear actuator. The Not In Auto indicator on the front panel will light and the display indicates a motor disconnect event.

### 3.3.4 Motor Disconnect Switch (1200-4000 Amp Switches)

The Motor Disconnect toggle switch on the accessory control plate enables and disables the linear actuator.

- Placing the switch in the AUTO position enables the linear actuator.
- Placing the switch in the OFF position disables the linear actuator. When placed in the OFF position, the Not In Auto indicator on the front panel will light and the display indicates a motor disconnect event.

### 3.3.5 Auxiliary Contacts

Auxiliary contacts are provided on the utility and genset sides of the transfer switch. They are actuated by operation of the transfer switch during transfer and retransfer. The utility auxiliary contact switch is actuated when the transfer switch is connected to the utility. The genset auxiliary contact switch is actuated when the transfer switch is connected to the genset. The auxiliary contacts have current ratings of 10 amperes at 250 VAC. The contacts are wired to terminal block TB1.

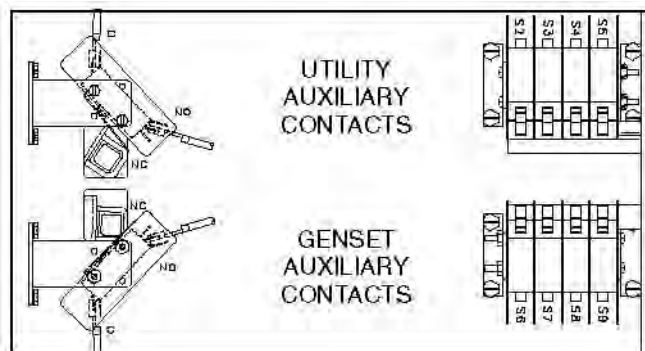


FIGURE 9. AUXILIARY CONTACTS

## 3.4 Electronic Control System

This section describes the standard and optional components of the electronic control system.

#### **⚠ WARNING**

***Improper calibration or adjustment of electronic control modules can cause death, severe personal injury, and equipment or property damage. Calibration and adjustment of these components must be performed by technically qualified personnel only.***

For further information regarding installation, calibration and adjustment of these components, refer to the:

- Installation Manual (shipped with the product)
- Service Manual (available through your distributor)

**⚠ WARNING**

*Accidental actuation of the linear motor could cause severe personal injury. Before making any adjustments, place the Motor Disconnect Switch in the OFF position. Return the switch to the Auto position after adjustments are completed.*

**⚠ WARNING**

*AC power within the cabinet and the rear side of the cabinet door presents a shock hazard that can cause severe personal injury or death. When the cabinet door is open, use extreme caution to avoid touching electrical contacts with body, tools, jewelry, clothes, hair, etc.*

### 3.4.1 Time Delays

#### 3.4.1.1 Time Delay Engine Start (TDES-A and TDES-B)

**Time Delay Default:** 3 seconds (for both TDES-A and TDES-B)

**Adjustable:** The value is set with the InPower service tool or the digital display.

- Adjustable from 0-15 seconds in 1 second increments on Level 1 controls.
- Adjustable from 0-120 seconds on Level 2 controls.
  - Values up to 20 seconds are adjustable in 1 second increments.
  - Values over 20 seconds are adjustable in 5 second increments.

**Purpose:** Prevents the generator set from starting during short power interruptions.

**Sequence of Events:** Timing begins at the Source 1 power interruption (or the preferred source interruption on gen-to-gen units). If the duration of interruption exceeds the delay time, the control system starts the generator.

**NOTICE**

**For long engine start time delays (over 15 seconds) a remote battery source must be used.**

For **Genset-to-Genset** applications: TDES-A is the start time delay to start the Source 2 genset and TDES-B is the start time delay to start the Source 1 genset.

For **Utility-to-Utility** applications: TDES-A and TDES-B are not available.

#### 3.4.1.2 Time Delay Engine Cool-down (TDEC-A and TDEC-B)

**Time Delay Default:** 10 minutes

**Adjustable:** Adjustable from 0-30 minutes, in 1 minute increments. The value is set with the InPower service tool or the digital display.

**Purpose:** Allows the generator set to cool without load before stopping.

**Sequence of Events:** Timing begins when the load is retransferred to Source 1 (or to the preferred source on gen-to-gen units). At the end of the delay, the stop signal is sent to the generator set. During this time delay, the generator set cools down without load before stopping.

For **Genset-to-Genset** applications: TDEC-A is the stop time delay to stop Source 2 genset and TDEC-B is the stop time delay to stop Source 1 genset.

For **Utility-to-Utility** applications: TDEC-A and TDEC-B are not available.

---

### 3.4.1.3 Time Delay Normal to Emergency (TDNE)

**Time Delay Default:** 5 seconds

**Adjustable:** Adjustable from 0-120 seconds, in 1 second increments. The value is set with the InPower service tool or the digital display.

**Purpose:** Allows the generator set to stabilize before the load is applied.

**Sequence of Events:** Timing begins when:

- Source 2 voltage and frequency reaches the settings of the control.
- Preferred source voltage (on gen-to-gen units) and frequency reaches the settings of the control.
- Preferred utility becomes available (on utility-to-utility units).

After the delay, the transfer switch transfers the load to Source 2.

### 3.4.1.4 Time Delay Emergency to Normal (TDEN)

**Time Delay Default:** 10 minutes

**Adjustable:** Configurable for 0 (disabled), 0.1, 5, 10, 15, 20, 25 or 30 minutes.

**Purpose:** Allows utility power to stabilize before retransfer. This delay also allows the generator to operate under load for a minimum amount of time before transferring back to utility power.

**Sequence of Events:** Timing begins with the transfer switch connected to the generator and after the utility becomes available following an outage (the green Utility Power Available LED is lit). This time delay also starts when an active test or exercise period has ended. After the delay, the transfer switch can retransfer the load to the utility power source.

- If the utility fails any time during this time delay, the control resets the timer and restarts it once utility power becomes available.
- If the generator fails at any time during this time delay, the timer expires and the normal retransfer sequence takes place.
- If the Override pushbutton is pressed or the Override input is grounded while the TDEN timer is active, the TDEN timer immediately expires.
- The TDEN timer will not begin if a Retransfer Inhibit input is active.

### 3.4.1.5 Time Delay Elevator (TDEL)

**Time Delay Default:** 0 seconds

**Adjustable:** Adjustable from 0-60 seconds, in 1 second increments. The value is set with the InPower service tool or the digital display.

**Purpose:** Allows an elevator to come to a complete stop before the switch transfers.

**Sequence of Events:** Timing begins after the transfer or retransfer timing ends. TDEL only times when transferring between two live sources.

### 3.4.1.6 Time Delay Programmed Transition (TDPT)

**Time Delay Default:** 0 seconds

**Adjustable:** Configurable for 0 (disabled), 0.5, 1, 2, 3, 4, 6 or 10 seconds.



---

**Purpose:** Allows the transfer switch to pause in the Neutral position for an adjustable period of time whenever there is a transfer from one source to another.

- This intentional delay allows the residual voltage of an inductive load to sufficiently decay before connecting it to another power source.
- This delay prevents potentially damaging voltage and current transients in the customer's power system.

**Sequence of Events:** Timing begins whenever the transfer switch has disconnected from one source and is in the Neutral position.

- If TDPT is set to zero, then the transfer switch transfers from one source to the other with no neutral position delay.
- The control also detects if the transfer switch has disconnected from the first source before connecting it to the second one.
- If there is a power source failure while the TDPT is active, the control only transfers to the remaining active power source.
- The control does not terminate the TDPT timer if either source fails while the transfer switch is in the Neutral position.

## 3.4.2 System Sensors

### 3.4.2.1 Under-Voltage Sensing

All controls include under-voltage sensors for Source 1 and Source 2.

**Default Value:**

- Pick-up: 90%
- Drop-out: 90% of the pick-up setting

**Range:**

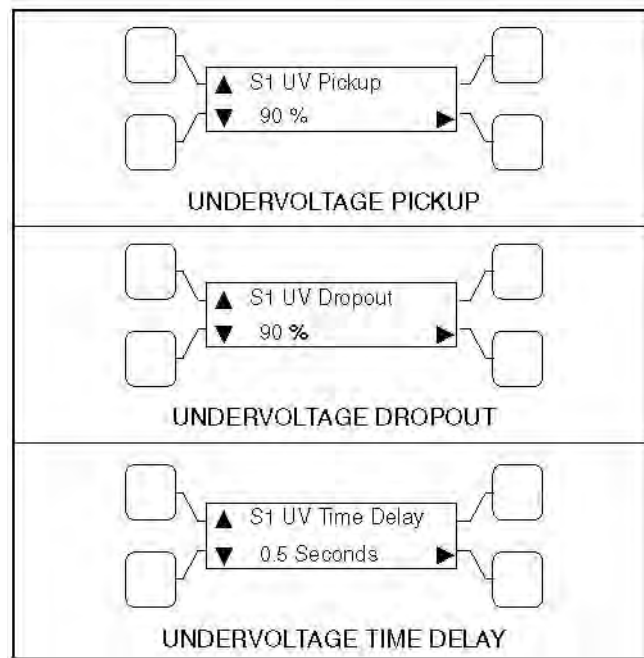
- The pick-up range for a rising voltage is 85 to 100% of the nominal voltage set point.
- The under-voltage sensing range for a falling voltage (drop-out) is 75 to 98% of the pick-up voltage setting.

**Default Delay Time:** 0.5 second

**Adjustable:** The adjustable range for the time delay period is 0.1 to 1.0 seconds in 0.1 second increments. These values are set with the PC service tool or the digital display.

**Sequence of Events:**

- When a sensor detects a voltage below the set drop-out voltage for a period longer than the time delay, it deems the voltage as unacceptable.
- When the sensor detects a voltage at or above the set pick-up point, it deems the voltage as acceptable.



**FIGURE 10. UNDER-VOLTAGE SENSING SUBMENUS**

### 3.4.2.2 Over-Voltage Sensing

All controls include over-voltage sensors for Source 1 and Source 2 that can be disabled and not used. The over-voltage sensing feature is enabled by default.

**Default Value:**

- Over-voltage (drop-out) sensing range: 110%
- Pick-up range: 95%

**Range:**

- The over-voltage sensing range (drop-out) for a rising voltage is 105 to 135% of the nominal voltage set point.
- The pick-up range for a falling voltage is 95 to 99% of the drop-out setting.

**Default Delay Time:** 3.0 seconds

**Adjustable:** The adjustable range for the delay time period is 0.5 to 120.0 seconds in 1 second intervals. These values are set with the PC service tool or the digital display.

**Sequence of Events:**

- When a sensor detects a voltage above the set dropout voltage for a period longer than the time delay, it deems the voltage as unacceptable.
- When the sensor detects a voltage at or below the set pickup point, it deems the voltage as acceptable.

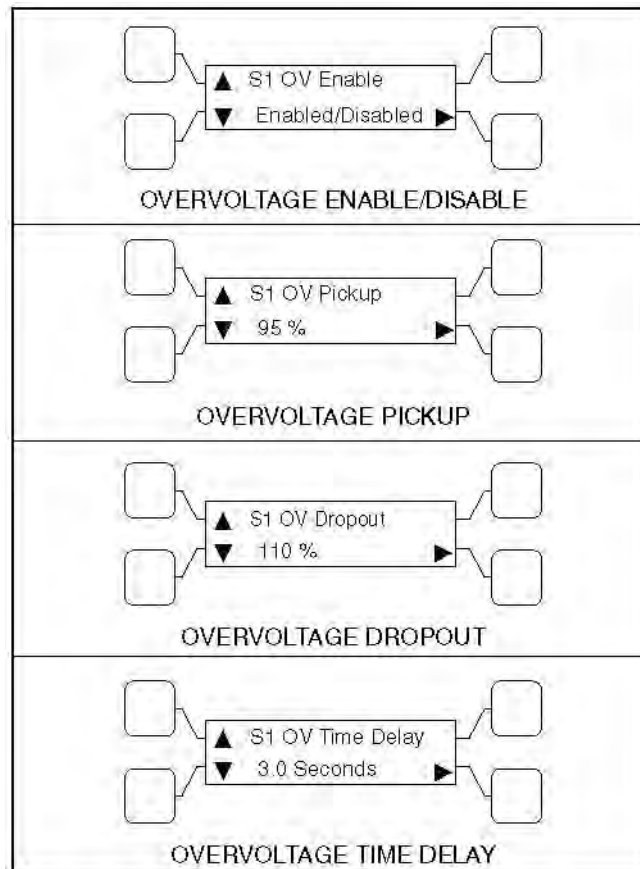


FIGURE 11. OVER-VOLTAGE SENSING SUBMENUS

### 3.4.2.3 Frequency Sensing

All controls include frequency sensors for Source 1 and Source 2 that can be disabled and not used.

**Default Value:**

- Nominal frequency: 60 Hz
- Frequency pick-up bandwidth:  $\pm 10\%$
- Frequency drop-out: 1% beyond pick-up bandwidth setting

**Range:**

- The nominal frequency can be set between 45.0 and 60.0 Hz in 0.1 Hz increments.
- The acceptable frequency bandwidth (pick-up) is  $\pm 5$  to  $\pm 20\%$  of the nominal frequency set point.
- The drop-out frequency is 1 to 5% beyond the pick-up.

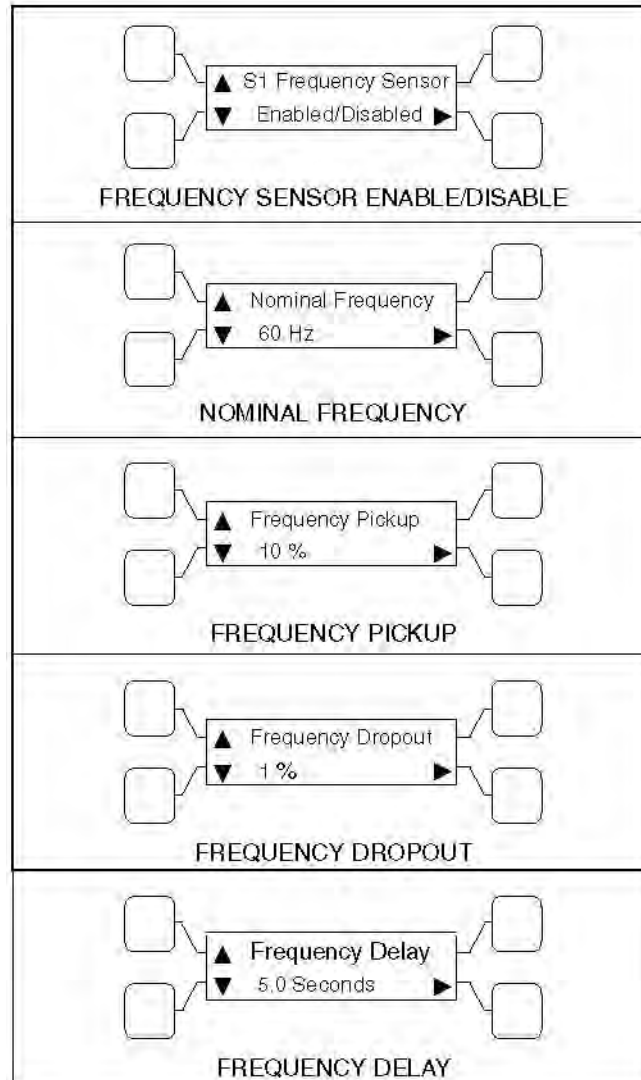
The frequency sensing feature is enabled by default.

**Default Delay Time:** 1.0 second

**Adjustable:** The adjustable range for the time delay period is 0.1 to 15 seconds.

**Sequence of Events:**

- When a sensor detects a frequency outside the dropout bandwidth for a period longer than the time delay, it deems the frequency as unacceptable.
- When the sensor detects a frequency within the pickup bandwidth, it deems the frequency as acceptable.

**FIGURE 12. FREQUENCY SUBMENUS****3.4.2.4 Voltage Imbalance Sensing**

Three phase Level 2 controllers include a voltage imbalance sensor for both Source 1 and Source 2. This feature informs the operator when there is significant voltage imbalance between the phases of Source 1 or Source 2. This feature is used for equipment protection.

**NOTICE**

**This sensor is inactive for single phase systems and indicates no failures. To prevent nuisance faults, the setting can be increased up to 10% of the nominal voltage.**

This sensor can be enabled using the PC service tool or the digital display Setup submenus.

**Default Value:** 10%

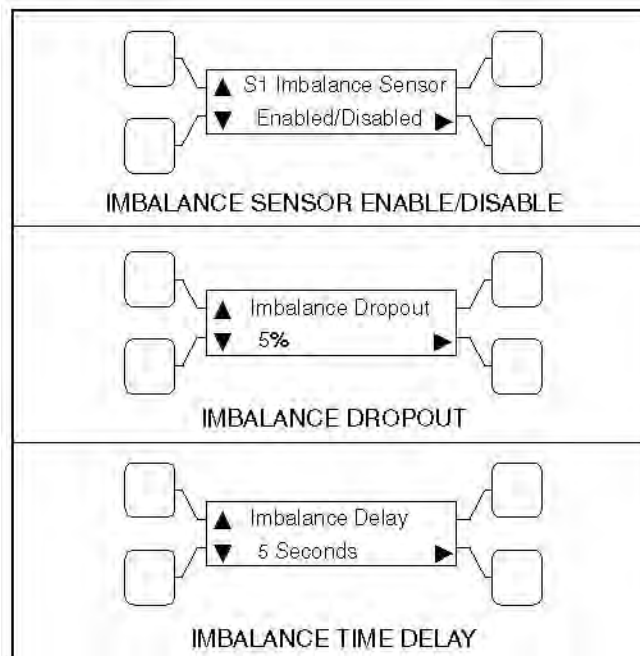
**Range:**

- The maximum deviation from the average voltage is greater than a user-specified value between 2 and 10% (dropout) of the average voltage in 1% increments.
- The pickup value is fixed at 10% of the dropout.

**Default Delay Time:** 10 seconds

**Adjustable:** The adjustable range for the time delay period for the imbalance sensor drop-out is 2 to 20 seconds.

**Sequence of Events:** A voltage imbalance is typically caused by severe single phase loading. The sensor indicates a failure when the maximum deviation from the average voltage is greater than a user-specified value (dropout) of the average voltage.



**FIGURE 13. VOLTAGE IMBALANCE SENSOR SUBMENUS**

### 3.4.2.5 Phase Rotation Sensing

Three phase Level 2 controllers include a phase rotation sensor.

This feature monitors the phase rotation of the source opposite from the connected source. Both voltage sources must be applied in order to check phase rotation.

This feature protects against equipment damage by preventing transfer to a source that is out of phase. This generally occurs on new installations or after storm damage or generator rewiring. This feature is required in fire pump applications.

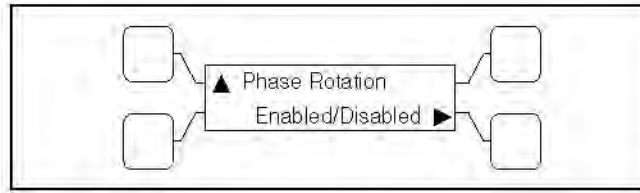
#### **⚠ CAUTION**

***Level 1 controls do not support three-phase sensing on Source 2. Do not select the three-phase option for the Source 2 Sensing adjustment with Level 1 controls, even if the system is three phase. This setting will prevent Source 2 from becoming available.***

**Default Value:** Disabled

**Adjustable:** The adjustable range for phase rotation sensing is Enabled or Disabled (On or Off).

**Sequence of Events:** When the alternate source is out of phase rotation with the connected source, transfer is inhibited.



**FIGURE 14. PHASE ROTATION SENSING SUBMENU**

### 3.4.2.6 Loss of Single Phase Sensing

Three phase Level 2 controllers include a loss of single phase sensor.

#### NOTICE

**This sensor is inactive for single phase systems and indicates no failures.**

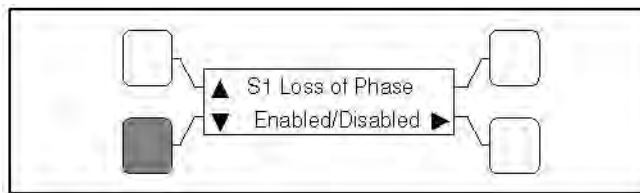
This feature initiates a transfer from a source that has lost a single phase and prevents a transfer to a source that has lost a single phase. This is generally caused by a single phase to line ground or open.

This feature is mainly used to protect three phase devices, such as motors.

**Default Value:** Disabled

**Adjustable:** The adjustable range for loss of single phase sensing is Enabled or Disabled (On or Off).

**Sequence of Events:** The controller indicates a fault when the relative phase angle between any line-to-line phase angle drops to less than 90 degrees.



**FIGURE 15. LOSS OF PHASE SENSING SUBMENU**

### 3.4.2.7 Transfer Times

The controller senses and records the time it takes for the transfer switch to break from one source and reconnect to the other source.

#### NOTICE

**Transfer times are not recorded if Programmed Transition delay is in use.**

### 3.4.3 Transfer Modes

A transfer mode can be selected from the front panel digital display.

Since not all automatic transfer switches are configured the same, some may not have access to all transition mode types. The transfer modes available on your transfer switch are identified in the following section.

The transfer switch mode setting can be changed with the PC service tool or with the digital display.

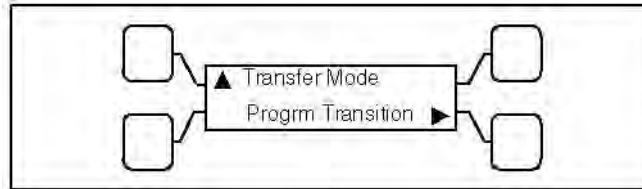


FIGURE 16. TRANSFER MODE SUBMENU

#### 3.4.3.1 Available Transfer Modes

- Open Transition (OT) with Sync Check
- Programmed Transition (PT)
- Closed Transition (CT)

#### 3.4.3.2 Open Transition with Sync Check

Open transition with sync check executes an open transition (OT) transfer when both sources of power are within specified tolerances of frequency, voltage and relative phase difference. If both sources meet the tolerances, a fast transfer occurs.

##### 3.4.3.2.1 Transfer from Source 1 to Source 2 (OT)

This sequence begins with Source 1 supplying power to the load. The Source 1 Available and Source 1 Connected indicators are lit. The sequence ends with Source 2 (generator) assuming the load.

1. When Source 1 goes "out of spec," the control starts a Time Delay to Engine Start (TDES) timer and the Source 1 Available indicator goes out.
2. If the TDES expires without a return to acceptable Source 1 power, the genset receives a remote start signal. The engine starts and accelerates to rated speed.
3. When the alternator output reaches the "pickup" level, the Source 2 Available indicator is lit. The control starts the Time Delay Normal to Emergency (TDNE) timer.

##### 3.4.3.2.2 Transfer from Source 2 to Source 1 (OT)

This sequence begins with Source 2 supplying power to the load. The Source 2 Available and Source 2 Connected indicators are lit. The sequence ends with Source 1 (utility) assuming the load.

1. When Source 1 returns to "in spec," the Source 1 Available indicator is lit and the control starts the Time Delay Emergency to Normal (TDEN) timer. When this time is complete, the controller starts monitoring both live sources looking for when they are in sync

2. When both sources are in sync, the switch transfers the load to Source 1. However, if the two sources fail to synchronize and the "Return PT Enabled" feature is active, the switch executes a programmed transition by stopping in the Neutral position and transferring the load to Source 1. If Source 2 goes offline while the controller is trying to synchronize the two sources, the controller executes a Programmed Transition and transfers the load to Source 1.
3. A Time Delay Engine Cool-down (TDEC) for the genset is activated. When the engine cool-down delay expires, the genset shuts down and the Source 2 Available indicator goes out.

#### 3.4.3.2.3 Return PT Enable

A feature included with controls that have a Sync Check sensor is Return to Programmed Transition.

**Adjustable:** This feature can be enabled and disabled with the PC service tool or with the digital display, if available.

**Sequence of Events:** If the two sources fail to synchronize within two minutes, a Failed to Synchronize event occurs. If the Return to Programmed Transition feature is enabled, the control reverts to transferring the transfer switch to the programmed transition mode.

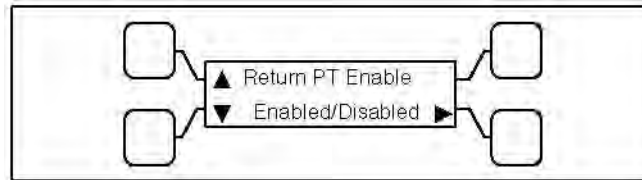


FIGURE 17. RETURN TO PROGRAMMED TRANSITION SUBMENU

#### 3.4.3.2.4 Sync Check Sensor

Sync Check is used to determine when both sources of power are within specified tolerances of frequency, voltage, and relative phase difference. If both sources are within this range, a fast or synchronized transfer occurs.

The transfer switch controller measures non-programmed transition transfer times from one source to another. It takes into account relay coils and solenoids energizing.

**Default Value:**

- Frequency bandwidth: 1.0 Hz
- Voltage: 10 V
- Offset: 0 milliseconds

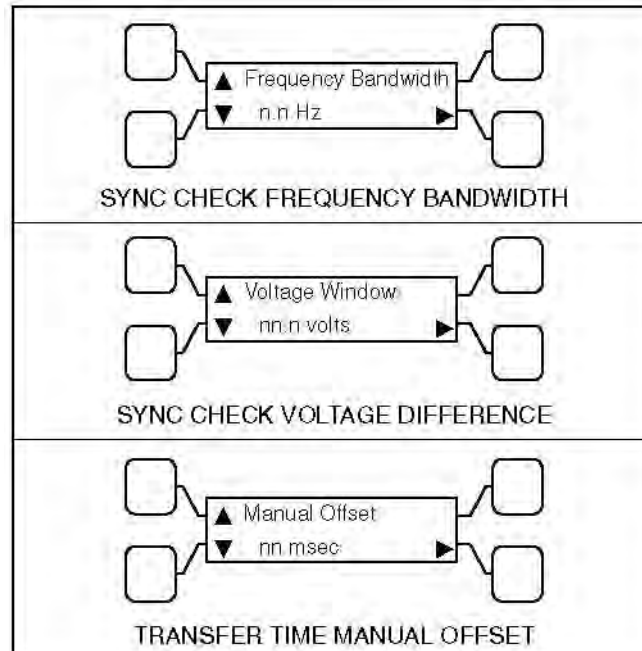
**Range:**

- The frequency bandwidth range is from 0.1 and 1.0 Hz.
  - The frequency difference between the sources must be equal to or less than the set value in order for transfer to occur.
- The voltage window is from 5 and 25 volts.
  - The average voltage difference between the two sources must be equal to or less than the set value in order for transfer to occur.
- The manual offset range is from -25 to +25 milliseconds.



**Adjustable:** Synchronicity parameters are adjustable. The transfer switch mode setting can be changed with the PC service tool or with the digital display, if available.

**Sequence of Events:** If enabled, the Sync Check sensor overrides programmed transition whenever transferring between two live sources. If only one power source is available, programmed transition overrides the Sync Check sensor.



**FIGURE 18. SYNCHRONICITY PARAMETER SUBMENUS**

### 3.4.3.2.5 Active Sync Feature

When the transfer switch is configured to transfer in closed transition mode it is recommended to use the active sync feature. When the active sync feature is enabled,

the transfer switch control can send a Sync Enable command to the genset to synchronize with the utility. This command is activated just before the Sync Check sensor is activated.

To use the Active Sync feature, it must first be enabled. The Active Sync feature can be enabled with the PC service tool or the digital display, if available.

#### NOTICE

The active sync feature may be used with a non-paralleling genset control as well as a paralleling control. A non-paralleling genset control will not synchronize the genset to the utility but enabling the active sync feature will impose the active sync time delay so that the two source must remain synchronized for the set time period maximizing the reliability of the transfer. When using a non-paralleling genset with this feature it is recommended to set the generator set frequency to 0.1 Hz higher than the utility to make sure that the generator set will come into sync with the utility.

**Default Value:** 0.5 seconds

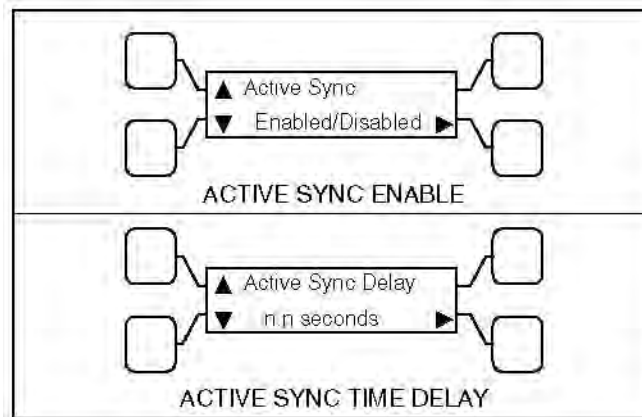
**Range:** The Active Sync Time Delay is adjustable from 0 to 5 seconds in 0.1 second increments.

**Default Delay Time:**

**Adjustable:** The Active Sync Delay timer can be set with the PC service tool or the digital display.

**Sequence of Events:** When the Active Sync feature is enabled, the control runs an Active Sync Time Delay (if greater than 0) and sends the Sync Enable command to the genset. The Active Sync Time Delay is used to check the stability of the system before transferring to the other source. The two sources must remain synchronized for this period of time period before a transfer command is given.

When a paralleling genset control receives a Sync Enable command and detects the Source 1 bus voltages, the genset control automatically synchronizes its speed and phase to match the Source 1 bus. The Sync Check sensor monitors both sources. When they are synchronized, a transfer or retransfer command is initiated.



**FIGURE 19. ACTIVE SYNC SUBMENUS**

#### 3.4.3.2.6 Speed Adjust

If a PowerCommand transfer switch and a non-paralleling genset are networked together, the transfer switch control can send a Speed Adjust command to the genset to increase its speed just enough to increase its frequency by 0.5 Hz.

#### NOTICE

**The genset must be capable of reacting to a Speed Adjust command. This feature is only available if a PowerCommand network is installed.**

**Default Value:** Speed Adjust is always enabled unless Active Sync is enabled.

**Sequence of Events:** The command is activated just before the Sync Check sensor is activated. It is used when the genset takes a long time to drift in sync with the utility. This increases the number of "in-phase" opportunities to satisfy the Sync Check sensor.

#### 3.4.3.3 Programmed Transition

Programmed transition executes a programmed transition (PT) transfer by disconnecting the load from the source of power, pausing in the neutral position of the transfer switch (between switched positions) to allow transient voltages from the load to diminish, and then the load is switched to the other source.

---

#### 3.4.3.3.1 Transfer from Source 1 to Source 2 (PT)

This sequence includes a programmed transition and begins with Source 1 supplying power to the load. The Source 1 Available and Source 1 Connected indicators are lit. The sequence ends with Source 2 (generator) assuming the load.

1. When source 1 goes "out of spec," the control starts a Time Delay Engine Start (TDES) timer and the Source 1 Available indicator goes out.
2. If the TDES expires without a return to acceptable Source 1 power, the genset receives a remote start signal. The engine starts and accelerates to rated speed.
3. When the alternator output reaches the "pickup" level, the Source 2 Available indicator lights. The transfer switch starts the Time Delay Normal to Emergency (TDNE) timer. When this time is complete, the switch moves to the Neutral position. The Source 1 Connected indicator goes out.
4. The transfer switch stops in the Neutral position for the Time Delay Programmed Transition (TDPT) and then completes its transition to the Source 2 position. The Source 2 Connected indicator lights.

#### 3.4.3.3.2 Transfer from Source 2 to Source 1 (PT)

This sequence begins with Source 2 supplying power to the load. The Source 2 Available and Source 2 Connected indicators are lit. The sequence ends with Source 1 (utility) assuming the load.

1. When Source 1 returns to "in spec," the Source 1 Available indicator lights and the digital board starts the Time Delay Emergency to Normal (TDEN) timer. When this time is complete, the switch moves to the neutral position (the Source 2 indicator goes out).
2. If there is a programmed transition delay, the transfer switch stops in the Neutral position for the Time Delay Programmed Transition (TDPT) and then completes its transition to the Source 1 position. The Source 1 Connected indicator lights and the Time Delay Engine Cooldown (TDEC) timer starts.
3. When the engine cool-down delay expires, the genset shuts down and the Source 2 Available indicator goes out.

#### 3.4.3.4 Closed Transition

Closed transition executes a load transfer by momentarily paralleling both sources (a maximum of 100ms) before switching sources.

##### 3.4.3.4.1 Transfer from Source 1 to Source 2 (CT)

This sequence begins with Source 1 supplying power to the load. The Source 1 Available and Source 1 Connected indicators are lit. The sequence ends with Source 2 (generator) assuming the load.

1. When Source 1 goes "out of spec," the digital board starts a Time Delay to Engine Start (TDES) timer and the Source 1 Available indicator goes out.
2. If the TDES expires without a return to acceptable Source 1 power, the genset receives a remote start signal, the engine starts and accelerates to rated speed.
3. When the alternator output reaches the "pickup" level, the Source 2 Available indicator is lit. The transfer switch starts the Time Delay Normal to Emergency (TDNE) timer. When this time is complete, the switch moves to the Neutral position. The Source 1 Connected indicator goes out.

4. If there is a programmed transition delay, the transfer switch stops in the Neutral position for the Time Delay Programmed Transition (TDPT) and then completes its transition to the Source 2 position. The Source 2 Connected indicator is lit.

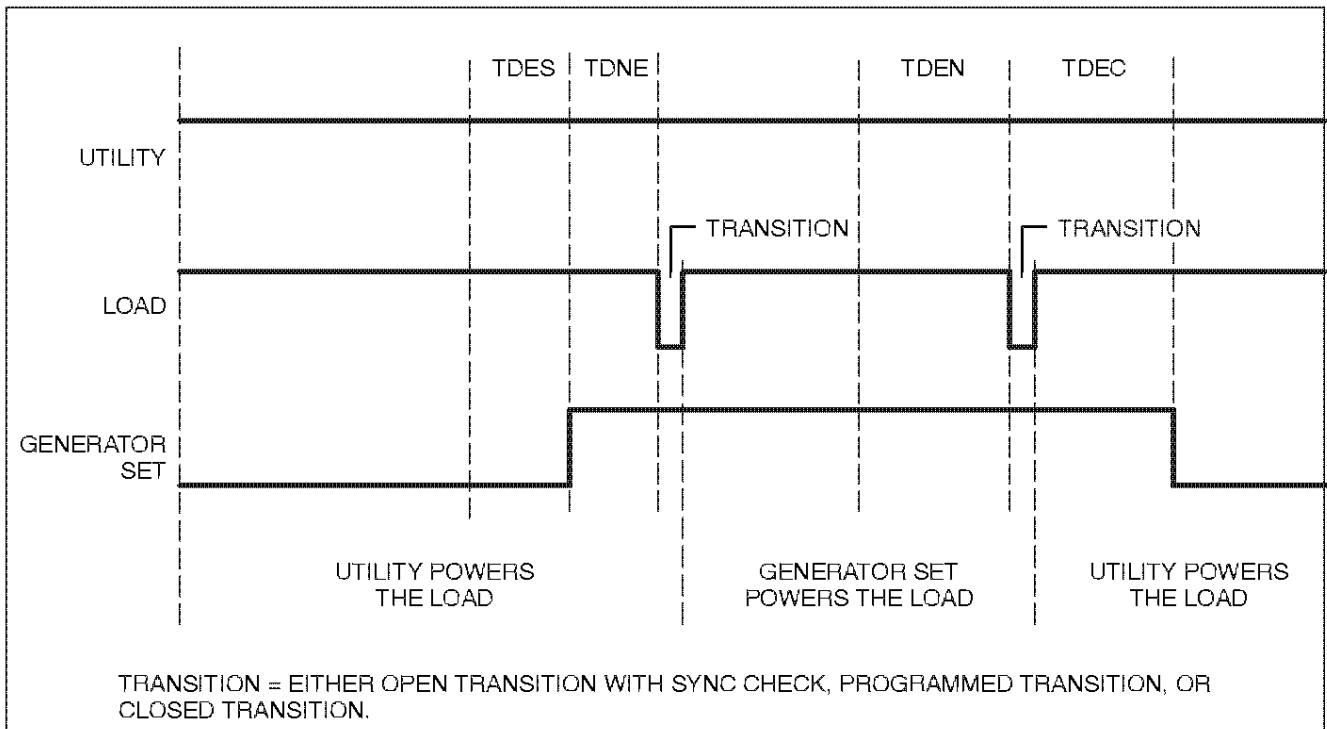
### 3.4.3.4.2 Transfer from Source 2 to Source 1 (CT)

This sequence begins with Source 2 supplying power to the load. The Source 2 Available and Source 2 Connected indicators are lit. The sequence ends with Source 1 (utility) assuming the load.

1. When Source 1 returns to "in spec," the Source 1 Available indicator is lit and the digital board starts the Time Delay Emergency to Normal (TDEN) timer. When this time is complete, the controller starts monitoring both live sources until they are in phase.
2. When they are in phase, the controller closes the Source 1 contact and allows Source 1 and Source 2 to simultaneously feed the load for a maximum of 100ms.
3. After the 100ms timer expires, the controller opens the Source 2 contacts.
4. A Time Delay Engine Cool-down (TDEC) for the genset is activated. When the engine cool-down delay expires, the genset shuts down and the Source 2 Available indicator goes out.

## 3.4.4 Front Panel Test - Sequence of Events

If the test button is pushed on the Front Panel, then the controller simulates a Source 1 or Utility failure and proceeds to transfer the load to the generator.



**FIGURE 20. FRONT PANEL TEST SEQUENCE OF OPERATION**

---

### 3.4.4.1 Transfer from Source 1 to Source 2 (Front Panel Test)

This sequence begins with Source 1 supplying power to the load continuously. The Source 1 Available and Source 1 Connected indicators are lit. The sequence ends with Source 2 (generator) assuming the load.

1. When the operator holds the Test button on the front panel for at least two seconds, the digital board starts a Time Delay to Engine Start (TDES) timer.
2. When the TDES timer expires, the genset receives a remote start signal. The engine starts and accelerates to rated speed.
3. When the alternator output reaches the "pickup" level, the Source 2 Available indicator lights. The transfer switch starts the Time Delay Normal to Emergency (TDNE) timer. When this time is complete, the controller proceeds to transfer the load in accordance with how it is configured.
  - If the controller is configured for OT with Sync Check, it monitors the two sources until they are in phase and transfers the load to Source 2. The Source 2 Connected indicator lights.
  - If the controller is configured for Programmed Transition and there is a programmed transition delay, the transfer switch stops in the Neutral position for the Time Delay Programmed Transition (TDPT) and then completes its transition to the Source 2 position. The Source 2 Connected indicator lights.
  - If the controller is configured for Closed Transition, it monitors the two sources until they are in phase, close Source 2 for a maximum of 100ms, and open Source 1. The Source 2 Connected indicator lights.

### 3.4.4.2 Transfer from Source 2 to Source 1 (Front Panel Test)

This sequence begins with Source 2 supplying power to the load. The Source 2 Available and Source 2 Connected indicators are lit. The sequence ends with Source 1 (utility) assuming the load.

1. When the operator pushes the Test button on the Front Panel, the digital board starts the Time Delay Emergency to Normal (TDEN) timer.
2. When the TDEN is complete, the controller proceeds to transfer the load in accordance with how it is configured.
  - If the controller is configured for OT with Sync check, it monitors the two sources until they are in phase and transfers the load to Source 1. The Source 1 Connected indicator lights.
  - If the controller is configured for Programmed Transition and there is a programmed transition delay, the transfer switch stops in the Neutral position for the Time Delay Programmed Transition (TDPT) and then completes its transition to the Source 1 position. The Source 1 Connected indicator lights.
  - If the controller is configured for Closed Transition, it monitors the two sources until they are in phase, closes Source 1 for a maximum of 100ms, and opens Source 2. The Source 1 Connected indicator lights.
3. A Time Delay Engine Cool-down (TDEC) for the genset is activated. When the engine cool-down delay expires, the genset shuts down and the Source 2 Available indicator goes out.

### 3.4.4.3 Test With or Without Load

The operator can test the transfer switch, generator, and power system locally. The operator can choose to transfer the load during the test or only test the generator. A test sequence can be activated either through the switch panel push button or through the PowerCommand network.

#### NOTICE

**The Test button does not function unless the Front Panel Security Switch is in the Program position.**

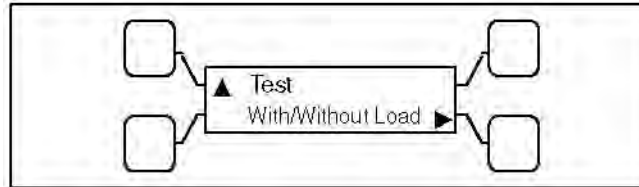


FIGURE 21. TEST WITH OR WITHOUT LOAD SUBMENU

### 3.4.4.4 Programmable Generator Exerciser

Programmable generator exercises and exercise exceptions are generally programmed to be recurring. They can be programmed from the PC service tool or the digital display, if available.

Level 1 controllers include two programmable generator exercises and two programmable exercise exceptions. All events can be set using the PC service tool or the digital display.

#### NOTICE

**Early versions of software on Level 1 controllers allow for setting only one exercise period and one exercise exception using the digital display.**

Level 2 controllers include eight programmable generator exercises and eight programmable exercise exceptions. All events can be set using the PC service tool or the digital display.

#### NOTICE

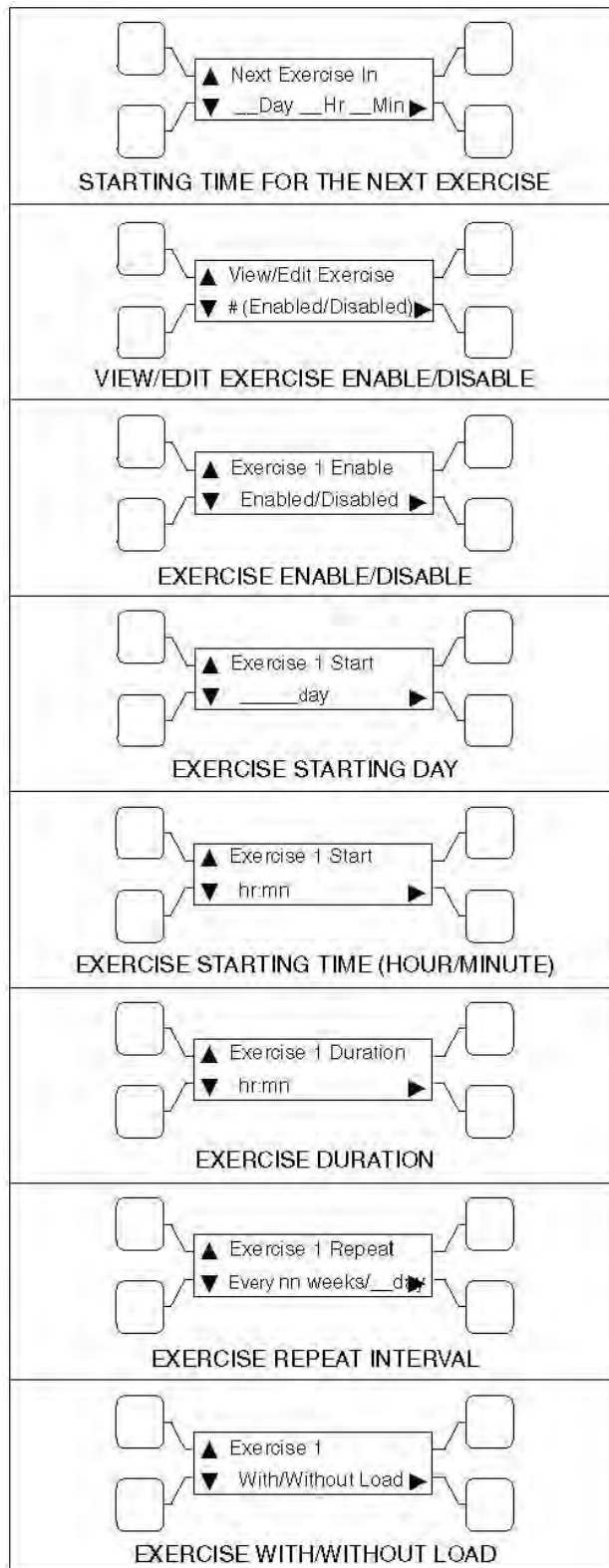
**Early versions of software on Level 2 controllers allow for setting only two exercise periods and two exercise exceptions using the digital display.**

All controllers have a push-button switch on the digital module that enables and disables the exerciser clock. The Real-Time clock must be set before exercise programs are entered.

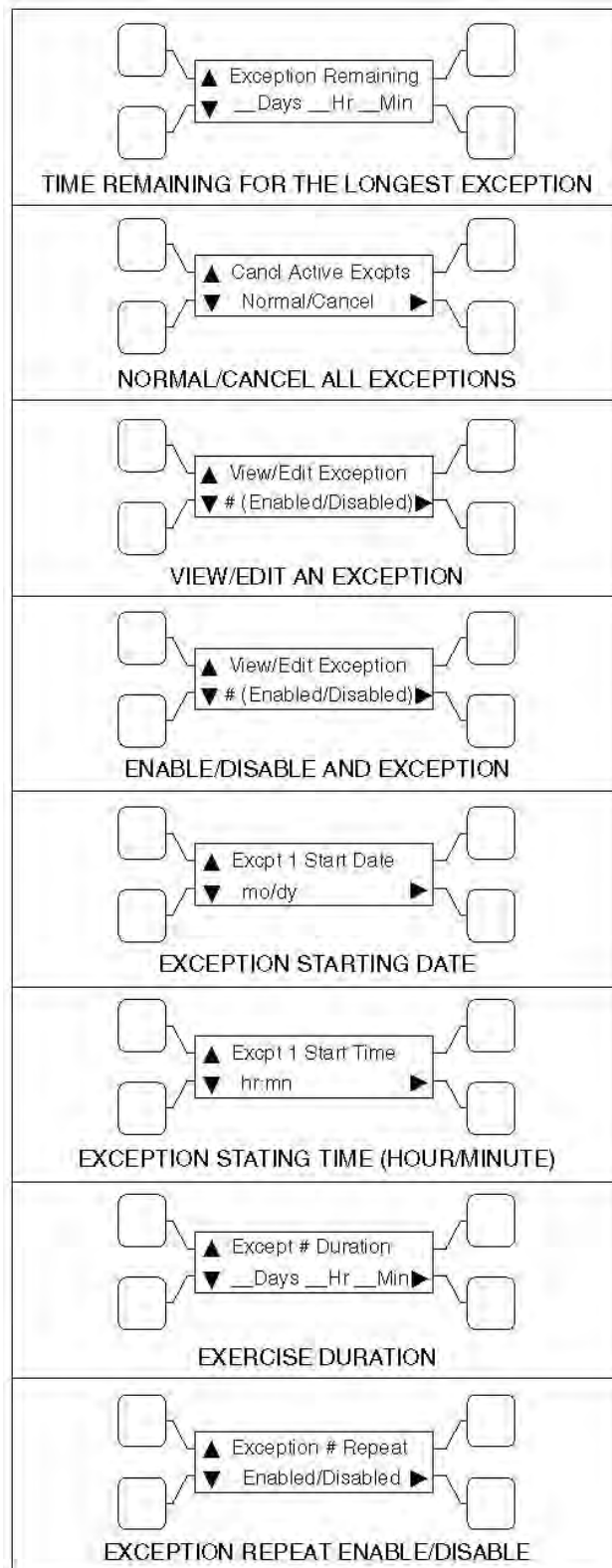
For **utility-to-genset** configurations: the exerciser clock initiates genset start and run cycles at specified intervals for specified durations.

#### NOTICE

**The exerciser is not used in utility-to-utility or genset-to-genset configurations.**



**FIGURE 22. EXERCISE SUBMENUS**



**FIGURE 23. EXERCISE EXCEPTIONS SUBMENUS**



### 3.4.4.5 Real-Time Clock

All controllers have a real-time clock that keeps track of the time and date. The controller uses the real-time clock to time and date stamp all events.

#### NOTICE

The clock is not set at the factory. To set the clock, use the PC service tool or the digital display.

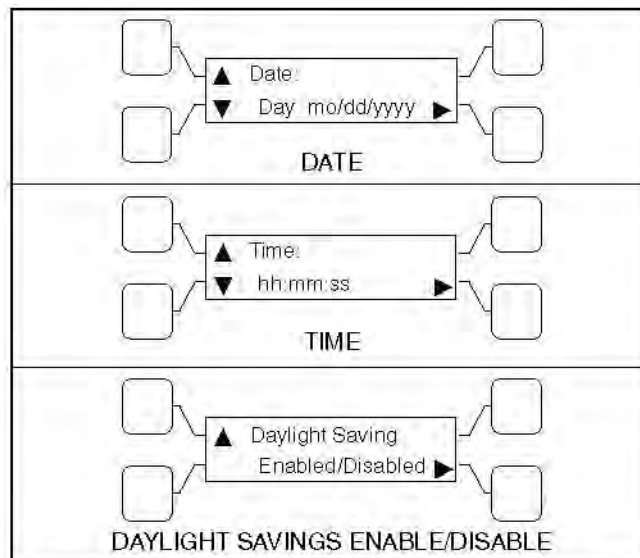


FIGURE 24. CLOCK SUBMENUS

### 3.4.4.6 Sleep Mode

After a period of screen inactivity (35 minutes), the digital display goes blank. Screen inactivity is when there is no user interaction with the menu system and when there are no events. The digital display is reactivated when an event occurs or when an operator touches one of the menu buttons.

In order to conserve controller battery power, the loss of utility power also causes the digital display to go blank. The digital display is reactivated when a second power source becomes available.

The status of the controller batteries can be viewed using the digital display.

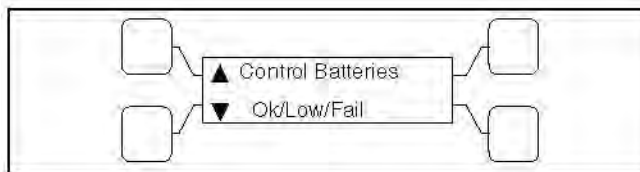


FIGURE 25. CONTROLLER BATTERIES STATUS SUBMENU

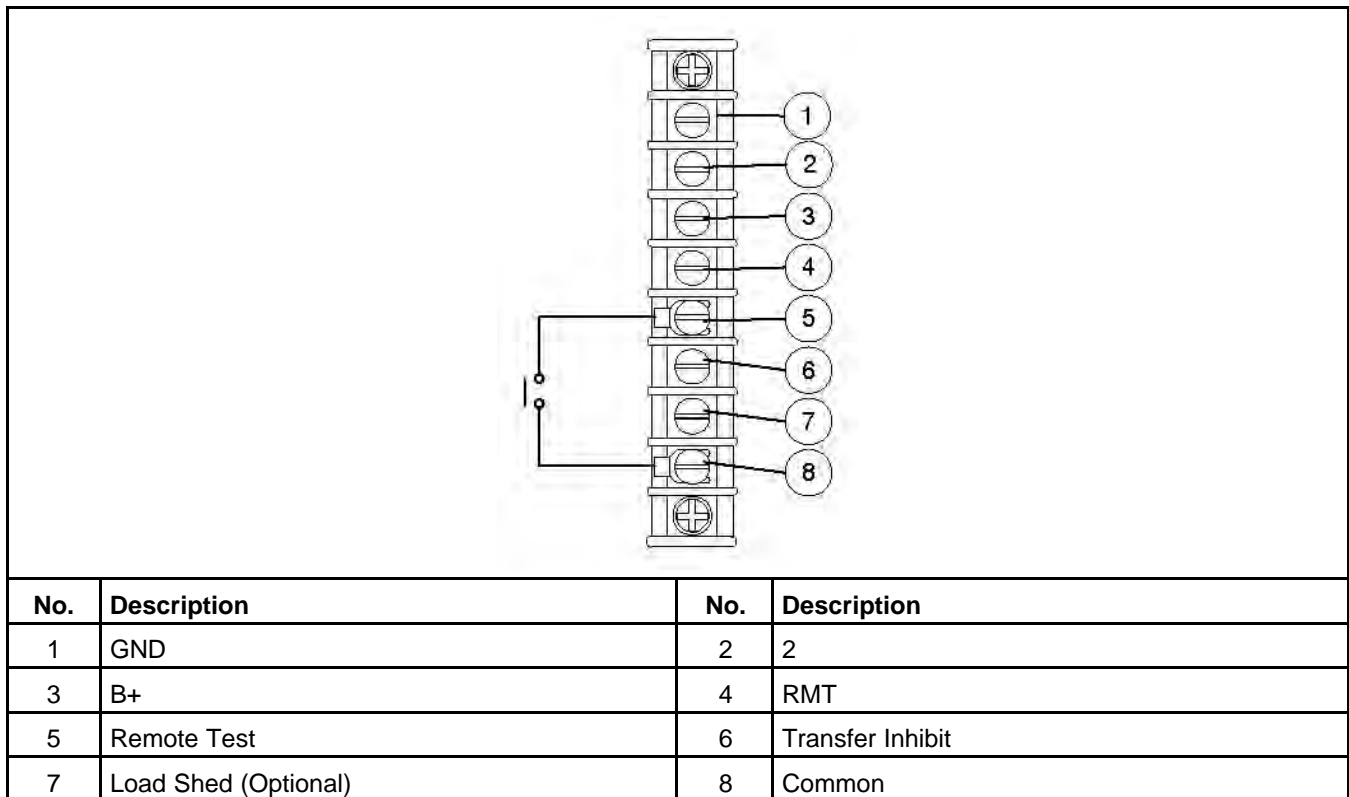
### 3.4.4.7 Remote Test Switch

The transfer switch can be wired with a remote test switch.

For **utility-to-genset** applications, closure of a set of contacts across the remote test transfer input (TB2-5 and TB2-8) causes the transfer switch to sense a simulated utility power failure and sends a start/run signal to the generator set and transfers the load to the genset when it becomes available.

For **utility-to-utility** applications, closure of a set of contacts across the remote test transfer input causes the transfer switch to sense a simulated power failure of the primary source and transfers the load to the backup source.

Opening a set of contacts across the remote test transfer input causes the transfer switch to sense that the primary source has been restored and transfers the load back to the primary source (Source 1).



**FIGURE 26. TB2 CONNECTIONS FOR REMOTE TEST TRANSFER**

### 3.4.4.8 Remote Test Input

The transfer switch may be wired for a remote test input. The switch is used to start and stop manually initiated system tests. As with the control panel Test pushbutton, the remote test input can be configured to test with or without load.

A remote test input is set up by connecting a dry (voltage free) contact between TB2-5 and TB2-8. Closing the contact starts a test and opening the contact cancels the test. The Test LED flashes to signify the start of a test and stays on during the test.

Closing the contact causes the transfer switch to sense a (simulated) utility power failure and sends a start/run signal to the genset. If the control is set up to test with load, the load is transferred to the genset when the genset becomes available. The Utility Power Available LED remains on to show that the utility did not fail.

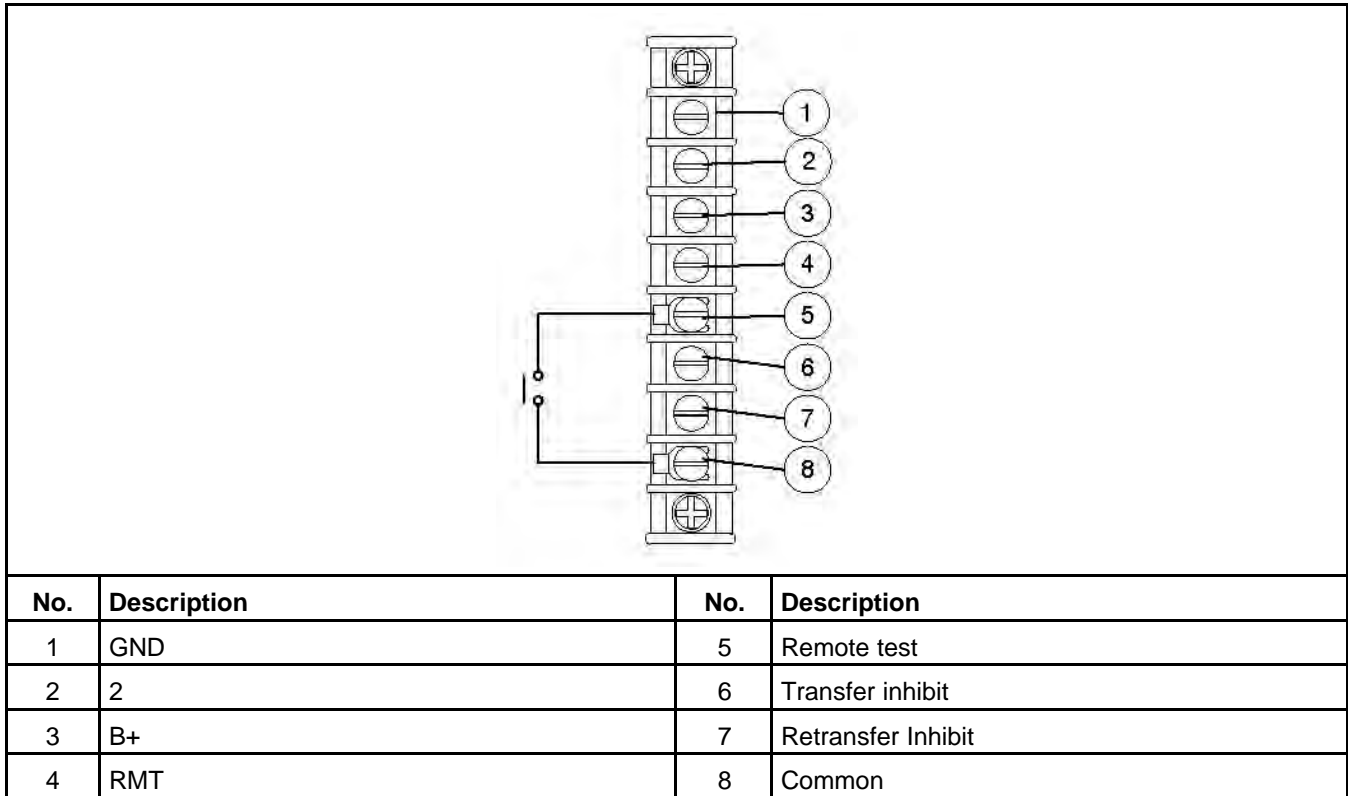


FIGURE 27. TB2 CONNECTIONS FOR REMOTE TEST TRANSFER

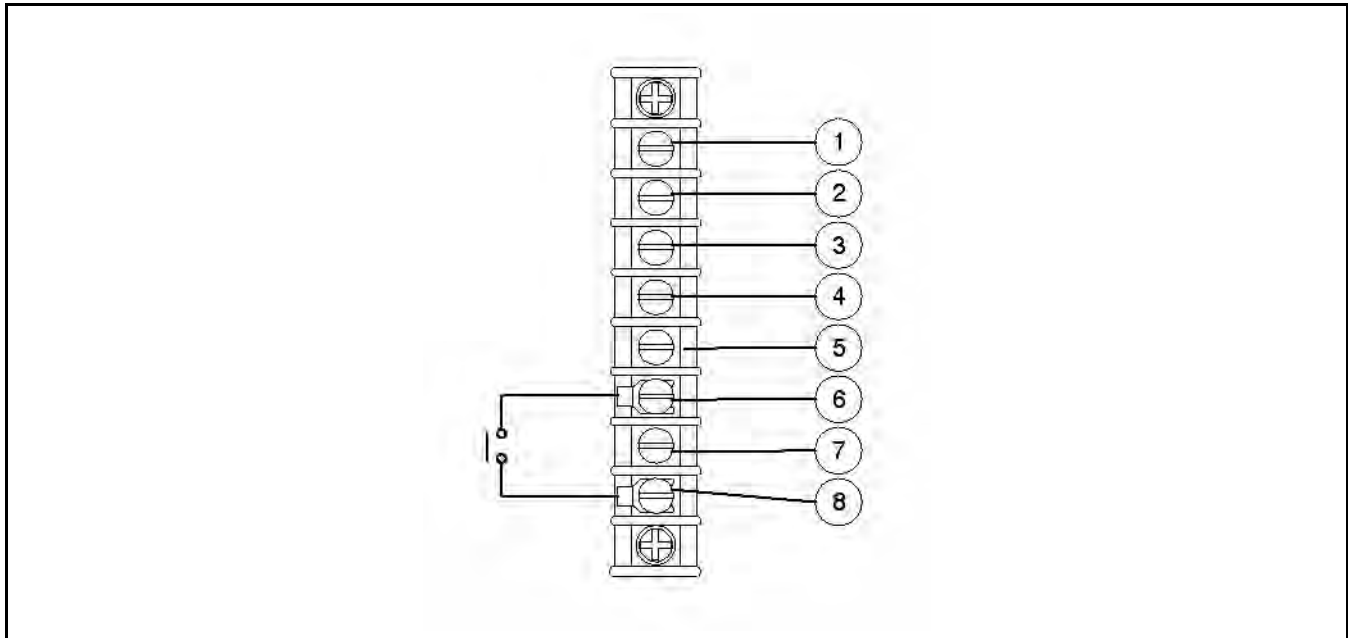
**NOTICE**

TB1 and TB2 will accept 22 AWG - 12 AWG wire with 3/8 inch (10 mm) strip. Torque to 9 in-lbs.

### 3.4.4.9 Transfer Inhibit (PowerCommand Control)

This feature is used to control load transfer to generator sets. When activated, load transfer will not take place unless the Override button on the switch panel is pressed or the transfer inhibit input is disabled. Transfer Inhibits are set up by connecting a remote contact between TB2-6 and TB2-8. Closing the contact enables the feature and opening the contact disables it.

In systems that have multiple closed transition transfer switches the transfer inhibit function should be used to make sure that multiple switches don't transfer at the same time. Refer to the section on closed transition ATS considerations.



No.	Description	No.	Description
1	GND	2	2
3	B+	4	RMT
5	Remote test	6	Transfer inhibit
7	Load Shed (Optional)	8	Common

**FIGURE 28. TB2 CONNECTIONS FOR TRANSFER INHIBIT**

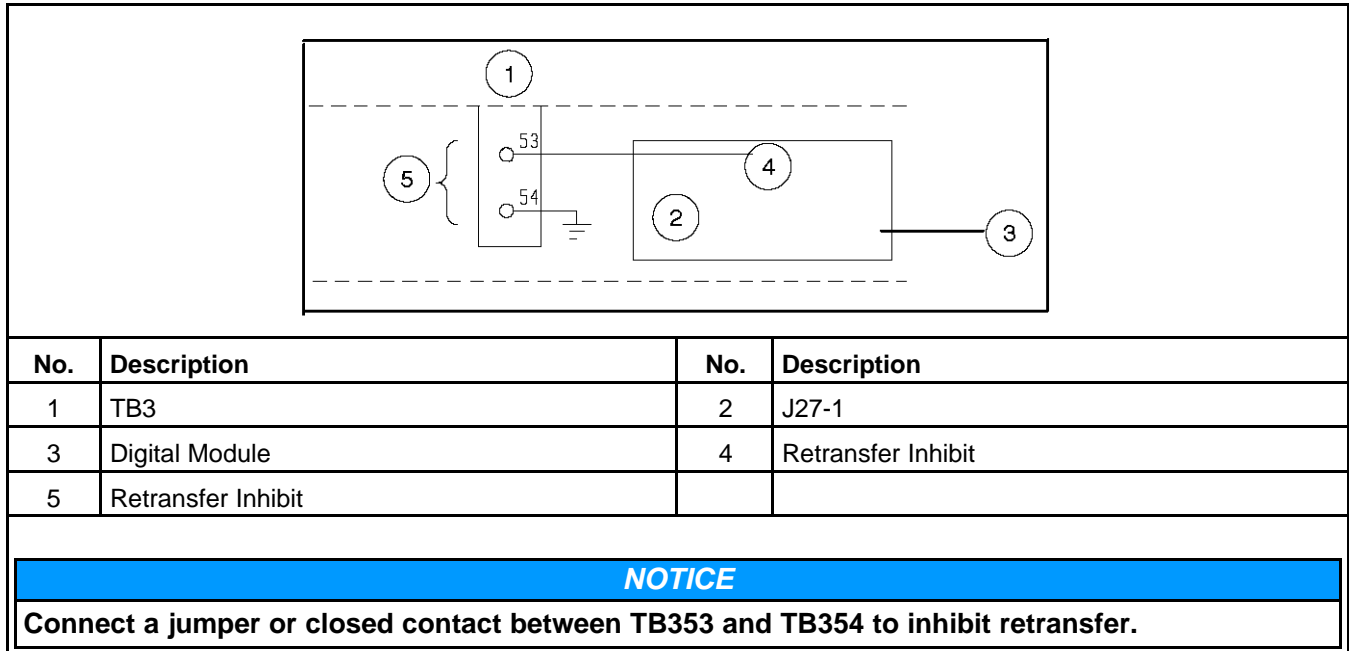
### 3.4.4.10 Retransfer Inhibit (PowerCommand Control)

This feature is used to prevent the ATS from automatically transferring the load back to Source 1 (or the preferred source in genset-to-genset applications). When activated, load transfer will not take place unless the Override button on the switch panel is pressed, the retransfer inhibit input is disabled, or Source 2 (or the backup source in genset-to-genset applications) fails.

In systems that have multiple closed transition transfer switches the retransfer inhibit function should be used to make sure that multiple switches don't transfer at the same time. Refer to the section on closed transition ATS considerations.

<b>NOTICE</b>
<b>If Source 2 (or the backup source in genset-to-genset applications) fails, the Retransfer Inhibit is ignored.</b>

Retransfer Inhibits are set up by connecting a remote contact between TB3-53 and TB3-54. Closing the contact enables the feature and opening the contact disables it. When enabled, the event is displayed on the front panel.

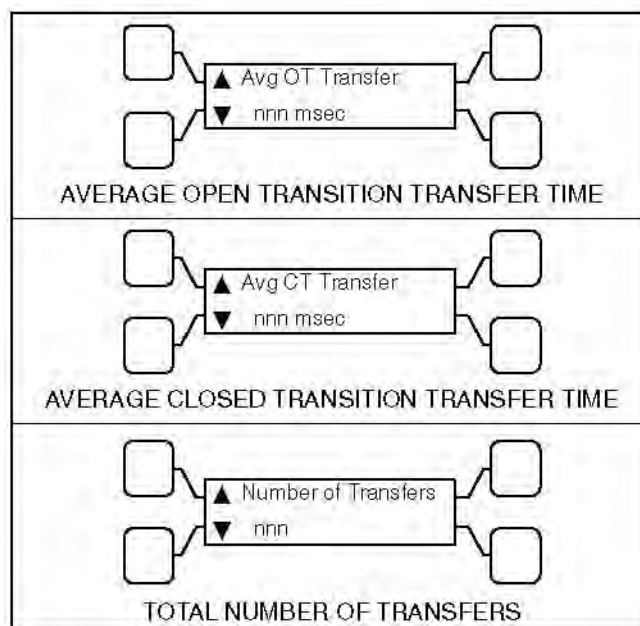


**FIGURE 29. TB3 CONNECTIONS FOR RETRANSFER INHIBIT**

### 3.4.4.11 Transfer Times

The controller senses and records the time it takes for the transfer switch to break from one source and reconnect to the other source.

The controller keeps track of open transition transfer times and provides an average open transition transfer time. The controller records the transfer time if the transition mode is an open transition with Sync Check or when a Programmed Transition is used and the Programmed Transition time delay is zero.



**FIGURE 30. TRANSFER SUBMENUS**

## 3.5 Options

### 3.5.1 Battery Charger Options

Two battery chargers are available. One battery charger is rated for 2 amperes at 12 or 24 VDC. The other battery charger is rated for 15 amperes at 12 VDC or 12 amperes at 24 VDC.

A float-charge battery charger regulates its charge voltage to continuously charge without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery.

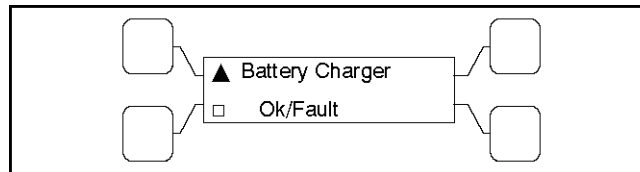


FIGURE 31. BATTERY CHARGER STATUS SUBMENU

#### 3.5.1.1 2-Amp/10-Amp Float Battery Charger Option

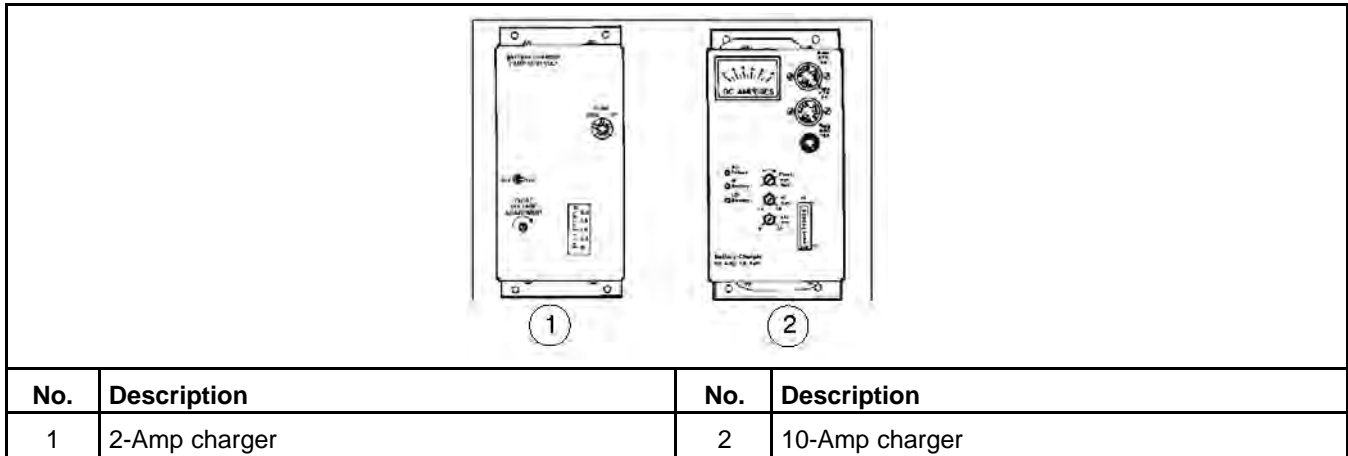
A float-charge battery charger regulates its charge voltage to continuously charge without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery.

Two chargers were available. One battery charger is rated for 10 amperes at 12 or 24 VDC. The other battery charger is rated for 2 amperes at 12 or 24 VDC.

- The 2-ampere battery charger has an ammeter to indicate charging current and a fuse to protect the battery charger circuit.
- The 10-ampere battery charger has three fuses (two on the AC input and one on the DC output), three fault display LEDs, and an ammeter for indication of charging current.

On the 10-ampere charger, three sets of (Form-C) alarm contacts (corresponding to the three fault LEDs) are also available. Using an optional alarm contact harness, these contacts can be wired by the installer to activate other audible or visual alarms.

Under normal operating conditions, the Low Bat and AC Fail relays are energized and the High Bat relay is de-energized. In response to a Low Bat or AC Fail condition, the appropriate normally energized relay (Low Bat or AC Fail) drops out. In response to a High Bat condition, the normally de-energized High Bat relay is energized.

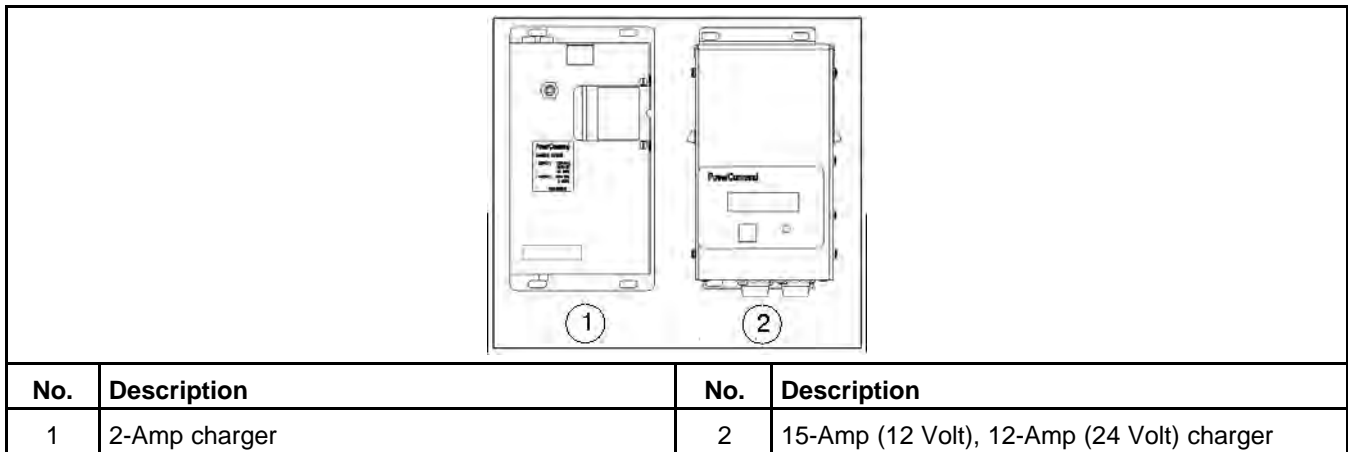


**FIGURE 32. 2-AMP AND 10-AMP FLOAT BATTERY CHARGERS**

### 3.5.1.2 2-Amp/15-Amp (12VDC), 12-Amp (24VDC) Float Battery Charger Option

A float-charge battery charger regulates its charge voltage to continuously charge without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery.

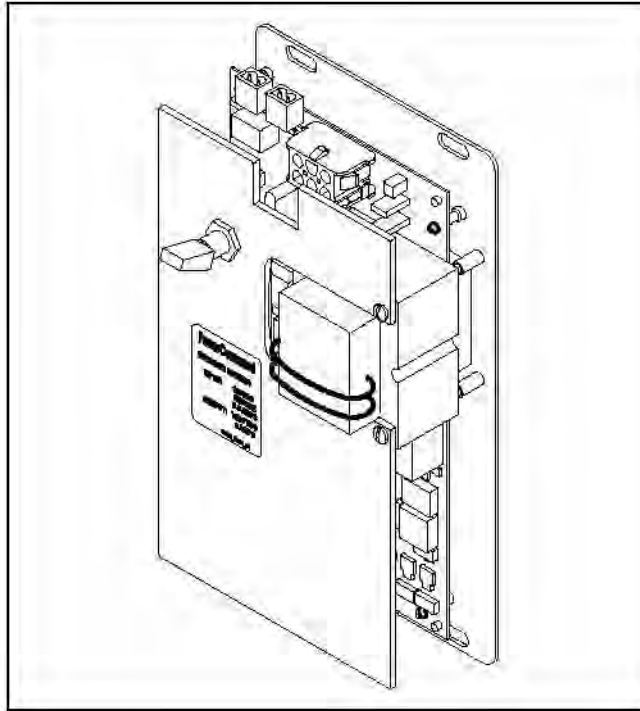
Two battery chargers are available. One battery charger is rated for 2 amperes at 12 or 24VDC. The other battery charger is rated for 15 amperes at 12 VDC or 12 amperes at 24 VDC.



**FIGURE 33. 2-AMP (12 OR 24VDC) AND 15-AMP (12VDC, OR 12-AMP (24VDC))**

### 3.5.1.3 2-Amp Battery Charger

The 2-ampere battery charger has a 5 amp DC output circuit breaker switch on the front of the battery charger. The charger also includes a 5 amp AC fuse to protect the battery charger circuit.



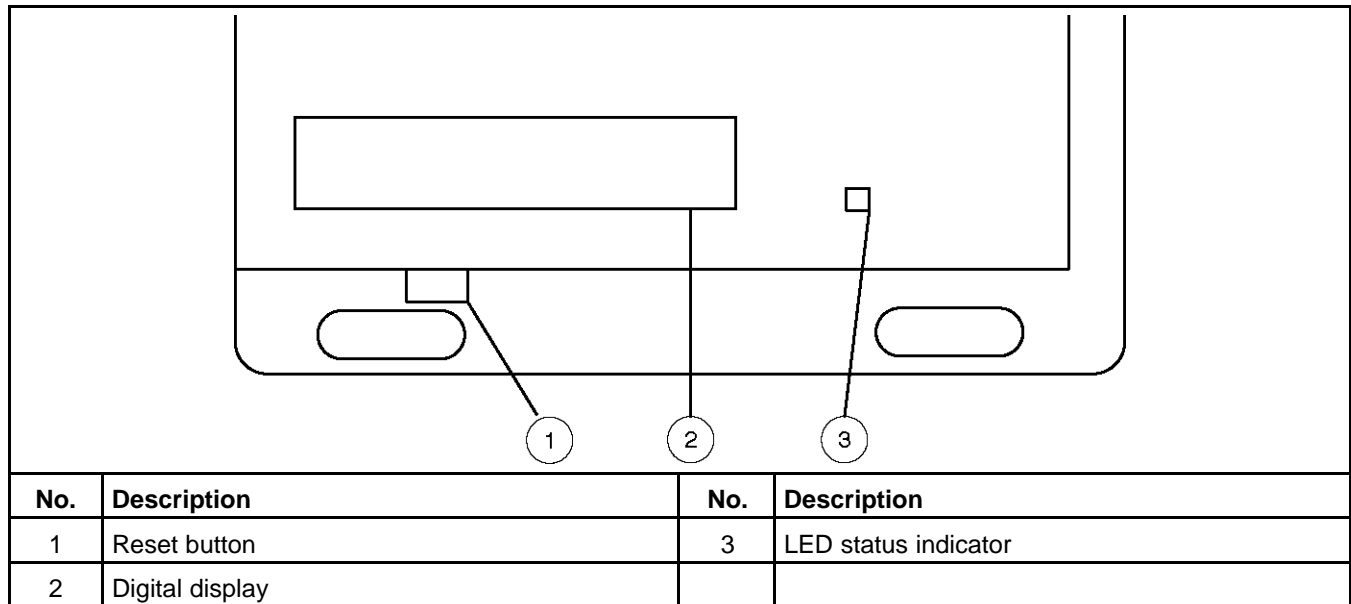
**FIGURE 34. 2-AMP POWERCOMMAND BATTERY CHARGER**

### **3.5.1.3.1 2-Amp Control Panel**

The 2-amp battery charger control panel includes a digital display, a RESET button and an LED status indicator.

- The 2-line x 16-character digital display displays menus and faults.
- The RESET button is used to select menu options and to clear fault messages.
- The status LED displays the appropriate color for the following conditions.
  - **Green** - On solid indicates unit is charging
  - **Red** - On solid indicates a fault condition. The fault number is shown on the digital display.





**FIGURE 35. 2-AMP BATTERY CHARGER CONTROL PANEL**

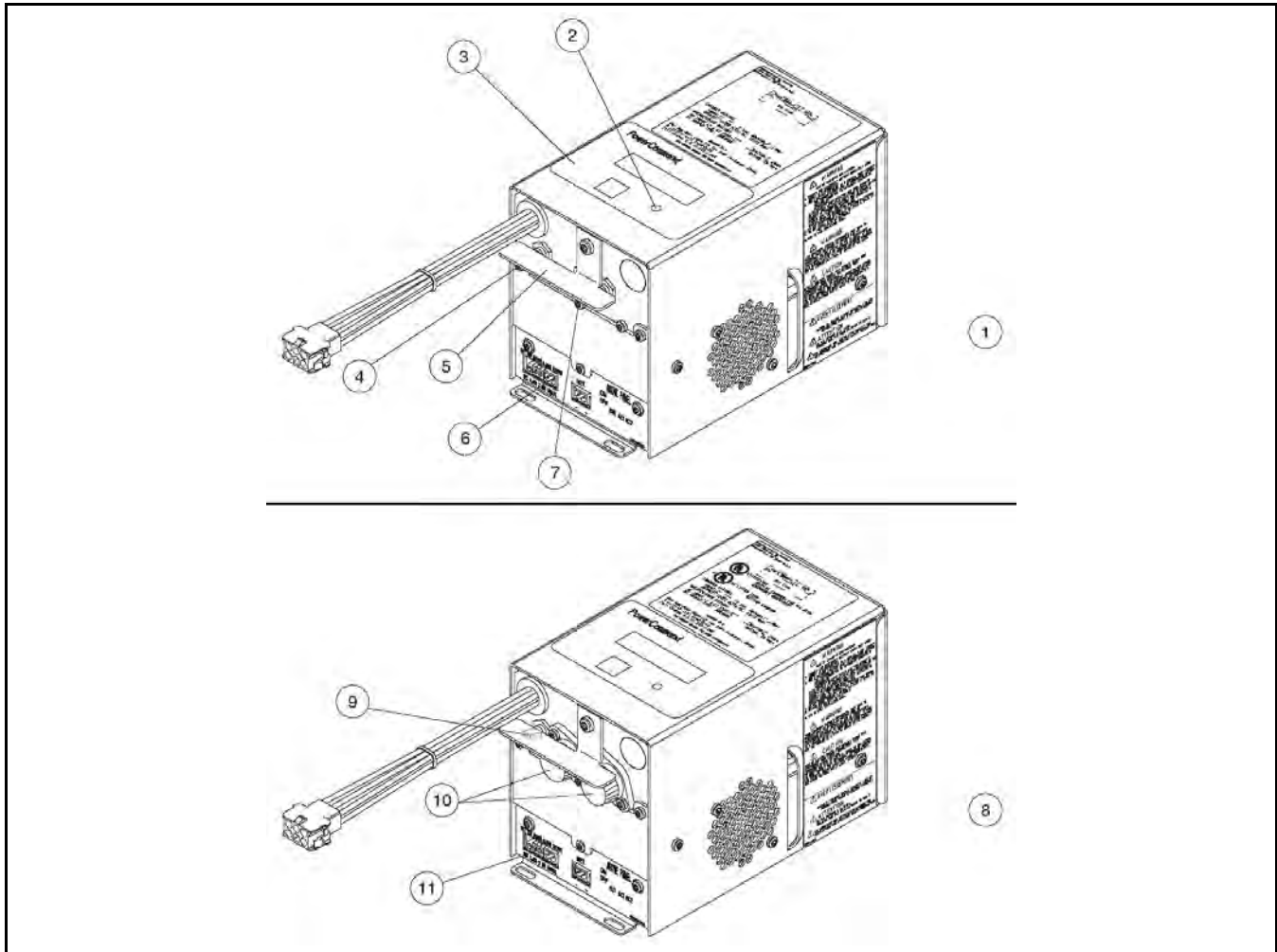
### 3.5.1.3.2 2-Amp Battery Charger Configuration

The **RESET** button on the control panel is used to configure the battery charger for the correct battery voltage. (More information on Setup menus is included in the Battery Charger Operator Manual.)

### 3.5.1.4 15/12-Amp Battery Charger

There are two types of 15/12-amp PowerCommand battery chargers. All 15/12-amp battery chargers have a 20 amp DC circuit breaker switch on the bottom of the battery charger.

- **The 120, 208, and 240 VAC battery chargers include:**
  - Two 10-Amp AC circuit breaker switches
  - A circuit breaker guard
- **The 277, 380, 416, and 600 VAC battery chargers include:**
  - Two AC fuse holders



No.	Description	No.	Description
1	120, 208 and 240 VAC battery chargers	7	AC input breaker
2	Status LED	8	227, 380, 416, 480 and 600 VAC battery chargers
3	Control panel	9	20-Amp DC output circuit breaker switch (shown in ON position)
4	DC output breaker	10	AC input fuse holders
5	Circuit breaker guard	11	Optional battery temperature sensor connector
6	Fault alarm output connector		

**FIGURE 36. 15/12-AMP POWERCOMMAND BATTERY CHARGERS**

**3.5.1.4.1 Control Panel**

The 15/12-amp charger control panel includes a digital display, a Reset button, and an LED status indicator.

- The 2-line x 16-character digital display displays menus and faults.
- The Reset button is used to select menu options and to clear fault messages.

- The status LED is displays the appropriate color for the following conditions.
  - **Green** - On solid indicates unit is charging
  - **Amber** - On solid indicates Equalizing
  - **Red** - On solid indicates a fault condition. The fault number is shown on the digital display.

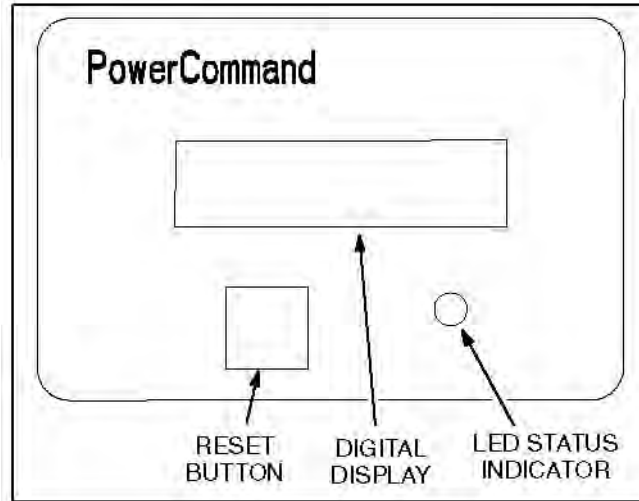


FIGURE 37. 15/12-AMP CHARGER CONTROL PANEL

#### 3.5.1.4.2 Battery Charger Configuration

The **RESET** button on the control panel is used to configure the battery charger. (More information on Setup menus is included in the Battery Charger Operator Manual.)

- **Battery Voltage and Type** - The battery charger must be correctly configured, using the Setup menus, for the correct battery voltage and type before it is connected to the battery. The battery voltage can be set for 12 or 24 VDC (default = 12 VDC). The battery type can be set for Lead-Acid, Gel, or AGM batteries (default = Lead-Acid).

#### NOTICE

A factory installed battery charger is set up for the proper DC battery voltage requested on the production order, with the Lead-Acid battery type selected as the default.

- **Battery Equalization** - Battery equalization is available for lead-acid batteries that are completely charged, using the Equalize Battery screen in the Setup menus. When battery equalization is in process, the LED status indicator turns amber.

#### 3.5.1.4.3 Optional Battery Temperature Sensor

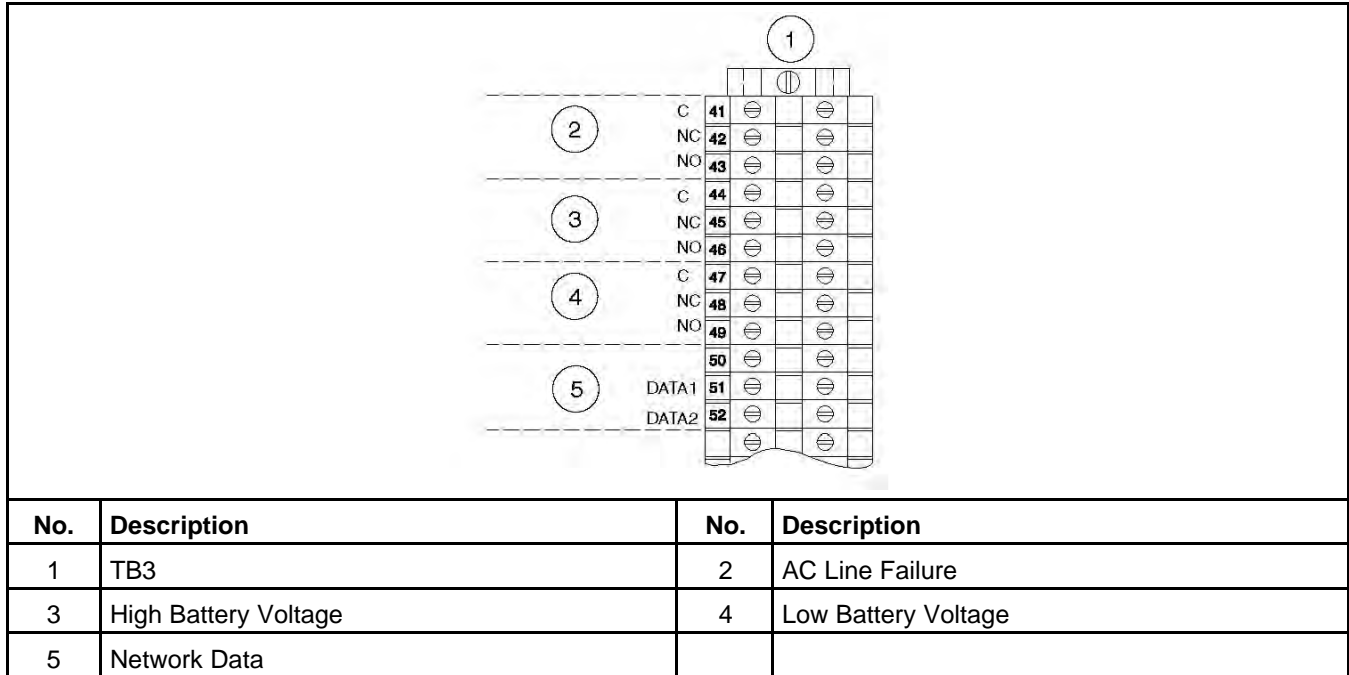
A connector for an optional battery temperature sensor is located on the bottom of the battery charger. When used to monitor battery temperature, the optional battery temperature sensor is connected from the battery charger to the positive terminal of the battery. A fault message (fault code 2263) is displayed if the battery temperature is too high (reaches 131 °F (55 °C)).

#### 3.5.1.5 Battery Charger Alarm Contacts Options

The optional 10-ampere battery charger can include three sets of Form-C relay contacts, as an additional option.

Under normal operating conditions, the Low Bat and AC Fail relays are energized and the High Bat relay is de-energized. In response to a Low Bat or AC Fail condition, the appropriate normally energized relay (Low Bat or AC Fail) drops out. In response to a High Bat condition, the normally de-energized High Bat relay is energized.

The contacts are rated for 4 amperes at 120 VAC or 30 VDC. Connections to these contacts are made at terminals 41-42-43 (AC Failure), 44-45-46 (High Battery Voltage) and 47-48-49 (Low Battery Voltage) of TB3.



**FIGURE 38. BATTERY CHARGER STATUS SUBMENU**

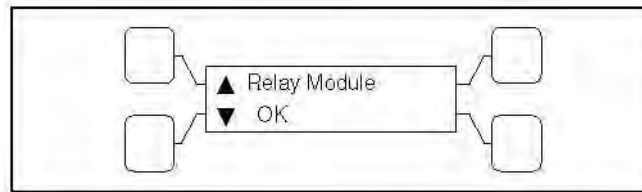
**3.5.1.5.1 Relay Module Option**

The Relay Module provides nine sets of Form-C contacts and two sets of normally open contacts that are rated for 2 Amps at 30 VDC or 0.60 Amps at 120 VAC. The module includes the Elevator Pre-Transfer Delay Signal. The relay contacts may be used with other applications.

The Relay Module is located on the left inside wall of the transfer switch enclosure.

The Fail to Disconnect relay is active when the transfer switch remains connected to both sources for more than 100 msec during a closed transition transfer. It should be wired to the shunt trip of the breaker feeding the ATS on either the normal or the emergency side. Refer to the section on closed transition ATS wiring considerations.

The status of the relay module (OK or Not Installed) can be viewed with the digital display. This menu is included in the About submenus.



**FIGURE 39. RELAY MODULE STATUS SUBMENU**

### 3.5.1.5.2 Relay Signal Module

**TABLE 1. RELAY SIGNAL MODULE**

Relay Signal	Control Type
Source 1 Connected	Level 1 and Level 2
Source 1 Available	Level 1 and Level 2
Source 2 Connected	Level 1 and Level 2
Source 2 Available	Level 1 and Level 2
Test/Exercise Active	Level 1 and Level 2
Load Shed Active	Level 1 and Level 2
Fail to Transfer/Retransfer	Level 2
Fail to Synchronize	Level 2
Fail to Disconnect	Closed Transition Level 2
Elevator Pre-Transfer	Level 1 and Level 2
Transfer Switch Not In Auto	Level 1 and Level 2

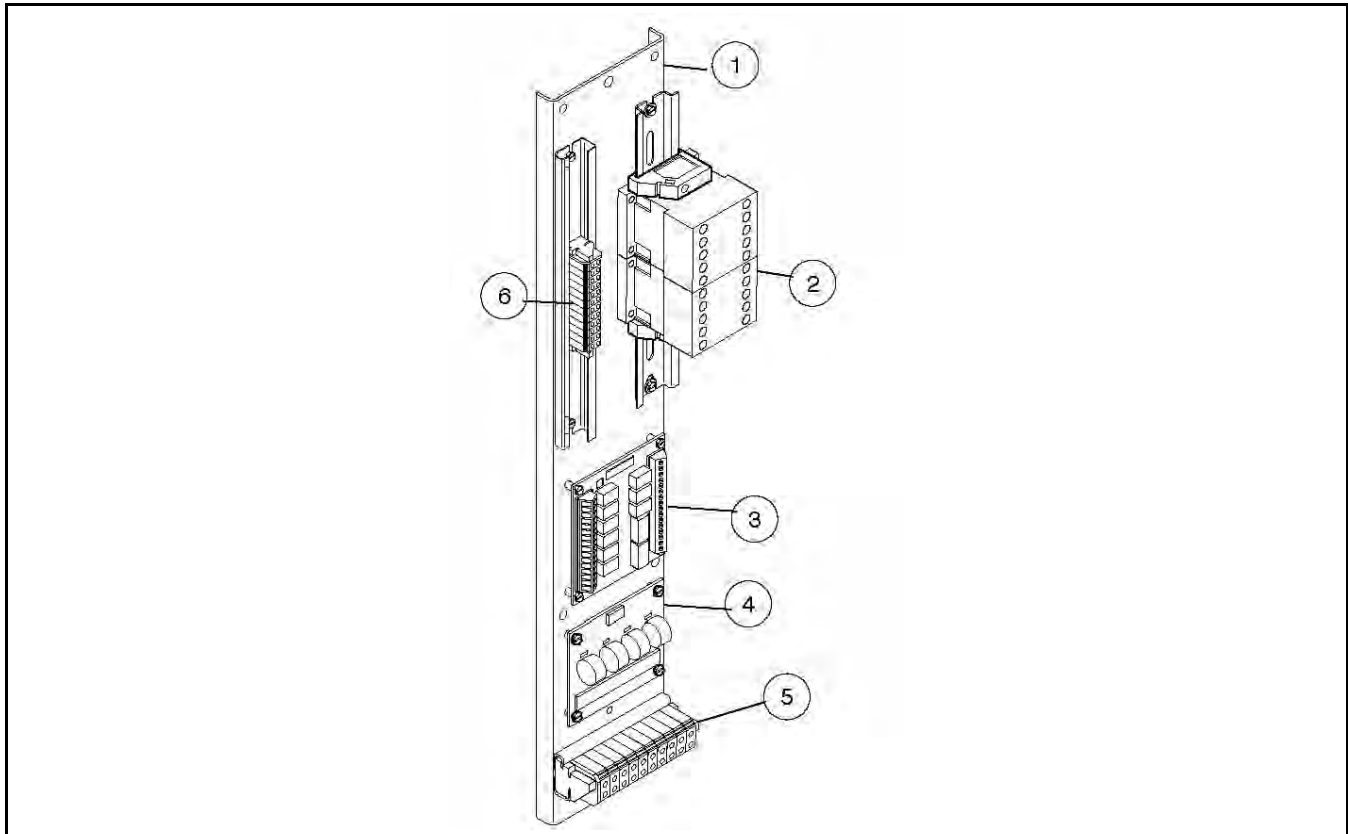
### 3.5.1.5.3 Auxiliary Relays Option

Auxiliary relays provide contacts for energizing external alarms, remote indicators and control equipment such as louver motors and water pumps.

All relays have two normally open and two normally closed contacts that are rated for 10 Amps at 600 VAC. Connections to the auxiliary relays are made directly to the relay terminals.

There are two types of auxiliary relay coils:

- 12 VDC
- 24 VDC



No.	Description	No.	Description
1	Mounting panel	4	Current module
2	Auxiliary relays	5	TB4
3	Relay module	6	TB3

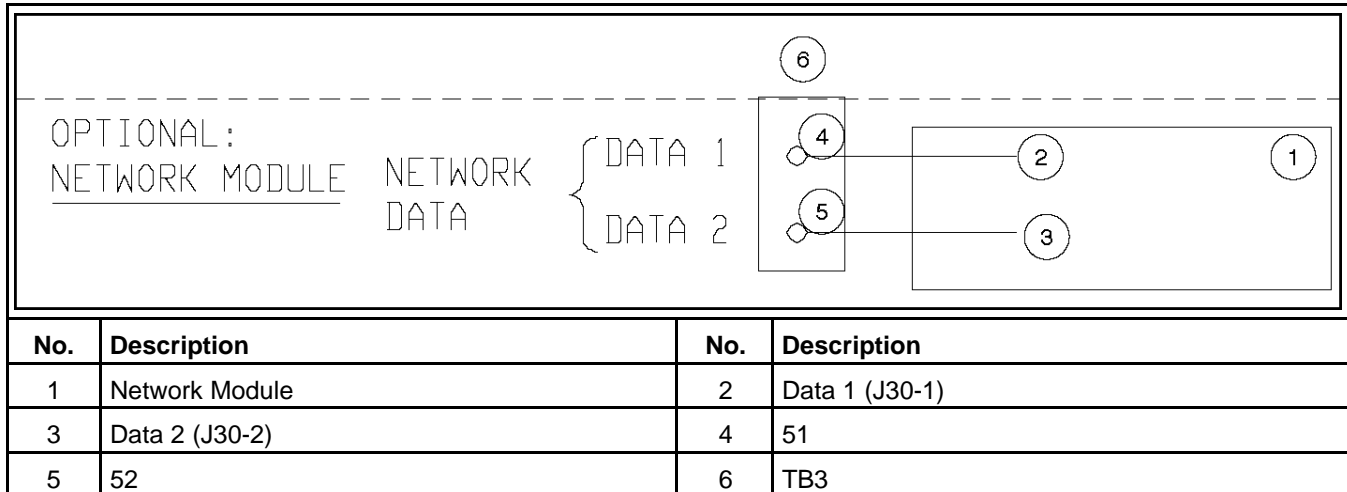
**FIGURE 40. CONTROL WIRING CONNECTIONS**

### 3.5.2 PowerCommand Network Interface Option

The PowerCommand® network interface option includes a PowerCommand Network Communications Module (NCM) that provides a connection to the PowerCommand network. The module is LonWorks compatible for integration into customer monitoring strategy.

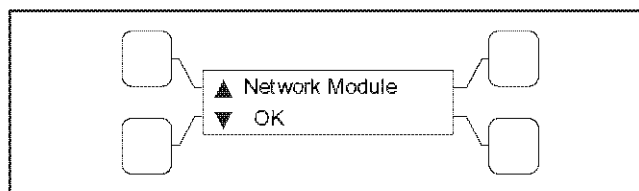
The Network Interface Module is only enabled with the PC service tool.

For installations that include an NCM, stranded twisted pair network cable is connected to the left side of terminals 51 and 52 on TB3. The NCM is located on the left side of the digital module.



**FIGURE 41. NETWORK COMMUNICATIONS MODULE CONNECTIONS**

The status of the NCM (OK, Not Installed, Not Enabled or Not Available) can be viewed with the digital display. This menu is located in the About submenus.



**FIGURE 42. NETWORK MODULE STATUS SUBMENU**

**NOTICE**

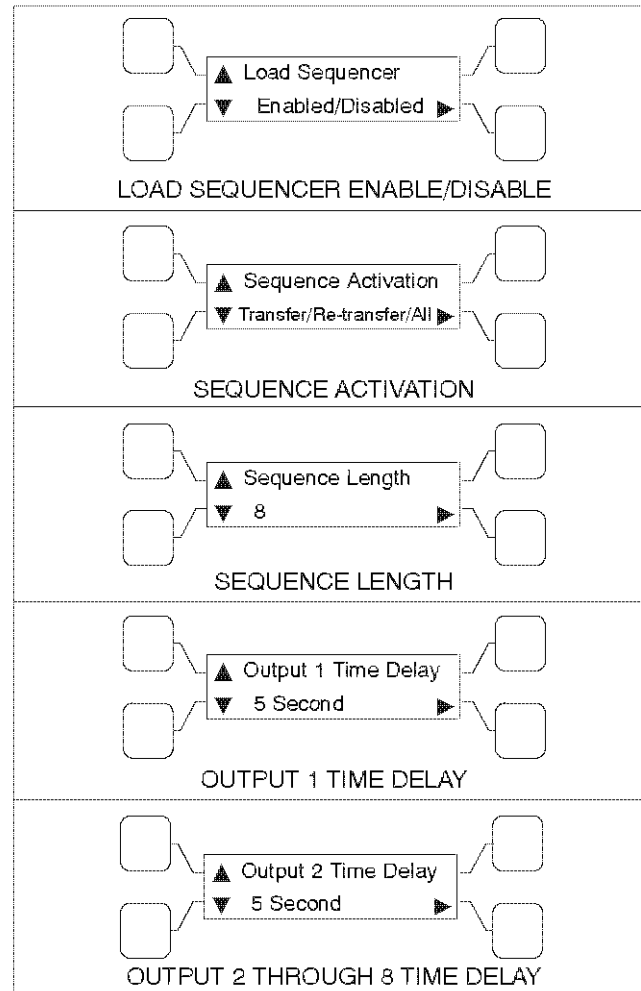
**Early production NCMs included two Lithium batteries and a battery hold-down bracket. Current production NCMs no longer use batteries.**

### 3.5.2.1 Network Sequencer

When an NCM is installed, controllers can include up to eight timed network variables to use for turning on loads in sequence after a transfer, a retransfer or both. Each variable can be delayed up to 60 seconds for each of the outputs. The network variables are intended to activate relays on the Network Digital Input/Output Module (DIM). The DIM is located remotely from the transfer switch.

The Sequencer feature allows the user to send a predetermined sequence of network event announcements. The announcements are sent in a timed, sequential order and are used to turn ATS loads off and on. When used, a few seconds should be allowed between load steps to allow the generator voltage and frequency to stabilize.

The Sequencer submenus, available through the digital display, can only be viewed if the NCM is installed and enabled. These menus allow the user to enable/disable the feature, set the operational mode, activate up to eight relay output signals, and set an output time delay from 0 to 60 seconds for each of the outputs. Additional information on how to adjust these values is included in the Network Manual.



**FIGURE 43. SEQUENCER SUBMENUS**

### 3.5.2.2 Network System Device Status

If an NCM is installed, the user can view the status of up to 32 LonWorks networked devices through the digital display. The status of networked generator sets, additional ATSSs, and the Master Control (if connected) can be viewed.



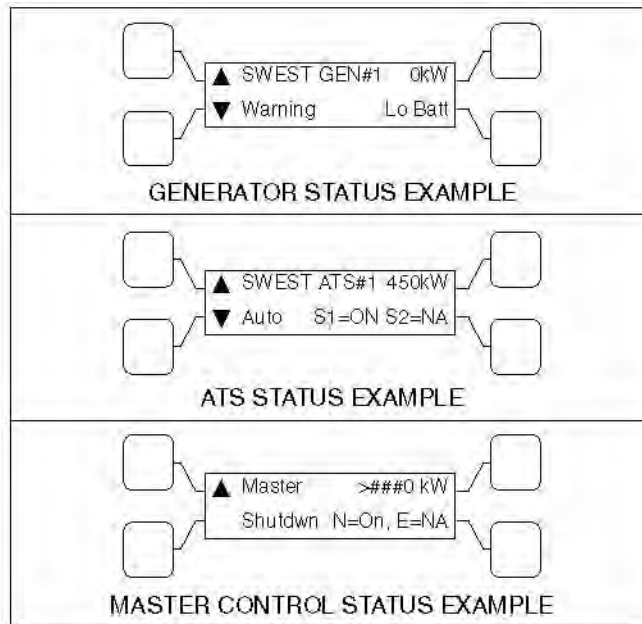


FIGURE 44. SYSTEM SUBMENUS

### 3.5.2.3 Network Communications Module (NCM)

**NOTICE**

The current Network Communications Module being used on OTPC transfer switches includes a self-installation feature. To self-install, press and hold the Service button (S3) for at least two seconds until the Node "OK" LED (DS3) begins flashing

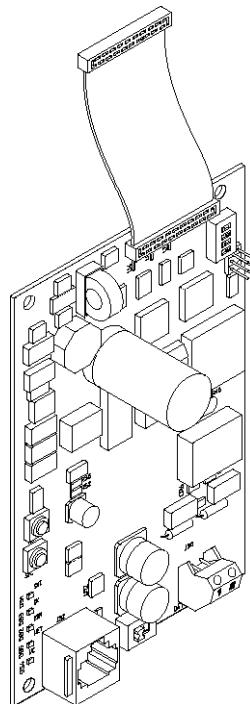


FIGURE 45. NETWORK COMMUNICATIONS MODULE (NCM)

### 3.5.2.4 Network Communications Module (NCM)

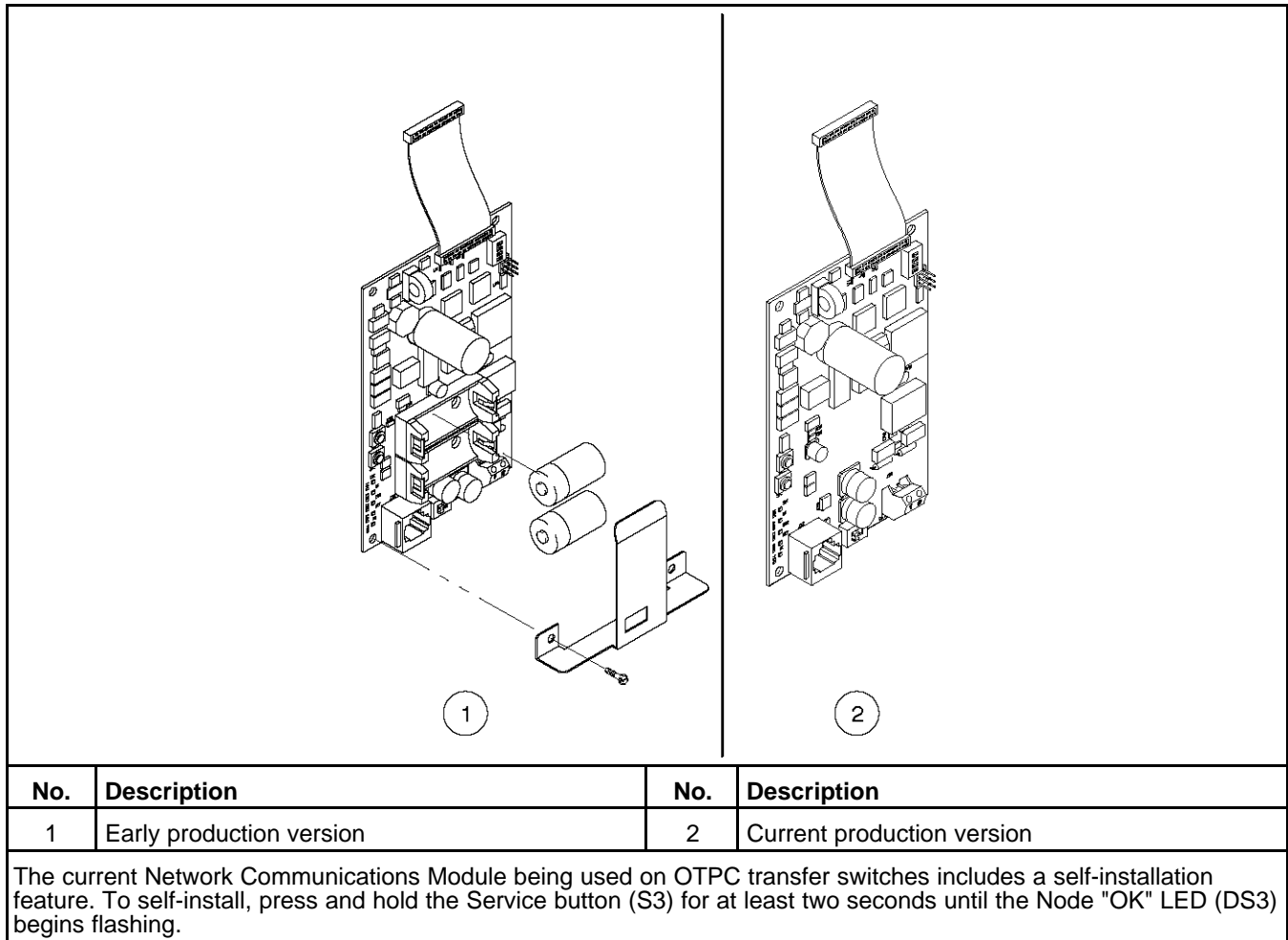


FIGURE 46. NETWORK COMMUNICATIONS MODULE (NCM)

### 3.5.3 Load Sequencing Option

Controllers can include up to eight timed network variables to use for turning on loads in sequence after a transfer, a retransfer, or both. The Network Communications Module (NCM) must be installed. Each variable can be delayed up to 60 seconds after the preceding variable. The network variables are intended to activate relays on the Network Digital Input/Output Module (DIM). The DIM is located remotely from the transfer switch.

### 3.5.4 Load Current and Power Sensor Option

Three-phase Level 2 controllers can include a load current and power sensor (Current Module). The control senses the four load currents (three line currents and the neutral current), three load voltages, and three power factor angles. The control calculates the real load power and the apparent load power.

The load current sensing feature is active on Level 2 controllers when the Current Module is installed and connected to the Digital Module.

The control issues a warning when the neutral current exceeds a user specified value between 100 and 150% of the rated current during a specified time period between 10 and 60 seconds.

The warning threshold (100 - 150%) and time delay (10 - 60 sec) can only be set with the PC service tool.

The status of the load current module (OK or Not Installed) can be viewed with the digital display. This menu is included in the About submenus.

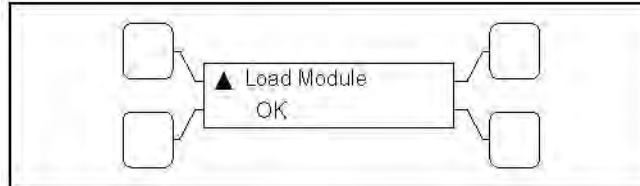


FIGURE 47. LOAD CURRENT MODULE STATUS SUBMENU

### 3.5.5 Source 1 and Source 2 Connected Relays

The Source 1 and Source 2 Connected relays are energized when their respective power sources are available, ready to produce power and connected to the load.

These relays are latching relays and will retain their last state in case of a complete loss of power.

### 3.5.6 Source 1 and Source 2 Available Relays

The Source 1 and Source 2 Available relays are energized when their respective power sources are producing power.

### 3.5.7 Test or Exercise Active Relay

The Test or Exercise Active relay is energized when the system is in test or exercise mode.

### 3.5.8 Load Shed Relay

The Load Shed relay is active when the transfer switch has been commanded to disconnect the load from power Source 2.

### 3.5.9 Fail to Transfer/Retransfer Relay

The Fail to Transfer/Retransfer relay is energized whenever the transfer switch does not *open* or *close* within a set time interval after the command to transfer or retransfer.

### 3.5.10 Fail to Synchronize Relay

The Fail to Synchronize relay is energized when the two power sources did not come into synchronicity (frequency, voltage, phase) within a two-minute limit; during a transfer between two live sources.

### 3.5.11 Fail to Disconnect Relay

The Fail to Disconnect relay (causes a fault) is used only in closed transition modes. The relay is energized whenever the two sources remain parallel longer than a set time limit.

### 3.5.12 Elevator Pre-Transfer Delay Relay

The **Elevator Pre-Transfer Delay** signal delays transfer (or retransfer) for a specified time to give warning to an elevator control that a transfer (or retransfer) is about to occur.

This time delay (TDEL) is adjustable over a range of 0 to 60 seconds. The default value is 0 seconds. The value is set with the PC service tool or the digital display, if available.

### 3.5.13 Not-in-Auto Relay

The ATS **Not-In-Auto** relay is energized when any one of the following occurs:

- Motor Disconnect Switch is set to Off
- Wiring harness is disconnected from J12 on the Power Module
- Controller is set to Offline

## 3.6 Control Panel (PowerCommand Control)

The PowerCommand control features are divided into three groups:

- **Bar graph meter panel** - is not available on Level 1 and is optional on Level 2 controls.
- **Switch panel** - is standard on all transfer switches.
- **Digital display** - is standard on Level 2 controls and is optional on Level 1 controls.

### 3.6.1 Bar Graph Meter Panel

The bar graph meter panel is not available on Level 1 controls and is optional on Level 2 controls.

This feature includes:

- **A three phase AC ammeter** -displays percent of full load currents in amperes (1-125%).
- **A power meter** - displays the real power in percent of full load in kilowatts (0-125%).
- **A power factor meter** - displays the real power delivered to the load (1.0 - 0.6 lagging) and (1.0 - 0.9 leading).
- **A frequency meter** - displays the output frequency (percent of nominal frequency), of the power source connected to the load (70-110%).
- **A three phase AC voltmeter** - displays percent of line to neutral voltages of the power source connected to the load (70-110%).

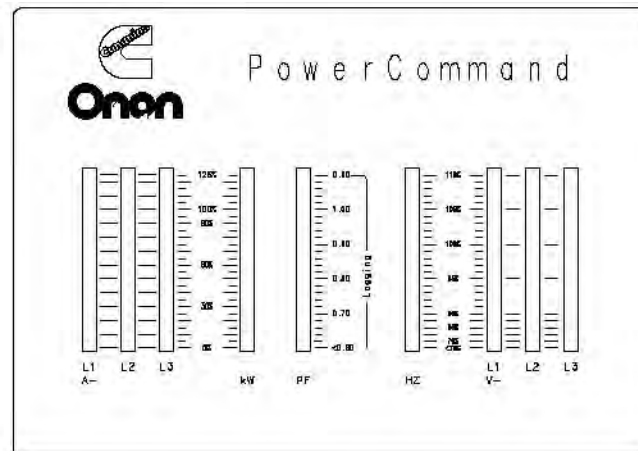


FIGURE 48. BAR GRAPH METER PANEL

### 3.6.2 Switch Panel

The switch panel is a standard feature on all PowerCommand controlled (PC) transfer switches. It contains six indicator lamps and three membrane switches.

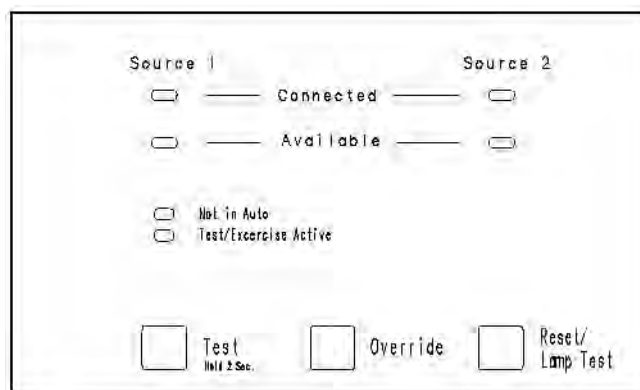


FIGURE 49. SWITCH PANEL

**Source 1 Available and Source 2 Available:** These indicators are lit when the corresponding sources have acceptable output voltage and/or frequency. These indicators can be lit simultaneously.

**Source 1 Connected:** This indicator is lit when the transfer switch is in the normal position and Source 1 is supplying power to the load.

**Source 2 Connected:** This indicator is lit when the transfer switch is in the emergency position and Source 2 is supplying power to the load.

**Not in Auto:** For all configurations, this indicator flashes when the transfer switch is not in Auto.

#### NOTICE

The transfer switch is not in Auto when any of the following signals are active:

- Motor Disconnect Switch is set to OFF
- Wiring harness is disconnected from J12 on the power module

- Controller is set to OFFLINE

**Test/Exercise Active:** The Test/Exercise Active indicator is lit when the transfer switch has a test or exercise in progress.

**Test:** For utility-to-genset applications, the Test switch sends a start signal to the generator set designated Source 2 and blinks the Test/Exercise Active indicator.

After the start and transfer time delays or source synchronization, Source 2 starts and assumes the load (if the With Load option is selected).

- Press the Test switch again to end the test; the Test/Exercise Active indicator goes out and Source 1 resumes as the source of power.

**Override:** The Override switch terminates most system time delays.

#### NOTICE

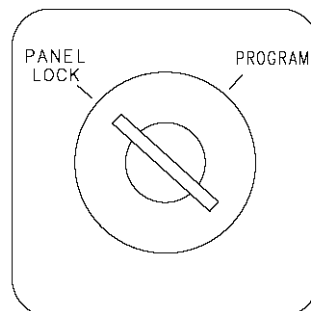
**The Program Transition (TDPT), Elevator Signal (TDEL) and Engine Cool Down (TDEC) are not affected by this switch.**

- If you press this switch while the Transfer Inhibit input is active, the switch proceeds to transfer the load.
- If you press this switch while the Retransfer Inhibit input is active, the switch proceeds to retransfer the load.

**Reset/Lamp Test:** The Reset/Lamp Test switch turns on all control panel indicators. This switch also acknowledges events.

### 3.6.2.1 Security Key Switch Option

The optional security key switch is located on the front panel. When it is in the Panel Lock position, it disables the front panel input switches, Test and Override. It also prevents changes to the digital display from the setup menus; however, the current values are displayed. Changes can be made when the switch is in the Program position.



**FIGURE 50. SECURITY KEY SWITCH**

### 3.6.3 Digital Display

The digital display is standard on Level 2 controls and optional on Level 1 controls. It contains a 2-line by 20-character digital display module and 6 momentary contact membrane switches. The module displays the menu system. The switches are used to navigate through the menu system.

Each menu indicates the function of the four buttons at the sides of the display module. Not all buttons are active for each menu.

**Sleep Mode:** After a period of screen inactivity (no user interaction with the menu system and no occurring events), the digital display goes blank. The digital display is reactivated when an event occurs or when an operator touches one of the menu buttons.

In order to conserve controller battery power, the loss of utility power also causes the digital display to go blank. The digital display is reactivated when a second power source becomes available.

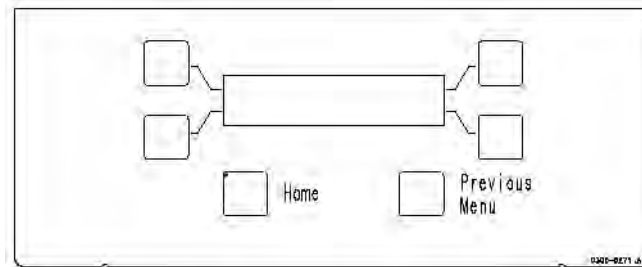


FIGURE 51. DIGITAL DISPLAY

### 3.6.4 Time Delay Glossary

Time Delay	Abbreviation	Definition
Start Time Delay	TDES	This delay is adjustable from 0 to 15 seconds in 1 second increments on Level-1 controls and from 0 to 120 seconds in 1 second increments on Level-2 controls. The default value is 3 seconds for both. This brief time delay prevents the generator set from starting during short power interruptions. Timing starts at the Source 1 power interruption. If the duration of interruption exceeds the delay time, the control system signals the generator set to start. The value is set with the PC service tool or the digital display when it is available.
	TDES-A and TDES-B	For genset-to-genset applications, TDES-A is the start time delay to start Source 2 genset and TDES-B is the start time delay to start Source 1 genset. For utility-to-utility applications, TDES-A and TDES-B are not available.
Stop Time Delay (Cool-down)	TDEC	This delay is adjustable from 0 to 30 minutes in 1 minute increments. The default value is 10 minutes. It begins timing when the load is retransferred to Source 1. At the end of the delay, the stop signal is sent to the generator set. During this time delay, the generator set cools down at no load before stopping. The value is set with the PC service tool or the digital display when it is available.
	TDEC-A and TDEC-B	For genset-to-genset applications, TDEC-A is the stop time delay to stop Source 2 genset and TDEC-B is the stop time delay to stop Source 1 genset. For utility-to-utility application, TDEC-A and TDEC-B are not available.
Transfer Time Delay	TDNE	This delay begins when Source 2 (typically the generator) voltage and frequency reach the settings of the control. After the delay, the transfer switch transfers the load to Source 2. This brief time delay allows the generator set to stabilize before the load is applied. It has an adjustable range of 0 to 120 seconds in 1 second increments. The default value is 10 seconds. The value is set with the PC service tool or the digital display when it is available. TDNE is the delay from preferred source to backup source in utility-to-utility applications and gen-to-gen applications.

Time Delay	Abbreviation	Definition
Retransfer Time Delay	TDEN	<p>This delay begins the moment Source 1 line voltage and frequency return to specified values. After the delay, the transfer switch can retransfer the load to Source 1. The delay allows the Power Source 1 to stabilize before retransfer. It has an adjustable range of 0 to 30 minutes in 1 minute increments. The default value is 10 minutes. The value is set with PC service tool or the digital display when it is available.</p> <p>TDEN is the delay from backup source to preferred source in utility-to-utility applications and gen-to-gen applications.</p>
Programmed Transition Time Delay	TDPT	<p>This delay is the time that the switch spends in the neutral position, when neither source is connected to the load, during a transfer or a retransfer. It begins when the switch moves to the neutral position and opens the contacts of the switch connected to the load. After the delay the control transfers the load. This time delay allows residual voltage of inductive loads to decay sufficiently before connecting it to another source. It is adjustable from 0 to 60 seconds in 1 second increments. The default value is 0 seconds. The proper adjustment is a function of the load. This feature is enabled by default. The value is set with the PC service tool or the digital display when it is available.</p>
Elevator Pretransfer Time Delay	TDEL	<p>The Elevator Pre-Transfer Delay Signal delays transfer (or retransfer) for a specified time to give warning to an elevator control that a transfer (or retransfer) is about to occur. It is adjustable from 0 to 60 seconds in 1 second increments. The default value is 0 seconds. This feature is enabled by default. The value is set with the PC service tool or the digital display when it is available.</p>



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# 4 Operation

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## 4.1 Manual Operation

The transfer switch has operator handles for manually transferring the load. Manual operation must be performed by qualified personnel under **No-Load Conditions** only.

### 4.1.1 Manual Operation - 40 to 1000 Amp Switches

 **WARNING**

*Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load. Follow the "Safety Related Work Practices" listed in NFPA 70E.*

1. Open the cabinet door of the automatic transfer switch.
2. Move the Motor Disconnect switch to the Off position.
3. **Transfer - from Source 1 (Normal) to Source 2 (Emergency):**
  - a. Pull the upper manual operator handle down.
  - b. Push the lower manual operator handle down.
4. **Retransfer - from Source 2 to Source 1:**
  - a. Pull the lower manual operator handle up.
  - b. Push the upper manual operator handle up.
5. Before moving the Motor Disconnect switch back to the Auto position, remember the transfer switch transfers the load to the active power source. If both power sources are available, it transfers the load to the Source 1 or to the preferred source.

 **WARNING**

*Automatic transfer switch operation results in rapid movement of the manual operator handles and presents a hazard of severe personal injury. Keep hands clear of handles when switching back to automatic operation.*

6. Move the Motor Disconnect switch to the Auto position.
7. Close the cabinet door.

### 4.1.2 Manual Operation - 1200 to 4000 Amp Switches

The transfer switch has operator handles that are intended for maintenance use only. Manual operation must be performed by qualified personnel under **NO-LOAD CONDITIONS ONLY**. Use the following procedure:

 **WARNING**

*Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load. Follow the "Safety Related Work Practices" listed in NFPA 70E.*

### 4.1.2.1 Manual Transfer to Source 1

**⚠ WARNING**

***Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load. Follow the "Safety Related Work Practices" listed in NFPA 70E.***

If you determine that Source 1 is available but the transfer switch does not automatically retransfer, perform this procedure to manually retransfer to Source 1.

1. Open the Source 2 and Source 1 disconnect switches or breakers that feed the transfer switch. If there is no Source 2 side disconnect, turn off the generator set.
2. When you are certain that neither power source is supplying power to the transfer switch, open the transfer switch cabinet door and turn the Motor Disconnect switch to OFF.

**⚠ WARNING**

***Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load.***

3. A manual operating handle is provided with the transfer switch. The handle is a steel rod or tube, with a knob or hand grip on one end. On standard transfer switches, there are two manual operator slots - one for the contacts of each power source.
  - a. Insert the handle in the slot for the Source 1 (Normal) contacts and open the Source 1 contacts.
  - b. Insert the handle in the slot for the Source 2 (Emergency) contacts and close the Source 2 contacts. Be certain to push the handle all the way to the LOCK position. A distinct over-center locking action can be felt.
  - c. Return the handle to its storage position.

**⚠ WARNING**

***Automatic transfer switch operation results in rapid movement of the manual operator mechanism and presents a hazard of severe personal injury if the operator handle is engaged in the mechanism. Remove the handle and place it in its storage position.***

4. After the switch has been transferred to Source 1 and the operator handle has been removed from the mechanism, close and lock the handle door.
5. Close the Source 2 and Source 1 disconnect switches or breakers that feed the transfer switch. Start the generator set if it was previously turned off.
6. If the transfer switch is not functioning correctly, call your dealer or distributor immediately.

### 4.1.2.2 Manual Transfer to Source 2

**⚠ WARNING**

***Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load. Follow the "Safety Related Work Practices" listed in NFPA 70E.***

If you determine that Source 2 is available but the transfer switch does not automatically transfer, perform this procedure to manually transfer to Source 2.

1. Open the disconnect switches or breakers that feed the transfer switch. If there is no Source 2 disconnected, turn off the generator set.
2. When you are certain that neither power source is supplying power to the transfer switch, open the transfer switch cabinet door and turn the Motor Disconnect switch to OFF.

**⚠ WARNING**

***Manual operation of the transfer switch under load presents a shock hazard that can cause severe personal injury or death. Do not attempt to operate switch manually when it is under load.***

3. A manual operating handle is provided with the transfer switch. The handle is a steel rod or tube, with a knob or hand grip on one end. On standard transfer switches, there are two manual operator slots - one for the contacts of each power source.
  - a. Insert the handle in the slot for the Source 1 (Normal) contacts and open the Source 1 contacts.
  - b. Insert the handle in the slot for the Source 2 (Emergency) contacts and close the Source 2 contacts. Be certain to push the handle all the way to the LOCK position. A distinct over-center locking action can be felt.
  - c. Return the handle to its storage position.

**⚠ WARNING**

***Automatic transfer switch operation results in rapid movement of the manual operator mechanism and presents a hazard of severe personal injury if the operator handle is engaged in the mechanism. Remove the handle and place it in its storage position.***

4. After the switch has been transferred to Source 2 and the operator handle has been removed from the mechanism, close and lock the handle door.
5. Close the disconnect switches or breakers that feed the transfer switch. Start the generator set if it was previously turned off.
6. If the transfer switch is not functioning correctly, call your dealer or distributor immediately.

## 4.2 Automatic Operation

For utility-to-genset and genset-to-genset configurations, the generator set control must also be set for automatic (in the AUTO position) operation.

For automatic operation of the transfer switch, place the following control switches in the following positions:

### 4.2.1 Motor Disconnect Switch

For automatic operation of the transfer switch, place the Motor Disconnect switch in the **AUTO** position.

---

## 4.3 System Testing

### 4.3.1 Generator Set Manual Start Test

This test is used with utility-to-genset applications only.

1. Set the Test With/Without Load variable to the Without Load value.
2. Press and hold the Test switch for two seconds. The generator set starts and runs after the start time delay.
3. At the end of the test period, press the Test switch again. The generator cools down and stops.

### 4.3.2 With-Load Standby System Test

1. Set the Test With/Without Load variable to the With Load value (refer to the Digital Display Menu System section or the PC service tool for details).

NOTICE
<b>The Test With/Without Load variable must be set to the With Load value in order to test with load.</b>

2. Press and hold the Test switch for two seconds. To bypass the transfer time delay and cause a faster load transfer, press the Override switch. The generator set starts and assumes the load after the start time delay.
3. At the end of the test period, press the Test switch again. To bypass the retransfer time delay and cause a faster load retransfer, press the Override switch. The generator stops after the stop time delay.

## 4.4 Generator Set Exercise

Run the generator for at least 30 minutes once each week with at least 50% load (if possible). If you do not want to use the exerciser, use the Test switch, to test the generator set each week.

The exerciser can be programmed for specified exercise periods and is used to exercise the generator set automatically with or without load.

- The **PC service tool** is required to set the exercise parameters on transfer switches without the digital display.
- The **digital display** (when available) can be used to set exercise parameters for up to eight exercise periods and eight exceptions.

All controllers have a switch to enable or disable pre-set exercise routines. The pushbutton is located on the Digital Module above the batteries, next to the LED light bar display. This button is used by service personnel to disable unexpected transfers while servicing the switch.

NOTICE
<b>If a power failure occurs during the exercise routine, the controller overrides the routine and transfers the load.</b>

## 4.5 Planned Maintenance

Performing the annual planned maintenance procedures increases reliability of the transfer switch.

The following procedures must only be done by technically qualified personnel, according to procedures in the Service Manual. If repair or component replacement is necessary, call your dealer or distributor.

**⚠ WARNING**

***AC power within the cabinet and the rear side of the cabinet door presents a shock hazard that can cause severe personal injury or death. Incorrect installation, service or parts replacement can result in severe personal injury, death and/or equipment damage. All corrective service procedures must be done only by technically qualified personnel, according to procedures in the Service Manual.***

**⚠ WARNING**

***The transfer switch presents a shock hazard that can cause severe personal injury or death unless all AC power is removed. Be sure to set the generator set operation selector switch to Stop, disconnect AC line power, disconnect the battery charger from its AC power source and disconnect the starting battery (negative [-] lead first) before servicing.***

**⚠ WARNING**

***Ignition of explosive battery gases can cause severe personal injury. Do not smoke or cause any spark, arc or flame while servicing batteries.***

**TABLE 2. PLANNED MAINTENANCE**

Disconnect All Sources of AC Power:

1. Disconnect both AC power sources from the transfer switch before continuing. Turn the generator set operation selector switch to Stop. (The selector switch is located on the generator set control panel.)
2. If there is an external battery charger, disconnect it from its AC power source. Then disconnect the set starting battery (negative [-] lead first).

Clean:

1. Thoroughly dust and vacuum all controls, meters, switching mechanism components, interior buswork and connecting lugs.
2. Close the cabinet door and wash exterior surfaces with a damp sponge (mild detergent and water).

**⚠ WARNING**

***Do not allow water to enter the cabinet, especially at meters, lamps and switches.***

## Inspect:

1. Check bus work and supporting hardware for carbon tracking, cracks, corrosion or any other types of deterioration. If replacement is necessary, contact your dealer or distributor.
2. Check stationary and movable contacts. If contact replacement is necessary, contact your dealer or distributor.
3. Check system hardware for loose connections.
4. Check all control wiring and power cables (especially wiring between or near hinged door) for signs of wear or deterioration.
5. Check all control wiring and power cables for loose connections.
6. Check the cabinet interior for loose hardware.

## Perform Routine Maintenance:

1. Tighten bus work, control wiring, power cables and system hardware as necessary.

**NOTICE**

**Hardware torque values are given in the Service Manual.**

2. Re-torque all cable lug connections.

**NOTICE**

**Lug torque requirements are listed in the Service Manual.**

## Connect AC Power and Check Operation:

1. Connect the set starting battery (negative [-] lead last). Connect the utility AC power source, enable the generator set power source. If applicable, connect power to the battery charger.
2. Verify proper operation of the battery charger.
3. Test system operation as described in this section. Close and lock the cabinet door.

# 5 Digital Display Menu System

---

This section describes the Digital Display Menu System and navigation through the menus. The menus display status information, events, and setup menus. Setup menus contain parameters with adjustable values. The descriptions in this section include ranges for the parameters and default values. The digital display is an option with Level 1 controls and is standard with Level 2 controls. The system menus can also be accessed with the PC service tool.

The Digital Display Menu System is a 2-line by 20-character graphical display screen and six buttons. The screen or menu displays status information, parameters, events and messages. The buttons change screens and parameters. Two buttons have names: Home and Previous Menu. These buttons are used for navigation. Messages include navigational indicators for the other four buttons.

## 5.1 Main Menus

The main menu system consists of three top-level menus that list vertical menus (or submenus). The submenu display status information. This information cannot be changed in the main menu. The main menu contains eight submenus including the Setup Menu.

## 5.2 Password and Setup Menus

Before you can navigate and change setup parameters, you must enter a password; however, you can bypass the password and examine but not change parameters. When parameters are changed in any setup menu, you are prompted to either save the changes or restore the old values.

## 5.3 Navigation

The following image represents the typical functions of the Main Menu navigational buttons.



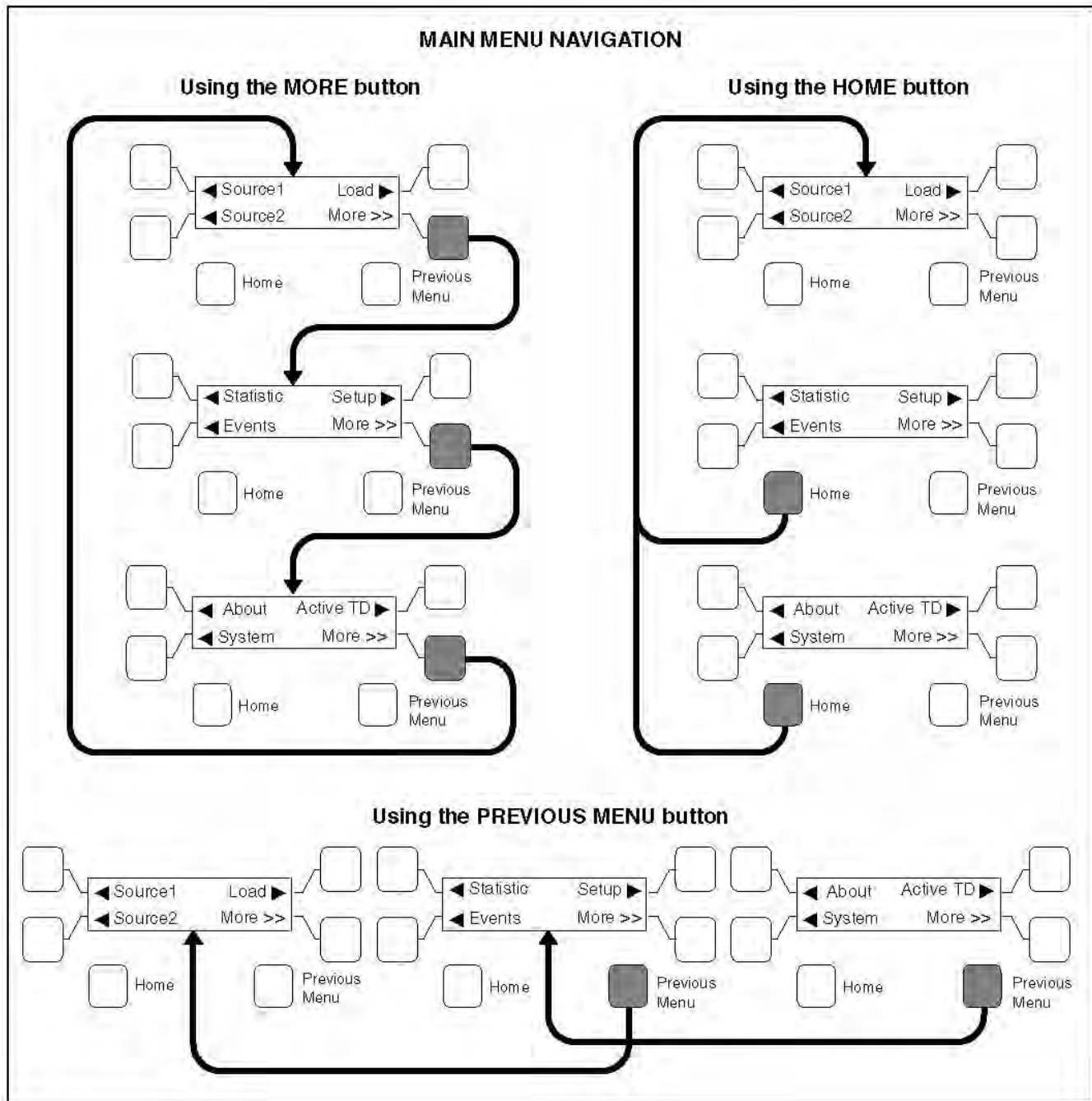


FIGURE 52. NAVIGATION

## 5.4 Main Menu Descriptions

### 5.4.1 First Main Menu

- The Source 1 and Source 2 buttons move between submenus that monitor aspects to both power sources:
  - Line-to-Line Voltage

- Frequency
- Source Connected
- Running Time
- Pressing the Home button returns to the First Main Menu display within any of the Source 1, Source 2, or Load submenus.
- The Load button moves through submenus to display information on the load connected source:
  - Voltage Output
  - Amps and Frequency
  - Power Factor and Output
- The More button advances to the Second Main Menu.
- The Previous Menu button is not active at this level.

### 5.4.1.1 Source 1 and Source 2 Submenus

Use the push button to the left of the display screen to navigate through the following screens:

- **Volts L12 L23 L31:**
  - The Level 1 control will only read line-to-line voltages.
  - The Level 2 control is capable of reading line-to-line and line-to-neutral voltages, depending on the application.
  - Source 1 and Source 2 reads three-phase voltage for three-phase systems and single-phase voltage for single-phase systems.
  - The Level 1 control will only read single-phase voltages for Source 2.
    - If the voltage is measured at 10 volts or less, the display reads 0.
    - On Level 1 controllers (Source 2), only one voltage will be displayed at L12.
    - On Level 1 controllers (Source 1), displays 3-phase voltage for 3-phase systems or single-phase voltage for single-phase systems.
- **Volts L1N L2N L3N:**
  - Level 2 reads line-to-neutral voltages, level 1 will not
    - Numbers do not display if the system has no neutral.
    - This screen does not display with Level 1 controllers
- **Frequency:** Displays the sensed line frequency for Source 1 or Source 2.
- **Source 1 (or 2):** Displays the position of contactors for either Source 1 or Source 2.
- **Run Time Source 1 (2):** Displays the total time the transfer switch has been connected to either Source 1 or Source 2.

### 5.4.1.2 Load Submenus

**NOTICE**

**This subset is not available on Level 1 Controls and is optional on Level 2 Controls.**

---

Use the Source 1 and Source 2 push button to the left of the display screen to navigate through the following screens:

- **Volts L12 L23 L31:** Line-to-Line Load Voltage Screen
- **Volts L1N L2N L3N:** Line-to-Neutral Voltage for Load
- **Amps L1 L2 L3:** Line Currents for Load
- **Frequency:** Sensed line frequency for Load connected source
- **Real Power kW:** Real Power of the transfer switch
- **Apparent Power KVA:** Total Apparent Power of the transfer switch
- **Power Factor:** Average Power Factor of the transfer switch. This will be displayed as lead or lag.
- **Neutral Current:** Neutral Current of the transfer switch.

## 5.4.2 Second Main Menu

- The Statistic button displays information about either source:
  - Run Time
  - Average Transfer Time
  - Total Number of Transfers
  - Total Number of Failures
  - Battery and (optional) Charger status
  - Control on Time
- The Events button displays the last 50 events or fault codes recorded on the controller.
- The Home button returns to the First Main Menu.
- The Setup button enters the password protected adjustment program:
  - Adjust Sensors
  - Set Time Delays
  - Test and Exercise
  - Exercise Exceptions
  - Transition Mode Trim
  - Load Sequencer Enable
- The More button advances to the Third Main Menu.
- The Previous Menu button returns to the First Main Menu.

### 5.4.2.1 Events Submenus

The Events program displays information about either source. The controller stores and records the last fifty events in chronological order, beginning with the most recent event. The date and time are listed with each event.

\* Indicates that the event is currently active.

Use the push button to the left of the display screen to navigate through the screens.

## 5.4.2.2 Setup Submenus

The Setup button enters the password-protected adjustment programs to:

- Adjust Sensors
- Set Time Delays
- Test and Exercise
- Exercise Exceptions
- Transition Mode Trim
- Load Sequencer Enable

### 5.4.2.2.1 Entering the Password Program

Press the Setup button to access the Enter Password menu.

The password is 574.

1. Use the + and - buttons to select a number.
2. Use the right arrow button to move the cursor to the next field.
3. When the password is set, press the right triangle button to enter the Setup program.

## 5.4.3 Third Main Menu

- The About button displays general information about the transfer switch and controller.
- The System button provides access to data from surrounding devices communicating through a LonWorks network. If the optional network card is not included with the transfer switch, the System button is not active.
- The Home button returns to the First Main Menu.
- The Active TD button displays all active time delays.
- The More button returns the display to the First Main Menu.
- The Previous Menu button returns to the Second Main Menu.

### 5.4.3.1 About Submenus (Prior to Software Version 1.20.250)

The About submenus contain read-only information about the transfer switch and controller.

- **Name of Switch:** Displays the name of the switch as defined in the Event Handling Requirement.
- **Software Version:** Displays the current firmware version of the controller.
- **Build Date:** Displays the manufacturing date of the controller.
- **ATS Configuration:** Displays the configuration of the controller. Changes are made by servicing personnel using the PC service tool.

**Data:**

- Test Mode
- Util-Gen
- Utility-Utility
- Genset-Genset

- Unknown
- **ATS Type:** Displays the mode of operation the control is using. Adjustments can be made by service personnel using the PC service tool.

**Data:**

- OT = Open Transition
- BT = Bypass Transition
- Unknown
- **ATS Board Level:** Displays the ATS board level (1 or 2).

**NOTICE**

**This menu was not included in early versions of software.**

- **Network Module:** This screen indicates if a Network Communications Module is installed and enabled.
  - Hardware Detected + Software Enabled = OK
  - Hardware NOT Detected + Software Enabled = Not Installed
  - Hardware Detected + Software NOT Enabled = Not Enabled
  - Hardware NOT Detected + Software NOT Enabled = Not Available

- **Relay Module:** This screen indicates if the Relay Module hardware is installed.

**Data:**

- OK
- Not Installed
- **Load Module:** This screen indicates if the Load Current Module hardware is installed. This feature is not available on Level 1 Controllers.

**Data:**

- OK
- Not Installed

### 5.4.3.2 About Submenus (Software Version 1.20.250 and Greater)

The About submenus contain read-only information about the transfer switch and controller.

- **Name Tag:** Displays the name of the switch as defined in the Event Handling Requirement.
- **Software Version:** Displays the current firmware version of the controller.
- **Bootcode Version:** Displays the current bootcode version of the controller.
- **Build Date:** Displays the manufacturing date of the controller.
- **Switch Mechanism:** Displays the switch mechanism of the controller.
- **ATS Configuration:** Displays the configuration of the controller. Changes are made by servicing personnel using the PC service tool.

**Data:**

- Off line
- Util-Gen
- Util-Util
- Gen-Gen
- **ATS Type:** Displays the mode of operation the control is using. Adjustments can be made by service personnel using the PC service tool.

**Data:**

- OT = Open Transition
- BT = Bypass Transition
- **ATS Board Level:** Displays the ATS board level (1 or 2).
- **Network Module:** This screen indicates if a Network Communications Module is installed and enabled.
  - Hardware Detected + Software Enabled = OK
  - Hardware NOT Detected + Software Enabled = Not Installed
  - Hardware Detected + Software NOT Enabled = Not Enabled
  - Hardware NOT Detected + Software NOT Enabled = Not Available
- **Relay Module:** This screen indicates if the Relay Module hardware is installed.

**Data:**

- OK
- Not Installed
- **Load Module:** This screen indicates if the Load Current Module hardware is installed. This feature is not available on Level 1 Controllers.

**Data:**

- OK
- Not Installed

### 5.4.3.3 Active TD Submenus (Prior to Software Version 1.12)

- **Test in Process:** Shows time delay activity, the type of time delay and a countdown. If there is no active time delays, the message "No Timer Active" is displayed.

<b>NOTICE</b>
<b>Active TD menus were not available in early versions of software.</b>

---

### 5.4.3.4 Active TD Submenus (Software Version 1.12 and Greater)

The Active TD submenus generally show the time delay activity, type of time delay and countdown. This is not specific to the Test in Process submenu.

- **TDNE:** Pressing the Active TD menu button shows that TDNE is one of the active time delays enabled in the control.
- **Changeover in:** This menu shows a Preferred Source Changeover Timer and remaining time (Utility-to-Utility and Genset-to-Genset applications only).
- **No Timer Active:** This message is displayed only if there are no active time delays.

## 5.4.4 Setup Menu Navigation and Description

### 5.4.4.1 Setup Group 1

This group allows programming the operational parameters of the switch for Source 1 and Source 2.

The Sensor submenus are used for setting the:

- Phase Type
- Nominal Type
- Under-voltage Settings
- Over-voltage Settings
- Time Delays
- Frequency Settings
- Imbalance Settings
- Phase Loss
- Phase Rotation

The Sync Check sensor submenus allow programming synchronous conditions for Source 1 and Source 2 that must be met before transferring from one to the other source.

#### 5.4.4.1.1 Sensor 1 and Sensor 2 Submenus (Prior to Software Version 1.12)

**When entering numerical values:**

Use the + and - buttons to select numerical values or toggle through a list of selections.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

Use the right-facing arrow button to move the cursor to the next field.

- **Sensor 1 and Sensor 2:** These submenus are identical, except:
  - S1 refers to Source 1
  - S2 refers to Source 2

**NOTICE**

**For 2-wire system, select 1 phase-2 wire.  
For a single phase-3 wire system, select 1 phase-3 wire.  
For a 3 phase system, select 3 phase.**

- **S1 or S2 Nominal Voltage:** System voltage for Source 1 or Source 2. Enter the system voltage between 110 and 600 VAC.

**NOTICE**

**Level 1 Controls are Line-to-Line voltages and Level 2 Controls are Line-to-Neutral voltages.**

- **S1 or S2 UV Pickup:** Under-Voltage sensor pickup for Source 1 or Source 2. Enter a number between 85 and 100% of the nominal voltage (Default 90%).
- **S1 or S2 UV Dropout:** Under-Voltage sensor dropout voltage. Enter a number between 75 and 98% of the under-voltage pickup percentage (Default 90%).
- **S1 or S2 UV Time Delay:** Under-Voltage dropout time delay. Enter a time between 0.0 and 1.0 seconds (Default 0.5 seconds).
- **S1 or S2 OV Enable:** Over-Voltage sensing enable. Choose Enabled or Disabled (Default Enabled).
- **S1 or S2 OV Pickup:** Over-Voltage pickup. This adjusts the over-voltage pickup as a percentage of the over-voltage dropout. Enter a number between 95 and 99% (Default 95%).
- **S1 or S2 OV Dropout:** Over-Voltage dropout. Enter a percentage between 105 and 135% of the nominal voltage (Default 110%).
- **S1 or S2 OV Time Delay:** Over-Voltage time delay. Enter a range between 0.5 and 120 seconds (Default 3 seconds).
- **S1 or S2 Frequency Sensor:** Monitors line frequency on A-Phases of both sources (Default Enabled).
- **Nominal Frequency:** Enter a frequency between 45 and 65 Hz (Default 60 Hz).
- **Frequency Pickup:** Enter a percentage between 5 and 20% of the nominal frequency (Default 10%).
- **Frequency Dropout:** Enter a percentage between 2 and 5% of the frequency pickup (Default 1%).
- **Frequency Delay:** Enter a time between 0.1 and 15.0 seconds (Default 5 seconds).
- **S1 or S2 Imbalance Sensor (Level 2 Controllers Only):** Detects unbalanced voltages on 3-phase sources (Default Disabled).
- **Imbalance Dropout (Level 2 Controllers Only):** Enter a percentage between 2 and 10% (Default 5%).
- **Imbalance Delay (Level 2 Controllers Only):** Enter a time between 2 and 20 seconds (Default 5 seconds).
- **S1 or S2 Loss of Phase (Level 2 Controllers Only):** The loss of single phase sensing can be enabled or disabled (Default Disabled).



- **Phase Rotation** (Level 2 Controllers Only): The phase rotation sensing can be enabled or disabled (Default Enabled).

#### 5.4.4.1.2 Sensor 1 and Sensor 2 Submenus (Software Version 1.12 and Greater)

##### When entering numerical values:

Use the + and - buttons to select numerical values or toggle through a list of selections.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

Use the right-facing arrow button to move the cursor to the next field.

- **Sensor 1 and Sensor 2:** These submenus are identical, except:
  - S1 refers to Source 1
  - S2 refers to Source 2

#### NOTICE

**For a single-phase, 2-wire system, select 1 phase-2 wire.  
For a single phase-3 wire system, select 1 phase-3 wire.  
For a 3 phase system, select 3 phase.**

- **Delta or Wye Conn** (Level 2 Controllers Only): Delta or Wye configuration. This menu is only displayed with Level 2 controllers. Chose Delta or Wye.
- **S1 or S2 Nominal Voltage:** System voltage for Source 1 or Source 2. Enter the system voltage between 110 and 600 VAC.

#### NOTICE

**Level 1 Controls are Line-to-Line voltages and Level 2 Controls are Line-to-Neutral voltages.**

- **S1 or S2 UV Pickup:** Under-Voltage sensor pickup for Source 1 or Source 2. Enter a number between 85 and 100% of the nominal voltage (Default 90%).
- **S1 or S2 UV Dropout:** Under-Voltage sensor dropout voltage. Enter a number between 75 and 98% of the under-voltage pickup percentage (Default 90%).
- **S1 or S2 UV Time Delay:** Under-Voltage dropout time delay. Enter a time between 0.0 and 4.0 seconds (Default 0.5 seconds).
- **S1 or S2 OV Enable:** Over-Voltage sensing enable. Choose Enabled or Disabled (Default Enabled).
- **S1 or S2 OV Pickup:** Over-Voltage pickup. This adjusts the over-voltage pickup as a percentage of the over-voltage dropout. Enter a number between 95 and 99% (Default 95%).
- **S1 or S2 OV Dropout:** Over-Voltage dropout. Enter a percentage between 105 and 135% of the nominal voltage (Default 110%).
- **S1 or S2 OV Time Delay:** Over-Voltage time delay. Enter a range between 0 and 120 seconds (Default 3 seconds).

- **S1 or S2 Frequency Sensor:** Monitors line frequency on A-Phases of both sources (Default Enabled).
- **Nominal Frequency:** Enter a frequency between 45 and 65 Hz (Default 60 Hz).
- **Frequency Pickup:** Enter a percentage between 5 and 20% of the nominal frequency (Default 10%).
- **Frequency Dropout:** Enter a percentage between 1 and 5% of the frequency pickup (Default 1%).
- **Frequency Delay:** Enter a time between 0.1 and 15.0 seconds (Default 5 seconds).
- **S1 or S2 Imbalance Sensor (Level 2 Controllers Only):** Detects unbalanced voltages on 3-phase sources (Default Disabled).
- **Imbalance Dropout (Level 2 Controllers Only):** Enter a percentage between 2 and 10% (Default 4%).
- **Imbalance Delay (Level 2 Controllers Only):** Enter a time between 2 and 20 seconds (Default 5 seconds).
- **S1 or S2 Loss of Phase (Level 2 Controllers Only):** The loss of single phase sensing can be enabled or disabled (Default Disabled).
- **Phase Rotation (Level 2 Controllers Only):** The phase rotation sensing can be enabled or disabled (Default Enabled).

#### 5.4.4.2 Setup Group 2

The Time Delay submenus allow programming time for the:

- Engine Start
- Power Source 1 to Source 2
- Power Source 2 to Source 1
- Engine Cool-down
- Programmed Transition
- Elevator Pre-Transfer
- Generator set-to-Generator set Engine Controls

Test submenus allow programming the front panel test switch to test the source with or without load. If the configuration is genset-to-genset, Source 1 or Source 2 is selectable.

Exerciser submenus allows programming an exercise routine for Power Source 2 and are available only on utility-to-genset controls. The number of exercise programs that can be set is dependent upon the software version installed and the type of control. Exerciser submenus also allow for adding and deleting exercise exceptions. Up to 8 routines and exceptions can be programmed using the PC service tool.

##### 5.4.4.2.1 Time Delay Submenus (Prior to Software Version 1.12)

**When entering numerical values:**

Use the + and - buttons to select numerical values or toggle through a list of selections.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

Use the right-facing arrow button to move the cursor to the next field.

- **TDNE:** In a Normal to Emergency transfer this function allows Source 2 to stabilize before the load is applied. Enter a time from 0 to 120 seconds (Default 10 seconds).
- **TDEN:** In an Emergency to Normal transfer this allows Source 1 to stabilize before retransfer. Enter a time from 0 to 30 minutes (Default 10 minutes).
- **TDESa:** Sets the time delay for Engine Start on generator set (a) used in utility-generator and generator-generator mode. Prevents nuisance generator set starting during brief power interruptions. This menu does not appear in utility-to-utility installations. Enter a range from 0 to 120 seconds (Default 3.0 seconds).
- **TDECa:** Sets the time delay for Engine Cool-down following a retransfer. This menu does not appear in utility-to-utility installations. Enter a time from 0 to 30 minutes (Default 10 minutes).
- **TDPT:** Sets the time delay for programmed transition, a setting of 0.0 disables the program. Enter a time from 0 to 60 seconds (Default 0 seconds).
- **TDEL:** Sets the time delay to wait for an elevator pre-transfer signal. Enter a time from 0 to 60 seconds (Default 0 seconds).
- **TDESb (Level 2 Controllers Only):** Sets the Engine Start time delay for generator set (b). Enter a time from 0 to 120 seconds (Default 3 seconds).
- **TDECb (Level 2 Controllers Only):** Sets the time delay for Engine Cool-down to begin. Enter a time of 0 to 30 minutes (Default 10 minutes).
- **Changeover Enable (Level 2 Controllers Only):** Changeover Enabled/Disabled. Select Enabled or Disabled.
- **Changeover Delay (Level 2 Controllers Only):** If Changeover Enabled is enabled, this menu sets the amount of time a single generator can be run before switching to the other generator. Enter a time from 1 to 336.0 hours (Default 24 hours).

#### 5.4.4.2.2 Time Delay Submenus (Software Version 1.12 and Greater)

**When entering numerical values:**

Use the + and - buttons to select numerical values or toggle through a list of selections.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

Use the right-facing arrow button to move the cursor to the next field.

#### **NOTICE**

**TDNE, TDESa, TDESb, TDEL and TDPT values up to 20 seconds are adjustable in 1 second increments. Values over 20 seconds are adjustable in 5 second increments.**

#### **NOTICE**

**For long engine start time delays (over 15 seconds) a remote battery source should be used.**

- **TDNE:** In a Normal to Emergency transfer this function allows Source 2 to stabilize before the load is applied. Enter a time from 0 to 120 seconds (Default 10 seconds).

- **TDEN:** In an Emergency to Normal transfer this allows Source 1 to stabilize before retransfer. Enter a time from 0 to 30 minutes (Default 10 minutes).
- **TDESa:** Sets the time delay for Engine Start on generator set (a) used in utility-generator and generator-generator mode. Prevents nuisance generator set starting during brief power interruptions. This menu does not appear in utility-to-utility installations. Enter a range from 0 to 120 seconds (Default 3.0 seconds).
- **TDECa:** Sets the time delay for Engine Cool-down following a retransfer. This menu does not appear in utility-to-utility installations. Enter a time from 0 to 30 minutes (Default 10 minutes).
- **TDPT:** Sets the time delay for programmed transition, a setting of 0.0 disables the program. Enter a time from 0 to 60 seconds (Default 0 seconds).
- **TDEL:** Sets the time delay to wait for an elevator pre-transfer signal. Enter a time from 0 to 60 seconds (Default 0 seconds).
- **TDESb** (Level 2 Controllers only, set as gen-to-gen): Sets the Engine Start time delay for generator set (b). Enter a time from 0 to 120 seconds (Default 3 seconds).
- **TDECb** (Level 2 Controllers only, set as gen-to-gen): Sets the time delay for Engine Cool-down to begin. Enter a time of 0 to 30 minutes (Default 10 minutes).
- **Changeover Enable** (Level 2 Controllers only, set as gen-to-gen): Changeover Enabled/Disabled. Select Enabled or Disabled.
- **Changeover Delay** (Level 2 Controllers only, set as gen-to-gen): If Changeover Enabled is enabled, this menu sets the amount of time a single generator can be run before switching to the other generator. Enter a time from 1 to 336.0 hours (Default 24 hours).

#### 5.4.4.2.3 Test Submenus

The following menu is used only in Utility-to-Genset applications

- **With/Without Load:** Allows an operator to automatically test the transfer switch, generator and power system.
  - Sets the function of the Test Switch on the front panel (Default Test with Load).

The following menu is used only in Genset-to-Genset and Utility-to-Utility applications

- **Source 1/Source 2:** Allows for the selection of the preferred source (Default Source 1, gen-to-gen and utility-to-utility only).

#### 5.4.4.2.4 Exerciser Submenus (Software Versions Prior to 1.5.190)

These submenus are available only in Utility-to-Genset applications.

Only one program is available for Level 1 controllers.

- **Exercise Enable:** Enables or disables all the functions of exercising the generators(s).
- **Next Exercise:** Displays the time remaining until the next exercise cycle. This display is readable only when the exerciser is Enabled (may not be displayed in software version 1.0).
- **Program 1:** This screen allows disabling Exercise Program 1 only.
- **Start Day 1:** The first four programming submenus for the exercise cycle. Sets the day an exercise cycle will occur. Select a day between Sunday (0) and Saturday (6).

- **Start Time 1:** Sets a time for the exercise cycle to begin. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59.
- **Duration 1:** Sets the length of time the exercise cycle will run. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59.
- **Program 1 Repeat:** Sets an interval the exercise cycle will repeat. Enter a cycle between 0 and 52 weeks. Typical values are 1 or 2.
- **Exercise 1:** Enables or disables exercising the generator(s) with or without a load.

Level 2 controllers allow for two exercise programs to be set up from the Setup menu screen. Six additional programs and eight exceptions can be setup using the PC service tool.

- **Program 2 (Level 2 Controllers Only):** This screen allows disabling Exercise Program 2 only.
- **Start Day 2 (Level 2 Controllers Only):** Sets the day of the second exercise cycle. Enter a day between Sunday (0) and Saturday (6).
- **Start Time 2 (Level 2 Controllers Only):** Sets the time the second exercise cycle will begin. Enter a time within a 24 hour period: hh=0-23, mm=0-59.
- **Duration 2 (Level 2 Controllers Only):** Sets a time limit the second exercise cycle will run. Enter a time within a 24 hour period: hh=0-23, mm=0-59.
- **Program 2 Repeat (Level 2 Controllers Only):** Sets an interval the second exercise cycle will repeat. Enter a range from 0-52 weeks. Typical values are 1 or 2.
- **Exercise 2 (Level 2 Controllers Only):** Enables or disables the second exercise program to run the generator(s) with or without load.

#### 5.4.4.2.5 Exerciser Submenus (Software Versions 1.5.190 and Greater)

These submenus are available only in Utility-to-Genset applications.

Only one program is available for Level 1 controllers.

- **Exercise Feature:** Enables or disables all the functions of exercising the generators(s).

#### NOTICE

Instead of "Exercise Feature", this menu is titled "Exercise Enable" in some early versions of software. This menu is no longer included with current software.

- **Next Exercise In:** Displays the time remaining until the next exercise cycle. If no exercises are enabled, the message "No Next Exercise" is displayed.
- **Exercise 1 Enable:** This screen allows disabling Exercise 1 only (Default Disabled).
- **Exercise 1 Start:** The first four programming submenus for the exercise cycle. Sets the day an exercise cycle will occur. Select a day between Sunday (0) and Saturday (6). (Default Sunday)
- **Exercise 1 Start:** Sets a time for the exercise cycle to begin. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59. (Default 00:00)
- **Exercise 1 Duration:** Sets the length of time the exercise cycle will run. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59. (Default 00:00)
- **Exercise 1 Repeat:** Sets an interval the exercise cycle will repeat. Enter a cycle between 0 and 52 weeks. Typical values are 1 or 2. (Default 0 Weeks)

- **Exercise 1:** Enables or disables the first exercise program to run the generator(s) with or without a load. (Default Without Load)

Level 2 controllers allow for two exercise programs to be set up from the Setup menu screen. Six additional programs and eight exceptions can be setup using the PC service tool.

- **Exercise 2 Enable** (Level 2 Controllers Only): This screen allows disabling Exercise Program 2 only. (Default Disabled)
- **Exercise 2 Start** (Level 2 Controllers Only): Sets the day of the second exercise cycle. Enter a day between Sunday (0) and Saturday (6). (Default Sunday)
- **Exercise 2 Start** (Level 2 Controllers Only): Sets the time the second exercise cycle will begin. Enter a time within a 24 hour period: hh=0-23, mm=0-59. (Default 00:00)
- **Exercise 2 Duration** (Level 2 Controllers Only): Sets a time limit the second exercise cycle will run. Enter a time within a 24 hour period: hh=0-23, mm=0-59. (Default 00:00)
- **Exercise 2 Repeat** (Level 2 Controllers Only): Sets an interval the second exercise cycle will repeat. Enter a range from 0-52 weeks. Typical values are 1 or 2. (Default 0 Weeks)
- **Exercise 2** (Level 2 Controllers Only): Enables or disables the second exercise program to run the generator(s) with or without load. (Default Without Load)

#### 5.4.4.2.6 Exerciser Exceptions Submenus (Software Versions 1.5.190 and Greater)

These submenus are available only in Utility-to-Genset applications.

Level 2 Controllers allow for adding and deleting exceptions to the two exercise programs set up from the Setup menu screen.

- **Exceptions Active:** Indicates the number of active exercise exceptions. If there are no active exceptions, the message "No Exceptions Active" is displayed.
- **Cancel Active Excppts:** This screen allows cancelling all exceptions (Default Normal).
- **Exception 1:** This screen allows enabling/disabling Exception 1 only (Default Disabled).
- **Excpt 1 Start Date:** Sets the month and day for Exception 1. Enter a starting date that the exerciser will not run: mo = 1-12, dy = 1-31.
- **Excpt1 Start Time:** Sets a time of day for Exception 1. Enter a starting time of day that the exerciser will not run: hr = 0-23, nm = 0-59.
- **Except 1 Duration:** Sets the time period that Exception 1 will override an exercise. Enter a time: dy = 1-31, hr = 2-23, mn = 0-59.
- **Exception 1 Repeat:** This screen allows enabling/disabling Exception 1 repeating (Default Disabled).
- **Exception 2** (Level 2 Controllers Only): This screen allows enabling/disabling Exception 2 only (Default Disabled).
- **Exception 2 Start Date** (Level 2 Controllers Only): Sets the month and day for Exception 2. Enter a starting date that the exercise will not run: mo = 1-12, dy = 1-31.
- **Excpt 2 Start Time** (Level 2 Controllers Only): Sets a time of day for Exception 2. Enter a time of day that the exercise will not run: hh=0-23, mm=0-59. (Default 00:00)
- **Except 2 Duration** (Level 2 Controllers Only): Sets the time period that Exception 2 will override an exercise. Enter a time: dy = 1-31, hr = 0-23, mn = 0-59.

- **Exception 2 Repeat** (Level 2 Controllers Only): This screen allows enabling/disabling Exception 2 repeating (Default Disabled).

#### 5.4.4.2.7 Exerciser Submenus (Software Versions 1.12-1.13.244)

These submenus are available only in Utility-to-Genset applications.

Only one program is available for Level 1 controllers.

#### NOTICE

**Level 2 controllers allow for two exercise programs to be set up from the Setup menu screen.**

- **Exercise Feature:** Enables or disables all the functions of exercising the generators(s).

#### NOTICE

**Instead of "Exercise Feature", this menu is titled "Exercise Enable" in some early versions of software. This menu is no longer included with current software.**

- **Next Exercise In:** Displays the time remaining until the next exercise cycle. If no exercises are enabled, the message "No Next Exercise" is displayed.
- **Exercise 1 Enable:** This screen allows disabling Exercise 1 only (Default Disabled).
- **Exercise 1 Start:** The first four programming submenus for the exercise cycle. Sets the day an exercise cycle will occur. Select a day between Sunday (0) and Saturday (6). (Default Sunday)
- **Exercise 1 Start:** Sets a time for the exercise cycle to begin. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59. (Default 00:00)
- **Exercise 1 Duration:** Sets the length of time the exercise cycle will run. Enter a time within a 24 hour period: hh=0 - 23, mm = 0-59. (Default 00:00)
- **Exercise 1 Repeat:** Sets an interval the exercise cycle will repeat. Enter a cycle between 0 and 52 weeks. Typical values are 1 or 2. (Default 0 Weeks)

#### NOTICE

**0 = exercise one time only  
1 = exercise once a week  
2 = exercise every other week**

- **Exercise 1:** Enables or disables the first exercise program to run the generator(s) with or without a load. (Default Without Load)

Level 2 controllers allow for two exercise programs to be set up from the Setup menu screen. Six additional programs and eight exceptions can be setup using the PC service tool.

- **Exercise 2 Enable** (Level 2 Controllers Only): This screen allows disabling Exercise Program 2 only. (Default Disabled)
- **Exercise 2 Start** (Level 2 Controllers Only): Sets the day of the second exercise cycle. Enter a day between Sunday (0) and Saturday (6). (Default Sunday)

- **Exercise 2 Start** (Level 2 Controllers Only): Sets the time the second exercise cycle will begin. Enter a time within a 24 hour period: hh=0-23, mm=0-59. (Default 00:00)
- **Exercise 2 Duration** (Level 2 Controllers Only): Sets a time limit the second exercise cycle will run. Enter a time within a 24 hour period: hh=0-23, mm=0-59. (Default 00:00)
- **Exercise 2 Repeat** (Level 2 Controllers Only): Sets an interval the second exercise cycle will repeat. Enter a range from 0-52 weeks. Typical values are 1 or 2. (Default 0 Weeks)

NOTICE
<p><b>0 = exercise one time only</b>  <b>1 = exercise once a week</b>  <b>2 = exercise every other week</b></p>

- **Exercise 2** (Level 2 Controllers Only): Enables or disables the second exercise program to run the generator(s) with or without load. (Default Without Load)

#### 5.4.4.2.8 Exerciser Exceptions Submenus (Software Versions 1.13.244-1.5.190)

These submenus are available only in Utility-to-Genset applications.

Level 1 Controllers allow for setting two exceptions and Level 2 Controllers allow for setting exceptions to the eight exercise programs setup from the digital display screen.

- **Exception Remaining:** Indicates the time remaining for the exception of the longest duration. If there are no active exceptions, the message "No Excepts Active" is displayed on the first line.
- **Cancel Active Excppts:** This screen allows cancelling all exceptions (Default Normal).
- **View/Edit Exception:** This screen allows for selecting an Exception and displaying its status. Enter a number between 1 and 8 (Default 1). If a password is not entered:
  - Only the View/Edit Exercise and View/Edit Exception menus can be modified.
  - When the View/Edit Exercise or View/Edit Exception menus are modified, the Save Changes/Cancel Changes submenu is displayed upon exiting the Exercise submenus.

NOTICE
<p><b>The number selected here must match the Exercise number selected in the "View/Edit Exercise" menu.</b></p>

- **Exception #:** This menu is used to enable/disable the Exception selected in the previous menu (Default Disabled)
- **Excerpt 1 Start Date:** Sets the month and day for Exception 1. Enter a starting date that the exercise will not run: mo = 1-12, dy = 1-31.
- **Excerpt 1 Start Time:** Sets a time of day for Exception 1. Enter a starting time of day that the exercise will not run: hr = 0-23, mn = 0-59.
- **Exception # Duration:** Sets the time period that the exception will override the same numbered exercise. Enter a time: days = 1-31, hr = 0-23, mn = 0-59.
- **Exception # Repeat:** This menu allows for enabling/disabling repeating the Exception (Default Disabled).



### 5.4.4.3 Setup Group 3

The Mode submenu allows programming the type of transition the switch uses.

The Clock submenus program the time and date, as well as daylight savings time.

The Sequencer submenu displays the Load Sequencer software feature, available only with LonWorks Network Communication Module. This program allows the user to send a predetermined sequence of event announcements in a timed, sequential order to turn the load off and on.

#### 5.4.4.3.1 Mode Submenu (Prior to Software Version 1.20.250)

**Transfer Mode:** The transfer mode is preset and cannot be changed.

#### 5.4.4.3.2 Mode Submenu (Software Version 1.20.250 and Greater)

- **Transfer Mode:**
  - Program Transition
  - Open Sync Check

#### NOTICE

Available settings vary from genset to genset.

#### 5.4.4.3.3 Clock Submenus

The Clock submenus allow the user to set the actual date and time, as well as select the Daylight Saving Time option.

- **Date:** Sets the actual day and date. Enter a month between Jan (1) and Dec (12), a date between 1 and 31 and a year between 1 and 9999.
- **Time:** Sets the actual time of day. Enter the actual time within a 24 hour period: hh = 1-23, mm = 0-59, ss = 0-59.
- **Daylight Saving:** Activates the Daylight Savings time option. Selecting Enabled automatically updates the clock +/- one hour on the appropriate days (Default Disabled).

#### NOTICE

The Daylight Savings Time program is set for North America. If you are anywhere outside of North America, the time should be changed manually.

- The first Sunday in April - moves the time forward one hour.
- The last Sunday in October - moves the time back one hour.

#### 5.4.4.3.4 Sequencer Submenus

Sequencer is available only with the optional Network Communication Module. The module must be installed and enabled with the PC service tool before these screens are displayed.

- **Load Sequencer:** When enabled, allows event announcements to be sent to the transfer switch.
- **Sequence Activation:** Sets activation for certain operational modes. Choose Transfer, Re-transfer or All.

- **Sequence Length:** The control can activate a maximum of 8 relay output signals. Enter the number of relay output signals desired to activate: 1 through 8.
- **Output 1 Time Delay:** When Load Sequencer is triggered, the controller deactivates all remote relay output signals. Starting with Relay 1, the controller counts down the specified time delay, the activates Relay 1. Enter a time from 0 to 60 seconds.

The process repeats until all relay signals have been sequenced. The maximum time delay for all 8 signals is 8 minutes.

#### NOTICE

**Menus continue through Output 8, depending on the number of Sequence Lengths specified.**

#### 5.4.4.4 Changing Setup Parameters (Software Prior to Version 1.12)

Pressing the 1 phase-2 wire button in any submenu causes a cursor to appear in the location of the editable field. In most cases, there is only one field to edit.

Use the + and - buttons to select numerical values or to toggle through a list of selections.

Default values are shown in parenthesis.

Use the right-facing arrow button to move the cursor to the next field.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

If changes are made, press the right-facing arrow button to enter the new value and return to the previous menu.

Changing any data within the Setup submenus will invoke a Save/Restore screen when exiting the Setup submenu groups.

If the Previous Menu button is pressed during an editing session, the data will not be changed.

If the Home button is pressed during an editing session, the Save/Restore screen is invoked.

#### 5.4.4.5 Changing Setup Parameters (Software Version 1.12 and Greater)

Pressing the 1 phase-2 wire button in any submenu causes a cursor to appear in the location of the editable field. In most cases, there is only one field to edit.

Use the + and - buttons to select numerical values or to toggle through a list of selections.

Default values are shown in parenthesis.

Use the right-facing arrow button to move the cursor to the next field.

When entering numerical values, the - button lowers the value to its lowest range, then begins again at the top end of the range. The + button increases the value to its highest range, then begins again at the low end of the range.

If changes are made, press the right-facing arrow button to enter the new value and return to the previous menu.

Changing any data within the Setup submenus will invoke a SAVE CHANGES/CANCEL CHANGES screen when exiting the Setup submenu groups.

If the PREVIOUS MENU button is pressed during an editing session, the data will not be changed.

If the Home button is pressed during an editing session, the SAVE CHANGES/CANCEL CHANGES screen is invoked.

# 6 Wiring Considerations for Closed Transition Switches

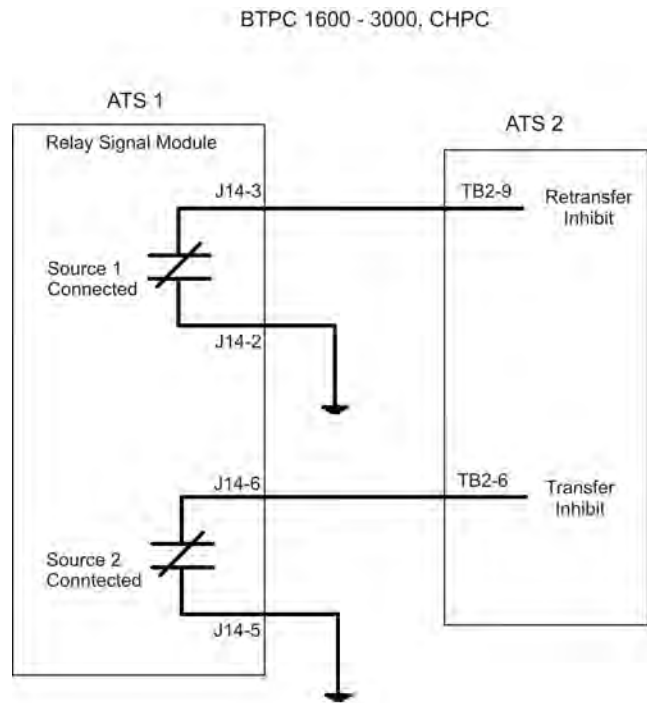
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## 6.1 Wiring Considerations for Closed Transition Transfer Switches

There are two functions that should be used with closed transition transfer switches: The transfer and re-transfer inhibit functions should be used to prevent two switches from transferring at the same time and the fail to disconnect output of the relay signal module should be wired to the shunt trip of one of the breakers feeding the ATS to prevent extended paralleling of the two sources.

## 6.2 Re-transfer and transfer inhibit functions

In applications with more than one closed transition ATS, the transfer and re-transfer inhibit functions should be used to prevent multiple transfer switches from transferring at the same time. For example to prevent two switches from re-transferring from the genset to the utility at the same time wire the normally closed contact that indicates the first ATS is connected to the normal source into the retransfer inhibit input of the transfer switch that is intended to transfer second. Ground the common aux contact on the first switch so that the re-transfer inhibit input on the second switch is grounded when the first transfer switch is not connected to the normal source. This will inhibit the second switch from beginning its retransfer sequence (including all time delays) until after the first transfer switch has transferred back to the normal source. A similar wiring scheme can be used when transferring to the emergency source so that only one switch transfers at a time. Switch position indicators are available on the relay signal module which is included with all Cummins closed transition ATS models. [Figure 53](#) and [Figure 54](#) illustrate how this can be done with all of Cummins' closed transition transfer switch models.

**FIGURE 53. BTPC 1600-3000, CHPC**

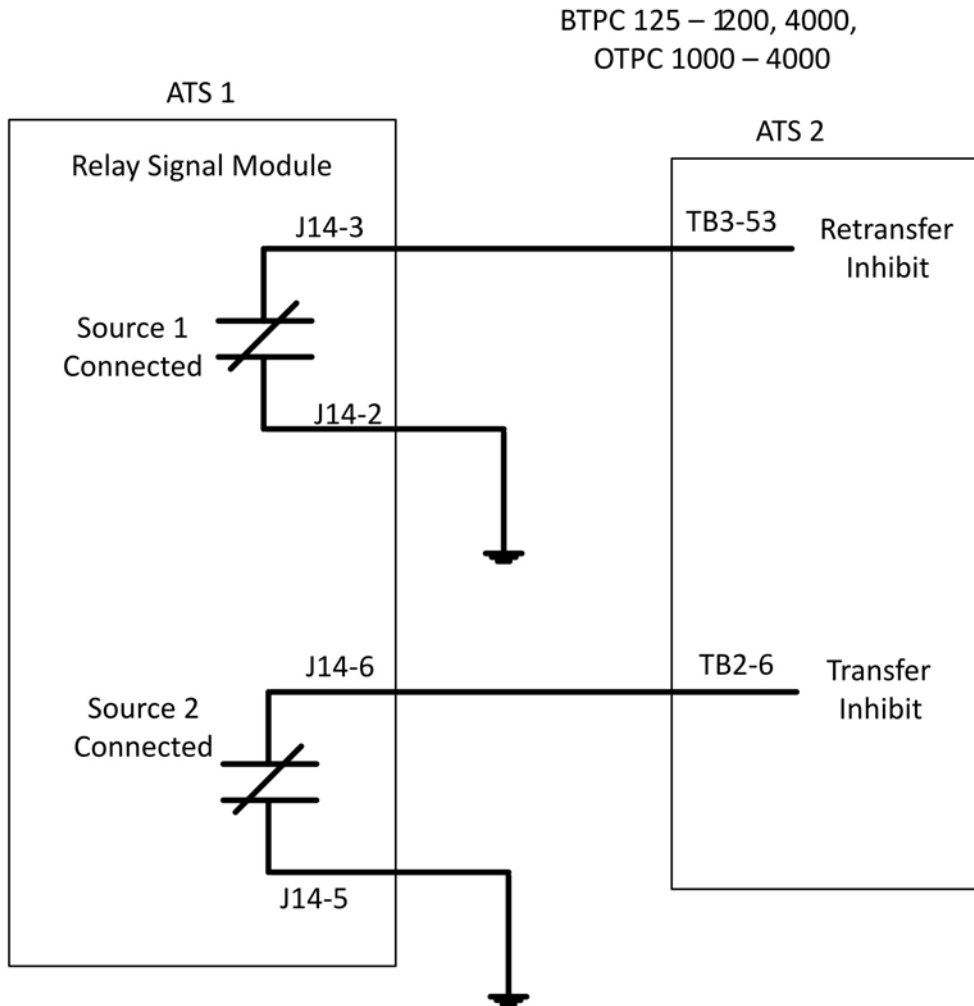
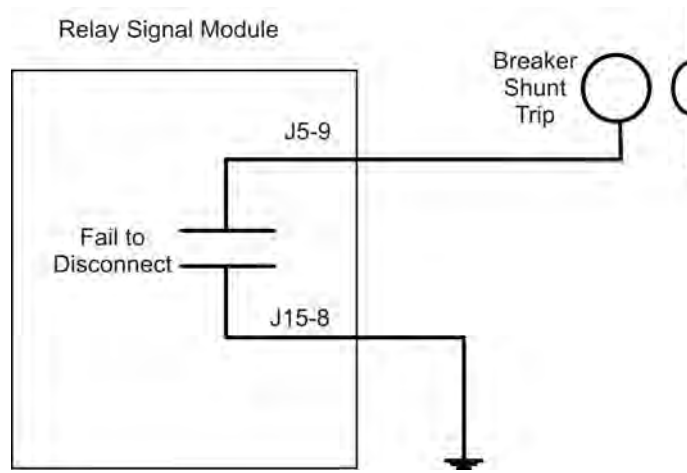


FIGURE 54. BTPC 125-1200, 4000, OTPC 1000-4000

### 6.3 Fail to disconnect

The Fail to Disconnect relay is active when the transfer switch remains connected to both sources for more than 100 msec during a closed transition transfer. It should be wired to the shunt trip of the breaker feeding the ATS on either the normal or the emergency side. The fail to disconnect relay is located on the relay signal module. See [Figure 55](#).



**FIGURE 55. BREAKER SHUNT TRIP**

# 7 Troubleshooting

## 7.1 Control Module LED Indicators and Switch

The digital module located on the inside of the switch enclosure door contains ten LED indicators. The indicators provide some information about the current control status. These indicators may be helpful in troubleshooting the transfer switch when the Digital Display is not available.

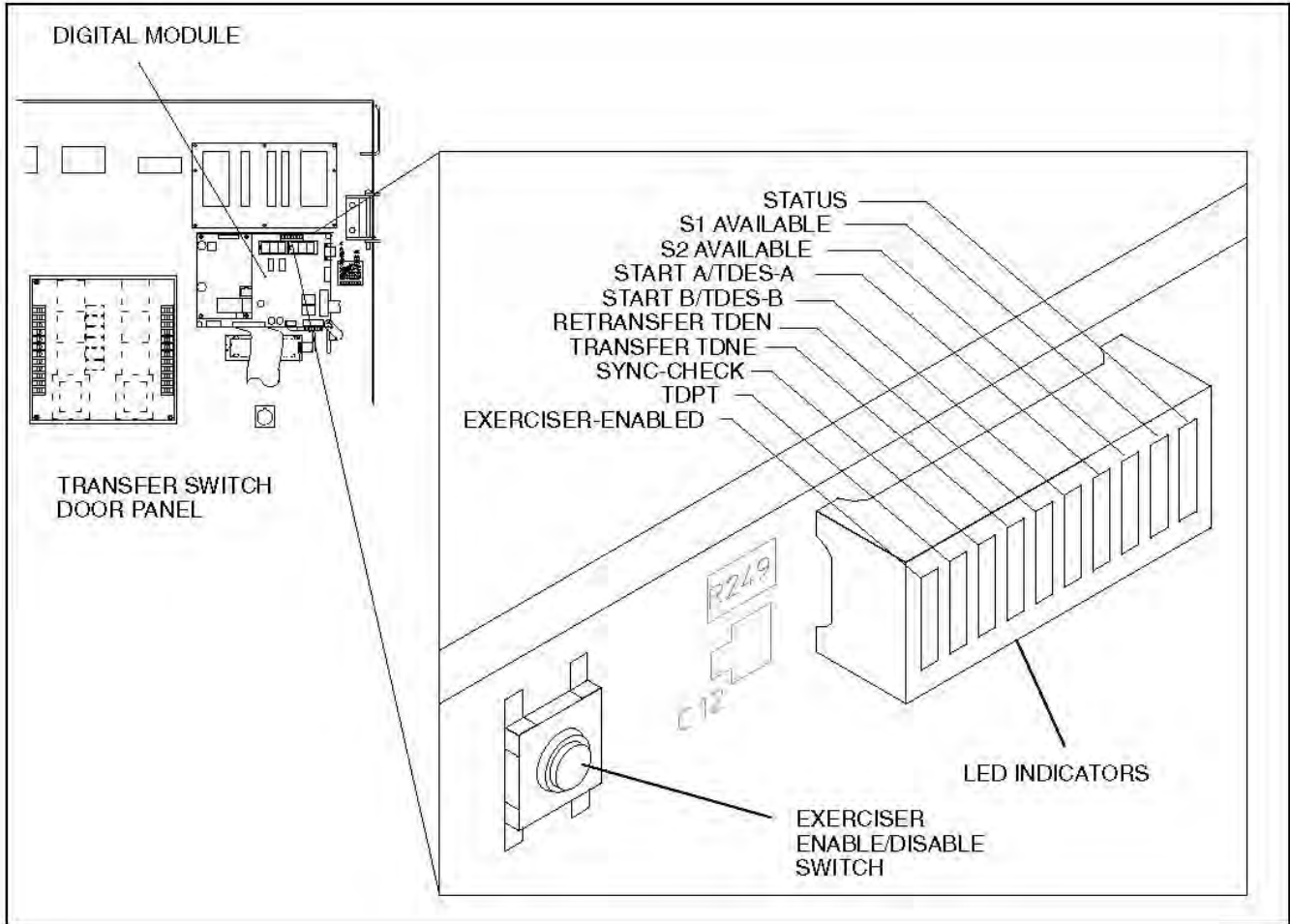


FIGURE 56. LED LOCATION ON DIGITAL MODULE (SHOWN ON THE 40 TO 125 AMP SWITCH)

TABLE 3. DIGITAL MODULE LED INDICATORS

Indicator	Definition
Status	Blinks at 1/2 Hz rate when the controller has power and the program is running without error. This indicator flashes the event code of an active event until the event is acknowledged with the Reset switch on the front panel. This indicator is sometimes referred to as the heart beat because it blinks constantly when the controller does not have an active event.
S1 Available	Lights when Power Source 1 has acceptable voltage and frequency limits. This indicator lights when the Source 1 Available indicator on the control panel lights.



Indicator	Definition
S2 Available	Lights when Power Source 2 has acceptable voltage and frequency limits. This indicator lights when the Source 2 Available indicator on the control panel lights.
Start A/TDES-A	<ol style="list-style-type: none"> <li>1. Lights constantly when the control has commanded Source 2 to start</li> <li>2. Blinks at 1/2 Hz rate during the time delay to engine start (TDESa)</li> </ol>
Start B/TDES-B	<p>This indicator is only used for genset-to-genset applications when Source 1 is a generator not a utility.</p> <ol style="list-style-type: none"> <li>1. Lights constantly when the control has commanded Source 1 to start</li> <li>2. Blinks at 1/2 Hz rate during the time delay to engine start (TDESb)</li> </ol>
Retransfer/TDEN	<ol style="list-style-type: none"> <li>1. Lights when the control energizes the Retransfer relay</li> <li>2. Blinks at 1/2 Hz rate during the time delay to retransfer (TDEN)</li> </ol>
Transfer/TDNE	<ol style="list-style-type: none"> <li>1. Lights when the control energizes the Transfer relay</li> <li>2. Blinks at 1/2 Hz rate during the time delay to transfer (TDNE)</li> </ol>
Sync-Check	Blinks at 1-second rate when the in-phase sensor is active (maximum of 120 seconds).
TDPT	<p>Time Delay Programmed Transition</p> <p>Blinks at 1/2 Hz rate during the programmed transition time delay</p>
Exerciser Enabled	Lights when the Exerciser clock is enabled and blinks during an exercise period. The small switch next to the indicator enables and disables the exerciser. The operator can also enable and disable the exerciser from the Digital Display when it is available.

## 7.2 Fault Flash-Out

The control flashes an active fault code on the Digital Module Status indicator until it is acknowledged with the Reset switch on the front panel. The control flashes each digit of the fault code with a pause between digits and a longer pause between repetitions.

The control moves acknowledged events to the event history file. This file can hold a maximum of 50 fault and non-fault events. The digital display and the PC Service Tool can read the contents of the Event history file.

## 7.3 Exerciser Enable/Disable Switch

The Exerciser Enable/Disable switch enables the control to exercise the genset during future scheduled exercise periods and lights the Exerciser Enabled indicator or disables the scheduled exercise period and turns the indicator off. This button is used by service personnel to disable unexpected transfers while servicing the switch.

## 7.4 Troubleshooting Transfer Switch With the Digital Display

The Digital Display shows two types of events: fault events and non-fault events. The last 50 events, both fault and non-fault events, can be viewed with the Digital Display. You can also read all events in the event history file by using the PC Service Tool.

## 7.4.1 Fault Events

Fault events should be considered alarms for the transfer switch operator. They indicate that the transfer switch is not operating correctly.

### 7.4.1.1 Fault Codes and Messages

The following table lists the fault codes and fault message, and gives corrective actions for each fault code.


**TABLE 4. FAULT CODES AND MESSAGES**

343	Controller Checksum Error
441	Low Controller Battery
1113	ATS Fail to Close: Transfer
1114	ATS Fail to Close: Retransfer
597	Battery Charger Malfunction
477*	Network Battery Low
1468	Network Communications Error
* This fault code only applies to older transfer switches that included an Network Communications Module (NCM) with batteries.	

The controller displays the fault message on the Digital Display and flashes the asterisk indicator. You must press the Reset button on the control panel to acknowledge a fault and clear the display.

### 7.4.1.2 Troubleshooting Fault Codes

**TABLE 5. TROUBLESHOOTING**

 <b>WARNING</b>
<i>Some ATS service procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of electricity and machinery hazards should perform service. See Safety Precautions.</i>
<b>CONTROLLER CHECKSUM ERROR (343)</b> The checksum of the Flash EPROM does not match the checksum stored in the controller
<b>Corrective Action:</b> <ol style="list-style-type: none"> <li>1. Reset the control by removing power.</li> <li>2. Remove and re-install Digital Module batteries.</li> <li>3. Contact Cummins/Onan Service if checksum error is repeated on power up.</li> <li>4. Reset real-time clock.</li> </ol>
<b>LOW CONTROLLER BATTERY (441)</b> Low Lithium battery voltage
<b>Corrective Action:</b> <ol style="list-style-type: none"> <li>1. Replace Digital Module batteries.</li> <li>2. Press the Reset button on the front panel.</li> <li>3. Reset real-time clock.</li> </ol>

---

## 7.5 Fault Event Definitions

### 7.5.1 Controller Checksum Error

The controller checks the Flash EPROM checksum after each microprocessor reset. The checksum is stored in nonvolatile EEPROM. If a checksum error fault occurs, the controller still attempts a normal boot-up sequence.

The controller Fault Flash-out subsystem flashes this fault on the Status indicator until the fault is acknowledged (reset). Reset the control by removing power (including the batteries). If checksum error is repeated on power up, replace the Digital Module.

### 7.5.2 Low Controller Battery

The controller monitors the voltage of the Lithium batteries that supply power to the controller. If the battery voltage drops to 5 VDC, the controller sets the fault status to active.

The controller Fault Flash-out subsystem flashes this fault until the fault is acknowledged (reset).

### 7.5.3 ATS Fail to Close: Transfer

The controller first verifies that the transfer switch moved from Source 1 to Neutral within the time limit defined in the Fail to Close Time Delay. The controller also verifies that the transfer switch moved from Neutral to Source 2 within the time limit defined in the Fail to Close Time Delay.

If the Fail to Close time limit is exceeded, the controller changes the fault status to active. The fault remains active until the Reset button is pressed.

### 7.5.4 ATS Fail to Close: Re-Transfer

The controller first verifies that the transfer switch moved from Source 2 to Neutral within the time limit defined in the Fail to Close Time Delay. The controller also verifies that the transfer switch moved from Neutral to Source 1 within the time limit defined in the Fail to Close Time Delay.

If the Fail to Close time limit is exceeded, the controller changes the fault status to active. The fault remains active until the Reset button is pressed.

### 7.5.5 Battery Charger Malfunction

The controller monitors the status of the optional battery charger. If the Battery Charger Fault input is active, this event is active.

The controller Fault Flash-out subsystem flashes this fault until the fault is acknowledged (reset).

### 7.5.6 Network Battery Low

This event is detected by the optional Network Communications Module (NCM) and is communicated to the controller. If the battery voltage drops, the controller sets the fault status to active.

The controller Fault Flash-out subsystem flashes this fault on the Status indicator until the fault is acknowledged (reset).

---

## 7.5.7 Network Communications Error

This event is detected by the Network Communications Module (NCM) and is communicated to the transfer switch controller. This indicates that the device is no longer communicating with other devices on the network.

The controller Fault Flash-out subsystem flashes this fault until the fault is acknowledged (reset).

## 7.6 15/12-Amp Battery Charger Troubleshooting and Faults

The 15/12-amp battery charger includes one set of Form-B alarm contacts (corresponding to the status LED on the control panel). When red, this LED indicates a fault condition. The control panel also displays fault codes.

When a fault occurs, the red fault LED lights and a brief description of the fault and the numeric fault code is displayed on the digital display. To correct the fault, find the fault code number and take the suggested corrective actions. If the problem persists, call an authorized Cummins Power Generation distributor for help.

### 7.6.1 Clearing Faults

Most displayed faults are cleared by removing the fault. However, faults 379 - OVER CURR, 442 - HIGH BATT VOLT, and 9115 - BATT FAIL can only be cleared by cycling completely through the Setup menus or by powering down the charger after the fault is corrected. (More information on Setup menus is included in the Battery Charger Operator's Manual.)

### 7.6.2 Fault Alarm Output Connector

The battery charger includes a fault output relay that is activated (contacts close) when faults occur. The contacts are rated at 2 amps/30 VDC. This feature can be used by wiring a fault indicator to the fault alarm output connector located on the front of the battery charger. A 2-pin plug connector (323-1678-02) is shipped with the 15/12-amp transfer switch battery charger.

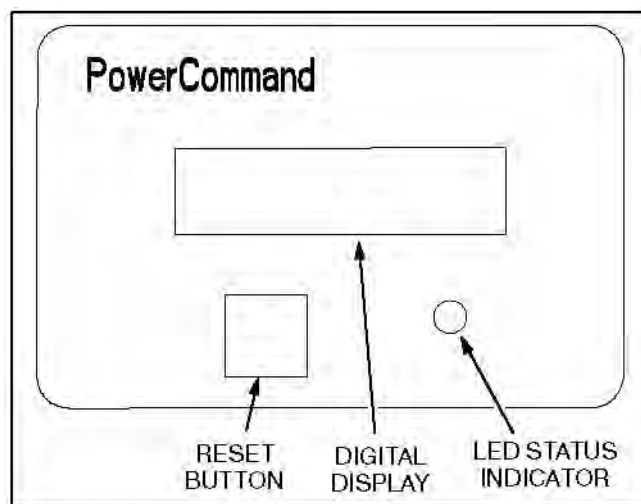


FIGURE 57. 15/12-AMP CHARGER CONTROL PANEL

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## 7.7 Code 101 – Source 1 Connected (Event)

**Logic:**

Source 1 is connected to the transfer switch.

**Description:**

This event is active whenever the Source 1 position input is active. There is an associated LED output on the front panel, a relay output on the Relay Module, and a Digital Display screen that also indicate Source 1 is connected.

**Possible Cause:**

Source 1 limit switch feedback indicates switch position closed.

**Diagnosis and Repair:**

No further action required.

## 7.8 Code 102 – Source 1 Available (Event)

**Logic:**

Source 1 has reached the specified voltage and frequency targets.

**Description:**

This event is active whenever the Source 1 sensors (over/under voltage, over/under frequency, phase rotation, loss of phase, voltage imbalance) indicate that Source 1 is within acceptable limits. There is an associated LED output on the front panel and a relay output on the Relay Module.

**Possible Causes:**

1. Voltage feedback is within specification of the voltage select.
  - a. Level 1, nominal voltage is line-to-line.
  - b. Level 2, nominal voltage is line-to-neutral.
2. Frequency feedback is within specification of the frequency select.

**Diagnosis and Repair:**

No further action required.

## 7.9 Code 103 – Source 2 Connected (Event)

**Logic:**

Source 2 is connected to the transfer switch.

**Description:**

This event is active whenever the Source 2 position input is active. There is an associated LED output on the front panel, a relay output on the Relay Module, and a Digital Display screen that also indicate Source 2 is connected.

**Possible Cause:**

Source 2 limit switch feedback indicates switch position closed.

**Diagnosis and Repair:**

No further action required.

## 7.10 Code 104 – Source 2 Available (Event)

**Logic:**

Source 2 has reached the specified voltage and frequency targets.

**Description:**

This event is active whenever the Source 2 sensors (over/under voltage, over/under frequency, phase rotation, loss of phase, voltage imbalance) indicate that Source 2 is within acceptable limits. There is an associated LED output on the front panel and a relay output on the Relay Module.

**Possible Causes:**

1. Voltage feedback is within specification of the voltage select.
  - a. Level 1, nominal voltage is line-to-line.
  - b. Level 2, nominal voltage is line-to-neutral.
2. Frequency feedback is within specification of the frequency select.

**Diagnosis and Repair**

No further action required.

## 7.11 Code 105 – Emergency Start A (Event)

**Logic:**

Source A has received a start command from the transfer switch.

**Description:**

This event is active whenever the controller requires the Source 2 genset to start and reach rated speed — otherwise known as an emergency start. There is also a discrete output called Emergency Start A. Conditions which may prompt an emergency start are loss of nominal voltage or frequency of Source B, a test in progress with Source A as preferred source, or exercise transfer switch with Source A as the preferred source.

**Possible Causes:**

1. Loss of nominal voltage or frequency of Source B.
2. Test in progress with Source A as preferred source.
3. Exercise transfer switch with Source A as preferred source.

**Diagnosis and Repair:**

No further action required.

## 7.12 Code 106 – Test Start A (Event)

**Logic:**

Source A has received a test start command from the control or the network.

**Description:**

This event is active whenever the controller performs a Test sequence. The controller also activates the Emergency Start A output in order for the generator to interpret that a Test/Exercise start is called for. The genset will not start if only the Test Start A event is active.

The test input may be sent from front panel, service tool, or network.

**Possible Causes:**

1. Test input sent from front panel or service tool.
2. Test input sent from network.

**Diagnosis and Repair:**

No further action required.

## 7.13 Code 107 – Emergency Start B (Event)

**Logic:**

Source B has received a start command from the transfer switch.

**Description:****NOTICE**

**Only applicable in genset-to-genset configuration. Generator B is Source 1.**

This event is active whenever the controller requires the Source 1 genset to start and reach rated speed — otherwise known as an emergency start. There is also a discrete output called Emergency Start B. Conditions which may prompt an emergency start are loss of nominal voltage or frequency of Source A, a test in progress with Source B as preferred source, or exercise transfer switch with Source B as the preferred source.

**Possible Causes:**

1. Loss of nominal voltage and frequency of Source A.

2. Test in progress with Source B as preferred source.
3. Exercise transfer switch with Source B as preferred source.

**Diagnosis and Repair**

No further action required.

## 7.14 Code 108 – Test Start B (Event)

**Logic:**

Source B has received a test start command from the control or the network.

**Description:****NOTICE**

**Only applicable in genset-to-genset configuration. Generator B is Source 1.**

This event is active whenever the controller performs a Test sequence. The controller also activates the Emergency Start B output in order for the generator to interpret that a Test/Exercise start is called for. The genset will not start if only the Test Start B event is active.

The test input may be sent from front panel, service tool, or network

**Possible Causes:**

1. Test input sent from front panel or service tool.
2. Test input sent from network.

**Diagnosis and Repair:**

No further action required.

## 7.15 Code 109 – Time Delay Engine Start A (Event)

**Logic:**

Source A engine start in user configured delayed time set-point.

**Description:**

This event is active whenever the Time Delay Start A timer is active. This event is inactive whenever the timer expires or is not active. The control activates this output whenever the control requires generator A to start.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

This delay prevents the generator set from starting during short power interruptions. Timing starts at the Source 1 power interruption. If the user-defined duration (0 – 15 seconds) of interruption exceeds the time delay, the control systems starts Generator A.



**Possible Cause:**

Time Delay Engine Start A trim is more than 0 seconds after start command has been received.

**Diagnosis and Repair:**

No further action required.

## 7.16 Code 111 – Time Delay Engine Start B (Event)

**Logic:**

Source B engine start in user configured delayed time set-point.

**Description:****NOTICE**

**Only applicable in genset-to-genset configuration. Generator B is Source 1.**

This event is active whenever the Time Delay Start B timer is active. This event is inactive whenever the timer expires or is not active. The control activates this output whenever the control requires genset B to start.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

This delay prevents the generator set from starting during short power interruptions. Timing starts at the Source 1 power interruption. If the user-defined duration (0 – 15 seconds) of interruption exceeds the time delay, the control systems starts Generator B.

**Possible Cause:**

Time delay engine start B trim is more than 0 seconds after start command has been received.

**Diagnosis and Repair:**

No further action required.

## 7.17 Code 112 – Time Delay Transfer (Event)

**Logic:**

Switch has commanded to transfer away from the preferred source with configured time delay normal to emergency trim.

**Description:**

This event is active whenever the Time Delay Source 1 to Source 2 timer is active — also called the time delay transfer. This event is inactive whenever the timer expires or is not active. The control activates this output when the control is counting down to transfer the switch from Source 1 to Source 2. The digital display displays this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

This time delay begins after Source 2 becomes available and allows Source 2 to stabilize before the load is applied. This delay will initiate when the preferred source fails, there is a test in progress with time delay, or an exercise transfer switch with time delay.

**Possible Causes:**

1. Preferred source failed and time delay normal to emergency trim is greater than 0 seconds.
2. Test in progress with time delay normal to emergency trim greater than 0 seconds.
3. Exercise transfer switch with time delay normal to emergency trim greater than 0 seconds.

**Diagnosis and Repair:**

No further action required.

## 7.18 Code 113 – Time Delay Retransfer (Event)

**Logic:**

Switch has commanded to retransfer back to the preferred source with configured time delay emergency to normal trim.

**Description:**

This event is active whenever the Time Delay Source 2 to Source 1 timer is active—also called the time delay retransfer. This event is inactive whenever the timer expires or is not active. The control activates this output when the control is counting down to transfer the switch from Source 2 to Source 1.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

This event is active whenever the Time Delay Source 2 to Source 1 timer is active—also called the time delay retransfer. This event is inactive whenever the timer expires or is not active. The control activates this output when the control is counting down to transfer the switch from Source 2 to Source 1.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

**Possible Causes:**

1. Preferred source recovered and time delay emergency to normal trim is greater than 0 seconds.
2. Test in progress with time delay emergency to normal trim greater than 0 seconds.
3. Exercise transfer switch with time delay emergency to normal trim greater than 0 seconds.

**Diagnosis and Repair:**

No further action required.

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## 7.19 Code 114 – Engine Cool-Down A (Event)

**Logic:**

Time Delay Engine Cool-down A timer has started, but not expired.

**Description:**

This event is active whenever the Time Delay Engine Cool-down Timer is active and is inactive when the timer expires or is inactive. The control activates this output whenever the control is cooling down the genset. The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

This time delay allows the generator to cool down under no load conditions before the control turns it off.

**Possible Causes:**

Time delay engine cool-down A timer is greater than 0 seconds.

**Diagnosis and Repair:**

No further action required.

## 7.20 Code 115 – Program Transition (Event)

**Logic:**

The switch has executed a program transition between sources.

**Description:**

This event is active whenever the programmed transition timer is active (whenever the control is delaying the transfer switch in the neutral position). This event is inactive whenever the timer expires or is not active. The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

Programmed Transition stops the switch in the neutral position for a user-defined interval of time. This delay allows residual current from inductive loads to decay to an acceptable level before transfer is complete.

**Possible Causes:**

Time delay program transition timer is greater than 0 seconds.

**Diagnosis and Repair:**

No further action required.

## 7.21 Code 116 – Transfer Pending (Event)

**Logic:**

There is a pending transfer active in the elevator relay module.

**Description:**

Whenever the Elevator Pre-transfer output is active, the controller sets this to active. The control activates this event whenever a transfer pending signal is needed in the power system – this is typically used as an early warning signal for elevator systems. When the timer expires, the event will go to inactive.

The digital display shows this event when it becomes active. In addition, it displays an active countdown, in seconds, of the time delay.

**Possible Causes:**

The elevator relay input has been activated.

**Diagnosis and Repair:**

No further action is required.

## 7.22 Code 117 – Test in Progress (Event)

**Logic:**

The control is operating under a test sequence.

**Description:**

This event is active whenever a test sequence is active. There is an associated LED output on the front panel and a relay output on the Relay Module. This allows the ATS operator to automatically test the transfer switch, generator, and power system.

When this event is active, the Test/Exercise Active LED on the front panel is lit and the Test/Exercise relay on the relay module is activated.

Test input may be sent from the front panel, service tool, or network.

**Possible Causes:**

1. Test input sent from front panel or service tool.
2. Test input sent from network.

**Diagnosis and Repair:**

No further action required.

## 7.23 Code 118 – Exercise Active (Event)

**Logic:**

The control is operating under an exercise sequence.

**Description:**

This event is active whenever an exercise is active. There is an associated LED output on the front panel and a relay output on the Relay Module. This allows the ATS operator to program and store multiple engine-generator exercise events.

---

When this event is active, the Test/ Exercise Active LED on the front panel is lit and the Test/Exercise relay on the relay module is activated.

This feature is only available with transfer switches with front panel display.

**Possible Cause:**

Exercise input programmed on front panel or service tool.

**Diagnosis and Repair:**

No further action required.

## 7.24 Code 119 – Sync Check (Event)

**Logic:**

The sync check sensor has been activated and is verifying if sources A and B meet conditions for synchronicity.

**Description:**

This event is active whenever as in-phase transfer (using the Sync Check Sensor) is pending. During this time, the Sync Check Sensor determines the acceptable conditions for a closed-transition or open transition with sync check transfers.

**Possible Causes:**

1. A closed transition command has been activated (applicable only to CT capable switches).
2. An open transition with Sync Check has been activate.

**Diagnosis and Repair:**

No further action required.

## 7.25 Code 121 – S1 Under Voltage (Event)

**Logic:**

Control has sensed that Source 1 voltage dropped below the specified dropout voltage percentage and the under voltage time delay has expired.

**Description:**

This event is active whenever Source 1 voltage is less than the acceptable limits. When the sensor detects a low voltage condition over a user-defined time period, this event is triggered. It should be noted that both the drop-out voltage and the time period are user-defined.

**Possible Causes:**

1. Nominal voltage set incorrectly.
2. Source 1 voltage is lower than the specified dropout voltage of the nominal voltage.
3. Source 1 phase multiplier and offsets need adjustment.

**Diagnosis and Repair:**

Contact support channel.

## 7.26 Code 122 – S1 Over Voltage (Event)

**Logic:**

Control has sensed that Source 1 voltage exceeded the specified dropout voltage percentage and the over voltage time delay has expired.

**Description:**

This event is active whenever Source 1 voltage is greater than the acceptable limits. When the sensor detects a high voltage condition over a specified time period, this event is triggered. It should be noted that both the drop-out voltage and the time period are user-defined.

**Possible Causes:**

1. Nominal voltage set incorrectly.
2. Source 1 voltage is lower than the specified dropout voltage of the nominal voltage.
3. Source 1 phase multiplier and offsets need adjustment.

**Diagnosis and Repair:**

Contact support channel.

## 7.27 Code 123 – S1 Frequency Fail (Event)

**Logic:**

Source 1 frequency is out of specified tolerance range.

**Description:**

This event is active whenever Source 1 frequency is outside acceptable limits, as defined by the user.

**Possible Causes:**

1. Incorrect frequency settings.
2. Frequency is outside of the dropout range.

**Diagnosis and Repair:**

Contact support channel.

## 7.28 Code 124 – S1 Loss Phase (Event)

**Logic:**

The relative phase angle between any line-to-line voltage has dropped to less than 90 degrees.

**Description:**

This event is active whenever Source 1 is missing one or more of its three phase voltages, or when the phase angle between any two lines drops below 90 degrees.

This feature is mainly used to protect three-phase devices, like motors. It is only available on Level 2 controls, in a three-phase application. This feature initiates a transfer away from a source that has lost a single phase and it prevents transfer to a source that has lost a single phase.

**Possible Causes:**

1. One of the three phases is open or has been shorted.
2. Sensing Leads to Power Module are loose or broken.

**Diagnosis and Repair:**

Contact support channel.

## 7.29 Code 125 – S1 Imbalance Fail (Event)

**Logic:**

Sensor has detected there is an unbalanced voltage condition on a three-phase system for source 1.

**Description:**

This event is active whenever there is a significant imbalance between the phases of Source 1. The voltage must deviate from the average voltage by a user-specified value between 2 and 10% (drop-out).

This feature is used for equipment protection. It is used in three-phase applications and informs the operator when there is a significant voltage imbalance between the phases of Source 1 or Source 2. The imbalance is typically caused by severe single phase loading. To prevent nuisance faults, the setting can be increased up to ten percent of nominal voltage.

**Possible Cause:**

Incorrect imbalance settings.

**Diagnosis and Repair:**

Contact support channel.

## 7.30 Code 126 – S2 Under Voltage (Event)

**Logic:**

Control has sensed that Source 2 voltage dropped below the specified dropout voltage percentage and the under voltage time delay has expired.

**Description:**

This event is active whenever Source 2 voltage is less than the acceptable limits. When the sensor detects a low voltage condition over a specified time period, this event is triggered. It should be noted that both the drop-out voltage and the time period are user-defined.

**Possible Causes:**

1. Nominal voltage set incorrectly.
2. Source 2 voltage is lower than the specified dropout voltage of the nominal voltage.
3. Source 2 phase multiplier and offsets need adjustment.

**Diagnosis and Repair:**

Contact support channel.

## 7.31 Code 127 – S2 Over Voltage (Event)

**Logic:**

Control has sensed that Source 2 voltage exceeded the specified dropout voltage percentage and the over voltage time delay has expired.

**Description:**

This event is active whenever Source 2 voltage is greater than the acceptable limits. When the sensor detects a high voltage condition over a specified time period, this event is triggered. It should be noted that both the drop-out voltage and the time period are user-defined.

**Possible Causes:**

1. Nominal voltage set incorrectly.
2. Source 2 voltage is lower than the specified dropout voltage of the nominal voltage.
3. Source 2 phase multiplier and offsets need adjustment.

**Diagnosis and Repair:**

Contact support channel.

## 7.32 Code 128 – S2 Frequency Fail (Event)

**Logic:**

Source 2 frequency is out of specified tolerance range.

**Description:**

This event is active whenever Source 2 frequency is outside acceptable limits, as defined by the user.

**Possible Causes:**

1. Incorrect frequency settings.



2. Frequency is outside of the dropout range.

**Diagnosis and Repair:**

Contact support channel.

## 7.33 Code 129 – S2 Loss Phase (Event)

**Logic:**

The relative phase angle between any line-to-line voltage has dropped to less than 90 degrees.

**Description:**

This event is active whenever Source 2 is missing one or more of its three phase voltages, or when the phase angle between any two lines drops below 90 degrees.

This feature is mainly used to protect three-phase devices, like motors. It is only available on Level 2 controls, in a three-phase application. This feature initiates a transfer away from a source that has lost a single phase and it prevents transfer to a source that has lost a single phase.

**Possible Causes:**

1. One of the three phases is open or has been shorted.
2. Sensing Leads to Power Module are loose or broken.

**Diagnosis and Repair:**

Contact support channel.

## 7.34 Code 131 – S2 Imbalance Fail (Event)

**Logic:**

Sensor has detected there is an unbalanced voltage condition on a three-phase system for source 2.

**Description:**

This event is active whenever there is a significant imbalance between the phases of Source 2. The voltage must deviate from the average voltage by a user-specified value between 2 and 10% (drop-out).

This feature is used for equipment protection. It is used in three-phase applications and informs the operator when there is a significant voltage imbalance between the phases of Source 2.

**Possible Cause:**

Incorrect imbalance settings.

**Diagnosis and Repair:**

Contact support channel.

## 7.35 Code 132 – Phase Rotation Failure (Event)

**Logic:**

Source 1 and Source 2 do not have the same phase rotation.

**Description:**

This event is active whenever Source 1 and Source 2 voltages have difference phase sequences. This feature is used to protect against equipment damage. It is only available on Level 2 controls. This feature is required in fire pump applications and is enabled by default.

This feature monitors the phase rotation of the non-connected source in relation to the connected source. When the non-connected source is out of phase rotation with the connected source, transfer is inhibited. This generally occurs on new installations or after storm damage or generator rewiring.

The phase rotation shall only be checked if both sources have acceptable voltage and frequency.

**Possible Causes:**

1. Invalid phase rotation.
2. Distortion caused by customer loads.

**Diagnosis and Repair:**

Contact support channel.

## 7.36 Code 133 – Motor Disconnect (Event)

**Logic:**

Motor disconnect input has been detected by the control.

**Description:**

This event is active whenever the ATS Motor Disconnect input is active. This input causes the controller to enter a non-automatic mode – it does not try to move the transfer switch mechanism.

**Possible Cause:**

Motor disconnect input is in the OFF position.

**Diagnosis and Repair:**

Verify linear motor disconnect switch is in AUTO.

## 7.37 Code 134 – Load Shed (Event)

**Logic:**

The transfer switch was signaled to shed load from the generator.

**Description:**

This event is active whenever the Load Shed input is active or the *nviLoadShedCmd* input is active. Load Shed causes the transfer switch to disconnect from an otherwise available source in order to reduce the load demand on that source. The switch is moved to the Neutral position.

**Possible Causes:**

1. The *Load Shed* relay (optional) was energized because the transfer switch was signaled to shed load from the generator.
2. Connections at J15-15 and J15-16 were energized causing a logic input from the load shed to the control.

**Diagnosis and Repair:**

No further action is required.

## 7.38 Code 135 – Transfer Inhibit (Event)

**Logic:**

The control has received a transfer inhibit command.

**Description:**

This event is active whenever the Transfer Inhibit input is active, or the *nviTransferInhCmd* input is active. Transfer Inhibit is used to prevent the ATS from automatically transferring the load to Source 2.

While the Transfer Inhibit is active, the Not in Auto signal will be turned on.

**Possible Cause:**

(J27-4) TB2-6 (Transfer Inhibit) is receiving a ground signal. Not in auto signal will be turned on.

**Diagnosis and Repair:**

Load transfers can only take place by pressing the override button on the switch panel or disabling the transfer inhibit input.

## 7.39 Code 136 – Retransfer Inhibit (Event)

**Logic:**

Switch has commanded to retransfer back to the preferred source but is inhibited by outside input.

**Description:**

This event is active whenever the Retransfer Inhibit input is active, or the *nviReTransferInhCmd* input is active. Even though the Not-in-Auto light is lit, the transfer switch will function correctly. Transfer Inhibit is used to prevent the ATS from automatically transferring the load back to Source 1.

When this event is active, (J27-1) TB3-53 (Retransfer Inhibit) is receiving a ground signal. Not in auto signal will be turned on.

**Possible Cause:**

(J27-1) TB3-53 (Retransfer Inhibit) is receiving a ground signal. Not in auto signal will be turned on.

**Diagnosis and Repair:**

No further action required.

## 7.40 Code 137 – Bypassed to S1 (Event)

**Logic:**

The Bypass mechanism has been placed into S1 position.

**Description:**

This event is active when operator manually connects the Bypass switch to Source 1. Upon detecting the Bypass Source 1 input is active, the control activates the Not In Auto LED, activates the Not In Auto relay output, and changes the Bypassed Source 1 event status to active.

**Possible Causes:**

1. The handle has moved to the bypass S1 position.
2. The limit switch AB41 has been closed.

**Diagnosis and Repair:**

No further action required.

## 7.41 Code 138 – Bypassed to S2 (Event)

**Logic:**

The bypass mechanism has been placed into S2 position.

**Description:**

This event is active when operator manually connects the Bypass switch to Source 2. Upon detecting the Bypass Source 2 input is active, the control activates the Not In Auto LED, activates the Not In Auto relay output, and changes the Bypassed Source 2 event status to active.

**Possible Causes:**

1. The handle has moved to the bypass S2 position.
2. The limit switch AB33 has been closed.

**Diagnosis and Repair:**

No further Action Required.

---

## 7.42 Code 139 – Not in Auto (Fault)

**Logic:**

The Switch is not in the automatic mode of operation.

**Description:**

1. The Motor Disconnect Switch is Off.
2. The Transfer Inhibit signal is active.
3. The Retransfer Inhibit signal is active.
4. The Load Shed signal is active.
5. The Bypass switch is connected.
6. C1 capacitor is cracked.

**Diagnosis and Repair:**

1. Move Motor Disconnect Switch to Auto.
2. Remove Transfer Inhibit signal.
3. Remove Retransfer Inhibit signal.
4. Remove Load Shed signal.
5. Disconnect bypass switch.
6. Check C1 capacitor.
  - a. Remove C1 capacitor.
  - b. Inspect capacitor for physical damage.
  - c. If possible, test capacitor with a digital multimeter.
  - d. Replace as necessary.

## 7.43 Code 141 – Service Tool (Event)

**Logic:**

The control is connected to the Service Tool via serial link.

**Description:**

This event is active whenever the PC service tool is connected to the controller. The purpose for this event is to provide a chronological service history, which is stored in the ATS.

**Possible Cause:**

The control has received the connect command from the computer.

**Diagnosis and Repair:**

No further action is required.

## 7.44 Code 143 – Sync Enable (Event)

**Logic:**

The control is ready to run the sync check sensor.

**Description:**

This event is only displayed if active synchronicity is enabled. This event becomes active when the control sends a Sync Enable message to a network control generator. In Closed Transition applications with active synchronizing, the controller will use the Sync Enable command instead of the Speed Adjust command. The controller activates the Sync Enable command just before activating the Sync Check Sensor. When the generator control receives the Sync Enable input and it detects the Source-1 bus voltages, the generator control will automatically synchronize its speed and phase to match the Source-1 bus.

**Possible Cause:**

The Sync Enable command has activated the Sync Check Sensor.

**Diagnosis and Repair:**

No Further action required.

## 7.45 Code 144 – Speed Adjust (Event)

**Logic:**

Switch is monitoring frequency of S1 and S2 and communicated to generator to alter speed before retransferring back to the preferred source based upon configured value.

**Description:**

This event is used to send a Speed Adjust message to a network generator control. The controller sends the message and logs the event. This signal causes the genset to increase speed by ½ Hz to sync with the utility. This signal ends when the transfer is complete.

**Possible Causes**

Generator is given speed command to retransfer to utility during close transition operation.

**Diagnosis and Repair:**

No further action required.

## 7.46 Code 145 – Fail to Sync (Event)

**Logic:**

Sources failed to synchronize (voltage, frequency, phase) within a two-minute limit during a transfer.

**Description:**

This event indicates the two power sources have failed to synchronize either voltage, phase or frequency within the hardcoded time limit of 120 seconds.

The event stays active until the Reset/Lamp Test button on the front panel is pressed. The Fail to Sync output stays closed until the Reset button is pressed.

After a Fail to Sync event occurs, another Fail to Sync event may occur or, if set up to do so, the transfer switch may go to open transition. If not set up to go to open transition, a series of Fail to Sync events may repeat until the system synchronizer is adjusted or repaired.

**Possible Causes:**

1. Frequency difference between the two sources is not within 1.0 Hz.
2. Average voltage difference between the two sources is not within 5 – 25 volts (AC).
3. Relative phase angle between the two sources is not within 25° or is moving towards 0°.

**Diagnosis and Repair:**

No further action required.

## 7.47 Code 146 – Sequencer Output 1-8 (Event)

**Logic:**

The transfer switch is performing load (add) sequencing with other switches connected in the network.

**Description:**

The Load Sequencer feature consists of eight programmable timers which can control eight different network devices in a timed sequence. Each Load Sequencer output is an independent Event Announcement, This is necessary for the Network Control Module (NCM) to receive and transmit event changes. When these outputs are active, the transfer switch is typically inhibiting another transfer switch from loading the active source. This allows a gentle loading of a transfer switch when performing a transfer or retransfer sequence. The Event Handler generates an Event Announcement whenever the Load Sequencer outputs (1-8) change state.

**Possible Cause:**

The load sequencer feature has been activated and the switch has received the sequencer signal.

**Diagnosis and Repair:**

No further action is required.

## 7.48 Code 155 – Network Wink (Event)

**Logic:**

Transfer switch was manually given a command to send an identification signal via network to all other nodes that are connected.

**Description:**

The network wink event is active whenever the Network Control Module (NCM) performs a logical write command to the controller. Network wink events are used by network service technicians to identify a particular network device in order to identify it from other devices. The controller responds to an active network wink event by placing a Network Wink message on the digital display.

**Possible Cause:**

Transfer switch was manually given a command to send a network wink.

**Diagnosis and Repair:**

No further action required.

## 7.49 Code 156 – Common Alarm A (Event)

**Logic:**

Source 2 is not available.

**Description:**

When this event is active and the digital relay module is utilized, if Genset A is not available this fault will signal to the transfer switch to execute a time delay engine start (TDES) for Genset B and transfer to that source once it is available. It will “lock out” Genset A until the fault is cleared. This is primarily used in generator to generator applications.

**Possible Causes:**

1. Genset A has a common alarm failure.
2. Digital relay module common alarm input is shorted to battery power.

**Diagnosis and Repair:**

Contact support channel.

## 7.50 Code 157 – Common Alarm B (Event)

**Logic:**

Source 1 is not available.

**Description:**

When this event is active and the digital relay module is utilized, if Genset B is not available this fault will signal to the transfer switch to execute a time delay engine start (TDES) for Genset A and transfer to that source once it is available. It will “lock out” Genset B until the fault is cleared. This is primarily used in generator to generator applications.

**Possible Causes:**

1. Genset B has a common alarm failure.
2. Digital relay module common alarm input is shorted to battery power.



**Diagnosis and Repair:**

Contact support channel.

## 7.51 Code 158 – Loss of Power (Event)

**Logic:**

The constant DC voltage of the controller has fallen below the normal operating point but kept above the basic operation voltage.

**Description:**

If this event is displayed on the front panel, the controller will shut itself down within 5 seconds of the message being displayed.

If this event is listed in the Event History log, it indicates that the control went to sleep after not receiving AC power from either source for 30 seconds.

The controller signals the network card and other devices that the ATS controller is going to shutdown due to lack of power. This signal triggers a time-delay start or other sequences. After these sequences are complete the controller shuts itself off in order to conserve the back-up batteries. The network card responds by not communicating to the controller.

**Possible Cause:**

Transfer switch has voltage input failure causing voltage dip to control.

**Diagnosis and Repair:**

Contact support channel.

## 7.52 Code 159 – TD Stop B (Event)

**Logic:**

Time Delay Stop Event B. The ATS begins timing delay when the load is retransferred to Source A.

**Description:**

This event is active when the controller initiates a time delay before shutting down Generator B after a retransfer. This is done to ensure stability on Source 1 before shutdown.

**Possible Cause:**

ATS retransferred to Source A.

**Diagnosis and Repair:**

No further action required.

---

## 7.53 Code 161 – High Neutral Amps (Event)

**Logic:**

Neutral current exceeded specified current threshold over a predetermined period of time.

**Description:****NOTICE**

**This event is detected only on switches equipped with the Load Monitoring bar graph.**

The control issues a warning when the neutral current exceeds a user specified value between 100% to 150% of the rated current during a specified time period between 10 to 60 seconds.

**Possible Causes:**

1. Current transformers wired incorrectly.
2. Bad current transformers.
3. Current transformer improperly calibrated.

**Diagnosis and Repair:**

Contact support channel.

## 7.54 Code 162 –Preferred Source 1 (Event)

**Logic:**

Source 1 is designated the preferred source.

**Description:**

This event is active when the preferred source variable changes from Source 2 to Source 1.

**Possible Cause:**

The operator selects source 1 as the preferred source.

**Diagnosis and Repair:**

No further action required.

## 7.55 Code 163 –Preferred Source 2 (Event)

**Logic:**

Source 2 is designated the preferred source.

**Description:**

This event is active when the preferred source variable changes from Source 1 to Source 2.

**Possible Cause:**

The operator selects source 2 as the preferred source.

**Diagnosis and Repair:**

No further action required.

## 7.56 Code 164 – Source 1 Stopped (Event)

**Logic:**

Source 1 has been stopped.

**Description:**

After Source 1 has been shut down, this event indicates the genset is no longer running.

**Possible Causes:**

Genset B has been shut down.

**Diagnosis and Repair:**

No further action required.

## 7.57 Code 165 – Source 2 Stopped (Event)

**Logic:**

Source 2 has been stopped.

**Description:**

After Source 2 has been shut down, this event indicates the genset is no longer running.

**Possible Causes:**

Genset A has been shut down.

**Diagnosis and Repair:**

No further action required.

## 7.58 Code 167 – Control Lockout (Event)

**Logic:**

Transfer switch faults out on a “Fail-to-Close” or “Fail-to-Open” during either the transfer or re-transfer.

**Description:**

This event occurs when any of faults listed below occur.

**Possible Causes:**

1. Source 1 fails to open.
2. Source 1 fails to close.
3. Source 2 fails to open.
4. Source 2 fails to close.

**Diagnosis and Repair:**

In all four cases, the control lockout condition can be terminated by pressing to reset button on the front panel. However, it is recommended that the source of the lockout be investigated using InPower.

1. Refer to Fault Code 2397.
2. Refer to Fault Code 2396.
3. Refer to Fault Code 1453.
4. Refer to Fault Code 1452.

## 7.59 Code 168 – Panel Lock (Event)

**Logic:**

Key Switch is in the Panel Lock Position.

**Description:****NOTICE**

**This event will only occur on transfer switches equipped with the optional security key switch.**

This event is active when the key switch is in the Panel Lock position. When the Key Switch is in the Panel Lock position, the front panel Test and Override pushbuttons are disabled and no changes to the setup menus can be made.

**Possible Cause:**

Key Switch is in the Panel Lock position.

**Diagnosis and Repair:**

1. Key Switch is in the Panel Lock position.
  - a. Turn Key Switch to the Program position.

## 7.60 Code 169 – Max Parallel Time Exceeded (Event)

**Logic:**

Maximum Parallel Time has completed a user-defined time period.

**Description:**

At the beginning of a closed transition, a user-defined Maximum Parallel Time Delay is initiated. After the predetermined set time has expired, the original source is removed.

**Possible Cause:**

Transfer switch has exceeded max parallel time trim.

**Diagnosis and Repair:**

No action required.

## 7.61 Code 441 – Low Controller Battery (Event)

**Logic:**

Controller battery has dropped below 5.2 VDC.

**Description:**

Insufficient voltage is supplied to the controller.

**Possible Causes:**

1. No Battery.
2. Battery no longer holds charge.

**Diagnosis and Repair:**

Contact support channel.

## 7.62 Code 597 –Battery Charger Malfunction (Fault)

**Logic:**

The controller monitors the status of the optional battery charger. If the battery charger Fault input is active, this event is active.

**Description:**

For transfer switches that include a genset battery charger, this event signals the controller that the genset battery charger is malfunctioning and may need to be replaced.

This is not a standard factory connection. For more information, contact your dealer or distributor.

The event remains active until the Reset button on the front panel is pressed.

**Possible Causes:**

1. For 277, 380, 416, and 600 VAC chargers - Bad battery charger fuse(s).
2. For 120, 208, and 240 VAC chargers – Tripped circuit breakers.
3. Bad connection at optional relay module.
4. Refer to OEM manual.

**Diagnosis and Repair:**

Contact support channel.

## 7.63 Code 1113 – ATS Fail to Close: Transfer (Fault)

**Logic:**

Transfer switch failed to move in the predetermined time period.

**Description:**

For utility-to-genset applications, this event is active if the transfer switch failed to move from Source 1 to Neutral or Neutral to Source 2 within a preset time limit.

For utility-to-utility and genset-to-genset applications, this event is active if the transfer switch failed to move from the preferred source to the backup source within a preset time limit.

For open transition transfer switches, the controller first verifies the transfer switch moved from Source 1 to Neutral within the time limit defined in the Fail to Open Time Delay. The controller also verifies that the transfer switch moved from Neutral to Source 2 within the time limit defined in the Fail to Close Time Delay.

For closed transition transfer switches, the controller verifies that the ATS retransferred from Source 1 to Source 2 within the time limits.

**Possible Causes:**

1. Transfer switch “Fail to Close Time Limit” setting needs adjustment or is incorrect.
2. No Transfer signal.
3. No Programmed Transition signal.
4. Transfer switch S2 limit switch has failed/improperly adjusted.
5. Faulty limit switch wiring and/or digital board.
6. Linear actuator does not move when energized.
7. Mechanical damage to switch mechanism.

**Diagnosis and Repair:**

Contact support channel.

## 7.64 Code 1114 – ATS Fail to Close: RE-Transfer (Fault)

**Logic:**

The control detects a “Fail to Close” fault whenever the transfer switch does not move within the time interval after the command to transfer to the normal source (S1). A “Fail to Close” fault will be detected if the transfer switch either “Fails to Open” or it “Fails to Close”. The front panel reset button must be pressed to exit this condition.

**Description:**

For utility-to-genset applications, this event is active if the transfer switch failed to move from Source 2 to Neutral or Neutral to Source 1 within a preset time limit.

---

For utility-to-utility and genset-to-genset applications, this event is active if the transfer switch failed to move from the preferred source to the backup source within a preset time limit.

For open transition transfer switches, the controller first verifies the transfer switch moved from Source 2 to Neutral within the time limit defined in the Fail to Open Time Delay. The controller also verifies that the transfer switch moved from Neutral to Source 1 within the time limit defined in the Fail to Close Time Delay.

For closed transition transfer switches, the controller verifies that the ATS retransferred from Source 2 to Source 1 within the time limits.

**Possible Causes:**

1. Transfer switch “Fail to Close Time Limit” setting needs adjustment or is incorrect.
2. No Transfer signal.
3. No Programmed Transition signal.
4. Transfer switch S2 limit switch has failed/improperly adjusted.
5. Faulty limit switch wiring and/or digital board.
6. Linear actuator does not move when energized.
7. Mechanical damage to switch mechanism.

**Diagnosis and Repair:**

Contact support channel.

## 7.65 Code 1121 – ATS Fail to Disconnect (Fault)

**Logic:**

Controller has sense that neither source has opened during a parallel transition.

**Description:**

This event is active when both sources have paralleled, there is a failure to open either power source, and all attempts to automatically separate them within a set period of time have failed. This event applies to only closed transition modes and is needed to trip an external circuit breaker. The event remains active until the Reset button on the front panel is pressed.

**Possible Causes:**

1. Time Delay Fail to disconnect to low.
2. Mechanical fault or damage preventing or slowing switch movement.
3. Limit switches not working or being activated.

**Diagnosis and Repair:**

Contact support channel.

## 7.66 Code 1452 – Fail to Close S2 (Fault)

**Logic:**

Full transition from Source 1 to Source 2 was not established.

**Description:**

While attempting to transfer the load to Source 2, the control was not able to close Source 2 contacts within a certain time interval after the command. A Fail to Close fault will be detected if the transfer switch fails to open or it fails to close. This event is followed by a Control Locked Out event.

**Possible Causes:**

1. Transfer switch “Fail to Close Time Limit” setting needs adjustment or is incorrect.
2. No Transfer signal.
3. No Programmed Transition signal.
4. Switch is jammed or stuck.
5. Limit switches not working or being activated.
6. Linear actuator does not move when energized.

**Diagnosis and Repair:**

Contact support channel.

## 7.67 Code 1453 – Failed to Open S2 (Fault)

**Logic:**

Source 2 did not open during retransfer in allotted time.

**Description:**

While attempting to transfer the load to Source 1, the control was not able to open the Source 2 contacts within the user-defined Fail to Open time limit. This event is followed by a “Control Lock Out” event.

**Possible Causes:**

1. No Transfer signal.
2. Linear actuator does not move when energized.
3. No Programmed Transition signal.
4. Switch is jammed or stuck.
5. Limit switches not working or being activated.

**Diagnosis and Repair:**

Contact support channel.



---

## 7.68 Code 1468 – Network Communications Error (Fault)

**Logic:**

The LonWorks card has generated a network communication error fault.

**Description:**

This event is detected by the Network Communications Module (NCM) and is communicated to the transfer switch controller. This indicates that the device is no longer communicating with other devices on the network. The controller Fault Flash-out subsystem flashes this fault until the fault is reset.

**Possible Causes:**

1. The ATS network card has been disconnected from the other elements in the network.
2. The ATS network card has lost network information.
3. The ATS network card is not commissioned correctly.
4. One of the elements connected to the transfer switch is not communicating correctly.
5. One of the elements connected to the transfer switch is not commissioned correctly.
6. Bad network card.

**Diagnosis and Repair:**

Contact support channel.

## 7.69 Code 2396 – Failed to Close S1 (Fault)

**Logic:**

Full transition from Source 2 to Source 1 was not established.

**Description:**

While attempting to transfer the load to Source 1, the control was not able to close Source 1 contacts within a certain time interval after the command. A Fail to Close fault will be detected if the transfer switch fails to open or it fails to close. This event is followed by a Control Locked Out event.

**Possible Causes:**

1. Transfer switch “Fail to Close Time Limit” setting needs adjustment or is incorrect.
2. No Transfer signal.
3. No Programmed Transition signal.
4. Switch is jammed or stuck.
5. Limit switches not working or being activated.
6. Linear actuator does not move when energized.

**Diagnosis and Repair:**

Contact support channel.

## 7.70 Code 2397 – Fail to Open S1 (Fault)

**Logic:**

Source 1 did not open during transfer in allotted time.

**Description:**

While attempting to transfer the load to Source 1, the control was not able to open the Source 2 contacts within the user-defined Fail to Open time limit. This event is followed by a “Control Lock Out” event.

**Possible Causes:**

1. No Transfer signal.
2. No Programmed Transition signal.
3. Switch is jammed or stuck.
4. Limit switches not working or being activated.
5. Linear actuator does not move when energized.

**Diagnosis and Repair:**

Contact support channel.

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**Rocky  
Mountain**

# Tab #4 Accessories



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# Owner Manual

## Operator/Installation/Service/Parts

Our energy working for you.™



**Power  
Generation**

## Accessory

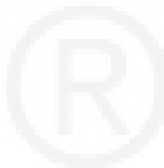
PowerCommand® Universal Annunciator 300-5929

# Safety Precautions

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**⚠ DANGER** *High voltage is deadly. Installation and service of the network annunciator involves working with high voltage equipment. Installation and service must be performed by trained and experienced personnel working with such equipment. Disconnect the utility line from the transfer switch and disconnect power from the battery charger, day tank, and any other power equipment where connections are to be made.*

**⚠ WARNING** *Accidental starting of the generator set while working on it can cause severe injury or death. Disconnect the battery cables to prevent accidental starting. Always disconnect the negative (-) cable first and connect it last to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while connecting or disconnecting the positive (+) cable. Arcing can ignite explosive hydrogen gas given off by the battery and cause severe injury. Ventilate the battery compartment before removing cables.*





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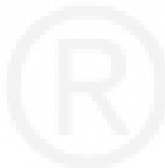
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# Introduction

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## ABOUT THIS MANUAL

This manual provides information for operating, installing, selecting customer options, and troubleshooting the universal annunciator control. A parts list is also included for all available service parts. Study this manual carefully and observe all warnings and cautions. Installing the control properly will contribute to better performance and safer operation.

## SOFTWARE VERSIONS

Since its initial release, the universal annunciator's software has been upgraded. The upgrades have included changed features and the ability of the annunciator to be connected to additional devices. Before connecting to a device, always make sure your annunciator includes the appropriate software. Below are some things that need to be considered because of changes in software.

- Starting with version 1.06, the predefined configuration factory defaults are set to the parameters in the NFPA 110 table. The factory defaults for earlier versions of software are set to the parameters in the Legacy NFPA 110 table. For more information, see pages 19 and 20.
- Starting with version 2.00, universal annunciator communication is available using either a PCCNet network or a Modbus network. Only the PCCNet network was available in earlier versions.

- When connected to a PCC2100, then PCC2100 version 2.5 or greater is required to use the universal annunciator.

**NOTE:** Use InPower to view the software version of your annunciator.

## HOW TO OBTAIN SERVICE

When the universal annunciator requires servicing, contact the nearest dealer or distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

If you are unable to locate a dealer or distributor, consult the yellow Pages. Typically, our distributors are listed under:

Generators-Electric,  
Engines-Gasoline or Engines-Diesel, or  
Recreational Vehicles-Equipment,  
Parts and Service.

For the name of your local Cummins Power Generation distributor in the United States or Canada, call 1-800-888-6626 (this automated service utilizes touch-tone phones only).

For outside North America, call Cummins Power Generation, 1-763-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Cummins Power Generation using the fax number 1-763-528-7229.



***Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and/or mechanical service.***



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# Description

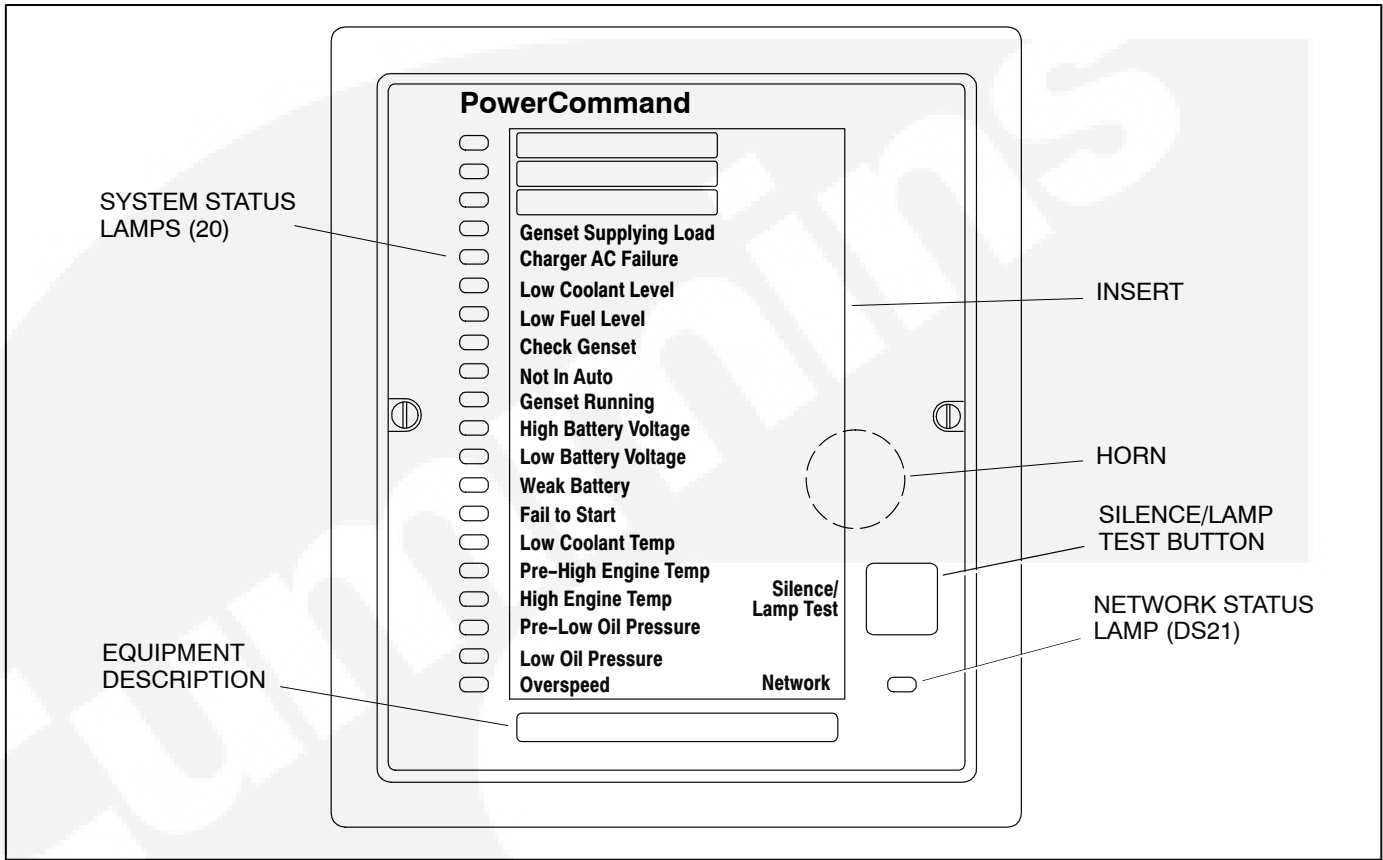


FIGURE 1. ANNUNCIATOR PANEL

## GENERAL

The universal annunciator (see Figure 1) provides lamps and a horn to annunciate the operating status and fault conditions of an emergency power system. It is designed for connection to either a 12 VDC or a 24 VDC control system. It can be configured to be either a positive or negative signal device.

This annunciator can be used to replace legacy annunciators 300-4510 ANN (negative signal) and 300-4511 ANP (positive signal).

Two versions of the universal annunciator are available.

- 300-5929-01 = Panel Mounted
- 300-5929-02 = Panel with Enclosure

## NETWORK TYPES

The universal annunciator can communicate using either a PCCNet or a Modbus network. The func-

tionality differs, depending upon which network is being used.

The Network LED (DS21) is not configurable and does not activate the horn. With a Modbus network, the Network LED is used as a Modbus activity LED.

## PCCNet Network

When connected to a PCCNet, multiple devices can broadcast their NFPA 110 status. The annunciator monitors broadcasts and ORs together all sources along with its discrete inputs and displays the OR's status on its 20 system status LEDs. When each device on the PCCNet network broadcasts its NFPA110 status logical, it will only activate a bit if the device is the source of that status. The annunciator does the same thing. It only broadcasts the status of its direct wired inputs. The annunciator will not OR together all sources and send the information to other devices.

When the annunciator powers up, the network LED is off. If a network device is not found (such as with Legacy applications), it remains off.

When the annunciator starts to receive status information from one or more devices, it turns green. The annunciator keeps track of the number of devices from which it has received status information. If six seconds elapses without receiving status information from each device, the network LED turns red. If the device count goes back to the previous high value, the network LED changes from red back to green.

### **Modbus Network**

When connected to a Modbus network, the annunciator acts as a Modbus slave. The Modbus master must request updates from the annunciator. All communications with the annunciator are done via request/response. The annunciator does not initiate any communications.

A single Modbus master can send status data to up to four annunciators on a single Modbus network. Each annunciator ORs together the status data with its discrete inputs and displays the status on its 20 LEDs. When the Modbus master reads the annunciator status, it can read either the status of the direct wired inputs or the status of the LEDs.

When the annunciator powers up, it turns off the network LED on the front panel. When there is Modbus network activity, the network LED (DS21) on the front panel turns green (or stays green). After ten seconds of no network activity, the LED turns off.

If Modbus data has been received and the ten-second timer has expired or the annunciator has re-

ceived bad data, then the network LED turns red and the active system status LEDs turn off. If this occurs, the system status LEDs with configured audible alarms will display a quick flash until communications are reestablished and the network LED becomes active again or the Silence button is pressed. If the network LED is red and data is received, then the network LED will again turn green and the ten-second timer starts. The updated status is then displayed by the system status LEDs.

### **Modbus Communications**

Before Modbus can be used for communications, the universal annunciator must be set up for Modbus communications by selecting the Modbus NFPA 110 configuration table. For more information, see “Annunciator Configuration” on page 18.

With Modbus communications, there is a Remote Terminal Unit (RTU) two-wire RS-485 master/slave multi-drop network configuration, where the annunciator is defined as the slave.

Port communications, by default, occur at a baud rate of 19,200 baud and even parity. The baud rate and parity are configurable via Modbus registers.

A PLC can be the master device in the Modbus network. The Modbus node address is configurable and is set to node 1 by default.

A list of available annunciator registers is included at the back of this manual (see “Modbus Register Table” on page 33).

The controller is designed to respond within 100 ms of a request for information from the master.



## OPERATION

- Table 1 lists the conditions monitored by the annunciator. The status lamps always announce the present state of each condition.
- In PCCNet mode, the annunciator broadcasts information a minimum of every five seconds and whenever a change occurs.
- Press the Silence/Lamp Test button to silence the horn, if activated. Several annunciators serving one emergency power system can be interconnected so that all the horns can be silenced from any location. Subsequent faults will cause the horn to sound again.
- All indicator lamps should light (turn green) when you press the Silence/Lamp Test button. When you press and hold the Silence/Lamp Test button, all indicator lamps will cycle through the colors (green, amber, red) and then display the current configuration. When the button is released, the current status of just the hard-wired inputs are displayed for one second.
- Pressing the Silence/Lamp Test button does not reset the switch or sensor that is providing the fault signal. The lamp for the associated fault will continue to remain in the active condition (solid or flashing) until the fault is corrected. After correcting the fault condition, the annunciator lamp goes out.

**NOTE:** If a lamp is configured with the Invert Hardware Active Signals function, the color and flash characteristics are displayed during normal operation and the lamp goes out during the active condition.

- When the annunciator powers up, it turns the Network lamp off. If it never finds another network device (as with legacy applications), it remains off. When communications with another device are established or re-established, the Network lamp turns green. If communications with a device broadcasting annunciator data are lost for 30 seconds (PCCNet) or 10 seconds (Modbus), the Network lamp turns red; the horn will not sound.

- With legacy annunciator installations, normal status could be announced with Normal Utility Power and Normal Battery Voltage lamps. When replacing a legacy annunciator with this annunciator, this can be accomplished either by using the Check Genset and Weak Battery inputs or by using one of the Customer Fault inputs for Normal Utility Power.

## EVENT PROCESSING

The 20 status lamps always announce the present state of each event. Unless a lamp is configured to invert its hard-wired inputs, the lamp displays its configured color and flash characteristics when the event occurs. Lamps that are configured to invert hard-wired inputs display their color and flash characteristics during normal operation.

### Alarm Processing

An audible alarm sounds anytime an event that is configured as audible becomes active. An alarm can be deactivated by:

- Pressing the Silence/Lamp Test pushbutton
- Receiving a silence command via the digital input
- Receiving a silence command via the PCCNet network
- Receiving a silence command via the Modbus network

If another audible alarm event occurs while a silenced lamp is active, the alarm again sounds.

Because the alarm remains active until the condition is corrected (the event becomes inactive), the lamp normally continues to display its color and flash characteristics after the Silence/Lamp Test pushbutton is pressed. However, if a lamp is configured as audible, the event occurs, and then it becomes inactive before the Silence/Lamp Test pushbutton is pressed, the alarm will sound but the lamp will not continue to flash its configured color and flash characteristics. Instead, it will display a quick blip (0.2 seconds On and 1.8 seconds Off).

**TABLE 1. ANNUNCIATOR CONDITIONS MONITORED**

STANDARD LEGEND	CONDITION INDICATED	STATUS LAMP	
		NEW INSTALLATION	LEGACY REPLACEMENT*
Customer Fault 1	Customer selected fault condition	DS1	DS18
Customer Fault 2	Customer selected fault condition	DS2	DS19
Customer Fault 3	Customer selected fault condition	DS3	DS20
Genset Supplying Load	Genset is supplying the load	DS4	DS6
Charger AC Failure	Battery charger is signaling a failure	DS5	DS15
Low Coolant Level	Coolant level below preset minimum	DS6	DS17
Low Fuel Level	Fuel level below preset minimum	DS7	DS16
Check Genset	Use InPower or the genset keypad to check the genset for fault conditions	DS8	NA
Not in Auto	Switch on the control is in the Not in Auto position. The genset will not start automatically.	DS9	DS14
Genset Running	Generator has output voltage	DS10	DS4
High Battery Voltage**	Battery voltage too high (overcharging)	DS11	DS1
Low Battery Voltage**	Battery voltage too low (poor battery or charger failure)	DS12	DS2
Weak Battery	Genset battery is weak	DS13	NA
Fail to Start	Engine fails to start after full cranking cycle (overcrank)	DS14	DS13
Low Coolant Temp	Engine coolant heater has malfunctioned	DS15	DS11
Pre-High Engine Temp	Engine coolant approaching maximum temp.	DS16	DS9
High Engine Temp	Genset has shut down due to high coolant temp.	DS17	DS10
Pre-Low Oil Pressure	Oil pressure approaching minimum	DS18	DS7
Low Oil Pressure	Genset has shut down due to low oil pressure	DS19	DS8
Overspeed	Engine has shut down due to overspeed	DS20	DS12
Normal Battery Voltage	Battery Voltage OK	NA	DS3
Normal Utility Power	Utility power supplying the load	NA	DS5
<p>* "Legacy Replacement" refers to replacing 300–4510 ANN negative signal and 300–4511 ANP positive signal annunciators with Universal Annunciator 300–5929.</p> <p>** Battery Voltage Specification (The setting must be low or high for a minimum of five seconds):                      Low Battery Voltage Setting: <math>12 \pm 0.5</math> VDC for 12-volt system; <math>24 \pm 1</math> VDC for 24-volt system                      High Battery Voltage Setting: <math>16 \pm 0.5</math> VDC for 12-volt system; <math>32 \pm 1</math> VDC for 24-volt system</p> <p>Switch Inputs:                      Positive Sense Mode: Input impedance is 1.82 Kohms to ground; maximum input voltage = 31 VDC.                      Negative Sense Mode: Input impedance is 1.82 Kohms to Bat+; inputs are at Bat+ level when open.                      Sink/Source current threshold for detection: 150 uA minimum, 3 mA maximum.                      Maximum allowable sink/source current: 20mA.                      Power Supply should be between 6.5 VDC and 31 VDC.</p>			



# Installation

## GENERAL INFORMATION

A block diagram of a typical installation is shown in Figure 2. The installation shows a typical PCCNet network that includes a genset that is connected to four automatic transfer switches (ATs) and a battery charger. In this example, the annunciator has inputs from both the PCCNet network and from hard-wired inputs.

### Network Considerations

The total network length cannot exceed 4000 feet (1219 meters). Depending on the installation, either a cable with a single twisted pair or two twisted pairs can be used. The following are recommended, but are not mandatory: Belden 9729 or equivalent (two pair of stranded 24 AWG (or larger) twisted pair cable with shield). Unshielded cable may not provide the maximum distance in a noisy environment. Care must be taken when selecting the appropriate cable.

**In order to meet NFPA 37 requirements, stranded copper cable must be used.**

**The network cable must be used only for transmitting network data and for installations with remote isolated power supplies to provide common logic reference. The second twisted pair is meant only to be used for a common logic reference.** It cannot be used to provide power to the annunciator boards. Power to the annunciator must be provided via TB1-16 and one of the TB1 GND connections.

J2-1 can be interconnected to provide a common logic reference when applicable. J2-1 can be used to interconnect two controls where one of the controls uses a floating DC Power Supply not connected to Earth ground and the other is connected to Earth ground (see Figure 3). Otherwise, using J2-1 can induce a ground loop.

If a single power source (see Figure 4) is used, then care must be taken to make sure that at least mini-

mal voltage is supplied to all boards by taking into consideration the wire gauge, current used, and distance traveled. A single power source should be considered for only a small number of controllers. Otherwise, a separate floating power supply must be used.

J2-3 and J2-4 is a twisted pair and must be interconnected between all controllers on the network to transmit network data.

J2-2 and J2-5 should not be connected to the network. J2-2 is for factory use only.

Each cable shield or interconnected cable shield must be connected to GND at only one point to prevent ground loops.

INPUT PIN	DESCRIPTION
TB1-15	GND
TB1-16	BATT In
TB1-17	GND
TB1-18	GND
J2-1	GND
J2-2	Factory Use Only
J2-3	RS-484 Data A
J2-4	RS-485 Data B
J2-5	No Connection

Although a typical network installation includes only one annunciator, additional annunciators can be installed. The Network Configuration Address function can be used to configure each annunciator with one of four different addresses. This feature allows annunciators to display different network information, depending on the address assigned. For more information, see page 22.

When two or more annunciators serve the same emergency power system, all of the terminals marked TB1-10 (new annunciator installations) or TB1-20 (legacy annunciator replacement installations) must be interconnected so that the horns can all be silenced from any location.

## ROUTING OF CABLES

Communication over stranded unshielded twisted pair (UTP) could be distorted by external sources of electromagnetic interference (EMI), especially if the conductors are physically degraded in any way. To avoid or minimize this interference, observe the following guidelines.\*

**⚠ CAUTION** *Electromagnetic interference (EMI) can cause communication signal distortion, which can cause network failure and unintended equipment operation. Read and follow these wiring guidelines.*

Observe all local wiring codes. Refer to the NEC (NFPA70) section on *Wiring Methods and Materials* for general wiring methods and procedures.

**Routing:** Whenever possible, cabling should be installed over corridor areas or along lines that are parallel to the contours of buildings. All deviations from straight runs should be made at right angles. Keep wire away from sharp, abrasive, and hot surfaces.

**Separation from sources of EMI:** All cabling should be installed in such a way as to comply with the minimum separations from AC power sources.

In general, communications wiring should not be located in spaces that are shared with electrical panels, transformers, or other high voltage equipment.

**Tension:** All cabling should be free from tension at both ends, as well as over the length of each run.

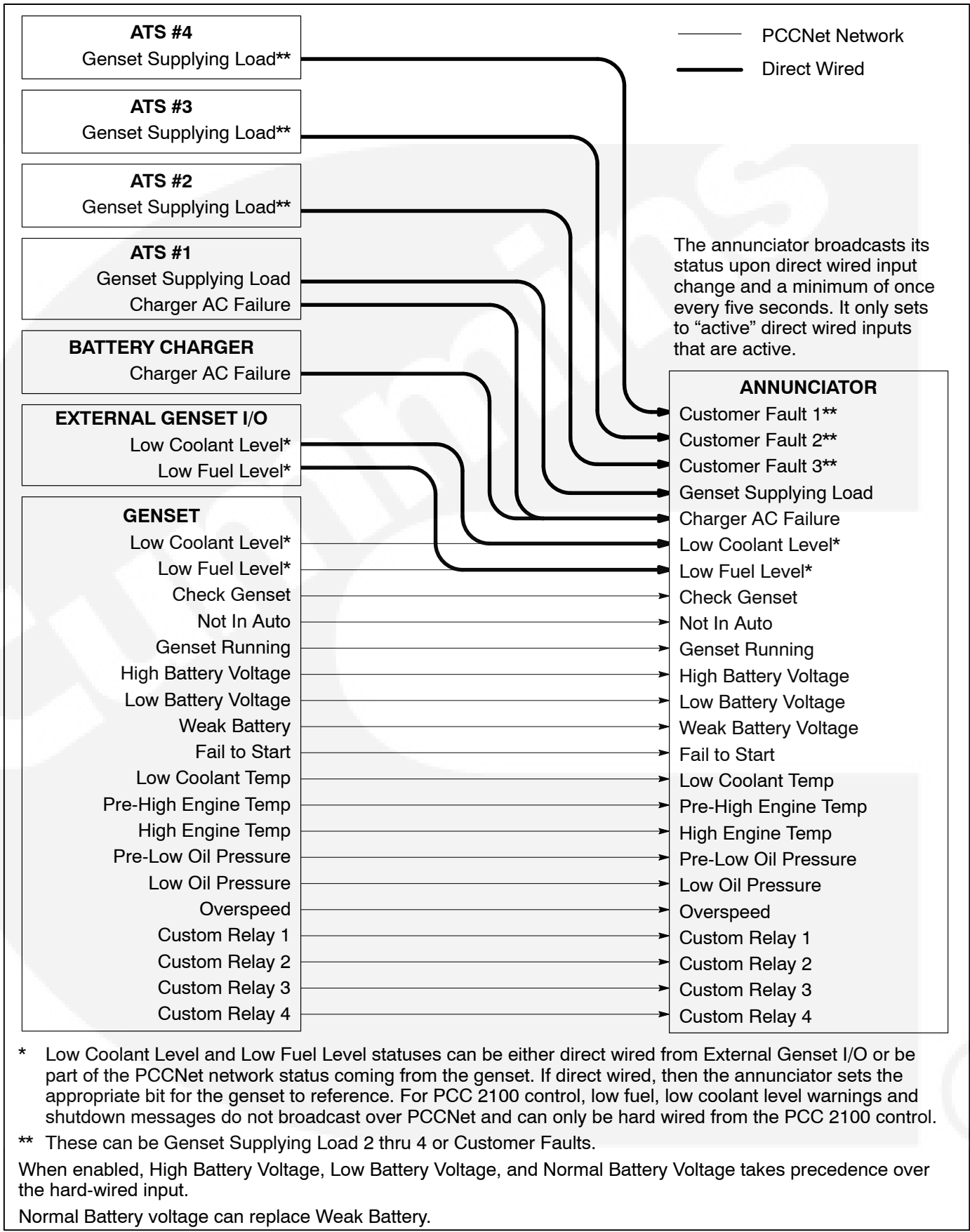
**Stranded Twisted pairs:** All terminations should be made in such a way as to **minimize the extent to which each stranded twisted pair is unraveled at the point of its physical termination**. Allow no more than 0.5 inch (13 mm) of exposed untwisted pairs.

**Cable bends:** Cable bends, or radii, should be no less than eight times the cable diameter.

**Harsh, hazardous, or corrosive environments:** Communications wiring should not be installed where vapors, fumes, corrosives, dusts, or other industrial byproducts are present without taking appropriate precautions to protect the cables. Installers and cabling manufacturers of the materials involved must be consulted in all such cases.

**Grounding and bonding:** When shielded cables are used, all applicable regulations for grounding and bonding as defined by local building codes for electrical materials must be strictly adhered to. In some cases, qualified installers or manufacturers will make related recommendations in the interest of human safety or mechanical protection of installed cables (e.g., shielding against rodents).





**FIGURE 2. TYPICAL ANNUNCIATOR INSTALLATION (PCCNET NETWORK)**

When multiple controllers are remotely located then the common logic reference between the controls can be provided by the second twisted pair wires in the network cable. The remote power supplies MUST be floating power supplies.

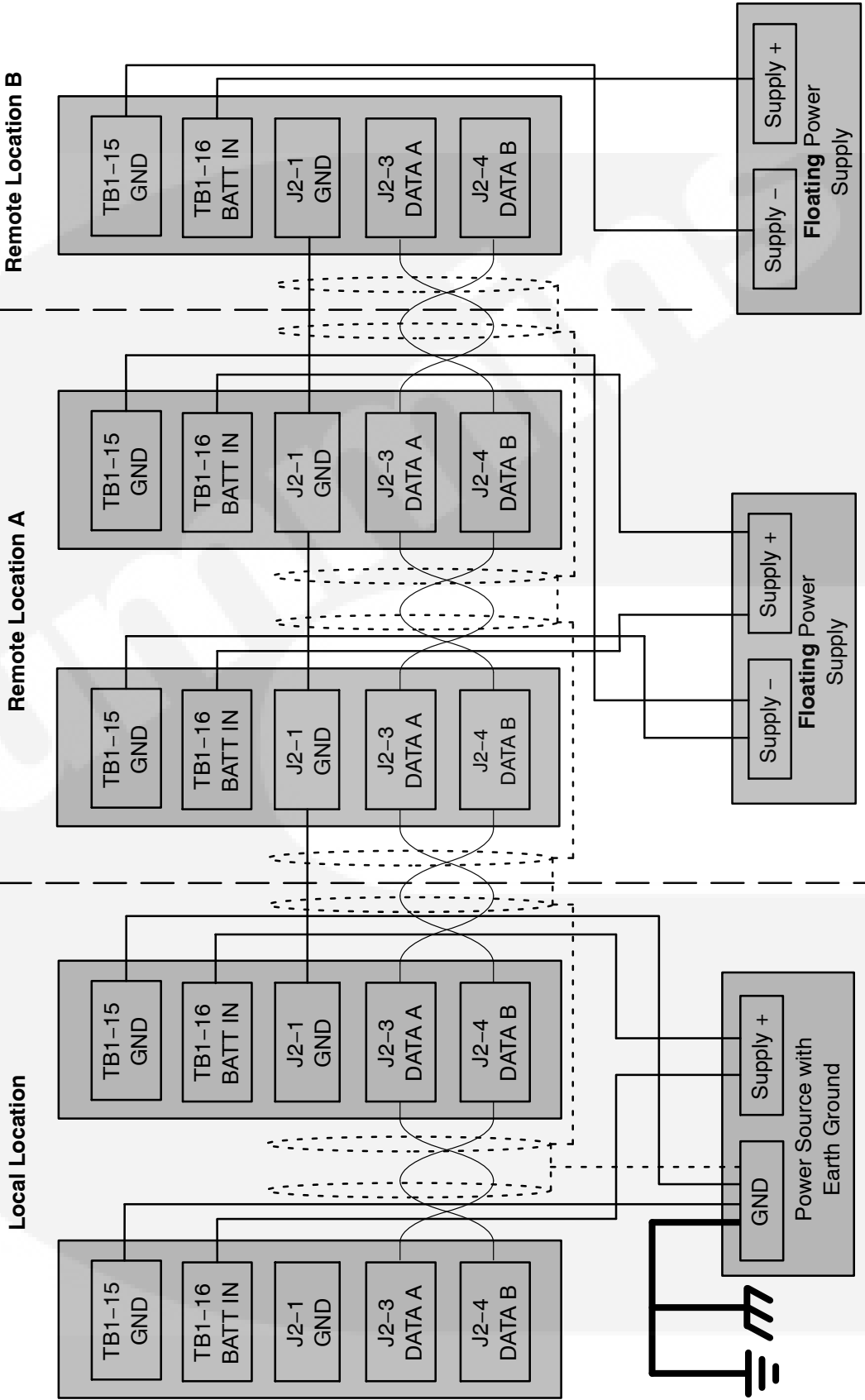


FIGURE 3. MULTIPLE REMOTE CONTROLLERS WIRING DIAGRAM

When a limited number of controllers are remotely located then the common logic reference between the controls and the power source can be provided by a pair of heavy gauge wires.

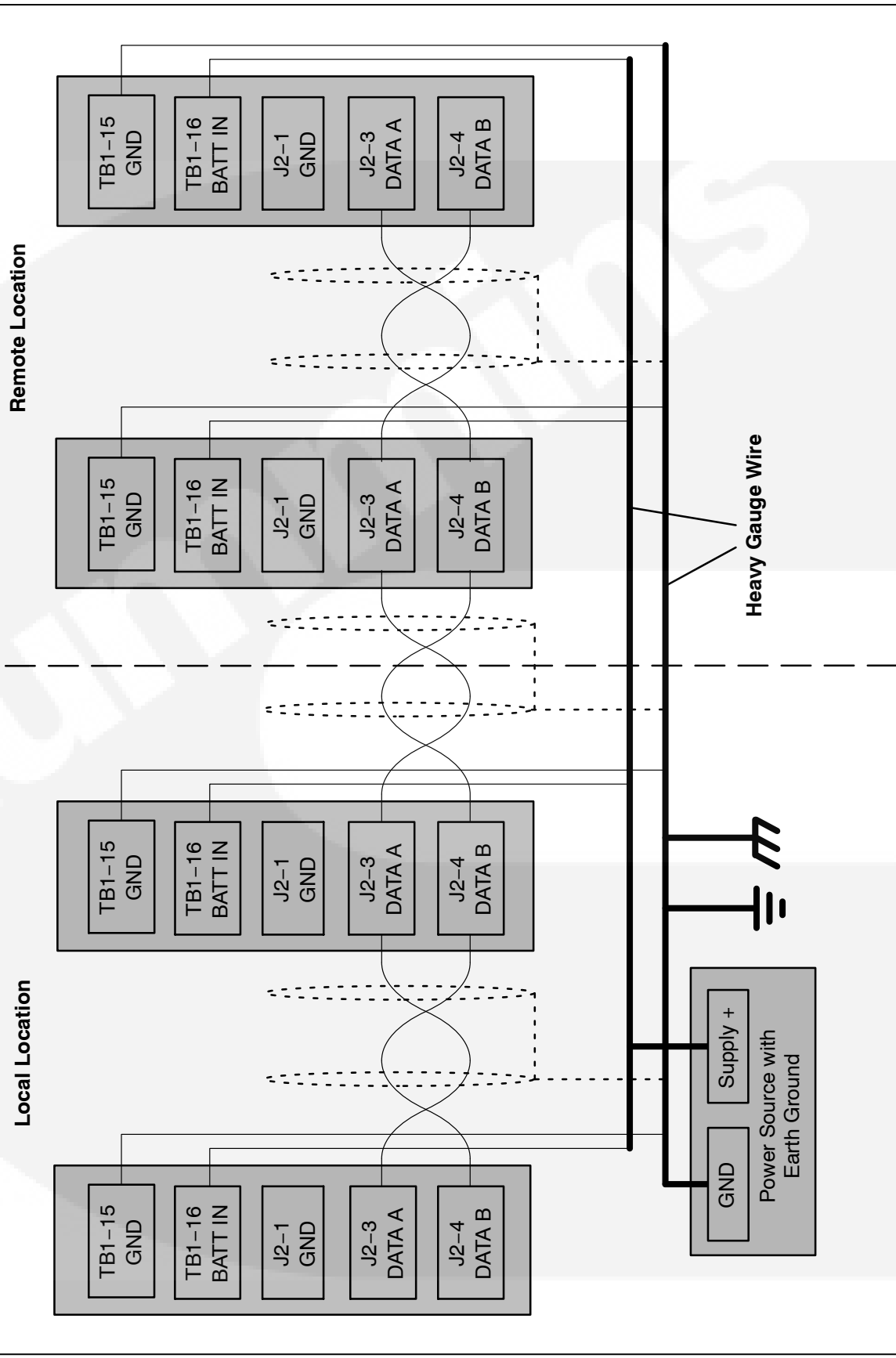


FIGURE 4. MULTIPLE REMOTE CONTROLLERS WITH ONE POWER SOURCE WIRING DIAGRAM

## Custom Relays

The annunciator can control four custom (N.O.) relays that can be used as custom outputs that are controlled by external devices.

For example, when a specified event becomes active, a message can be sent by the external device (for example, a PCC1301 control) to the annunciator to turn the relay on or off. Only one event per relay is allowed. Refer to your genset Service Manual for information on how to set up the genset controller to control the relays.

The rating for the custom relays is 0.2 amps @ 125 VAC, 1A @ 30 VDC.

Wiring for these relays is done via the TB3 connector (see Figure 6) — TB3-1 to TB3-2 for relay 1, TB3-3 to TB3-4 for relay 2, etc.

CONNECTION	DESCRIPTION
TB3-1	Custom Relay 1, Contact A
TB3-2	Custom Relay 1, Contact B
TB3-3	Custom Relay 2, Contact A
TB3-4	Custom Relay 2, Contact B
TB3-5	Custom Relay 3, Contact A
TB3-6	Custom Relay 3, Contact B
TB3-7	Custom Relay 4, Contact A
TB3-8	Custom Relay 4, Contact B

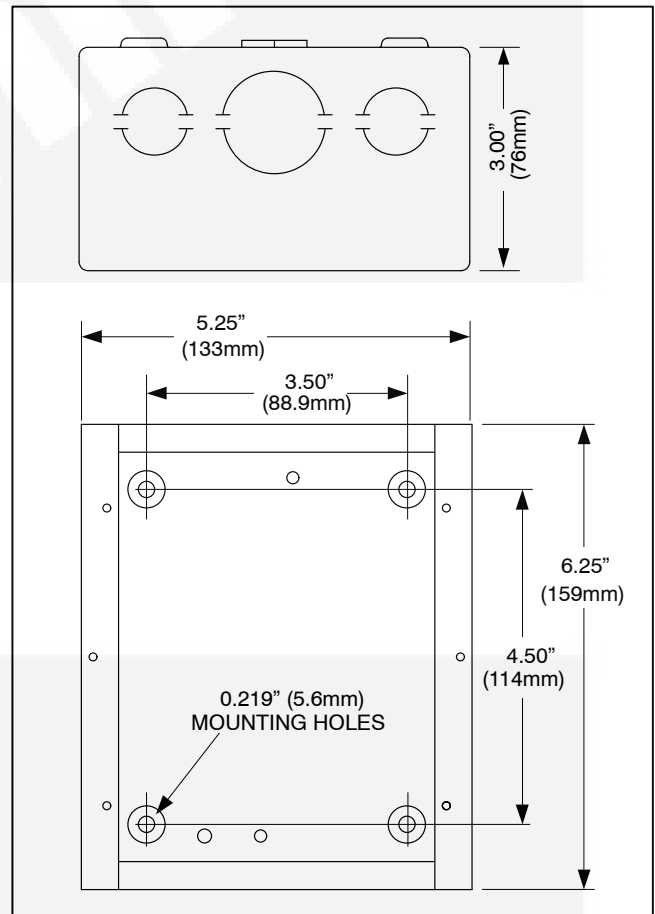
## ANNUNCIATOR INSTALLATION

Select a location for mounting the annunciator that is **accessible**. Make sure all components can be **easily removed for service**. The annunciator should be mounted in an environment that has a temperature range of  $-40^{\circ}$  to  $176^{\circ}$ F ( $-40^{\circ}$  to  $80^{\circ}$ C) and relative humidity between 10 and 95%. The power supply input voltage must be from 6 to 31 VDC (reverse protected).

1. Remove the annunciator panel from the control box.
2. Locate the desired location on the wall and use the box as a template to mark the required holes (see Figure 5). Be sure to check for wiring, plumbing, and gas lines behind the wall before cutting or drilling.

**⚠ WARNING** *Drilling into utility lines can cause severe personal injury or death. Make sure no wires, plumbing, or gas lines run behind the mounting area before drilling the mounting holes.*

3. Drill the mounting holes and mount the box securely to the wall. For flush mounting, the front edges of the box should be flush with the surface of the wall.
4. Remove knock-outs, as needed for wiring, from the top and/or bottom of the control box.



**FIGURE 5. ANNUNCIATOR CONTROL BOX FOOTPRINT**

**⚠ DANGER** *High voltage is deadly. Installation and service of the network annunciator involves working with high voltage equipment. Installation and service must be performed by trained and experienced personnel working with such equipment. Disconnect the utility line from the transfer switch and disconnect power from the battery charger, day tank, and any other power equipment where connections are to be made.*

**⚠WARNING** *Accidental starting of the generator set while working on it can cause severe injury or death. Disconnect the battery cables to prevent accidental starting. Always disconnect the negative (-) cable first and connect it last to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while connecting or disconnecting the positive (+) cable. Arcing can ignite explosive hydrogen gas given off by the battery and cause severe injury. Ventilate the battery compartment before removing cables.*

5. Before making any wiring connections, disconnect the utility line from the transfer switch. Make sure the genset cannot start by pressing the RUN/STOP switch to STOP and by disconnecting the starting battery (negative [-] battery cable first). Disconnect the power to the battery charger.
6. Route the wiring from the annunciator to the genset, transfer switch, and battery charger (see Table 2). Do not route wiring in the same conduit as AC wiring. Allow pigtails of at least 12 inches (304 mm) at each end for connections.
7. Connect the auxiliary switches to the transfer switch, the battery charger malfunction switch, and the customer faults to GROUND for negative signal annunciators and to B+ for positive signal annunciators (see Table 2).
8. When two or more annunciators serve the same emergency power system, interconnect all the terminals marked TB1-10 (new annunciator installations) or TB1-20 (legacy annunciator replacement installations) so that the horns can all be silenced from any location. The connections are made to TB1-10 on the new annunciators.

**NOTE:** Pressing the Silence/Lamp Test button silences all horns of the connected annunciators but will only test the lamps of the annunciator whose button is pressed.

9. Apply power to the annunciator. When power is applied to the annunciator,
  - a. Lamps DS1 thru DS21 cycle on and off, displaying the available colors (green, amber, red).
  - b. LED N3 on the back of the control board (see Figure 6) starts flashing (green – one flash per second), indicating that the annunciator is in Running Mode.
  - c. When the annunciator establishes communications with another device, the Network lamp (DS21) turns green.
10. Check the lamp characteristics on the annunciator control board and, if necessary, change the configuration to meet the needs of your installation (see “Annunciator Configuration” on page 18). Make sure that the annunciator is properly set up for the correct negative or positive input, reporting battery voltage, and predefined configuration table.
11. Press the Silence/Lamp Test button. All indicator lamps should light (turn green). Press and hold the Silence/Lamp Test button to cycle through the colors (green, amber, red) and then the current configuration is displayed.
12. Secure the annunciator to the control box with the screws provided with the annunciator.
13. Reconnect the utility line to the transfer switch, reconnect the battery to the generator set (negative [-] battery cable last), reconnect the battery charger, and return the generator set to automatic standby.

## REPLACING LEGACY ANNUNCIATORS

The following describes how to replace a 300–4510 ANN negative signal or 300–4511 ANP positive signal annunciator with this annunciator.

**⚠ DANGER** *High voltage is deadly. Installation and service of the network annunciator involves working with high voltage equipment. Installation and service must be performed by trained and experienced personnel working with such equipment. Disconnect the utility line from the transfer switch and disconnect power from the battery charger, day tank, and any other power equipment where connections are to be made.*

**⚠ WARNING** *Accidental starting of the generator set while working on it can cause severe injury or death. Disconnect the battery cables to prevent accidental starting. Always disconnect the negative (-) cable first and connect it last to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while connecting or disconnecting the positive (+) cable. Arcing can ignite explosive hydrogen gas given off by the battery and cause severe injury. Ventilate the battery compartment before removing cables.*

1. Disconnect the utility line from the transfer switch. Make sure the genset cannot start by pressing the RUN/STOP switch to STOP and by disconnecting the starting battery (negative [-] battery cable first). Disconnect the power to the battery charger.
2. Remove the existing annunciator panel from the control box. Tag and remove the wire connections. Examine the wires for damage and replace, if necessary.
3. Remove the new annunciator panel from the control box.
4. If necessary, replace the existing control box with the control box included in this kit and remove knock-outs, as needed for wiring, from the top and/or bottom of the control box.
5. Connect the existing wires to the new annunciator. Refer to Table 2 on specifics on wiring the annunciator. The battery is connected to the TB1-16 terminal in both 12 volt and 24 volt systems. If battery check is not desired, the three lamps can be used for custom indications, using TB2-4, TB2-5, and TB2-6.
6. Modify the insert card to match the installation. Text can be added to the three blank boxes located at the top of the insert. If the predefined legend is not desired, text can be covered with white tape and the desired text written on the tape. In addition, the back of the insert has all blank spaces for writing text. In a legacy annunciator replacement, the modifications shown in Table 3 are typical.
7. Apply power to the annunciator. When power is applied to the annunciator,
  - a. Lamps DS1 thru DS21 cycle on and off, displaying the available colors (green, amber, red).
  - b. LED N3 on the back of the control board (see Figure 6) starts flashing (green – one flash per second), indicating that the annunciator is in Running Mode.
8. Press the Silence/Lamp Test button briefly. All indicator lamps should light (turn green).
9. Check the lamp characteristics on the annunciator control board and, if necessary, change the configuration to meet the needs of your installation (see “Annunciator Configuration” on page 18). Make sure that the annunciator is properly set up for the correct negative or positive input, reporting battery voltage, and predefined configuration table. Standard default configurations for the lamp and horn settings are set at the factory.
10. Secure the annunciator to the control box with the screws provided with the annunciator.
11. Reconnect the utility line to the transfer switch, reconnect the battery to the generator set (negative [-] battery cable last), reconnect the battery charger, and return the generator set to automatic standby.



**TABLE 2. LEGACY INTERCONNECTIONS**

<b>LEGACY ANNUNCIATOR CONNECTIONS</b>	<b>DESCRIPTION</b>	<b>NEW ANNUNCIATOR CONNECTIONS</b>
TB1-1 (12 VDC) TB1-2 (24 VDC)	BATT	TB1-16
TB1-3	GND	TB1-15
TB1-4	Genset Running	TB2-3
TB1-5	Normal Utility or Check Genset	TB1-8
TB1-6	Genset Supplying Load	TB1-4
TB1-7	Pre-Low Oil Pressure	TB2-11
TB1-8	Low Oil Pressure	TB2-12
TB1-9	Pre-High Engine Temp	TB2-9
TB1-10	High Engine Temp	TB2-10
TB1-11	Low Coolant Temp	TB2-8
TB1-12	Overspeed	TB2-13
TB1-13	Fail to Start	TB2-7
TB1-14	Not In Auto	TB2-2
TB1-15	Charger AC Failure	TB1-5
TB1-16	Low Fuel Level	TB1-7
TB1-17	Customer Fault 1	TB1-1
TB1-18	GND	TB2-1
TB1-19	GND	TB2-14
TB1-20	Silence Lamp Test (N.O.)	TB1-10
TB1-21	GND	TB1-9
TB1-22	Remote Alarm (N.O.)	TB1-13
TB1-23	GND	TB1-12
TB1-24	GND	TB1-17
TB2-1	High Battery Voltage or Customer Indication 1	TB2-4
TB2-2	Low Battery Voltage or Customer Indication 2	TB2-5
TB2-3	Normal Battery Voltage or Customer Indication 3 or Weak Battery	TB2-6
TB2-4	Low Coolant Level	TB1-6
TB2-5	Customer Fault 2	TB1-2
TB2-6	Customer Fault 3	TB1-3
TB2-7	Silence Lamp Test (N.C.)	TB1-11
TB2-8	Remote Alarm (N.C.)	TB1-14

**TABLE 3. INSERT MODIFICATIONS**

<b>LAMP</b>	<b>INSERT CARD MODIFICATION</b>
1	Customer Fault 1 text can be written in the blank space provided.
2	Customer Fault 2 text can be written in the blank space provided.
3	Customer Fault 3 text can be written in the blank space provided.
8	A "Normal Utility Power" sticky label can be placed over "Check Genset" or white tape can be used to cover "Check Genset" with "Normal Utility Power" written on the tape.
11	A blank sticky label or white tape can be used to cover "High Battery Voltage" and Custom Indication 1 text can be written on the label/tape.
12	A blank sticky label or white tape can be used to cover "Low Battery Voltage" and Custom Indication 2 text can be written on the label/tape.
13	A "Normal Battery Voltage" sticky label can be placed over "Weak Battery" or white tape can be used to cover "Weak Battery" with "Normal Battery Voltage" written on the tape.
Text for all other lamps should not need to be changed.	

# Customer Options

## OPTIONS

The annunciator with version 1.06 can only be configured via the three push buttons on the back of the annunciator.

The annunciator with version 2.00 or higher can be configured by:

1. Using the three push buttons on the back of the annunciator,
  2. By PCCNet communications,
- or
- By Modbus communications.

When configuring via PCCNet or Modbus, the external device must have special code for performing this function.

Annunciator functions can be modified to meet the needs of your installation. Individual status lamp colors (red, green, or amber), flash, and alarm characteristics can be changed. The S1 button on the control board (see Figure 6) can be used to enter the configuration mode and make adjustments.

Customer indications and customer faults can also be added.

The annunciator also has connections for Remote Silence/Lamp Test and Remote Alarm.

The following subsections describe how to modify and utilize optional features.

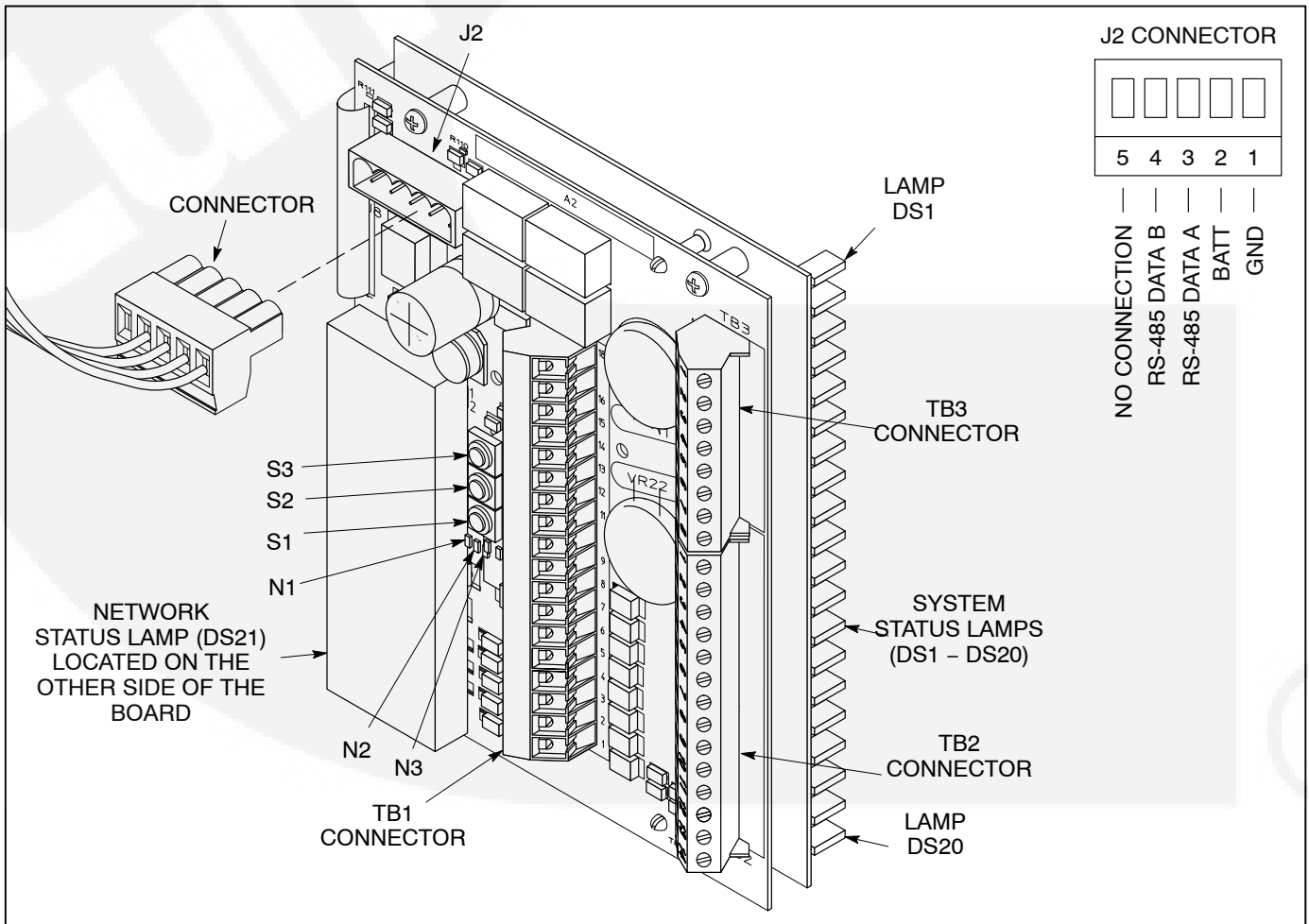


FIGURE 6. ANNUNCIATOR CONTROL BUTTONS, STATUS LAMPS, AND CONNECTORS

## ANNUNCIATOR CONFIGURATION

During normal operation, the annunciator is in Running Mode. When in Running Mode, only the N3 LED is flashing (green). Configuration Mode must be entered to modify or check lamp characteristics and annunciator settings. When in Configuration Mode, the three LEDs on the back panel are used to display which configuration function is presently selected. One or more of the front panel system status lamps (DS1–DS20) are used to display the configurations available with each function.

Three momentary buttons on the back panel are used to set configurations:

- The S1 button is used to enter or leave Configuration Mode and to cycle through the configuration functions. While in Running Mode, the N1 LED will light if the S1 button is pressed.
- The S2 button is used in certain configuration functions to cycle through each of the 20 lamps. While in Running Mode, the N2 LED will light if the S2 button is pressed.
- The S3 button is used to select the available configurations. While in Running Mode, the N3 LED will light if the S3 button is pressed.

A summary of configuration settings is included in Table 7, located at the end of this section.

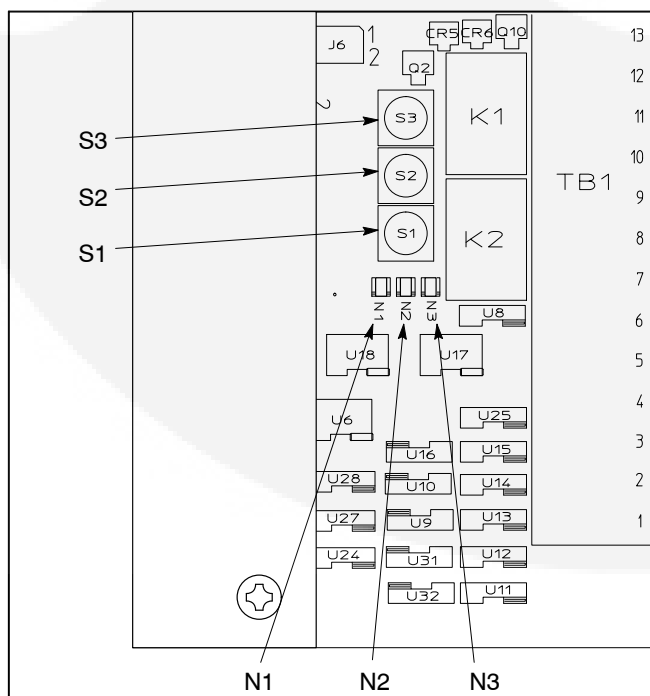


FIGURE 7. CONFIGURATION BUTTONS AND LEDs

## Entering Configuration Mode

During normal operation (Running Mode), the green N3 LED flashes at one flash per second.

1. Press and hold S1 for 5 seconds to enter Configuration Mode.
2. During the five seconds that S1 is pressed, N1 lights and N3 continues to flash.
3. After S1 has been pressed for five seconds, N1, N2, and N3 go out. You have entered Configuration Mode when all three LEDs are off.

## Configuration Functions

Upon entering Configuration Mode, eight configuration functions can be selected by pressing the S1 button. Table 4 shows the sequence of the functions that are available. The black-filled squares indicate which LEDs are lit for each function.

TABLE 4. CONFIGURATION FUNCTIONS

	FUNCTION	LED		
		N1	N2	N3
1	Select Predefined Configuration Table for all 20 lamps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Report Battery Voltage	■	<input type="checkbox"/>	<input type="checkbox"/>
3	Select Negative/Positive Input	<input type="checkbox"/>	■	<input type="checkbox"/>
4	Select Network Configuration Address	■	■	<input type="checkbox"/>
5	Configure individual Lamps with Color and Flash Characteristics	<input type="checkbox"/>	<input type="checkbox"/>	■
6	Configure individual Lamps with Audible Alert	■	<input type="checkbox"/>	■
7	Invert Active Signals	<input type="checkbox"/>	■	■
8	Enable Global Horn	■	■	■

Information on how to configure these functions is shown on the following pages. With each function, all configurations that are available are listed (including the default configuration). For most functions, a color is assigned to one or more lamps to indicate which configuration is currently selected.

**NOTE:** Active conditions are not displayed when in Configuration Mode. If a condition occurs while in Configuration Mode, it will not be displayed until after you have returned to Running Mode (see “Exiting Configuration Mode” on page 23).

## Selecting Predefined Configuration Tables

LED		
N1	N2	N3
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Upon entering Configuration Mode, N1, N2, and N3 LEDs are all off, indicating that the Predefined Configuration Mode function has been selected. If a different configuration function is presently selected, repeatedly press the S1 button until all three LEDs are off.

Two sets of predefined lamp configurations are available (“Modbus and NFPA 110” for new annunciator installations and “Legacy NFPA 110” for re-

placement of legacy annunciators). The default settings for each of these configurations are shown in Table 5. If one of the two predefined configuration tables is selected, characteristics (color, flash, and audible alert) for all 20 discrete input lamps are automatically set. However, after selecting the table of attributes, characteristics of individual lamps can be modified (see page 22).

Selecting a predefined configuration table only needs to be done once. If you customize a predefined configuration table by changing default settings, always keep the configuration mode setting as “No Change.” Otherwise, individual changes may be lost.

**TABLE 5. DEFAULT LAMP CONFIGURATION TABLES**

Lamp	Description	Modbus and NFPA 110 (DS1 = Red)			Legacy NFPA 110 (DS1 = Amber)		
		Color	Horn	Flash	Color	Horn	Flash
DS1	Customer Fault 1	Green	No	No	Red	Yes	No
DS2	Customer Fault 2	Amber	No	No	Red	Yes	No
DS3	Customer Fault 3	Red	No	No	Red	Yes	No
DS4	<b>Genset Supplying Load</b>	Amber	No	No	Green	No	No
DS5	<b>Charger AC Failure</b>	Amber	Yes	No	Red	No	No
DS6	<b>Low Coolant Level</b>	Amber	Yes	No	Red	Yes	No
DS7	<b>Low Fuel Level</b>	Red	Yes	No	Red	Yes	No
DS8	<b>Check Genset</b> (Modbus and NFPA 110) <i>or</i> Normal Utility (Legacy NFPA 110)	Amber	No	No	Green	No	No
DS9	<b>Not In Auto</b>	Red	Yes	Yes	Red	Yes	No
DS10	<b>Genset Running</b>	Amber	No	No	Green	No	No
DS11	<b>High Battery Voltage</b>	Amber	Yes	No	Red	No	No
DS12	<b>Low Battery Voltage</b>	Red	Yes	No	Red	No	No
DS13	<b>Weak Battery</b> (Modbus and NFPA 110) <i>or</i> Normal Battery Voltage (Legacy NFPA 110)	Red	Yes	No	Green	No	No
DS14	<b>Fail to Start</b>	Red	Yes	No	Red	Yes	No
DS15	<b>Low Coolant Temp</b>	Red	Yes	No	Red	Yes	No
DS16	<b>Pre-High Engine Temp</b>	Amber	Yes	No	Amber	Yes	No
DS17	<b>High Engine Temp</b>	Red	Yes	No	Red	Yes	No
DS18	<b>Pre-Low Oil Pressure</b>	Red	Yes	No	Amber	Yes	No
DS19	<b>Low Oil Pressure</b>	Red	Yes	No	Red	Yes	No
DS20	<b>Overspeed</b>	Red	Yes	No	Red	Yes	No

**Bold type** indicates the items that are printed on the annunciator overlay. The remaining slots are blank (see Figure 1).

For software versions **prior to version 2.00**, when you select the Predefined Configuration Mode function, lamp DS1 displays the color associated with the predefined configuration shown in the table below. To change the predefined configuration, press the S3 button to select the color assigned to one of the predefined configuration tables, as shown below.

DS1 COLOR	CONFIGURATION
Green	No Change (For customized configurations)
Amber	Legacy NFPA 110 (Default with software version 1.05 or earlier)*
Red	NFPA 110 (Default, starting with software version 1.06)*

\* Starting with version 1.06, the factory defaults are set to the parameters in the NFPA 110 table. The factory defaults for earlier versions of software are set to the parameters in the Legacy NFPA 110 table.

If you have an unused, factory fresh annunciator, you can determine which table has been pre-selected by pressing the Silence/Lamp Test button when the annunciator is in Run mode (not Configuration mode). If the top three LEDs are Green, Amber, Red, then the NFPA 110 table has been preselected. If the top three LEDs are Red, Red, Red, then the Legacy NFPA 110 has been preselected. If a different pattern is displayed, the table doesn't match your needs, or if the annunciator has been used before, then select the predefined table that best matches your needs.

**NOTE:** When the predefined Legacy NFPA 110 table is selected, then "Report 12 Volt" battery voltage function is automatically selected. When the predefined NFPA 110 table is selected, then "Don't Report" battery reporting function is automatically selected.

It may be necessary to change this setting for your installation. For more information on reporting battery voltage, see "Reporting Battery Voltage" below.

For software versions **starting with version 2.00**, when you select the Predefined Configuration Mode function, lamps DS1 and DS2 are used to display the color associated with the predefined configuration shown in the table below. To change the predefined configuration, press the S3 button to select the color assigned to one of the predefined configuration tables, as shown below.

If Modbus communications is desired, select the Modbus NFPA 110 table.

COLOR		CONFIGURATION
DS1	DS2	
Green	Off	No Change: PCCNet (For customized configurations)
Green	Green	No Change: Modbus (For customized configurations)
Amber	Off	PCCNet Legacy NFPA 110
Red	Off	PCCNet NFPA 110
Amber	Amber	Modbus NFPA 110

**NOTE:** When the predefined Legacy NFPA 110 table is selected, then "Report 12 Volt" battery voltage function is automatically selected. When the predefined NFPA 110 table is selected, then "Don't Report" battery reporting function is automatically selected. When the predefined Modbus table is selected, then "Don't Report" is automatically selected. It may be necessary to change this setting for your installation. For more information on reporting battery voltage, see "Reporting Battery Voltage" below.



## Reporting Battery Voltage

LED		
N1	N2	N3
■	□	□

To check on or modify the status of the Reporting Battery Voltage function, enter the Configuration Mode and repeatedly press the S1 button until the N1 LED is lit. When the Reporting Battery Voltage function is selected, lamps DS11, DS12, and DS13 display the color indicating the status of this function.

**NOTE:** The Reporting Battery Voltage function is automatically selected when a Predefined Configuration Table is selected (see page 19).

A report high and low only configuration can be used when an input is available for Weak Battery, but no inputs are available for High Battery Voltage and Low Battery Voltage. A report high and low only configuration can also be used when it is desired to report a customer fault in place of Normal Battery.

To change the Reporting Battery Voltage function, press the S3 button until the color associated with the desired reporting configuration is displayed, as shown below.

COLOR			CONFIGURATION
DS11	DS12	DS13	
Green	Green	Green	Don't Report
Amber	Amber	Amber	Report - 12 Volt High/Low/Normal (Default)
Red	Red	Red	Report - 24 Volt High/Low/Normal
Amber	Amber	Off	Report - 12 Volt High/Low
Red	Red	Off	Report - 24 Volt High/Low

**TABLE 6. BATTERY VOLTAGE SETTINGS**

LOW	HIGH	CONFIGURATION
12 ± 0.5 VDC	16 ± 0.5 VDC	12 VDC
24 ± 1 VDC	32 ± 1 VDC	24 VDC

## Selecting Negative/Positive Input

LED		
N1	N2	N3
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

The annunciator can be configured to be either a Positive or Negative signal device. The polarity of the annunciator must match that of the emergency power system.

To check on or modify the status of the Negative/Positive Input function, enter the Configuration Mode and repeatedly press the S1 button until only the N2 LED is lit. When the Negative/Positive Input function is selected, all 20 lamps are lit and are the same color (either red or green). Press the S3 button to modify the Negative/Positive Input function, as shown below.

DS1–20 COLOR	CONFIGURATION
Green	Positive Input
Red	Negative Input (Default)

## Configuring the Network Configuration Address

LED		
N1	N2	N3
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

The annunciator can be configured to communicate using one of the four available network configuration addresses. This feature allows for up to four annunciators to be installed in a network, all displaying different network information.

To check on or modify the status of the Network Configuration Address function, enter the Configuration Mode and repeatedly press the S1 button until the N1 and N2 LEDs are lit. The first four lamps are used to indicate the address. Press the S3 button to modify the Network Configuration Address function, as shown below.

DS1	DS2	DS3	DS4	CONFIGURATION
Green	Off	Off	Off	Network Address 1 (Default)
Off	Green	Off	Off	Network Address 2
Off	Off	Green	Off	Network Address 3
Off	Off	Off	Green	Network Address 4

**NOTE:** Always use Network Configuration Address 1 (default) to set up NFPA 110 annunciators.

## Configuring the Color and Flash Characteristics of individual Lamps

LED		
N1	N2	N3
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Each of the 20 status lamps can be configured to be red, green, or amber. Each lamp can be configured to flash or not flash. Each lamp can also be disabled (turned off). Default lamp characteristics are determined by the predefined configuration table selected (see page 19).

To select the lamp configuration function after entering Configuration Mode, repeatedly press the S1 button until the N3 LED is lit.

When this function is selected, the characteristics of all 20 lamps are shown and the first lamp (DS1) flashes. To scroll through the other lamps, repeatedly press the S2 button until the desired lamp flashes a quick flash.

To modify the characteristics on an individual lamp, press the S3 button. The lamp characteristics are:

- Solid Green
- Solid Amber
- Solid Red
- One Second Flashing Green
- One Second Flashing Amber
- One Second Flashing Red
- Disabled (Off) – A lamp that is disabled cannot be configured with an audible alert.

**NOTE:** When a lamp is selected for flash configuration, a double flash can be observed. After selecting the next lamp, the lamp that was configured to flash will flash at a slower rate (once per second).



## Configuring individual Lamps with An Audible Alert

LED		
N1	N2	N3
■	□	■

Each of the 20 status lamps can be configured with an Audible Alert that sounds when the associated LED becomes active.

**NOTE:** A lamp that is disabled cannot be configured with an audible alert.

To view and modify the status of the Audible Alert function of the lamps, enter the Configuration Mode and repeatedly press the S1 button until the N1 and N3 LEDs are lit.

When this function is selected, the alert status of all 20 lamps is shown and the first lamp (DS1) flashes. The default alert status is determined by the predefined configuration table selected (see page 19). To scroll through the lamps, repeatedly press the S2 button until the desired lamp flashes. Press the S3 button to modify the Audible Alert function, as shown below.

DS1-20 COLOR	CONFIGURATION
Green	Sound Disabled
Red	Sound Enabled

## Inverting Active Hardware Signals

LED		
N1	N2	N3
□	■	■

The state of each of the 20 hardware input signals can optionally be individually inverted. If set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active.

After entering Configuration Mode, repeatedly press the S1 button until the N2 and N3 LEDs are lit.

When this function is selected, the characteristics of first lamp (DS1) are shown. To scroll through the other lamps, repeatedly press the S2 button until

the desired lamp flashes. Press the S3 button to modify the Invert Active Signal function, as shown below.

DS1-20 COLOR	CONFIGURATION
Green	Don't Invert (Default)
Red	Invert

## Enabling Global Horn

LED		
N1	N2	N3
■	■	■

Although individual lamps can be set up with an audible alert, the horn will not sound unless the Global Horn function is enabled. To check on or change the status of the Global Horn function, enter the Configuration Mode and repeatedly press the S1 button until the N1, N2, and N3 LEDs are lit.

When the Global Horn Enable function is selected, lamp DS1 displays the color indicating the status of this function. Press S3 to change the color associated with the global horn configuration, as shown below.

DS1 COLOR	CONFIGURATION
Green	Horn Disabled
Amber	Horn Enabled – Soft
Red	Horn Enabled – Loud (Default)

## Exiting Configuration Mode

All changes are automatically saved upon exiting the configuration mode. To exit the configuration mode,

1. Press and hold S1 for 5 seconds.
2. After S1 has been pressed for five seconds, N3 begins to flash, indicating that you have returned to Running Mode.

**NOTE:** If you do not manually exit Configuration Mode, the annunciator automatically exits this mode after ten minutes of button inactivity. Any changes that were made are automatically saved.

## **CUSTOMER FAULTS**

Three customer faults are available for annunciation of the customers specified conditions. Add the fault descriptions to the control panel insert. Refer to Table 5 for interconnect locations.

### **REMOTE SILENCE/LAMP TEST**

Two remote Silence/Lamp Test connections are available (refer to Table 5). One Silence/Lamp Test has normally open contacts (connection TB1-10) and is used as both input and output for the Silence/

Lamp Test function. The other Silence/Lamp Test has normally closed contacts (connection TB1-11) and can only be used as an output for the Silence/Lamp Test function. Both contacts are rated at two amps maximum.

### **REMOTE ALARM**

Two remote alarm connections are available (refer to Table 5). One remote alarm has normally open contacts (connection TB1-13) and the other has normally closed contacts (connection TB1-14). Both contacts are rated at two amps maximum.







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# Troubleshooting

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**⚠️ WARNING** *Faulty service of the equipment monitored by the annunciator can lead to severe injury or death from electrocution, and equipment or property damage due to fire. Service must be performed by trained and experienced personnel.*

## PRE-CHECK

Verify the proper power supply wiring connection is made and that the power supply voltage range is correct for your installation.

- The power supply wiring connection for a **new annunciator installation** must be between TB1-16 (BATT) and TB1-15 (GND).
- The power supply wiring connection for a **legacy annunciator replacement** that was between TB1-2 and TB1-3 (GND) for a 12-volt system or between TB1-1 and TB1-3 (GND) for a 24-volt system must now be between TB1-16 (BATT) and TB1-15 (GND).
- The power supply voltage range must be between 6.5 and 31 VDC.

Verify that the annunciator is correctly set up to be either a positive or negative signal device. To check the negative/positive input status, remove the annunciator panel from the control box and use the configuration buttons to enter Configuration Mode and check on the negative/positive input status (see pages 18 and 22).

## TROUBLESHOOTING

### Incorrect Battery Voltage Sensing

If incorrect or no battery voltage indication appears, perform the following checks.

1. For a **new annunciator installation**, verify that B+ is connected to TB1-16 and that the ground (GND) connection is made to TB1-15.
2. For a **legacy annunciator replacement**, verify that B+ is no longer connected to TB1-2 on a 12-volt system or connected to TB1-1 on a 24-volt system and that the ground (GND) connection is not made to TB1-3. B+ must be connected to TB1-16 and the ground (GND) connection must be made to TB1-15.
3. Verify that the annunciator is configured to report battery voltage.
4. Verify that the annunciator has power by pressing the Silence/Lamp Test pushbutton. All 21 lamps should light.
5. Use a voltmeter to check the voltage between the “BATT IN” and a GND terminal to verify that it is correct.
6. If the failure still exists, the PCB is defective and must be replaced.

### Lamp Testing

All test lamps should light when the Silence/Lamp Test button is pressed. The following describes the sequence of events that should occur if you press and hold the Silence/Lamp Test button.

1. If there are no active audible alarms, all lamps (DS1 thru DS21) switch from green to amber to red.
2. Lamps DS1 thru DS20 display their configured color, flash, and audible alert characteristics.
3. After releasing the Silence/Lamp Test button, the status of the lamps that are hard-wired is displayed for one second.

## All Indicators Fail to Light

If the indicators fail to light when the Silence/Lamp Test button is pressed, then perform the following checks.

1. Verify that the annunciator has power between TB1-16 (+) and TB1-15 (GND).
2. Verify that the J1 connector (membrane panel ribbon cable to PCB assembly – located on the back of the board) is secure (see Figure 8). Press the Silence/Lamp Test pad.
3. If the problem continues, momentarily jumper the J1 pins together. If all the indicators light when J1 pins are jumpered together, the membrane touch panel is defective and must be replaced.
4. If the failure still exists, the PCB is defective and must be replaced.

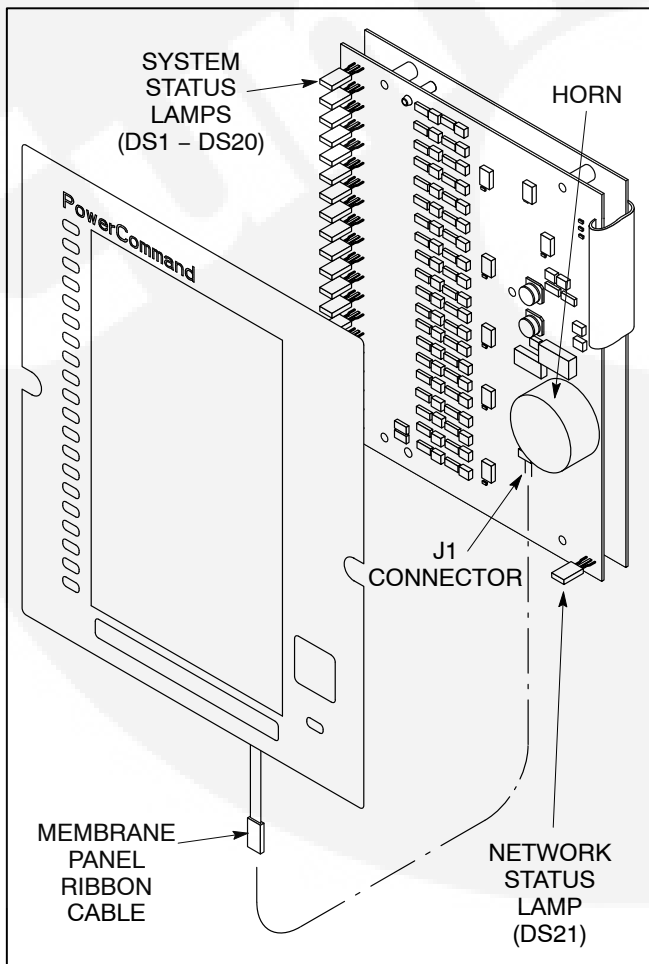


FIGURE 8. J1 CONNECTION

## One or More Failed Lamps

If one or more lamps fail to light when the Silence/Lamp Test button is pressed, the lamp(s) and/or PCB is/are defective. If any defective lamp is used, replace the PCB.

## Input Fails to Light Lamp

If a status lamp fails to light when the corresponding input condition is activated, but the lamp does light during a lamp test, then verify the input connections.

1. Enter Configuration Mode and verify that the lamp has been enabled (see “Annunciator Configuration” on page 18).
2. Apply B+ to the respective input and verify that the lamp fails to light.
3. Apply GND to the respective input and verify that the lamp fails to light.
4. If the lamp lights with the proper input, check for a poor connection or defective lead back to the signal source.
5. If the status lamp still does not light, the lamp and/or PCB is defective. Replace the PCB if the lamp is used.

## Not All Lamps Display the Desired Characteristics

If one or more lamps do not display the desired characteristics when the Silence/Lamp Test button is pressed and held (see “Lamp Testing on the previous page), perform the following checks.

1. Enter Configuration Mode and verify that the desired individual lamp characteristics have been set (see page 23).
2. While in Configuration Mode, verify that the Invert Active Signals function is correctly set (see page 23).

## Lamps Are Lit At the Wrong Time

If most or all lamps are lit during normal operation but you do not want them to be lit, perform the following checks.

1. Enter Configuration Mode and verify that the correct negative/positive input setting has been made (see page 23).
2. While in Configuration Mode, verify that the Invert Active Signals function is correctly set (see page 23).

## Excessive Battery Voltage Indications

If there are numerous indications of High Battery Voltage or Low Battery Voltage, perform the following checks.

1. Enter Configuration Mode and verify that the correct Reporting Battery Voltage configuration has been made (see page 23). The configuration must be properly set for a 12 or 24 VDC control system.
2. Check the battery and/or battery charger for proper voltage/operation.

## Alarm Failure

If a fault fails to signal an audible alarm, but does light the lamp, perform the following checks.

**NOTE:** If both the alarm and lamp fail to function, perform the checks under “Input Fails to Light Lamp.”

1. Enter Configuration Mode and verify that the Global Horn function has been enabled (see “Enabling Global Horn” on page 23). If Global Horn is disabled, lamp DS1 will be green.
2. While in Configuration Mode, verify that the lamp has been configured with an audible alert. (see “Configuring individual Lamps with an Audible Alert” on page 23). If the alert for the lamp is disabled, it will be green.
3. Verify that during the fault input condition, the remote alarm (N.O.) output (TB1-13 for new

annunciator installations or TB1-22 for legacy annunciator replacement installations) becomes grounded.

4. If steps one through three do not indicate any problems, tap on the side of the horn a few times. This action may free the piezo element and allow it to vibrate. Sometimes after extreme temperature changes, the piezo element becomes jammed and is unable to vibrate.
5. If the alarm still fails to sound, the PCB is defective and must be replaced.

## The Alarm Sounds But No Lamps are Flashing

Check to see if a lamp is displaying a quick blip (0.2 seconds On and 1.8 seconds Off). If a lamp is configured as inaudible (horn off), the event occurs, and then it becomes inactive before the Silence/Lamp Test pushbutton is pressed, the alarm will sound but the lamp will not continue to flash its configured color and flash characteristics.

## Remote/Silence Lamp Test Connection

If the local annunciator fails to silence the alarm horns of the remote interconnected annunciators, then verify that the Silence/Lamp Test (N.O.) terminals (TB1-10 for new annunciator installations or TB1-20 for legacy annunciator replacement installations) are interconnected. The connections are made to TB1-10 on the new annunciators.

## Genset Fault Fails to Go Inactive

If an annunciator fault status remains active but you believe it should be inactive, it may be that the genset controller is actually keeping the fault active. Some genset controllers (PCC2100, PCC3200) keep some faults active (High Engine Temperature, Low Oil Pressure) until the genset shuts down, restarts, and then runs without the fault condition in the fault range for a predetermined amount of time. Refer to the controller’s fault status list to see if the fault is still active. Some controllers display an asterisk (\*), indicating that the fault is still active. Refer to your genset or controller manual for more information.



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# Parts Information

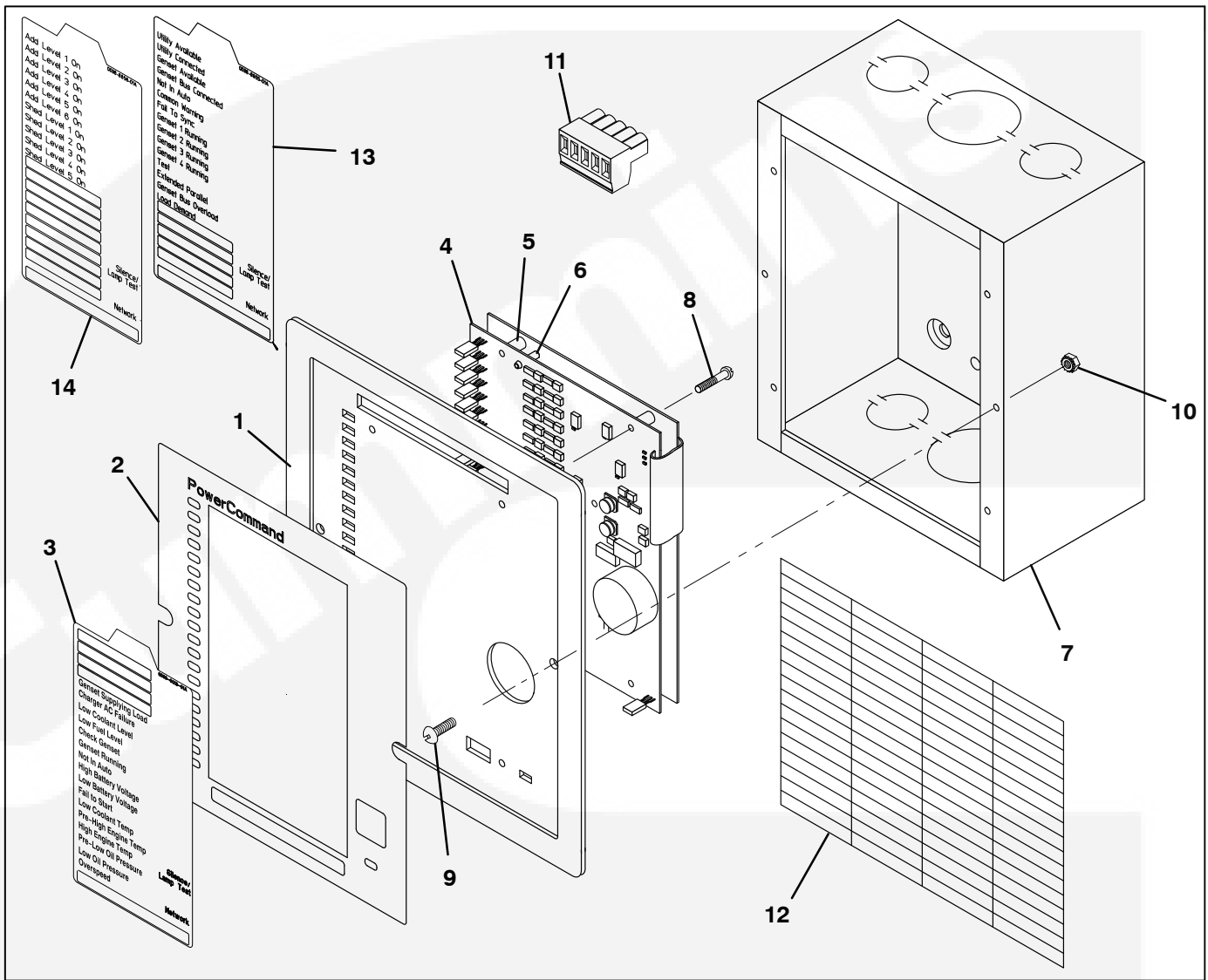


FIGURE 9. ANNUNCIATOR PARTS

REF NO.	PART NO.	QTY USED	PART DESCRIPTION	REF NO.	PART NO.	QTY USED	PART DESCRIPTION
			Annunciator	5	332-4064	4	Spacer
	300-5929-01	1	Panel Mounted	6	332-3332-04	3	Post, Circuit Board
	300-5929-02	1	Panel with Enclosure	7	301-3090	1	Control Box (Used with 300-5929-02 Annunciator)
1	319-4148-02	1	Panel, Annunciator	8	819-1160-01	3	Screw, Machine - Round Head (M3 x 10mm)
2	300-5338	1	Panel, Membrane	9	815-0385	2	Screw, Machine - Round Head (6-32 x 1/2") (Black)
3			Card, Insert - Membrane	10	870-0183	2	Nut, Hex - Lock (6-32)
	098-8321-01	1	English	11	323-2192-04	1	Connector
	098-8321-02	1	Spanish				
	098-8321-03	1	French				
	098-8321-04	1	Chinese				
4	327-1521	1	Board, Printed Circuit (PCB) - Annunciator				

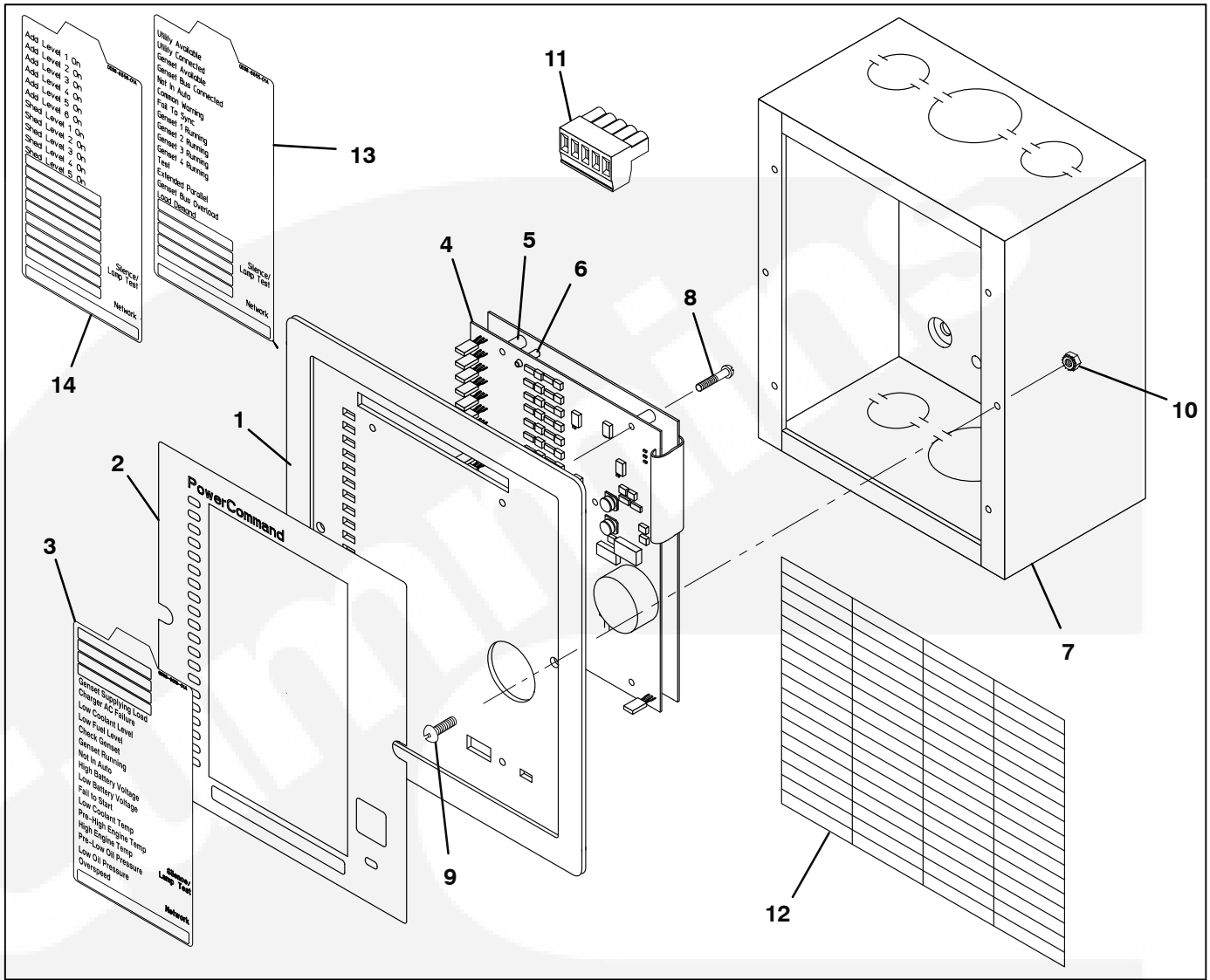


FIGURE 9. ANNUNCIATOR PARTS

REF NO.	PART NO.	QTY USED	PART DESCRIPTION	REF NO.	PART NO.	QTY USED	PART DESCRIPTION
12	098-6902	1	Label, Peel Off English	14	098-8856-01	1	Card, Insert – Membrane English
	098-6902-01	1	Label, Peel Off Spanish		098-8856-02	1	Card, Insert – Membrane Spanish
13	098-8855-01	1	Card, Insert – Membrane English		098-8856-03	1	Card, Insert – Membrane French
	098-8855-02	1	Card, Insert – Membrane Spanish		098-8856-04	1	Card, Insert – Membrane Chinese
	098-8855-03	1	Card, Insert – Membrane French				
	098-8855-04	1	Card, Insert – Membrane Chinese				

# Modbus Register Table

Modbus Address	System Name	Access	Specifications		Description
43000	High 4 LEDs	Read/Write	bit 0: Input 1(LSB) bit 1: Input 2 bit 2: Input 3 bit 3: Input 4	Default: 0	Read this register for the statuses of LEDs 1..4. Write to this register to control the status of the LEDs.
43001	Low 16 LEDs	Read/Write	bit 0: Input 5(LSB) bit 1: Input 6 bit 2: Input 7 bit 3: Input 8 .. bit 14: Input 19 bit 15: Input 20(MSB)	Default: 0	Read this register for the statuses of LEDs 5..20. Write to this register to control the status of the LEDs.
43002	High 4 Discrete Inputs	Read Only	bit 0: Input 1(LSB) bit 1: Input 2 bit 2: Input 3 bit 3: Input 4	Default: n/a	Read this register for the statuses of discrete inputs 1..4.
43003	Low 16 Discrete Inputs	Read Only	bit 0: Input 5(LSB) bit 1: Input 6 bit 2: Input 7 bit 3: Input 8 .. bit 14: Input 19 bit 15: Input 20(MSB)	Default: n/a	Read this register for the statuses of discrete inputs 5..20.
43004	High Battery Status	Read Only	0: OK 1: Too High	Default: n/a	Annunciator generated high battery voltage status. To use this status the Report Battery Voltage register must not be set to Don't Report.
43005	Low Battery Status	Read Only	0: Ok 1: Too Low	Default: n/a	Annunciator generated low battery voltage status. To use this status the Report Battery Voltage register must not be set to Don't Report.
43006	Audible Alarm Status	Read Only	0: Inactive 1: Active	Default: n/a	Read current state of audible alarm.
43007	Silence Button	Read/Write	0: Not Pressed 1: Pressed	Default: Not Pressed	Silence Button has been pressed since the last time this register was read.
43008	Relay 1 State	Read/Write	0: Inactive 1: Active	Default: Inactive	Read current state of relay or write desired state.
43009	Relay 2 State	Read/Write	0: Inactive 1: Active	Default: Inactive	Read current state of relay or write desired state.
43010	Relay 3 State	Read/Write	0: Inactive 1: Active	Default: Inactive	Read current state of relay or write desired state.
43011	Relay 4 State	Read/Write	0: Inactive 1: Active	Default: Inactive	Read current state of relay or write desired state.
43021	Configure LED 1	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.

<b>Modbus Address</b>	<b>System Name</b>	<b>Access</b>	<b>Specifications</b>		<b>Description</b>
43022	Configure LED 2	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43023	Configure LED 3	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43024	Configure LED 4	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43025	Configure LED 5	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43026	Configure LED 6	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43027	Configure LED 7	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43028	Configure LED 8	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43029	Configure LED 9	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43030	Configure LED 10	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43031	Configure LED 11	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43032	Configure LED 12	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43033	Configure LED 13	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43034	Configure LED 14	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43035	Configure LED 15	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.

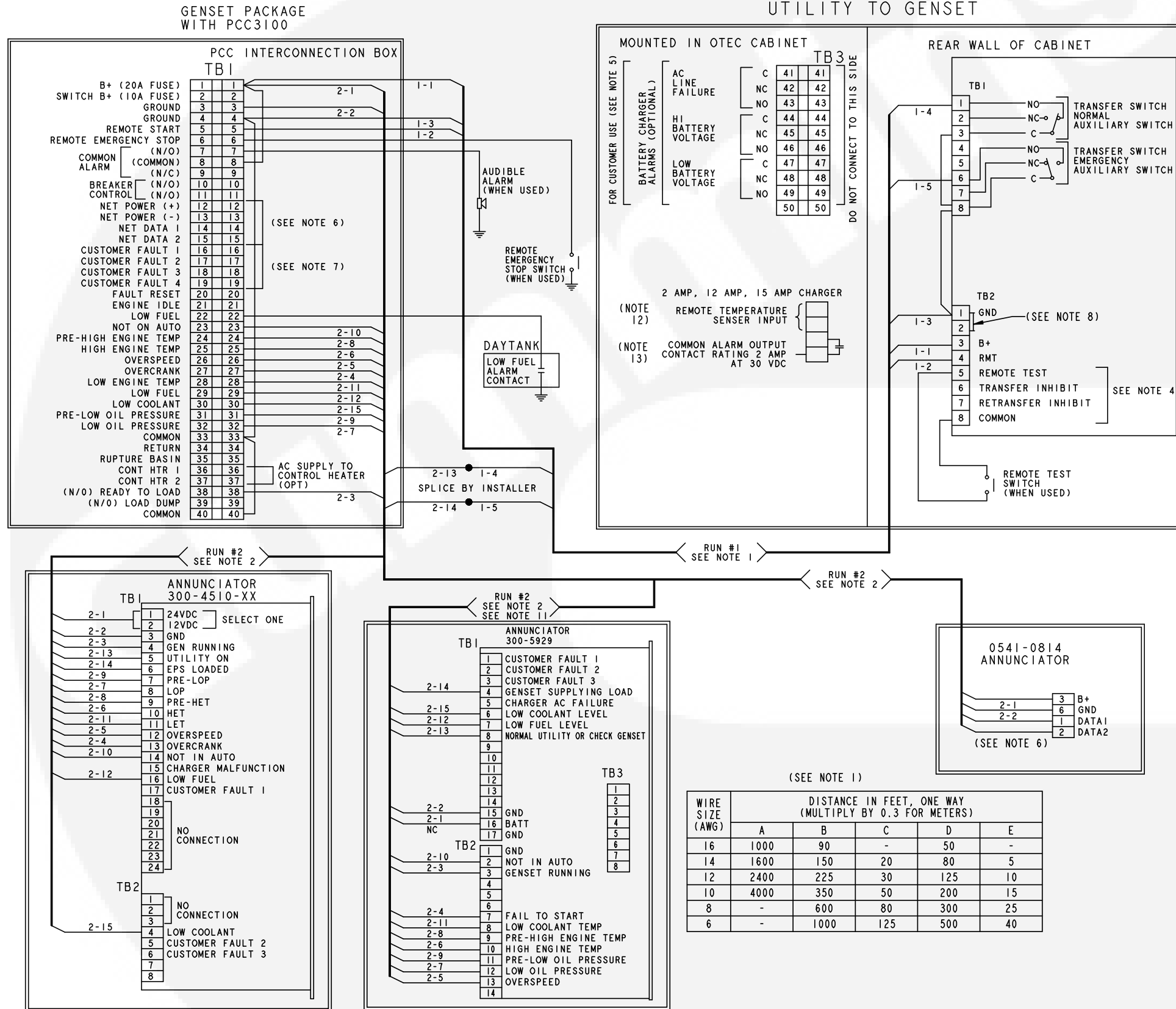
Modbus Address	System Name	Access	Specifications		Description
43036	Configure LED 16	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43037	Configure LED 17	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43038	Configure LED 18	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43039	Configure LED 19	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43040	Configure LED 20	Read/Write	See Modbus LED Configuration Structure	Default: See Modbus NFPA 110 Table	Set-up Individual LED.
43041	Report Battery Voltage	Read/Write	0: Don't Report 1: 12 volt Hi/Low/Normal 2: 24 volt Hi/Low/Normal 3: 12 volt Hi/Low 4: 24 volt Hi/Low	Default: Don't Report	Specifies if annunciator generated voltage statuses should be displayed on the annunciator.
43042	Neg/Pos Input Select	Read/Write	0: Negative 1: positive	Default: Negative	Specifies whether the annunciator discrete inputs accepts negative signals or positive signals.
43043	Global Horn Enable	Read/Write	0: Disabled 1: Enabled – Soft 2: Enabled – Load	Default: Enabled – Load	Overall control of the audible alarm.
43044	Network Configuration Address	Read/Write	1: Modbus Address 1 2: Modbus Address 2 3: Modbus Address 3 4: Modbus Address 4	Default: Modbus Address 1	If you change the address then you will not be able to communicate with the annunciator until the Modbus Master also changes its sending address.
43045	Modbus Baud Rate	Read/Write	0: 2400 Baud 1 :4800 Baud 2 :9600 Baud 3 :19200 Baud	Default: 19200	If you change baud rates then you will not be able to communicate with the annunciator until the Modbus Master also changes its baud rate.
43046	Modbus Parity	Read/Write	0: Even 1 :Odd 2 :None	Default: Even	If you change parity then you will not be able to communicate with the annunciator until the Modbus Master also changes its parity.
43047	Save Trims	Read/Write	0: Do Nothing 1: Save Trims	Do Nothing	Use to save adjustments to non-volatile memory. Perform Save Trims after all configurations have been updated.



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OTEC  
UTILITY TO GENSET

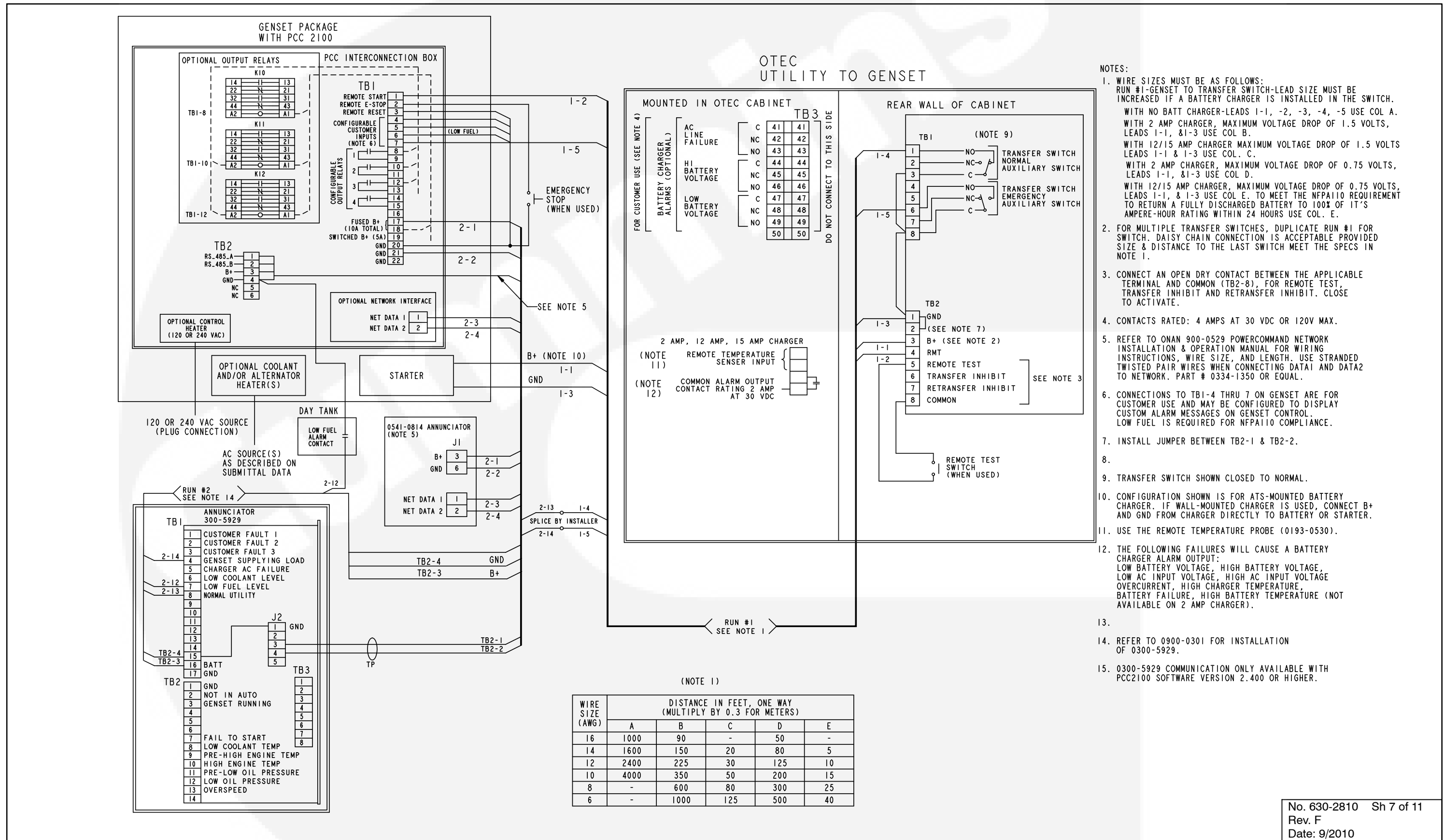


- NOTES:**
- WIRE SIZES MUST BE AS FOLLOWS:  
 RUN #1-GENSET TO TRANSFER SWITCH-LEAD SIZE MUST BE INCREASED IF A BATTERY CHARGER IS INSTALLED IN THE SWITCH.  
 WITH NO BATT CHARGER-LEADS 1-1, -2, -3, -4, -5 USE COL A.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1, & 1-3 USE COL B.  
 WITH 12/15 AMP CHARGER MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1 & 1-3 USE COL. C.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL D.  
 WITH 12/15 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL E. TO MEET THE NFPA110 REQUIREMENT TO RETURN A FULLY DISCHARGED BATTERY TO 100% OF IT'S AMPERE-HOUR RATING WITHIN 24 HOURS USE COL. E.
  - FOR 300-4510 ANNUNCIATOR, RUN #2-GENSET TO ANNUNCIATOR-ALL LEADS, USE COL. A.
  - FOR MULTIPLE TRANSFER SWITCHES, DUPLICATE RUN #1 FOR EACH SWITCH. DAISY CHAIN CONNECTION IS ACCEPTABLE PROVIDED WIRE SIZE & DISTANCE TO THE LAST SWITCH MEET THE SPECS IN NOTE 1.
  - CONNECT AN OPEN DRY CONTACT BETWEEN THE APPLICABLE TERMINAL AND COMMON (TB2-8). FOR REMOTE TEST, TRANSFER INHIBIT AND RETRANSFER INHIBIT TO ACTIVATE.
  - CONTACTS RATED: 4 AMPS AT 30 VDC OR 120V MAX.
  - NETWORK CONNECTIONS: USE BELDEN 9729 24 GAUGE TWISTED, STRANDED, SHIELDED CABLE. SHIELD SHOULD BE GROUNDED AT ONE END. TOTAL NETWORK LENGTH NOT TO EXCEED 4000 FEET. UP TO 20 NODES CAN BE CONNECTED TO THE NETWORK. (NOTE ANY COMMUNICATIONS WIRE CONNECTED TO THE GENSET SHOULD BE STRANDED CABLE.).
  - INPUTS FOR CUSTOMER FAULTS. GROUNDED SIGNAL REQUIRED TO ACTIVATE INPUT (MAX 50 MA.)
  - INSTALL JUMPER BETWEEN TB2-1 & TB2-2. FOR SETS WITH PCC 3100 CONTROL.
  - TRANSFER SWITCH SHOWN CLOSED TO NORMAL.
  - CONTACTS RATED: 2 AMPS AT 30 VDC OR 0.60 AMPS AT 120 VAC.
  - REFER TO 0900-0301 FOR INSTALLATION OF 0300-5929.
  - USE THE INVENTER REMOTE TEMPERATURE PROBE (0193-0530).
  - THE FOLLOWING FAILS WILL CAUSE A BATTERY CHARGER ALARM OUTPUT:  
 LOW BATTERY VOLTAGE, HIGH BATTERY VOLTAGE, LOW AC INPUT VOLTAGE, HIGH AC INPUT VOLTAGE, OVERCURRENT, HIGH CHARGER TEMPERATURE, BATTERY FAILURE, HIGH BATTERY TEMPERATURE (NOT AVAILABLE ON 2 AMP CHARGER).
  - NETWORK CONNECTIONS: USE BELDEN 9729 24 GAUGE TWISTED, STRANDED, SHIELDED CABLE. SHIELD SHOULD BE GROUNDED AT ONE END. TOTAL NETWORK LENGTH NOT TO EXCEED 4000 FEET. UP TO 20 NODES CAN BE CONNECTED TO THE NETWORK. (NOTE ANY COMMUNICATIONS WIRE CONNECTED TO THE GENSET SHOULD BE STRANDED CABLE.).

**FIGURE 10. TYPICAL INTERCONNECTION WIRING DIAGRAM (WITH PCC3100)**

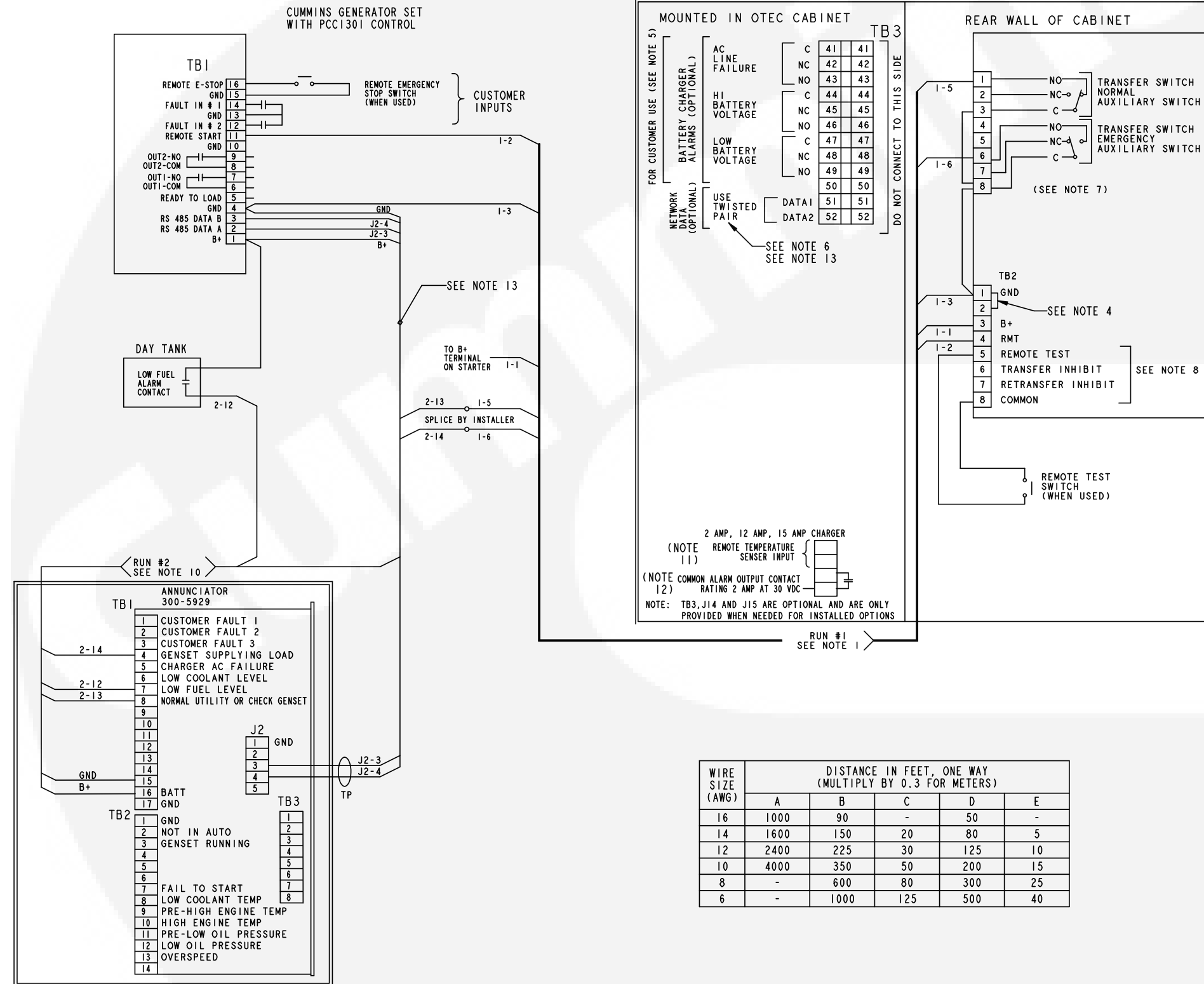






**FIGURE 12. TYPICAL INTERCONNECTION WIRING DIAGRAM (WITH PCC2100)**

OTEC UTILITY TO GENSET



- NOTES:**
- WIRE SIZES MUST BE AS FOLLOWS:  
 RUN #1-GENSET TO TRANSFER SWITCH-LEAD SIZE MUST BE INCREASED IF A BATTERY CHARGER IS INSTALLED IN THE SWITCH.  
 WITH NO BATT CHARGER-LEADS 1-1, -2, -3, -5, -6 USE COL. A.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1, & 1-3 USE COL B.  
 WITH 12/15 AMP CHARGER MAXIMUM VOLTAGE DROP OF 1.5 VOLTS, LEADS 1-1 & 1-3 USE COL. C.  
 WITH 2 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL D.  
 WITH 12/15 AMP CHARGER, MAXIMUM VOLTAGE DROP OF 0.75 VOLTS, LEADS 1-1, & 1-3 USE COL E. TO MEET THE NFPA110 REQUIREMENT TO RETURN A FULLY DISCHARGED BATTERY TO 100% OF IT'S AMPERE-HOUR RATING WITHIN 24 HOURS USE COL. E.
  - RUN #2-GENSET TO ANNUNCIATOR-ALL LEADS, USE COL. A
  - FOR MULTIPLE TRANSFER SWITCHES, DUPLICATE RUN #1 FOR EACH SWITCH. DAISY CHAIN CONNECTION IS ACCEPTABLE PROVIDED WIRE SIZE & DISTANCE TO THE LAST SWITCH MEET THE SPECS IN NOTE 1.
  - INSTALL JUMPER BETWEEN TB2-1 & TB2-2.
  - CONTACTS RATED: 4 AMPS AT 30 VDC OR 120V MAX.
  - USE STRANDED TWISTED PAIR WIRES WHEN CONNECTING DATA1 AND DATA2 TO THE NETWORK.
  - TRANSFER SWITCH SHOWN CLOSED TO NORMAL
  - CONNECT AN OPEN DRY CONTACT BETWEEN THE APPLICABLE TERMINAL AND COMMON (TB2-8). FOR REMOTE TEST, TRANSFER INHIBIT AND RETRANSFER INHIBIT. CLOSE TO ACTIVATE.
  - CONTACTS RATED: 2 AMPS AT 30 VDC OR 0.60 AMPS AT 120 VAC.
  - REFER TO 0900-0301 FOR INSTALLATION OF 0300-5929.
  - USE THE INVENTER REMOTE TEMPERATURE PROBE (0193-0530).
  - THE FOLLOWING FAILS WILL CAUSE A BATTERY CHARGER ALARM OUTPUT:  
 LOW BATTERY VOLTAGE, HIGH BATTERY VOLTAGE, LOW AC INPUT VOLTAGE, HIGH AC INPUT VOLTAGE, OVERCURRENT, HIGH CHARGER TEMPERATURE, BATTERY FAILURE, HIGH BATTERY TEMPERATURE (NOT AVAILABLE ON 2 AMP CHARGER).
  - NETWORK CONNECTIONS: USE BELDEN 9729 24 GAUGE TWISTED, STRANDED, SHIELDED CABLE. SHIELD SHOULD BE GROUNDED AT ONE END. TOTAL NETWORK LENGTH NOT TO EXCEED 4000 FEET. UP TO 20 NODES CAN BE CONNECTED TO THE NETWORK. (NOTE ANY COMMUNICATIONS WIRE CONNECTED TO THE GENSET SHOULD BE STRANDED CABLE.).

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 Rev. F  
 Date: 9/2010

FIGURE 13. TYPICAL INTERCONNECTION WIRING DIAGRAM (WITH PCC1301)

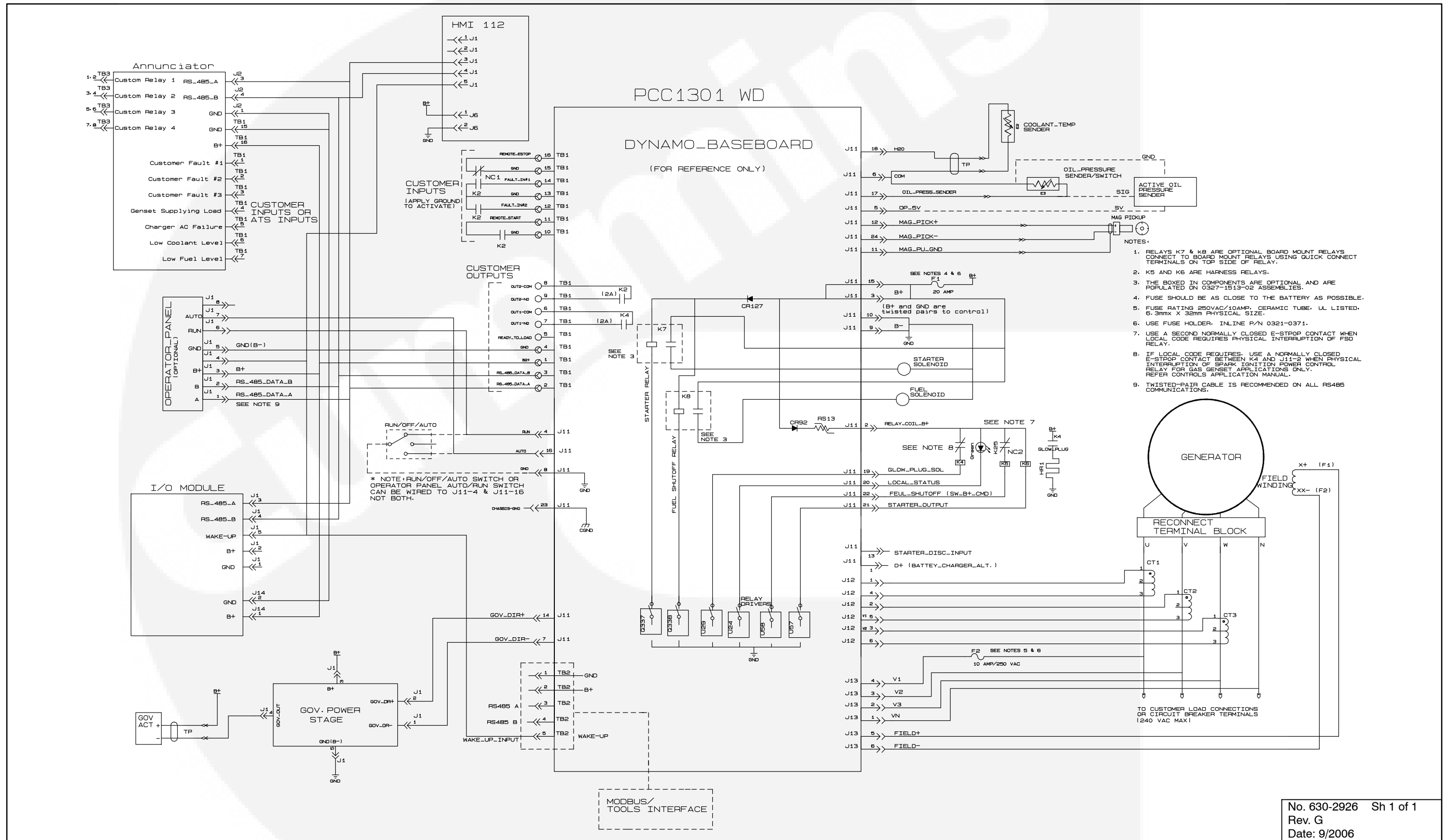


FIGURE 14. 1301 CONTROL WIRING DIAGRAM

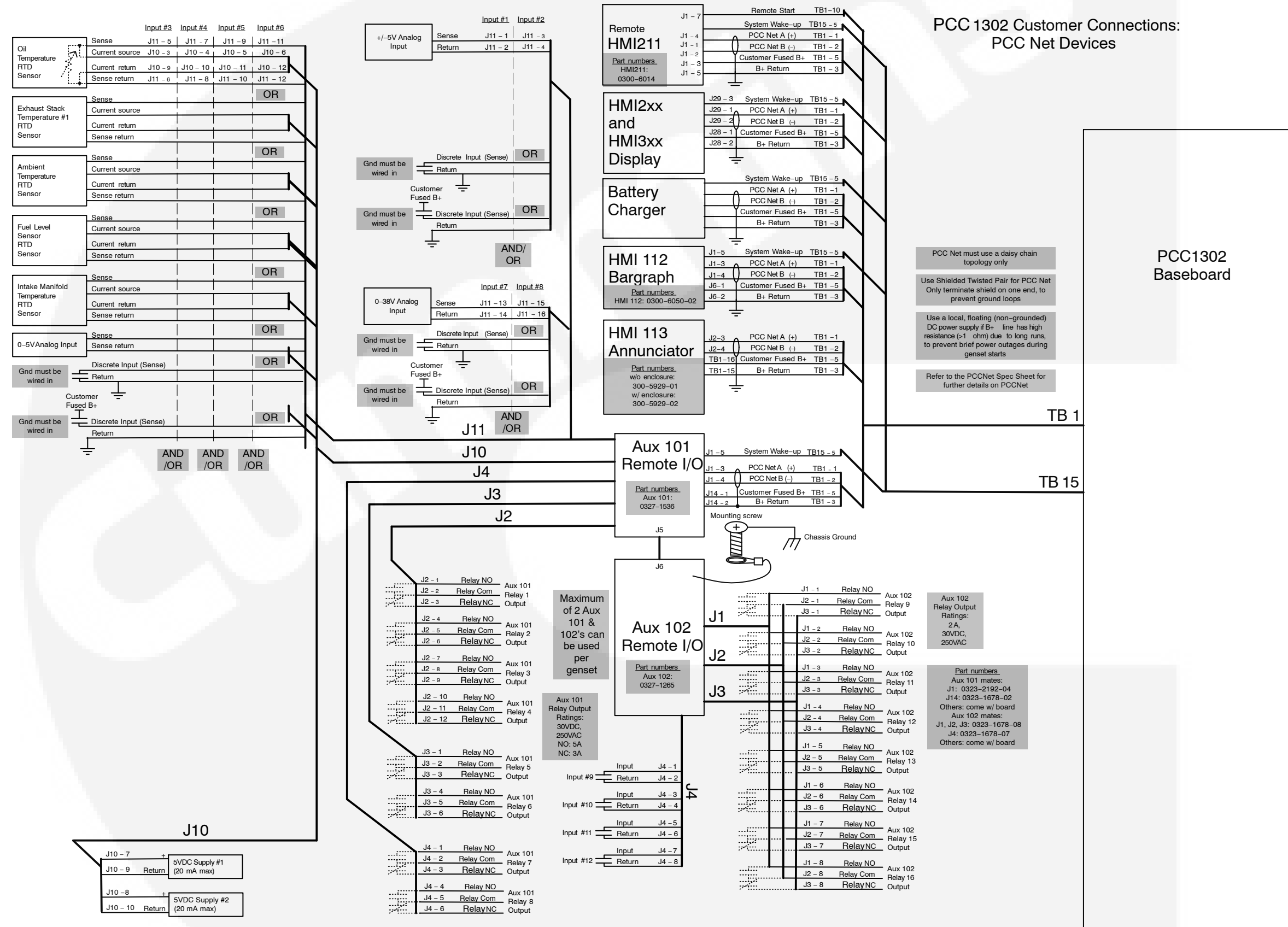
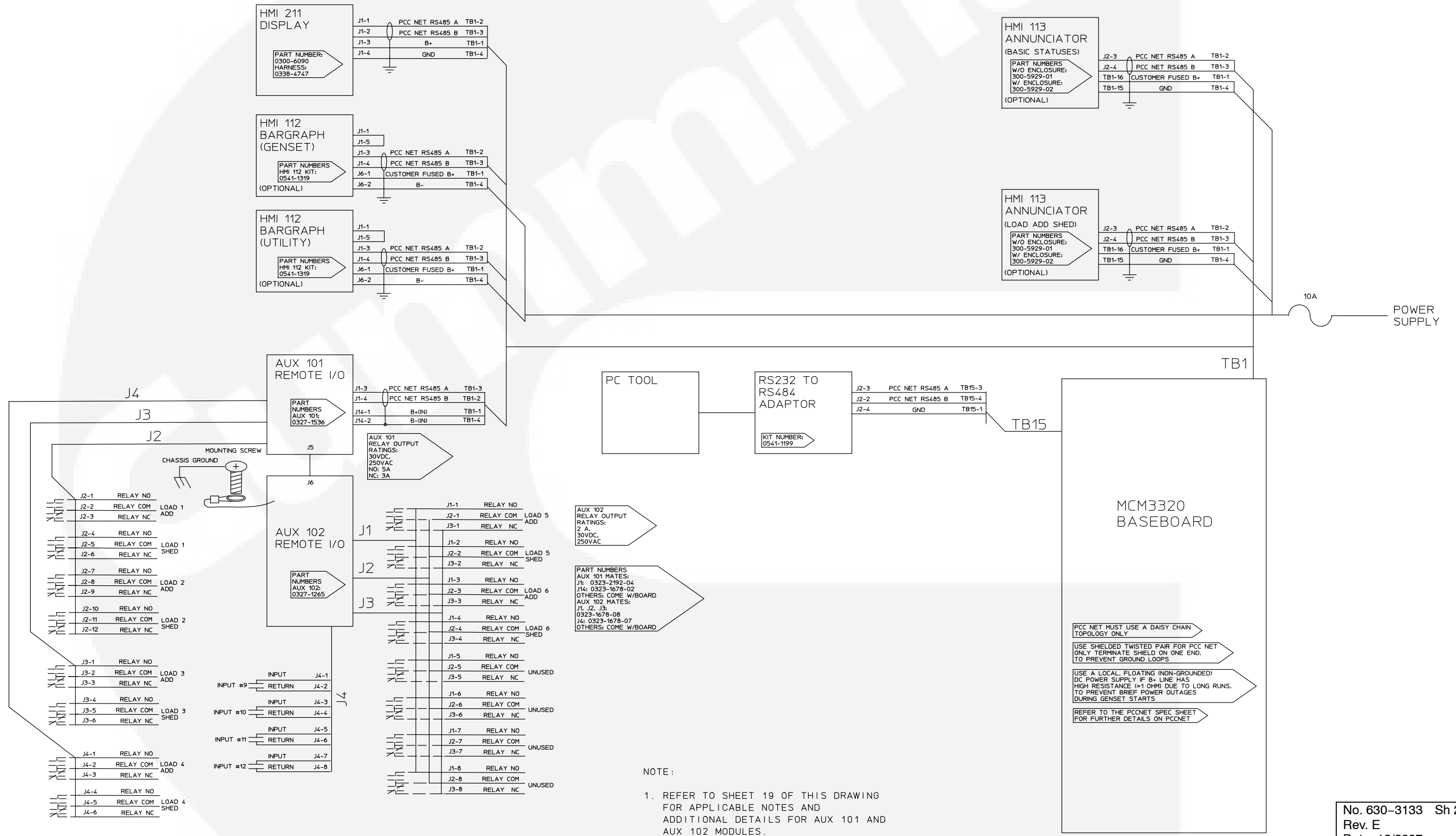


FIGURE 15. 1302 CONTROL WIRING DIAGRAM

MASTER CONTROL MODULE 3.3  
CUSTOMER CONNECTIONS:  
PCC NET DEVICES

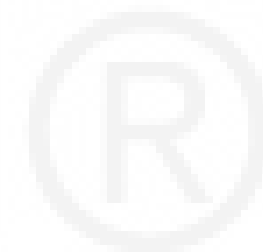


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Rev. E  
Date: 12/2007

FIGURE 16. MCM3320 CONTROL WIRING DIAGRAM

Cummins

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## Installation & Operation Manual

NRG12-10: 12-Volt, 10-Amp Battery Charger

NRG24-10: 24-Volt, 10-Amp Battery Charger

NRG22-10: 12/24-Volt, 10-Amp Battery Charger

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SENS Part Number: 101295  
Document Revision: Q  
DCN Number: 106080  
Date: January 17, 2012

Installation or service questions?  
Call SENS at 1.800.742.2326 (303.678.7500)  
between 8 a.m. and 5 p.m. (Mountain Time)  
Monday through Friday, or visit our website.

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## IMPORTANT SAFETY INSTRUCTIONS FOR INSTALLER AND OPERATOR

---

1. **SAVE THESE INSTRUCTIONS.**
2. **DO NOT EXPOSE CHARGER TO RAIN OR SNOW.**
3. Use of an attachment not recommended or sold by SENS may result in a risk of fire, electric shock, or injury to persons.
4. **ONLY TRAINED AND QUALIFIED PERSONNEL MAY INSTALL AND SERVICE THIS UNIT.**
5. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; shut off power at the branch circuit protectors and have the unit serviced or replaced by qualified personnel.
6. To reduce risk of electric shock, disconnect the branch circuit feeding the charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.

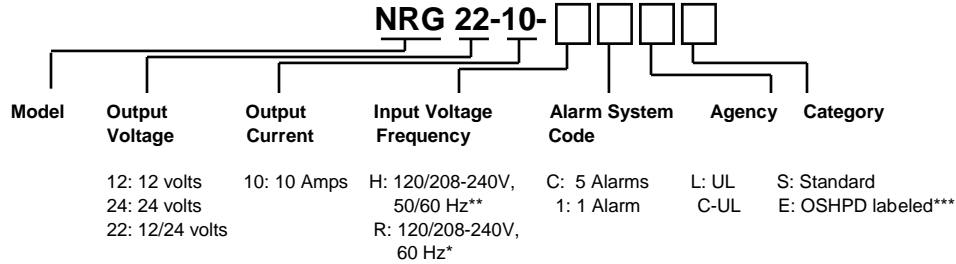
**WARNING:  
RISK OF EXPLOSIVE  
GASES.**

- A. **WORKING IN THE VICINITY OF A LEAD-ACID OR NICKEL-CADMIUM BATTERY IS DANGEROUS. STORAGE BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL BATTERY OPERATION. FOR THIS REASON, IT IS OF UTMOST IMPORTANCE THAT EACH TIME BEFORE USING YOUR CHARGER, YOU READ THIS MANUAL AND FOLLOW THE INSTRUCTIONS EXACTLY.**
  - B. To reduce the risk battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of any equipment you intend to use in the vicinity of a battery. Review cautionary markings on these products and on the engine.
7. **PERSONAL PRECAUTIONS**
- A. Someone should be within range of your voice or close enough to come to your aid when you work near a storage battery.
  - B. Have plenty of fresh water and soap nearby in case battery electrolyte contacts skin, clothing, or eyes.
  - C. Wear complete eye protection and clothing protection. Avoid touching eyes while working near a storage battery.
  - D. If battery electrolyte contacts skin or clothing, wash immediately with soap and water. If electrolyte enters eye, immediately flood the eye with running cold water for at least 10 minutes and get medical attention immediately.
  - E. **NEVER** smoke or allow a spark or flame in vicinity of battery or engine.
  - F. Be extra cautious to reduce risk of dropping a metal tool onto battery. It might spark or short circuit battery or other electrical part that may cause explosion. Using insulated tools reduces this risk, but will not eliminate it.
  - G. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a storage battery. A storage battery can produce a short circuit current high enough to weld a ring or the like to metal, causing a severe burn.
  - H. **Use this charger for charging LEAD-ACID or LIQUID ELECTROLYTE NICKEL-CADMIUM batteries only.** Do not use this battery charger for charging dry cells, alkaline, lithium, nickel-metal-hydride, or sealed nickel-cadmium batteries that are commonly used with home appliances. These batteries may burst and cause injuries to persons and damage to property.
  - I. **NEVER** charge a frozen battery.

**MODEL NUMBER CONFIGURATION**

This manual contains important safety, installation and operating instructions for SENS battery charger model NRG12-10 (configured for 12V,10A only), NRG24-10 (configured for 24V, 10A only) and NRG22-10 (field configurable for 12V or 24V, 10A).

**Model Number Breakout**



NOTE: Not all configurations are available on all models. Contact the factory for confirmation.

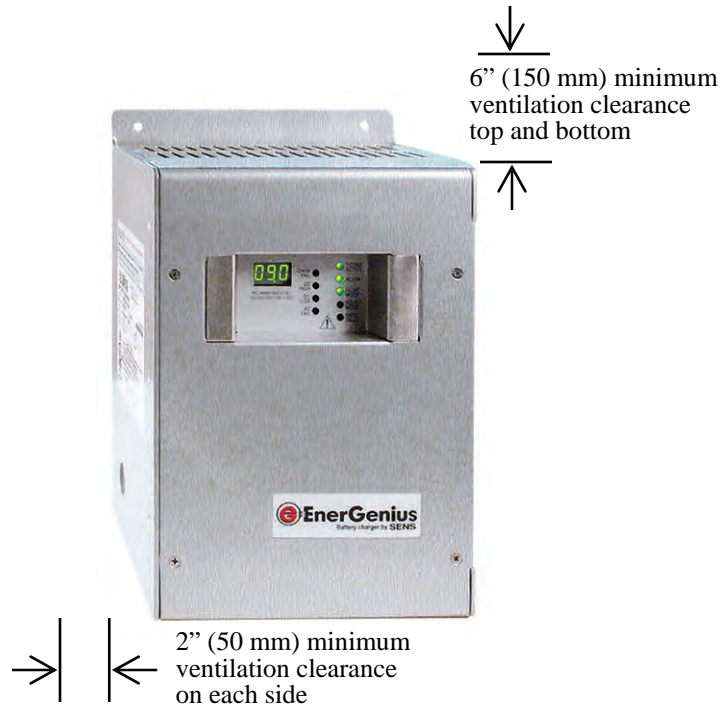
\*UL listed, CSA certified

\*\*UL listed, CSA certified and CE marked

\*\*\*California Special Seismic Certification Pre-Approval

**INSTALLATION INSTRUCTIONS**

**WARNING:**  
**ONLY TRAINED AND QUALIFIED PERSONNEL MAY INSTALL AND SERVICE THIS UNIT.**

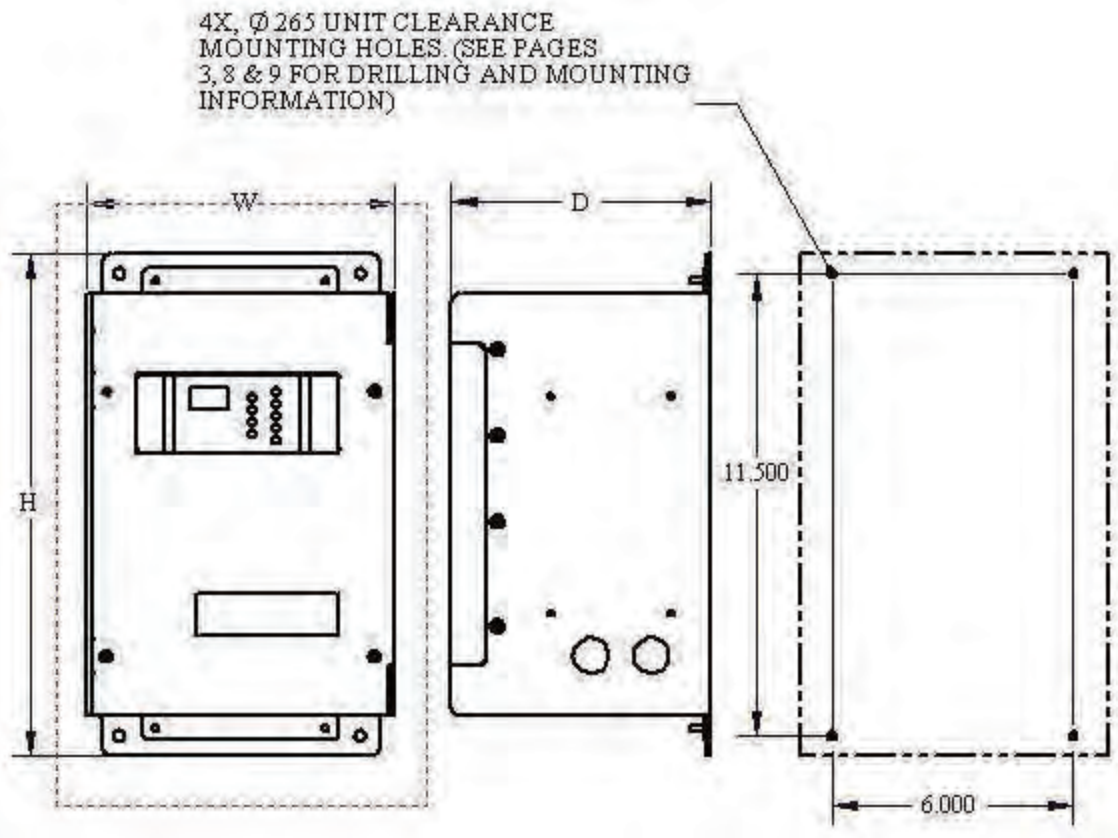


Mount to vertical surface of 3/4" (19 mm) plywood or other material of equal strength and durability, using four mounting screws 1/4" (6 mm) diameter.

**1. PREPARING FOR USE:**

**WARNING:**  
**ONLY TRAINED AND QUALIFIED**  
**PERSONNEL MAY INSTALL AND**  
**SERVICE THIS UNIT.**

- A. INSTALLATION OF THE UNIT MUST COMPLY WITH LOCAL ELECTRICAL CODES AND OTHER APPLICABLE INSTALLATION CODES.**
- B. INSTALLATION MUST BE MADE ACCORDING TO THE INSTALLATION INSTRUCTIONS AND ALL APPLICABLE SAFETY REGULATIONS.**

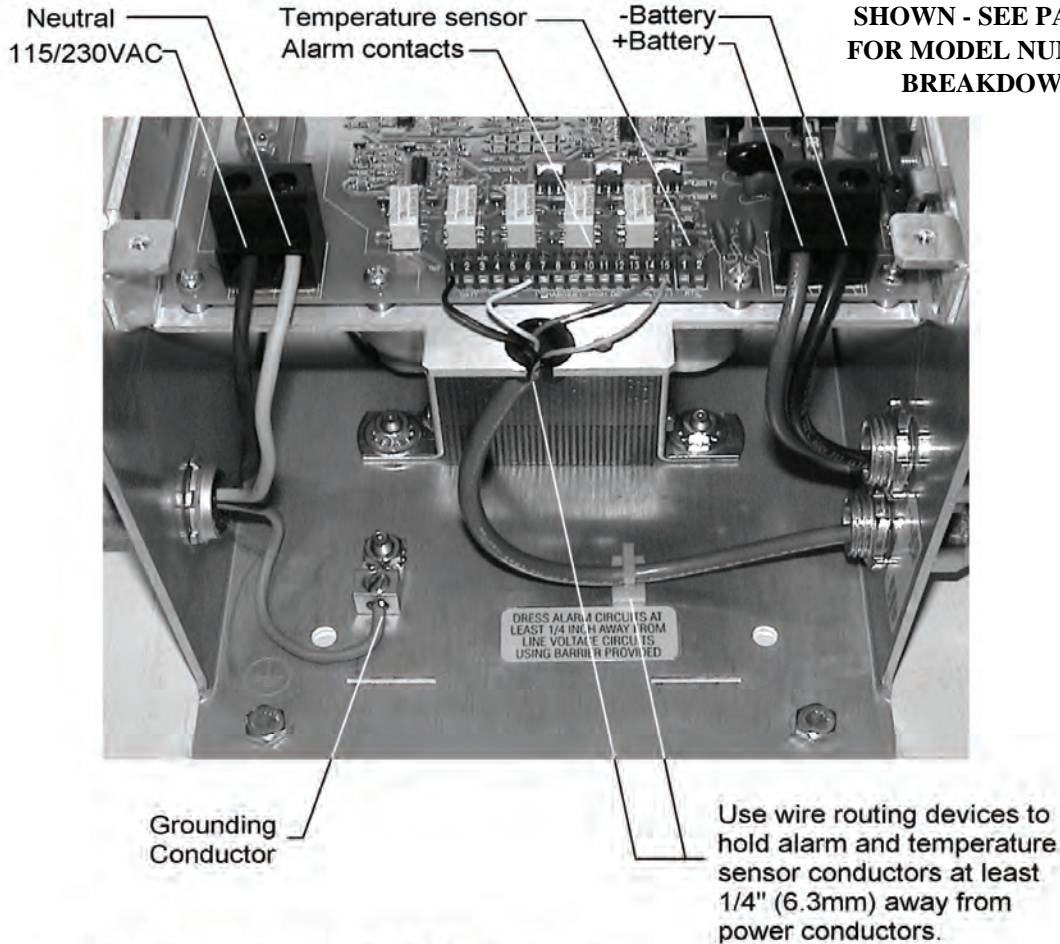


Charger Dimensions:

- W: 7.66 Inches (195 mm).
- H: 12.50 Inches (318 mm).
- D: 6.48 Inches (165 mm).



**FIVE ALARM MODEL  
SHOWN - SEE PAGE 3  
FOR MODEL NUMBER  
BREAKDOWN**



**Use conductors rated 90C or higher.  
Input conductors must be suitable for 10A circuits.  
Battery conductors must be suitable for 30A circuits. See Section 5.  
Alarm and temperature sensor may use low power conductors.**

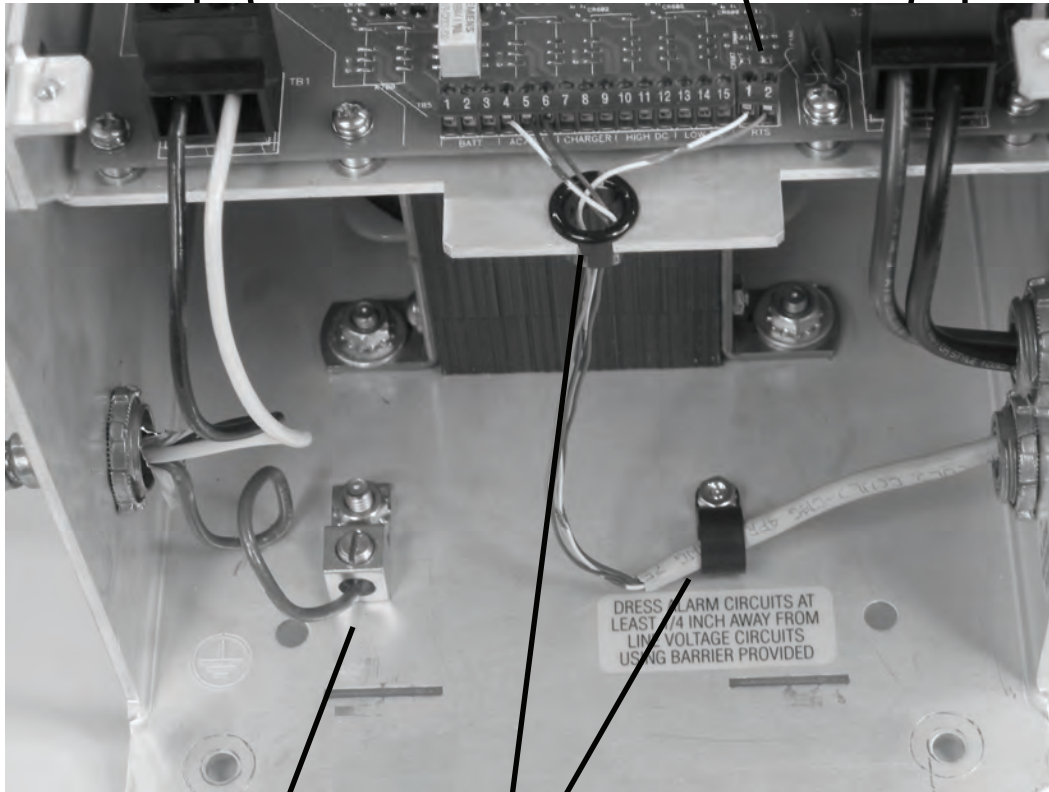
- C. This unit is permanently connected to the AC circuit and to the battery. An external disconnect device with a minimum of 0.12”(3 mm) pole separation must be located in the AC input to the charger.
  - Do not energize the AC supply circuit until **ALL** wiring is connected, internal controls are properly set, and the cover is secured. Always shut the AC supply circuit off before installing or removing any wiring or opening the cover for any reason.
  - Always observe proper polarity of the DC output leads.
  - Always connect the output leads in this order: ungrounded charger output first, then ungrounded battery terminal, then grounded charger output, and grounded battery terminal last. If the battery must be disconnected for service, remove the output wiring in the reverse of the order given above.
- D. Be sure battery terminals are clean and properly tightened. Be careful to keep corrosion from coming in contact with eyes.
- E. Add distilled water to each cell until the electrolyte reaches the level specified by the battery manufacturer. This helps purge excess gas from the cells. Do not over fill. For a battery without cell caps, carefully follow the manufacturer’s recharging instructions.
- F. Study all battery manufacturer’s specific precautions such as removing or not removing cell caps while charging and recommended rates of charge.
  - The recommended charge current range must include the rated output current of this charger, which is 10 amperes.
  - Set the float voltage jumper to the battery manufacturer’s recommended float charge voltage. Incorrect charge voltage will accelerate generation of explosive gases, increasing the risk of fire or explosion.

Neutral 115/230VAC

Temperature Sensor Alarm Contacts

-Battery +Battery

ONE ALARM MODEL SHOWN- SEE PAGE 3 FOR MODEL NUMBER BREAKDOWN



Grounding Conductor

Use wire routing devices to hold alarm and temperature sensor conductors at least 1/4" (6.3 mm) away from power conductors.

- G. Enable the automatic boost charge mode (equalizing charge) only if recommended by the battery manufacturer
- H. Determine the voltage of the battery by referring to the engine or battery owner's manual and make sure that the 12V/24V select jumper is set to the correct voltage.

---

## 2. CHARGER LOCATION

Do not set a battery or any other object on top of the charger. This will obstruct the ventilation openings and cause excessive heating. Ensure the charger is protected from blowing or dripping water.

---

## 3. GROUNDING INSTRUCTIONS

This battery charger should be connected to a grounded, metal, permanent wiring system; or an equipment grounding conductor (earthing conductor) should be run with the circuit conductors and connected to the equipment grounding terminal in the charger. This terminal is marked with the ground symbol. Connections to the battery charger should comply with all local codes and ordinances.

**4. NEUTRAL CONNECTION**

The grounded circuit conductor (neutral) should be connected to the terminal marked “N” on the input terminal block, TB1.

**5. WIRE RATINGS**

- A. All conductors should be rated for use at 90° C or higher.
- B. All input and output conductor sizes should be coordinated with the fault protection devices: 10A on AC input (14 AWG, 2.5 mm<sup>2</sup> typical), 30A on DC output (10 AWG, 6.0 mm<sup>2</sup> typical). 1 A on Alarm terminal block (20 AWG, 0.5 mm<sup>2</sup> typical).
- C. *Before installation*, ensure adequate battery to charger wire gauge. Wire gauge that is too small may activate the open battery detector and the charger will shut down. The maximum allowed resistance seen by the charger is found in TABLE 1. These figures already include an allowance for charger variations (they are 80% of the typical trip-point) and are for the complete circuit: total of battery leads, battery's internal resistance, and any external equipment. The total resistance seen by the charger must not exceed the following values:

**TABLE 1**

	<b>12V</b>	<b>24V</b>
<b>Maximum Resistance</b>	58mΩ	116mΩ

- D. To determine the appropriate cable and length, please refer to the following table:

**TABLE 2**

Wire Size		Resistance per Foot	Maximum Charger to Battery Distance (Ft.)		Recommended Charger to Battery Distance (Ft.)	
AWG	mm <sup>2</sup>	mΩ/Ft.	12V	24V	12V	24V
10	6.0	1.00	25	50	10	19
8	10	0.63	40	79	15	30
6	16	0.40	63	126	24	48

The above lengths consider the resistance of the battery and cables only and do not take into account any additional interconnects.

The above lengths are for operation at 25C. For high temperature installations (40C) reduce lengths by 10%.

In the case of high resistance in the cables to the battery the charger Battery Fault LED may flash (approximately once every 60 seconds). Cable runs exceeding the proper length for the cable gauge used most often cause this problem. The appropriate solution is to change the cable gauge to properly correspond with the necessary cable length (see TABLE 2). In some cases where the resistance is not too far above maximum, the charger may recover after some time (approximately 10 minutes) and start charging the batteries. If it is not possible to decrease the system resistance the Battery Fault feature can be disabled. Please contact SENS at 1-800-742-2326 for further information.

- E. Refer to local electrical codes for additional requirements.
- F. See Section 10 for Terminal Block wire ranges.

**6. FUSE RATINGS**

- A. CAUTION: For continued protection against risk of fire, replace only with same type and rating of fuse.
- B. DC Output Fuse – SENS part number 304530. Bussman Type BK/ATC-30, or Littelfuse 257030 [ATO30], 30A, 32V, fast acting, blade type automotive
- C. AC Input Fuse – SENS part number 304473. Bussman Type BK/AGC-10, 10A, 250VAC, fast acting, ferrule type cylindrical, ¼” X 1-¼”

---

## 7. MOUNTING LOCATION

- A. See the safety instructions for important information concerning the charger location.
- B. The charger should be installed in a sheltered area, protected from rain and snow.
- C. The charger should not be located where temperatures are expected to be colder than -20° C, or hotter than +40° C for operation at rated output current.

**WARNING:**

**NEVER CHARGE STORAGE BATTERIES AT TEMPERATURES ABOVE OR BELOW THE LIMITS SPECIFIED BY THE BATTERY MANUFACTURER. NEVER ATTEMPT TO CHARGE A FROZEN BATTERY.**

- D. Allow sufficient room for routing the fixed wiring to the charger. AC input enters the left side; DC output and alarms exit on the right.
- E. Leave clear space for ventilation all around the unit: at least 6 inches (15 cm) at the top and bottom; at least 2 inches (5 cm) on the sides.
- F. Charger should be mounted on a flat vertical surface so that the chassis does not warp when tightened to the wall.
- G. The charger should be mounted vertically, with the input and output terminal blocks lowermost.

**WARNING:**

**OTHER MOUNTING ORIENTATIONS INTERFERE WITH PROPER VENTILATION AND MAY CAUSE THE CHARGER TO OVERHEAT.**

- H. Do not mount the charger over any heat generating equipment.
- I. Minimize vibrations that the charger will be subjected to.

---

## 8. STATIC DISCHARGE PRECAUTIONS

The printed circuit board contains static sensitive components. Damage can occur even when static levels are too low to produce a noticeable discharge shock. To avoid static discharge damage:

- A. Handle the charger by the chassis only. Remove the cover only when access is essential for installation and service, and replace it promptly when finished.
- B. If possible, wear an approved static protection strap. If one is not available, touch one hand to the chassis before contacting any other part of the charger.

---

## 9. MOUNTING PROCEDURES

**WARNING:**

**THIS CHARGER IS INTENDED FOR COMMERCIAL AND INDUSTRIAL USE. ONLY TRAINED PERSONNEL WHO ARE QUALIFIED TO PERFORM ELECTRICAL INSTALLATIONS SHOULD INSTALL OR SERVICE THIS UNIT.**

The charger mounts to a wall or other vertical support. The mounting surface must safely support the charger's weight, which is 25 pounds (11.3 kg), and also the weight of the fixed wiring.

Mounting on a concrete surface:

- All mounting hardware is provided by the installer.
- Use optional ¾ inch thick, 18 in. x 24 in. sheet of marine plywood (not provided) to provide a suitable mounting surface for the charger.
- Drill four holes to secure the plywood to the wall using a minimum of four ¼ in. drive pin type expansion anchors to secure the plywood to the wall. Secure the plywood to the wall.
- Drill four holes using the mounting diagram on pg. 4 for ¼ in. (or M6) draw nut type expansion anchors through the plywood into the cement wall.
- Insert the four draw nut type expansion anchors through the plywood into the cement wall.
- Mount charger to draw nut type expansion anchors with nuts and flat washers.



Mounting on a drywall:

- Use ¾ in. thick plywood to span two vertical support members in the wall. The plywood sheet normally does not have to be more than 2 ft. by 2 ft. square.
- Place plywood to avoid electrical wiring, plumbing, etc., concealed behind wall.
- Secure the plywood to the vertical support members using ¼ in. by 2 in. lag bolts and flat washers in a minimum of four places.
- Mark four holes on the plywood using the mounting diagram on pg. 4. Drill pilot holes into the plywood to secure the mounting bolts.
- Mount charger using four ¼ in. by 1/2 in. or M6 lag bolts and flat washers.

Mounting on a metal surface:

- Mount charger using four ¼ -20 by 3/4 in. hex head bolts, flat washers and split lock washers or M6 fastening hardware suitable to attach the battery charger to a frame, panel or cross member in four places. Use the mounting diagram on pg. 4 to place the pilot holes, if needed.
- Tighten all bolts to recommended torque of 45-50 inch pounds.

**10. WIRING**

- A. All wiring must comply with applicable codes and local ordinances. See Section 5 for recommended gauges.
- B. The charger contains a DC output fuse for *internal* fault protection, but this will not protect the DC wiring from fault currents available *from the battery*. **CONSULT NATIONAL CODES AND LOCAL ORDINANCES TO DETERMINE IF ADDITIONAL BATTERY FAULT PROTECTION IS NECESSARY IN YOUR INSTALLATION**

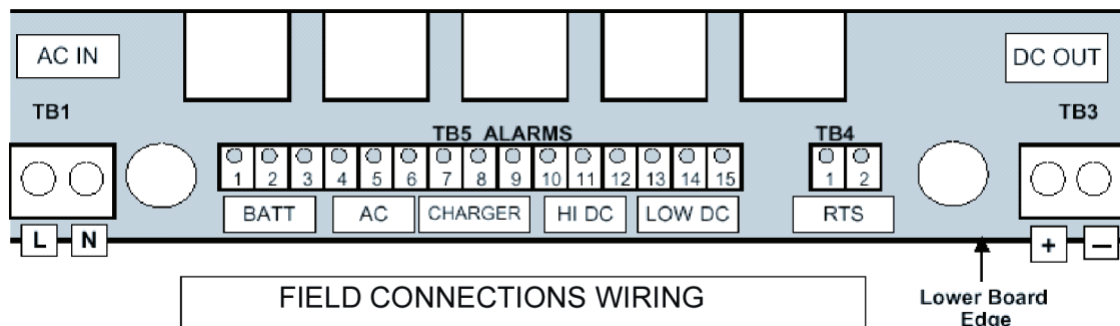
**WARNING:**  
**ENSURE THAT AC POWER IS DISCONNECTED AT THE CIRCUIT BREAKER OR OTHER SAFETY DISCONNECT BEFORE WIRING THE CHARGER.**

- C. Connect the equipment grounding conductor (earthing) to the charger’s grounding terminal. This should always be the first wire connected and the last wire disconnected.
- D. Connect the DC output conductors to TB3. Make the connections in the order shown in Figure 2A (negative ground) or Figure 2B (positive ground). The terminals accept 14 through 6 AWG (2.5 through 16 mm<sup>2</sup>) conductors.

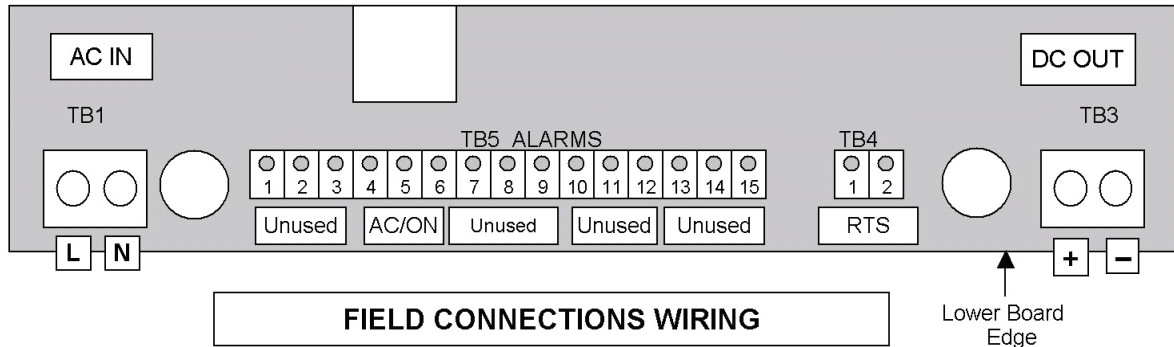
**CAUTION:**  
**OBSERVE POLARITY. THE POSITIVE CHARGER OUTPUT TERMINAL IS LABELED “+” AND THE NEGATIVE TERMINAL IS LABELED “-”.**

**FIVE ALARM MODEL SHOWN- SEE PAGE 3 FOR MODEL NUMBER BREAKDOWN**

**WARNING:**  
**BE SURE TO ROUTE DC POWER WIRING AT LEAST ¼ INCH (6.3 MM) AWAY FROM AC WIRING, ALARM WIRING, AND THE CIRCUIT BOARD.**

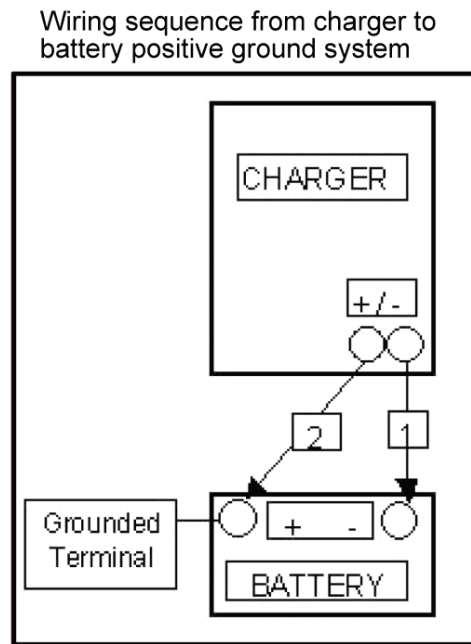
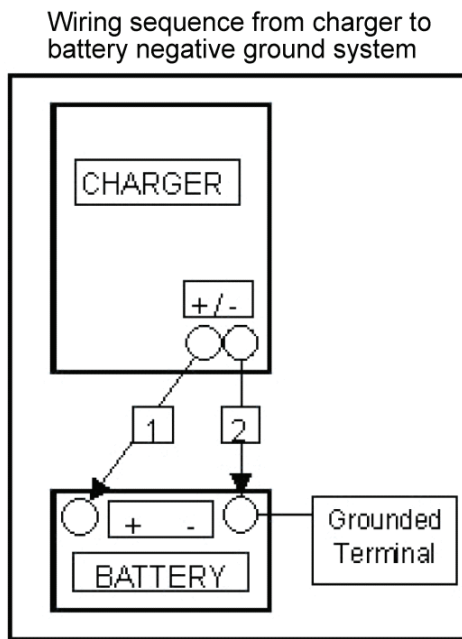


**ONE ALARM MODEL  
SHOWN - SEE PAGE 3  
FOR MODEL NUMBER  
BREAKDOWN**



**FIGURE 2A**

**FIGURE 2B**



- E. Connect the AC line and neutral conductors at TB1. If there is an identified grounded circuit conductor (neutral), attach it to the terminal marked N. TB1 will accept 14-6 AWG (2.5-16 mm<sup>2</sup>) conductors.

**WARNING:**  
**BE SURE TO ROUTE ALL AC WIRING AT LEAST ¼ INCH (6 MM) AWAY FROM DC WIRING, ALARM WIRING, AND THE CIRCUIT BOARD.**

- F. If the optional alarms are used, connect the alarm wiring to their respective terminals on TB5. Route alarm wiring through the plastic bushing below TB5, keeping the conductors at least ¼ inch (6 mm) away from DC wiring, AC wiring, and the circuit board. The terminals accept 24-16 AWG (0.25-1.5 mm<sup>2</sup>) conductors.

**WARNING:**  
**CONNECT ALARM TERMINALS ONLY TO LOW VOLTAGE, LIMITED ENERGY (“CLASS 2”) CIRCUITS. ALARM CIRCUITS ARE RATED 2A AT 30 VDC, 0.5A AT 125 VAC, MAXIMUM SWITCHING CAPACITY 62.5VA, 60W.**

**FIVE ALARM MODEL**

RELAY CONTACTS	BATTERY FAULT ALARM	AC FAIL ALARM	CHARGER FAIL ALARM	HIGH BATTERY ALARM (HI DC)	LOW BATTERY ALARM (LO DC)
Common	TB5-1 COM	TB5-4 COM	TB5-7 COM	TB5-10 COM	TB5-13 COM
OPEN ON ALARM	TB5-2 OK	TB5-5 OK	TB5-8 OK	TB5-11 OK	TB5-14 OK
CLOSE ON ALARM	TB5-3 FAIL Defaults to OK with no AC input	TB5-6 FAIL Defaults to Fail with no AC input	TB5-9 FAIL Defaults to OK with no AC input	TB5-12 FAIL Defaults to OK with no battery	TB5-15 FAIL Defaults to fail with no battery

**ONE ALARM MODEL**

RELAY CONTACTS	Not Used	MASTER ALARM	Not Used	Not Used	Not Used
Common	TB5-1 No Connection	TB5-4 COM	TB5-7 No Connection	TB5-10 No Connection	TB5-13 No Connection
OPEN ON ALARM	TB5-2 No Connection	TB5-5 OK	TB5-8 No Connection	TB5-11 No Connection	TB5-14 No Connection
CLOSE ON ALARM	TB5-3 No Connection	TB5-6 FAIL Defaults to Fail with no AC input	TB5-9 No Connection	TB5-12 No Connection	TB5-15 No Connection

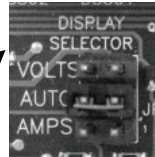
- G. If the optional remote temperature sensor is used:
- Remove the internal sensor at TB4, if it is present.
  - Locate the remote sensor where it will accurately detect the battery temperature.
  - Connect the remote sensor leads to TB4. The sensor is not polarized, so it does not matter which lead connects to terminal #1.
  - Route sensor wiring through the plastic bushing below TB5, keeping the conductors at least ¼ inch (6 mm) away from DC wiring, AC wiring, and the circuit board.

- H. Verify that all connections are secure and in the proper locations. Tighten all unused screws on the terminal blocks to secure them against vibration.
- I. Ensure all wires are routed so the cover will not pinch them.

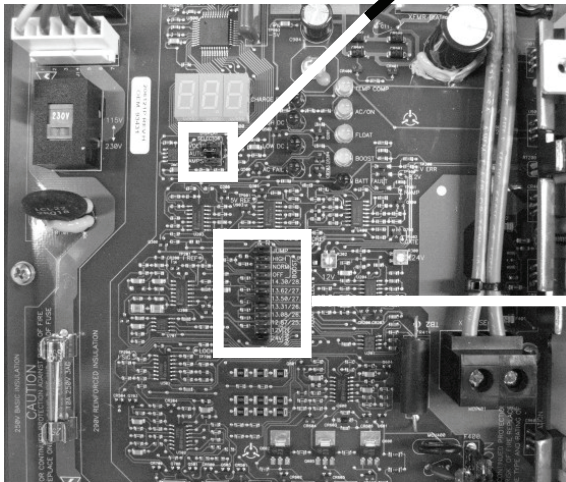
## 11. INTERNAL ADJUSTMENTS

**WARNING:**  
**MAKE SURE THE AC POWER TO THE CHARGER IS SHUT OFF WHILE MAKING THE FOLLOWING ADJUSTMENTS.**

AC line voltage switch  
 110-120V: Use 115V position  
 208-240V: Use 230V position



Meter Display Jumper JP800. Choose VOLTS, AMPS, or AUTO for meter display view.



**SAME FOR ALL MODELS**

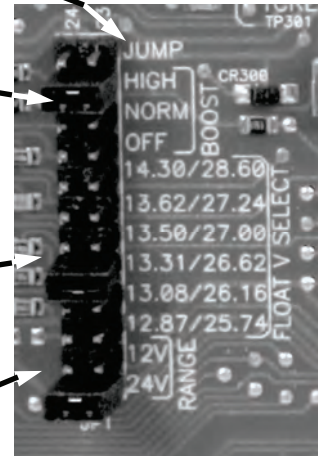
“Jump start” battery initialization mode

Jumper JP1.  
 Configure battery and output voltage settings.

Automatic boost jumper  
 Use NORM setting for fast charge. Use Off setting for float charge

Float voltage jumper  
 Set according to battery supplier's specifications

Battery range jumper  
 (12V or 24V battery)



- A. Set the AC voltage select switch (SW100) according to the line voltage. Use the 115V position for nominal mains voltages between 110V and 120V. Use the 230V position for nominal mains voltages between 208V and 240V.
- B. Set the battery range jumper (JP1A) according to nominal battery voltage. Use the 12V position for 12V batteries. Use the 24V position for 24V batteries.
- C. Set the boost mode jumper (JP1B) according to whether the battery should have automatic boost charging. If the battery manufacturer recommends boost charging (equalization) use the NORMAL position. If not, use the OFF position.
- D. Set the float voltage select jumper (JP1C) according to the battery manufacturer's recommended 25°C float voltage. The settings are:
  - 14.30/28.60 for 10 or 20 cell Nickel Cadmium at 1.43V/cell
  - 13.62/27.24 for 6 or 12 cell (VRLA) lead-acid at 2.27V/cell, and for 19 cell Nickel Cadmium at 1.43V/cell
  - 13.50/27.00 for 6 or 12 cell (VRLA or high capacity) lead-acid at 2.25V/cell, and for 19 cell Nickel Cadmium at 1.42V/cell
  - 13.31/26.62 for 6 or 12 cell (flooded) lead-acid at 2.22V/cell, and for 19 cell Nickel Cadmium at 1.40V/cell
  - 13.08/26.16 for 6 or 12 cell lead-acid at 2.18V/cell
  - 12.87/25.74 for 9 or 18 cell Nickel Cadmium at 1.43V/cell

- E. Set the Display Selector jumper to one of the 3 available positions on JP800 (see photograph previous page):
- VOLTS – Place the short jumper in the “upper” position next to the word “VOLTS”. The 3-digit LED meter display will show DC Volts only
  - AUTO – Place the short jumper in the center position next to the word “AUTO”. The 3-digit LED meter display will automatically and continuously alternate between DC Amps and DC Volts. The display shows DC Amps for approximately 6 seconds and DC Volts for approximately 3 seconds.
  - AMPS – Place the short jumper in the “lower” position next to the word “AMPS”. The 3-digit LED meter display will show DC Amps only.

**WARNING:**

**USE ONE JUMPER ONLY ON THE DISPLAY SELECTOR JP800. USE ONLY THE “SHORT” JUMPER PROVIDED FOR JP800, TO AVOID INTERFERENCE WHEN REPLACING THE COVER (“TALL” JUMPERS ARE TO BE USED ONLY ON JP1).**

- F. The JUMP position allows initial charging of Nickel Cadmium batteries, or new lead acid batteries supplied from the manufacturer dry and discharged, from a zero charge state. The JUMP feature can also be used when recharging excessively discharged batteries already in service. To initially charge/commission zero charge batteries, place a jumper (spare provided with charger) in the JUMP position on JP1. Operate the charger long enough to retain more than 1.5V/cell for lead acid and 1.0V/cell for nickel cadmium batteries or until the charger returns to FLOAT MODE (FLOAT MODE LED will be green). See SENS Application Note 10 to finish fully commissioning the batteries, as using the JUMP feature alone is not sufficient. Once the batteries are fully charged, the jumper may be removed or left in the JUMP position permanently. The jumper may remain in the JUMP position permanently to ensure that the charger is able to recharge very low or dead batteries. If battery voltage is below 9V (12V system) or 18V (24V system) when AC power is restored and the JUMP feature is not activated, the charger will go into Battery Fault (alarm state that disables charger). In this situation the charger will not charge the batteries. If the JUMP feature is enabled when AC power is restored, the charger will begin charging. Depending on the battery state of charge, the charger may go into Battery Fault and remain so for some period of time (generally 12 – 24 hours) while the batteries are slowly charged. The Battery Fault LED will cycle (approximately once every minute) during this time. Once Battery Fault stops cycling, the charger will return to FLOAT or BOOST MODE as normally demanded.

**WARNING:**

**USE THE JUMP FEATURE ONLY WITH LIQUID ELECTROLYTE NICKEL-CADMIUM BATTERIES, OR WITH RECENTLY FILLED NEW LEAD ACID BATTERIES SUPPLIED FROM THE MANUFACTURER DRY AND DISCHARGED. WHILE THE JUMP FEATURE MAY BE USED TO CHARGE EXCESSIVELY DISCHARGED LEAD ACID BATTERIES THAT HAVE ALREADY BEEN IN SERVICE, CONSULT THE BATTERY MANUFACTURER TO DETERMINE IF AND HOW THEY CAN SAFELY BE RESTORED TO SERVICE.**

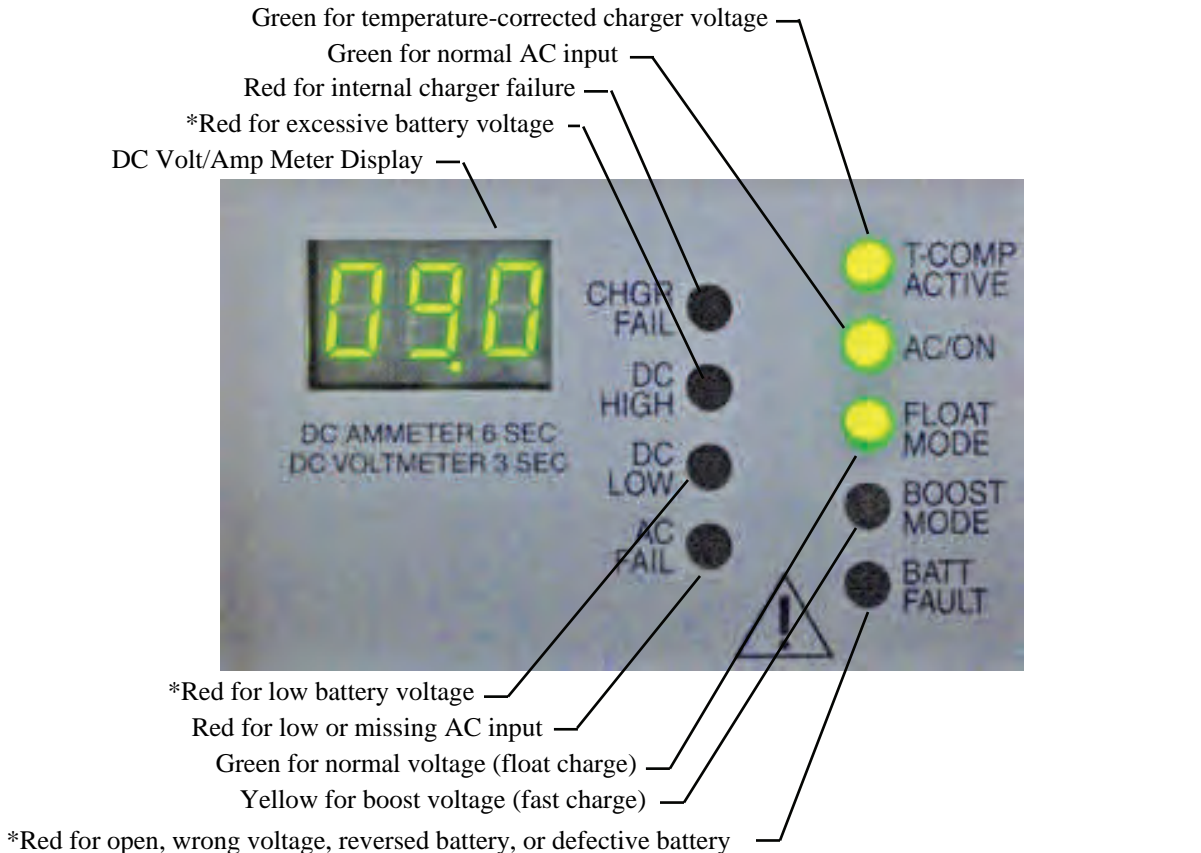
**WARNING:**

**LEAVING A JUMPER IN THE JUMP POSITION DISABLES THE BATTERY VOLTAGE INTERLOCK, WHICH INCREASES THE RISK OF ACCIDENTALLY OVERCHARGING 12V BATTERIES WITH 24V SETTINGS. INCORRECT CHARGE VOLTAGE WILL ACCELERATE GENERATION OF EXPLOSIVE GASES, INCREASING THE RISK OF FIRE OR EXPLOSION.**

- G. Replace the cover by sliding it straight onto the charger. Ensure the cover’s locating tabs engage the slots in the chassis. Secure the cover with its four mounting screws.



## 12. CHECK OUT



\* Active only on five alarm models - see page 3 for model number breakdown

### See OPERATOR INSTRUCTION section for LED indicator definitions:

- A. Verify the status LEDs:
  - **AC FAIL** should be **ON**. If not, the DC output may be open or reversed, or the battery may be extremely discharged.
  - **BATT FAULT** should be **OFF**. If it lights, check for reversed polarity of the DC wiring.
  - The **DC LOW** (Low Battery) LED may be either on or off, depending on the battery's state of charge.
  - All other LEDs and the meter display should be off.
  - If the **DC HIGH** LED is on, check battery voltage jumper setting.
- B. Apply AC power by closing the branch circuit breaker and any other disconnect devices.
- C. The meter display should light immediately after power on. The green **AC/ ON** LED should be lighted. If a temperature sensor is present, either internal or remote, the green **T-COMP** (Temperature Compensation) LED should be lighted.
- D. If the **BATT FAULT** LED lights when AC is applied, this indicates that the battery voltage does not agree with the **Range** jumper setting. The charger is interlocked, and will not operate in this condition. Disconnect AC power, then correct the jumper setting or battery voltage before proceeding.
- E. After a short delay (typically 10 seconds or less), the charger will produce output.
- F. If the meter display jumper is selected to read Amps or automatic Volts/Amps:
  - Current should be close to 10A if the battery requires recharging. If automatic boost is enabled, the **BOOST MODE** LED may light, in which case the battery will be charged until it reaches 106% of the float voltage. If boost is disabled, the green **FLOAT MODE** LED should be on and the battery will charge until it reaches the float voltage setting.
  - Output current will be low if the battery is fully charged, possibly too low to read on the meter. This is normal, provided the correct charging voltage is present. The green **FLOAT MODE** LED should light when output current is below approximately 9 A (5A for single alarm).

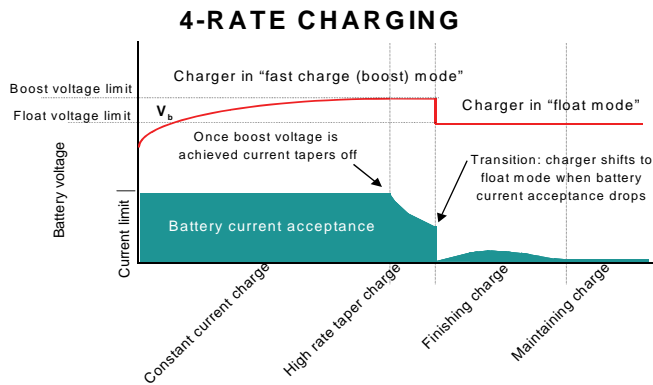
## OPERATOR INSTRUCTIONS

**WARNING:**  
**NO OPERATOR SERVICEABLE PARTS INSIDE.**  
**DO NOT OPEN. COVER MUST BE IN PLACE DURING USE.**  
**USE THIS CHARGER FOR CHARGING LEAD-ACID OR NICKEL-CADMIUM BATTERIES ONLY.**

### A. ADVANCED DESIGN FEATURES

#### Battery Friendly:

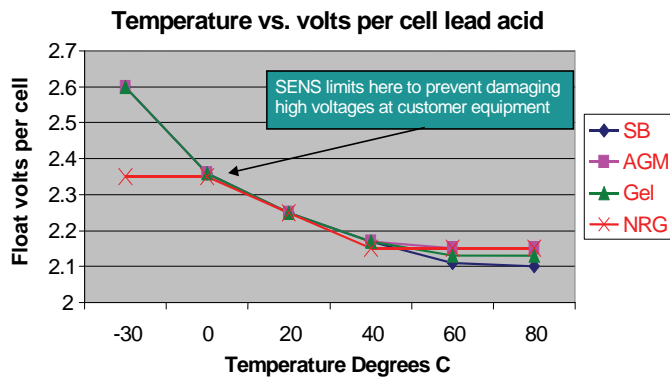
- Float and boost voltage selectable at install per specific battery vendor recommendations.
- Remote temperature compensation for most accurate float and boost voltage control.
- Able to charge a dead battery.
- Float and Boost voltage electronically controlled with a 4-rate fast charge program. See chart below.



#### Temperature Compensation:

- The battery charger is temperature compensated to match the negative temperature coefficient of the battery. Thus, the output voltage will increase slightly as the temperature decreases and decrease as temperature increases.
- The output voltage is clamped at 0 and +40 Degrees C to protect against extremely high or low output voltage. See chart below.

#### AUTOMATIC TEMPERATURE COMPENSATION



**Fault Tolerant:** The charger is protected from the following faults:

- Internal power component failures.
- Over heating (over temperature output power reduction).
- Protected against power line transients and surges.

#### Battery Fault Protection and Alarm:

- The battery charger automatically checks the battery voltage before power-on startup. If the battery volt-

age is either too high or too low, the charger enters a “lockout” period for approximately 10 seconds before attempting an automatic restart.

- The “JUMP” feature (described in Section 11-F in this manual) may be used to allow the battery charger to override the lockout and start charging a low-voltage discharged battery.
- The battery charger will not start if the battery or battery cables have a short circuit, and will start automatically with a good battery if the short circuit is removed.
- In addition to detecting low battery voltage and short circuits, the battery charger also monitors the peak voltage at its DC output terminals and will enter lockout if the DC cable resistance is too high or if the battery’s internal resistance is too high.
- If a battery is connected backwards, this reverse polarity condition will keep the battery charger in lockout and it will remain in lockout until the battery is disconnected. A reverse polarity condition will not blow a fuse; the battery charger will start and run normally when a good battery is connected with correct polarity.
- Whenever one of these fault conditions triggers the battery fault protection circuitry as described above, the “Batt Fault” relay and LED are both activated.
- If polarity is correct, DC cables OK, and the “JUMP” feature attempted, the battery fault alarm most likely indicates a defective battery. Replace with a new battery.

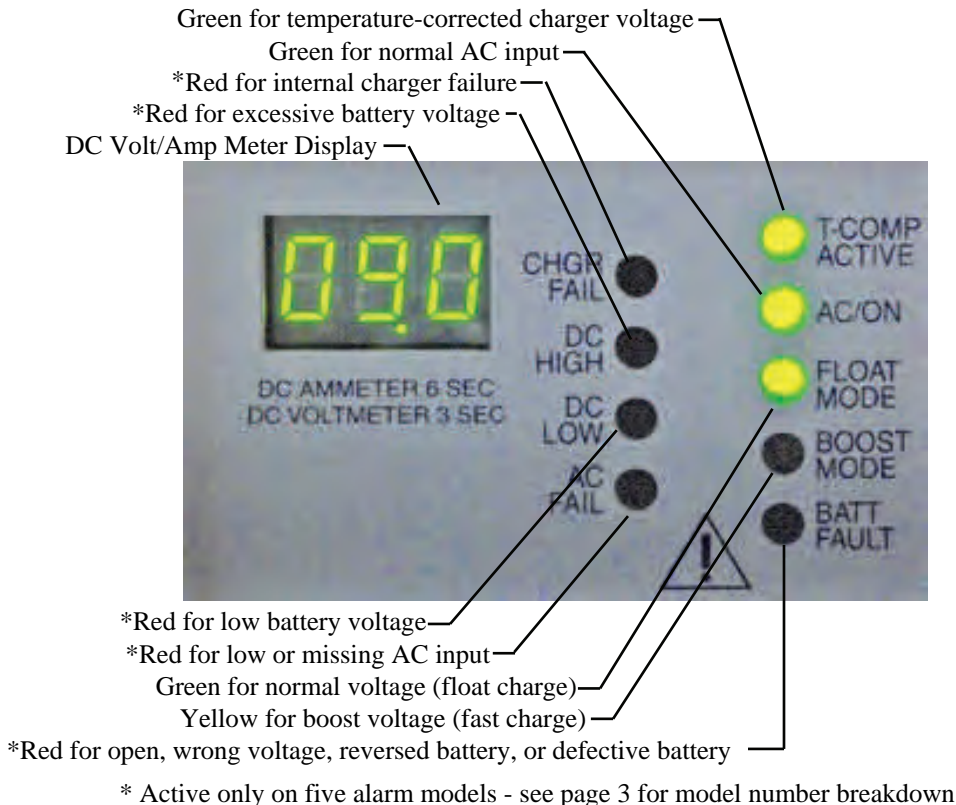
**Robust Hardened Construction:**

- Shock and Vibration tested to UL 991, 2G.
- Shock and Vibration tested to UL 991, 5G option available.
- Lightning transient immunity to ANSI/IEEE C62.41 Cat. B and EN 50082-2 heavy industrial.
- Wide operating temperature range: -20 to + 40 Degrees C. Charger will operate at reduced output current rating up to +60 Degrees C.
- Conformal coated printed wiring boards for erosion protection.

**Worldwide Agency Approvals:**

- UL listed, UL 1012, UL 1236.
- CUL listed to CSA C22.2 107.2- M89.
- CE marked for EMC directive (industrial environment) and EN 60335-2-29.
- Worldwide operating voltage and frequency ranges.

**B. FRONT PANEL LED INDICATOR DEFINITIONS AND TROUBLE SHOOTING:**

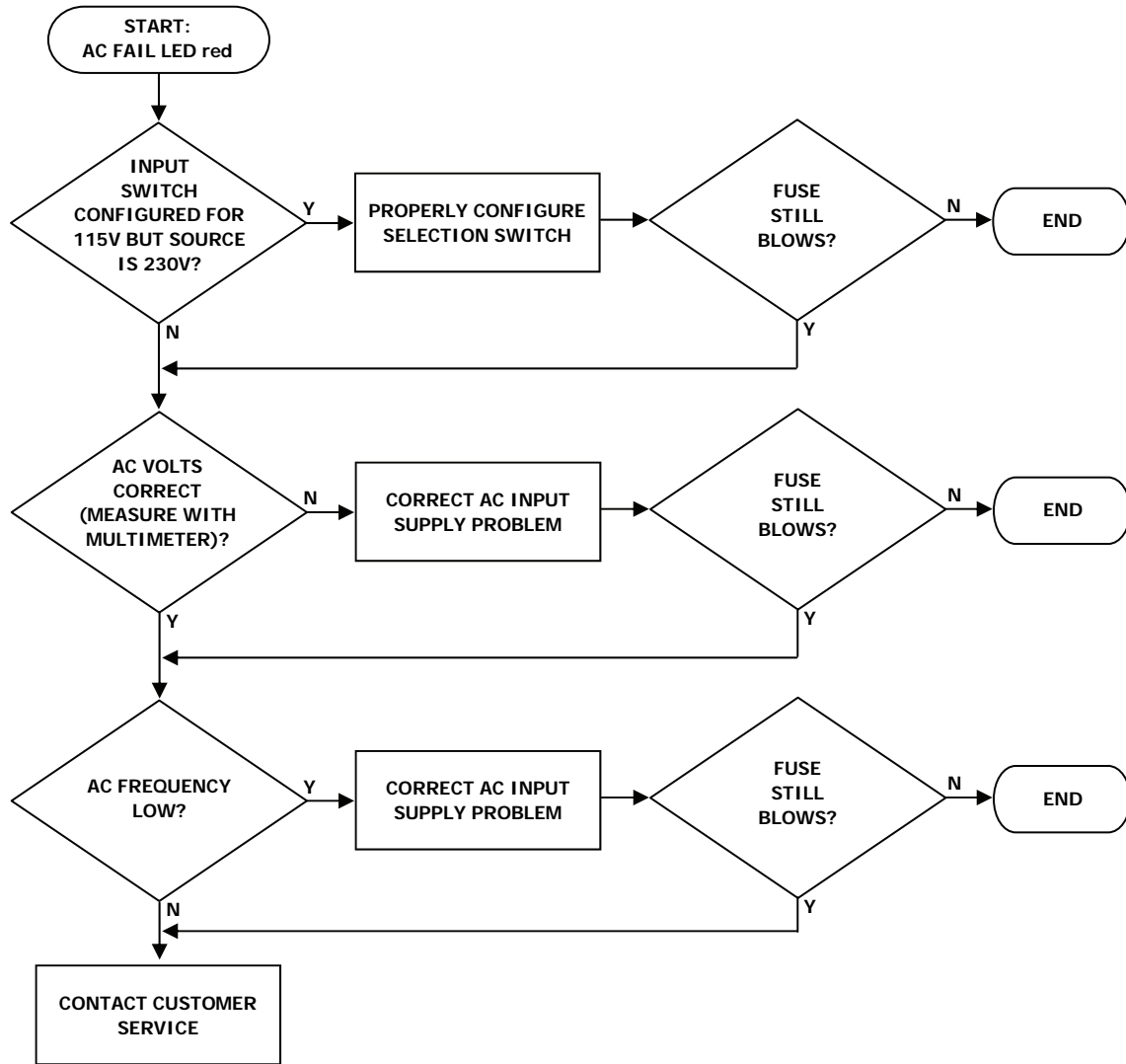




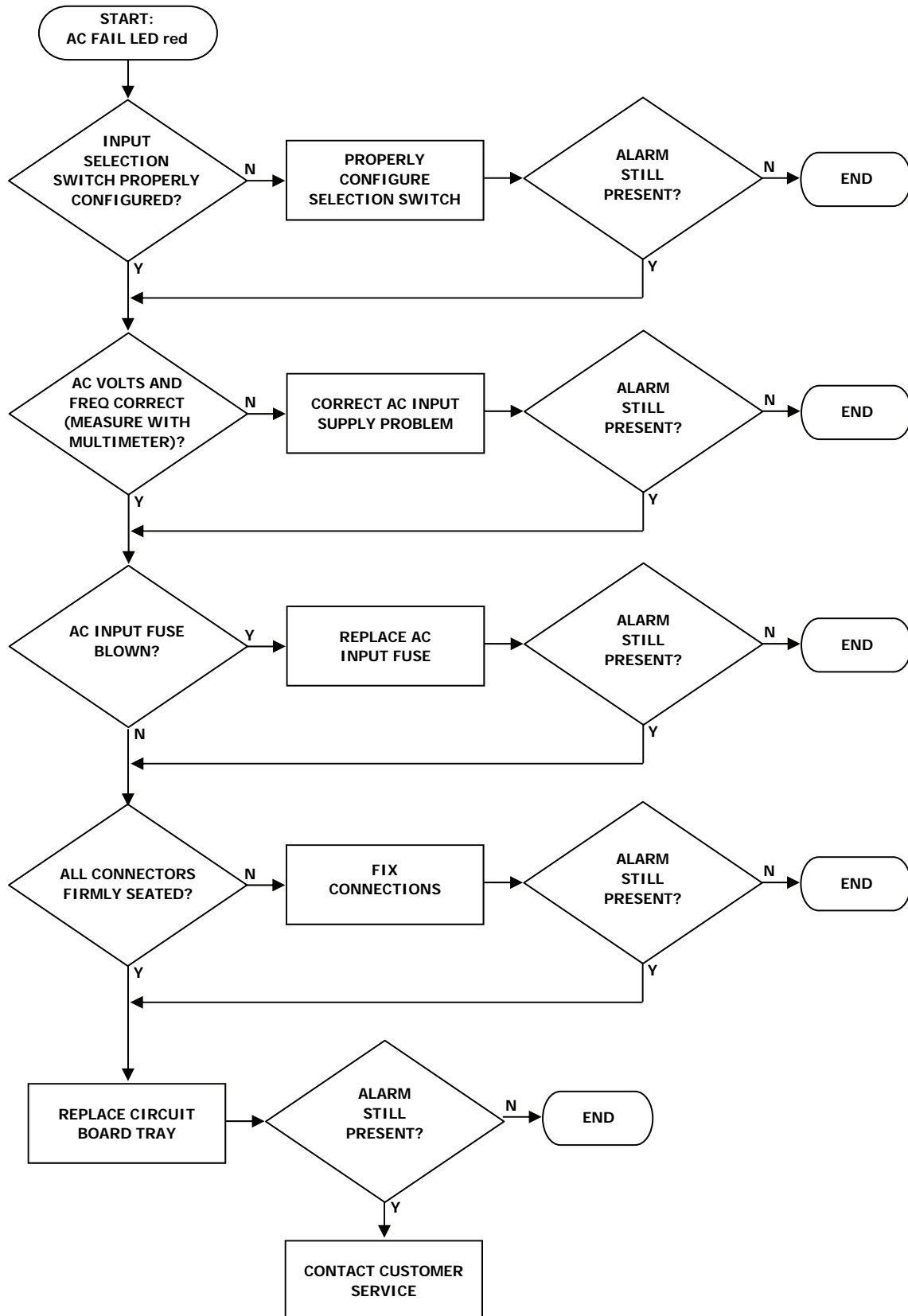
ITEM	TEXT	LED	Meaning	Troubleshooting
1	CHGR FAIL	RED	Charger Fail	Charger unable to provide charging current to battery. Replace unit. AC input voltage is too low to supply proper current when load is applied. Control board is damaged and should be re-
2	* DC HIGH	RED	Battery DC Voltage High	Check that the battery range voltage jumper setting agrees with battery used. High battery alarm voltage is 17v for 12v system
3	DC LOW	RED	Battery DC Voltage Low	Check that battery range voltage jumper setting agrees with battery used. Check for defective battery. Check DC load. Low battery alarm voltage is 12v for 12v system
4	AC FAIL	RED	Input AC Missing	Check AC input voltage to charger. Have qualified installer check AC line voltage switch setting. Setting must agree with AC voltage at site. Check AC fuse.
5	T-COMP	GREEN	On if Temperature Compensation Working, Off if Temperature Compensation Option not used.	Confirm if temperature compensation is intended to be used. Only one sensor (Local or remote) should be connected.
6	AC/ ON	GREEN	1 alarm model: Charger operating normally 5 alarm model: AC input good	Should be on in normal use. 1 alarm model: If LED is OFF, AC FAIL, CHGR FAIL or BATT FAULT LED should be ON. 5 alarm model: If LED is OFF, AC FAIL should be ON.
7	FLOAT MODE	GREEN	Charger Output in Float Mode	If the automatic boost jumper is in the OFF location, this LED will always be on. If the automatic boost jumper is in the "NORM" location, this LED will come on after the battery
8	BOOST MODE	AMBER	Charger Output in Boost Mode	This LED will not be on if the automatic boost jumper is in the OFF location, or if the automatic boost jumper is in the "NORM" location and the battery is nearly fully charged up.
9	BATT FAULT	RED	Battery Fault-Charger automatically disabled:	<ul style="list-style-type: none"> <li>• Battery reversed.</li> <li>• High resistance in charger leads (leads too small, too long , poorly connected, open).See Section 5 for information on wire length and gauge.</li> <li>• Battery internal open circuit.</li> <li>• Battery voltage does not match charger voltage range</li> <li>• Defective Battery, replace with new battery</li> </ul>

\* Active only on five alarm models - see page 3 for model number breakdown

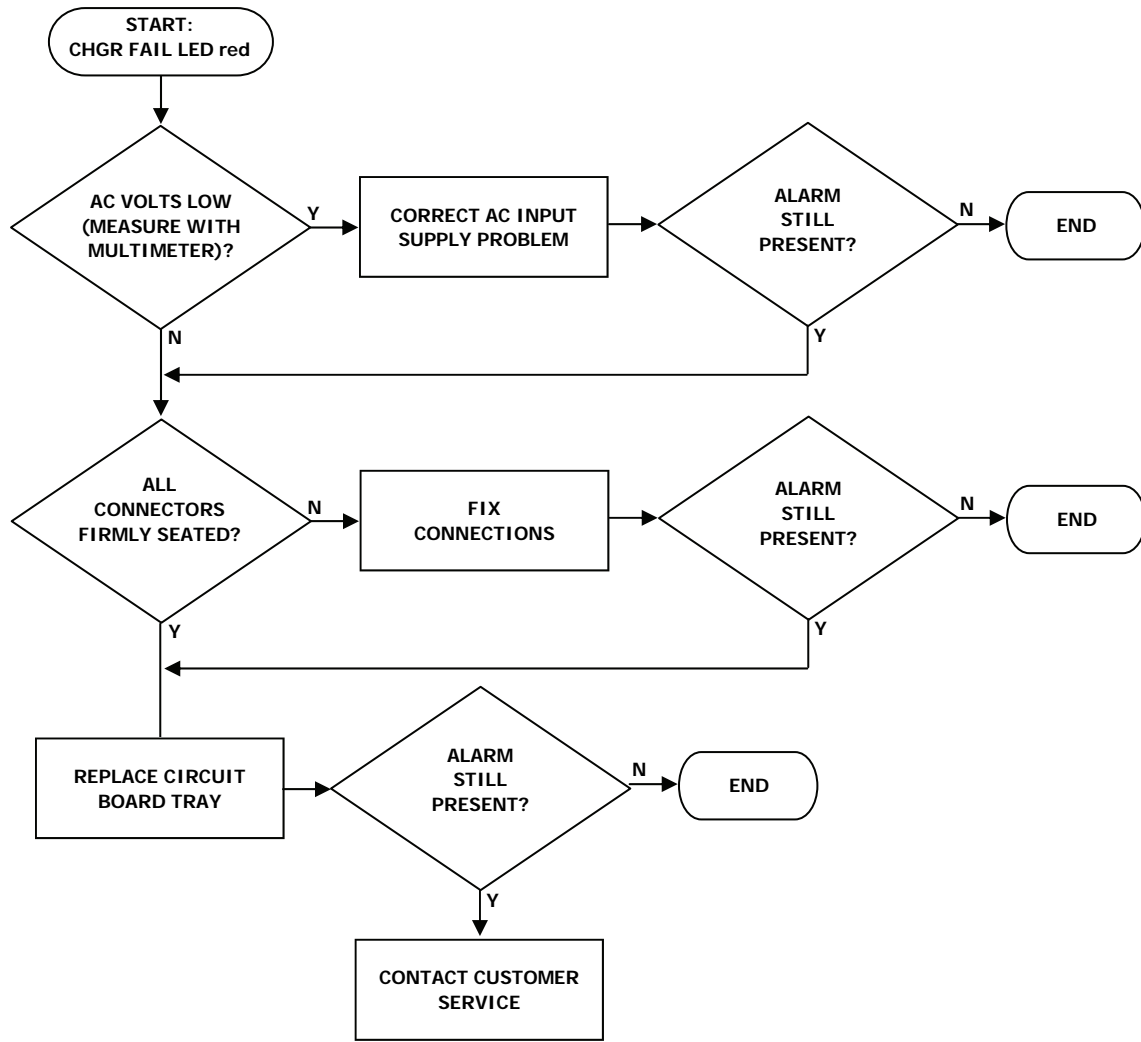
**TROUBLESHOOTING GUIDE—REPEATED BLOWN AC FUSE**



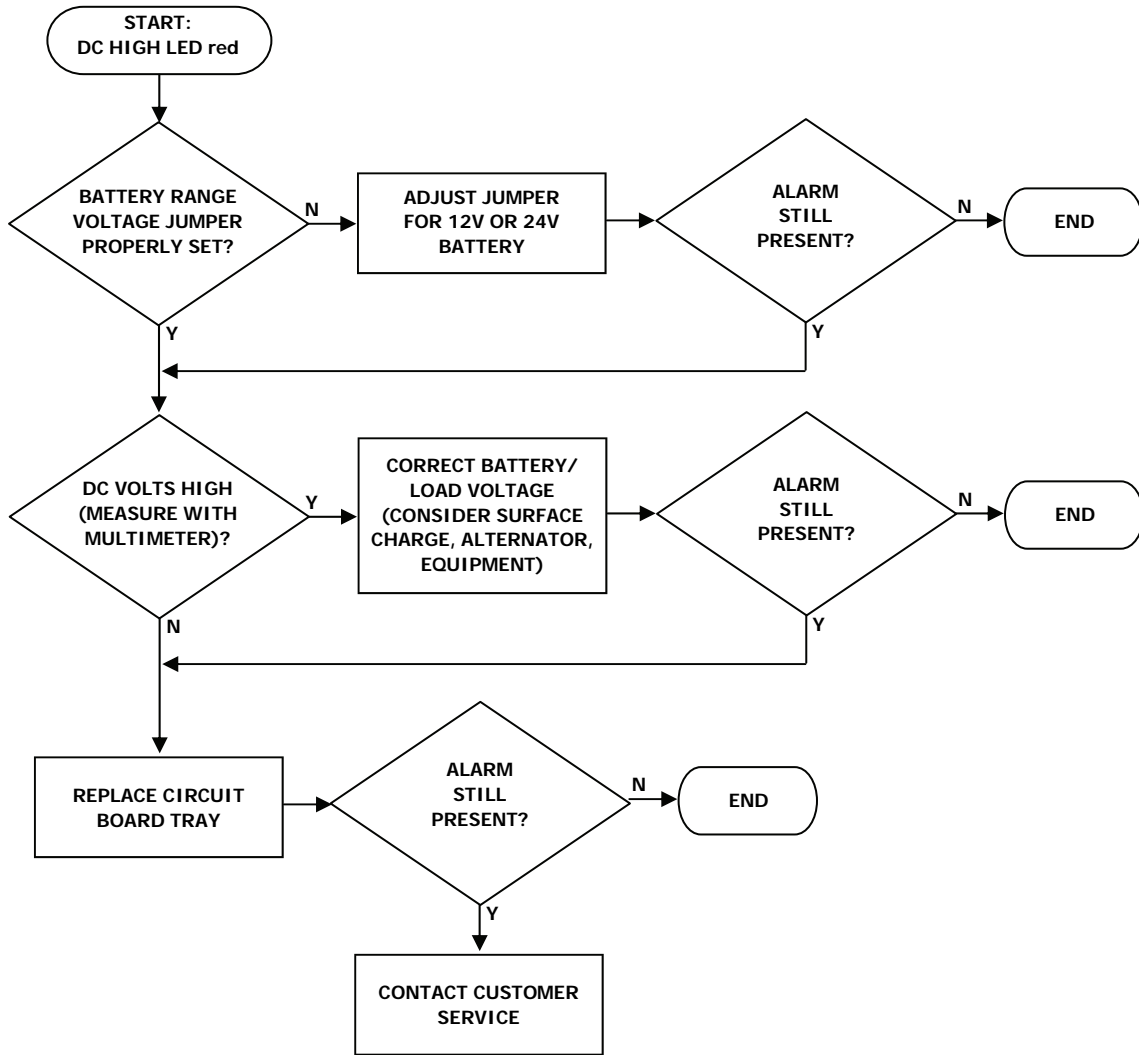
**TROUBLESHOOTING GUIDE—AC FAIL ALARM**



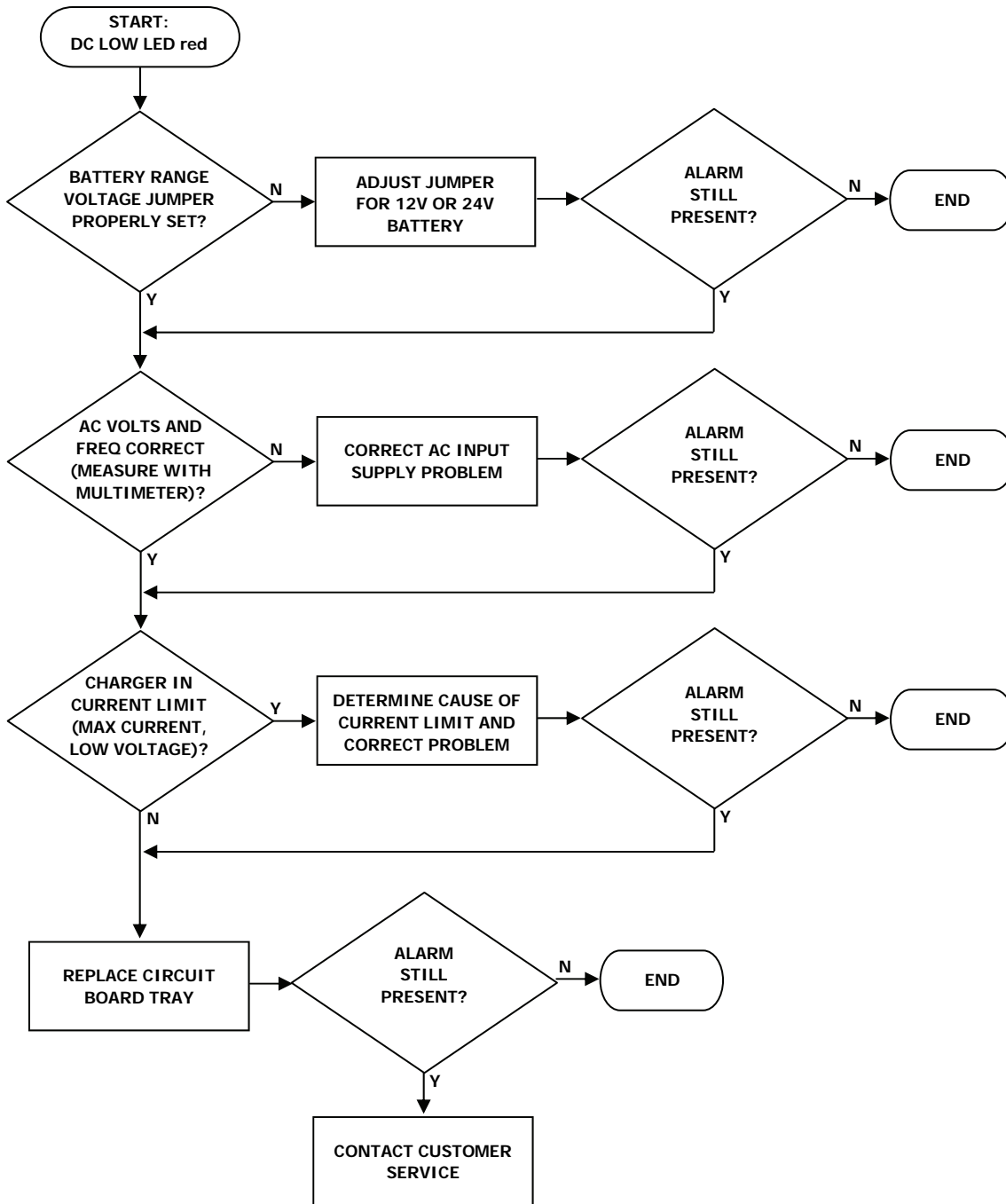
**TROUBLESHOOTING GUIDE—CHARGER FAIL ALARM**



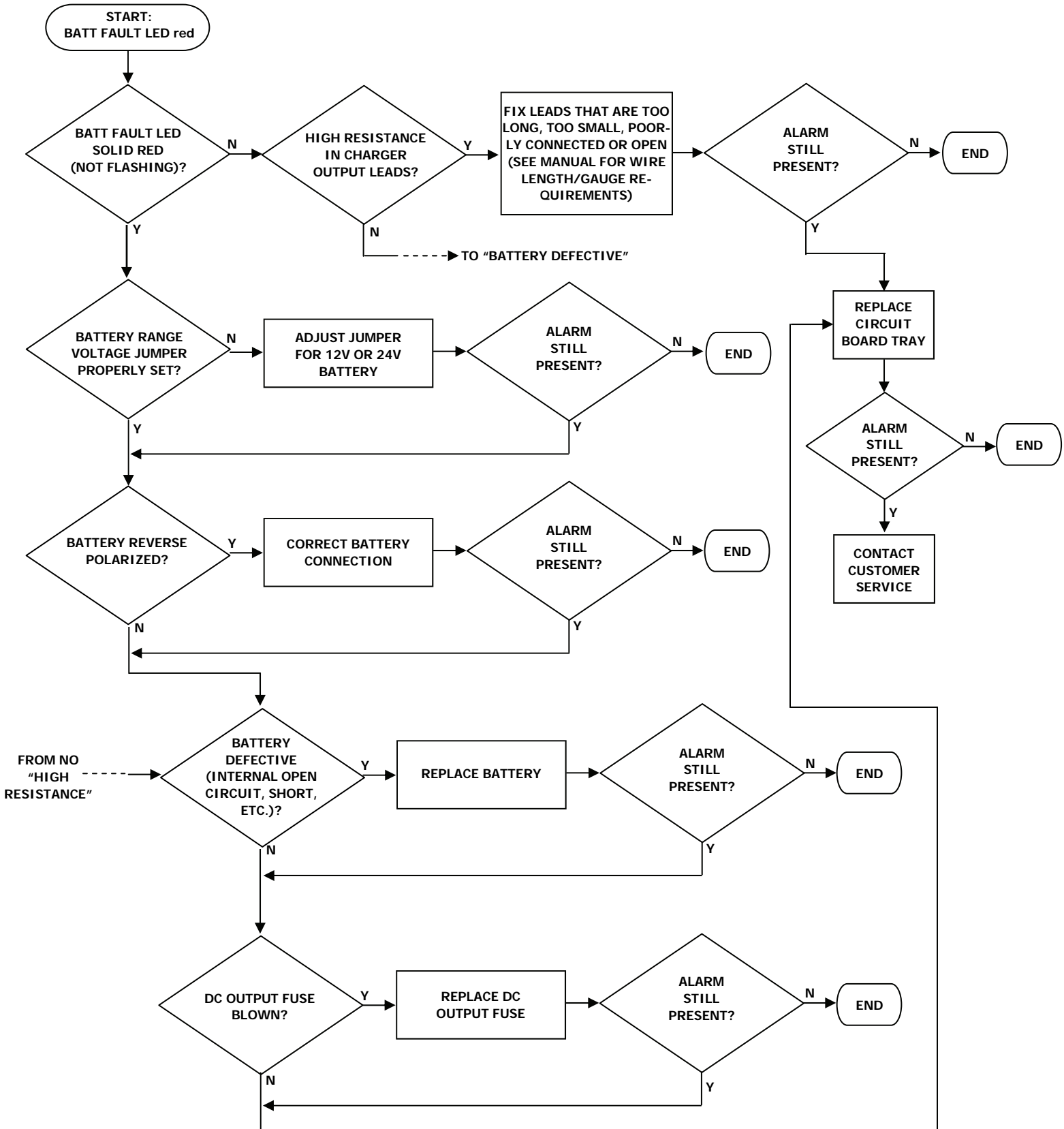
**TROUBLESHOOTING GUIDE—DC HIGH ALARM**



**TROUBLESHOOTING GUIDE—DC LOW ALARM**



**TROUBLESHOOTING GUIDE—BATTERY FAULT ALARM**



**NORMAL SET UP:**

1. Apply AC power by closing the branch circuit breaker and any other disconnect devices.
2. The meter display should light immediately after power on. The green **AC/ ON** LED should be lighted. If a temperature sensor is present, either internal or remote, the green **T-COMP** (Temperature Compensation) LED should be lighted.
3. After a short delay (typically 10 seconds or less), the charger will produce output. If the meter display jumper is selected to read Volts or automatic Volts/Amps, the voltmeter reading should increase, indicating the battery is being charged.
4. If the meter display jumper is selected to read Amps or automatic Volts/Amps:
  - Current should be close to 10A if the battery requires recharging. If automatic boost is enabled, the **BOOST MODE** LED may light, in which case the battery will be charged until it reaches 106% of the float voltage. If boost is disabled, the green **FLOAT MODE** LED should be on and the battery will charge until it reaches the float voltage setting.
  - Output current will be low if the battery is fully charged, possibly too low to read on the meter. This is normal, provided the correct charging voltage is present. The green **FLOAT MODE** LED should light up when output current is below approximately 9.0 A (5A for single alarm).

**C. ALARM DESCRIPTION, FIVE ALARM MODEL:**

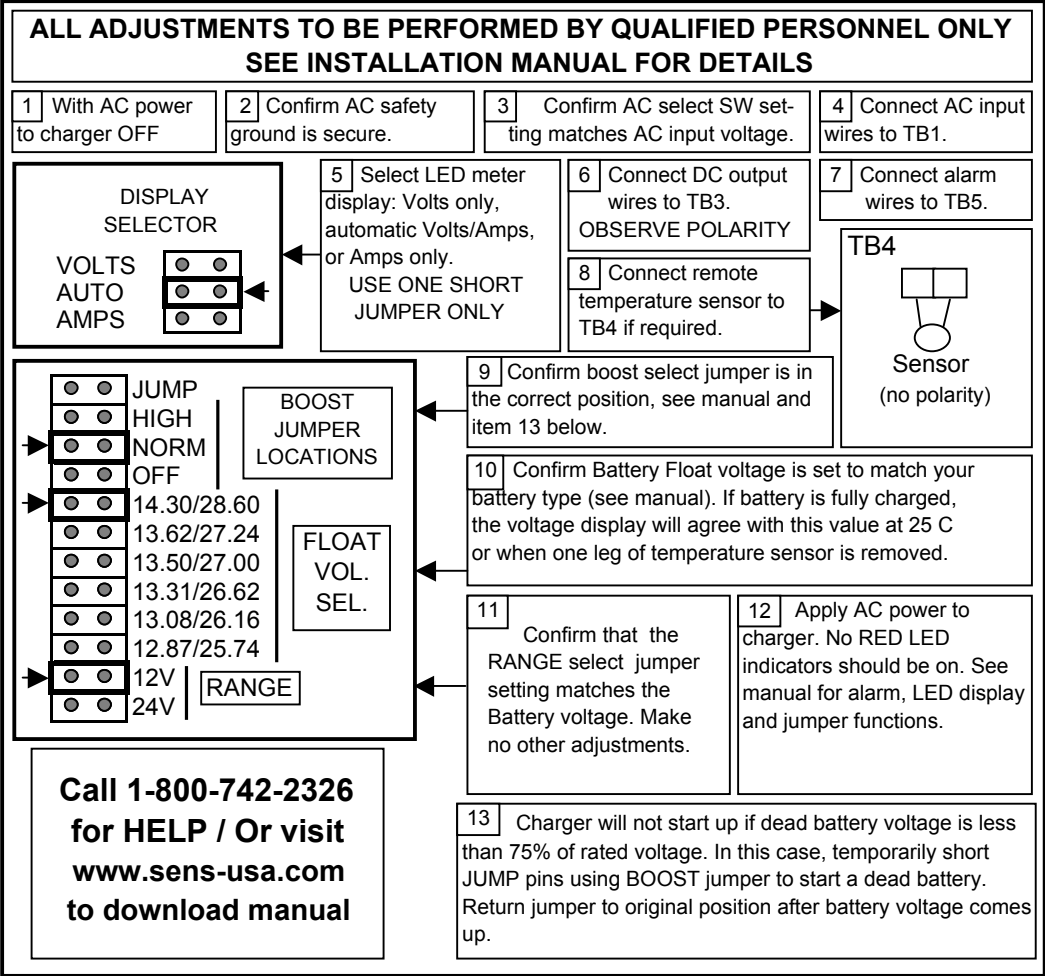
RELAY CONTACTS	BATTERY FAULT ALARM	AC FAIL ALARM	CHARGER FAIL ALARM	HIGH BATTERY ALARM (HI DC)	LOW BATTERY ALARM (LO DC)
COMMON	TB5-1 COM	TB5-4 COM	TB5-7 COM	TB5-10 COM	TB5-13 COM
OPEN ON ALARM	TB5-2 OK	TB5-5 OK	TB5-8 OK	TB5-11 OK	TB5-14 OK
CLOSE ON ALARM	TB5-3 FAIL Defaults to OK with no AC input	TB5-6 FAIL Defaults to Fail with no AC input	TB5-9 FAIL Defaults to OK with no AC input	TB5-12 FAIL Defaults to OK with no battery	TB5-15 FAIL Defaults to fail with no battery

**D. ALARM DESCRIPTION, ONE ALARM MODEL:**

RELAY CONTACTS	Not Used	* MASTER ALARM	Not Used	Not Used	Not Used
COMMON	TB5-1 No Connection	TB5-4 COM	TB5-7 No Connection	TB5-10 No Connection	TB5-13 No Connection
OPEN ON ALARM	TB5-2 No Connection	TB5-5 OK	TB5-8 No Connection	TB5-11 No Connection	TB5-14 No Connection
CLOSE ON ALARM	TB5-3 No Connection	TB5-6 FAIL Defaults to Fail with no AC input	TB5-9 No Connection	TB5-12 No Connection	TB5-15 No Connection

\* The MASTER ALARM is a summary alarm. It will close on CHGR FAIL, AC FAIL or BATT FAULT.





**Call 1-800-742-2326  
for HELP / Or visit  
[www.sens-usa.com](http://www.sens-usa.com)  
to download manual**

5.00" max

5.00" max

**NOTES:**

1. LETTERING TO BE BLACK INK ON SILVER FOIL LABEL, MATERIAL RATED PER R/C (PGDQ2). LABEL ADHESIVE PROVIDED MUST BE SUITABLE FOR USE ON ALUMINUM & RATED FOR 80 DEG C MINIMUM.
2. PSA MATERIAL IS TO BE PROVIDED WITH RELEASE LINER.
3. RADIUS CORNERS .125" MAXIMUM.
4. THIS DRAWING NOT TO SCALE.



DCN No.	105963		
Drawn By:	HN	Date:	2/7/2011
Approved By:		Date:	
DWG Name:	LABEL, INSIDE COVER, NRG10/20		
PN: 808526	DWG REV.	E	

# STOP!

Verify that all settings shown below are correct *before energizing charger*. **CAUTION:** Correct settings are essential to ensure proper battery performance and long battery life. *Before installation*, ensure adequate battery to charger wire gauge. Wire gauge that is too small may activate the open battery detector and the charger will shut down:

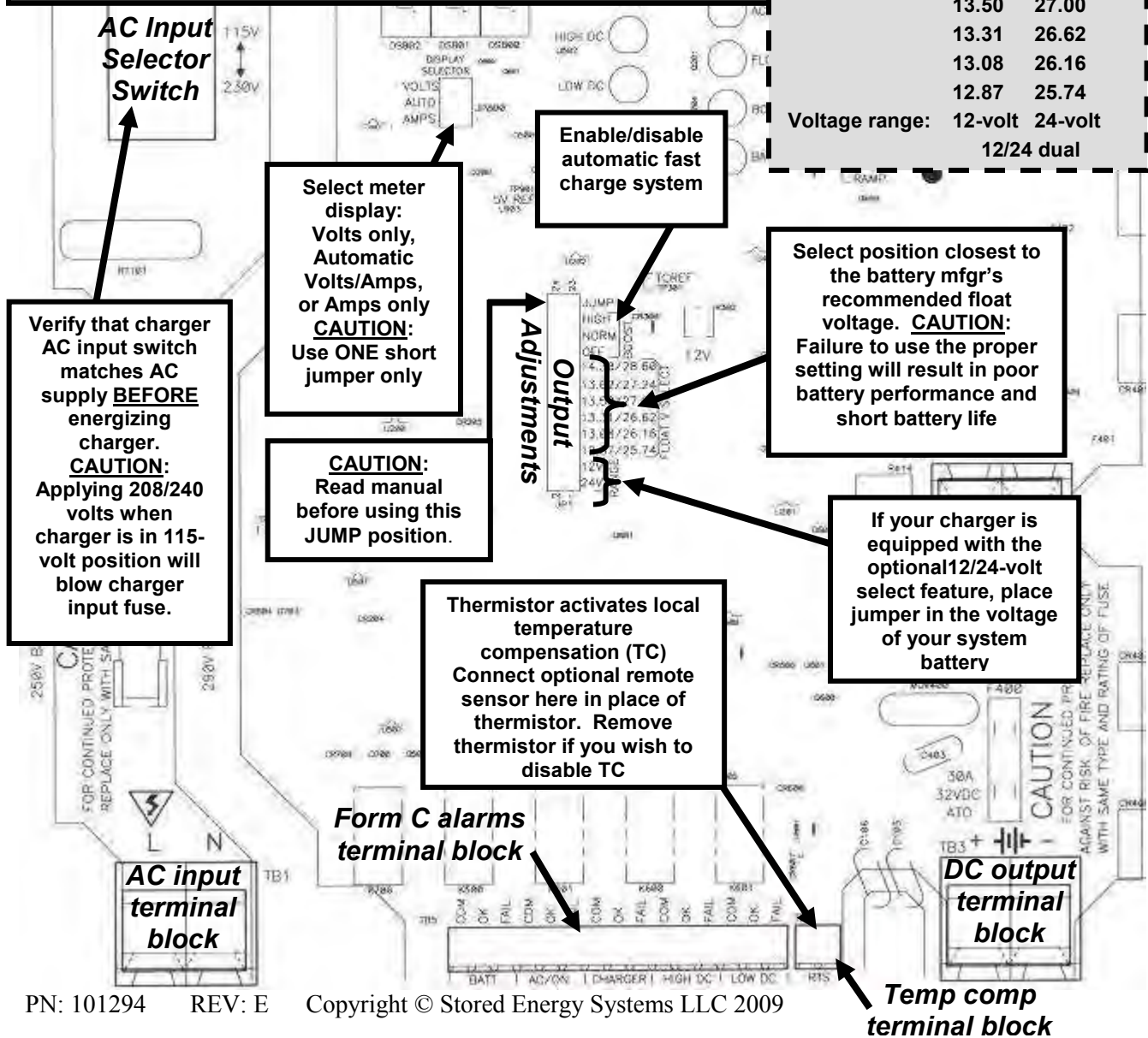
AWG	Recommended Charger to Battery Distance (Ft.)			
	12V/10A	24V/10A	12V/20A	24V/20A
10	10	19	N/A	N/A
8	15	30	7	15
6	24	48	12	24

For runs exceeding the above values, call SENS at 1-800-742-2326 or (303) 678-7500.

## FACTORY SETTINGS

Charger is factory set for the following settings. Change the setting if needed for your battery or site conditions

Input:	208-240 VAC
	120 VAC
Jump:	DISABLED
Fast charge:	ENABLED / OFF
Float voltage:	14.30 28.60
	13.62 27.24
	13.50 27.00
	13.31 26.62
	13.08 26.16
	12.87 25.74
Voltage range:	12-volt 24-volt
	12/24 dual





## **SENS Limited Warranty: NRG Series Battery Charger**

### **What is covered?**

This warranty covers any defect in material and workmanship on NRG model battery chargers manufactured by Stored Energy Systems, a Colorado Limited Liability Company (SENS).

### **What this warranty does not cover:**

This warranty does not cover damages, defects or failures of your equipment resulting from shipping damage, accidents, installation errors, unauthorized adjustment or repair, unauthorized third-party service, failure to follow instructions, misuse, fire, flood, acts of persons not in our control, and acts of God.

### **For how long:**

Three years from date of shipment, except magnetic parts and power semiconductors, which are covered for 10 years.

### **What we will do:**

If your battery charger is defective within the warranty period, we will repair it or, at our option, replace it at no charge to you.

If we choose to replace your charger, we may replace it with a new or refurbished one of the same or similar design. The repair or replacement will be warranted for the remainder of the original warranty period. If we determine that your charger cannot be repaired or replaced, we will refund its purchase price to you.

### **What we ask you to do:**

Contact SENS service department to obtain warranty service instructions. To obtain warranty service the product must be returned, freight prepaid, to the factory under a Return Material Authorization (RMA) number provided by SENS. If, in SENS' opinion, the problem can be rectified in the field, SENS may elect to ship replacement parts for customer installation instead of having the product returned to the factory.

### **Limitation:**

This warranty is limited to defects in material or workmanship of the product. It does not cover loss of time, inconvenience, property damage or any consequential damages. Repair, replacement or refund of the purchase price of the equipment is your exclusive remedy.

## **Extended Warranty: NRG Series Battery Charger**

### **Extended Warranty Period**

At any time during the standard Limited Warranty period, customer may purchase extended warranty to lengthen the warranty period on the entire product to 5 or 10 years from date of original shipment. All other terms of SENS Limited Warranty (see above) apply.

## **Premium Warranty: NRG Series Battery Charger**

### **Premium Warranty Coverage**

At the time of original Product purchase, Customer may purchase premium warranty coverage for the standard warranty period or for extended periods of 5 or 10 years from date of original shipment. With premium warranty coverage, SENS will, if requested by Customer, pay reasonable and customary labor and mileage charges for the user to replace or repair the charger, limited to 100% of the Company's original net Product invoice amount, in the form of a credit toward future purchases of Product from the Company. All other terms of SENS Limited Warranty (see above) apply.

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**Rocky  
Mountain**

# Tab #5 Warranty



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# Cummins NPower LLC Generator Sets Limited Warranty

5/1/2014

## Commercial Generating Set

This limited warranty applies to all Cummins NPower LLC (hereinafter referred to as "Cummins NPower" branded commercial generating sets and associated accessories (hereinafter referred to as "Product"). This warranty covers any failures of the Product, under normal use and service, which result from a defect in material or factory workmanship.

## Warranty Period:

The warranty start date for stationary Product is the date of initial start up, demonstration or 18 months after factory ship date, whichever is sooner. The warranty start date for rental or oil and gas products is the date of receipt of Product by the end customer. See table for details.

### Base Warranty Duration (Whichever occurs first)

Rating	Months	Maximum Hours
Emergency Standby Power (ESP)	12	500
Prime Power (PRP)	12	Unlimited

**Emergency Standby Power (ESP)** is defined as the maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a reliable utility power outage. The permissible average power output over 24 hours of operation shall not exceed 70% of the ESP. For applications supporting an unreliable utility service, the Prime Power (PRP) rating should be used.

**Prime Power (PRP)** is defined as being the maximum power which a generating set is capable of delivering continuously while supplying a variable electrical load. The permissible average power output over 24 hours of operation shall not exceed 70% of the PRP.

## Cummins NPower Responsibilities:

In the event of a failure of the Product during the warranty period due to defects in material or workmanship, Cummins NPower will only be responsible for the following costs:

- All parts and labor required to repair the Product.
- Reasonable travel expenses to and from the Product site location.
- Maintenance items that are contaminated or damaged by a warrantable failure.

## Owner Responsibilities:

The owner will be responsible for the following:

- Notifying Cummins NPower distributor or dealer within 30 days of the discovery of failure.
- Installing, operating, commissioning and maintaining the Product in accordance with Cummins NPower's published policies and guidelines.
- Providing evidence for date of commissioning.
- Providing sufficient access to and reasonable ability to remove the Product from the installation in the event of a warrantable failure.

In addition, the owner will be responsible for:

- Incremental costs and expenses associated with Product removal and reinstallation resulting from difficult or non-standard installations.





- Costs associated with rental of generating sets used to replace the Product being repaired.
- Costs associated with labor overtime and premium shipping requested by the owner.
- All downtime expenses, fines, all applicable taxes, and other losses resulting from a warrantable failure.

### **Limitations:**

This limited warranty does not cover Product failures resulting from:

- Inappropriate use relative to designated power rating or application guidelines.
- Normal wear and tear, negligence, accidents or misuse.
- Improper and/or unauthorized installation.
- Lack of maintenance or unauthorized repair.
- Noncompliance with any Cummins NPower published guideline or policy.
- Use of improper or contaminated fuels, coolants or lubricants.
- Improper storage before and after commissioning.
- Owner's delay in making Product available after notification of potential Product problem.
- Replacement parts and accessories not authorized by Cummins NPower.
- Use of Battle Short Mode.
- Owner or operator abuse or neglect such as: operation without adequate coolant or lubricants; over-fueling; over-speeding; lack of maintenance to lubricating, cooling or air intake systems; late servicing and maintenance; improper storage, starting, warm-up, run-in or shutdown practices, or for progressive damage resulting from a defective shutdown or warning device.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the generating set.

This Limited Warranty **does not** apply to:

- Costs of maintenance, adjustments, installation, commissioning or start-up.
- Starting batteries, battery chargers, heating elements, trailers and enclosures.
- Components added to the Product after shipment from Cummins NPower.

Please contact your local Cummins NPower Distributor for clarification concerning these limitations.

### **Extended Warranty**

An Extended Coverage may be purchased to include parts and labor for the engine and generator for 5 year, 1500 hour period. The extended engine warranty is outlined as described in Bulletin #3624423 for Cummins ENCOMPASS Extended Coverage program.

### **Cummins NPower Right to Failed Components:**

Failed components claimed under warranty remain the property of Cummins NPower. Cummins NPower has the right to reclaim any failed component that has been replaced under warranty.

**THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS NPOWER IN REGARD TO THE PRODUCT. CUMMINS NPOWER MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT IS CUMMINS NPOWER LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

This limited warranty shall be enforced to the maximum extent permitted by applicable law. This limited warranty gives the owner specific rights that may vary from state to state or from jurisdiction to jurisdiction.



# Warranty Statement

**Our energy working for you.™**



## Global Power Electronics Warranty Statement

### Paralleling System Transfer Switch

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## Limited Warranty

### Transfer Switch and Paralleling Systems

This limited warranty applies to all Cummins Power Generation® branded Transfer Switches, Paralleling Systems and associated accessories (hereinafter referred to as "Product").

This warranty covers any failures of the Product, under normal use and service, which result from a defect in material or factory workmanship.

### Warranty Period:

The warranty start date is the date of commissioning<sup>†</sup>, demonstration or 18 months after factory ship date, whichever is sooner.

<sup>†</sup> Date of commissioning not to exceed date of Generator Set initial start-up.

### Transfer Switch Coverage Duration:

The warranty coverage duration for Transfer Switches is defined in the table below for the different product families:

Product Family	Duration
GTEC, LT, LC, RSS, RST, OTEC	<ul style="list-style-type: none"> <li>1 Year: Parts, Labor &amp; Travel</li> </ul>
PLTO, PLTH, PLTS, PLTE	<ul style="list-style-type: none"> <li>2 Years: Parts, Labor &amp; Travel</li> </ul>
Other Power Transfer Devices <sup>††</sup>	<ul style="list-style-type: none"> <li>2 Years: Parts, Labor &amp; Travel</li> </ul>
OT, OTPC, BTPC, OHPC, CHPC	<ul style="list-style-type: none"> <li>Years 0-2: Parts, Labor &amp; Travel</li> <li>Years 3-5: Parts Only</li> <li>Years 6-10: Main Contacts Only</li> </ul>

<sup>††</sup> Devices manufactured by Cummins Power Generation that allow power transfer between two power sources.

### Paralleling Systems Coverage Duration:

The warranty coverage duration for Paralleling Systems is for a period of 2 Years from the warranty start date.

## Cummins Power Generation®

### Responsibilities:

In the event of a failure of the Product during the warranty period due to defects in material or workmanship, Cummins Power Generation® will only be responsible for the following costs:

- All parts and labor required to repair the Product<sup>†††</sup>.
- Reasonable travel expenses to and from the Product site location<sup>†††</sup>.

<sup>†††</sup> Years 0-2 only for OT, OTPC, BTPC, OHPC & CHPC family of Transfer Switches.

### Owner Responsibilities:

The owner will be responsible for the following:

- Notifying Cummins Power Generation® distributor or dealer within 30 days of the discovery of failure.
- Installing, operating, commissioning and maintaining the Product in accordance with Cummins Power Generation®'s published policies and guidelines.
- Providing evidence for date of commissioning.
- Providing sufficient access to and reasonable ability to remove the Product from the installation in the event of a warrantable failure.

In addition, the owner will be responsible for:

- Incremental costs and expenses associated with Product removal and reinstallation resulting from non-standard installations.
- Costs associated with rental of power generating equipment used to replace the Product being repaired.
- Costs associated with labor overtime and premium shipping requested by the owner.
- All downtime expenses, fines, all applicable taxes, and other losses resulting from a warrantable failure.

**Limitations:**

This limited warranty does not cover Product failures resulting from:

- Inappropriate use relative to designated power rating.
- Inappropriate use relative to application guidelines.
- Non-conformance to applicable industry standards for installation
- Normal wear and tear.
- Improper and/or unauthorized installation.
- Negligence, accidents or misuse.
- Lack of maintenance or unauthorized repair.
- Noncompliance with any Cummins Power Generation® published guideline or policy.
- Improper storage before and after commissioning.
- Owner’s delay in making Product available after notification of potential Product problem.
- Use of steel enclosures within 60 miles of the coast of salt water when aluminum or an alternate non-corrosive material enclosure option is available.
- Replacement parts and accessories not authorized by Cummins Power Generation®.
- Owner or operator abuse or neglect such as: late servicing and maintenance and improper storage.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the transfer switch or paralleling system.

This limited warranty does not cover costs resulting from:

- Difficulty in gaining access to the Product.
- Repair of cosmetic damage to enclosures.

Please contact your local Cummins Power Generation® Distributor for clarification concerning these limitations.

**CUMMINS POWER GENERATION® RIGHT TO FAILED COMPONENTS:**

Failed components claimed under warranty remain the property of Cummins Power Generation®. Cummins Power Generation® has the right to reclaim any failed component that has been replaced under warranty.

**Extended Warranty:**

Cummins Power Generation® offers several levels of Extended Warranty Coverage. Please contact your local Cummins Power Generation ® Distributor for details.

[www.cumminspower.com](http://www.cumminspower.com)

**THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS POWER GENERATION ® IN REGARD TO THE PRODUCT. CUMMINS POWER GENERATION® MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

**IN NO EVENT IS CUMMINS POWER GENERATION® LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

This limited warranty shall be enforced to the maximum extent permitted by applicable law. This limited warranty gives the owner specific rights that may vary from state to state or from jurisdiction to jurisdiction.

Product Model Number: \_\_\_\_\_

Product Serial Number: \_\_\_\_\_

Date in Service: \_\_\_\_\_

Notes:

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**Rocky  
Mountain**

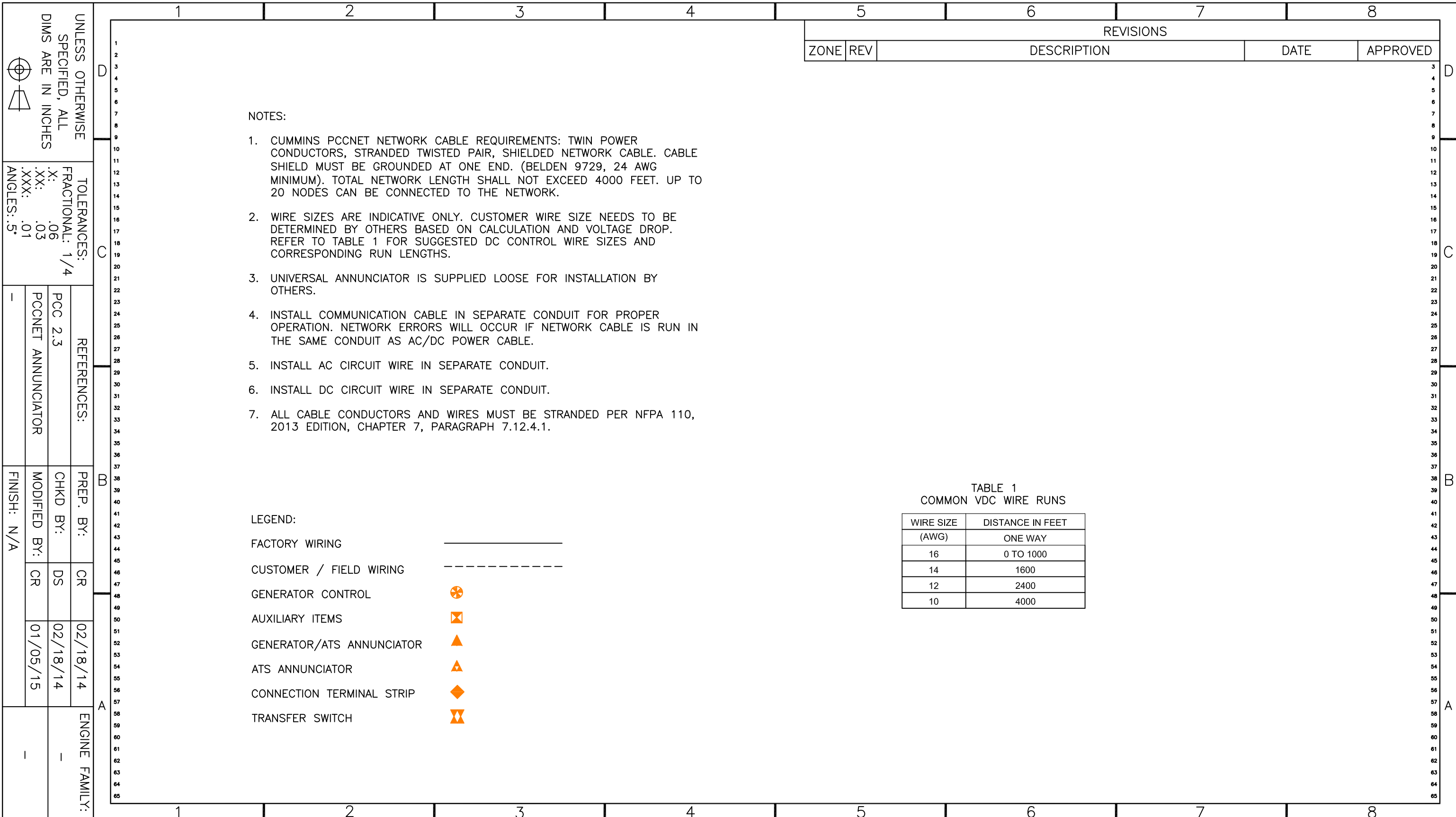
# Tab #6

# Drawings & Diagrams

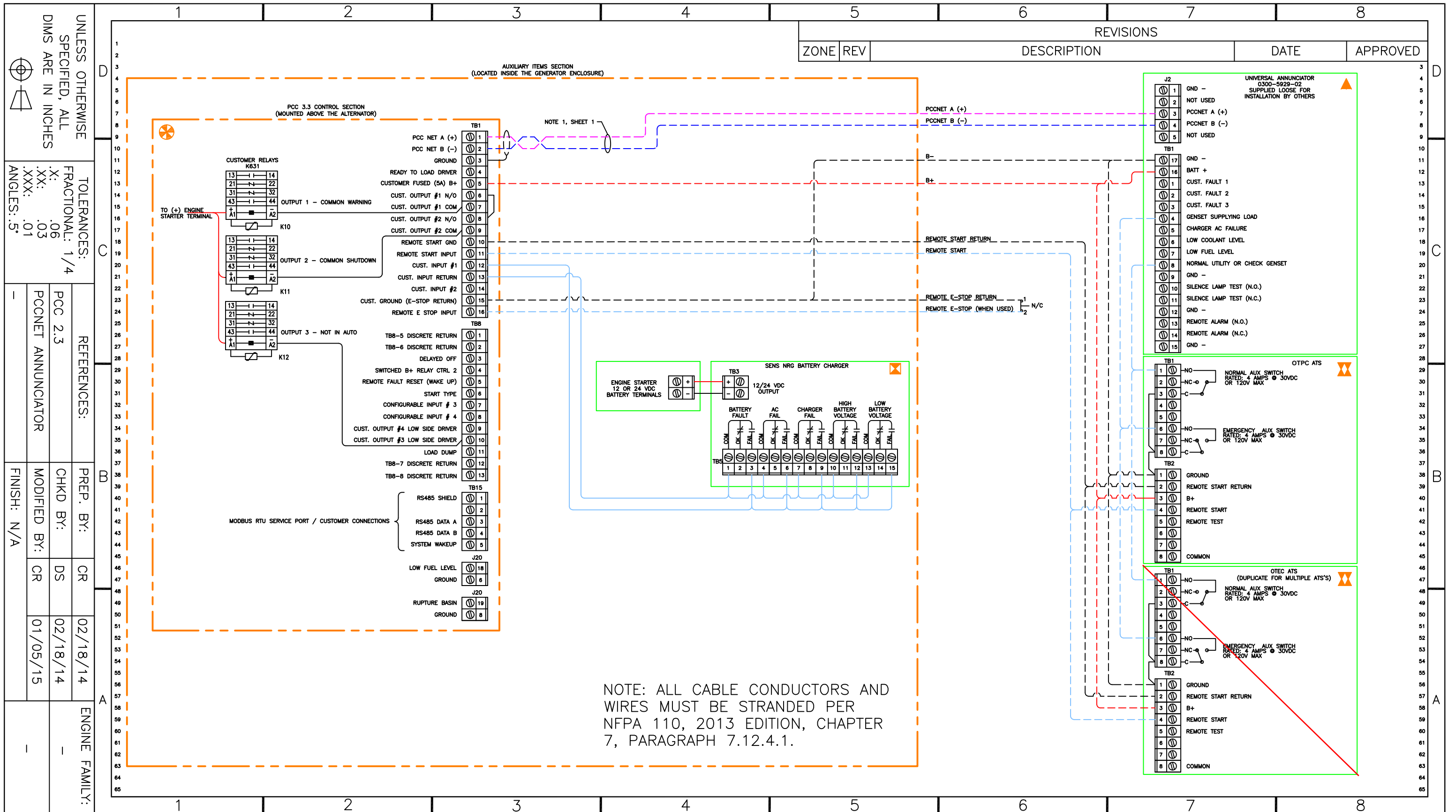


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	CONTRACTOR NAME: -	CONTACT NO: -	CRM PROJECT NO: -	SIZE: B DWG NO: S66511A-5 REV: A
				SCALE: NONE DO NOT SCALE SHEET: 1 OF 2



ZONE		REV	DESCRIPTION	DATE	APPROVED

UNLESS OTHERWISE SPECIFIED, ALL DIMS ARE IN INCHES

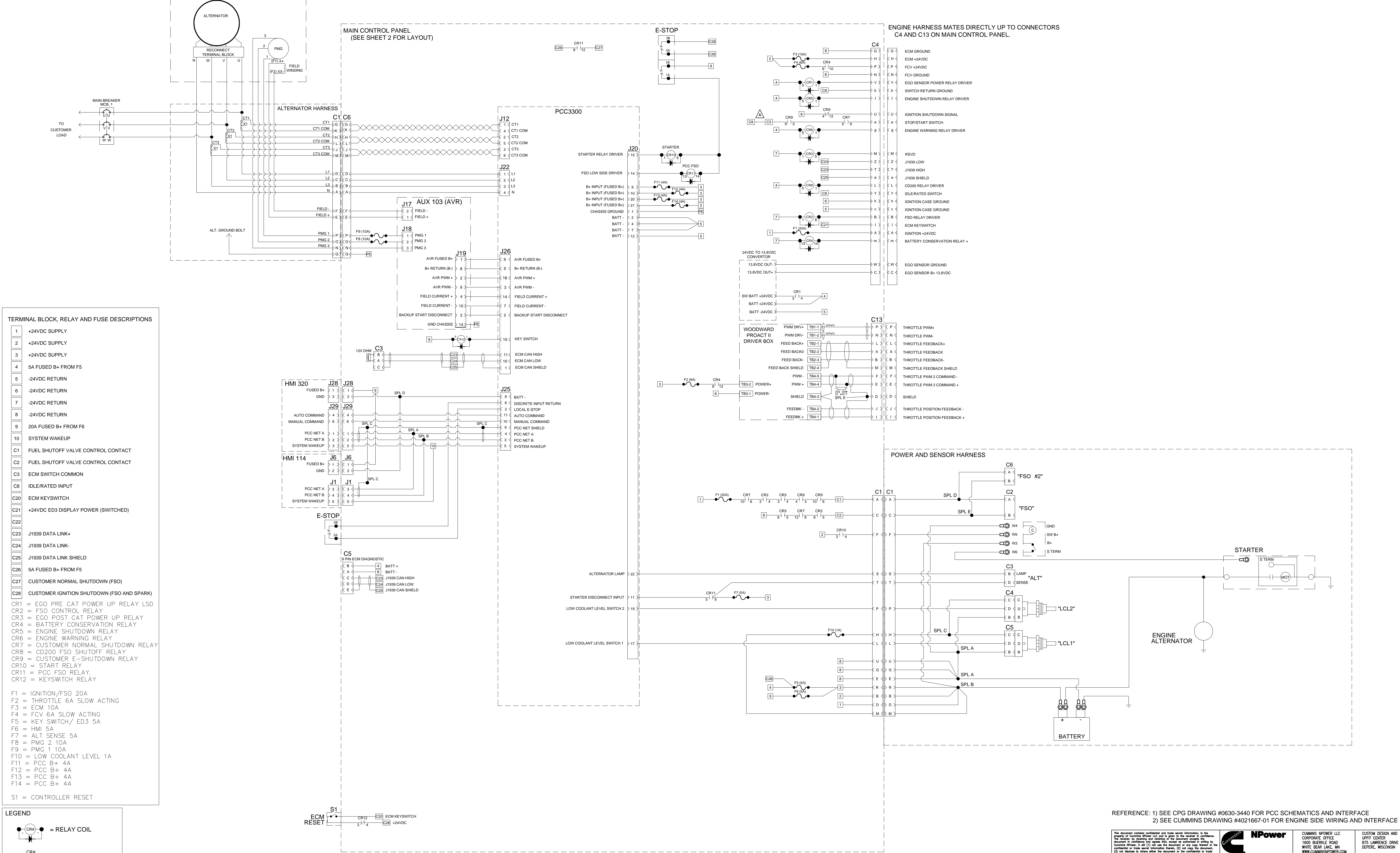
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REFERENCES:  
 PCC 2.3  
 PCCNET ANNUNCIATOR

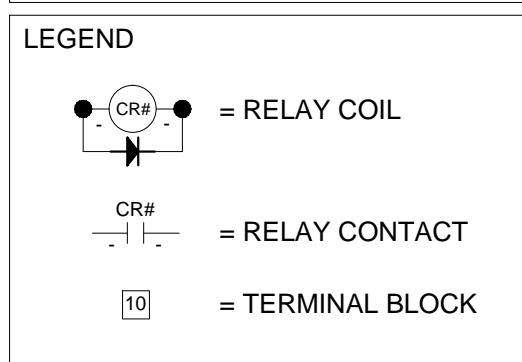
PREP. BY: CR  
 CHKD BY: DS  
 MODIFIED BY: CR  
 FINISH: N/A

ENGINE FAMILY:

SITE NAME:	—	CONTACT NAME:	—	CUSTOMER PROJECT NO:	—	TITLE:	INTERCONNECT WIRING DIAGRAM	
CONTRACTOR NAME:	—	CONTACT NO:	—	CRM PROJECT NO:	—	SIZE B	DWG NO: S66511A-5	REV: A
						SCALE:	NONE	SHEET: 2 OF 2



- TERMINAL BLOCK, RELAY AND FUSE DESCRIPTIONS**
- 1 +24VDC SUPPLY
  - 2 +24VDC SUPPLY
  - 3 +24VDC SUPPLY
  - 4 5A FUSED B+ FROM F5
  - 5 -24VDC RETURN
  - 6 -24VDC RETURN
  - 7 -24VDC RETURN
  - 8 -24VDC RETURN
  - 9 20A FUSED B+ FROM F6
  - 10 SYSTEM WAKEUP
  - C1 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C2 FUEL SHUTOFF VALVE CONTROL CONTACT
  - C3 ECM SWITCH COMMON
  - C8 IDLERATED INPUT
  - C20 ECM KEYSWITCH
  - C21 +24VDC ED3 DISPLAY POWER (SWITCHED)
  - C22 J1939 DATA LINK+
  - C23 J1939 DATA LINK-
  - C24 J1939 DATA LINK SHIELD
  - C26 5A FUSED B+ FROM F5
  - C27 CUSTOMER NORMAL SHUTDOWN (FSO)
  - C28 CUSTOMER IGNITION SHUTDOWN (FSO AND SPARK)
- CR1 = EGO PRE CAT POWER UP RELAY LSD  
 CR2 = FSO CONTROL RELAY  
 CR3 = EGO POST CAT POWER UP RELAY  
 CR4 = BATTERY CONSERVATION RELAY  
 CR5 = ENGINE SHUTDOWN RELAY  
 CR6 = ENGINE WARNING RELAY  
 CR7 = CUSTOMER NORMAL SHUTDOWN RELAY  
 CR8 = CD200 FSO SHUTOFF RELAY  
 CR9 = CUSTOMER E-SHUTDOWN RELAY  
 CR10 = START RELAY  
 CR11 = PCC FSO RELAY  
 CR12 = KEYSWITCH RELAY
- F1 = IGNITION/FSO 20A  
 F2 = THROTTLE 6A SLOW ACTING  
 F3 = ECM 10A  
 F4 = FCV 6A SLOW ACTING  
 F5 = KEY SWITCH/ ED3 5A  
 F6 = HMI 5A  
 F7 = ALT SENSE 5A  
 F8 = PMG 2 10A  
 F9 = PMG 1 10A  
 F10 = LOW COOLANT LEVEL 1A  
 F11 = PCC B+ 4A  
 F12 = PCC B+ 4A  
 F13 = PCC B+ 4A  
 F14 = PCC B+ 4A
- S1 = CONTROLLER RESET



REFERENCE: 1) SEE CPG DRAWING #0630-3440 FOR PCC SCHEMATICS AND INTERFACE  
 2) SEE CUMMINS DRAWING #4021667-01 FOR ENGINE SIDE WIRING AND INTERFACE

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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
0.0005	0.0005	0.0127
0.0010	0.0010	0.0254
0.0015	0.0015	0.0381
0.0020	0.0020	0.0508
0.0030	0.0030	0.0762
0.0040	0.0040	0.1016
0.0050	0.0050	0.1270

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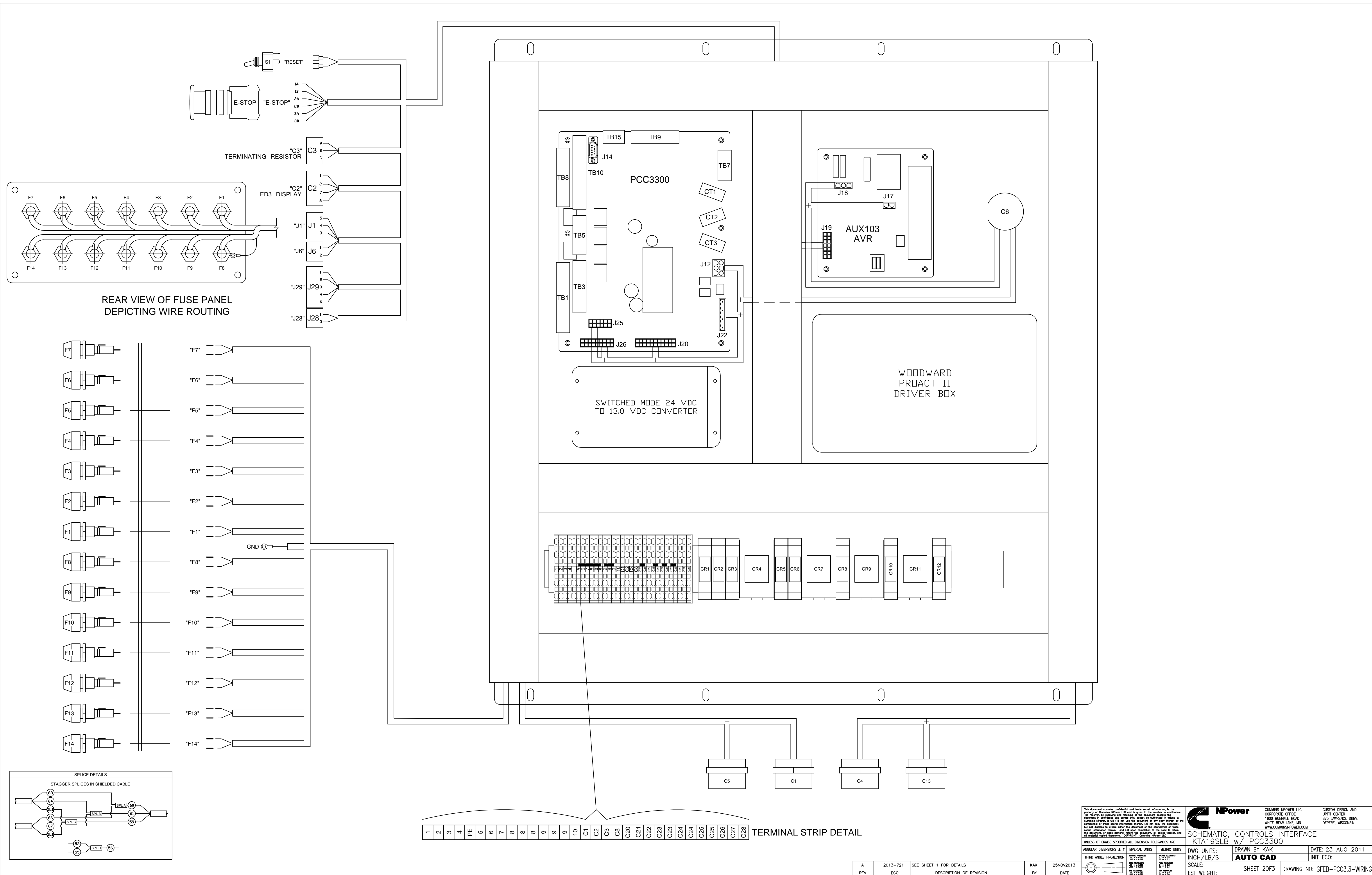
**CUMMINS NPower**  
 CUMMINS NPOWER LLC  
 CORPORATE OFFICE  
 1600 BLUEBERRY ROAD  
 WHITE BEAR LAKE, MN  
 WWW.CUMMINSPOWER.COM

CUSTOM DESIGN AND  
 UPRIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

SCHEMATIC, CONTROLS INTERFACE  
 KTA19SLB w/ PCC3300

DATE: 23 AUG 2011  
 INIT ECO:  
 DRAWN BY: KAK  
 AUTO CAD

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	REMOVED C7. ADDED SHEET 3. ADDED JUMPER BETWEEN TERMINALS C3 & C8.	KAK	25NOV2013



REAR VIEW OF FUSE PANEL  
DEPICTING WIRE ROUTING

SWITCHED MODE 24 VDC  
TO 13.8 VDC CONVERTER

WOODWARD  
PROACT II  
DRIVER BOX

TERMINAL STRIP DETAIL

- 1
- 2
- 3
- 4
- PE
- 5
- 6
- 7
- 8
- 8
- 9
- 9
- 10
- C1
- C3
- C8
- C8
- C20
- C21
- C22
- C23
- C23
- C24
- C24
- C25
- C25
- C26
- C27
- C28

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1600 BLUESKLE ROAD  
WHITE BEAR LAKE, MN  
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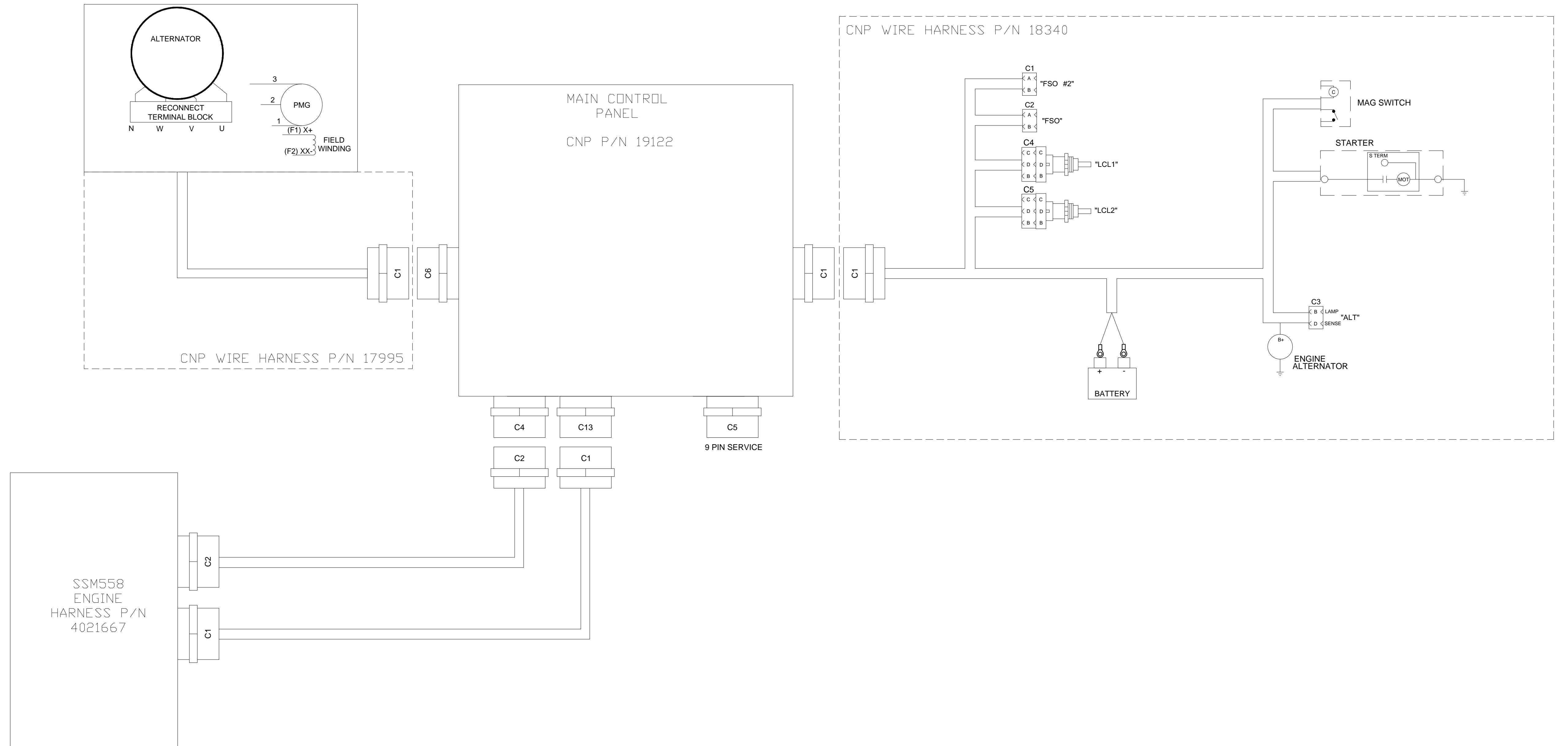
CUSTOM DESIGN AND  
LIFT CENTER  
875 LAWRENCE DRIVE  
DEPERE, WISCONSIN

SCHEMATIC, CONTROLS INTERFACE  
KTA19SLB w/ PCC3300

DWG UNITS: INCH/LB/S  
SCALE: EST WEIGHT: SHEET 20F3

DRAWN BY: KAK  
**AUTO CAD**  
DATE: 23 AUG 2011  
INIT ECO: DRAWING NO: GFEB-PCC3.3-WIRING

A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE



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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	± 0.005	± 0.13
	± 0.010	± 0.25
	± 0.015	± 0.38
	± 0.030	± 0.76

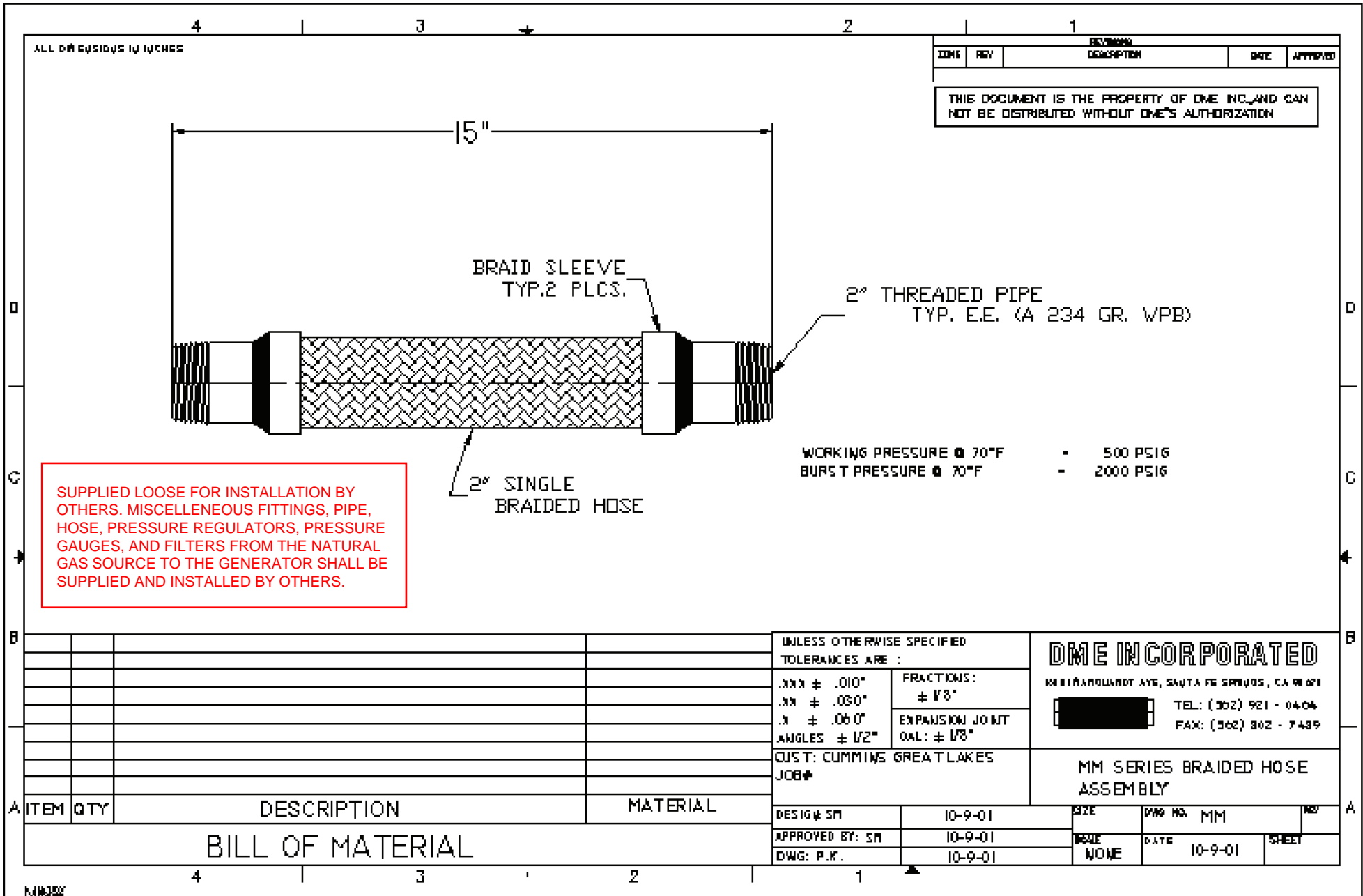
**NPower**  
 CUMMINS NPOWER LLC  
 CORPORATE OFFICE  
 1600 BLUERIDGE ROAD  
 WHITE BEAR LAKE, WI  
 WWW.CUMMINSPOWER.COM

CUSTOM DESIGN AND  
 UPRIT CENTER  
 875 LAWRENCE DRIVE  
 DEPERE, WISCONSIN

**SCHEMATIC, CONTROLS INTERFACE**  
**KTA19SLB W/ PCC3300**

DWG UNITS: INCH/LB/S	DRAWN BY: KAK	DATE: 23 AUG 2011
SCALE:	SHEET 30F3	INIT ECO:
EST WEIGHT:	DRAWING NO: GFEB-PCC3.3-WIRING	

REV	ECO	DESCRIPTION OF REVISION	BY	DATE
A	2013-721	SEE SHEET 1 FOR DETAILS	KAK	25NOV2013



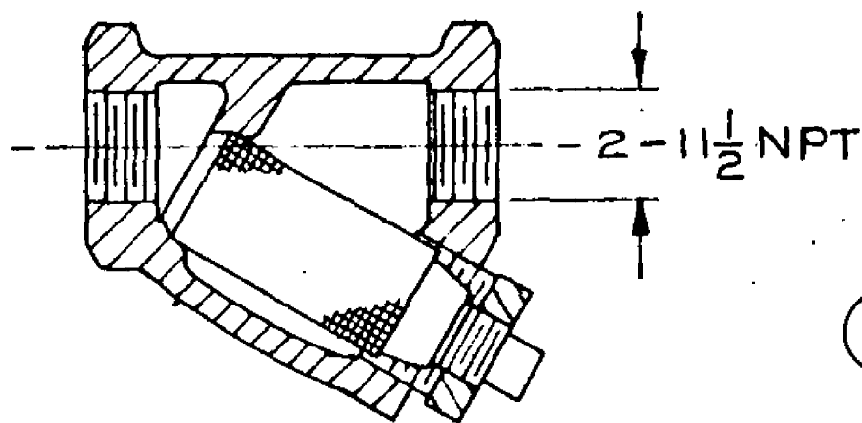
149-0751

**MICROFILMED**

ER NO	LET	NO	REVISION	ENG	CKR	DATE
			SUPSD'S 149P751 W/CHGS-OLD DWG DTD	TJA	CP	2-10-59
	A		NOTE 3 WAS 30 OR 40 MESH	TJA	WB	10-24-73
	A		"W/LINER" REMOVED	TJA	WB	1-9-74
	A		WAS 40 MESH, 1/64 OPEN, D10 WIRE	TJA	WB	3-25-74
	A		ADDED NOTE 3-B	TJA	HP	10-31-77
73329	B	1	REVISED NOTES 3 & 3A	W/S	BG	9-4-96

SUPPLIED LOOSE FOR  
INSTALLATION BY OTHERS.  
2" NPT INLET/OUTLET

**V.O. DRAWING**



**NOTES:**

1. 2" PIPE SIZE
2. MATL-CAST SEMI-STEEL BODY
3. 20 MONEL WIRE MESH
  - A. 20 MESH: .033 OPENING
  - B. ALTN MATL: STAINLESS STEEL WIRE MESH
4. SELF CLEANING
5. FOR USE WITH NATURAL GAS.

NEAT ASSY	SIMILAR TO	SEPIA FROM	149A558	ITEM	PART NO.	DWG SIZE	QTY	* BULK	DESCRIPTION OR MATERIAL
		DR	JER		relay price tp	me			DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota <h1 style="text-align: center;">STRAINER</h1>
		CKR	CP		weld sa hsg gd	qr			
		ENGR	WW		src punch crank ct	po			
		SAMP REL		DATE	2-12-71	sc	~		
TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± ANGLES ± HOLES ± .006 - .002		DECIMALS 2 PLACE ± 3 PLACE ±		PROD REL	WW 2-18-71	MODE			DWG SIZE 149-0751 A

FORM 10074



**ENGINE SERVICE CONNECTIONS**

GAS INLET -----2.00" NPT  
 ENGINE WATER IN -----3.50" O.D.  
 ENGINE WATER OUT -----3.00" O.D.  
 DE-AERATION -----1/4" NPT  
 MAG PICK-UP -----5/8-18 UNF  
 OIL DRAIN PLUG ---1\_1/16-12 UN-2B ORING  
 EXHAUST STACK -----5.00" 125#/150# ANSI FLANGE  
 AFTERCOOLER WATER IN -----1.25" O.D.  
 AFTERCOOLER WATER OUT -----1.25" O.D.  
 EXH TEMP COUPLING -----1/4" NPT

**FLUID CAPACITIES**

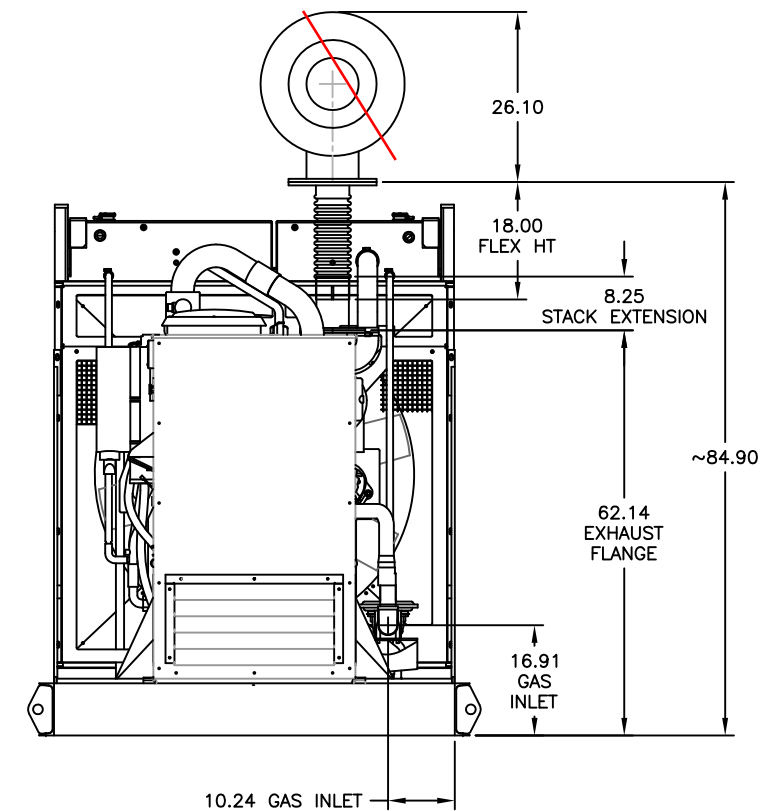
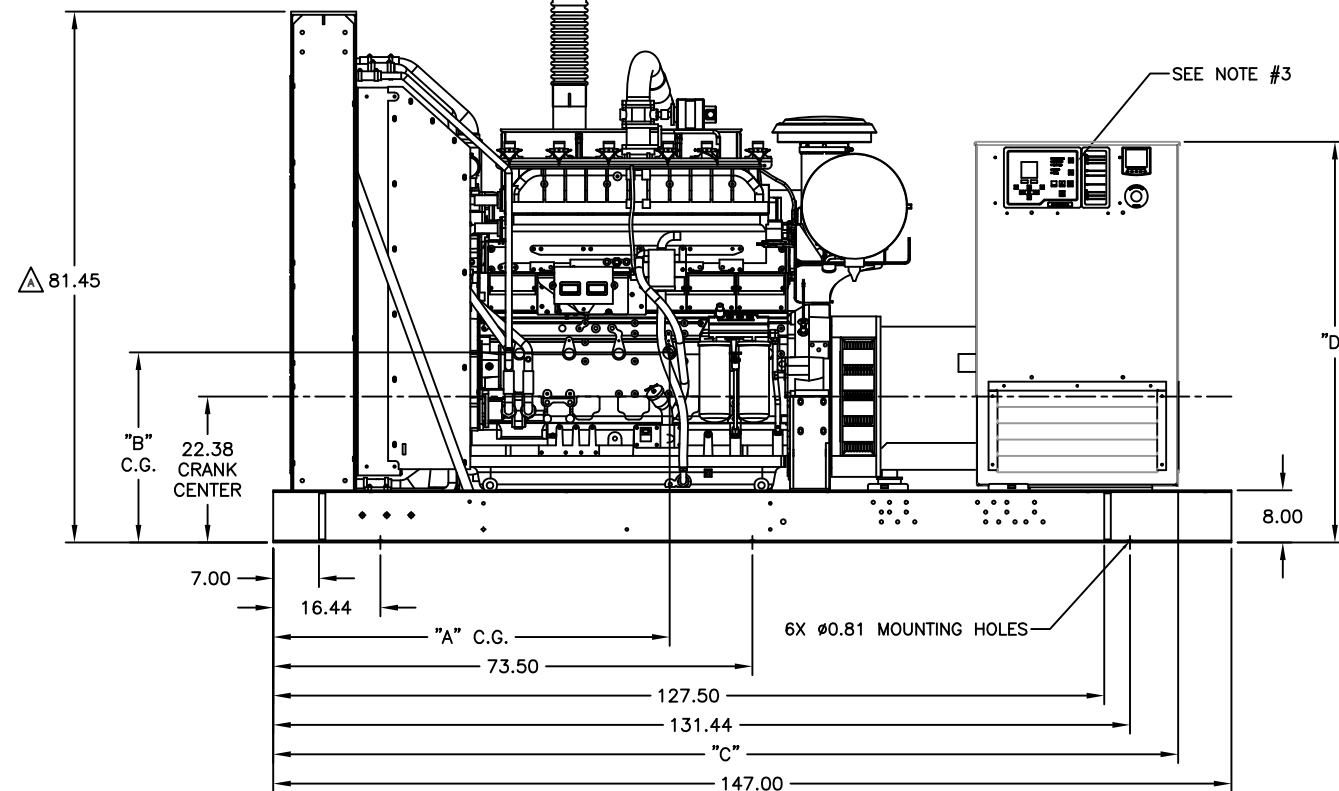
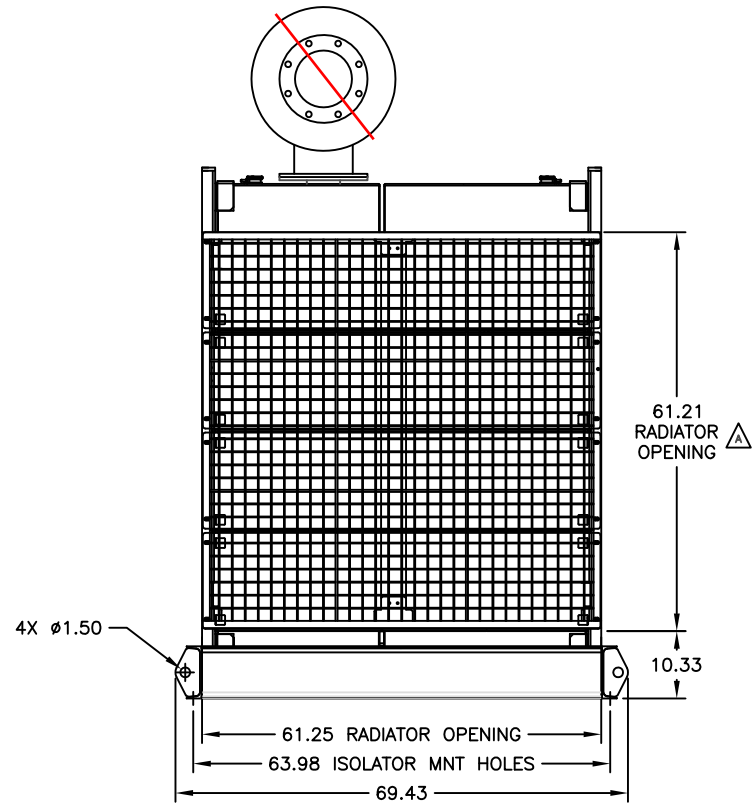
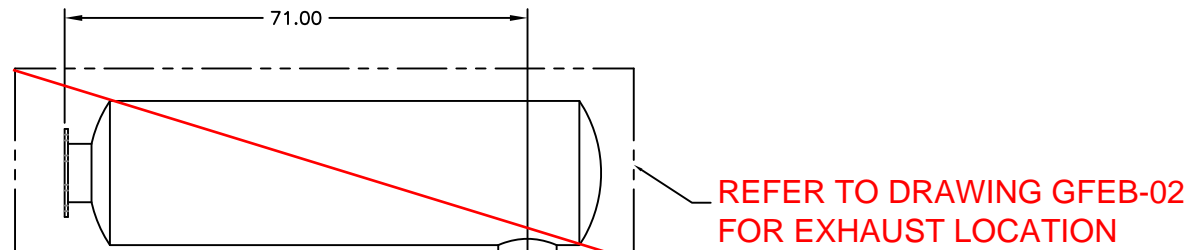
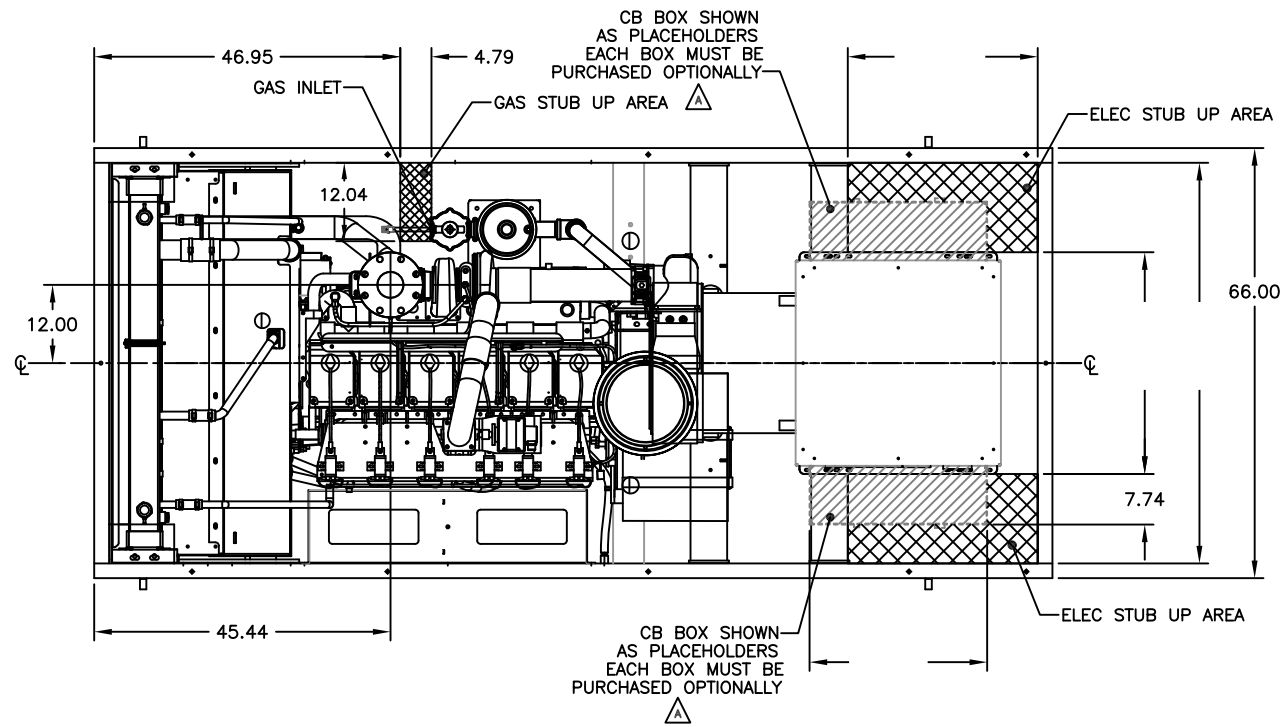
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 ENGINE COOLANT -----32 QTS  
 AFTERCOOLER COOLANT -----4 QTS  
 RAD JACKET WATER -----12.20 GAL  
 RAD AFTERCOOLER -----11.42 GAL

**SERVICE NOTES**

10.00 REQUIRED TO REMOVE OIL PAN  
 15.00 REQUIRED TO REMOVE OIL DIPSTICK  
 1.81 REQUIRED TO REMOVE OIL FILTER

GENERATOR FRAME SIZE	DIM* "A"	DIM "B"	DIM "C"	DIM "D"	DIM "E"	TOTAL WEIGHT* (WET) LBS/KG
NEWAGE UCI274 K	62.21	29.00	132.34	63.26	32.75	8840/4010
NEWAGE HCI434 C	63.68	28.79	138.84	61.48	29.13	9127/4140
NEWAGE HCI434 D	64.59	28.67	138.84	61.48	29.13	9298/4218
NEWAGE HCI434 E	65.57	28.55	138.84	61.48	29.13	9482/4301
NEWAGE HCI434 F	66.97	28.37	138.84	61.48	29.13	9759/4427
NEWAGE HCI534 C	68.73	28.15	141.71	59.91	24.89	10146/4600
NEWAGE HCI534 D	68.73	28.15	141.71	59.91	24.89	10429/4730

\*SEE NOTES 1 AND 2



- NOTES
1. ALL WEIGHTS AND DIMENSIONS ARE APPROXIMATE
  2. WEIGHTS DO NOT INCLUDE SILENCER, BATTERIES OR OPTIONAL EQUIPMENT.
  3. CONTROLLER CAN BE MOUNTED ON EITHER SIDE
  4. REQUIRES USE OF SPREADER BAR WHEN LIFTING TO PREVENT DAMAGE TO UNIT.
  5. GENSETS HAVE INTEGRAL ISOLATION

A	2013-216	ADDED CB PNL ZONES & NOTES; OIL CAPACITY: 16 GALLONS WAS 26 81.45 WAS 79.38; 61.21 WAS 59.39	DJH	16APR2013
REV	ECO	DESCRIPTION OF REVISION	BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	DWG UNITS: INCH/LB/S	SCALE: N/A
	EST WEIGHT: N/A	SHEET 10F1

ASSY, GENSET, OPEN, KTA19SLB RADIATOR COOLED

DRAWN BY: GVD  
 DATE: 27MAY2010

EST. 1989

DRAWING NO: GFEB-01



### ENGINE SERVICE CONNECTIONS

GAS INLET -----2.00" NPT  
 ENGINE WATER IN -----3.50" O.D.  
 ENGINE WATER OUT -----3.00" O.D.  
 DE-AERATION -----1/4" NPT  
 MAG PICK-UP -----5/8-18 UNF  
 OIL DRAIN PLUG -----1\_1/16-12 UN-2B ORING  
 EXHAUST STACK -----5.00" 125#/150# ANSI FLANGE  
 AFTERCOOLER WATER IN -----1.25" O.D.  
 AFTERCOOLER WATER OUT -----1.25" O.D.  
 EXH TEMP COUPLING -----1/4" NPT

### FLUID CAPACITIES

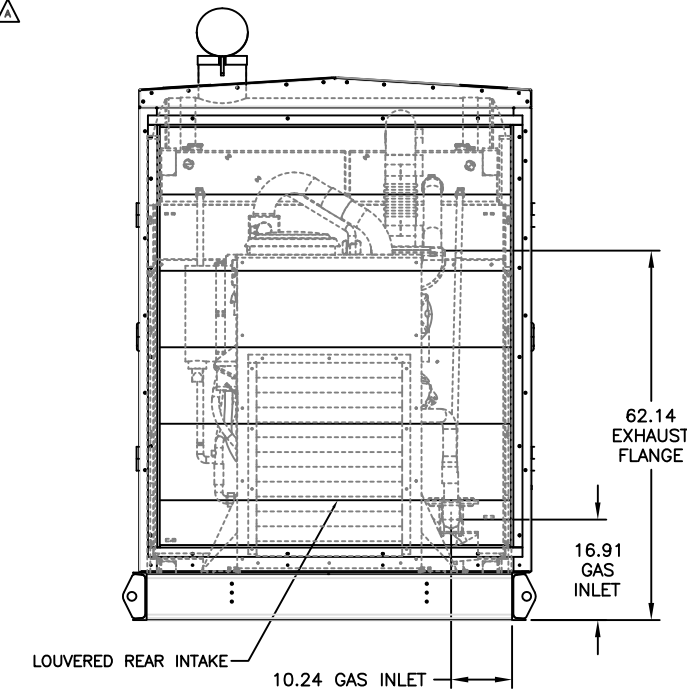
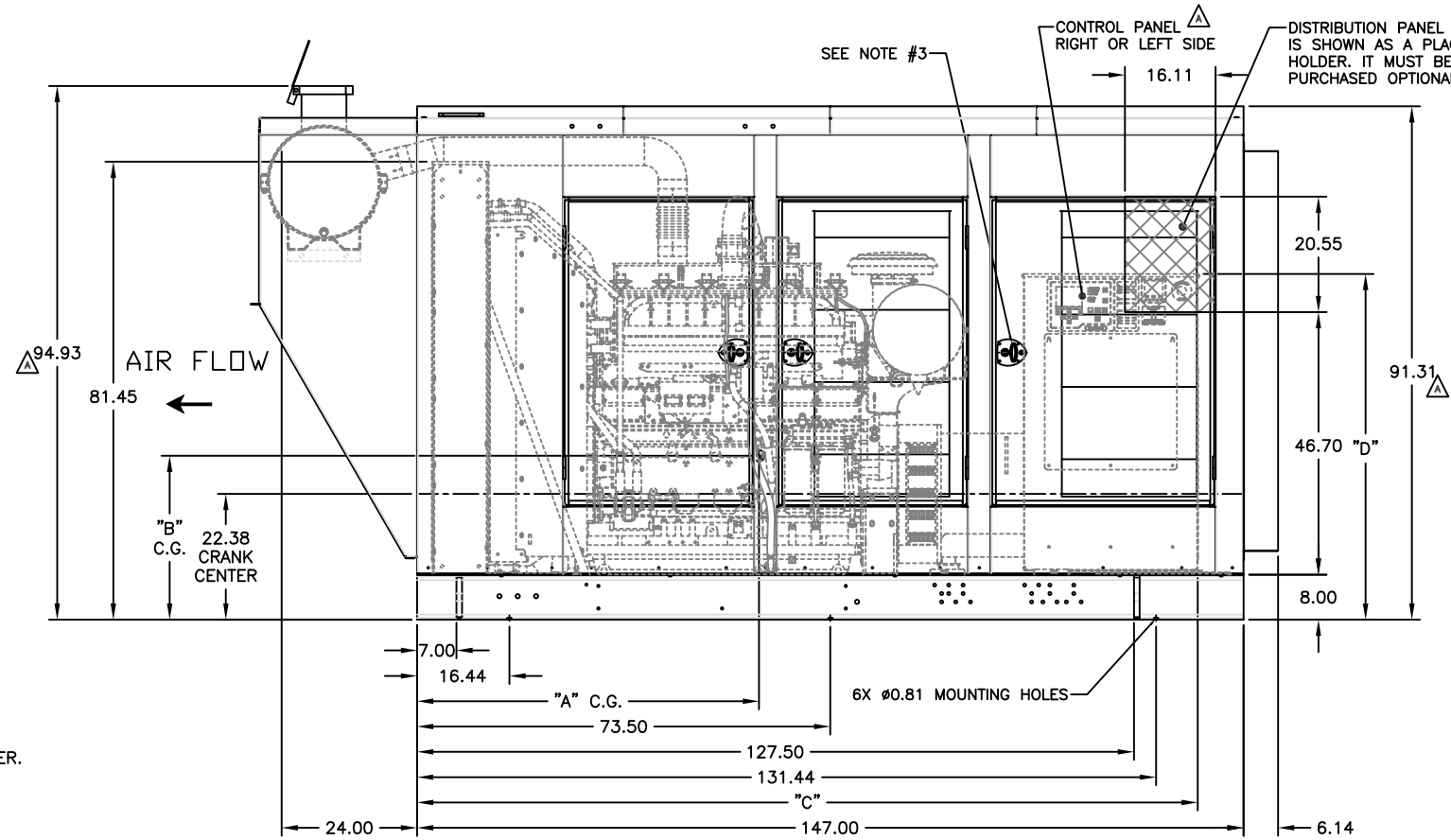
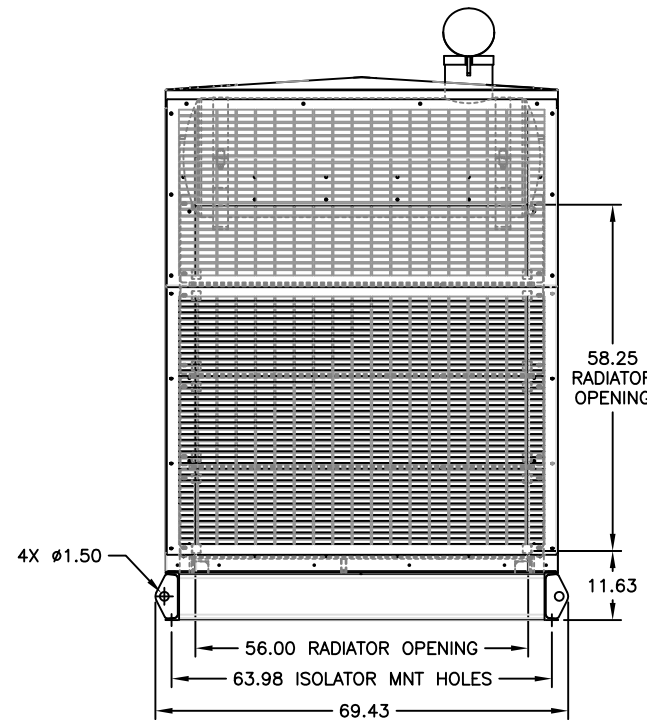
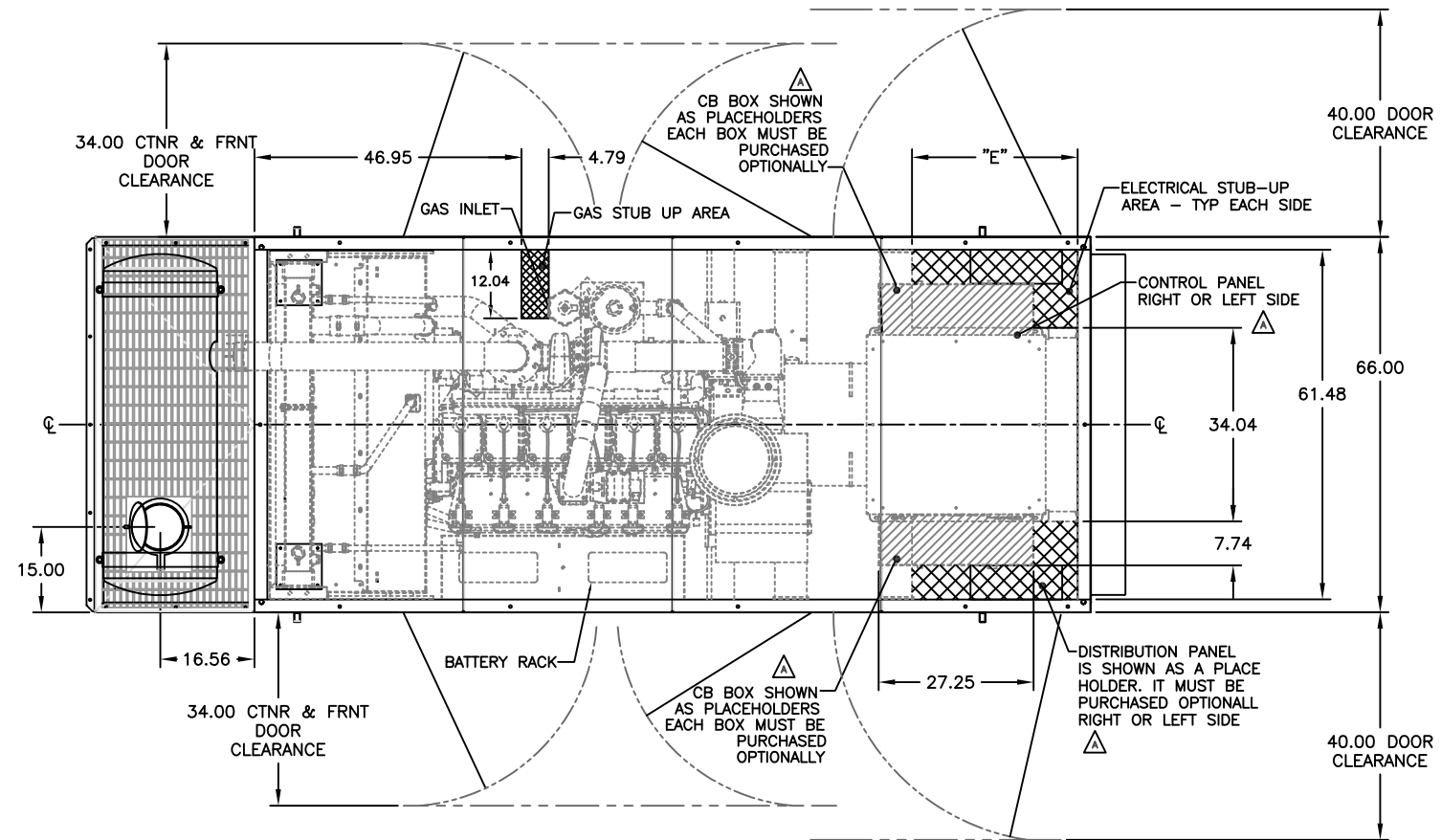
ENGINE OIL -----16 GAL  
 ENGINE COOLANT -----32 QTS  
 AFTERCOOLER COOLANT -----4 QTS  
 RAD JACKET WATER -----12.20 GAL  
 RAD AFTERCOOLER -----11.42 GAL

### SERVICE NOTES

10.00 REQUIRED TO REMOVE OIL PAN  
 15.00 REQUIRED TO REMOVE OIL DIPSTICK  
 1.81 REQUIRED TO REMOVE OIL FILTER

GENERATOR FRAME SIZE	DIM* "A"	DIM "B"	DIM "C"	DIM "D"	DIM "E"	TOTAL WEIGHT* (WET) LBS/KG
NEWAGE UC1274 K	62.21	29.00	132.34	63.26	32.75	10740/4872
NEWAGE HC1434 C	63.68	28.79	138.84	61.48	29.13	11027/5002
NEWAGE HC1434 D	64.59	28.67	138.84	61.48	29.13	11198/5080
NEWAGE HC1434 E	65.57	28.55	138.84	61.48	29.13	11382/5163
NEWAGE HC1434 F	66.97	28.37	138.84	61.48	29.13	11659/5289
NEWAGE HC1534 C	68.73	28.15	141.71	59.91	24.89	12040/5462
NEWAGE HC1534 D	68.73	28.15	141.71	59.91	24.89	12329/5592

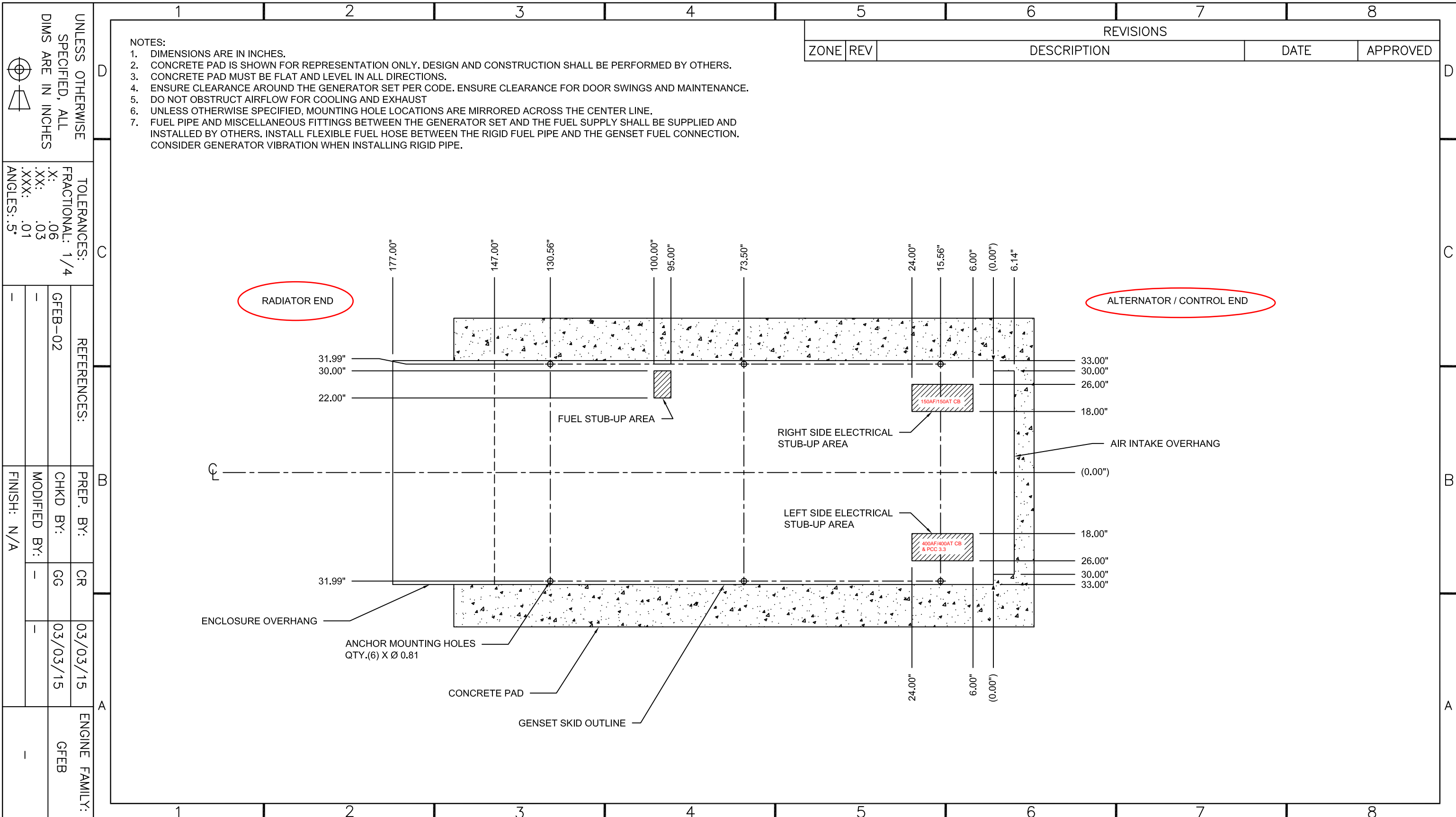
\*SEE NOTES 7, 8 AND 9



- NOTES:
- ENCLOSURE IS TO BE PAINTED ONAN GREEN UNLESS OTHERWISE NOTED ON ORDER.
  - ALL HARDWARE TO BE STAINLESS STEEL
  - ALL DOORS KEYED ALIKE
  - STAINLESS STEEL LIFT-OFF DOOR HINGES
  - FOLDING T-HANDLE COMPOSITE DOOR LATCH
  - ENCLOSURE IS 14 GAUGE
  - ALL WEIGHTS AND DIMENSIONS ARE APPROXIMATE
  - WEIGHTS DO NOT INCLUDE BATTERIES OR OPTIONAL EQUIPMENT.
  - WEIGHTS INCLUDE STANDARD CRITICAL GRADE EXHAUST. FOR HOSPITAL GRADE EXHAUST ADD 400 LBS/182 KG.
  - CONTROLLER CAN BE MOUNTED ON EITHER SIDE OF CABINET.
  - REQUIRES USE OF SPREADER BAR WHEN LIFTING TO PREVENT DAMAGE TO UNIT.
  - GENSET DOES NOT INCLUDE FLOOR. CONTACT FACTORY FOR PRICING.
  - GENSETS HAVE INTEGRAL ISOLATION

<p>UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS TOLERANCES ARE:</p> <p>ANGULAR DIMENSIONS ± 1° IMPERIAL UNITS METRIC UNITS</p> <p>THIRD ANGLE PROJECTION</p>		<p>ASSY, GENSET, KTA19SLB                  STD ENCL, INT SILENCER</p> <p>DWG UNITS: INCH/LB/S                  SCALE: N/A                  EST WEIGHT: N/A</p>	<p>DRWN BY: GVD                  AUTO CAD                  SHEET 10F1</p>	<p>DATE: 09JUL2010                  E + INT. DBU                  DRAWING NO: GFEB-02</p>
<p>A 2013-193</p>	<p>UPDATED ENCL HEIGHT &amp; EXHAUST;                  ADDED CB/DIST PNL ZONES &amp; NOTES;                  OIL CAPACITY: 16 GALLONS WAS 26</p>	<p>DJH 11APR2013</p>	<p>BY DATE</p>	<p>DATE: 09JUL2010</p>

<p>NPpower</p>	<p>CUMMINS NPPOWER LLC                  CORPORATE OFFICE                  1600 WHEELER ROAD                  WHITE BEAR LAKE, IN                  WWW.CUMMINSNPPOWER.COM</p>	<p>CUSTOM DESIGN AND                  UPFIT CENTER                  875 LAWRITCE                  DRIVE                  DEPERE, WISCONSIN</p>
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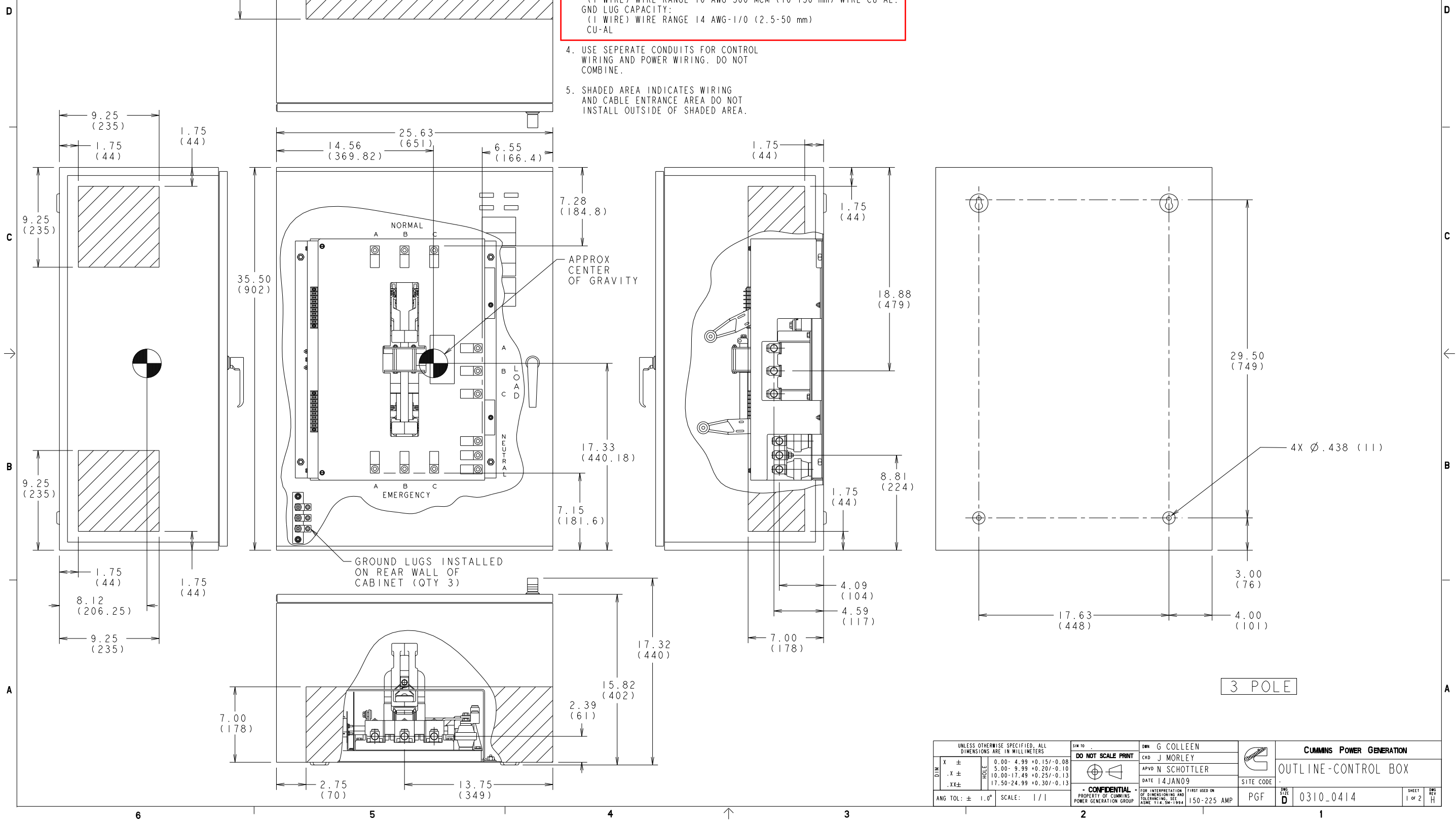


<b>Rocky Mountain</b> 8211 E 96th AVE HENDERSON, COLORADO 80640 PH: 303-287-0201 FAX: 303-287-4837	SITE NAME:	CONTACT NAME:	CUSTOMER PROJECT NO:	TITLE: ELECTRICAL STUB-UP & MOUNTING
	CONTRACTOR NAME:	CONTACT NO:	CRM PROJECT NO:	SIZE: B DWG NO: S66545A-7 REV: A SCALE: NONE DO NOT SCALE SHEET: 1 OF 1

REL NO	LTR NO	REVISION	DRN	CHK	APVD	DATE
ECO-103286	H	1	GAC	JM	NS	02FEB09

NOTES:

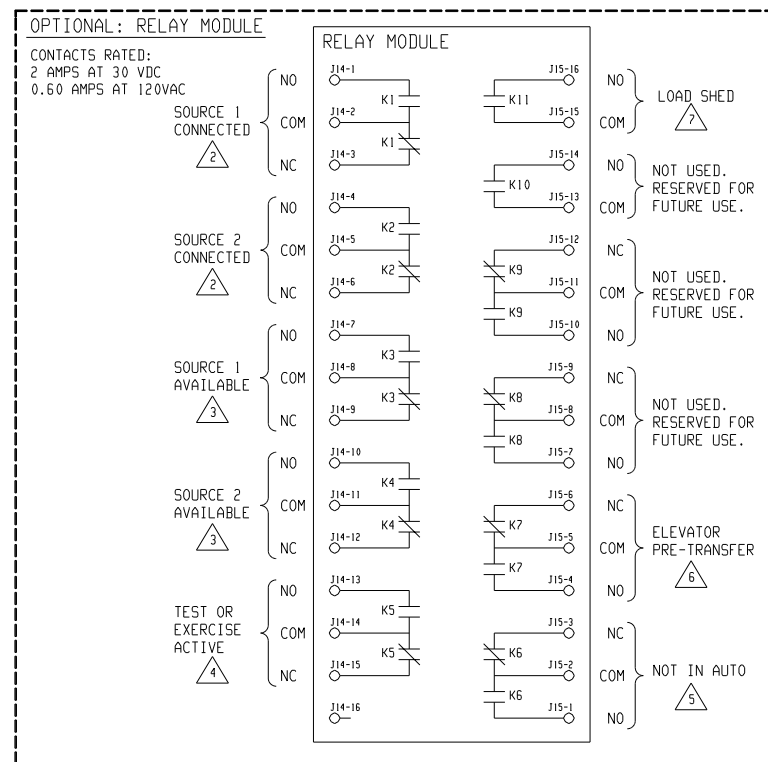
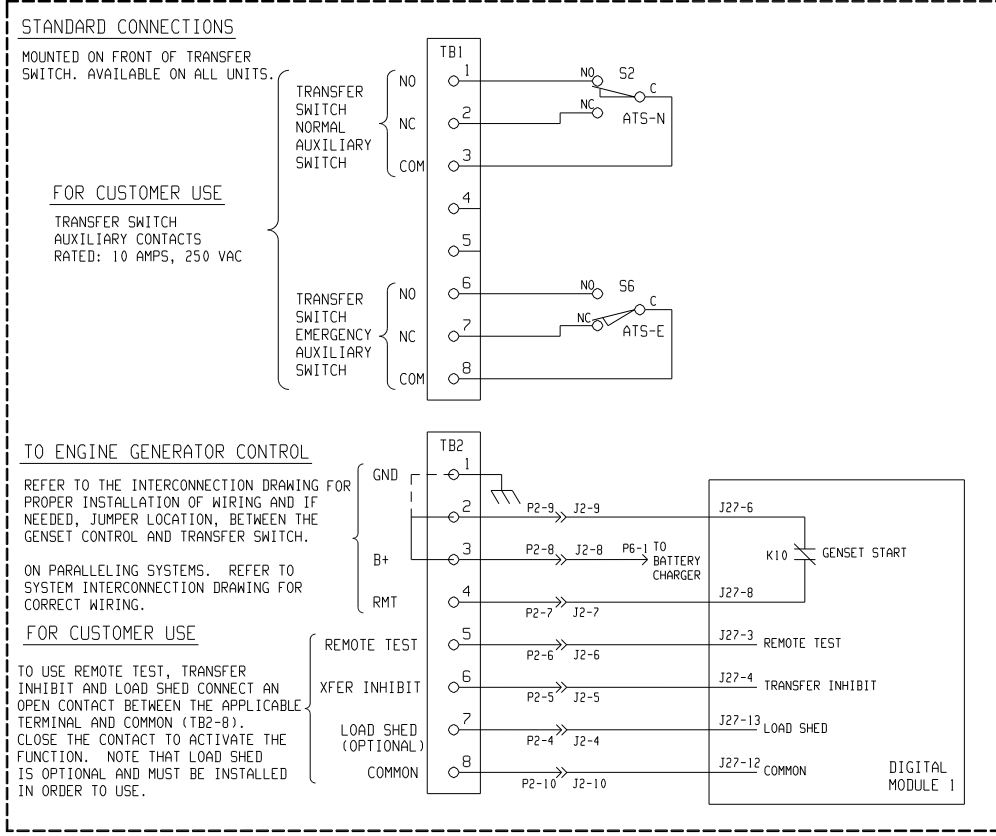
- APPROX. WEIGHT: 165 LBS  
MASS: 75 kg
- DIMENSIONS IN ( ) ARE MILLIMETERS.
- LUG CAPACITY:  
(1 WIRE) WIRE RANGE 16 AWG-300 MCM (16-150 mm) WIRE CU-AL.  
GND LUG CAPACITY:  
(1 WIRE) WIRE RANGE 14 AWG-1/0 (2.5-50 mm) CU-AL
- USE SEPERATE CONDUITS FOR CONTROL WIRING AND POWER WIRING. DO NOT COMBINE.
- SHADED AREA INDICATES WIRING AND CABLE ENTRANCE AREA DO NOT INSTALL OUTSIDE OF SHADED AREA.
- WIRING BENDING SPACE CONFORMS TO NATIONAL ELECTRIC CODE (NFPA70).
- REFER TO THE NATIONAL ELECTRIC CODE FOR MINIMUM CLEAR SPACE IN FRONT OF THIS ENCLOSURE.



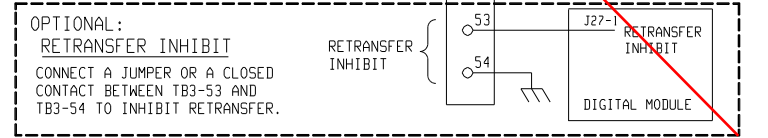
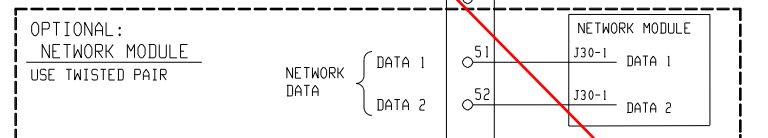
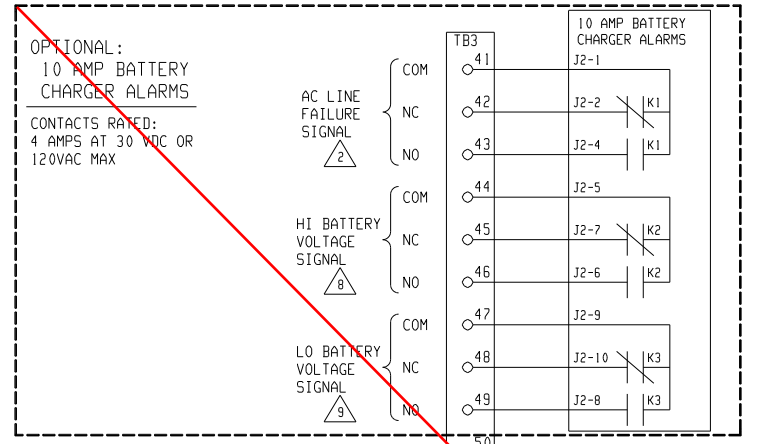
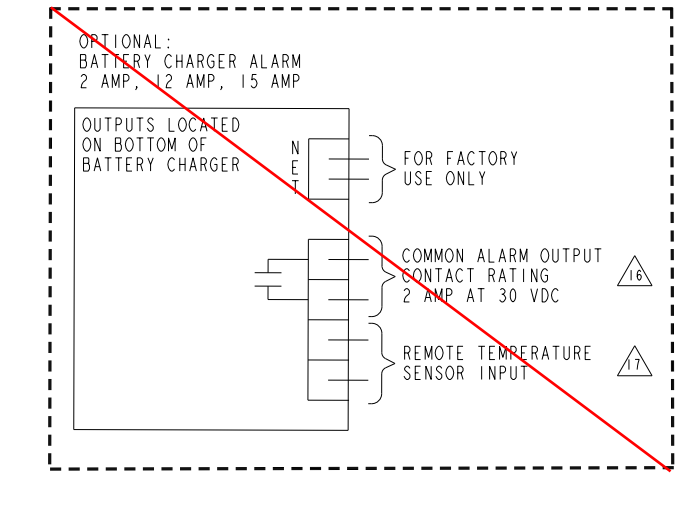
UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS		SIM TO		DRN G COLLEEN		CUMMINS POWER GENERATION	
DO NOT SCALE PRINT		CRD J MORLEY		APVD N SCHOTTLER		OUTLINE-CONTROL BOX	
DATE 14JAN09		SITE CODE		PGF		0310-0414	
ANG TOL: ± 1.0°		SCALE: 1/1		PROPERTY OF CUMMINS POWER GENERATION GROUP		SHEET 1 OF 2	

REL NO	LTR	NO	REVISION	ZONE	DR	CHKD	APPROVED	DATE
ECO-101282	E	1	ADDED NOTE 18		GAC	JM	YW	10SEP08
		2	SEE SHEET 2		GAC	JM	YW	10SEP08

CUSTOMER CONNECTIONS



- NOTES:
- TB1 AND TB2 ARE MOUNTED ON THE FRONT OF THE TRANSFER SWITCH. TB3 IS MOUNTED ON THE LEFT INSIDE PANEL OF THE ENCLOSURE.
  - SHOWN WITH SOURCE NOT CONNECTED.
  - SHOWN WITH SOURCE NOT AVAILABLE.
  - SHOWN NOT ACTIVE. CONTACTS CHANGE STATE DURING TEST OR EXERCISE PERIOD.
  - SHOWN WITH CONTROL IN AUTOMATIC MODE. CONTACTS CHANGE STATE WHEN CONTROL IS NOT IN AUTO.
  - SHOWN NOT ACTIVE. CONTACTS CHANGE STATE FOR AN ADJUSTABLE TIME BEFORE LOAD TRANSFER OCCURS.
  - SHOWN NOT ACTIVE. CONTACTS CHANGE STATE DURING LOAD SHED.
  - SHOWN UNDER NORMAL BATTERY VOLTAGE CONDITION. CONTACTS TRANSFER UNDER A HIGH BATTERY VOLTAGE CONDITION.
  - SHOWN UNDER A LOW BATTERY VOLTAGE CONDITION.



- SEE SHEET 2.
  - SEE SHEET 2.
  - SEE SHEET 4.
  - SEE SHEET 4.
  - SEE SHEET 5.
  - THE FOLLOWING WILL CAUSE A BATTERY CHARGER ALARM OUTPUT:
- LOW BATTERY VOLTAGE
  - HIGH BATTERY VOLTAGE
  - LOW AC INPUT VOLTAGE
  - HIGH AC INPUT VOLTAGE
  - OVERCURRENT
  - HIGH CHARGER TEMPERATURE
  - BATTERY FAILURE
  - HIGH BATTERY TEMPERATURE:
- NOT AVAILABLE ON 2 AMP CHARGER
- UTILITY TO GENSET LEVEL 1 CONTROL 3 AND 4 POLE  
OTPC 40-600 AMP, OTPCSE 40-125 AMP & OTPCSE 300-600 AMP  
120 VOLT 1 PHASE L-N  
240 VOLT 1 PHASE  
190 VOLT 3 PHASE  
208 VOLT 3 PHASE  
220 VOLT 3 PHASE  
240 VOLT 3 PHASE  
380 VOLT 3 PHASE  
415 VOLT 3 PHASE  
440 VOLT 3 PHASE  
480 VOLT 3 PHASE
- OPTIONS:  
DISPLAY MODULE  
NETWORK MODULE  
LOAD SHED  
RELAY MODULE  
BATTERY CHARGER  
BATTERY CHARGER ALARMS  
RETRANSFER INHIBIT
18. SEE SHEET 2.

**CLASSIFICATION OF CHARACTERISTICS**

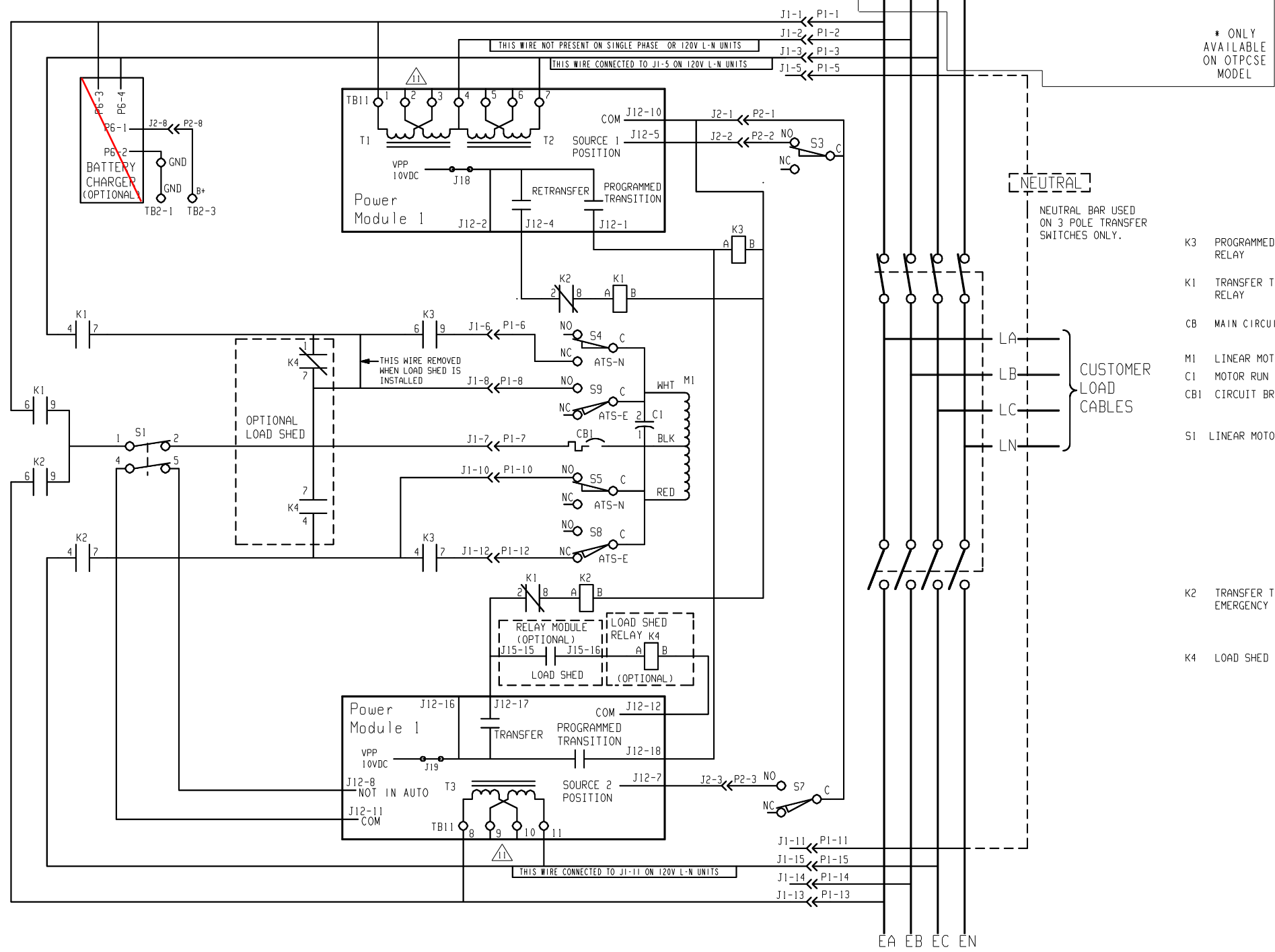
CRITICAL ●  
MAJOR ●  
MINOR (NONE) ○  
LINE BELOW SYMBOL ● APPLIES TO UPPER LIMIT  
LINE ABOVE SYMBOL ● APPLIES TO LOWER LIMIT  
NO LINES WITH SYMBOL APPLIES TO BOTH LIMITS  
KEY INSTRUCTION (NO TOLERANCE) ▼

APPROVED LARRY SMITH  
DATE 01/18/99

ITEM	PART NO	QTY	DESCRIPTION OR MATERIAL	REV
DO NOT SCALE PRINT				
ANG TOL±				
DRAWN TO 1/1 SCALE OF				
ITEM	PART NO	QTY	DESCRIPTION OR MATERIAL	REV
DR	S D MORE			08/01/04
CHKR	I A MAHADESHWAR			08/01/04
APPROVED	MILLER			08/01/04
CUMMINS POWER GENERATION			120-480 VAC	
WD-TRANSFER SWITCH			SHEET 5 OF 5	

REL NO	LTR	NO	REVISION	ZONE	DR	CHKR	APPROVED	DATE
ECO-101282	E	2	SEE ECO	-	GAC	JM	YW	10SEP08

SCHMATIC DIAGRAM



\* ONLY AVAILABLE ON OTPCSE MODEL

NEUTRAL  
NEUTRAL BAR USED ON 3 POLE TRANSFER SWITCHES ONLY.

- K3 PROGRAMMED TRANSITION RELAY
- K1 TRANSFER TO NORMAL RELAY
- CB MAIN CIRCUIT BREAKER
- M1 LINEAR MOTOR
- C1 MOTOR RUN CAPACITOR
- CB1 CIRCUIT BREAKER
- S1 LINEAR MOTOR DISABLE
- K2 TRANSFER TO EMERGENCY RELAY
- K4 LOAD SHED RELAY

NOTES:

10. ALL DEVICES ARE SHOWN DE-ENERGIZED, WITH THE TRANSFER SWITCH CLOSED TO NORMAL. 4 POLE TRANSFER SWITCH SHOWN. ON 3 POLE MODELS THE SWITCHED NEUTRAL POLE IS REPLACED WITH A SOLID NEUTRAL BAR.
11. SEE SHEET 3 FOR TRANSFORMER PRIMARY JUMPERS.
12. FOR SINGLE PHASE UNITS:  
120/240, 3 WIRE - CONNECT POWER CABLES TO A AND C  
120 L-N, 2 WIRE - CONNECT POWER CABLES TO A AND NEUTRAL
18. FOR OTPCSE MODEL, LIST OF MAIN CIRCUIT BREAKER TYPE SHOWN BELOW:  
SWITCH RATING: 40-125A MAIN CIRCUIT BREAKER TYPE SQUARE D, TYPE "HG"  
300-600A SQUARE D, TYPE "PJ"

CLASSIFICATION OF CHARACTERISTICS

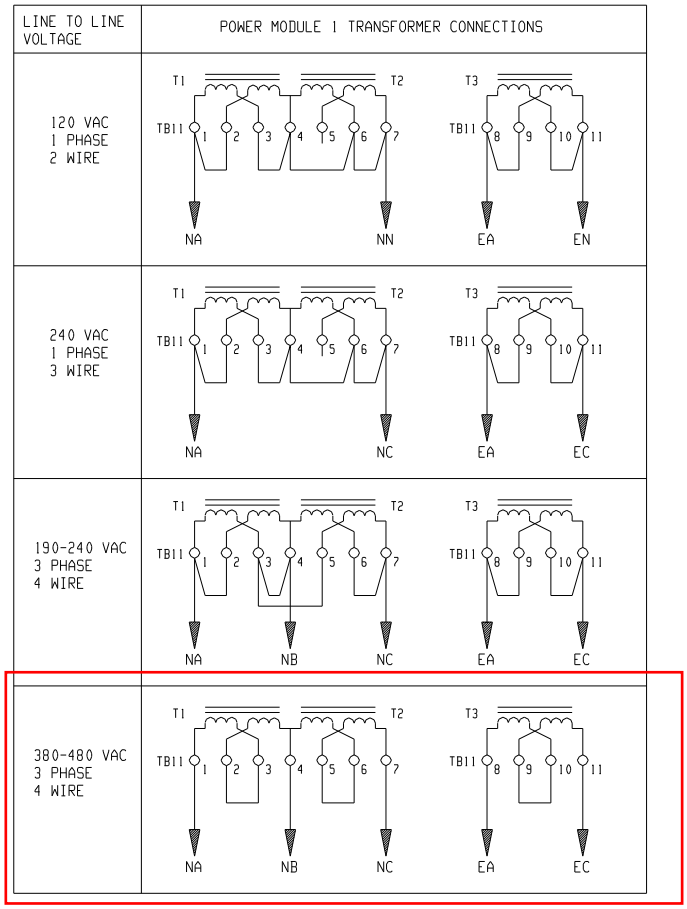
CRITICAL	●	
MAJOR	◐	APPROVED LARRY SMITH
MINOR (NONE)	○	DATE 01/18/99
LINE BELOW SYMBOL	●	APPLIES TO UPPER LIMIT
LINE ABOVE SYMBOL	◐	APPLIES TO LOWER LIMIT
NO LINES WITH SYMBOL	○	APPLIES TO BOTH LIMITS
KEY INSTRUCTION	▽	(NO TOLERANCE)

ITEM	PART NO	QTY	DESCRIPTION OR MATERIAL	REV	
DO NOT SCALE PRINT					
ANG TOL ±	0.09	0.99	+0.15/-0.00	004-200	+0.00/-0.03
	5.00	9.99	+0.20/-0.10	201-421	+0.00/-0.04
	10.00	17.49	+0.25/-0.13	422-103	+0.01/-0.05
	17.50	24.99	+0.30/-0.13	704-999	+0.02/-0.05

DR	S D MORE	DATE	08/01/04
CHKR	I A MAHADESHWAR	DATE	08/01/04
APPROVED	MILLER	DATE	08/01/04

CUMMINS POWER GENERATION	1400 73RD AVE NE	MINNEAPOLIS, MINNESOTA 55432
WD-TRANSFER SWITCH		
SITE CODE	PGA	
DWG NO	0626-2303	SHEET 2 of 5





SEE 0626-2304 FOR 600 VOLT CONNECTIONS.

CLASSIFICATION OF CHARACTERISTICS  
 CRITICAL ●  
 MAJOR ●  
 MINOR (NONE)  
 LINE BELOW SYMBOL ● APPLIES TO UPPER LIMIT  
 LINE ABOVE SYMBOL ● APPLIES TO LOWER LIMIT  
 NO LINES WITH SYMBOL APPLIES TO BOTH LIMITS  
 KEY INSTRUCTION (NO TOLERANCE) ▼

APPROVED LARRY SMITH  
 DATE 01/18/99

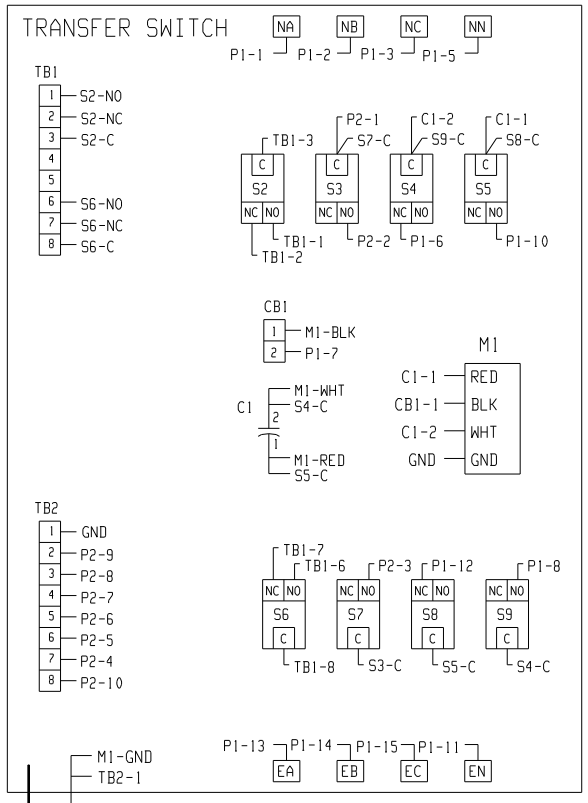
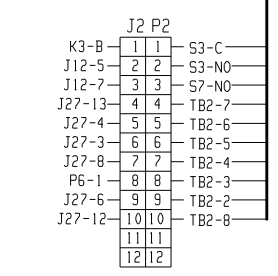
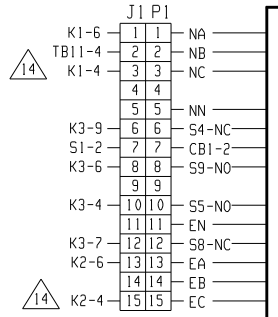
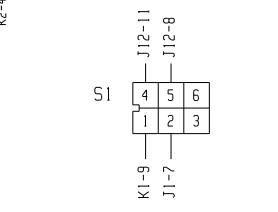
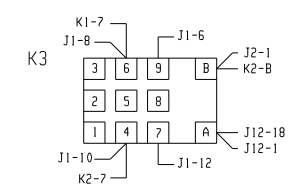
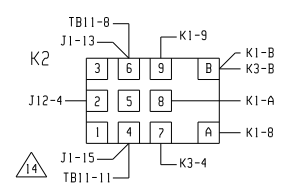
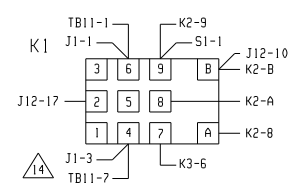
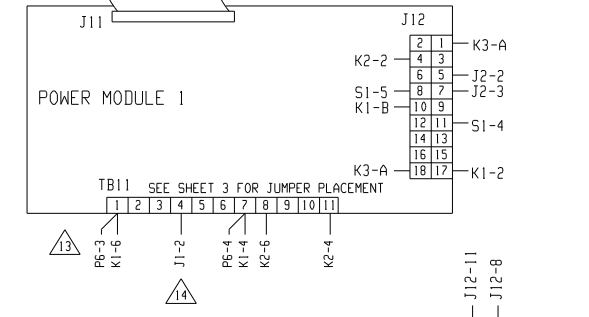
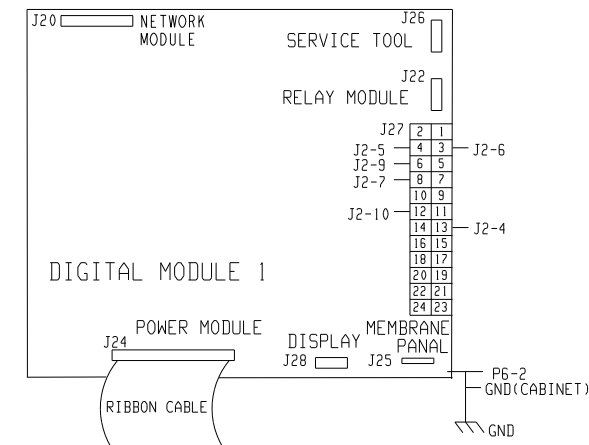
DO NOT SCALE PRINT		TOLERANCE UNLESS OTHERWISE SPECIFIED		DIM		ITEM PART NO		DESCRIPTION OR MATERIAL		REV DES	
		mm		inch		NAME		DATE		DATE	
ANG TOL±		0.09 - 0.99 +0.15/-0.00		.004 - .200 +.001/-0.003		DR S D MORE		08/01/04		CUMMINS POWER GENERATION 1400 73RD AVE NE WINNEAPOLIS, MINNESOTA 55432	
DRAWN TO SCALE OF		5.00 - 9.99 +0.20/-0.10		.201 - .421 +.002/-0.004		CHKR DR I A MAHADESHWAR		08/01/04		TITLE WD-TRANSFER SWITCH	
1/1		10.00 - 17.49 +0.25/-0.13		.422 - .763 +.010/-0.005		APPROVED MILLER		08/01/04		SITE CODE	
		17.50 - 24.99 +0.30/-0.13		.764 - .999 +.012/-0.005		MODEL FIRST USED ON		01PC 40-600A SPEC A		SHEET 3 of 5	
						TOLERANCING SEE 6.2 AND 7.1.4, 5M-1982		120-480 VAC		DWG NO 0626-2303	

STANDARD WIRING

REAR VIEW OF DOOR

LEFT SIDEWALL

REAR WALL OF CABINET



P1-5  
 P1-11  
**NEUTRAL BAR**  
 NEUTRAL BAR IS USED ON 3 POLE MODELS ONLY.

NOTES:  
 SEE SHEET 3 FOR TB11 JUMPER CONNECTIONS.  
 ON ALL SINGLE PHASE, 2 OR 3 WIRE UNITS: THE WIRE CONNECTED FROM J1-2 TO TB11-4 IS NOT PRESENT.  
 IN ADDITION, ON 120 VOLT L-N, 2 WIRE UNITS: THE WIRE CONNECTED FROM K1-4 TO J1-5 AND THE WIRE CONNECTED FROM K2-4 TO J1-15 WILL BE CONNECTED FROM K2-4 TO J1-11.

CLASSIFICATION OF CHARACTERISTICS  
 CRITICAL ●  
 MAJOR ●  
 MINOR (NONE)  
 LINE BELOW SYMBOL ● APPLIES TO UPPER LIMIT  
 LINE ABOVE SYMBOL ● APPLIES TO LOWER LIMIT  
 NO LINES WITH SYMBOL APPLIES TO BOTH LIMITS  
 KEY INSTRUCTION (NO TOLERANCE)

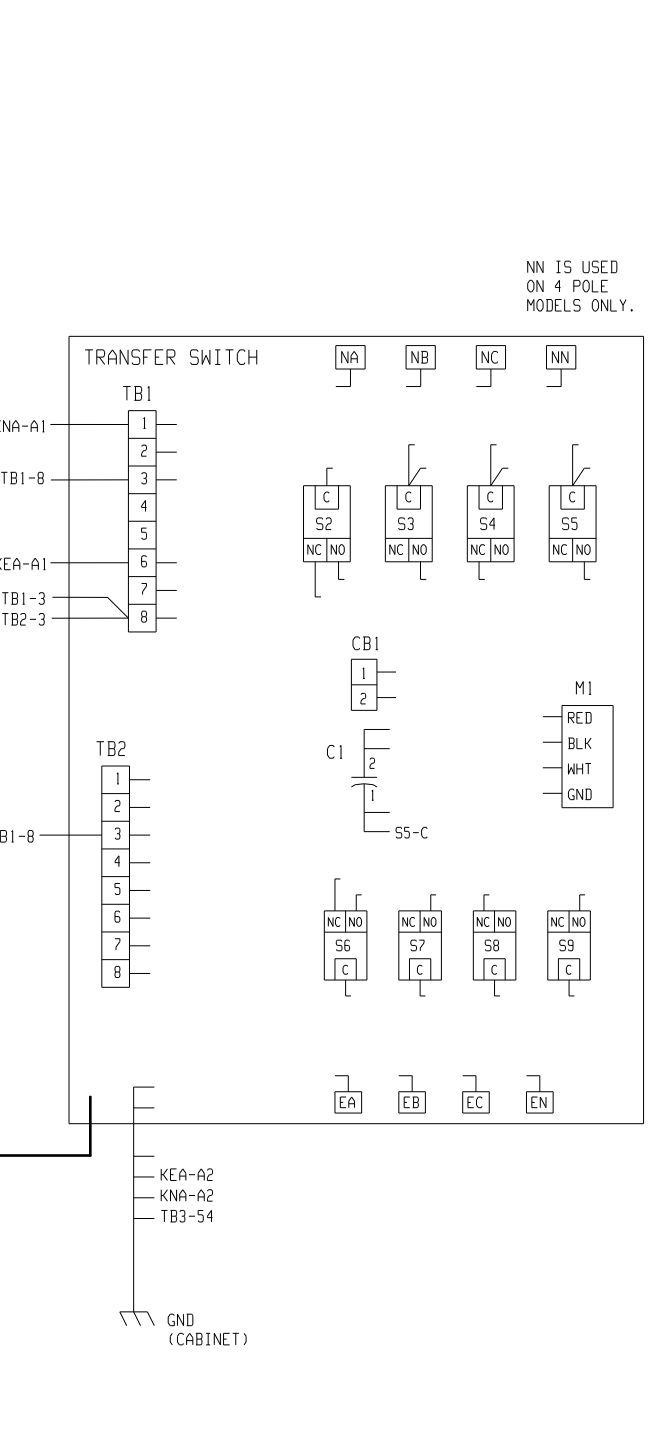
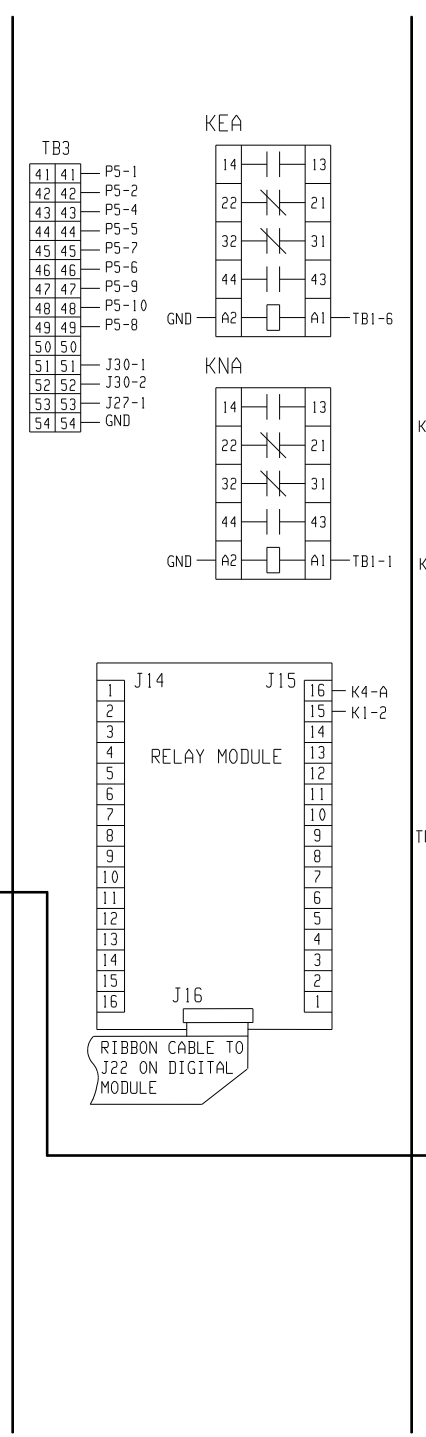
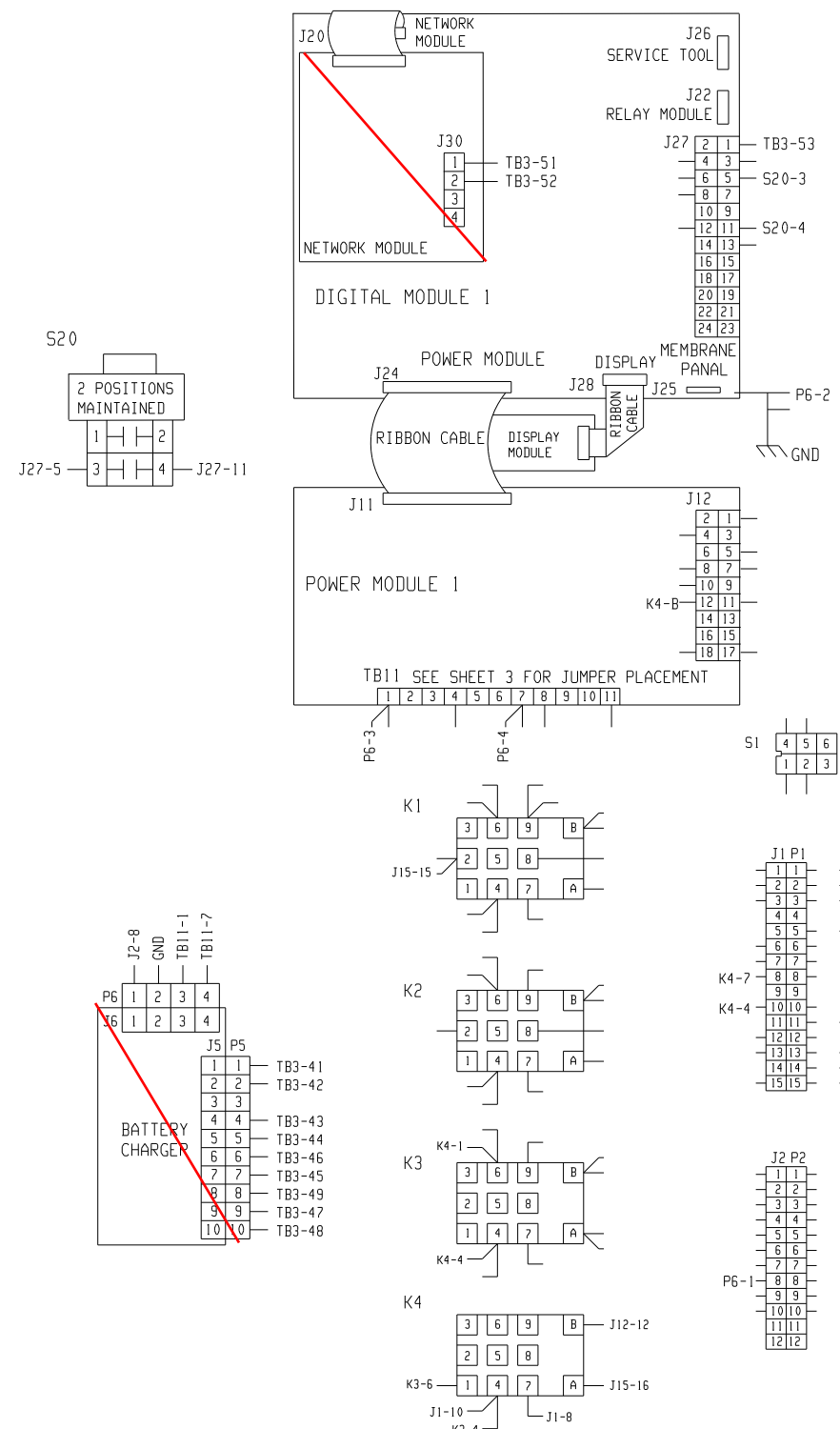
APPROVED LARRY SMITH  
 DATE 01/18/99

DO NOT SCALE PRINT		TOLERANCE UNLESS OTHERWISE SPECIFIED		DIM TO		ITEM PART NO		DESCRIPTION OR MATERIAL		REV DES	
		mm		inch		DR S D MORE		DATE		CUMMINS POWER GENERATION	
		X ±		.X ±		CHKR DR I A MAHADESHWAR		08/01/04		1400 73RD AVE NE	
		.XX ±		.XX ±		MFG		08/01/04		MINNEAPOLIS, MINNESOTA 55432	
		XXX ±		XXX ±		APPROVED MILLER		08/01/04		TITLE WD-TRANSFER SWITCH	
ANG TOL ± °		0.09 - 0.99 +0.15/-0.00		0.04 - 200 +.000/- .003		THIS DOCUMENT IS THE PROPERTY OF CUMMINS POWER GENERATION. IT CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION WHICH MUST NOT BE REPRODUCED, COPIED, OR DISCLOSED WITHOUT EXPRESSLY AUTHORIZED BY CUMMINS POWER GENERATION OR ITS REPRESENTATIVE.		MODEL FIRST USED ON 01PC 40-600 SPEC A		SHEET 4 of 5	
DRAWN TO SCALE OF 1/1		5.00 - 9.99 +0.20/-0.10		201 - 421 +.000/- .004		TOLERANCING, SEE 6.0		120-480 VAC		DWG NO 0626-2303	
		10.00 - 17.99 +0.25/-0.13		.422 - .103 +.010/- .005						SITE CODE PGA	
		17.50 - 24.99 +0.30/-0.13		.704 - .999 +.012/- .005						DWG DATE 08/01/04	

OPTION WIRING  
LEFT SIDEWALL

REAR WALL OF CABINET

REAR VIEW OF DOOR



NEUTRAL BAR  
NEUTRAL BAR IS USED ON 3 POLE MODELS ONLY.

NOTES:  
15. WIRING FOR RELAYS KNA AND KEA IS TYPICAL. POWER CONNECTIONS MAY VARY SLIGHTLY IF MORE OR LESS RELAYS ARE USED.

CLASSIFICATION OF CHARACTERISTICS  
 CRITICAL ●  
 MAJOR ●  
 MINOR (NONE) ○  
 LINE BELOW SYMBOL ● APPLIES TO UPPER LIMIT  
 LINE ABOVE SYMBOL ● APPLIES TO LOWER LIMIT  
 NO LINES WITH SYMBOL APPLIES TO BOTH LIMITS  
 KEY INSTRUCTION (NO TOLERANCE) ▼

APPROVED LARRY SMITH  
 DATE 01/18/99

DO NOT SCALE PRINT		TOLERANCE UNLESS OTHERWISE SPECIFIED		DIM TO		ITEM PART NO		DESCRIPTION OR MATERIAL		REV DES	
		mm	Inch	FROM	TO	NAME	DATE				
		0.25 ±	.010 ±	THIRD ANGLE PROJECTION		DR S D MORE	08/01/04				
		0.50 ±	.020 ±			CHKR DR I A MAHADESHWAR	08/01/04				
		1.00 ±	.040 ±			APPROVED MILLER	08/01/04				
		1.50 ±	.060 ±								
		2.00 ±	.080 ±								
		2.50 ±	.100 ±								
		3.00 ±	.120 ±								
		3.50 ±	.140 ±								
		4.00 ±	.160 ±								
		4.50 ±	.180 ±								
		5.00 ±	.200 ±								
		5.50 ±	.220 ±								
		6.00 ±	.240 ±								
		6.50 ±	.260 ±								
		7.00 ±	.280 ±								
		7.50 ±	.300 ±								
		8.00 ±	.320 ±								
		8.50 ±	.340 ±								
		9.00 ±	.360 ±								
		9.50 ±	.380 ±								
		10.00 ±	.400 ±								
		10.50 ±	.420 ±								
		11.00 ±	.440 ±								
		11.50 ±	.460 ±								
		12.00 ±	.480 ±								
		12.50 ±	.500 ±								
		13.00 ±	.520 ±								
		13.50 ±	.540 ±								
		14.00 ±	.560 ±								
		14.50 ±	.580 ±								
		15.00 ±	.600 ±								
		15.50 ±	.620 ±								
		16.00 ±	.640 ±								
		16.50 ±	.660 ±								
		17.00 ±	.680 ±								
		17.50 ±	.700 ±								
		18.00 ±	.720 ±								
		18.50 ±	.740 ±								
		19.00 ±	.760 ±								
		19.50 ±	.780 ±								
		20.00 ±	.800 ±								
		20.50 ±	.820 ±								
		21.00 ±	.840 ±								
		21.50 ±	.860 ±								
		22.00 ±	.880 ±								
		22.50 ±	.900 ±								
		23.00 ±	.920 ±								
		23.50 ±	.940 ±								
		24.00 ±	.960 ±								
		24.50 ±	.980 ±								
		25.00 ±	1.000 ±								
		25.50 ±	1.020 ±								
		26.00 ±	1.040 ±								
		26.50 ±	1.060 ±								
		27.00 ±	1.080 ±								
		27.50 ±	1.100 ±								
		28.00 ±	1.120 ±								
		28.50 ±	1.140 ±								
		29.00 ±	1.160 ±								
		29.50 ±	1.180 ±								
		30.00 ±	1.200 ±								
		30.50 ±	1.220 ±								
		31.00 ±	1.240 ±								
		31.50 ±	1.260 ±								
		32.00 ±	1.280 ±								
		32.50 ±	1.300 ±								
		33.00 ±	1.320 ±								
		33.50 ±	1.340 ±								
		34.00 ±	1.360 ±								
		34.50 ±	1.380 ±								
		35.00 ±	1.400 ±								
		35.50 ±	1.420 ±								
		36.00 ±	1.440 ±								
		36.50 ±	1.460 ±								
		37.00 ±	1.480 ±								
		37.50 ±	1.500 ±								
		38.00 ±	1.520 ±								
		38.50 ±	1.540 ±								
		39.00 ±	1.560 ±								
		39.50 ±	1.580 ±								
		40.00 ±	1.600 ±								
		40.50 ±	1.620 ±								
		41.00 ±	1.640 ±								
		41.50 ±	1.660 ±								
		42.00 ±	1.680 ±								
		42.50 ±	1.700 ±								
		43.00 ±	1.720 ±								
		43.50 ±	1.740 ±								
		44.00 ±	1.760 ±								
		44.50 ±	1.780 ±								
		45.00 ±	1.800 ±								
		45.50 ±	1.820 ±								
		46.00 ±	1.840 ±								
		46.50 ±	1.860 ±								
		47.00 ±	1.880 ±								
		47.50 ±	1.900 ±								
		48.00 ±	1.920 ±								
		48.50 ±	1.940 ±								
		49.00 ±	1.960 ±								
		49.50 ±	1.980 ±								
		50.00 ±	2.000 ±								
		50.50 ±	2.020 ±								
		51.00 ±	2.040 ±								
		51.50 ±	2.060 ±								
		52.00 ±	2.080 ±								
		52.50 ±	2.100 ±								
		53.00 ±	2.120 ±								
		53.50 ±	2.140 ±								
		54.00 ±	2.160 ±								
		54.50 ±	2.180 ±								
		55.00 ±	2.200 ±								
		55.50 ±	2.220 ±								
		56.00 ±	2.240 ±								
		56.50 ±	2.260 ±								
		57.00 ±	2.280 ±								
		57.50 ±	2.300 ±								
		58.00 ±	2.320 ±								
		58.50 ±	2.340 ±								
		59.00 ±	2.360 ±								
		59.50 ±	2.380 ±								
		60.00 ±	2.400 ±								
		60.50 ±	2.420 ±								
		61.00 ±	2.440 ±								
		61.50 ±	2.460 ±								
		62.00 ±	2.480 ±								
		62.50 ±	2.500 ±								
		63.00 ±	2.520 ±								
		63.50 ±	2.540 ±								
		64.00 ±	2.560 ±								
		64.50 ±	2.580 ±								
		65.00 ±	2.600 ±								
		65.50 ±	2.620 ±								
		66.00 ±	2.640 ±								
		66.50 ±	2.660 ±								
		67.00 ±	2.680 ±								
		67.50 ±	2.700 ±								
		68.00 ±	2.720 ±								
		68.50 ±	2.740 ±								
		69.00 ±	2.760 ±								
		69.50 ±	2.780 ±								
		70.00 ±	2.800 ±								
		70.50 ±	2.820 ±								
		71.00 ±	2.840 ±								



REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-146025	A	1	PRODUCTION_RELEASE	SGM	GRB	L. SMITH	22AUG14

73.2

SHORT-CIRCUIT WITHSTAND/CLOSING RATINGS						
Specific Fuse Manufacturer and Type Listing						
When protected by a fuse of the specific fuse class and up to the fuse amperes listed below, this transfer switch is suitable for use in a circuit capable of delivering up to the short circuit current and voltage listed below.						
Short-Circuit Current RMS Symmetrical Amperes	Short Circuit AC Voltage	Fuse Class	Maximum Fuse Amperes			
200000	600	J, RK1, RKS	600			
200000	600	L, T	1200			
Specific Circuit Breaker Manufacturer and Type Listing						
When protected by a circuit breaker of a specific manufacturer and type, and up to the maximum breaker amperes listed below, this transfer switch is suitable for use in a circuit capable of delivering up to the short circuit current and voltage listed below, but not more than the rating of the specific circuit breaker.						
Short-Circuit Current RMS Symmetrical Amperes	Short Circuit AC Voltage	Maximum Breaker Amperes				
30000	600	400				
GE						
TEYD	TEYH	TEYL	THJK	TJK	TJJ	
Siemens						
BOCH	FD6	HFD6	HJD6 <sup>1</sup>	JXD2	NFGA	QJ2
BOD	FD6A	HFGA	HJGA	JXD6 <sup>1</sup>	NGB	QJ2-H
CC	FXD6	HFXD6	HJXD6 <sup>1</sup>	LDGA	NGDA	QJH2
COD	FXD6A	HFXD6	HLGA	LFGA	NGG	
ED2	HDGA	HHFXD6	HLGB	LJGA	NJGA	
ED4	HED4	HHJD6 <sup>1</sup>	HQJ2	LLGA	NLGA	
ED6	HED6	HHJXD6 <sup>1</sup>	JD6 <sup>1</sup>	LLGB	NLGB	
1 - 240 Volt Maximum						
Eaton						
BAB	EGE <sup>3</sup>	GHBGFEP	JGE	QBHW	QHCX	
CHKD <sup>2</sup>	EGH <sup>3</sup>	GHS	JGH	QC	QHPW	
CKD <sup>2</sup>	EGS <sup>3</sup>	GHC	JGS	OCF	QHPX	
DK	EHD	GHCGFEP	KD	OCGF	OPGF	
ED	FD	HFD	KDB	OCGFEP	OPGFEP	
EDB	FDB	HJD	OBGF	OCGFEP	OPGFEP	
EDC	FDE	HKD	OBGFEP	OCGFEP	OPGFEP	
EDH	GBHS	HOP	OBH	OCHW	OPHW	
EDS	GD	JD	OBHGF	OCR		
EGB <sup>2</sup>	GHB	JDB	OBHGFEP	OHCW		
2 - 310 trip unit only 3 - Limited to 70 amps maximum						

A048E949.A

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NOTES:

1. LABEL SHOWN ON PRINT IS NOT ARTWORK. VENDOR ARTWORK CREATED TO PRODUCE THIS LABEL MUST BE SIGNED OFF BY CUMMINS POWER GENERATION PURCHASING.
2. ALL TEXT TO BE HELVETICA SANS SERIF, OR EQUIVALENT.
3. BLACK TEXT AND WHITE BACKGROUND.
4. MATERIAL THICKNESS: 10 MIL.
5. SEE CUMMINS POWER GENERATION MATERIAL SPECIFICATIONS FOR APPLICATION INFORMATION.
6. IF CORNERS SHOWN SQUARE, RADIUS OPTIONAL.
7. IF CSA AGENCY APPROVAL REQUIRED LOCATE VENDOR CSA IDENTIFICATION MARK IN LOWER RIGHT HAND CORNER.
8. LOCATE LABEL PART NUMBER & REVISION LETTER WHERE SHOWN.

**-THIS IS A CONTROLLED ITEM-**

PER CPG PROCEDURE FRE-1002

TO MAINTAIN COMPLIANCE WITH REQUIREMENTS OF THE CODES, STANDARDS, OR AGENCIES LISTED BELOW

- CSA     UL     CE     RVIA     ABYC  
 IBC     OTHER \_\_\_\_\_     OTHER \_\_\_\_\_

CHANGES, DEVIATIONS, OR SUBSTITUTIONS OF MATERIAL, PROCESS, OR PERFORMANCE FOR THIS ITEM MUST BE APPROVED BY THE FOLLOWING CONTROLLED ITEM APPROVER

RESPONSIBLE CIA ROLE PE TRANSFER SWITCH CIA

RESPONSIBLE CIA ROLE \_\_\_\_\_

RESPONSIBLE CIA ROLE \_\_\_\_\_

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS		SIM TO 0098-6886		DWN S.MADARAKALL		CUMMINS POWER GENERATION	
DO NOT SCALE PRINT		DWN S.MADARAKALL		CKD G.BAIRAGI		LABEL, INFORMATION (WITHSTAND RATING)	
APVD L. SMITH		DATE 22AUG14		SITE CODE		PGF	
ANG TOL: ± 1.0°		SCALE: 1/1		FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5M-1994		FIRST USED ON 0T 150-260A	
- CONFIDENTIAL - PROPERTY OF CUMMINS POWER GENERATION GROUP		DWN S.MADARAKALL		DATE 22AUG14		DWG SIZE B	
		DWN S.MADARAKALL		DATE 22AUG14		DWG REV A	
		DWN S.MADARAKALL		DATE 22AUG14		SHEET 1 OF 1	
		DWN S.MADARAKALL		DATE 22AUG14		DWG REV A	

REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-147537	A	I	PRODUCTION_RELEASE	SGM	GRB	L. SMITH	06NOV14

73

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**Special Withstand Ratings**

**Circuit Breaker Protection**  
When protected by one of the following circuit breakers rated not more than 400 amperes, this transfer switch is rated for use on a circuit capable of delivering not more than the indicated RMS symmetrical amperes at the voltage shown.

Type	Interrupting Rating at		
	240 VAC	480 VAC	600 VAC
AKRU, AKU	200000	200000	200000
FB, FC	200000	150000	42000
FE	200000	150000	-
FG	200000	150000	65000
SEL, SFL	100000	65000	25000
SEP, SFP	200000	100000	25000
SGL	100000	65000	65000
SGP	200000	100000	65000
TEC & TECL	100000	100000	100000
TEL, TELM, TFL	100000	65000	25000
THLC1, THLC2, THLC4	200000	200000	50000

**Siemens**

Type	Interrupting Rating at		
	240 VAC	480 VAC	600 VAC
CEDE, CFDE	200000	200000	100000
CJDE, CLDE	200000	150000	100000
SCJDE, SCLDE	200000	150000	100000

**Square D**

Type	Interrupting Rating at		
	240 VAC	480 VAC	600 VAC
DG, HG, JG, LG	65000	35000	18000
DJ, HJ, JJ, LJ	100000	65000	25000
DL	125000	100000	25000
FI, KI, LI, HR, JR, LR	200000	200000	100000
HD, JD, LD	25000	18000	14000
HL, JL, LL	125000	100000	50000

**Eaton**

Type	Interrupting Rating at		
	240 VAC	480 VAC	600 VAC
DSL, LA, ND	200000	200000	200000
FDC, JDC, EGC	200000	100000	35000
KDC, LDC, JGC, LGC	200000	100000	50000
JGU	200000	150000	50000
JGX	200000	200000	35000
LCL	200000	200000	100000
LGU	200000	150000	65000
LGX	200000	200000	65000

**Merlin Gerin**

Type	Interrupting Rating at		
	240 VAC	480 VAC	600 VAC
CE100L	150000	100000	42000
CF250L, CJ400L	150000	150000	65000
CR100L	150000	50000	42000
NSF100N	65000	18000	-
NSF150N, NSF250N	65000	35000	18000
NSF150N, NSF250H	100000	65000	25000
NSJ400N, NSJ600N	65000	35000	18000
NSJ400H, NSJ600H	100000	65000	25000
NSJ400L, NSJ600L	150000	100000	25000

A048J539 A

**-THIS IS A CONTROLLED ITEM-**  
PER POLICY-PROCEDURE PGG 1-01-01-116

TO MAINTAIN COMPLIANCE WITH REQUIREMENTS OF THE CODES, STANDARDS, OR AGENCIES LISTED BELOW


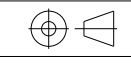

CSA    UL    CE    RVIA    ABYC  
 IBC    OTHER \_\_\_\_\_    OTHER \_\_\_\_\_

CHANGES, DEVIATIONS, OR SUBSTITUTIONS OF MATERIAL, PROCESS, OR PERFORMANCE FOR THIS ITEM MUST BE APPROVED BY THE FOLLOWING CONTROLLED ITEM APPROVER \_\_\_\_\_

RESPONSIBLE CIA ROLE PE TRANSFER SWITCH CIA  
RESPONSIBLE CIA ROLE \_\_\_\_\_  
RESPONSIBLE CIA ROLE \_\_\_\_\_

NOTES:

- LABEL SHOWN ON PRINT IS NOT ARTWORK. VENDOR ARTWORK CREATED TO PRODUCE THIS LABEL MUST BE SIGNED OFF BY CUMMINS POWER GENERATION PURCHASING.
- ALL TEXT TO BE HELVETICA SANS SERIF, OR EQUIVALENT.
- BLACK TEXT AND WHITE BACKGROUND.
- MATERIAL THICKNESS: 10 MIL.
- SEE CUMMINS POWER GENERATION MATERIAL SPECIFICATIONS FOR APPLICATION INFORMATION.
- IF CORNERS SHOWN SQUARE, RADIUS OPTIONAL.
- IF CSA AGENCY APPROVAL REQUIRED LOCATE VENDOR CSA IDENTIFICATION MARK IN LOWER RIGHT HAND CORNER.
- LOCATE LABEL PART NUMBER & REVISION LETTER WHERE SHOWN.

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS		SIM TO 0098-6919	DWN S. MADARAKALL		<b>CUMMINS POWER GENERATION</b>												
DO NOT SCALE PRINT		CKD G. BAIRAGI	APVD L. SMITH		LABEL, INFORMATION (SPECIAL BREAKER)												
<table border="1"> <tr> <td>DIM</td> <td>X ± 1</td> <td>0.00- 4.99 +0.15/-0.08</td> </tr> <tr> <td></td> <td>.X ± 0.8</td> <td>5.00- 9.99 +0.20/-0.10</td> </tr> <tr> <td></td> <td>.XX ± 0.38</td> <td>10.00-17.49 +0.25/-0.13</td> </tr> <tr> <td></td> <td></td> <td>17.50-24.99 +0.30/-0.13</td> </tr> </table>		DIM	X ± 1		0.00- 4.99 +0.15/-0.08		.X ± 0.8	5.00- 9.99 +0.20/-0.10		.XX ± 0.38	10.00-17.49 +0.25/-0.13			17.50-24.99 +0.30/-0.13	DATE 06NOV14	SITE CODE	
DIM	X ± 1	0.00- 4.99 +0.15/-0.08															
	.X ± 0.8	5.00- 9.99 +0.20/-0.10															
	.XX ± 0.38	10.00-17.49 +0.25/-0.13															
		17.50-24.99 +0.30/-0.13															
ANG TOL: ± 1.0°	SCALE: 1/1				FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5M-1994 FIRST USED ON 01/01/PC/OTEC 150-260A PGF	SHEET 1 of 1 DWG REV A											



**Rocky  
Mountain**

# Tab #7

# Start-Up & Testing



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## **START-UP & TESTING**

**Field Start-Up and Test reports will be supplied in the final O&M manuals after the generator set and all related equipment supplied by Cummins Rocky Mountain have been commissioned.**

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# **GROUNDING & BONDING**

**Operations & Maintenance Manual  
December 2015**



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## ERITECH® COPPERBONDED GROUND RODS



[Print this page](#)

In a grounding system, the ground electrode provides the physical connection to the earth and is the instrument used to dissipate current into it. There are two main types of electrodes.

“**Natural**” electrodes are intrinsic to the facility and include metal underground water pipe, the metal frame of the building (if effectively grounded), and reinforcing bar in concrete foundations.

“**Made**” electrodes are installed specifically to improve the performance of the grounding system and include wire meshes, metallic plates, buried copper conductor and rods or pipe driven into the ground.

The ground rod is the most widely used grounding electrode. ERICO® is the world's largest manufacturer of ground rods and offers a complete line of rods and accessories to meet the needs of every user.

### FEATURES

#### Copperbonded Ground Rods

- Resist corrosion better than galvanized rods allowing for a 30-year service life in most soils
- State of the art manufacturing process ensures uniform plating thickness
- Average tensile strength of 80,000 psi and straightness tolerance of .010" per linear foot
- Exceed the requirements of ANSI®/UL® 467-1984, CSA®, and ANSI/NEMA® GR-1

#### Pointed Copperbonded Ground Rods

- Manufactured of high strength 1035 cold drawn steel
- The ERICO preferred ground rod

#### Compression Couplers for Pointed Rods

- For use when coupling pointed rods

#### Sectional Copperbonded Ground Rods

- For use when it is necessary to deep-drive rods
- Cold-rolled threads - stronger than cut threads

#### Threaded Couplers for Sectional Rods

- For use when coupling sectional rods

#### Drive Studs for Sectional Rods

- Screws into threaded coupler while rod is being driven

### APPLICATIONS

ERICO has a complete line of ground rods and accessories to meet the needs of every user.

### MORE INFORMATION

View product information by region: [North & Latin America](#) · [Europe](#) · [Asia & Australia](#)

Product Information - North & Latin America [Return to Top](#)

### RELATED PRODUCTS

CADWELD® PLUS ONE SHOT

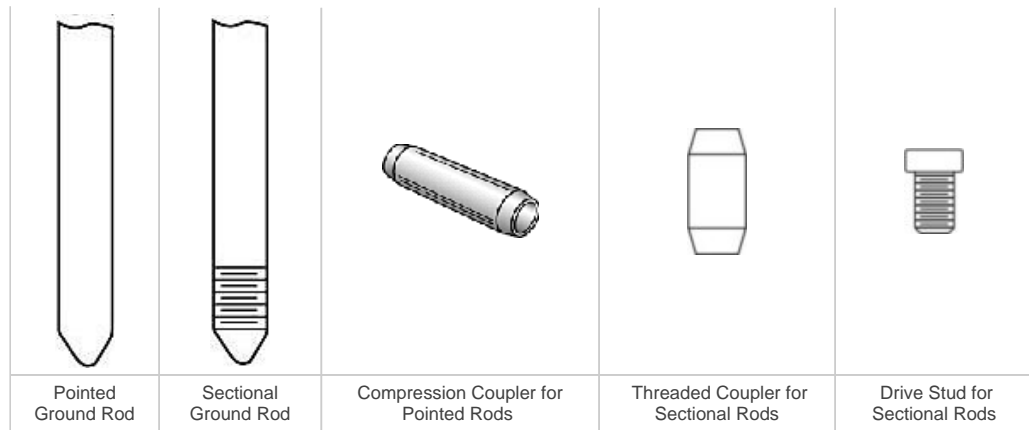
ERITECH® Ground Rod Accessories - North & Latin America

GEM® - Ground Enhancing Material

### AVAILABILITY

North America  
Latin America  
Asia/Australia  
Europe/Middle East/Africa





#### Pointed Copperbonded Ground Rods

Part No.	Plating Thickness (mil)	Diameter (in)	Length (ft)	Standard Package	Weight per 100
613852	5	3/8	5	5	160
613862	5	3/8	6	5	198
613880	10	3/8	8	5	270
611255	5	1/2	5	5	296
611265	5	1/2	6	5	310
611285	5	1/2	8	5	482
611380*	10	1/2	8	5	553
611205	5	1/2	10	5	557
611300*	10	1/2	10	5	738
615850	10	5/8	5	5	420
615860	10	5/8	6	5	509
615880*	10	5/8	8	5	680
615883*	13-REA	5/8	8	5	680
615800*	10	5/8	10	5	844
615803*	13-REA	5/8	10	5	844
615812*	10	5/8	12	5	1000
615815*	10	5/8	15	5	1275
613460	10	3/4	6	5	750
613480*	10	3/4	8	5	1000
613483*	13	3/4	8	5	1000
613400*	10	3/4	10	5	1240
613412*	10	3/4	12	5	1480
613415*	10	3/4	15	5	1850
614400*	10	1	10	5	2204

\* UL Listed

#### Sectional Copperbonded Ground Rods

Part No.	Plating Thickness (mil)	Diameter (in)	Length (ft)	Standard Package	Weight per 100
631380*	10	FS 1/2	8	5	540
631300*	10	FS 1/2	10	5	688
635830	10	5/8	3	5	262

635840	10	5/8	4	5	344
635850	10	5/8	5	5	420
635860	10	5/8	6	5	504
635880*	10	5/8	8	5	680
635883*	13- REA	5/8	8	5	680
635800*	10	5/8	10	5	844
633480*	10	3/4	8	5	1000
633400*	10	3/4	10	5	1240
634400*	10	1	10	5	2204

\* UL Listed

Product Information - Europe [Return to Top](#)

Part Number	Description	Nominal Diameter		Length		Pack	Unit Weight (kg)
		mm	inches	m	feet		
155000	1.2M38*	9	3/8"	1.2	4	5	0.650
155010	1.5M38*	9	3/8"	1.5	5	5	0.800
155030	2.1M38*	9	3/8"	2.1	7	5	1.100
155050	3.0M38*	9	3/8"	3.0	10	5	1.600
155060	1.2M12	12.5	1/2"	1.2	4	5	0.800
155070	1.5M12	12.5	1/2"	1.5	5	5	1.150
155090	2.1M12	12.5	1/2"	2.1	7	5	1.600
155110	3.0M12	12.5	1/2"	3.0	10	5	2.300
155240	1.2M58	14.2	5/8"	1.2	4	5	1.500
155250	1.5M58	14.2	5/8"	1.5	5	5	1.900
155270	2.1M58	14.2	5/8"	2.1	7	5	2.450
155290	3.0M58	14.2	5/8"	3.0	10	5	3.750
155420	1.2M34	17.2	3/4"	1.2	4	5	2.150
155430	1.5M34	17.2	3/4"	1.5	5	5	2.750
155450	2.1M34	17.2	3/4"	2.1	7	5	3.800
155470	3.0M34	17.2	3/4"	3	10	5	5.450

\* Non-Extending

Product Information - Asia & Australia [Return to Top](#)

Part No.	Nominal Diameter		Actual Diameter		Length		Pack	Master Bundle	Unit Weight (kg)
	in	mm	in	mm	feet	m			
611350	1/2"	13	0.500"	12.70	5	1.52	5	100	1.56
611360	1/2"	13	0.500"	12.70	6	1.83	5	100	2.01
611380*	1/2"	13	0.500"	12.70	8	2.44	5	100	2.50
611300*	1/2"	13	0.500"	12.70	10	3.05	5	100	3.13
615840	5/8"	15	0.561"	14.25	4	1.22	5	100	1.53
615850	5/8"	15	0.561"	14.25	5	1.52	5	100	1.91
615860	5/8"	15	0.561"	14.25	6	1.83	5	100	2.31
615880*	5/8"	15	0.561"	14.25	8	2.44	5	100	3.08
615800*	5/8"	15	0.561"	14.25	10	3.05	5	100	3.83

613460	3/4"	17	0.677"	17.20	6	1.83	5	50	3.37
613480*	3/4"	17	0.677"	17.20	8	2.44	5	50	4.55
613400*	3/4"	17	0.677"	17.20	10	3.05	5	50	5.62
614400*	1.0"	23	0.910"	23.11	10	3.05	3	25	5.74

\*UL listing requires a minimum of 10 mil thickness of copper with minimum rod diameter 0.500" and a minimum of 8 feet length

ANSI is a registered trademark of the American National Standards Institute. UL is a registered trademark of Underwriters Laboratories. CSA is a registered trademark of the Canadian Standards Association Int'l. NEMA is a registered trademark of the National Electrical Manufacturers Association.

**Due to a policy of continued product development, specifications are subject to change without notice.**

CADDY, CADWELD, CRITEC, ERICO, ERIFLEX, ERITECH, and LENTON are registered trademarks of ERICO International Corporation.

[+ Warning, Warranty and Limitation of Liability](#)

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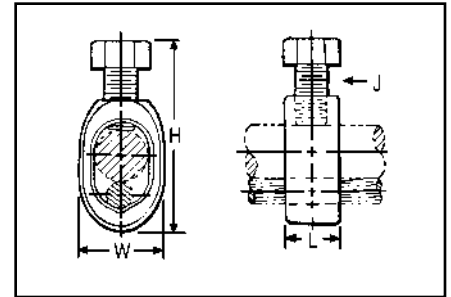
Copyright © 2009 ERICO International Corporation. [About Us](#) [Privacy and Legal Statements](#)

**TYPE GRC**

**HIGH STRENGTH  
GROUND ROD CLAMP**

For Copper Cable to Rod

High copper alloy ground connector for joining a range of cable to copper clad, galvanized steel, and stainless steel ground rods. Slips over end of rod, one-wrench installation. UL467 Listed for direct burial in earth and concrete.



REA LISTED



Catalog Number	Drive Rod	Conductor Range		H	W	L	J
		Min.	Max.				
GRC12	1/2	10 Sol.	2 Str.	2.00	.89	.63	3/8
GRC58	5/8		1 Str.	2.19	.95	.63	
GRC34	3/4	8 Sol.	1/0 Str.	2.47	1.09	.65	

**TYPE GCRT1/0  
GROUND  
CONNECTORS**



**GROUND CLAMP  
RANGE TAKING, UP TO 1/0**

The GCRT1/0 is a range taking ground rod clamp offering another choice from the BURNDY® family of connectors. The GCRT1/0 works on 1/2", 5/8" and 3/4" ground rods with a wire range of #8 through 1/0! The clamp is UL467 Listed for direct burial in earth and concrete. Catalog number **GCRT1/0**.



**Features and Benefits**

- Range taking design helps reduce inventory.
- UL Listed and CSA Certified.
- UL467 Listed for direct burial in earth and concrete.



**TYPE GRL**

**LIGHT DUTY  
ECONOMICAL GROUND ROD  
CLAMP**

UL467 Listed. Acceptable for direct burial.



Catalog Number	Rod Size	Conductor Range	
		Minimum	Maximum
GRL3*	3/8	10 AWG	4 AWG
GRL4	1/2	10 AWG	2 AWG
GRL5	5/8	10 AWG	2 AWG
GRL6	3/4	10 AWG	2 AWG

\* GRL3 not UL Listed.

Blue highlighted items are industry standard and most frequently ordered.

E-60

### BURNDYWeld®

The BURNDYWeld® connection process is a simple, efficient method of welding copper to copper or copper to steel. One advantage is that NO outside power is required when using the BURNDYWeld® exothermic process. The BURNDYWeld® process uses high temperature reaction of powdered copper oxide and aluminum. The reaction takes place in a semi-permanent graphite mold. These molds will last for fifty or more welds if proper care is given. The reaction takes place very rapidly, therefore the total amount of heat applied to the conductors or surfaces is considerably less than that of brazing or soldering. It is important to remember this when welding to insulated cable or thin wall pipe.

This system is very field friendly, since it is light and portable and requires no outside power source. It requires very little time or skill to obtain an efficient, maintenance free connection when using the BURNDYWeld® process.

For more information visit our website at [www.burndy.com](http://www.burndy.com).

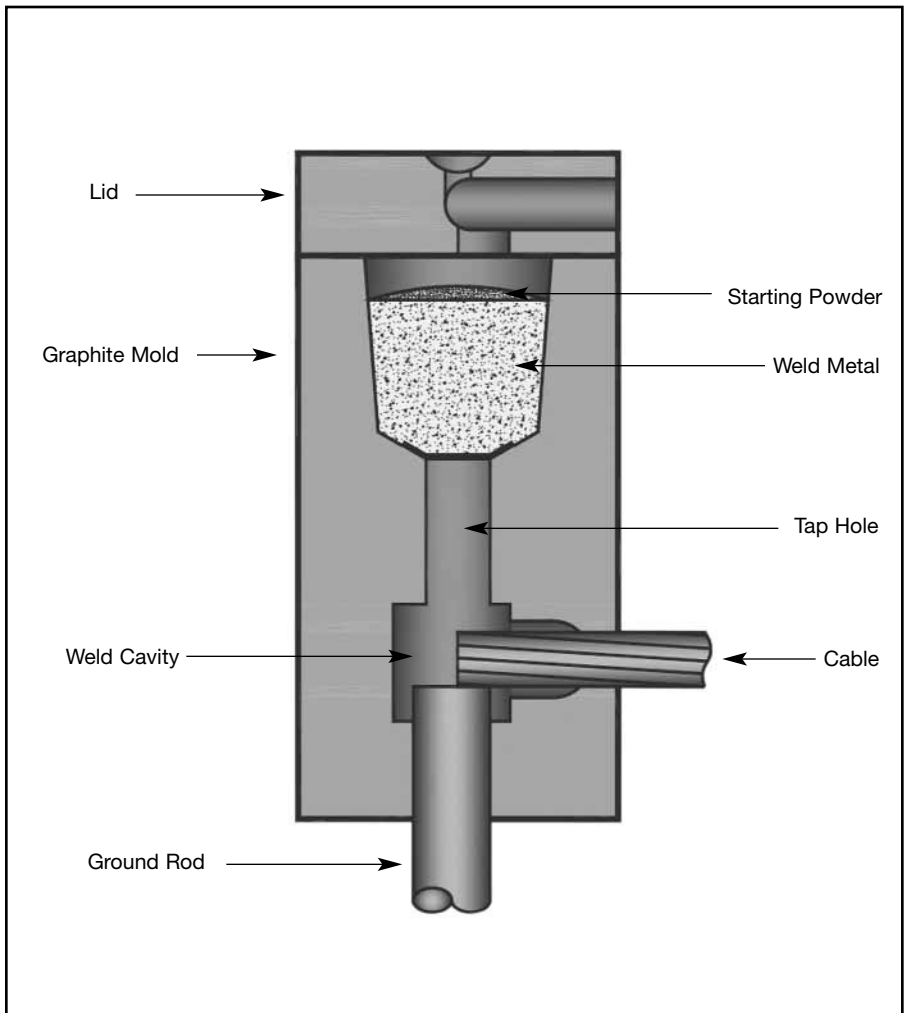
The BURNDYWeld® process has been used to weld materials other than copper for electrical purposes. Materials welded include:

Stainless Steel	Columbium	Brass
Copperweld®	Plain Steel	Bronze
Nichrome V	Everdur®	Niobium
Galvanized Steel	Kama	Chromax
Silcone Bronze	Steel Rail	Cast Iron
Copper Clad Steel	Cor-Ten®	Monel

When welding to galvanized steel it is recommended to resurface exposed bare steel.

The BURNDYWeld® connection is a molecular weld. The weld metal has the same melting point as copper. These factors along with the increased cross section of the connection, BURNDYWeld® connections:

1. Will not be affected by a high current surge. Tests have shown that the electrical conductor will melt before the BURNDYWeld® connection when subjected to high short circuit current. Consult IEEE Standard 837-1989.
2. Will not loosen or corrode at the point of weld. There are no contact surfaces or mechanical pressures involved. A BURNDYWeld® connection becomes an integral part of the conductor.
3. Have a current-carrying capacity equal to or greater than that of the conductors.



For mold types or BURNDYWeld® items not shown, please contact factory.

Blue highlighted items are industry standard and most frequently ordered.

**Making a BURNDYWeld® Connection**



**Step 1**

Position cleaned conductors in mold after making sure mold is dry, by pre-heating or making a test joint.



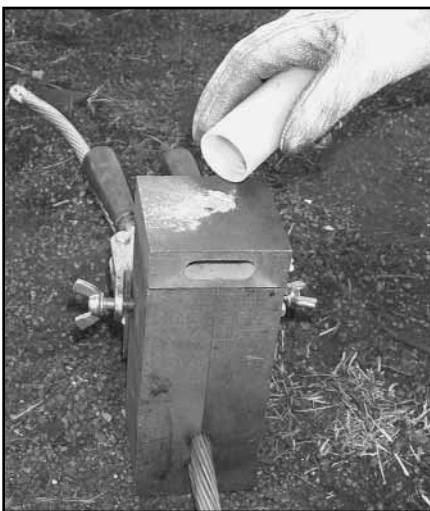
**Step 2**

Place metal disc in bottom of mold crucible.



**Step 3**

Dump powder into crucible, being careful not to loosen all the starting powder.



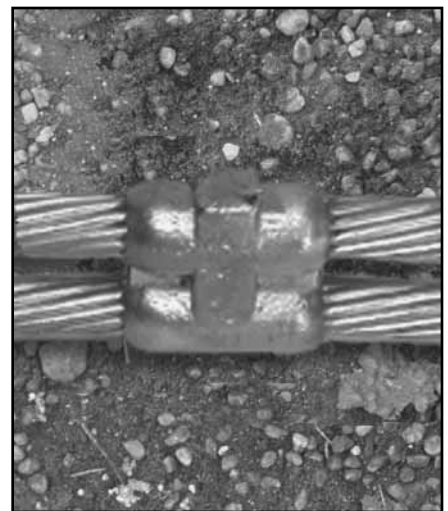
**Step 4**

Close lid and place a small amount of starting powder in the ignition pocket.



**Step 5**

Ignite the starting powder with the Flint Ignitor.



**Step 6**

Wait 15 seconds, then remove weld and clean mold before making next connection.

**For mold types or BURNDYWeld® items not shown, please contact factory.**

**Blue highlighted items are industry standard and most frequently ordered.**

### WELD METAL

E-62

BURNDYWeld® Weld Metal is packed in moisture-resistant plastic cartridges that have tight fitting caps. These cartridges, along with the necessary steel discs, are then packed in boxes that are hermetically-sealed. This ensures the powder arriving in good condition, always dry and ready for fast positive ignition.



BURNDYWeld® Weld Metal comes in several types; one for welding copper to copper, copper to steel, copper to rail, copper to cast iron and one for welding copper to steel for cathodic protection. The size and weight (in grams) of the cartridge are marked on each individual cartridge.

Standard Cartridge Size	Cast Iron Cartridge Size	Cathodic Protection Cartridge Size	Rail Cartridge Size	Cartridges Per Box
15	15CI	15CP	15R	20
25	25CI	25CP	25R	20
32	32CI	32CP	32R	10
45	45CI	45CP	45R	20
65	65CI	65CP	65R	20
90	90CI	—	90R	10
115	115CI	—	115R	10
150	—	—	150R	10
200	—	—	200R	10
250	—	—	250R	10
500	—	—	500R	10

BURNDYWeld® Weld Metal is sold in box quantities only.

#### Steel Discs Sold Separately

Weld Metal Size	Catalog Number	Package Quantity
	Steel Discs Only	
15 to 65	B370320-01	20
90 to 115	B370320-02	10
150 to 500	B370320-03	10

For mold types or BURNDYWeld® items not shown, please contact factory.

Blue highlighted items are industry standard and most frequently ordered.

# **ELECTRICAL INSULATION**

**Operations & Maintenance Manual  
December 2015**





**Roxul Mineral wool insulation MI 2" R**  
**Value=4.2 per 1"**  
 SKU ROXUL-AFB-MI

Purchase Roxul AFB mineral stone wool insulation SAFE® (Rockwool) is a light-weight, semi-rigid stone wool batt insulation that provides fire resistance and sound control.

**Applications:**

This product is designed for commercial, industrial, and residential buildings as a fire stopping insulation. Ideal for filling:

- Perimeter gaps between concrete floor slabs and exterior wall systems
- Around conduit pipe and duct openings through walls and floor slabs
- Between fire walls and ceiling slabs

Roxul SAFE® is used in conjunction with a fire sealant to prevent passage of fire and smoke.

**Properties:**

- Non-combustible stone wool insulation with melting point of approx. 1177°C (2150°F)
- Does not promote smoke or flame spread when exposed to flame
- Minimal shrinkage to maintain critical line of defense against fire
- Low thermal conductivity
- Water and moisture resistant, does not absorb moisture to maintain insulating value
- Does not rot, promote mildew, fungi, or bacteria, or sustain vermin
- Can be faced with reinforced foil facings
- Earns LEED® points – talk to Roxul's LEED® Accredited Professional

Acoustical Performance:							
ASTM C423							
CO-EFFICIENTS AT FREQUENCIES							
Thickness	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
2.0"	0.26	0.68	1.12	1.10	1.03	1.04	1.00
3.0"	0.63	0.95	1.14	1.01	1.03	1.04	1.05
4.0"	1.03	1.07	1.12	1.04	1.07	1.08	1.10

**Dimensions:**

- 2" X 16" X 48" 16 Panels = 85.33 sq ft
- 2" X 24" X 48" 12 Panels = 96 sq ft
- 3" X 16" X 48" 12 Panels = 64 sq ft
- 3" X 24" X 48" 8 Panels = 64 sq ft

ROXUL AFB ships from Las Vegas

Call first for shipping costs, this product does not ship via UPS

Our distributor normally gives us a fixed shipping rate of \$80.00 if in a

# Product Information

## Silicone Sealants

DOW CORNING

# Dow Corning® 791 Silicone Weatherproofing Sealant

## FEATURES & BENEFITS

- Ideal for expansion, connection, perimeter and other movement joints
- Neutral cure – suitable for use on coated glass, galvanized steel, masonry and other porous and non-porous substrates
- Extension/compression movement capability of up to ±50 percent of the original joint width
- Excellent weatherability, virtually unaffected by sunlight, rain, snow, ozone
- Excellent unprimed adhesion to a wide variety of construction materials and building components
- Ease of application – ready to use as supplied
- Excellent rheology, low string upon gunning

## COMPOSITION

- One-part, neutral-cure, RTV silicone sealant

Neutral, one-part silicone sealant

## APPLICATIONS

- Dow Corning® 791 Silicone Weatherproofing Sealant is a specified, premium performance weather sealing product specifically designed for general glazing and weather sealing in curtain wall and building facades.

## TYPICAL PROPERTIES

Specification Writers: These values are not intended for use in preparing specifications. Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on this product.

Test <sup>1</sup>	Property	Unit	Result
<b>Uncured – As Tested at 50% RH and 23°C (73°F)</b>			
ASTM C639	Flow (sag or slump)	inches (mm)	0
ASTM C603	Extrusion Rate	g/minute	140
	Working Time	minutes	20
ASTM C679	Tack-free Time, 77°F, 50% RH	minutes	40
	Curing Time at 77°F (25°C) and 50% RH	days	7-14
	VOC Content <sup>2</sup>	g/L	31
<b>As Cured – After 21 days at 50% RH and 77°F (25°C)</b>			
ASTM D2240	Durometer Hardness, Shore A	points	34
ASTM C794	Peel Strength	lb/in (kg/cm)	30 (5.4)
ASTM C719	Joint Movement Capability	percent	±50
ASTM C1135	Tensile Adhesion Strength		
	At 25% extension	Psi (MPa)	40 (0.276)
	At 50% extension	Psi (MPa)	60 (0.414)

<sup>1</sup>ASTM – American Society for Testing and Materials.

<sup>2</sup>Based on South Coast Air Quality Management District of California. Maximum VOC is listed both inclusive and exclusive of water and exempt compounds. For a VOC data sheet for a specific sealant color, please send your request to [product.inquiry@dowcorning.com](mailto:product.inquiry@dowcorning.com).

## DESCRIPTION

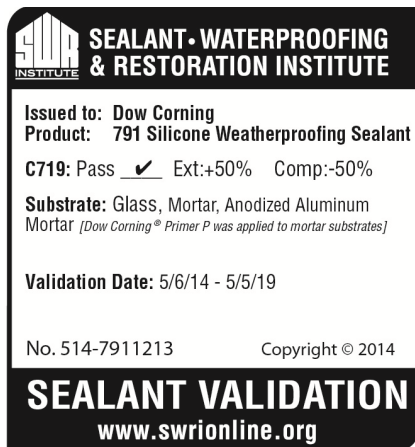
Dow Corning 791 Silicone Weatherproofing Sealant is a one-part, neutral-cure, architectural grade sealant. It easily extrudes in any weather and cures at ambient temperature by reaction with moisture in the air to form a durable, flexible silicone rubber seal.

## HOW TO USE

Please consult the *Dow Corning Americas Technical Manual*, Form No. 62-1112, for detailed information on state-of-the-art application methods and joint design. Please contact your local Dow Corning Sales Application Engineer for specific advice.

## Preparation

Clean all joints removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.



## Application Method

Install backing material or joint filler, setting blocks, spacer shims and tapes. Mask areas adjacent to joints to ensure neat sealant lines. Primer is generally not required on non-porous surfaces, but maybe necessary for optimal sealant of certain porous surfaces. A test placement is always recommended. Apply *Dow Corning* 791 Silicone Weatherproofing Sealant in a continuous operation using a positive pressure. (The sealant can be applied using many types of air-operated guns and most types of bulk dispensing equipment. Before a skin forms (typically within 15 minutes), tool the sealant with light pressure to spread the sealant against backing material and the joint surfaces. Remove masking tape as soon as the bead is tooled.

## APPROVALS/ SPECIFICATIONS

Meets the requirements of:

- ASTM C920 Type S, Grade NS, Class 50, Use NT, M, G, A

## COLORS

This product is available in 6 colors: black, gray, bronze, limestone, precast white and white. Custom

colors may be ordered to match virtually any substrate.

**HANDLING  
PRECAUTIONS**  
**PRODUCT SAFETY  
INFORMATION REQUIRED FOR  
SAFE USE IS NOT INCLUDED IN  
THIS DOCUMENT. BEFORE  
HANDLING, READ PRODUCT  
AND MATERIAL SAFETY DATA  
SHEETS AND CONTAINER  
LABELS FOR SAFE USE,  
PHYSICAL AND HEALTH  
HAZARD INFORMATION. THE  
MATERIAL SAFETY DATA  
SHEET IS AVAILABLE ON THE  
DOW CORNING WEBSITE AT  
DOWCORNING.COM, OR FROM  
YOUR DOW CORNING SALES  
APPLICATION ENGINEER, OR  
DISTRIBUTOR, OR BY CALLING  
DOW CORNING CUSTOMER  
SERVICE.**

## USABLE LIFE AND STORAGE

When stored at or below 30°C (86°F) in the original unopened containers, *Dow Corning* 791 Silicone Weatherproofing Sealant has a usable life of 12 months from the date of manufacture. Refer to product packaging for “Use By” date.

## PACKAGING INFORMATION

*Dow Corning* 791 Silicone Weatherproofing Sealant is available in 10.3-fl oz (305-mL) disposable plastic cartridges that fit ordinary caulking guns, 20-fl oz (590-mL) sausages.

## LIMITATIONS

*Dow Corning* 791 Silicone Weatherproofing Sealant is not approved for use as a structural sealant.

*Dow Corning* 791 Silicone Weatherproofing Sealant should not be used:

- In below-grade applications
- When surface temperatures exceed 50°C (122°F)

- On surfaces that are continuously immersed in water
- On building materials that bleed oils, plasticizers or solvents, green or partially vulcanized rubber gaskets or tapes
- On frost-laden or wet surfaces
- In totally confined joints (the sealant requires atmospheric moisture for cure)
- If the sealant is intended to be painted (paints do not typically adhere to most silicone sealants)
- To surfaces in direct contact with food or other food-grade applications

This product is neither tested nor represented as suitable for medical or pharmaceutical uses.

## HEALTH AND ENVIRONMENTAL INFORMATION

To support customers in their product safety needs, Dow Corning has an extensive Product Stewardship organization and a team of Product Safety and Regulatory Compliance (PS&RC) specialists available in each area.

For further information, please see our website, [dowcorning.com](http://dowcorning.com) or consult your local Dow Corning representative.

## LIMITED WARRANTY INFORMATION – PLEASE READ CAREFULLY

The information contained herein is offered in good faith and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information should not be used in substitution for customer’s tests to ensure that our products are safe, effective, and fully satisfactory for the intended end use. Suggestions of use shall not be taken as inducements to infringe any patent.

Dow Corning’s sole warranty is that our products will meet the sales specifications in effect at the time of shipment.

Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

**TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, DOW CORNING SPECIFICALLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY.**

**DOW CORNING DISCLAIMS LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

A 20-year Weatherseal Limited Warranty is available. Some testing may be required. Consult your Dow Corning Sales Application Engineer for details.

*We help you invent the future.*<sup>™</sup>

**dowcorning.com**

# **ELECTRICAL LABELING**

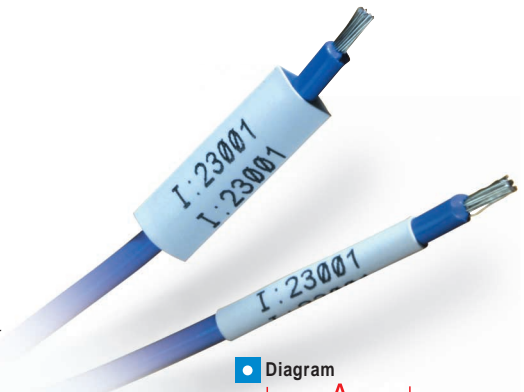
**Operations & Maintenance Manual  
December 2015**



▶ **WIRE AND CABLE MARKERS — PERMASLEEVE™ SLEEVES**

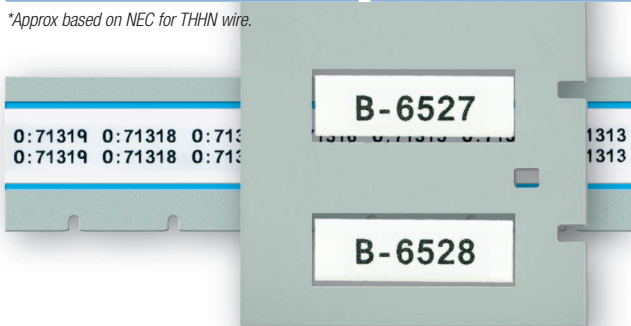
These full circle heat-shrink sleeves are the ultimate in marker durability, permanence and aesthetic appearance. Fast-shrink rate saves time & cost during installation. Available as individual 1-inch long markers or cut-to-length continuous supply.

▶ **B-342 Heat Shrink Polyolefin material, 3-to-1 shrink ratio, self-extinguishing, meets material & physical properties requirements of MIL-DTL-23053/5C class 1, MIL-M-81531, MIL-STD-202F, method 215 and UL 224. Temp Range: -67°F to 275°F (-55°C to 135°C).**



Wire Gauge*	Wire Diameter Range	Diagram	Part Number	Labels per Cartridge	Dimensions – inches		Dimensions – mm		Color
1.015" MARKER LENGTH									
22-16 Gauge	0.046 - 0.110 dia (1.20 - 2.80 mm)	■	XPS-125-1	100	1.015	0.235	25.78	5.96	BK on WT
18-12 Gauge	0.062 - 0.150 dia (1.60 - 3.80 mm)	■	XPS-187-1	100	1.015	0.335	25.78	8.50	BK on WT
16-10 Gauge	0.094 - 0.215 dia (2.40 - 5.50 mm)	■	XPS-250-1	100	1.015	0.439	25.78	11.15	BK on WT
12-6 Gauge	0.125 - 0.320 dia (3.20 - 8.10 mm)	■	XPS-375-1	100	1.015	0.645	25.78	16.38	BK on WT
CONTINUOUS (CUT TO LENGTH)									
22-16 Gauge	0.046 - 0.110 dia (1.20 - 2.80 mm)	■	XPS-125-CONT	1 roll (cont.)	12 ft.	0.235	3.65 m	5.96	BK on WT
22-16 Gauge	0.046 - 0.110 dia (1.20 - 2.80 mm)	■	XPS-125-CONT-YL-BK	1 roll (cont.)	12 ft.	0.235	3.65 m	5.96	BK on YL
18-12 Gauge	0.062 - 0.150 dia (1.60 - 3.80 mm)	■	XPS-187-CONT	1 roll (cont.)	12 ft.	0.335	3.65 m	8.50	BK on WT
18-12 Gauge	0.062 - 0.150 dia (1.60 - 3.80 mm)	■	XPS-187-CONT-YL-BK	1 roll (cont.)	12 ft.	0.335	3.65 m	8.50	BK on YL
16-10 Gauge	0.094 - 0.215 dia (2.40 - 5.50 mm)	■	XPS-250-CONT	1 roll (cont.)	8 ft.	0.439	2.44 m	11.15	BK on WT
16-10 Gauge	0.094 - 0.215 dia (2.40 - 5.50 mm)	■	XPS-250-CONT-YL-BK	1 roll (cont.)	8 ft.	0.439	2.44 m	11.15	BK on YL
12-6 Gauge	0.125 - 0.320 dia (3.20 - 8.10 mm)	■	XPS-375-CONT	1 roll (cont.)	8 ft.	0.645	2.44 m	16.38	BK on WT

\*Approx based on NEC for THHN wire.

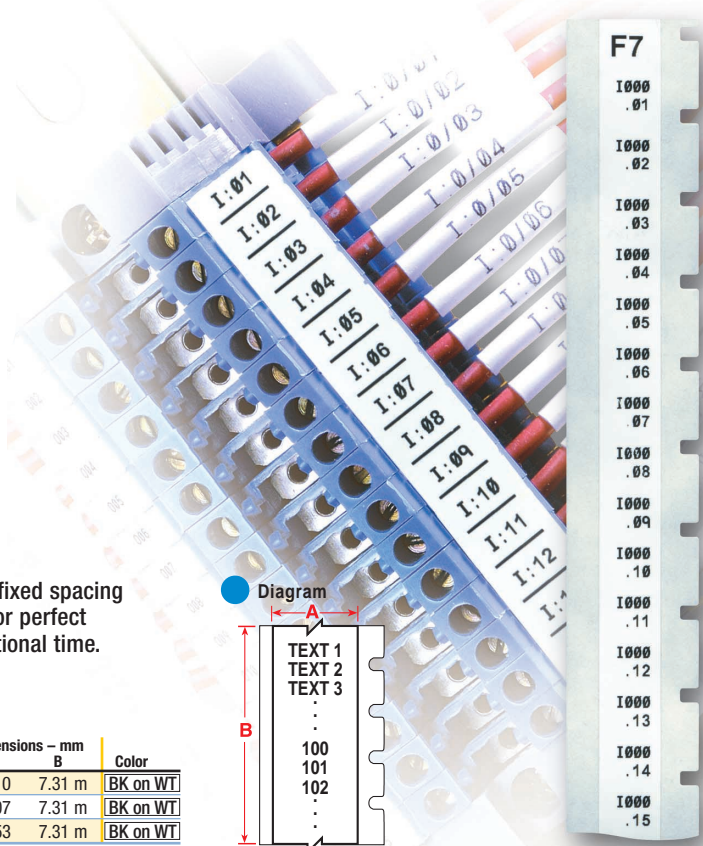
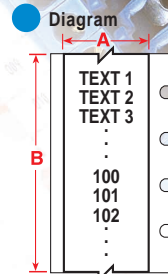
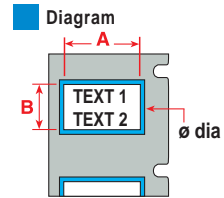
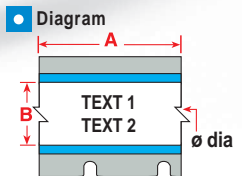


▶ **TERMINAL BLOCK MARKERS**

These specially-designed narrow-width markers automatically set to fixed spacing and separation between legends and rotate to top-down orientation for perfect alignment on terminal blocks. Printer can auto-serialize to save additional time.

▶ **B-498 Vinyl Cloth material. Temp Range: -40°F to 175°F (-40°C to 70°C).**

Width of Strip	Diagram	Part Number	Labels per Cartridge	Dimensions – inches		Dimensions – mm		Color
1.015" MARKER LENGTH								
0.240" wide	●	XC-240-498	1 roll (cont.)	0.240	24 ft.	6.10	7.31 m	BK on WT
0.318" wide	●	XC-318-498	1 roll (cont.)	0.318	24 ft.	8.07	7.31 m	BK on WT
0.375" wide	●	XC-375-498	1 roll (cont.)	0.375	24 ft.	9.53	7.31 m	BK on WT



PORTABLE PRINTERS AND LABELS IDXPERT ELECTRICAL I.D. LABELS

AUTOMATION & CONTROL

ENCLOSURES

POWER

MARKING & LABELING

TEST & MEASUREMENTS

PASSIVE & ACTIVE

OPTOELECTRONICS

ASSEMBLY

INDEX

**PanTher™ LS8 Hand-Held Thermal Transfer Printer and Accessories**



- ▶ Prints Labels, Wire Markers, Heat Shrink Tubing and Continuous Tape
- ▶ Unique Cutter Design Allows for Full or Partial Label Cutting
- ▶ Automatic Label Recognition with Last Legend Used and Number of Remaining Labels
- ▶ Cassette Includes Labels and Ribbon for Easy Media Changes
- ▶ Large Graphic Display to Maximize Label Design Area
- ▶ Easy-to-Use Compact, Rugged Design Comfortably Fits in One Hand
- ▶ Crisp Print Quality for High Grade Label Appearance

Stock No.	Mfr.'s Type	Description	EACH
70045074	LS8EQ	Includes LS8EQ printer with QWERTY keypad, one cassette of S100X150VAC self-laminating labels, six AA alkaline batteries and quick reference card	405.00
70283261	LS8-CASE	Rigid Carrying Case	82.64
70283262	LS8-CLN	Cleaning Kit	67.81
70283263	LS8-IB	Protective Impact Bumper	16.39

**PanTher™ LS8E Hand-Held Thermal Transfer Printer and Accessories**



- ▶ Cut-to-Length Functionality Eliminates Label Waste and Label Trimming Labor
- ▶ Partial Cut Feature Available to Provide Tear-Apart Strips of Labels
- ▶ Label Cassette Contains Integrated Memory Device for Automatic Formatting, Recall of Last Legend Used and Number of Labels Remaining in Cassette
- ▶ Large Graphic Display with Backlight for Improved Visibility
- ▶ Fast Loading Label Cassette Includes Both Label Material and Ribbon to Make Changing Labels Easy
- ▶ Prints Self-Laminating Labels, Heat Shrink Tubing, Die-Cut Component Labels and Continuous Tape
- ▶ USB Interface for Importing Data, System Upgrades and Printing from a Wireless Laptop or Desktop Computer

Stock No.	Mfr.'s Type	Description	EACH
70253638	LS8EQ-KIT	Includes LS8EQ printer with QWERTY keypad, one cassette of S100X150VAC self-laminating labels, six AA alkaline batteries, LS8-CASE, LS8-PCKIT, LS8-IB, LS8-WS, quick reference card, and operator's manual	389.01

**P1™ Hand-Held Thermal Transfer Printer Cassettes**

**P1™ Self-Laminating Label Cassettes**

- ▶ Vinyl Labels Offer Crisp, Clear Legends with Superior Legibility
- ▶ Self-Laminating Labels Include a White Print-On Area and Clear Overlaminate to Protect the Legend for Durable Identification
- ▶ Labels Are Available in a Large Range of Sizes for Wire/Cable Labeling
- ▶ Width — 1"
- ▶ For LS8E and LE8EQ Printers



Stock No.	Mfr.'s Type	Description	Length (In.)	Print-On Ht. (In.)	Min. Cable OD (In.)	Max. Cable OD (In.)	EACH
70044265	S100X150VAC	For CAT 5e and CAT6, 200/Cassette	1.50	0.38	0.12	0.28	57.71
70044268	S100X225VAC	For 8-4 AWG, 125/Cassette	2.25	0.50	0.16	0.38	60.09

**P1™ Heat Shrink Label Cassettes**

- ▶ Labels Offer Crisp, Clear Legends with Superior Legibility
- ▶ Meets UL Standard 224 for Flammability and UL Standard 2043 Suitable for Use in Air Handling Spaces
- ▶ Shrink Ratio 3:1
- ▶ Each Cassette Contains a Continuous Roll of Flattened Polyolefin that Can Be Cut-to-Length and Partially Cut For LS8E and LS8EQ Printers



Stock No.	Mfr.'s Type	Description	Length (Ft.)	Width (In.)	Min. Cable OD (In.)	Max. Cable OD (In.)	EACH
70044964	H00X025H1C	1/8" Diameter	8	0.25	0.04	0.13	56.42
70045102	H00X034H1C	3/16" Diameter	8	0.34	0.06	0.19	61.70
70229061	H00X044H1C	1/4" Diameter	6	0.44	0.08	0.25	45.85

**P1™ Component Label Cassettes**

- ▶ Labels Offer Crisp, Clear Legends with Superior Legibility
- ▶ Multi-Purpose Labels for Identifying Flat Surfaces Such As Components, Control Panels, Circuit Boards and General Labeling
- ▶ White, Polyester Label
- ▶ For LS8E and LS8EQ Printers



Stock No.	Mfr.'s Type	Width (In.)	Height (In.)	Package Quantity	EACH
70283123	C060X020YJC	0.60	0.20	750/Cassette	66.59
70044228	C100X050YJC	1.00	0.50	500/Cassette	71.83
70044231	C200X100YJC	2.00	1.00	200/Cassette	87.41

**P1™ Continuous Tape Cassettes**

- ▶ Tapes Offer Crisp, Clear Legends with Superior Legibility
- ▶ Print Custom Pipe Markers, Voltage Markers, Signs and Bin Marker Labels on Demand
- ▶ Available in a Variety of Colors, Widths and Materials For LS8E and LS8EQ Printers



Stock No.	Mfr.'s Type	Description	Height (In.)	Length (Ft.)	EACH
70044272	T100X000VUC-BK	Black on Orange, Vinyl Tape	1.00	25	56.33
70044273	T100X000VXC-BK	Black on Yellow, Vinyl Tape	1.00	25	56.33
70231000	T038X000VPC-BK	Black on White, Vinyl Tape	0.38	25	43.37
70226361	T050X000VPC-BK	Black on White, Vinyl Tape	0.50	25	43.37

**Ribbons for Use with TDP43ME Thermal Transfer Desktop Printer**

- ▶ Hybrid — Use with Self-Laminating, Heat Shrink and Component Labels
- ▶ Resin — Use with Component Labels and Continuous Tape
- ▶ Can Be Used on PANDUIT PTR2/PTR2E Thermal Transfer Desktop Printers

Stock No.	Mfr.'s Type	Description	Height (In.)	Length (Ft.)	EACH
70283116	RMEH4BL	Black Hybrid Thermal Transfer Ribbon	4.25	300	48.79
70283117	RMER4BL	Black, Resin Thermal Transfer Ribbon	4.25	300	48.79
70283118	RMER4WH	White, Resin Thermal Transfer Ribbon	4.25	300	109.53



**NEW**



Note: For additional printers see the Allied website.





## EZL-75 Thermal Label Printer and EZL Printer Labels



Quick and cost-effective labeling solution!

### EZL-75 Thermal Label Printer

If your labeling needs don't quite justify all the high-end features of T&B's EZL-100 printer, now there's a lower cost solution for simple labeling. The EZL-75 thermal label printer is just as easy to use as the EZL-100 printer. Simply type and print. Or don't even bother typing. Instead, use hot keys to choose among the EZL-75 printer's built-in library of symbols and more than 150 commonly used words for security, location and voice/data/video labeling.



- Hot keys provide one-touch flagging for wires and cables and fixed-length labels for faceplates and security panels
- Incremental alpha and numeric printing makes printing distribution panel labels fast and simple
- 13-character backlit display enhances readability
- Multiple line printing supports up to 2 lines per label
- Durable bumper safeguards against damage in the tool box
- Uses the same label cassettes (up to 1/2" width) as the EZL-100 printer

#### Specifications

- Dimensions: 4.5" (114mm) W x 7.5" (191mm) H x 2.1" (53mm) D
- Power: 9V DC, using 6 "AA" (not included) batteries or AC adapter
- Weight: 0.8 lbs. (363 grams)

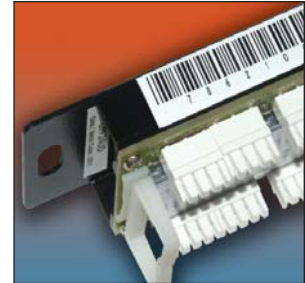
CAT. NO.	DESCRIPTION
EZL-75	Printer (includes (1) 1/2" white nylon quick-load cassette tape, quick start card, and user manual. AC power adapter not included)
EZL-ADP	Adapter for EZL-75 Printer 9V, 1.5A

Surface Applications		Vinyl and Flex Nylon	Perm. Polyester	Heat Shrink
Wire		•		•
Cable		•		•
Curved		•		
Smooth		•	•	
Flat		•	•	
Textured		•	•	
Highly Textured		•		
Length		11.5'	18.0'	5.0"
Width		1/2", 3/4"	3/8", 1/2"	1/4", 3/8"
		3/4"	3/4"	1/2", 3/4"

High-performance labels that last!

### Wire Marker Labels for EZL Printers

- Perfect for wire and cable
- Print heat-shrink sleeves on the spot!
- Clear, non-smudging lettering
- Chemical/solvent resistant
- Available in yellow, white, and metallic markers
- Flame retardant, Polyolefin material, 3:1 shrink ratio
- Easy-to-peel, split-back design



Easy barcode printing!

EZCODE®

CAT. NO.	LABEL SIZE (IN.)	RECOMMENDED WIRE SIZE (AWG)	LENGTH
<b>Clear Polyester</b>			
EZ-CP12	1/2"	Flat Applications Only	18'
EZ-CP34*	3/4"	Flat Applications Only	18'
<b>Red Vinyl</b>			
EZ-RV34*	3/4"	Any	18'
<b>White Permanent Polyester</b>			
EZ-WP38	3/8"	Flat Applications Only	18'
EZ-WP12	1/2"	Flat Applications Only	18'
EZ-WP34*	3/4"	Flat Applications Only	18'
<b>Metallic Permanent Polyester</b>			
EZ-MP38	3/8"	Flat Applications Only	18'
EZ-MP12	1/2"	Flat Applications Only	18'
EZ-MP34*	3/4"	Flat Applications Only	18'
<b>White Flexible Nylon</b>			
EZ-WN12	1/2"	Any	12.5'
EZ-WN34*	3/4"	Any	12.5'
<b>Yellow Flexible Nylon</b>			
EZ-YN12	1/2"	Any	12.5'
EZ-YN34*	3/4"	Any	12.5'
<b>Heat-Shrink White Polyolefin Labels</b>			
EZ-WHS14	1/4"	10 - 16	5'
EZ-WHS38	3/8"	6 - 14	5'
EZ-WHS12	1/2"	4 - 6	5'
EZ-WHS34*	3/4"	2 - 4	5'
<b>Heat-Shrink Yellow Polyolefin Labels</b>			
EZ-YHS14	1/4"	10 - 16	5'
EZ-YHS38	3/8"	6 - 14	5'
EZ-YHS12	1/2"	4 - 6	5'
EZ-YHS34*	3/4"	2 - 4	5'

Order in multiples of 5 cassettes.  
\* Labels fit EZL-100 printer only.

Wire Range (AWG)	Parts/BAG	W	C	L	E	D	PL	Thickness	Barrel Length	Barrel ID	Max Insulation Dia.
<b>Vinyl Female Disconnect</b>											
12-10	25	-	-	0.95	-	-	-	-	0.25	0.128	0.250
22-18	50	-	-	0.83	-	-	-	-	0.25	0.076	0.145
22-18	50	-	-	0.87	-	-	-	-	0.25	0.080	0.145
16-14	50	-	-	0.78	-	-	-	-	0.25	0.085	0.145
16-14	50	-	-	0.87	-	-	-	-	0.25	0.080	0.145
<b>Vinyl Male Disconnect</b>											
16-18	50	-	-	0.93	-	-	-	-	0.25	0.085	0.17

<b>Vinyl Fork Terminals</b>											
12-10	25	0.32	0.29	1.03	0.84	-	-	-	-	-	-
12-10	25	0.32	0.28	1.03	0.83	-	-	-	-	-	-
12-10	25	0.38	0.29	1.03	0.84	-	-	-	-	-	-
12-10	25	0.32	0.25	0.88	0.70	-	-	-	-	-	-
12-10	25	0.32	0.29	1.03	0.84	-	-	-	-	-	-
12-10	25	0.32	0.28	1.03	0.83	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
16-14	50	0.32	0.25	0.88	0.70	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
16-14	50	0.25	0.25	0.88	0.70	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
16-14	50	0.30	0.25	0.88	0.70	-	-	-	-	-	-
22-18	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
22-18	50	0.32	0.25	0.88	0.70	-	-	-	-	-	-
22-18	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
22-18	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
22-18	50	0.30	0.25	0.88	0.70	-	-	-	-	-	-
12-10	25	0.38	0.29	1.03	0.84	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-
16-14	50	0.30	0.25	0.85	0.70	-	-	-	-	-	-

<b>Vinyl Pin Terminals</b>											
16-14	50	-	-	0.92	-	-	0.47	-	-	-	-
22-18	50	-	-	0.92	-	-	0.47	-	-	-	-

<b>Vinyl Ring Terminals</b>											
12-10	25	0.38	0.29	1.03	0.84	-	-	-	-	-	-
12-10	25	0.53	0.44	1.26	0.99	-	-	-	-	-	-
12-10	25	0.54	0.44	1.26	0.99	-	-	-	-	-	-
12-10	25	0.38	0.29	1.03	0.84	-	-	-	-	-	-
16-14	50	0.33	0.29	0.90	0.74	-	-	-	-	-	-
16-14	50	0.31	0.33	0.93	0.78	-	-	-	-	-	-
16-14	50	0.47	0.40	1.08	0.85	-	-	-	-	-	-
16-14	50	0.25	0.22	0.80	0.67	-	-	-	-	-	-
16-14	50	0.47	0.40	1.08	0.85	-	-	-	-	-	-
16-14	50	0.25	0.22	0.80	0.67	-	-	-	-	-	-
16-14	50	0.31	0.33	0.93	0.78	-	-	-	-	-	-
22-18	50	0.31	0.33	0.93	0.78	-	-	-	-	-	-
22-18	50	0.25	0.22	0.80	0.67	-	-	-	-	-	-
22-18	50	0.31	0.33	0.93	0.78	-	-	-	-	-	-
12-10	25	0.38	0.29	1.03	0.84	-	-	-	-	-	-
16-14	50	0.25	0.22	0.80	0.67	-	-	-	-	-	-

<b>Heat Shrink Terminals</b>											
12-10	25	-	-	1.5	-	-	-	-	-	-	-
16-14	50	-	-	1.3	-	-	-	-	-	-	-



### Wire Marker Books

Part #	Description	
RMB0-9LT	MARKER BOOK	(45 EA: 0-9; 15 EA: L1/T3)
RMB0-15AZ	MARKER BOOK	(10 EA: A-Z; 0-15, +, -, /)
RMB1-45	MARKER BOOK	(10 EA: 1-45)
RMB46-90	MARKER BOOK	(10 EA: 46-90)

- Pre-Printed Wire Marker Books
- Contain vinyl-coated cloth letters, numbers and industry standard legends
- Each book contains a minimum of 450 marks



### General Purpose Tape

Part #	Description	
RTBLACK	3/4" X 66'	Black Vinyl Tape
RTBLUE	3/4" X 66'	Blue Vinyl Tape
RTGREEN	3/4" X 66'	Green Vinyl Tape
RTRED	3/4" X 66'	Red Vinyl Tape
RTWHITE	3/4" X 66'	White Vinyl Tape
RTYELLOW	3/4" X 66'	Yellow Vinyl Tape
RTBROWN	3/4" X 66'	Brown Vinyl Tape
RTGRAY	3/4" X 66'	Gray Vinyl Tape
RTORANGE	3/4" X 66'	Orange Vinyl Tape
RTVIOLET	3/4" X 66'	Violet Vinyl Tape

- General purpose tape
- 7 mil thickness
- Meets UL510 requirements
- Temperature rating 194°F/ 80°C

## Features

---

- Surface/chain mount with standard white reflector
- A variety of lengths available
- UL Listed

## Specifications

---

- Ballasts are thermally protected class P, non-PCB & UL listed. Electronic ballasts are sound rated A. Multi volt 0° F ballast T8 & T12, -20° T8 & T12 HO.
- Housings are formed from cold rolled steel and painted with a high gloss, baked white enamel finish after multi-stage cleaning and a phosphate coating to inhibit rust, has been applied.
- Surface, pendant, chain or suspended mounting.
- Reflectors are formed with lateral embossments and a return flange for strength and rigidity.



## Application

---

- Commercial/residential
- Warehouses
- Production areas
- Garages
- General Lighting

## Options

---

- Program start T8 HO
- LBF (T8 slim line low ballast factor)

## Accessories

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- Emergency battery pack
- V-hooks
- Stems/canopies
- Wire guard
- Occupancy sensor
- Uplight reflectors

Catalog Number	Type

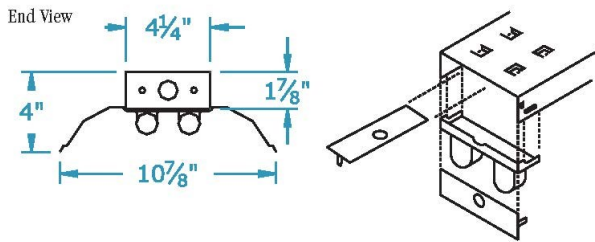
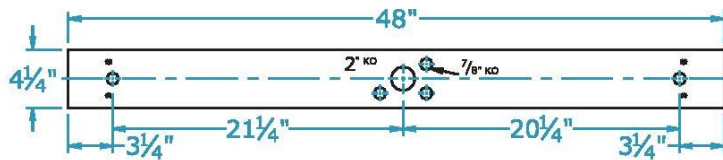
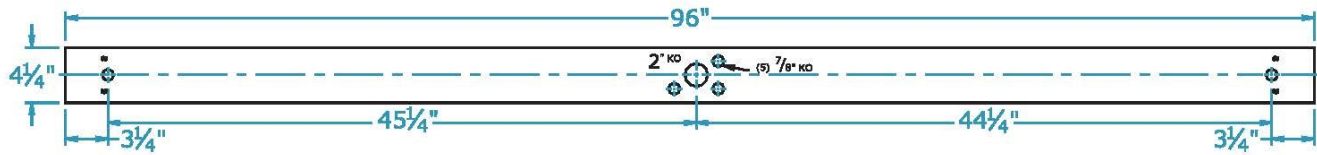
# 600 Series

4', 6' & 8'

## Dimensions

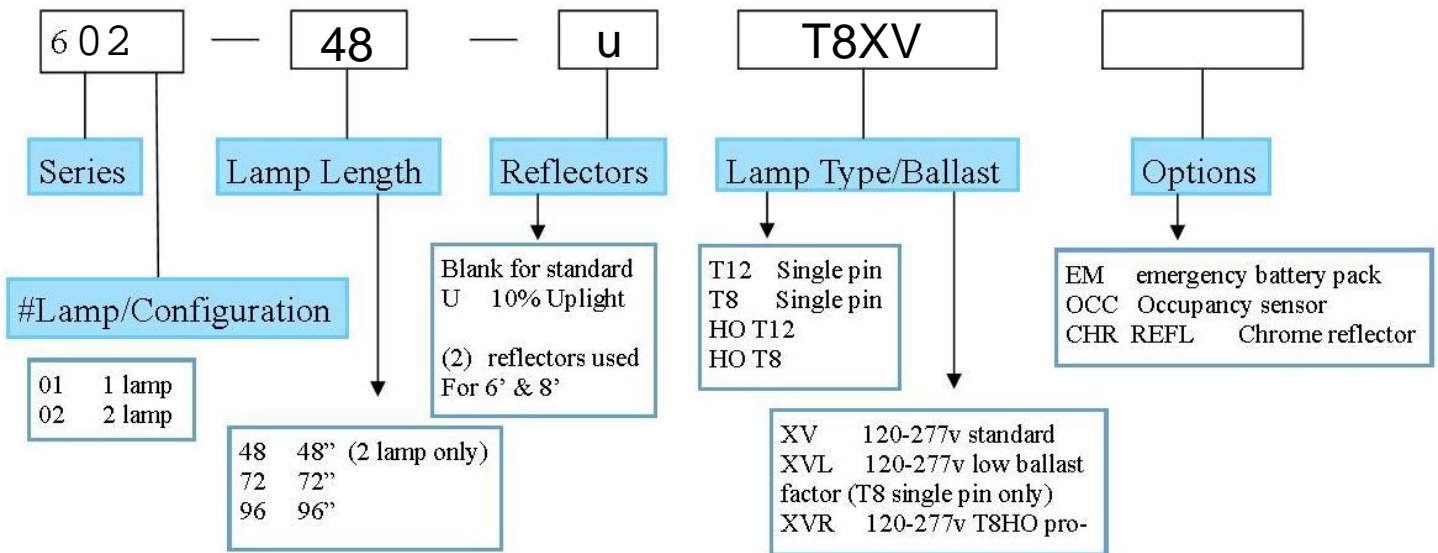
Dimensions are subject to change.  
Consult factory for verification.  
All configurations/options may not be shown.

Back View



## Ordering Information

Example: 602-96 HO T12 XV



# **LINK SEAL**

**Operations & Maintenance Manual  
December 2015**



# EXPERIENCE COUNTS



*Information and sizing charts updated 2-08.*

## ENGINEERING MANUAL

Link-Seal® Modular Seals  
Century-Line® Sleeves  
Cell-Cast® Disks



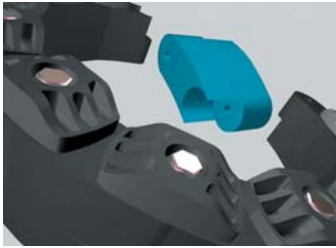
**Use the original engineered fit...  
there are no equals!**

Made in U.S.A.



# Link-Seal® Modular Seal Model Properties

## with EPDM Seal Elements



EPDM (Black)  
EPDM (Blue) Low Durometer

**Model “C” or “L” Link-Seal Modular Seal**  
Suitable for use in water, direct ground burial and atmospheric conditions. Provides electrical isolation where cathodic protection is required.  
**Type:** Standard  
**Seal Element:** EPDM (Black) or EPDM (Blue)  
**Pressure Plates:** Reinforced Nylon Polymer  
**Bolts & Nuts:** Steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating.  
**Temp. Range:** -40 to +250°F (-40 to +121°C)\*

**Model “S-316” Link-Seal Modular Seal**  
For chemical processing & waste water treatment. EPDM rubber is resistant to most inorganic acids and alkalis, some organic chemicals (acetone, alcohol, ketones).  
**Type:** Stainless  
**Seal Element:** EPDM (Black) or EPDM (Blue)  
**Pressure Plates:** Reinforced Nylon Polymer  
**Bolts & Nuts:** 316 Stainless Steel  
**Temp. Range:** -40 to +250°F (-40 to +121°C)\*

\* = Sustained operation near temperature limits may affect life expectancy.

## with Nitrile Seal Elements



Nitrile (Green)

**Model “O” Link-Seal Modular Seal**  
Nitrile rubber is resistant to oils, fuel and many solvents (gasoline, motor oil, kerosene, methane, jet fuel, hydraulic fluid, water, etc.).  
**Type:** Oil Resistant  
**Seal Element:** Nitrile (Green) Note: Not U.V resistant.  
**Pressure Plates:** Reinforced Nylon Polymer  
**Bolts & Nuts:** Steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating.  
**Temp. Range:** -40 to +210°F (-40 to +99°C)\*

**Model “OS-316” Link-Seal Modular Seal**  
Combination of oil resistant rubber and stainless steel hardware.  
**Type:** Oil Resistant  
**Seal Element:** Nitrile (Green) Note: Not U.V resistant.  
**Pressure Plates:** Reinforced Nylon Polymer  
**Bolts & Nuts:** 316 Stainless Steel  
**Temp. Range:** -40 to +210 °F (-40 to +99°C)\*

\* = Sustained operation near temperature limits may affect life expectancy.

## with Silicone Seal Elements



Silicone (Grey)

**Model “T” Link-Seal Modular Seal**  
Silicone rubber is ideal for temperature extremes. The “T” model is one-hour Factory Mutual approved.  
**Type:** High/Low Temperature  
**Seal Element:** Silicone (Grey)  
**Pressure Plates:** Steel Zinc Dichromate  
**Bolts:** Steel with 2-part Zinc Dichromate & proprietary corrosion inhibiting coating.  
**Temp. Range:** -67 to +400°F (-55 to +204°C)\*

**Model “FD/FS” Link-Seal Modular Seal**  
Double seal for added protection.  
**Type:** Fire Seals  
**Seal Element:** Silicone (Grey)  
**Pressure Plates:** Steel zinc dichromate  
**Bolts:** Steel with 2-part Zinc Dichromate proprietary corrosion inhibiting coating.  
**Temp. Range:** -67 to +400°F (-55 to +204°C)\*

NOTE: Sustains a constant temp. of 325°F. (163° C.)  
\* = Sustained operation near temperature limits may affect life expectancy.

### Material Properties of Link-Seal Modular Seal Elements

PROPERTY	ASTM METHOD	EPDM (EPDM L)	NITRILE	SILICONE
Hardness (shore A)	D-2240	50 ±5 (40 ±5)	50 ±5	50 ±5
Tensile	D-412	1450 psi	1300 psi	860 psi
Elongation	D-412	400%	300%	250%
Compression Set	S-395	15%	45%	40%
		22 hrs. @ 158°F (70°C)	22 hrs. @ 212°F (100°C)	22 hrs. @ 350°F (177°C)
Specific Gravity	D-297	1.10	1.15	1.40

### Material Properties of Composite Pressure Plates

PROPERTY	ASTM METHOD	VALUE
Izod Impact - Notched	D-256	2.05 ft-lb/in
Tensile Strength @ Yield	D-638	20,000 psi
Tensile Strength - Break	D-638	20,250 psi
Flexural Strength @ Yield	D-790	30,750 psi
Flexural Modulus	D-790	1,124,000 psi
Elongation, Break	D-638	11.07%
Specific Gravity	D-792	1.38
Moisture Content	--	0.18%

### Bolt & Nut Specifications

#### Standard: Carbon Steel

Carbon steel, zinc dichromated per ASTM B633, with an additional corrosion inhibiting proprietary organic coating. (passes 1470 hour salt spray test)  
Tensile Strength = 60,000 psi, minimum.

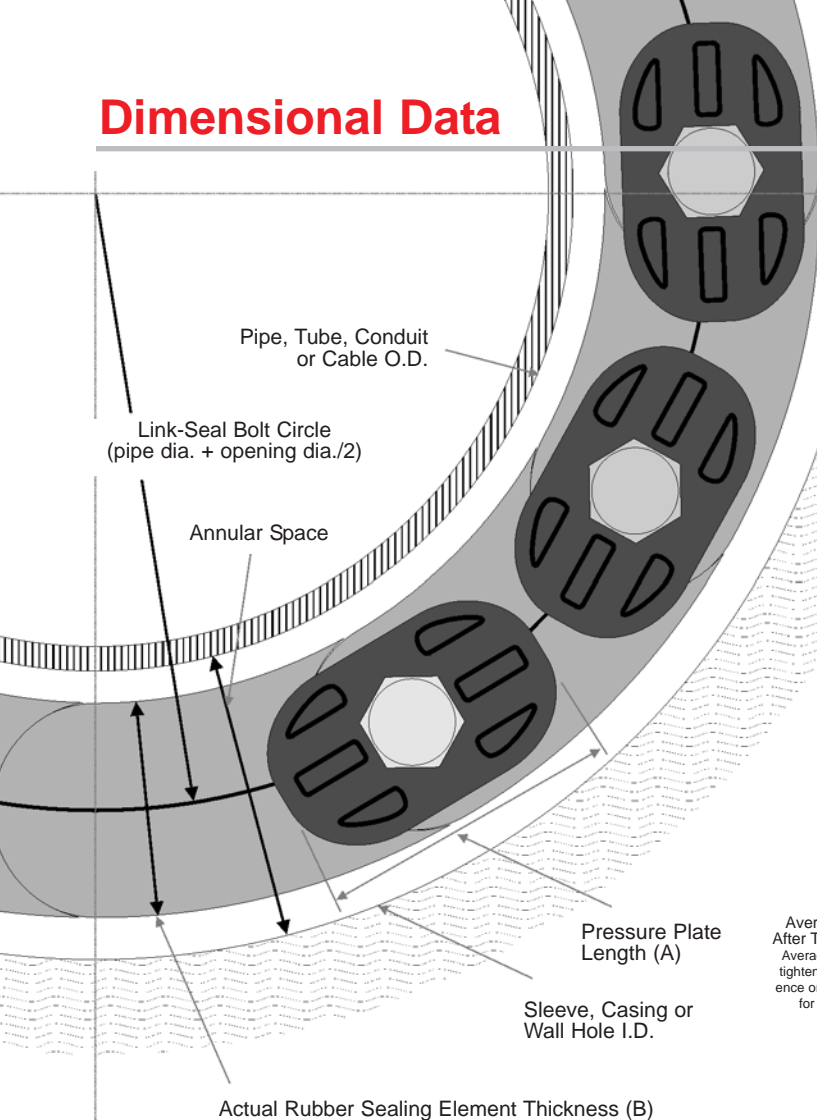
#### Option: Stainless Steel

ANSI Type = 316, Per ASTM F593-95  
Tensile Strength = 85,000 psi, average.

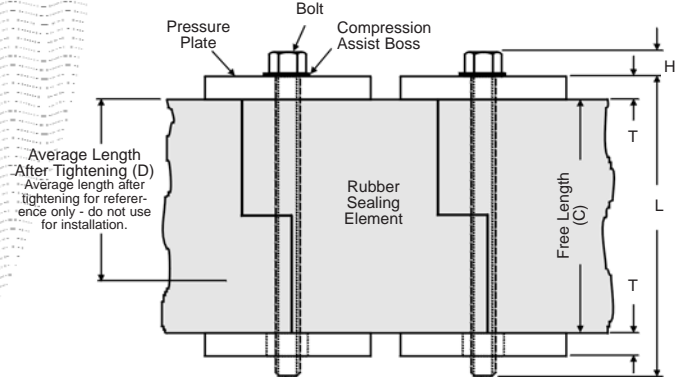




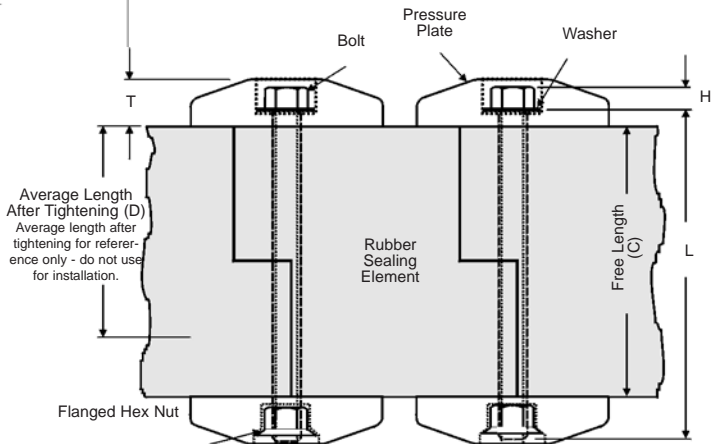
# Dimensional Data



## For LS-200 through LS-315



## For LS-325 through LS-600



## Dimensional Data for Models C, L, O, S-316 and OS-316 (Dimensions in inches except as noted)

LINK-SEAL MODEL NO.	RUBBER SEALING ELEMENT			PRESSURE PLATE		BOLT				WEIGHT FOR 10 LINK SECTION (LBS)	MIN. REQUIRED SEATING WIDTH
	ACTUAL THICKNESS (B)	FREE LENGTH (C)	AVG. LENGTH AFTER TIGHTENING (D)	(A)	(T)	HEX ACROSS FLATS	(H)	THREAD SIZE	(L)		
LS-200-C	0.48	1.75	1.38	1.06	0.31	M5 (slotted hex)	0.18	M5	2.50	0.75	2.25
LS-275-C	0.61	1.75	1.38	0.90	0.31	M5 (slotted hex)	0.18	M5	2.50	0.85	2.25
LS-300-C	0.69	2.37	1.87	1.50	0.44	0.50	0.22	5/16-18	3.50	2.10	3.00
LS-315-C	0.81	2.37	1.87	1.44	0.44	0.50	0.22	5/16-18	3.50	3.00	3.00
LS-325-C	0.88	2.63	2.00	3.13	1.00	0.50	0.22	5/16-18	4.50	5.50	4.00
LS-340-C	1.00	2.70	2.25	1.52	0.67	0.50	0.22	5/16-18	4.50	3.40	4.00
LS-360-C	1.24	2.70	2.25	2.05	0.77	0.50	0.22	5/16-18	4.50	5.00	4.00
LS-400-C	1.38	3.50	2.75	3.50	1.06	0.56	0.25	3/8-16	5.00	12.00	5.00
LS-410-C	1.43	3.37	2.87	2.52	0.88	0.56	0.25	3/8-16	5.00	8.20	5.00
LS-425-C	1.06	3.00	2.25	3.50	1.19	0.56	0.25	3/8-16	5.00	10.00	5.00
LS-475-C	1.56	3.38	2.63	2.63	0.88	0.56	0.25	3/8-16	5.00	10.00	5.00
LS-500-C	2.25	3.75	2.75	3.63	1.06	0.75	0.34	1/2-13	5.50	22.50	5.00
LS-525-C	2.06	3.75	2.87	3.63	1.06	0.75	0.34	1/2-13	5.50	21.00	5.00
LS-575-C	1.81	3.75	3.00	3.00	1.00	0.75	0.34	1/2-13	5.50	15.50	5.00
LS-600-C	3.09	4.00	3.00	6.00	1.90	1.16	.50	M20X2.5	7.10	60.60	6.00
LS-650-C	2.71	3.98	3.00	3.96	1.19	.75	.31	M12X1.75	6.88	26.10	6.00



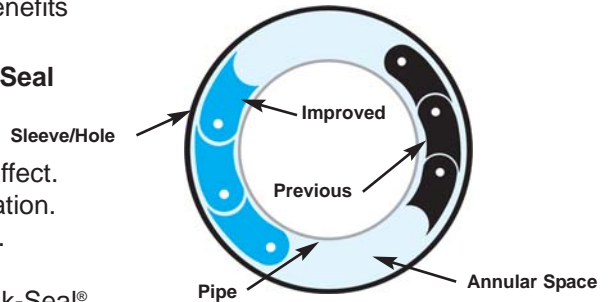


# Link-Seal® Sizing Method

Pipeline Seal & Insulator, Inc. has re-evaluated the Link-Seal® modular seal standard sizing for the sizing charts that are included in this Engineering Manual and our Selection Guide. The updated Link-Seal® sizing method puts the most rubber in the hole. Please see the graphic, listed features, and sizing chart examples below for a complete understanding of the Link-Seal® sizing method. This updated method benefits the engineer, owner and contractor.

## Features: More Rubber in Annular Space = Better Performing Seal

- Improved engineered fit.
- Improved vibration dampening.
- Minimum loads on bolts and pressure plates with same sealing effect.
- Most sealing pressure/most volume of sealing element in penetration.
- Curvature of link sized to penetration O.D. and I.D. for smooth fit.



In accomplishing putting more rubber in the annular space, the Link-Seal® assembly may require a larger size link with less links per belt or a smaller size link with more links per belt. Sleeve and cored hole sizing has also been taken into consideration. The charts below show examples comparing previous chart selections and the updated chart selections.

## Compare: Solutions in **Bolded Blue** = Updated Link-Seal® Sizing Method.

### SDR-35 Gravity Sewer Pipe

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
15	15.30	CS-20-*	LS-575-***	17	WS-20-37-S-*	LS-575-***	17	20.000	LS-525-***	14
<b>15</b>	<b>15.30</b>	<b>CS-20-*</b>	<b>LS-475-***</b>	<b>20</b>	<b>WS-20-37-S-*</b>	<b>LS-575-***</b>	<b>17</b>	<b>18.000</b>	<b>LS-360-***</b>	<b>24</b>
24	24.80	CC-30-**	LS-525-***	21	WS-30-37-S-*	LS-525-***	21	28.000	LS-400-***	22
<b>24</b>	<b>24.80</b>	<b>CC-30-**</b>	<b>LS-525-***</b>	<b>21</b>	<b>WS-28-37-S-*</b>	<b>LS-425-***</b>	<b>22</b>	<b>28.000</b>	<b>LS-475-***</b>	<b>31</b>

### Steel and Plastic Pipe with Same Outside Diameter

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
3	3.500	CS-5-*	LS-300-***	8	WS-5-25-S-*	LS-300-***	8	5.000	LS-300-***	8
<b>3</b>	<b>3.500</b>	<b>CS-5-*</b>	<b>LS-300-***</b>	<b>8</b>	<b>WS-6-28-S-*</b>	<b>LS-360-***</b>	<b>7</b>	<b>5.000</b>	<b>LS-300-***</b>	<b>8</b>
10	10.750	CS-14-*	LS-400-***	10	WS-14-37-S-*	LS-425-***	10	14.000	LS-400-***	10
<b>10</b>	<b>10.750</b>	<b>CS-14-*</b>	<b>LS-410-***</b>	<b>15</b>	<b>WS-14-37-S-*</b>	<b>LS-425-***</b>	<b>10</b>	<b>14.000</b>	<b>LS-475-***</b>	<b>14</b>
16	16.000	CS-20-*	LS-400-***	15	WS-20-37-S-*	LS-400-***	15	20.000	LS-575-***	18
<b>16</b>	<b>16.000</b>	<b>CS-20-*</b>	<b>LS-410-***</b>	<b>21</b>	<b>WS-20-37-S-*</b>	<b>LS-475-***</b>	<b>21</b>	<b>20.000</b>	<b>LS-575-***</b>	<b>18</b>

### Ductile Iron Pipe (AWWA-C900, C905, PVC Water Pipe)

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
10	11.100	CS-14-*	LS-400-***	10	WS-16-37-S-*	LS-575-***	13	14.000	LS-400-***	10
<b>10</b>	<b>11.100</b>	<b>CS-14-*</b>	<b>LS-410-***</b>	<b>15</b>	<b>WS-14-37-S-*</b>	<b>LS-340-***</b>	<b>24</b>	<b>14.000</b>	<b>LS-400-***</b>	<b>10</b>
16	17.400	CS-22-*	LS-400-***	16	WS-22-37-S-*	LS-575-***	19	22.000	LS-525-***	16
<b>16</b>	<b>17.400</b>	<b>CS-22-*</b>	<b>LS-360-***</b>	<b>28</b>	<b>WS-22-37-S-*</b>	<b>LS-475-***</b>	<b>23</b>	<b>20.000</b>	<b>LS-360-***</b>	<b>27</b>

## Link-Seal® Sizing Alternatives

**Experience Counts....** There are a lot of sizing solutions for a particular application. (See 16" D.I. Pipe Example) → For the best/improved solution for either existing or new penetrations, let our vast network of experienced personnel assist you in correctly sizing the best solution using one of the 16 unique sizes of links available in 4 sealing elements. If your application is not in the provided charts; use Method 2 sizing, contact PSI or an authorized Link-Seal® distributor.

**Note:** The Link-Seal® sizing charts in printed issues *LSEM/10-04*, *PSI-LSCLCC-2/05* and *LSEM/8-06* are still valid fits for field applications. **It's suggested you use the latest updated provided sizing.**



### Example: A Ductile Iron Pipe 16" Cored Hole Ductile Iron

Link-Seal® Size, # Links	Cored Hole Size
LS-340-***- <b>37</b>	20" Cored Hole
LS-360-***- <b>27</b>	20" Cored Hole
LS-425-***- <b>16</b>	20" Cored Hole
LS-500-***- <b>16</b>	22" Cored Hole
LS-525-***- <b>16</b>	22" Cored Hole
LS-575-***- <b>19</b>	22" Cored Hole
LS-600-***- <b>10</b>	24" Cored Hole

\*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)

# Sizing Procedure - Method 1

**Link-Seal® Modular Seals may be sized by using one or more methods.**

**Method 1** - Use the charts provided (Pages 9, 10 & 11) for standard pipe sizes and types.

## Method 1 - Link-Seal® Modular Seal Sizing

(If your pipe type and size matches with standard pipe charts.)

1. From the following nine charts (pages 9, 10 & 11), find the one that applies to your pipe type and locate correct pipe size (Nominal Diameter & Actual Outside Diameter). Verify that your pipe O.D. matches the actual outside diameter shown on the chart.
2. Determine the type of wall opening to be used: Century-Line® non-metallic (CS Model Sleeve), WS Steel Sleeve or Cast/Core Drilled Hole.
3. Begin at column heading "Pipe Size - Nominal". Read across to the sizing section for your sleeve type and wall opening Century-Line® (CS Model Sleeve), WS Steel Sleeve or Cast/Core Drilled. The first column identifies the sleeve model or hole diameter...the second column identifies the Link-Seal modular seal size... and the third column provides the number of links required for a complete seal assembly.
4. Determine the best Link-Seal modular seal Model for your application from Page 5.

### Example:

Pipe Type = SDR-35 Gravity Sewer Pipe  
 Nominal Diameter = 12"  
 Actual O.D. = 12.50"  
 Sleeve = Non-metallic Century-Line® (CS) Sleeve  
 I.D. = 12.26"

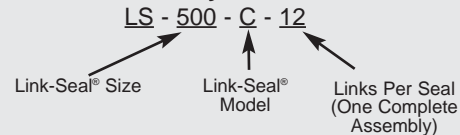
### Information Obtained From Charts

Link-Seal Size Number: LS-500  
 (Determined from "Link-Seal® Size" Column)  
 Links per Seal: 12  
 (Determined from "Links Per Seal" Column)

### Information Obtained from Charts on Page 5

Link-Seal® Model Number = C  
 (Based on application and usage)

### Code for Ordering One Complete Link-Seal Modular Seal Assembly



## Century-Line® Non-Metallic Sleeve or WS Steel Sleeve Sizing

(If your pipe type and size matches with standard pipe charts.)

1. When ordering Link-Seal® modular seals, note sleeve part numbers in columns CS Model Number (Century-Line®) or WS Model Number and indicate sleeve length in inches.

**NOTE:** Century-Line® sleeves are shipped standard in 16" lengths and can be field cut to as short as 8" in length. Please see page 23 for installation techniques.



### Example:

Same as Above

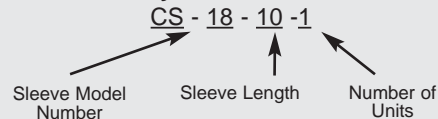
### Information Obtained From Charts

CS Sleeve Number = CS-18

### Determine Sleeve Length

(Based on wall thickness)  
 Sleeve Length = 10"

### Code for Ordering One Complete Century-Line Sleeve Assembly



## Cell-Cast Hole Forming Disk Sizing

(If your pipe type and size matches with standard pipe charts.)

1. When ordering Cell-Cast Disks, note the CC Model Number and combine 3" or 4" Cell-Cast Disks to create wall thickness. Please see page 24 for installation techniques.

**\*Note:** Threaded rod must be requested when ordered. Specify TRA at the end of the ordering code.



### Example:

Needing a 32" hole for a 14" thick wall.

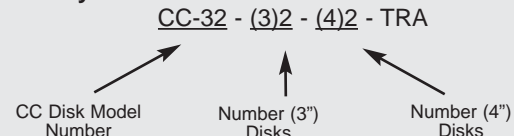
### Information Obtained From Charts

CC Model Number = CC-32

### Determine Number of Cell-Cast Disks

(Based on wall thickness)  
 Wall-Thickness = 14"

### Code for Ordering One Complete Cell-Cast Disk Assembly - \*Note: TRA=Threaded Rod Assembly



# Sizing Charts for Standard Pipe



## SDR-35 Gravity Sewer Pipe

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
4	4.22	CS-6-*	LS-315-***	11	WS-6-28-S-*	LS-315-***	10	6.000	LS-315-***	10
6	6.28	CS-8-*	LS-315-***	15	WS-8-32-S-*	LS-315-***	15	8.000	LS-315-***	15
8	8.40	CS-10-*	LS-325-***	9	WS-10-36-S-*	LS-315-***	19	12.000	LS-475-***	12
10	10.50	CS-14-*	LS-475-***	14	WS-14-37-S-*	LS-360-***	17	14.000	LS-475-***	14
12	12.50	CS-18-*	LS-500-***	12	WS-16-37-S-*	LS-360-***	20	16.000	LS-475-***	17
15	15.30	CS-20-*	LS-475-***	20	WS-20-37-S-*	LS-575-***	17	18.000	LS-360-***	24
18	18.70	CS-24-*	LS-575-***	21	WS-22-37-S-*	LS-360-***	29	22.000	LS-475-***	24
21	22.05	CC-30-**	LS-600-***	13	WS-26-37-S-*	LS-475-***	28	26.000	LS-575-***	24
24	24.80	CC-30-**	LS-525-***	21	WS-28-37-S-*	LS-425-***	22	28.000	LS-475-***	31
27	27.95	CC-32-**	LS-400-***	25	WS-32-37-S-*	LS-400-***	25	32.000	LS-575-***	30
30	32.00	CC-38-**	LS-500-***	28	WS-36-37-S-*	LS-400-***	29	36.000	LS-575-***	34

\* = Specify sleeve length in inches \*\* = See Cell-Cast® Page 16 \*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)  
 Technically there is no limit to the pipe size that can be sealed using Link-Seal® modular seals. Please contact factory for sizes not listed and for CS model plastic sleeves for walls less than 8" thick.

## Steel and Plastic Pipe with Same Outside Diameter (IPS)

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
1/2	0.840	CS-2-*	LS-200-***	4	WS-2-15-S-*	LS-275-***	5	2.000	LS-200-***	4
3/4	1.050	CS-3-*	LS-315-***	4	WS-2-1/2-20-S-*	LS-275-***	6	3.000	LS-315-***	4
1	1.315	CS-3-*	LS-300-***	4	WS-2-1/2-20-S-*	LS-200-***	5	3.000	LS-300-***	4
1-1/4	1.660	CS-3-*	LS-275-***	7	WS-3-21-S-*	LS-275-***	8	3.000	LS-275-***	8
1-1/2	1.900	CS-3-1/2-*	LS-300-***	5	WS-3-21-S-*	LS-200-***	7	4.000	LS-315-***	6
2	2.375	CS-4-*	LS-300-***	6	WS-3-1/2-22-S-*	LS-200-***	8	4.000	LS-300-***	6
2-1/2	2.875	CS-4-*	LS-200-***	9	WS-4-23-S-*	LS-200-***	9	4.000	LS-200-***	9
3	3.500	CS-5-*	LS-300-***	8	WS-6-28-S-*	LS-360-***	7	5.000	LS-300-***	8
3-1/2	4.000	CS-6-*	LS-340-***	10	WS-6-28-S-*	LS-340-***	9	6.000	LS-315-***	10
4	4.500	CS-6-*	LS-300-***	10	WS-6-28-S-*	LS-300-***	10	6.000	LS-300-***	10
5	5.563	CS-8-*	LS-360-***	10	WS-8-32-S-*	LS-340-***	13	8.000	LS-340-***	13
6	6.625	CS-10-*	LS-475-***	10	WS-10-36-S-*	LS-475-***	10	10.000	LS-475-***	10
8	8.625	CS-12-*	LS-475-***	12	WS-12-37-S-*	LS-475-***	12	12.000	LS-475-***	12
10	10.750	CS-14-*	LS-410-***	15	WS-14-37-S-*	LS-425-***	10	14.000	LS-475-***	14
12	12.750	CS-16-*	LS-475-***	17	WS-16-37-S-*	LS-425-***	12	16.000	LS-475-***	17
14	14.000	CS-16-*	LS-340-***	30	WS-18-37-S-*	LS-475-***	18	18.000	LS-575-***	16
16	16.000	CS-20-*	LS-410-***	21	WS-20-37-S-*	LS-475-***	21	20.000	LS-575-***	18
18	18.000	CS-22-*	LS-340-***	38	WS-22-37-S-*	LS-475-***	23	22.000	LS-575-***	20
20	20.000	CS-25-*	LS-500-***	18	WS-24-37-S-*	LS-475-***	25	24.000	LS-475-***	26
22	22.000	CS-25-*	LS-360-***	34	WS-26-37-S-*	LS-475-***	28	26.000	LS-575-***	24
24	24.000	CC-30-**	LS-500-***	21	WS-28-37-S-*	LS-475-***	30	28.000	LS-475-***	31
26	26.000	CC-30-**	LS-400-***	23	WS-30-37-S-*	LS-400-***	23	30.000	LS-575-***	28
28	28.000	CC-32-**	LS-400-***	25	WS-32-37-S-*	LS-400-***	25	32.000	LS-575-***	30
30	30.000	CC-36-**	LS-500-***	26	WS-34-37-S-*	LS-400-***	27	34.000	LS-575-***	32
32	32.000	CC-38-**	LS-500-***	28	WS-36-37-S-*	LS-400-***	29	36.000	LS-575-***	34
34	34.000	CC-38-**	LS-400-***	30	WS-40-37-S-*	LS-500-***	29	38.000	LS-575-***	36
36	36.000	CC-42-**	LS-500-***	31	WS-42-37-S-*	LS-500-***	31	40.000	LS-575-***	38
42	42.000	CC-48-**	LS-500-***	36	WS-48-37-S-*	LS-500-***	36	46.000	LS-575-***	44
48	48.000	CC-54-**	LS-500-***	40	WS-53-37-S-*	LS-525-***	40	52.000	LS-575-***	50

\* = Specify sleeve length in inches \*\* = See Cell-Cast® Page 16 \*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)  
 Technically there is no limit to the pipe size that can be sealed using Link-Seal® modular seals. Please contact factory for sizes not listed and for CS model plastic sleeves for walls less than 8" thick.



# Sizing Charts for Standard Pipe



## Cast Iron Soil Pipe (Service Weight)

PIPE SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
2	2.300	CS-4*	LS-300-***	6	WS-4-23-S*	LS-315-***	6	4.000	LS-315-***	6
3	3.300	CS-5*	LS-300-***	8	WS-6-28-S*	LS-360-***	7	5.000	LS-300-***	8
4	4.300	CS-6*	LS-300-***	10	WS-6-28-S*	LS-315-***	10	6.000	LS-300-***	10
5	5.300	CS-8*	LS-410-***	8	WS-8-32-S*	LS-360-***	9	8.000	LS-360-***	9
6	6.300	CS-8*	LS-315-***	15	WS-8-32-S*	LS-315-***	15	8.000	LS-315-***	15
8	8.380	CS-10*	LS-325-***	9	WS-10-36-S*	LS-315-***	19	10.000	LS-315-***	19
10	10.500	CS-14*	LS-475-***	14	WS-14-37-S*	LS-360-***	17	14.000	LS-475-***	14
12	12.500	CS-18*	LS-500-***	12	WS-16-37-S*	LS-360-***	20	16.000	LS-475-***	17
15	15.620	CS-20*	LS-475-***	20	WS-20-37-S*	LS-475-***	20	18.000	LS-425-***	14

\* = Specify sleeve length in inches \*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)

## Electrical Metallic Tubing (EMT) Thin Wall

Conduit SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
1/2	0.706	CS-2*	LS-275-***	4	WS-2-15-S*	LS-275-***	5	2.000	LS-275-***	4
3/4	0.922	CS-2*	LS-200-***	4	WS-2-1/2-20-S*	LS-275-***	6	2.000	LS-200-***	4
1	1.163	CS-3*	LS-315-***	4	WS-2-1/2-20-S*	LS-275-***	6	3.000	LS-315-***	4
1-1/4	1.510	CS-3*	LS-275-***	8	WS-3-21-S*	LS-275-***	6	3.000	LS-275-***	8
1-1/2	1.740	CS-3-1/2*	LS-300-***	5	WS-3-21-S*	LS-275-***	8	3.000	LS-200-***	6
2	2.197	CS-4*	LS-315-***	6	WS-3-1/2-22-S*	LS-275-***	10	4.000	LS-315-***	6
2-1/2	2.875	CS-4*	LS-200-***	9	WS-4-23-S*	LS-200-***	9	4.000	LS-200-***	9
3	3.500	CS-5*	LS-315-***	9	WS-6-28-S*	LS-360-***	7	5.000	LS-300-***	8
4	4.500	CS-8*	LS-475-***	8	WS-6-28-S*	LS-300-***	10	6.000	LS-300-***	10

\* = Specify sleeve length in inches \*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)

## Intermediate Metal Conduit (IMC)

Conduit SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
1/2	0.815	CS-2*	LS-200-***	4	WS-2-15-S*	LS-275-***	5	2.000	LS-200-***	4
3/4	1.029	CS-2*	LS-200-***	4	WS-2-1/2-20-S*	LS-275-***	6	2.000	LS-200-***	4
1	1.290	CS-3-1/2*	LS-315-***	5	WS-2-1/2-20-S*	LS-200-***	5	3.000	LS-300-***	4
1-1/4	1.638	CS-3*	LS-275-***	8	WS-3-21-S*	LS-275-***	8	3.000	LS-275-***	8
1-1/2	1.883	CS-3-1/2*	LS-300-***	5	WS-3-21-S*	LS-200-***	7	4.000	LS-315-***	6
2	2.360	CS-4*	LS-300-***	6	WS-3-1/2-22-S*	LS-200-***	8	4.000	LS-300-***	6
2-1/2	2.857	CS-4*	LS-200-***	9	WS-4-23-S*	LS-200-***	9	4.000	LS-200-***	9
3	3.476	CS-5*	LS-315-***	9	WS-6-28-S*	LS-360-***	7	5.000	LS-300-***	8
3-1/2	3.970	CS-6*	LS-340-***	10	WS-6-28-S*	LS-340-***	9	6.000	LS-315-***	10
4	4.466	CS-6*	LS-315-***	11	WS-6-28-S*	LS-300-***	10	6.000	LS-300-***	10

\* = Specify sleeve length in inches \*\*\* = Specify LS Model C, S-316, L...etc when ordering (Example LS-475-C-17)

## Rigid (RSC), Aluminum (ASC), Galvanized (GSC), Non-Metallic Conduit (NRC)

Conduit SIZE (Nom.)	ACTUAL O.D. (Inches)	CS MODEL NON-METALLIC SLEEVE			WS MODEL STEEL SLEEVE			CAST OR CORE BIT DRILLED HOLE		
		MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	MODEL NUMBER	LINK-SEAL® SIZE	LINKS PER SEAL	HOLE I.D.	LINK-SEAL® SIZE	LINKS PER SEAL
1/2	0.840	CS-2*	LS-200-***	4	WS-2-15-S*	LS-275-***	5	2.000	LS-200-***	4
3/4	1.050	CS-3*	LS-315-***	4	WS-2-1/2-20-S*	LS-275-***	6	3.000	LS-315-***	4
1	1.315	CS-3*	LS-300-***	4	WS-2-1/2-20-S*	LS-200-***	5	3.000	LS-300-***	4
1-1/4	1.660	CS-3*	LS-275-***	7	WS-3-21-S*	LS-275-***	8	3.000	LS-275-***	8
1-1/2	1.900	CS-3-1/2*	LS-300-***	5	WS-3-21-S*	LS-200-***	7	4.000	LS-315-***	6
2	2.375	CS-4*	LS-300-***	6	WS-3-1/2-22-S*	LS-200-***	8	4.000	LS-300-***	6
2-1/2	2.875	CS-4*	LS-200-***	9	WS-4-23-S*	LS-200-***	9	4.000	LS-200-***	9
3	3.500	CS-5*	LS-300-***	8	WS-6-28-S*	LS-360-***	7	5.000	LS-300-***	8
3-1/2	4.000	CS-6*	LS-340-***	10	WS-6-28-S*	LS-340-***	9	6.000	LS-315-***	10
4	4.500	CS-6*	LS-300-***	10	WS-6-28-S*	LS-300-***	10	6.000	LS-300-***	10
5	5.563	CS-8*	LS-360-***	10	WS-8-32-S*	LS-340-***	13	8.000	LS-340-***	13
6	6.625	CS-10*	LS-475-***	10	WS-10-36-S*	LS-475-***	10	10.000	LS-475-***	10

Technically there is no limit to the conduit or pipe size that can be sealed using Link-Seal® modular seals.

Please contact factory for sizes not listed and for CS model plastic sleeves for walls less than 8" thick.

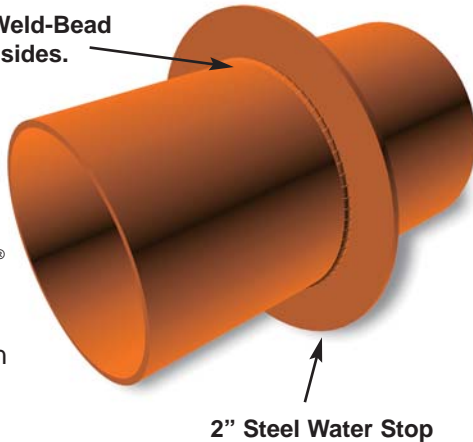




# WS Steel Wall Sleeves

WS Wall Sleeves are constructed from steel and available in a wide range of diameters and lengths. They are an excellent choice for installations where the Link-Seal® Modular Seal and WS sleeve assembly would be subject to extremely high temperatures or where fire seals are specified.

Continuous Weld-Bead on both sides.



## How To Order

Please see Pages 8 or 25 for ordering information on Link-Seal® modular seals and WS Steel Sleeves. For diameters larger than 24", contact PSI at 1-800-423-2410

## WS Steel Wall Sleeve Specification

Provide WS Steel sleeves for all pipes passing through concrete or masonry structures. The WS Sleeves shall be provided free of welding slag. WS Steel Sleeve sizes though 10" shall be Schedule 40 Steel Pipe or standard wall thickness. WS Steel Sleeve sizes 12" and larger shall have a .375" or standard wall thickness. WS Sleeves through wall shall be cast in place and the pipe shall be installed centered in sleeve. The 2" collar, (water-stop) shall be the same type of steel as the WS sleeve. The collar shall be welded all around on both sides to the

## Model WS (12" length)

MODEL	I.D.	lbs.	Kg.
WS-2-15-S-12	2.07	5.53	2.51
WS-2-1/2-20-S-12	2.47	7.91	3.58
WS-3-21-S-12	3.07	9.93	4.51
WS-3-1/2-22-S-12	3.55	11.70	5.31
WS-4-23-S-12	4.03	13.61	6.17
WS-5-25-S-12	5.05	17.91	8.12
WS-6-28-S-12	6.07	22.73	10.31
ws-6-18-S-12	6.25	14.82	6.72
WS-8-32-S-12	7.98	33.55	15.22
ws-8-18-S-12	8.25	21.94	9.95
WS-10-36-S-12	10.02	46.12	20.92
ws-10-25-S-12	10.25	33.67	15.27
WS-12-37-S-12	12.00	60.14	27.28
WS-14-37-S-12	13.25	62.04	28.14
WS-16-37-S-12	15.25	71.04	32.22
WS-18-37-S-12	17.25	79.98	36.28
WS-20-37-S-12	19.25	90.00	40.82
WS-22-37-S-12	21.25	98.00	44.45
WS-24-37-S-12	23.25	107.00	48.53

**Note:** ws rolled sleeves (6" & 8") = .1875" wall thickness; (10") = .25" wall thickness. Intermediate sleeves available, model information on-line in a pdf file.

sleeve at the point on the sleeve that positions it at the mid-point of the structural wall when the sleeve is in place. The WS Steel Sleeve w/water-stop shall be primed inside and outside with Rust-o-Leum red primer #5268 or approved equivalent.

Pipeline Seal and Insulator, Inc., Houston, Texas, U.S.A shall provide WS Steel Sleeves.

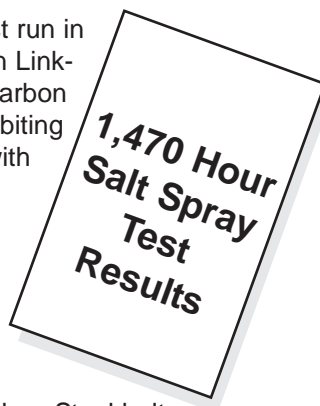
## Link-Seal® Modular Seal Bolt Test

An independent 1,470 hour salt spray test run in accordance to ASTM B117-97 has proven Link-Seal® modular seals' Zinc Dichromated Carbon Steel bolts, with proprietary corrosion inhibiting coating, to be superior when compared with competitive manufacturers.

### Test Criteria

Bolts subject to exposure in Salt Spray Cabinet for 1,470 hours according to ASTM B117-97.

The new Link-Seal Zinc Dichromated Carbon Steel bolt with proprietary corrosion inhibiting coating will provide greater resistance to the most hostile environmental conditions on earth.



1,470 hour salt spray test performed by an independent laboratory. Test results are available on request.





# Link-Seal® Modular Fire Seals

## 1-Hour Factory Mutual Approved

Link-Seal® modular fire seals provide up to one-hour protection against flames, smoke, gases and water, even when exposed to temperatures up to 1900°F. (1038°C.).

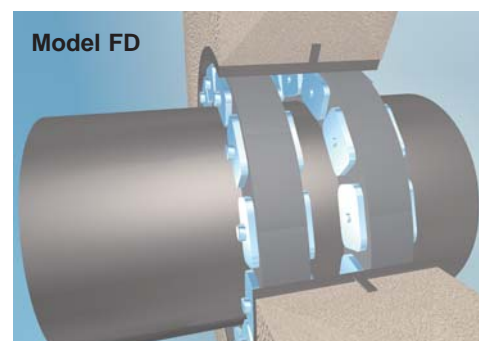
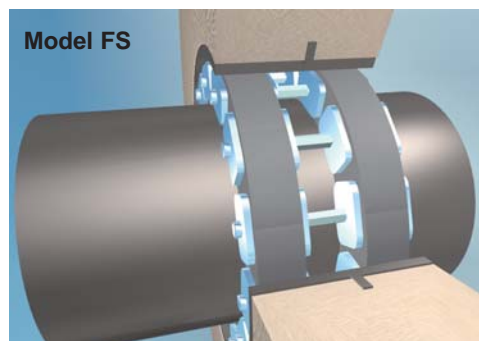
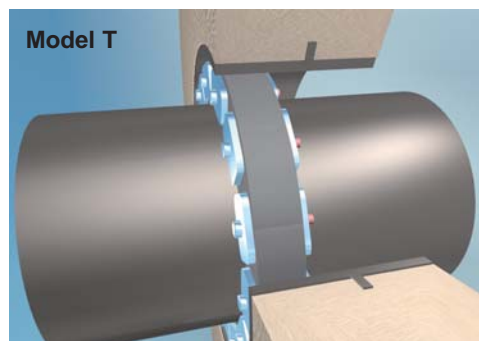
These seals are a proprietary Link-Seal® modular seal design formulated from Hi-Temp silicone and incorporate special designed carbon steel pressure plates. For installations from 1/2" to 120" diameter Link-Seal® modular fire seals are used with WS wall sleeves or core bit drilled openings.

### Model T

**One Hour FM Approved**  
Approved by Factory Mutual as a 1-hour fire stop in accordance with ASTM E814-81 Fire & Hose Stream Criteria Listing #J.I.OH4A5.AC

### Model FS or FD

these are essentially two T Models back-to-back for added protection. In Model FS, a tie rod tightens both seals simultaneously - for use when only one side of a hole is accessible.



### Minimum Wall & Floor Thickness for Model T Fire Rated Seals

LINK-SEAL® MODEL	MINIMUM WALL OR FLOOR THICKNESS
LS-200-T	2.25" (57 mm)
LS-275-T	2.25" (57 mm)
LS-300-T	3.00" (76 mm)
LS-315-T	3.00" (76 mm)
LS-325-T	4.00" (102 mm)
LS-340-T	4.00" (102 mm)
LS-360-T	4.00" (102 mm)
LS-400-T	5.00" (127 mm)
LS-410-T	5.00" (127 mm)
LS-425-T	5.00" (127 mm)
LS-475-T	5.00" (127 mm)
LS-500-T	5.00" (127 mm)
LS-525-T	5.00" (127 mm)
LS-575-T	5.00" (127 mm)

### Minimum Wall & Floor Thickness for Model FD or FS Fire Rated Seals

LINK-SEAL® MODEL	MINIMUM WALL OR FLOOR THICKNESS
LS-200-FD or FS	4.50" (114 mm)
LS-275-FD or FS	4.50" (114 mm)
LS-300-FD or FS	6.00" (152 mm)
LS-315-FD or FS	6.00" (152 mm)
LS-325-FD or FS	8.00" (203 mm)
LS-340-FD or FS	8.00" (203mm)
LS-360-FD or FS	8.00" (203mm)
LS-400-FD or FS	10.00" (254 mm)
LS-410-FD or FS	10.00" (254 mm)
LS-425-FD or FS	10.00" (254 mm)
LS-475-FD or FS	10.00" (254 mm)
LS-500-FD or FS	12.00" (305 mm)
LS-525-FD or FS	12.00" (305 mm)
LS-575-FD or FS	12.00" (305 mm)

## Link-Seal® Modular Fire Seals - Testing Procedure



Certified test furnace with pipe and cable penetrations and fire rated Link-Seal® modular seal installed in concrete floor slab. Twenty-seven thermo couples were used per slab.



Test slab being raised from furnace at completion of test. (Slab was then positioned vertically for hose stream test.)



Test slab after hose stream. Cold water striking the 1900°F. slab caused scalling of concrete, but left Link-Seal® modular seal intact. Unexposed side showed no evidence of water damage.

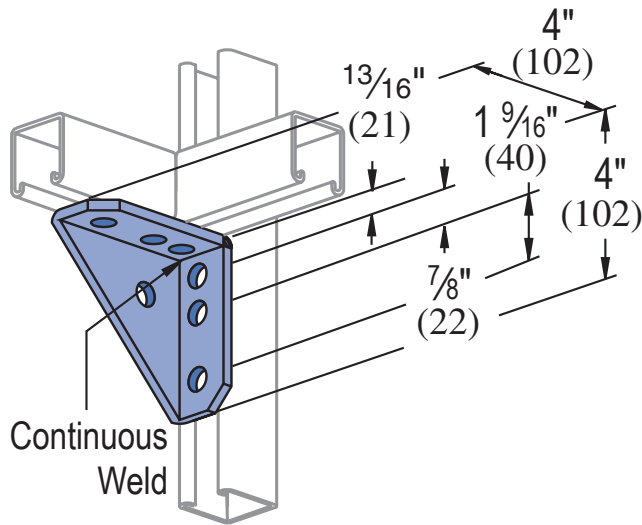


# **PLENUM CONDUIT SUPPORTS**

**Operations & Maintenance Manual  
December 2015**

P2484W

Wt/100 pcs: 134 Lbs (60.8 kg)



Standard Dimensions for 1 5/8" (41mm) width series channel fittings (Unless Otherwise Shown on Drawing)

Hole Diameter: 9/16" (14mm); Hole Spacing - From End: 13/16" (21mm); Hole Spacing - On Center: 1 7/8" (48mm); Width: 1 5/8" (41mm); Thickness: 1/4" (6mm)

**MATERIAL**

Fittings, unless noted, are made from hot-rolled, pickled and oiled steel plates, strip or coil, and conform to ASTM specifications A575, A576, A635, or A36. The fitting steel also meets the physical requirements of ASTM A1011 SS GR 33. The pickling of the steel produces a smooth surface free from scale.

Many fittings are also available in stainless steel, aluminum and fiberglass. Consult factory for ordering information.

**FINISHES**

Fittings are available in:

Perma-Green III (GR),

Electro-galvanized (EG), conforming to ASTM B633 Type III SC1;

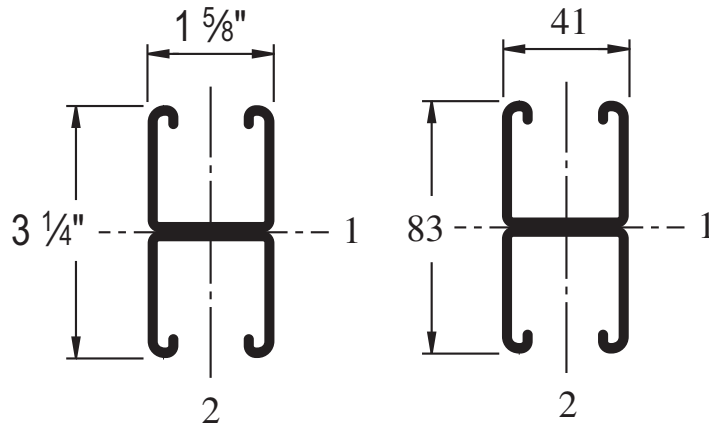
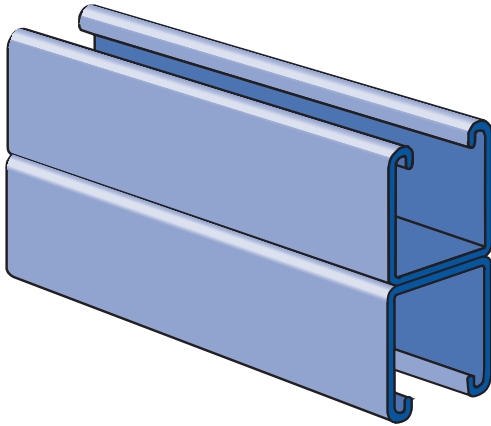
Hot-dipped galvanized (HG), conforming to ASTM A123 or A153 and

Plain (PL).





P1001



Notes:

\* Load limited by spot weld shear.

\*\*  $KL/r > 200$

NR = Not Recommended.

- Above loads include the weight of the member. This weight must be deducted to arrive at the net allowable load the beam will support.
- Long span beams should be supported in such a manner as to prevent rotation and twist.
- Allowable uniformly distributed loads are listed for various simple spans, that is, a beam on two supports. If load is concentrated at the center of the span, multiply load from the table by 0.5 and corresponding deflection by 0.8.
- For Pierced Channel, Beam Load Values in the tables are multiplied by the following factor:

"DS" Series	70%	"T" Series	85%
"KO" Series	95%	"H3" Series	90%
"SL" Series	85%	"HS" Series	90%

Wt/100 Ft: 378 Lbs (562 kg/100 m)  
 Allowable Moment 14,360 In-Lbs (1,620 N\*m)  
 12 Gauge Nominal Thickness .105" (2.7mm)

**MATERIAL**

Unistrut channels are accurately and carefully cold formed to size from low-carbon strip steel. All spot-welded combination members, except P1001T, are welded 3" (76 mm) maximum on center.

**STEEL: PLAIN**

12 Ga. (2.7 mm), 14 Ga.(1.9 mm) and  
 16 Ga. (1.5 mm) ASTM A1011 SS GR 33.

**STEEL: PRE-GALVANIZED**

12 Ga. (2.7 mm), 14 Ga. (1.9 mm) and  
 16 Ga. (1.5mm) ASTM A653 GR 33.

For other materials, see Special Metals or Fiberglass sections.

**FINISHES**

All channels are available in:

- Perma Green III (GR).
- Pre-galvanized (PG), conforming to ASTM A653 G90.
- Hot-dipped galvanized (HG), conforming to ASTM A123.
- Plain (PL).

## Domestic Wedge Anchor

Anchor made in the U.S.A., nut and washer made in Taiwan or China\*  
Carbon Steel and Stainless Steel Wedge Expansion Anchors

### PRODUCT DESCRIPTION

The Domestic Wedge Anchor is a threaded, torque-controlled, carbon steel or stainless steel wedge expansion anchor which is designed for consistent performance in concrete. Suitable base materials are normal-weight and sand-lightweight concrete. The anchor is manufactured with carbon steel body and expansion clip or a stainless steel body and expansion clip. Nut and washer are included.

### GENERAL APPLICATIONS AND USES

- Steel fixtures
- Support connections
- Equipment and railing

### FEATURES AND BENEFITS

- + Anchors made in the U.S.A., nut and washer made in Taiwan or China. (Domestic nut and washer available upon request.)
- + Nominal drill bit size is the same as the anchor diameter
- + Anchor can be installed through standard fixture holes
- + Length ID code and identifying marking stamped on head of each anchor
- + Anchor design allows for follow-up expansion after setting under tensile loading
- + Corrosion resistant stainless steel anchors

### APPROVALS AND LISTINGS

Tested to ASTM E 488

### GUIDE SPECIFICATIONS

**CSI Divisions:** 031600-Concrete Anchors, 05090-Metal Fastenings and 050519 Post-installed concrete anchors. Expansion anchors shall be Domestic Wedge Anchor as supplied by Powers Fasteners, Inc., Brewster, NY. Anchors shall be installed in accordance with published instructions and the Authority Having Jurisdiction.

### MATERIAL SPECIFICATIONS

Anchor component	Specification		
	Carbon Steel <sup>1</sup>	Type 303	Type 316
Anchor body	AISI C12L14	Type 303 Stainless Steel	Type 316 Stainless Steel
Washer	AISI C1010-1018	300 Series Stainless Steel	Type 316 Stainless Steel
Hex Nut	Low Carbon Steel, ASTM A563, Grade A	Type 18-8	Type 316 Stainless Steel
Expansion wedge (clip)	AISI C1010-1018 1037	Type 18-8	Type 316 Stainless Steel

1. Plated with Commercial Bright Zinc and supplementary chromate treatment in accordance with ASTM B 633, SC1 Type III.  
\* Domestic nut and washer available upon request.

SECTION CONTENTS	Page No.
General Information.....	1
Material Specifications .....	1
Installation Instructions .....	2
Installation Specifications.....	2
Reference Performance Data .....	3
Ordering Information .....	5



Domestic Wedge Anchor Assembly

### THREAD VERSION

UNC threaded stud

### ANCHOR MATERIALS

Carbon Steel, Type 303 Stainless Steel, or Type 316 Stainless Steel

### ANCHOR SIZE RANGE (TYP.)

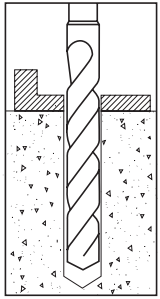
1/4" diameter through 1-1/4" diameter

### SUITABLE BASE MATERIALS

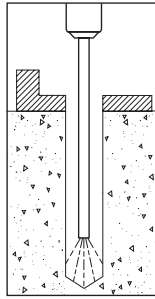
Normal-weight concrete  
Sand-lightweight concrete

**INSTALLATION INSTRUCTIONS**

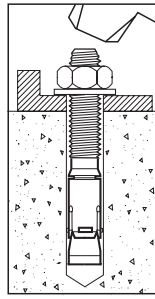
**Installation Instructions for Domestic Wedge Anchor**



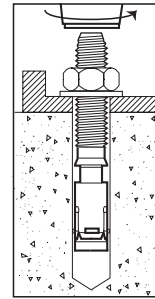
1.) Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.



2.) Remove dust and debris from the hole using a hand pump, compressed air or a vacuum to remove loose particles left from drilling.



3.) Position the supplied washer on the anchor and thread on the supplied nut. If installing through a fixture, drive the anchor through the fixture into the hole. Be sure the anchor is driven to the minimum required embedment depth.



4.) Tighten the anchor with a torque wrench by applying the required installation torque,  $T_{inst}$ .

**Installation Table for Domestic Wedge Anchor**

Anchor Property/ Setting Information	Notation	Units	Nominal Anchor Diameter (inch)							
			1/4	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Anchor outside diameter	$d$	in. (mm)	0.25 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Nominal drill bit diameter	$d_{bit}$	in.	1/4 ANSI	3/8 ANSI	1/2 ANSI	5/8 ANSI	3/4 ANSI	7/8 ANSI	1 ANSI	1-1/4 ANSI
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)	9/16 (14.3)	11/16 (17.5)	13/16 (20.6)	15/16 (23.8)	1-1/8 (28.6)	1-3/8 (34.9)
Minimum nominal embedment depth	$h_{nom}$	in. (mm)	1-1/8 (28.6)	1-1/2 (38.1)	2-1/4 (57.2)	2-3/4 (69.9)	3-1/4 (82.6)	3-7/8 (98.4)	4-1/2 (114.3)	5-1/2 (139.7)
Minimum hole depth	$h_o$	in. (mm)	1-3/8 (34.9)	1-7/8 (47.6)	2-3/4 (69.9)	3-1/4 (82.6)	3-3/4 (95.3)	4-3/8 (111.1)	5 (127.0)	6 (152.4)
Minimum member thickness	$h_{min}$	in. (mm)	3 (76.2)	3 (76.2)	3-3/8 (85.7)	4-1/8 (104.8)	4-7/8 (123.8)	5-13/16 (147.6)	6-3/4 (171.5)	8-1/4 (209.6)
Installation torque	$T_{inst}$	ft.-lbf. (N-m)	5-10 (6.8-13.6)	25-30 (33.9-40.7)	50-60 (67.8-81.4)	75-90 (102-122)	150-175 (203-237)	200-250 (271-339)	250-300 (339-407)	400-450 (542-610)
Torque wrench/socket size	-	in.	7/16	9/16	3/4	15/16	1-1/8	1-5/16	1-1/2	1-7/8
Nut height	-	in.	7/32	21/64	7/16	35/64	41/64	3/4	55/64	1-1/16

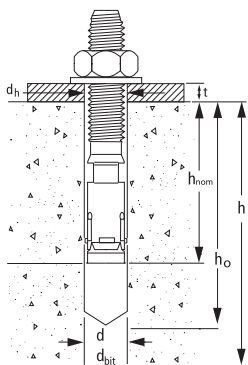
For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

**Length Identification**

Mark	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
From	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"
Up to but not including	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"	7"	7-1/2"	8"	8-1/2"	9"	9-1/2"	10"	11"	12"

Length identification mark indicates overall length of anchor.

**Installation Detail**



**Nomenclature**

- $d$  = Diameter of anchor
- $d_{bit}$  = Diameter of drill bit
- $d_h$  = Diameter of fixture clearance hole
- $h$  = Base material thickness  
The minimum value of  $h$  should be  $1.5h_{nom}$  or 3" whichever is greater
- $h_{nom}$  = Minimum nominal embedment
- $t$  = Fixture thickness
- $h_o$  = Minimum hole depth

**REFERENCE PERFORMANCE DATA**

**Ultimate Load Capacities for Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2</sup>**

Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)	Ultimate Tension Load Capacity (lbs.)	Ultimate Shear Load Capacity (lbs.)
1/4	1-1/8	1,170	1,445	1,770	1,815	2,775	2,635
	1-3/4	1,840		2,410		2,775	
	2-3/4	1,975		2,750		2,830	
3/8	1-1/2	1,630	4,320	3,640	5,120	4,450	6,235
	3	3,230		5,655		5,975	
	5	4,075		6,330		6,360	
1/2	2-1/4	4,000	7,420	6,715	9,380	9,615	9,890
	4	6,335		8,945		10,190	
	6	6,900		10,175		12,065	
5/8	2-3/4	5,000	8,265	8,750	12,930	9,760	16,375
	5	8,855		15,590		16,800	
	7	9,380		16,710		17,735	
3/4	3-1/4	6,640	12,505	11,315	17,050	16,230	22,965
	6	10,085		18,410		21,095	
	8	11,170		19,805		22,525	
7/8	3-7/8	8,395	18,250	16,355	20,235	16,800	23,980
	5-3/4	12,065		18,250		23,405	
1	4-1/2	9,775	23,620	18,250	27,605	27,460	28,910
	7-1/2	11,890		26,725		34,960	
	10	15,590		30,490		37,840	
1-1/4	5-1/2	17,550	32,275	22,970	42,690	32,370	55,565
	7	21,050		27,845		48,365	
	10	27,895		34,790		61,270	

**MECHANICAL ANCHORS**

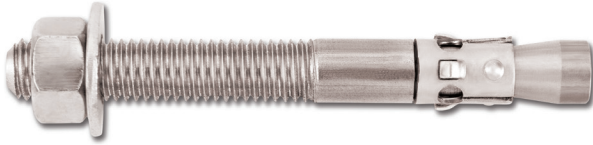
1. Tabulated load values are for anchors installed in uncracked concrete with no edge or spacing considerations. Concrete compressive strength must be at the specified minimum at the time of installation.  
 2. Ultimate load capacities must be reduced by a minimum safety factor of 4.0 or greater to determine allowable working loads.

**REFERENCE PERFORMANCE DATA**
**Allowable Load Capacities for Carbon Steel and Stainless Steel Domestic Wedge Anchor in Normal-Weight Concrete<sup>1,2,3</sup>**


Nominal Anchor Diameter (in.)	Minimum Embedment Depth (in.)	Concrete Compressive Strength, f'c					
		2,000 psi		4,000 psi		6,000 psi	
		Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)	Allowable Tension Load Capacity (lbs.)	Allowable Shear Load Capacity (lbs.)
1/4	1-1/8	295	360	445	455	695	660
	1-3/4	460		600		695	
	2-3/4	495		690		710	
3/8	1-1/2	410	1,080	910	1,280	1,115	1,560
	3	810		1,415		1,495	
	5	1,020		1,580		1,590	
1/2	2-1/4	1,000	1,855	1,680	2,345	2,405	2,475
	4	1,585		2,235		2,550	
	6	1,725		2,545		3,015	
5/8	2-3/4	1,250	2,065	2,190	3,235	2,440	4,095
	5	2,215		3,900		4,200	
	7	2,345		4,180		4,435	
3/4	3-1/4	1,660	3,125	2,830	4,265	4,060	5,740
	6	2,520		4,600		5,275	
	8	2,795		4,950		5,630	
7/8	3-7/8	2,100	4,565	4,090	5,060	4,200	5,995
	5-3/4	3,015		4,565		5,850	
1	4-1/2	2,445	5,905	4,565	6,900	6,865	7,230
	7-1/2	2,975		6,685		8,740	
	10	3,900		7,625		9,460	
1-1/4	5-1/2	4,390	8,070	5,745	10,675	8,095	13,890
	7	5,265		6,960		12,095	
	10	6,975		8,700		15,320	

1. Tabulated load values are for anchors installed in uncracked concrete. Concrete compressive strength must be at the specified minimum at the time of installation.  
 2. Allowable load capacities listed are calculated using and applied safety factor of 4.0.

**ORDERING INFORMATION**



**Domestic Wedge Anchor (Carbon Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7400USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7402USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7404USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7410USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7412USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7413USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7414USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7415USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7416USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7417USA	3/8" x 6-1/2"	1-1/2"	1-1/8"	50	200
7420USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7422USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7423USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7424USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7426USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7427USA	1/2" x 8-1/2"	2-1/4"	1-1/4"	25	100
7428USA	1/2" x 10"	2-1/4"	1-1/4"	25	100
7429USA	1/2" x 12"	2-1/4"	1-1/4"	25	100
7430USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7432USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7433USA	5/8" x 5"	2-3/4"	2"	25	100
7434USA	5/8" x 6"	2-3/4"	2"	25	75
7436USA	5/8" x 7"	2-3/4"	2"	25	75
7438USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7439USA	5/8" x 10"	2-3/4"	2"	25	75
7437USA	5/8" x 12"	2-3/4"	2"	25	75
7440USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7441USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7442USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7444USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7446USA	3/4" x 7"	3-1/4"	2"	20	60
7448USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7449USA	3/4" x 10"	3-1/4"	2"	10	30
7451USA	3/4" x 12"	3-1/4"	2"	10	30
7461USA	1" x 6"	4-1/2"	2-1/4"	10	40
7463USA	1" x 9"	4-1/2"	2-1/4"	10	30
7465USA	1" x 12"	4-1/2"	2-1/4"	5	15
7475USA	1-1/4" x 12"	5-1/2"	3-1/4"	5	15

**Installation Accessories**

Cat. No.	Description	Box Qty
08466	Adjustable torque wrench with 1/2" square drive (25 to 250 ft.-lbs.)	1
08280	Hand pump / dust blower	1

The published size includes the diameter and the overall length of the anchor. All anchors are packaged with nuts and washers.

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**Domestic Wedge Anchor (Type 303 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7300USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7302USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7304USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7310USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7312USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7313USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7314USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7315USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7316USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7320USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7323USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7324USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7326USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7330USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7332USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7333USA	5/8" x 5"	2-3/4"	2"	25	100
7334USA	5/8" x 6"	2-3/4"	2"	25	75
7336USA	5/8" x 7"	2-3/4"	2"	25	75
7338USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7340USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7341USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7342USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7344USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7346USA	3/4" x 7"	3-1/4"	2"	20	60
7348USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7349USA	3/4" x 10"	3-1/4"	2"	10	30

**Domestic Wedge Anchor (Type 316 Stainless Steel)**

Cat. No.	Size	Min. Embed.	Thread Length	Std. Box	Std. Ctn.
7600USA	1/4" x 1-3/4"	1-1/8"	3/4"	100	500
7602USA	1/4" x 2-1/4"	1-1/8"	3/4"	100	500
7604USA	1/4" x 3-1/4"	1-1/8"	3/4"	100	500
7610USA	3/8" x 2-1/4"	1-1/2"	7/8"	50	250
7612USA	3/8" x 2-3/4"	1-1/2"	1-1/8"	50	250
7613USA	3/8" x 3"	1-1/2"	1-1/8"	50	250
7614USA	3/8" x 3-1/2"	1-1/2"	1-1/8"	50	250
7615USA	3/8" x 3-3/4"	1-1/2"	1-1/8"	50	250
7616USA	3/8" x 5"	1-1/2"	1-1/8"	50	250
7620USA	1/2" x 2-3/4"	2-1/4"	1-1/4"	50	200
7622USA	1/2" x 3-3/4"	2-1/4"	1-1/4"	50	200
7623USA	1/2" x 4-1/4"	2-1/4"	1-1/4"	50	200
7624USA	1/2" x 5-1/2"	2-1/4"	1-1/4"	50	150
7626USA	1/2" x 7"	2-1/4"	1-1/4"	25	100
7630USA	5/8" x 3-1/2"	2-3/4"	2"	25	100
7632USA	5/8" x 4-1/2"	2-3/4"	2"	25	100
7633USA	5/8" x 5"	2-3/4"	2"	25	100
7634USA	5/8" x 6"	2-3/4"	2"	25	75
7636USA	5/8" x 7"	2-3/4"	2"	25	75
7638USA	5/8" x 8-1/2"	2-3/4"	2"	25	75
7640USA	3/4" x 4-1/4"	3-1/4"	2"	20	60
7641USA	3/4" x 4-3/4"	3-1/4"	2"	20	60
7642USA	3/4" x 5-1/2"	3-1/4"	2"	20	60
7644USA	3/4" x 6-1/4"	3-1/4"	2"	20	60
7646USA	3/4" x 7"	3-1/4"	2"	20	60
7648USA	3/4" x 8-1/2"	3-1/4"	2"	10	40
7652USA	7/8" x 8"	3-7/8"	2-1/4"	10	40
7663USA	1" x 9"	4-1/2"	2-1/4"	10	30

# WEDGE-ALL® Wedge Anchors



The Wedge-All® wedge anchors are a non-bottom bearing, wedge-style expansion anchor for use in solid concrete or grout-filled masonry. A one-piece clip ensures uniform holding capacity that increases as tension is applied. The threaded stud version is available in eight diameters and multiple lengths. A single size tie-wire version is available for wire supported fixtures. Threaded studs are set by tightening the nut. Tie-wire anchors are set with the claw end of a hammer.

### WEDGE-ALL SPECIAL FEATURES:

- One piece wrap around clip
- Threaded end is chamfered for ease of starting nut
- Most sizes feature full thread for added versatility

**MATERIAL:** Carbon and stainless steel

**FINISH:** Carbon steel anchors are available zinc plated or mechanically galvanized.

**CODES:** ICC-ES ESR-1396 (CMU); City of L.A. RR24682; Factory Mutual 3017082 and 3031136; Florida FL 11506.8; Underwriters Laboratories File Ex3605; Meets requirements of Federal Specifications A-A-1923A, Type 4. The Tie-Wire anchor is not code listed.

**!** The load tables list values based upon results from the most recent testing and may not reflect those in current code reports. Where code jurisdictions apply, consult the current reports for applicable load values.

**TEST CRITERIA:** The Wedge-All anchor has been tested in accordance with ICC-ES's Acceptance Criteria for Expansion Anchors (AC01) for the following:

- Static tension and shear loading
- Seismic and wind loading
- Combination tension and shear loading
- Critical and minimum edge distance

### INSTALLATION:

- Holes in metal fixtures to be mounted should exceed nominal anchor diameter by 1/16" for 1/4" thru 5/8" diameter anchors, and by 1/8" for all other diameters.
- Do not use an impact wrench to set or tighten the Wedge-All.

**!** Caution: Oversized holes in the base material will make it difficult to set the anchor and will reduce the anchor's load capacity.

### Threaded studs:

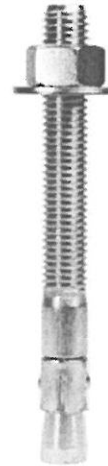
- Drill a hole in the base material using a carbide drill bit the same diameter as the nominal diameter of the anchor to be installed. Drill the hole to the specified embedment depth and blow it clean using compressed air. Overhead installations need not be blown clean. Alternatively, drill the hole deep enough to accommodate embedment depth and dust from drilling.
- Assemble the anchor with nut and washer so the top of the nut is flush with the top of the anchor. Place the anchor in the fixture and drive into the hole until washer and nut are tight against fixture.
- Tighten to the required installation torque.

### Tie-Wire:

- Drill a hole at least 1 1/2" deep using a 1/4" diameter carbide tipped bit.
- Drive the anchor into the hole until the head is seated against the base material.
- Set the anchor by prying/pulling the head with the claw end of the hammer.

### SUGGESTED SPECIFICATIONS:

Wedge anchors shall be a threaded stud with an integral cone expander and a single piece expansion clip. The stud shall be carbon steel with a minimum 70,000 psi tensile strength, or type 303, 304 or 316 stainless steel, as called for on the drawings. Anchors shall meet Federal Specification A-A-1923A, Type 4. Anchors shall be Wedge-All® anchors from Simpson Strong-Tie, Pleasanton, CA. Anchors shall be installed following the Simpson Strong-Tie instructions for Wedge-All anchors.

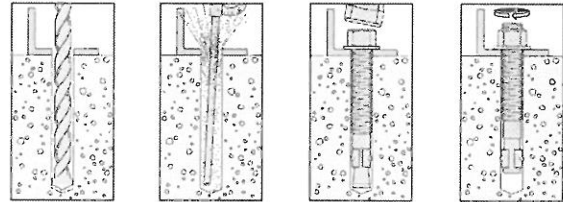


Wedge-All® Anchor

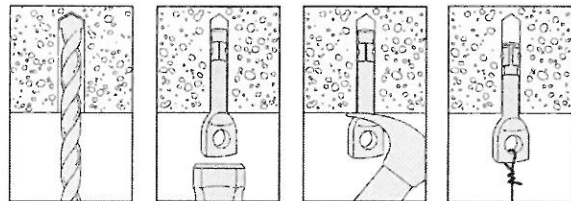


Tie-Wire Anchor (Zinc plate only)

### Wedge-All® Anchor Installation Sequence



### Tie-Wire Anchor Installation Sequence



### Wedge-All® Anchor Installation Data

Wedge-All Dia. (in.)	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
Bit Size (in.)	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
Min. Fixture Hole (in.)	5/16	7/16	9/16	1 1/16	7/8	1	1 1/8	1 3/8
Wrench Size (in.)	7/16	9/16	3/4	15/16	1 1/8	1 1/16	1 1/2	1 7/8

### Length Identification Head Marks on Wedge-All® Anchors (corresponds to length of anchor – inches).

Mark	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16	17	18
Up To But Not Including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16	17	18	19



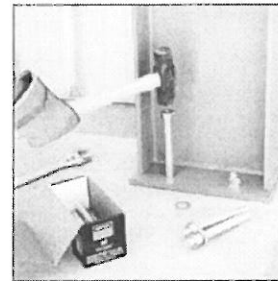
## Wedge-All® Anchor Product Data Carbon Steel: Zinc Plated and Mechanically Galvanized

Size (in.)	Carbon Steel Model No.	Mechanically Galvanized Model No.	Drill Bit Dia. (in.)	Thread Length (in.)	Quantity	
					Box	Carton
1/4 x 1 1/2 <sup>3</sup>	TWD25112 <sup>4</sup>	*	1/4	Hole dia. is 5/16	100	500
1/4 x 1 3/4	WA25134	WA25134MG		15/16	100	500
1/4 x 2 1/4	WA25214	WA25214MG		1 7/16	100	500
1/4 x 3 1/4	WA25314	WA25314MG		2 7/16	100	500
3/8 x 2 1/4	WA37214	WA37214MG	3/8	1 1/8	50	250
3/8 x 2 3/4	WA37234	WA37234MG		1 5/8	50	250
3/8 x 3	WA37300	WA37300MG		1 7/8	50	250
3/8 x 3 1/2	WA37312	WA37312MG		2 1/2	50	250
3/8 x 3 3/4	WA37334	WA37334MG		2 5/8	50	250
3/8 x 5	WA37500	WA37500MG		3 7/8	50	200
3/8 x 7	WA37700	WA37700MG	5 7/8	50	200	
1/2 x 2 3/4	WA50234	WA50234MG	1/2	1 1/16	25	125
1/2 x 3 3/4	WA50334	WA50334MG		2 1/16	25	125
1/2 x 4 1/4	WA50414	WA50414MG		2 13/16	25	100
1/2 x 5 1/2	WA50512	WA50512MG		4 1/16	25	100
1/2 x 7	WA50700	WA50700MG		4 9/16	25	100
1/2 x 8 1/2	WA50812	WA50812MG		6	25	50
1/2 x 10	WA50100	WA50100MG	6	25	50	
1/2 x 12	WA50120	WA50120MG	6	25	50	
5/8 x 3 1/2	WA62312	WA62312MG	5/8	1 7/8	20	80
5/8 x 4 1/2	WA62412	WA62412MG		2 1/8	20	80
5/8 x 5	WA62500	WA62500MG		3 3/8	20	80
5/8 x 6	WA62600	WA62600MG		4 3/8	20	80
5/8 x 7	WA62700	WA62700MG		5 3/8	20	80
5/8 x 8 1/2	WA62812	WA62812MG		6	20	40
5/8 x 10	WA62100	WA62100MG	6	10	20	
5/8 x 12	WA62120	WA62120MG	6	10	20	
3/4 x 4 1/4	WA75414	WA75414MG	3/4	2 3/8	10	40
3/4 x 4 3/4	WA75434	WA75434MG		2 7/8	10	40
3/4 x 5 1/2	WA75512	WA75512MG		3 3/8	10	40
3/4 x 6 1/4	WA75614	WA75614MG		4 3/8	10	40
3/4 x 7	WA75700	WA75700MG		5 3/8	10	40
3/4 x 8 1/2	WA75812	WA75812MG		6	10	20
3/4 x 10	WA75100	WA75100MG	6	10	20	
3/4 x 12	WA75120	WA75120MG	6	5	10	
7/8 x 6	WA87600	WA87600MG	7/8	2 1/8	5	20
7/8 x 8	WA87800	WA87800MG		2 1/8	5	10
7/8 x 10	WA87100	WA87100MG		2 1/8	5	10
7/8 x 12	WA87120	WA87120MG		2 1/8	5	10
1 x 6	WA16000	WA16000MG	1	2 1/4	5	20
1 x 9	WA19000	WA19000MG		2 1/4	5	10
1 x 12	WA11200	WA11200MG		2 1/4	5	10
1 1/4 x 9	WA12590	WA12590MG	1 1/4	2 3/4	5	10
1 1/4 x 12	WA12512	WA12512MG		2 3/4	5	10

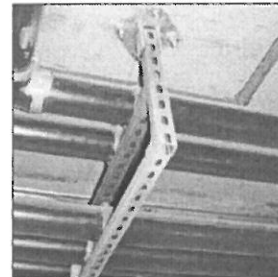
1. The published length is the overall length of the anchor. Allow one anchor diameter for the nut and washer thickness plus the fixture thickness when selecting the minimum length.
2. Special lengths are available on request. Load values are valid as long as minimum embedment depths are satisfied.
3. Tie-Wire Wedge-All® anchor, overall length is 2".
4. Tie-Wire Wedge-All® anchor also available in bulk quantity of 2,000, model TWD25112B.
5. Bulk packaged Wedge-All® anchors available, call Simpson Strong-Tie® for details.

### Material Specifications

Carbon Steel - Zinc Plated			
Component Materials			
Anchor Body	Nut	Washer	Clip
Material Meets minimum 70,000 psi tensile strength	Carbon Steel ASTM A 563, Grade A	Carbon Steel	Carbon Steel



**Application:** Interior environment, low level of corrosion resistance. See page 16 for more corrosion information.



Mechanical Anchors

### Material Specifications

Carbon Steel - Mechanically Galvanized <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Material Meets minimum 70,000 psi tensile strength	Carbon Steel ASTM A 563, Grade A	Carbon Steel	Carbon Steel

1. Mechanical Galvanizing meets ASTM B695, Class 55, Type 1.



**Application:** Exterior unpolluted environment, medium level of corrosion resistance. Well suited to humid environments. See page 16 for more corrosion information.



# WEDGE-ALL® Stainless-Steel Wedge Anchors



## Wedge-All® Anchor Product Data - Stainless Steel

Size (in.)	304/303 Stainless Model No. <sup>1</sup>	316 Stainless Model No. <sup>2</sup>	Drill Bit Dia. (in.)	Thread Length (in.)	Standard Quantity		Mini-Pack Quantity -R" Suffix in Model No. (see note below)	
					Box	Carton	Box	Carton
1/4 x 1 1/4	WA251344SS	WA251346SS	1/4	1 5/16	100	500	20	200
1/4 x 2 1/4	WA252144SS	WA252146SS		1 7/16	100	500	20	200
1/4 x 3 1/4	WA253144SS	WA253146SS		2 1/16	100	500	20	200
3/8 x 2 1/4	WA372144SS	WA372146SS	3/8	1 1/8	50	250	20	200
3/8 x 2 3/4	WA372344SS	WA372346SS		1 3/8	50	250	20	200
3/8 x 3	WA373004SS	WA373006SS		1 7/8	50	250	20	200
3/8 x 3 1/2	WA373124SS	WA373126SS		2 1/2	50	250	20	200
3/8 x 3 3/4	WA373344SS	WA373346SS		2 5/8	50	250	20	200
3/8 x 5	WA375004SS	WA375006SS		3 7/8	50	200	10	100
3/8 x 7	WA377004SS	WA377006SS		5 7/8	50	200	18	80
1/2 x 2 3/4	WA502344SS	WA502346SS	1/2	1 5/16	25	125	10	100
1/2 x 3 3/4	WA503344SS	WA503346SS		2 5/16	25	125	10	100
1/2 x 4 1/4	WA504144SS	WA504146SS		2 13/16	25	100	-	-
1/2 x 5 1/2	WA505124SS	WA505126SS		4 1/16	25	100	10	80
1/2 x 7	WA507004SS	WA507006SS		5 7/16	25	100	4	32
1/2 x 8 1/2	WA50812SS	WA508123SS	2	25	50	4	16	
1/2 x 10	WA50100SS	WA501003SS	2	25	50	4	16	
1/2 x 12	WA50120SS	WA501203SS	2	25	50	4	16	
5/8 x 3 1/2	WA623124SS	WA623126SS	5/8	1 7/8	20	80	10	100
5/8 x 4 1/2	WA624124SS	WA624126SS		2 7/8	20	80	10	80
5/8 x 5	WA625004SS	WA625006SS		3 3/8	20	80	10	80
5/8 x 6	WA626004SS	WA626006SS		4 3/8	20	80	10	80
5/8 x 7	WA627004SS	WA627006SS		5 3/8	20	80	4	16
5/8 x 8 1/2	WA62812SS	WA628123SS		2	20	40	4	16
5/8 x 10	WA62100SS	WA621003SS		2	10	20	4	16
5/8 x 12	WA62120SS	WA621203SS	2	10	20	4	16	
3/4 x 4 1/4	WA754144SS	WA754146SS	3/4	2 3/8	10	40	4	40
3/4 x 4 3/4	WA754344SS	WA754346SS		2 7/8	10	40	4	40
3/4 x 5 1/2	WA755124SS	WA755126SS		3 3/8	10	40	4	32
3/4 x 6 1/4	WA756144SS	WA756146SS		4 3/8	10	40	4	32
3/4 x 7	WA757004SS	WA757006SS		5 1/8	10	40	4	32
3/4 x 8 1/2	WA75812SS	WA758123SS		2 1/4	10	20	4	16
3/4 x 10	WA75100SS	WA751003SS		2 1/4	10	20	4	16
3/4 x 12	WA75120SS	WA751203SS	2 1/4	5	10	4	16	
7/8 x 6	WA87600SS	WA876003SS	7/8	2 1/8	5	20	4	8
7/8 x 8	WA87800SS	WA878003SS		2 1/8	5	10	4	8
7/8 x 10	WA87100SS	WA871003SS		2 1/8	5	10	4	8
7/8 x 12	WA87120SS	WA871203SS	2 1/8	5	10	-	-	
1 x 6	WA16000SS	WA160003SS	1	2 1/4	5	20	4	8
1 x 9	WA19000SS	WA190003SS		2 1/4	5	10	4	8
1 x 12	WA11200SS	WA112003SS		2 1/4	5	10	4	8
1 1/4 x 9	WA12590SS	WA125903SS	1 1/4	2 3/4	5	10	4 <sup>3</sup>	8
1 1/4 x 12	WA12512SS	WA125123SS		2 3/4	5	10	4 <sup>3</sup>	8

Mechanical Anchors

1. Anchors with the "SS" suffix in the model number are manufactured from type 303 stainless steel, the remaining anchors (with the "4SS" suffix) are manufactured from type 304 stainless steel. 303 stainless anchors may require extra lead time, call factory for details. Types 303 and 304 stainless steel perform equally well in certain corrosive environments.
2. Anchors with the "3SS" suffix in the model number may require extra lead time. Call Simpson Strong-Tie for details.
3. These package quantities available in type 303 stainless steel only.
4. The published length is the overall length of the anchor. Allow one anchor diameter for the nut and washer thickness plus the fixture thickness when selecting a length.

5. Special lengths are available on request. Load values are valid as long as minimum embedment depths are satisfied.

**Mini Pack:** These package quantities must be ordered with a "-R" suffix on the end of the standard model number. (example: WA505124SS-R).

### Material Specifications

304/303 Stainless Steel <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Type 303 and 304 Stainless Steel	Type 18-8 Stainless Steel	Type 18-8 Stainless Steel	Type 304 or 316 Stainless Steel

1. Type 303 and 304 stainless steels perform equally well in certain corrosive environments. Larger sizes are manufactured from type 303.

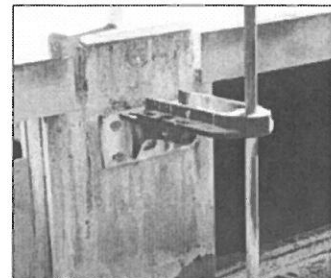
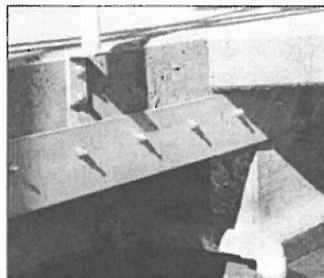
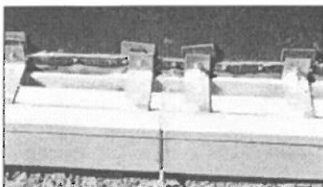
**Application:** Exterior environment, high level of corrosion resistance. Resistant to organic chemicals, many inorganic chemicals, mild atmospheric pollution and mild marine environments (not in direct contact with salt water). See page 16 for more corrosion information.

### Material Specifications

316 Stainless Steel <sup>1</sup>			
Component Materials			
Anchor Body	Nut	Washer	Clip
Type 316 Stainless Steel	Type 316 Stainless Steel	Type 316 Stainless Steel	Type 304 or 316 Stainless Steel

1. Type 316 stainless steel provides the greatest degree of corrosion resistance offered by Simpson Strong-Tie®.

**Application:** Exterior environment, high level of corrosion resistance. Resistant to chlorides, sulfuric acid compounds and direct contact with salt water. See page 16 for more corrosion information.





## Tension Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Normal-Weight Concrete



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load							Instal. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete		f'c ≥ 4000 psi (27.6 MPa) Concrete		
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	
1/4" (6.4)	1 1/8" (29)	2 1/2" (64)	1 3/8" (41)	680 (3.0)	167 (0.7)	170 (0.8)	205 (0.9)	960 (4.3)	233 (1.0)	240 (1.1)	8 (10.8)
	2 1/4" (57)	2 1/2" (64)	3 1/8" (79)	1,920 (8.5)	286 (1.3)	480 (2.1)	530 (2.4)	2,320 (10.3)	105 (0.5)	580 (2.6)	
3/8" (9.5)	1 3/4" (44)	3 3/4" (95)	2 3/8" (60)	1,560 (6.9)	261 (1.2)	390 (1.7)	555 (2.5)	2,880 (12.8)	588 (2.6)	720 (3.2)	30 (40.7)
	2 3/8" (67)	3 3/4" (95)	3 3/8" (92)	3,360 (14.9)	464 (2.1)	840 (3.7)	1,100 (4.9)	5,440 (24.2)	553 (2.5)	1,360 (6.0)	
	3 3/8" (86)	3 3/4" (95)	4 3/4" (121)	3,680 (16.4)	585 (2.6)	920 (4.1)	1,140 (5.1)	5,440 (24.2)	318 (1.4)	1,360 (6.0)	
1/2" (12.7)	2 1/4" (57)	5" (127)	3 1/8" (79)	3,280 (14.6)	871 (3.9)	820 (3.6)	1,070 (4.8)	5,280 (23.5)	849 (3.8)	1,320 (5.9)	60 (81.3)
	3 3/8" (86)	5" (127)	4 3/4" (121)	6,040 (26.9)	654 (2.9)	1,510 (6.7)	1,985 (8.8)	9,840 (43.8)	1,303 (5.8)	2,460 (10.9)	
	4 1/2" (114)	5" (127)	6 1/4" (159)	6,960 (31.0)	839 (3.7)	1,740 (7.7)	2,350 (10.5)	11,840 (52.7)	2,462 (11.0)	2,960 (13.2)	
5/8" (15.9)	2 3/4" (70)	6 1/4" (159)	3 3/8" (98)	4,520 (20.1)	120 (0.5)	1,130 (5.0)	1,640 (7.3)	8,600 (38.3)	729 (3.2)	2,150 (9.6)	90 (122.0)
	4 1/2" (114)	6 1/4" (159)	6 1/4" (159)	8,200 (36.5)	612 (2.7)	2,050 (9.1)	2,990 (13.3)	15,720 (69.9)	1,224 (5.4)	3,930 (17.5)	
	5 1/2" (140)	6 1/4" (159)	7 3/4" (197)	8,200 (36.5)	639 (2.8)	2,050 (9.1)	2,990 (13.3)	15,720 (69.9)	1,116 (5.0)	3,930 (17.5)	
3/4" (19.1)	3 3/8" (86)	7 1/2" (191)	4 3/4" (121)	6,760 (30.1)	1,452 (6.5)	1,690 (7.5)	2,090 (9.3)	9,960 (44.3)	1,324 (5.9)	2,490 (11.1)	150 (203.4)
	5" (127)	7 1/2" (191)	7" (178)	10,040 (44.7)	544 (2.4)	2,510 (11.2)	3,225 (14.3)	15,760 (70.1)	1,550 (6.9)	3,940 (17.5)	
	6 3/4" (171)	7 1/2" (191)	9 1/2" (241)	10,040 (44.7)	1,588 (7.1)	2,510 (11.2)	3,380 (15.0)	17,000 (75.6)	1,668 (7.4)	4,250 (18.9)	
7/8" (22.2)	3 3/8" (98)	8 3/4" (222)	5 3/8" (137)	7,480 (33.3)	821 (3.7)	1,870 (8.3)	2,275 (10.1)	10,720 (47.7)	1,253 (5.6)	2,680 (11.9)	200 (271.2)
	7 7/8" (200)	8 3/4" (222)	11" (279)	17,040 (75.8)	1,566 (7.0)	4,260 (18.9)	4,670 (20.8)	20,320 (90.4)	2,401 (10.7)	5,060 (22.6)	
1" (25.4)	4 1/2" (114)	10" (254)	6 1/4" (159)	15,400 (68.5)	2,440 (10.9)	3,850 (17.1)	3,885 (17.3)	15,680 (69.7)	1,876 (8.3)	3,920 (17.4)	300 (406.7)
	9" (229)	10" (254)	12 3/8" (321)	20,760 (92.3)	3,116 (13.9)	5,190 (23.1)	6,355 (28.3)	30,080 (133.8)	1,612 (7.2)	7,520 (33.5)	
1 1/4" (31.8)	5 3/8" (143)	12 1/2" (318)	7 3/8" (200)	15,160 (67.4)	1,346 (6.0)	3,790 (16.9)	4,990 (22.2)	24,760 (110.1)	625 (2.8)	6,190 (27.5)	400 (542.3)
	9 1/2" (241)	12 1/2" (318)	13 1/4" (337)	20,160 (89.7)	3,250 (14.5)	5,040 (22.4)	8,635 (38.4)	48,920 (217.6)	1,693 (7.5)	12,230 (54.4)	

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for edge distance and spacing on pages 144 and 146.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- Allowable loads for 1/4-inch size at 1 1/8-inch embedment apply to both the Wedge-All® and Tie-Wire anchors. Installation torque does not apply to the Tie-Wire anchor.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

\* See page 10 for an explanation of the load table icons



**Shear Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Normal-Weight Concrete**



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Shear Load					Install. Torque ft-lbs (N-m)	
				f'c ≥ 2000 psi (13.8 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 4000 psi (27.6 MPa) Concrete
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)	Allowable lbs. (kN)		
1/4 <sup>6</sup> (6.4)	1 1/8 (29)	2 1/2 (64)	1 3/8 (41)	920 (4.1)	47 (0.2)	230 (1.0)	230 (1.0)	230 (1.0)	8 (10.8)	
	2 1/4 (57)	2 1/2 (64)	3 1/8 (79)	•	•	230 (1.0)	230 (1.0)	230 (1.0)		
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	2,280 (10.1)	96 (0.4)	570 (2.5)	570 (2.5)	570 (2.5)	30 (40.7)	
	2 5/8 (67)	3 3/4 (95)	3 5/8 (92)	4,220 (18.8)	384 (1.7)	1,055 (4.7)	1,055 (4.7)	1,055 (4.7)		
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	•	•	1,055 (4.7)	1,055 (4.7)	1,055 (4.7)		
1/2 (12.7)	2 1/4 (57)	5 (127)	3 1/8 (79)	6,560 (29.2)	850 (3.8)	1,345 (6.0)	1,485 (6.6)	1,625 (7.2)	60 (81.3)	
	3 3/8 (86)	5 (127)	4 3/4 (121)	8,160 (36.3)	880 (3.9)	1,675 (7.5)	1,850 (8.2)	2,020 (9.0)		
	4 1/2 (114)	5 (127)	6 1/4 (159)	•	•	1,675 (7.5)	1,850 (8.2)	2,020 (9.0)		
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 7/8 (98)	8,720 (38.8)	1,699 (7.6)	1,620 (7.2)	1,900 (8.5)	2,180 (9.7)	90 (122.0)	
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	12,570 (55.9)	396 (1.8)	2,330 (10.4)	2,740 (12.2)	3,145 (14.0)		
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	•	•	2,330 (10.4)	2,740 (12.2)	3,145 (14.0)		
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	11,360 (50.5)	792 (3.5)	2,840 (12.6)	2,840 (12.6)	2,840 (12.6)	150 (203.4)	
	5 (127)	7 1/2 (191)	7 (178)	18,430 (82.0)	1,921 (8.5)	4,610 (20.5)	4,610 (20.5)	4,610 (20.5)		
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	•	•	4,610 (20.5)	4,610 (20.5)	4,610 (20.5)		
7/8 (22.2)	3 7/8 (98)	8 3/4 (222)	5 3/8 (137)	13,760 (61.2)	2,059 (9.2)	3,440 (15.3)	3,440 (15.3)	3,440 (15.3)	200 (271.2)	
	7 7/8 (200)	8 3/4 (222)	11 (279)	22,300 (99.2)	477 (2.1)	5,575 (24.8)	5,575 (24.8)	5,575 (24.8)		
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	22,519 (100.2)	1,156 (5.1)	5,730 (25.5)	5,730 (25.5)	5,730 (25.5)	300 (406.7)	
	9 (229)	10 (254)	12 5/8 (321)	25,380 (112.9)	729 (3.2)	6,345 (28.2)	6,345 (28.2)	6,345 (28.2)		
1 1/4 (31.8)	5 5/8 (143)	12 1/2 (318)	7 7/8 (200)	29,320 (130.4)	2,099 (9.3)	7,330 (32.6)	7,330 (32.6)	7,330 (32.6)	400 (542.3)	
	9 1/2 (241)	12 1/2 (318)	13 1/4 (337)	•	•	7,330 (32.6)	7,330 (32.6)	7,330 (32.6)		

Mechanical Anchors

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for spacing and edge distance on pages 144, 145 and 147.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- Allowable loads for 1/4-inch size at 1 1/8-inch embedment apply to both the Wedge-All® and Tie-Wire anchors. Installation torque does not apply to the Tie-Wire anchor.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

\*See page 10 for an explanation of the load table icons

## Tension Loads for Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete



\* See page 10 for an explanation of the load table icons

Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Allowable Tension Load lbs. (kN)			Install. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete	f'c ≥ 3000 psi (20.7 MPa) Concrete	f'c ≥ 4000 psi (27.6 MPa) Concrete	
1/4 (6.4)	1 1/8 (29)	2 1/2 (64)	1 5/8 (41)	155 (0.7)	185 (0.8)	215 (1.0)	8 (10.8)
	2 1/4 (57)	2 1/2 (64)	3 3/8 (79)	430 (1.9)	475 (2.1)	520 (2.3)	
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	350 (1.6)	500 (2.2)	650 (2.9)	30 (40.7)
	2 5/8 (67)	3 3/4 (95)	3 3/8 (92)	755 (3.4)	990 (4.4)	1,225 (5.4)	
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	830 (3.7)	1,025 (4.6)	1,225 (5.4)	
1/2 (12.7)	2 1/4 (57)	5 (127)	3 3/8 (79)	740 (3.3)	965 (4.3)	1,190 (5.3)	60 (81.3)
	3 3/8 (86)	5 (127)	4 3/4 (121)	1,360 (6.0)	1,785 (7.9)	2,215 (9.9)	
	4 1/2 (114)	5 (127)	6 1/4 (159)	1,565 (7.0)	2,115 (9.4)	2,665 (11.9)	
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 7/8 (98)	1,015 (4.5)	1,475 (6.6)	1,935 (8.6)	90 (122.0)
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	1,845 (8.2)	2,690 (12.0)	3,535 (15.7)	
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	1,845 (8.2)	2,690 (12.0)	3,535 (15.7)	
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	1,520 (6.8)	1,880 (8.4)	2,240 (10.0)	150 (203.4)
	5 (127)	7 1/2 (191)	7 (178)	2,260 (10.1)	2,905 (12.9)	3,545 (15.8)	
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	2,260 (10.1)	3,040 (13.5)	3,825 (17.0)	
7/8 (22.2)	3 7/8 (98)	8 3/4 (222)	5 3/8 (137)	1,685 (7.5)	2,050 (9.1)	2,410 (10.7)	200 (271.2)
	7 7/8 (200)	8 3/4 (222)	11 (279)	3,835 (17.1)	4,205 (18.7)	4,570 (20.3)	
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	3,465 (15.4)	3,495 (15.5)	3,530 (15.7)	300 (406.7)
	9 (229)	10 (254)	12 5/8 (321)	4,670 (20.8)	5,720 (25.4)	6,770 (30.1)	
1 1/4 (31.8)	5 5/8 (143)	12 1/2 (318)	7 7/8 (200)	3,410 (15.2)	4,490 (20.0)	5,570 (24.8)	400 (542.3)
	9 1/2 (241)	12 1/2 (318)	13 1/4 (337)	4,535 (20.2)	7,770 (34.6)	11,005 (49.0)	

1. The allowable loads listed are based on a safety factor of 4.0.
2. Allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces where permitted by code.
3. Refer to allowable load-adjustment factors for edge distance and spacing on pages 144 and 146.
4. Drill bit diameter used in base material corresponds to nominal anchor diameter.
5. Allowable loads may be linearly interpolated between concrete strengths listed.
6. The minimum concrete thickness is 1 1/2 times the embedment depth.



## Shear Loads for Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete



\* See page 10 for an explanation of the load table icons

Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Allowable Shear Load lbs. (kN)			Install. Torque ft-lbs (N-m)
				f'c ≥ 2000 psi (13.8 MPa) Concrete	f'c ≥ 3000 psi (20.7 MPa) Concrete	f'c ≥ 4000 psi (27.6 MPa) Concrete	
1/4 (6.4)	1 1/8 (29)	2 1/2 (64)	1 3/8 (41)	265 (1.2)	265 (1.2)	265 (1.2)	8 (10.8)
	2 1/4 (57)	2 1/2 (64)	3 3/8 (79)	265 (1.2)	265 (1.2)	265 (1.2)	
3/8 (9.5)	1 3/4 (44)	3 3/4 (95)	2 3/8 (60)	655 (2.9)	655 (2.9)	655 (2.9)	30 (40.7)
	2 3/8 (67)	3 3/4 (95)	3 3/8 (92)	1,215 (5.4)	1,215 (5.4)	1,215 (5.4)	
	3 3/8 (86)	3 3/4 (95)	4 3/4 (121)	1,215 (5.4)	1,215 (5.4)	1,215 (5.4)	
1/2 (12.7)	2 1/4 (57)	5 (127)	3 3/8 (79)	1,545 (6.9)	1,710 (7.6)	1,870 (8.3)	60 (81.3)
	3 3/8 (86)	5 (127)	4 3/4 (121)	1,925 (8.6)	2,130 (9.5)	2,325 (10.3)	
	4 1/2 (114)	5 (127)	6 1/4 (159)	1,925 (8.6)	2,130 (9.5)	2,325 (10.3)	
5/8 (15.9)	2 3/4 (70)	6 1/4 (159)	3 3/8 (98)	1,865 (8.3)	2,185 (9.7)	2,505 (11.1)	90 (122.0)
	4 1/2 (114)	6 1/4 (159)	6 1/4 (159)	2,680 (11.9)	3,150 (14.0)	3,615 (16.1)	
	5 1/2 (140)	6 1/4 (159)	7 3/4 (197)	2,680 (11.9)	3,150 (14.0)	3,615 (16.1)	
3/4 (19.1)	3 3/8 (86)	7 1/2 (191)	4 3/4 (121)	3,265 (14.5)	3,265 (14.5)	3,265 (14.5)	150 (203.4)
	5 (127)	7 1/2 (191)	7 (178)	5,300 (23.6)	5,300 (23.6)	5,300 (23.6)	
	6 3/4 (171)	7 1/2 (191)	9 1/2 (241)	5,300 (23.6)	5,300 (23.6)	5,300 (23.6)	
7/8 (22.2)	3 3/8 (98)	8 3/4 (222)	5 3/8 (137)	3,955 (17.6)	3,955 (17.6)	3,955 (17.6)	200 (271.2)
	7 7/8 (200)	8 3/4 (222)	11 (279)	6,410 (28.5)	6,410 (28.5)	6,410 (28.5)	
1 (25.4)	4 1/2 (114)	10 (254)	6 1/4 (159)	6,590 (29.3)	6,590 (29.3)	6,590 (29.3)	300 (406.7)
	9 (229)	10 (254)	12 3/8 (321)	7,295 (32.4)	7,295 (32.4)	7,295 (32.4)	
1 1/4 (31.8)	5 3/8 (143)	12 1/2 (318)	7 7/8 (200)	8,430 (37.5)	8,430 (37.5)	8,430 (37.5)	400 (542.3)
	9 1/2 (241)	12 1/2 (318)	13 3/4 (337)	8,430 (37.5)	8,430 (37.5)	8,430 (37.5)	

- The allowable loads listed are based on a safety factor of 4.0.
- Allowable loads may be increased by 16% for short-term loading due to wind or seismic forces where permitted by code.
- Refer to allowable load-adjustment factors for spacing and edge distance on pages 144, 145 and 147.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be linearly interpolated between concrete strengths listed.
- The minimum concrete thickness is 1 1/2 times the embedment depth.

Mechanical Anchors



# WEDGE-ALL® Wedge Anchors



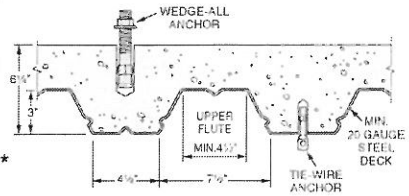
## Tension Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Sand-Lightweight Concrete over Metal Deck



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Tension Load (Install in Concrete)			Tension Load (Install through Metal Deck)			Install. Torque ft-lbs (N-m)
				f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
1/4 (TWD) (6.4)	1 1/2 (38)	3 3/8 (86)	2 3/4 (70)	.	.	.	1,440 (6.4)	167 (0.7)	360 (1.6)	.
1/2 (12.7)	2 1/4 (57)	6 3/4 (171)	4 1/8 (105)	3,880 (17.3)	228 (1.0)	970 (4.3)	3,860 (17.2)	564 (2.5)	965 (4.3)	60 (81.3)
5/8 (15.9)	2 3/4 (70)	8 3/8 (213)	5 (127)	5,920 (26.3)	239 (1.1)	1,480 (6.6)	5,220 (23.2)	370 (1.6)	1,305 (5.8)	90 (122.0)
3/4 (19.1)	3 3/8 (86)	10 (254)	6 1/8 (156)	7,140 (31.8)	537 (2.4)	1,785 (7.9)	6,600 (29.4)	903 (4.0)	1,650 (7.3)	150 (203.4)

\* See page 10 for an explanation of the load table icons

See Notes 1-8 Below



## Shear Loads for Carbon-Steel Wedge-All® (and Tie-Wire) Anchors in Sand-Lightweight Concrete over Metal Deck



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical Spacing in. (mm)	Shear Load (Install in Concrete)			Shear Load (Install through Metal Deck)			Install. Torque ft-lbs (N-m)
				f'c ≥ 3000 psi (20.7 MPa) Concrete			f'c ≥ 3000 psi (20.7 MPa) Concrete			
				Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
1/4 (TWD) (6.4)	1 1/2 (38)	3 3/8 (86)	2 3/4 (70)	.	.	.	1,660 (7.4)	627 (2.8)	415 (1.8)	.
1/2 (12.7)	2 1/4 (57)	6 3/4 (171)	4 1/8 (105)	5,575 (24.8)	377 (1.7)	1,395 (6.2)	7,260 (32.3)	607 (2.7)	1,815 (8.1)	60 (81.3)
5/8 (15.9)	2 3/4 (70)	8 3/8 (213)	5 (127)	8,900 (39.6)	742 (3.3)	2,225 (9.9)	8,560 (38.1)	114 (0.5)	2,140 (9.5)	90 (122.0)
3/4 (19.1)	3 3/8 (86)	10 (254)	6 1/8 (156)	10,400 (46.3)	495 (2.2)	2,600 (11.6)	11,040 (49.1)	321 (1.4)	2,760 (12.3)	150 (203.4)

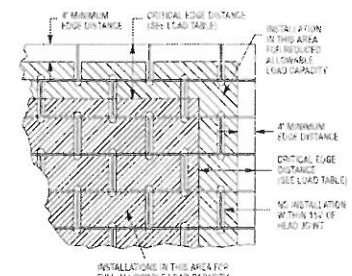
Lightweight Concrete On Metal Deck

- The allowable loads listed are based on a safety factor of 4.0.
- For installations in concrete (not through metal deck), allowable loads may be increased by 33 1/3% for short-term loading due to wind or seismic forces.
- For installations through metal deck, allowable tension loads must be decreased 23% and allowable shear loads may be increased 33 1/3% for short-term loading due to wind or seismic forces.
- Refer to allowable load-adjustment factors for edge distance on page 148.
- 100% of the allowable load is permitted at critical spacing. loads at reduced spacing have not been determined.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- The minimum concrete thickness is 1 1/2 times the embedment depth.
- Metal deck must be minimum 20 gauge.
- Anchors installed in the steel deck must have a minimum allowable edge distance of 1 1/2" from the inclined edge of the bottom flute.

## Tension and Shear Loads for Carbon-Steel Wedge-All® Anchors in Grout-Filled CMU



Size in. (mm)	Embed. Depth in. (mm)	Critical Edge Dist. in. (mm)	Critical End Dist. in. (mm)	Critical Spacing in. (mm)	8" Grout-Filled CMU Allowable Load Based on CMU Strength						Install. Torque ft-lbs (N-m)
					Tension Load			Shear Load			
					Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	Ultimate lbs. (kN)	Std. Dev. lbs. (kN)	Allow. lbs. (kN)	
<b>Anchor Installed on the Face of the CMU Wall at Least 1 1/4 inch Away from Head Joint (See Figure)</b>											
3/8 (9.5)	2 5/8 (67)	12 (305)	10 1/2 (267)	10 1/2 (267)	1,700 (7.6)	129 (0.6)	340 (1.5)	3,360 (14.9)	223 (1.0)	670 (3.0)	30 (40.7)
1/2 (12.7)	3 1/2 (89)	12 (305)	14 (356)	14 (356)	2,120 (9.4)	129 (0.6)	425 (1.9)	5,360 (23.8)	617 (2.7)	1,070 (4.8)	35 (47.4)
5/8 (15.9)	4 3/8 (111)	20 (508)	17 1/2 (445)	17 1/2 (445)	3,120 (13.9)	342 (1.5)	625 (2.8)	8,180 (36.4)	513 (2.3)	1,635 (7.3)	55 (74.5)
3/4 (19.1)	5 1/4 (133)	20 (508)	21 (533)	21 (533)	4,320 (19.2)	248 (1.1)	865 (3.8)	10,160 (45.2)	801 (3.6)	2,030 (9.0)	120 (162.6)



Shaded Area = Placement for Full and Reduced Allowable Load Capacity in Grout-Filled CMU

- The tabulated allowable loads are based on a safety factor of 5.0 for installations under the IBC and IRC. For installations under the UBC use a safety factor of 4.0 (multiply the tabulated allowable loads by 1.25).
- Listed loads may be applied to installations on the face of the CMU wall at least 1 1/4 inch away from headjoints.
- Values are for 8-inch-wide CMU Grade N, Type II, lightweight, medium-weight and normal-weight concrete masonry units conforming to UBC standard 21-4 or ASTM C90. The masonry units must be fully grouted with grout complying with UBC section 2103.4 or IBC section 2103.12. Mortar must be Type M or S prepared in accordance with section 2103.3 of the UBC and UBC standard 21-15, or IBC section 2103.8. The specified compressive strength of masonry, f'm, at 28 days must be a minimum of 1,500 psi.
- Embedment depth is measured from the outside face of the concrete masonry unit.
- Drill bit diameter used in base material corresponds to nominal anchor diameter.
- Allowable loads may be increased by 33 1/3 percent for short-term loading due to wind and seismic forces.
- Tension and shear loads for the Wedge-All® anchor may be combined using the parabolic interaction equation (n=5).
- Refer to allowable load-adjustment factors for edge distance on page 148.

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Mechanical Anchors



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Edge Distance, Tension and Shear Loads

How to use these charts:

1. The following tables are for reduced edge distance.
2. Locate the anchor size to be used for either a tension and/or shear load application.
3. Locate the edge distance ( $C_{act}$ ) at which the anchor is to be installed.
4. The load adjustment factor ( $f_c$ ) is the intersection of the row and column.
5. Multiply the allowable load by the applicable load adjustment factor.
6. Reduction factors for multiple edges are multiplied together.

### Edge Distance Tension ( $f_c$ )



Edge Dist. $C_{act}$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
		$C_{cr}$	2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10
	$C_{min}$	1	1 1/2	2	2 1/2	3	3 1/2	4	5
	$f_{cmin}$	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
1		0.70							
1 1/2		0.80	0.70						
2		0.90	0.77	0.70					
2 1/2		1.00	0.83	0.75	0.70				
3			0.90	0.80	0.74	0.70			
3 1/2			0.97	0.85	0.78	0.73	0.70		
3 3/4			1.00	0.88	0.80	0.75	0.71		
4				0.90	0.82	0.77	0.73	0.70	
4 1/2				0.95	0.86	0.80	0.76	0.73	
5				1.00	0.90	0.83	0.79	0.75	0.70
5 1/2					0.94	0.87	0.81	0.78	0.72
6					0.98	0.90	0.84	0.80	0.74
6 1/4					1.00	0.92	0.86	0.81	0.75
6 1/2						0.93	0.87	0.83	0.76
7						0.97	0.90	0.85	0.78
7 1/2						1.00	0.93	0.88	0.80
8							0.96	0.90	0.82
8 1/2							0.99	0.93	0.84
8 3/4							1.00	0.94	0.85
10								1.00	0.90
12 1/2									1.00
15									

\* See page 10 for an explanation of the load table icons

See Notes Below

### Edge Distance Shear ( $f_c$ ) (Shear Applied Perpendicular to Edge)



Edge Dist. $C_{act}$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
		$C_{cr}$	2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10
	$C_{min}$	1	1 1/2	2	2 1/2	3	3 1/2	4	5
	$f_{cmin}$	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
1		0.30							
1 1/2		0.53	0.30						
2		0.77	0.46	0.30					
2 1/2		1.00	0.61	0.42	0.30				
3			0.77	0.53	0.39	0.30			
3 1/2			0.92	0.65	0.49	0.38	0.30		
3 3/4			1.00	0.71	0.53	0.42	0.33		
4				0.77	0.58	0.46	0.37	0.30	
4 1/2				0.88	0.67	0.53	0.43	0.36	
5				1.00	0.77	0.61	0.50	0.42	0.30
5 1/2					0.86	0.69	0.57	0.48	0.35
6					0.95	0.77	0.63	0.53	0.39
6 1/4					1.00	0.81	0.67	0.56	0.42
6 1/2						0.84	0.70	0.59	0.44
7						0.92	0.77	0.65	0.49
7 1/2						1.00	0.83	0.71	0.53
8							0.90	0.77	0.58
8 1/2							0.97	0.83	0.63
8 3/4							1.00	0.85	0.65
10								1.00	0.77
12 1/2									1.00
15									

1.  $C_{act}$  = actual edge distance at which anchor is installed (inches).
2.  $C_{cr}$  = critical edge distance for 100% load (inches).
3.  $C_{min}$  = minimum edge distance for reduced load (inches).
4.  $f_c$  = adjustment factor for allowable load at actual edge distance.
5.  $f_{cor}$  = adjustment factor for allowable load at critical edge distance.  $f_{cor}$  is always = 1.00.
6.  $f_{cmin}$  = adjustment factor for allowable load at minimum edge distance.
7.  $f_c = f_{cmin} + [(1 - f_{cmin})(C_{act} - C_{min}) / (C_{cr} - C_{min})]$ .

### Load-Adjustment Factors for Reduced Spacing:

Critical spacing is listed in the load tables. No adjustment in load is required when the anchors are spaced at critical spacing. No additional testing has been performed to determine the adjustment factors for spacing dimensions less than those listed in the load tables.

Mechanical Anchors

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## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Edge Distance and Shear Load Applied Parallel to Edge

### How to use these charts:

1. The following tables are for reduced edge distance.
2. Locate the anchor size to be used for a shear load application.
3. Locate the edge distance ( $C_{act||}$ ) at which the anchor is to be installed.
4. The load adjustment factor ( $f_{c||}$ ) is the intersection of the row and column.
5. Multiply the allowable load by the applicable load adjustment factor.
6. Reduction factors for multiple edges are multiplied together.

### Edge Distance Shear ( $f_{c||}$ ) (Shear Applied Parallel to Edge with End Distance $\geq ED_{min}$ )



Edge Dist. $C_{act  }$ (in.)	Size	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4
	E		2 1/4	3 3/8	4 1/2	5 1/2	6 3/4	7 7/8	9
$ED_{min}$		9	13 1/2	18	22	27	31 1/2	36	38
$C_{crit  }$		2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10	12 1/2
$C_{min  }$		1	1 1/2	2	2 1/2	3	3 1/2	4	5
$f_{cmin  }$		1.00	0.93	0.70	0.62	0.62	0.62	0.62	0.62
1		1.00							
1 1/2		1.00	0.93						
2		1.00	0.95	0.70					
2 1/2		1.00	0.96	0.75	0.62				
3			0.98	0.80	0.67	0.62			
3 1/2			0.99	0.85	0.72	0.66	0.62		
4			1.00	0.90	0.77	0.70	0.66	0.62	
5				1.00	0.87	0.79	0.73	0.68	0.62
6					0.97	0.87	0.80	0.75	0.67
7					1.00	0.96	0.87	0.81	0.72
8						1.00	0.95	0.87	0.77
9							1.00	0.94	0.82
10								1.00	0.87
11									0.92
12									0.97
13									1.00

\* See page 10 for an explanation of the load table icons

1. Table is not applicable to anchors with  $ED < ED_{min}$ . Factors from this table may not be combined with load-adjustment factors for shear loads applied perpendicular to edge.
2.  $C_{act||}$  = actual edge distance (measured perpendicular to direction of shear load) at which anchor is installed (inches).
3.  $C_{crit||}$  = critical edge distance (measured perpendicular to direction of shear load) for 100% load (inches).
4.  $C_{min||}$  = minimum edge distance (measured perpendicular to direction of shear load) for reduced load (inches).
5.  $ED$  = actual end distance (measured parallel to direction of shear load) at which anchor is installed (inches).
6.  $ED_{min}$  = minimum edge distance (measured parallel to direction of shear load).
7.  $f_{c||}$  = adjustment factor for allowable load at actual edge distance.
8.  $f_{c||}$  = adjustment factor for allowable load at critical edge distance.  $f_{c||}$  is always = 1.00.
9.  $f_{cmin||}$  = adjustment factor for allowable load at minimum edge distance.
10.  $f_{c||}$  =  $f_{cmin||} + [(1 - f_{cmin||}) (C_{act||} - C_{min||}) / (C_{crit||} - C_{min||})]$ .



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Spacing, Tension Loads

### How to use these charts:

1. The following tables are for reduced spacing.
2. Locate the anchor size to be used for a tension load application.
3. Locate the anchor embedment (E) used for a tension load application.
4. Locate the spacing ( $S_{act}$ ) at which the anchor is to be installed.
5. The load adjustment factor ( $f_s$ ) is the intersection of the row and column.
6. Multiply the allowable load by the applicable load adjustment factor.
7. Reduction factors for multiple spacings are multiplied together.

### Spacing Tension ( $f_s$ )



$S_{act}$ (in.)	Dia.	1/4			3/8			1/2			5/8		
	E	1 1/8	2 1/4	1 3/4	2 5/8	3 3/8	2 1/4	3 3/8	4 1/2	2 3/4	4 1/2	5 1/2	
	$S_{cr}$	1 5/8	3 1/8	2 3/8	3 5/8	4 3/4	3 1/8	4 3/4	6 1/4	3 3/8	6 1/4	7 3/4	
	$S_{min}$	5/8	1 1/8	7/8	1 3/8	1 3/4	1 1/8	1 3/4	2 1/4	1 3/8	2 1/4	2 3/4	
	$f_{smin}$	0.43	0.70	0.43	0.43	0.70	0.43	0.43	0.70	0.43	0.43	0.70	
3/4		0.50											
1		0.64		0.48									
1 1/4		0.79	0.72	0.57			0.47						
1 1/2		0.93	0.76	0.67	0.46		0.54			0.46			
1 3/4		1.00	0.79	0.76	0.53	0.70	0.61	0.43		0.52			
2			0.83	0.86	0.59	0.73	0.68	0.48		0.57			
2 1/4			0.87	0.95	0.65	0.75	0.75	0.53	0.70	0.63	0.43		
2 1/2			0.91	1.00	0.72	0.78	0.82	0.57	0.72	0.69	0.47		
2 3/4			0.94		0.78	0.80	0.89	0.62	0.74	0.74	0.50	0.70	
3			0.98		0.84	0.83	0.96	0.67	0.76	0.80	0.54	0.72	
3 1/2			1.00		0.97	0.88	1.00	0.76	0.79	0.91	0.61	0.75	
4					1.00	0.93		0.86	0.83	1.00	0.68	0.78	
4 1/2						0.98		0.95	0.87		0.75	0.81	
5							1.00	1.00	0.91		0.82	0.84	
6									0.98		0.96	0.90	
7									1.00		1.00	0.96	
8												1.00	

\*See page 10 for an explanation of the load table icons

See Notes Below

### Spacing Tension ( $f_s$ )



$S_{act}$ (in.)	Dia.	3/4			7/8		1	1 1/4		
	E	3 3/8	5	6 1/4	3 7/8	7 7/8	4 1/2	9	5 5/8	9 1/2
	$S_{cr}$	4 3/4	7	9 1/2	5 5/8	11	6 1/4	12 5/8	7 7/8	13 1/4
	$S_{min}$	1 3/4	2 1/2	3 3/8	2	4	2 1/4	4 1/2	2 7/8	4 3/4
	$f_{smin}$	0.43	0.43	0.70	0.43	0.70	0.43	0.70	0.43	0.70
2		0.48			0.43					
3		0.67	0.49		0.60		0.54		0.46	
4		0.86	0.62	0.73	0.77	0.70	0.68		0.57	
5		1.00	0.75	0.78	0.94	0.74	0.82	0.72	0.68	0.71
6			0.87	0.83	1.00	0.79	0.96	0.76	0.79	0.74
7			1.00	0.88		0.83	1.00	0.79	0.90	0.78
8				0.93		0.87		0.83	1.00	0.81
9				0.98		0.91		0.87		0.85
10				1.00		0.96		0.90		0.89
11						1.00		0.94		0.92
12								0.98		0.96
13								1.00		0.99
14										1.00

1. E = Embedment depth (inches).
2.  $S_{act}$  = actual spacing distance at which anchors are installed (inches).
3.  $S_{cr}$  = critical spacing distance for 100% load (inches).
4.  $S_{min}$  = minimum spacing distance for reduced load (inches).
5.  $f_s$  = adjustment factor for allowable load at actual spacing distance.
6.  $f_{sct}$  = adjustment factor for allowable load at critical spacing distance.  $f_{sct}$  is always = 1.00.
7.  $f_{smin}$  = adjustment factor for allowable load at minimum spacing distance.
8.  $f_s = f_{smin} + \{(1 - f_{smin}) (S_{act} - S_{min}) / (S_{cr} - S_{min})\}$ .

Mechanical Anchors

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# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel and Stainless-Steel Wedge-All® Anchors in Normal-Weight Concrete: Spacing, Shear Loads

### How to use these charts:

1. The following tables are for reduced spacing.
2. Locate the anchor size to be used for a shear load application.
3. Locate the anchor embedment (E) used for a shear load application.
4. Locate the spacing ( $S_{act}$ ) at which the anchor is to be installed.
5. The load adjustment factor ( $f_s$ ) is the intersection of the row and column.
6. Multiply the allowable load by the applicable load adjustment factor.
7. Reduction factors for multiple spacings are multiplied together.

### Spacing Shear ( $f_s$ )



$S_{act}$ (in.)	Dia.	$\frac{1}{4}$					$\frac{1}{2}$			$\frac{3}{8}$		
	E	$1\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{5}{8}$	$3\frac{3}{8}$	$2\frac{1}{4}$	$3\frac{3}{8}$	$4\frac{1}{2}$	$2\frac{3}{4}$	$4\frac{1}{2}$	$5\frac{1}{2}$
	$S_{cr}$	$1\frac{5}{8}$	$3\frac{1}{8}$	$2\frac{3}{8}$	$3\frac{5}{8}$	$4\frac{3}{4}$	$3\frac{1}{8}$	$4\frac{3}{4}$	$6\frac{1}{4}$	$3\frac{7}{8}$	$6\frac{1}{4}$	$7\frac{3}{4}$
	$S_{min}$	$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{8}$	$2\frac{1}{4}$	$2\frac{3}{4}$
	$f_{smin}$	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
$\frac{3}{4}$		0.82										
1		0.87		0.81								
$1\frac{1}{4}$		0.92	0.80	0.84			0.80					
$1\frac{1}{2}$		0.97	0.83	0.88	0.80		0.83			0.80		
$1\frac{3}{4}$		1.00	0.86	0.91	0.83	0.79	0.86	0.79		0.82		
2			0.88	0.95	0.85	0.81	0.88	0.81		0.84		
$2\frac{1}{4}$			0.91	0.98	0.87	0.83	0.91	0.83	0.79	0.86	0.79	
$2\frac{1}{2}$			0.93	1.00	0.90	0.84	0.93	0.84	0.80	0.88	0.80	
$2\frac{3}{4}$			0.96		0.92	0.86	0.96	0.86	0.82	0.91	0.82	0.79
3			0.99		0.94	0.88	0.99	0.88	0.83	0.93	0.83	0.80
$3\frac{1}{2}$			1.00		0.99	0.91	1.00	0.91	0.86	0.97	0.86	0.82
4					1.00	0.95		0.95	0.88	1.00	0.88	0.84
$4\frac{1}{2}$						0.98		0.98	0.91		0.91	0.86
5						1.00		1.00	0.93		0.93	0.88
6									0.99		0.99	0.93
7									1.00		1.00	0.97
8												1.00

\* See page 10 for an explanation of the load table icons

See Notes Below

### Spacing Shear ( $f_s$ )



$S_{act}$ (in.)	Dia.	$\frac{3}{4}$			$\frac{7}{8}$		1		$1\frac{1}{4}$	
	E	$3\frac{3}{8}$	5	$6\frac{1}{4}$	$3\frac{7}{8}$	$7\frac{7}{8}$	$4\frac{1}{2}$	9	$5\frac{5}{8}$	$9\frac{1}{2}$
	$S_{cr}$	$4\frac{3}{4}$	7	$9\frac{1}{2}$	$5\frac{5}{8}$	11	$6\frac{1}{4}$	$12\frac{5}{8}$	$7\frac{7}{8}$	$13\frac{1}{4}$
	$S_{min}$	$1\frac{3}{4}$	$2\frac{1}{2}$	$3\frac{3}{8}$	2	4	$2\frac{1}{4}$	$4\frac{1}{2}$	$2\frac{7}{8}$	$4\frac{3}{4}$
	$f_{smin}$	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
2		0.81			0.79					
3		0.88	0.81		0.85		0.83		0.80	
4		0.95	0.86	0.81	0.91	0.79	0.88		0.84	
5		1.00	0.91	0.85	0.98	0.82	0.93	0.80	0.88	0.80
6			0.95	0.88	1.00	0.85	0.99	0.83	0.92	0.82
7			1.00	0.91		0.88	1.00	0.85	0.96	0.85
8				0.95		0.91		0.88	1.00	0.87
9				0.98		0.94		0.91		0.90
10				1.00		0.97		0.93		0.92
11						1.00		0.96		0.94
12								0.98		0.97
13								1.00		0.99
14										1.00

1. E = Embedment depth (inches).
2.  $S_{act}$  = actual spacing distance at which anchors are installed (inches).
3.  $S_{cr}$  = critical spacing distance for 100% load (inches).
4.  $S_{min}$  = minimum spacing distance for reduced load (inches).
5.  $f_s$  = adjustment factor for allowable load at actual spacing distance.
6.  $f_{s,cr}$  = adjustment factor for allowable load at critical spacing distance.  
 $f_{s,cr}$  is always = 1.00.
7.  $f_{s,min}$  = adjustment factor for allowable load at minimum spacing distance.
8.  $f_s = f_{s,min} + [(1 - f_{s,min}) (S_{act} - S_{min}) / (S_{cr} - S_{min})]$ .



# WEDGE-ALL® ANCHOR *Technical Information*



## Load-Adjustment Factors for Carbon-Steel Wedge-All® Anchors in Sand-Lightweight Concrete: Edge Distance, Tension and Shear Loads

How to use these charts:

- The following tables are for reduced edge distance.
- Locate the anchor size to be used for either a tension and/or shear load application.
- Locate the edge distance ( $C_{act}$ ) at which the anchor is to be installed.
- The load adjustment factor ( $f_c$ ) is the intersection of the row and column.
- Multiply the allowable load by the applicable load adjustment factor.
- Reduction factors for multiple edges are multiplied together.

Edge Distance Tension ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	1/4	1/2	5/8	3/4	
		$C_{cr}$	3/8	6/4	8/8	10
		$C_{min}$	1/8	2/4	3/8	4
	$f_{cmin}$	0.70	0.70	0.70	0.70	
1 3/8		0.70				
1 1/2		0.72				
2		0.79				
2 1/2		0.87				
2 3/4		0.91	0.70			
3		0.94	0.72			
3 3/8		1.00	0.75	0.70		
3 1/2			0.76	0.71		
4			0.79	0.74	0.70	
4 1/2			0.83	0.77	0.73	
5			0.87	0.80	0.75	
5 1/2			0.91	0.83	0.78	
6			0.94	0.86	0.80	
6 1/2			0.98	0.89	0.83	
6 3/4			1.00	0.90	0.84	
7				0.92	0.85	
7 1/2				0.95	0.88	
8				0.98	0.90	
8 3/8				1.00	0.92	
8 1/2					0.93	
9					0.95	
9 1/2					0.98	
10					1.00	

See Notes Below

Edge Distance Shear ( $f_c$ ) (Shear Applied Perpendicular to Edge)

Edge Dist. $C_{act}$ (in.)	Size	1/4	1/2	5/8	3/4	
		$C_{cr}$	3/8	6/4	8/8	10
		$C_{min}$	1/8	2/4	3/8	4
	$f_{cmin}$	0.30	0.30	0.30	0.30	
1 3/8		0.30				
1 1/2		0.34				
2		0.52				
2 1/2		0.69				
2 3/4		0.78	0.30			
3		0.87	0.34			
3 3/8		1.00	0.41	0.30		
3 1/2			0.43	0.32		
4			0.52	0.39	0.30	
4 1/2			0.61	0.46	0.36	
5			0.69	0.53	0.42	
5 1/2			0.78	0.60	0.48	
6			0.87	0.67	0.53	
6 1/2			0.96	0.74	0.59	
6 3/4			1.00	0.77	0.62	
7				0.81	0.65	
7 1/2				0.88	0.71	
8				0.95	0.77	
8 3/8				1.00	0.81	
8 1/2					0.83	
9					0.88	
9 1/2					0.94	
10					1.00	

See Notes Below

\* See page 10 for an explanation of the load table icons

Mechanical Anchors

## Load-Adjustment Factors for Carbon-Steel Wedge-All® Anchors in Face of Wall Installation in 8" Grout-Filled CMU: Edge Distance, Tension and Shear Loads

Edge Distance Tension ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2	5/8	3/4	
		$C_{cr}$	12	12	20	20
		$C_{min}$	4	4	4	4
	$f_{cmin}$	1.00	1.00	0.80	0.80	
4		1.00	1.00	0.80	0.80	
6		1.00	1.00	0.83	0.83	
8		1.00	1.00	0.85	0.85	
10		1.00	1.00	0.88	0.88	
12		1.00	1.00	0.90	0.90	
14				0.93	0.93	
16				0.95	0.95	
18				0.98	0.98	
20				1.00	1.00	

Edge Distance Shear ( $f_c$ )

Edge Dist. $C_{act}$ (in.)	Size	3/8	1/2	5/8	3/4	
		$C_{cr}$	12	12	20	20
		$C_{min}$	4	4	4	4
	$f_{cmin}$	0.79	0.52	0.32	0.32	
4		0.79	0.52	0.32	0.32	
5		0.82	0.58	0.36	0.36	
6		0.84	0.64	0.41	0.41	
7		0.87	0.70	0.45	0.45	
8		0.90	0.76	0.49	0.49	
9		0.92	0.82	0.53	0.53	
10		0.95	0.88	0.58	0.58	
11		0.97	0.94	0.62	0.62	
12		1.00	1.00	0.66	0.66	
13				0.70	0.70	
14				0.75	0.75	
15				0.79	0.79	
16				0.83	0.83	
17				0.87	0.87	
18				0.92	0.92	
19				0.96	0.96	
20				1.00	1.00	

- $C_{act}$  = actual edge distance at which anchor is installed (inches).
- $C_{cr}$  = critical edge distance for 100% load (inches).
- $C_{min}$  = minimum edge distance for reduced load (inches).
- $f_c$  = adjustment factor for allowable load at actual edge distance.
- $f_{c,crit}$  = adjustment factor for allowable load at critical edge distance.  $f_{c,crit}$  is always = 1.00.
- $f_{c,min}$  = adjustment factor for allowable load at minimum edge distance.
- $f_c = f_{c,min} + \frac{(1 - f_{c,min})(C_{act} - C_{min})}{(C_{cr} - C_{min})}$ .

**Load-Adjustment Factors for Reduced Spacing:** Critical spacing is listed in the load tables. No adjustment in load is required when the anchors are spaced at critical spacing. No additional testing has been performed to determine the adjustment factors for spacing dimensions less than those listed in the load tables.



### Wedge Anchor (Stud Anchor)

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R14134WA	78630019645	Wedge Anchor Zinc Plated	14 x 1-3/4	100PK	TS1124	W14134
R14214WA	78630019646	Wedge Anchor Zinc Plated	1/4 x 2-1/4	100PK	TS1214	W14214
R14314WA	78630019706	Wedge Anchor Zinc Plated	1/4 x 3-1/4	100PK	TS103	W14314
R38214WA	78630019647	Wedge Anchor Zinc Plated	3/8 x 2-1/4	50PK	TS3218	W38214
R38234WA	78630019648	Wedge Anchor Zinc Plated	3/8 x 2-3/4	50PK	TS3234	T38234
R383WA	78630019705	Wedge Anchor Zinc Plated	3/8 x 3	50PK	TS303	W38300
R38334WA	78630019649	Wedge Anchor Zinc Plated	3/8 x 3-3/4	25PK	TS312	W38334
R385WA	78630019851	Wedge Anchor Zinc Plated	3/8 x 5	15PK	TS385	W38500
R12234WA	78630019700	wedge Anchor Zinc Plated	1/2 x 2-3/4	25PK	TS4234	W12234
R12334WA	78630019717	Wedge Anchor Zinc Plated	1/2 x 3-3/4	25PK	TS4334	W12334
R12414WA	78630019852	Wedge Anchor Zinc Plated	1/2 x 4-1/4	10PK	TS4414	W12400
R12512WA	78630019853	Wedge Anchor Zinc Plated	1/2 x 5-1/2	10PK	TS4512	W12512
6426	78630044026	Wedge Anchor Zinc Plated	1/2 x 7	25PK	TS407	
6430	78630044028	Wedge Anchor Zinc Plated	5/8 x 3-1/2	25PK	TS5312	
R7300	78630044200	Wedge Anchor Stainless Steel	1/4 x 1-3/4	100PK	TS1134SS	WS14134
R7304	78630044204	Wedge Anchor Stainless Steel	1/4 x 3-1/4	100PK	TS103SS	WS14314
R7313	78630044210	Wedge Anchor Stainless Steel	3/8 x 3	50PK	TS303SS	WS38300
R7320	78630044216	Wedge Anchor Stainless Steel	1/2 x 3-3/4	50PK	TS4334SS	WS12334



### Hammer Drive Wedge Anchor

Part #	NAED	Description	Size	UOM	Metallics
DFS14134AS	78630080200	Hammer Drive Wedge Anchor Zinc Plated	1/4 x 1-3/4	100PK	HW14134
DFS12234AS	78630080207	Hammer Drive Wedge Anchor Zinc Plated	1/2 x 2-3/4	100PK	HW12234
DFS12312AS	78630080208	Hammer Drive Wedge Anchor Zinc Plated	1/2 x 3-1/2	50PK	HW12312



### Rod Hanger Wedge Anchor

Part #	NAED	Description	Size	UOM	Metallics
5810J	78630047032	Rod Hanger Wedge Anchor	5/16 Dia.	50PK	
5815	78630005815	Rod Hanger Wedge Anchor	3/8 Dia.	50PK	RCA38
5825	78630047034	Rod Hanger Wedge Anchor	1/2 Dia.	25PK	RCA12



### Hand Drive Pin

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R34DP	78630019634	Drive Pin Zinc Plated	1/4 x 3/4 Long	100PK	DP2	HD220
R1DP	78630019635	Drive Pin Zinc Plated	1/4 x 1 Long	100PK	DP3	HD230
R114DP	78630019636	Drive Pin Zinc Plated	1/4 x 1-1/4 Long	100PK	DP4	HD240
1405J	78630096458	Drive Pin Zinc Plated	1/4 x 1-1/2 Long	100PK	DP5	HD255
143	78630039014	Drive Pin Installation Tool		1PK	HDT2	



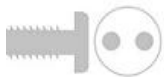
### Machine Screw > Flat Head > Phillips

Part #	NAED	Description	Size	UOM	Metallics (Slot)	Dottie (Slot)
R612FHP	78630019440	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1/2	100PK	FM80	FM63212
R634FHP	78630019441	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 3/4	100PK	FM81	FM63234
R61FHP	78630019442	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1	100PK	FM63	FM6321
R6114FHP	78630019443	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/4	100PK	FM68	FM632114
R6112FHP	78630019444	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/2	100PK	FM82	FM632112
6112FHP2C	78630034039	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1-1/2	200PK		
R62FHP	78630019445	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 2	100PK	FM83	FM6322
R6212FHP	78630019446	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 1/2	100PK	FM140	FM63212
R63FHP	78630019447	Flat Head Phillips Mach. Screw Zinc Plated	6-32 x 3	100PK	FM142	FM6323
R81FHP	78630096119	Flat Head Phillips Mach. Screw Zinc Plated	8-32 x 1	100PK	FM86	FM8321
R82FHP	78630096121	Flat Head Phillips Mach. Screw Zinc Plated	8-32 x 2	100PK	FM89	FM8322



### Machine Screw > Flat Head > Slotted

Part #	NAED	Description	Size	UOM	Metallics	Dottie
832X12FHSMSSZJ	78630002283	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1/2	100PK	FM84	FM83212
832X34FHSMSSZJ	78630002287	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 3/4	100PK	FM85	FM83234
832X114FHSMSSZJ	78630002289	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1-1/4	100PK	FM87	FM832114
832X112FHSMSSZJ	78630002293	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 1-1/2	100PK	FM88	FM832112
832X212FHSMSSZJ	78630002299	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 2-1/2	100PK	FM90	FM832212
832X3FHSMSSZJ	78630002301	Flat Head Slotted Mach. Screw Zinc Plated	8-32 x 3	100PK	FM91	FM8323
1032X2FHSMSSZJ	78630002339	Flat Head Slotted Mach. Screw Zinc Plated	10-32 x 2	100PK	FM93	FM10322
1420X12FHSMSSZJ	78630002357	Flat Head Slotted Mach. Screw Zinc Plated	1/4-20 x 1/2	100PK	FM99	FM1412
1420X2FHSMSSZJ	78630002369	Flat Head Slotted Mach. Screw Zinc Plated	1/4-20 x 2	100PK	FM104	FM142
R632FHSSKIT	78630019994	Flat Head Slotted Mach. Screw KIT	Assorted 6-32	1PK	FMK632	632



### Tamper Proof Machine Screw > Pan Head > Spanner

Part #	NAED	Description	Size	UOM	Metallics	Dottie
632X12PHSPMSSS	78630012530	Tamp. Resist Mach. Screw- Pan-Spanner	6-32 x 1/2	50PK	TP300SPC	T63212SP



### Self-Drilling Screw > Pan Head > Phillips

Part #	NAED	Description	Size	UOM	Metallics	Dottie
6X34PHPTJ	78630003087	Pan Head Phillips Self Drill Screw Zinc Plated	6 x 3/4	100PK	TEK11P	TEKPH634
6X1PHPTJ	78630003089	Pan Head Phillips Self Drill Screw Zinc Plated	6 x 1	100PK	TEK12P	TEKPH61
R812PHPT	78630019727	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1/2	100PK	TEK1P	TEKPH812
R834PHPT	78630019728	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 3/4	100PK	TEK2P	TEKPH834
R81PHPT	78630019735	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1	100PK	TEK14P	TEKPH81
8X112PHPTJ	78630003101	Pan Head Phillips Self Drill Screw Zinc Plated	8 x 1-1/2	100PK	TEK15P	TEKPH8112
R1012PHPT	78630019729	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1/2	100PK	TEK4P	TEKPH1012
R1034PHPT	78630019730	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 3/4	100PK	TEK3P	TEKPH1034
R101PHPT	78630019731	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1	100PK	TEK7P	TEKPH101
R10112PHPT	78630019756	Pan Head Phillips Self Drill Screw Zinc Plated	10 x 1-1/2	100PK	TEK19P	TEKPH10112

### Self-Drilling Screw > Pan Head > Square Drive

Part #	NAED	Description	Size	UOM	Dottie
10X114PHPT	786300X0034	Pan Head Square Drive Self Drill Screw Zinc Plated	10 x 1-1/4	100PK	TEKDD10114



### Self-Drilling Screw > Hex Washer Head

Part #	NAED	Description	Size	UOM	Metallics	Dottie
612HTJ	78630003045	Hex Washer Head Self Drill Screw Zinc Plated	6 x 1/2	100PK		TEKHW612
6X34HT	78630017460	Hex Washer Head Self Drill Screw Zinc Plated	6 x 3/4	100PK		
6X1HT	78630017465	Hex Washer Head Self Drill Screw Zinc Plated	6 x 1	100PK		
R812HT	78630019495	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1/2	100PK	TEKD1	TEKHW812
R834HT	78630019496	Hex Washer Head Self Drill Screw Zinc Plated	8 x 3/4	100PK	TEDK2	TEKHW834
R81HT	78630019497	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1	100PK	TEKD14	TEKHW81
8X114HTJ	78630096182	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1-1/4	100PK		TEKHW8114
8X112HTJ	78630096184	Hex Washer Head Self Drill Screw Zinc Plated	8 x 1-1/2	100PK	TEKD15	TEKHW8112
8X2HTJ	78630096186	Hex Washer Head Self Drill Screw Zinc Plated	8 x 2	100PK		TEKHW82
R1012HT	78630019501	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1/2	100PK	TEKD5	TEKHW1012
10X58HTJ	78630003059	Hex Washer Head Self Drill Screw Zinc Plated	10 x 5/8	100PK	TEKD17	
R1034HT	78630019502	Hex Washer Head Self Drill Screw Zinc Plated	10 x 3/4	100PK	TEKD6	TEKHW1034
R101HT	78630019503	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1	100PK	TEKD7	TEKHW101
R10114HT	78630019504	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1-1/4	100PK	TEKD18	TEKHW10114
R10112HT	78630019505	Hex Washer Head Self Drill Screw Zinc Plated	10 x 1-1/2	100PK	TEKD19	TEKHW10112
R102HT	78630019506	Hex Washer Head Self Drill Screw Zinc Plated	10 x 2	100PK	TEKD22	TEKHW102
R1234HT	78630019507	Hex Washer Head Self Drill Screw Zinc Plated	12 x 3/4	100PK	TEKD20	TEKHW1234
R121HT	78630019508	Hex Washer Head Self Drill Screw Zinc Plated	12 x 1	100PK	TEKD8	TEKHW121
R12112HT	78630019510	Hex Washer Head Self Drill Screw Zinc Plated	12 x 1-1/2	100PK	TEKD21	TEKHW12112
R122HT	78630019511	Hex Washer Head Self Drill Screw Zinc Plated	12 x 2	100PK	TEKD32	TEKHW122
R1434HT	78630019765	Hex Washer Head Self Drill Screw Zinc Plated	14 x 3/4	100PK	TEKD9	TEKHW1434
R141HT	78630019748	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1	100PK	TEKD10	TEKHW141
14X114HTJ	78630003079	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1-1/4	100PK		TEKHW14114
R14112HT	78630019750	Hex Washer Head Self Drill Screw Zinc Plated	14 x 1-1/2	100PK	TEKD11	TEKHW14112
R142HT	78630019751	Hex Washer Head Self Drill Screw Zinc Plated	14 x 2	100PK	TEKD34	TEKHW142
RTEKKIT	78630020030	Hex Washer Head Self Drill Screw KIT	Assorted	1PK	TEKDK1	



### Self-Drilling Screw > Heavy Duty Tek Screw

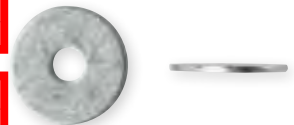
Part #	NAED	Description	Size	UOM	Metallics
1224X114HTJ	78630003377	Heavy Duty Steel-to-Steel Applications	12-24 x 1-1/4	100PK	TXV12114

BizLine Part #	UPC	Size	Description	Unit Size	Lid Colors	*Commonly sold products
<b>SCREWS, WASHERS, NUTS AND BOLTS</b>						
R61DSYZ	19736	6 x 1	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R61DSYZ5	19739	6 x 1	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6118DSYZ	19744	6 x 1-1/8	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6118DSYZ5	19740	6 x 1-1/8	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6114DSYZ	19732	6 x 1-1/4	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6114DSYZ5	19741	6 x 1-1/4	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R6158DSYZ	19733	6 x 1-5/8	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6158DSYZ5	19742	6 x 1-5/8	Bugle Phillip Drywall Screw Yellow Zinc	500	Red	
R62DSYZ	19734	6 x 2	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R62DSYZ250	19743	6 x 2	Bugle Phillip Drywall Screw Yellow Zinc	250	Red	
R8212DSYZ	19737	8 x 2½	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R83DSYZ	19738	8 x 3	Bugle Phillip Drywall Screw Yellow Zinc	100	Red	
R6114DSD	80004	6 x 1¼	Bugle Phillip Deck Screw Dacrotized	100	Red	
R812WT	19491	8 x ½	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R812WT5	19745	8 x ½	Wafer Head Phillip Self Drill Screw Zinc Plated	500	White	
R834WT	19492	8 x ¾	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R834WT5	19746	8 x ¾	Wafer Head Phillip Self Drill Screw Zinc Plated	500	White	
R81WT	19493	8 x 1	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R8114WT	19494	8 x 1¼	Wafer Head Phillip Self Drill Screw Zinc Plated	100	White	
R812HT	19495	8 x ½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R834HT	19496	8 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R81HT	19497	8 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R8112HT	19499	8 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R82HT	19500	8 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1012HT	19501	10 x ½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1058HT	19747	10 x 5/8	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1034HT	19502	10 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R101HT	19503	10 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R10114HT	19504	10 x 1¼	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R10112HT	19505	10 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R102HT	19506	10 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1234HT	19507	12 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R121HT	19508	12 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R12114HT	19509	12 x 1¼	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R12112HT	19510	12 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R122HT	19511	12 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R1434HT	19765	14 x ¾	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R141HT	19748	14 x 1	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R14112HT	19750	14 x 1½	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R142HT	19751	14 x 2	Hex Washer Head Self Drill Screw Zinc Plated	100	White	
R612PHPT	19752	6 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R61PHPT	19754	6 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R812PHPT	19727	8 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R834PHPT	19728	8 x ¾	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R81PHPT	19735	8 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R8112PHPT	19755	8 x 1½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R1012PHPT	19729	10 x ½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R1034PHPT	19730	10 x ¾	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R101PHPT	19731	10 x 1	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R10112PHPT	19756	10 x 1½	Pan Head Phillip Self Drill Screw Zinc Plated	100	White	
R6716FS	19512	6 x 7/16	Pan Head Phillip Sharp Point Framing Screw	100	Red	
R6716FT	19513	6 x 7/16	Pan Head Phillip Framing Tek	100	White	
R6716FSM	19514	6 x 7/16	Pan Head Phillip Sharp Point Framing Screw	1000	Red	
R632HN	19516	6-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R832HN	19517	8-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R1024HN	19518	10-24	Hex Machine Screw Nut Zinc Plated	100	Green	
R1032HN	19519	10-32	Hex Machine Screw Nut Zinc Plated	100	Green	
R1420HN	19520	¼-20	Finished Hex Nut Zinc Plated	100	Green	
R51618HN	19521	5/16-18	Finished Hex Nut Zinc Plated	100	Green	
R3816HN	19522	3/8-16	Finished Hex Nut Zinc Plated	100	Green	
R1213HN	19523	½-13	Finished Hex Nut Zinc Plated	100	Green	





BizLine Part #	UPC	Size	Description	Unit Size	Lid Colors	*Commonly sold products
<b>SCREWS, WASHERS, NUTS AND BOLTS</b>						
R1420NLN	55550	¼-20	Nylon Insert Lock Nut Zinc Plated	100	Green	
R14RC	19524	¼-20	Rod Coupling Nut Zinc Plated	100	Green	
R14RC10	19532	¼-20	Rod Coupling Nut Zinc Plated	10	Green	
R38RC	19525	⅜-16	Rod Coupling Nut Zinc Plated	100	Green	
R38RC10	19547	⅜-16	Rod Coupling Nut Zinc Plated	10	Green	
R12RC	19526	½-13	Rod Coupling Nut Zinc Plated	50	Green	
R12RC10	19563	½-13	Rod Coupling Nut Zinc Plated	10	Green	
R1420HNG5	12225	¼-20	Hex Nut Grade 5 Zinc Plated	100	Green	
R3816HNG5	12226	⅜-16	Hex Nut Grade 5 Zinc Plated	100	Green	
R316FWU	19527	⅜	Flat Washer USS Zinc Plated	100	Yellow	
R14FWU	19528	¼	Flat Washer USS Zinc Plated	100	Yellow	
R516FWU	19529	⅝	Flat Washer USS Zinc Plated	100	Yellow	
R38FWU	19530	⅜	Flat Washer USS Zinc Plated	100	Yellow	
R12FWU	19531	½	Flat Washer USS Zinc Plated	100	Yellow	
R6FWS	19533	#6	Flat Washer SAE Zinc Plated	100	Yellow	
R8FWS	19534	#8	Flat Washer SAE Zinc Plated	100	Yellow	
R10FWS	19535	#10	Flat Washer SAE Zinc Plated	100	Yellow	
R14FWS	11807	¼	Flat Washer SAE Zinc Plated	100	Yellow	
R38FWS	11808	⅜	Flat Washer SAE Zinc Plated	100	Yellow	
R12FWS	11771	½	Flat Washer SAE Zinc Plated	100	Yellow	
R3161FW	19536	⅜ x 1	Fender Washer Zinc Plated	100	Yellow	
R31614FW	19537	⅜ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R141FW	19538	¼ x 1	Fender Washer Zinc Plated	100	Yellow	
R14114FW	19539	¼ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R14112FW	19540	¼ x 1½	Fender Washer Zinc Plated	100	Yellow	
R142FW	19541	¼ x 2	Fender Washer Zinc Plated	100	Yellow	
R51614FW	19692	⅝ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R381FW	19691	⅜ x 1	Fender Washer Zinc Plated	100	Yellow	
R38114FW	19542	⅜ x 1¼	Fender Washer Zinc Plated	100	Yellow	
R38112FW	19543	⅜ x 1½	Fender Washer Zinc Plated	100	Yellow	
R382FW	19544	⅜ x 2	Fender Washer Zinc Plated	100	Yellow	
R12112FW	19545	½ x 1½	Fender Washer Zinc Plated	100	Yellow	
R122FW	19546	12 x 2	Fender Washer Zinc Plated	100	Yellow	
R6LW	19548	#6	Lock Washer Zinc Plated	100	Yellow	
R8LW	19549	#8	Lock Washer Zinc Plated	100	Yellow	
R10LW	19550	#10	Lock Washer Zinc Plated	100	Yellow	
R14LW	19551	¼	Lock Washer Zinc Plated	100	Yellow	
R516LW	19552	⅝	Lock Washer Zinc Plated	100	Yellow	
R38LW	19553	⅜	Lock Washer Zinc Plated	100	Yellow	
R12LW	19554	½	Lock Washer Zinc Plated	100	Yellow	
R14FW188	03900	1/4	Flat Washer 18-8 Stainless Steel	100	Yellow	
R38FW188	12228	3/8	Flat Washer 18-8 Stainless Steel	100	Yellow	
R12FW188	12229	1/2	Flat Washer 18-8 Stainless Steel	50	Yellow	
R14114FW188	12233	1/4 x 1-1/4	Fender Washer 18-8 Stainless Steel	100	Yellow	
R14LW188	03918	1/4	Lock Washer 18-8 Stainless Steel	100	Yellow	
R38LW188	12234	3/8	Lock Washer 18-8 Stainless Steel	100	Yellow	
R12LW188	12235	1/2	Lock Washer 18-8 Stainless Steel	50	Yellow	
R1412HBG5	19830	¼ x ½	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R1434HBG5	19831	¼ x ¾	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R141HBG5	19832	¼ x 1	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R381HBG5	19836	⅜ x 1	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R38114HBG5	19837	⅜ x 1¼	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R38112HBG5	19838	⅜ x 1½	Hex Bolt Grade 5 USS Zinc Plated	100	Orange	
R1412HB	19555	¼ x ½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R1434HB	19556	¼ x ¾	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R141HB	19557	¼ x 1	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R14114HB	19558	¼ x 1¼	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R14112HB	19559	¼ x 1½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R142HB	19560	¼ x 2	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R143HB	19562	¼ x 3	Hex Tap Bolt Grade 2 Zinc Plated	50	Orange	
R3812HB	19565	⅜ x ½	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R3834HB	19566	⅜ x ¾	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	
R381HB	19567	⅜ x 1	Hex Tap Bolt Grade 2 Zinc Plated	100	Orange	





# Bolts



## Hex Head Tap Bolt > Grade 2 > Full Thread

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R1412HB	78630019555	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1/2	100PK	HTB11	MB1412
1412HB2C	78630034004	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1/2	200PK		
R1434HB	78630019556	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3/4	100PK	HTB1	MB1434
1434HB2C	78630034035	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3/4	200PK		
R141HB	78630019557	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1	100PK	HTB2	MB141
141HB2C	78630034032	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1	200PK		
R14114HB	78630019558	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/4	100PK	HTB49	MB14114
14114HB2C	78630034043	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/4	200PK		
R14112HB	78630019559	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/2	100PK	HTB3	MB14112
14112HB2C	78630034042	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 1-1/2	200PK		
R142HB	78630019560	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 2	100PK	HTB4	MB142
R143HB	78630019562	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 3	50PK	HTB6	MB143
14X4HBG2ZJ	78630096314	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 4	50PK		MB144
14X5HBG2ZJ	78630009038	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/4 x 5	100PK		MB145
516X12HBG2GZJ	78630009053	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 1/2	100PK		MB51612
516X212HBG2Z	78630009072	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 2-1/2	100PK		MB516212
516X3HBG2Z	78630009076	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/16 x 3	100PK		MB5163
R3812HB	78630019565	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1/2	100PK	HTB88	MB3812
R3834HB	78630019566	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 3/4	100PK	HTB44	MB3834
R381HB	78630019567	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1	100PK	HTB45	MB381
R38114HB	78630019568	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1-1/4	100PK	HTB59	MB38114
R38112HB	78630019569	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 1-1/2	100PK	HTB23	MB38112
R382HB	78630019570	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 2	50PK	HTB24	MB382
R38212HB	78630019571	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 2-1/2	50PK	HTB25	MB38212
R383HB	78630019572	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 3	50PK	HTB26	MB383
38X5HBG2Z	78630009138	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/8 x 5	50PK		MB385
R1234HB	78630019575	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3/4	50PK		MB1234
1234HB1C	78630034011	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3/4	100PK		
R121HB	78630019576	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1	50PK	HTB46	MB121
R12114HB	78630019577	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1-1/4	50PK	HTB64	MB12114
R12112HB	78630019578	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 1-1/2	50PK	HTB47	MB12112
R122HB	78630019579	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 2	50PK	HTB33	MB122
R12212HB	78630019580	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 2-1/2	25PK	HTB34	MB12212
R123HB	78630019581	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 3	25PK	HTB35	MB123
12X5HBG2Z	78630009216	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	1/2 x 5	25PK		MB125
58X1HBG2Z	78630009238	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	5/8 x 1	25PK		MB581
34X1HBG2Z	78630009288	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 1	25PK		MB341
34X112HBG2Z	78630009292	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 1-1/2	25PK		MB34112
34X6HBG2Z	78630009320	Hex Tap Bolt Grade 2 Full Thrd Zinc Pltd	3/4 x 6	25PK		MB346

# Nuts



## Machine Screw Hex Nuts

Part #	NAED	Description	Size	UOM	Metallics	Dottie
R632HN	78630019516	Machine Screw Hex Nut Zinc Plated	6-32	100PK	N159	HN632
632HN2C	78630034012	Machine Screw Hex Nut Zinc Plated	6-32	200PK		
R832HN	78630019517	Machine Screw Hex Nut Zinc Plated	8-32	100PK	N160	HN832
832HN2C	78630034016	Machine Screw Hex Nut Zinc Plated	8-32	200PK		
R1024HN	78630019518	Machine Screw Hex Nut Zinc Plated	10-24	100PK	N161	HN1024
1024HN2C	78630034023	Machine Screw Hex Nut Zinc Plated	10-24	200PK		
R1032HN	78630019519	Machine Screw Hex Nut Zinc Plated	10-32	100PK	N162	HN1032
1032HN2C	78630034022	Machine Screw Hex Nut Zinc Plated	10-32	200PK		
632HNSS	78630070002	Machine Screw Hex Nut Stainless Steel	6-32	100PK	SN10	HNS632
832HNSS	78630070004	Machine Screw Hex Nut Stainless Steel	8-32	100PK	SN11	HNS832
1024HNSS	78630070006	Machine Screw Hex Nut Stainless Steel	10-24	100PK	SN12	HNS1024
1032HNSS	78630070008	Machine Screw Hex Nut Stainless Steel	10-32	100PK	SN13	HNS1032



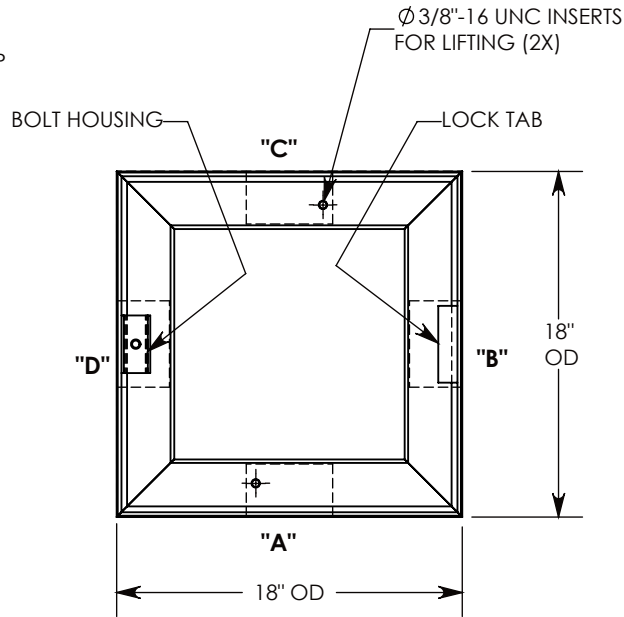
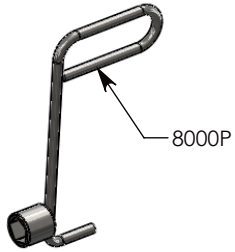
## Finished Hex Nuts

Part #	NAED	Description	Size	UOM	Metallics	Dottie
1420HN	78630011803	Grade 2 Finished Hex Nut Zinc Pltd	1/4-20	100PK	N163	HN14
1420HN2C	78630034020	Grade 2 Finished Hex Nut Zinc Pltd	1/4-20	200PK		
R51618HN	78630019521	Grade 2 Finished Hex Nut Zinc Pltd	5/16-18	100PK	N164	HN516
51618HN2C	78630034009	Grade 2 Finished Hex Nut Zinc Pltd	5/16-18	200PK		
R3816HN	78630019522	Grade 2 Finished Hex Nut Zinc Pltd	3/8-16	100PK	N165	HN38
1213HN	78630011806	Grade 2 Finished Hex Nut Zinc Pltd	1/2-13	100PK	N166	HN12
58FHNUSSZ	78630005030	Grade 2 Finished Hex Nut Zinc Pltd	5/8-11	50PK	N167	HN58
34FHNUSSZ	78630005032	Grade 2 Finished Hex Nut Zinc Pltd	3/4-10	50PK	N168	HN34
12HHNZ	78630005100	Grade 2 Hvy Finished Hex Nut Zinc Pltd	1/2-13	100PK	HHN12	
14HNG5USSZ	78630005400	Grade 5 Finished Hex Nut Zinc Pltd	1/4-20	100PK	G5N163	5HN14
38HNG5USSZ	78630005404	Grade 5 Finished Hex Nut Zinc Pltd	3/8-16	100PK	G5N165	5HN38
12HNG5USSZ	78630005408	Grade 5 Finished Hex Nut Zinc Pltd	1/2-13	100PK	G5N166	5HN12
14HNG8USSYZJ	78630005340	Grade 8 Finished Hex Nut Zinc Pltd	1/4-20	100PK	G8N163	8HN14
38HNG8USSYZJ	78630005342	Grade 8 Finished Hex Nut Zinc Pltd	3/8-16	100PK	G8N165	8HN38
1213HNG8USSYZJ	78630005344	Grade 8 Finished Hex Nut Zinc Pltd	1/2-13	50PK	G8N166	8HN12
R1420HN188	78630003909	Finished Hex Nut 18-8 Stainless Steel	1/4-20	100PK	SN14	HNS14
R3816HN188	78630003919	Finished Hex Nut 18-8 Stainless Steel	3/8-16	100PK	SN16	HNS38
R1213HN188	78630003910	Finished Hex Nut 18-8 Stainless Steel	1/2-13	100PK	SN18	HNS12
51618HNSS	78630070012	Finished Hex Nut 316 Stainless Steel	5/16-18	100PK	SN15	HNS516
5811HN316SS	78630070020	Finished Hex Nut 316 Stainless Steel	5/8-11	50PK		HNS58
3410HNSS	78630070022	Finished Hex Nut 316 Stainless Steel	3/4-10	50PK		HNS34
1420HNBS	78630070036	Finished Hex Nut Silicone Bronze	1/4-20	100PK	SBN14	HNBZ14
51618HNBS	78630070038	Finished Hex Nut Silicone Bronze	5/16-18	100PK	SBN516	HNBZ516
3816HNBS	78630070040	Finished Hex Nut Silicone Bronze	3/8-16	100PK	SBN38	HNBZ38
1213HNBS	78630070042	Finished Hex Nut Silicone Bronze	1/2-13	50PK	SBN12	HNBZ12
HNKIT	78630000086	Hex Nut KIT – Zinc Plated	Various	400PK	NK1	339

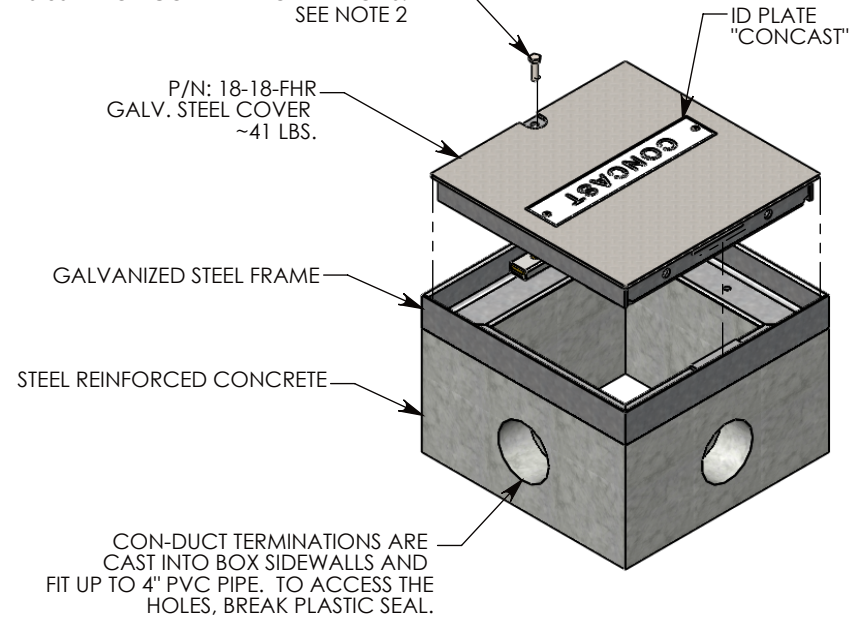
# **QUAZITE BOXES**

**Operations & Maintenance Manual  
December 2015**

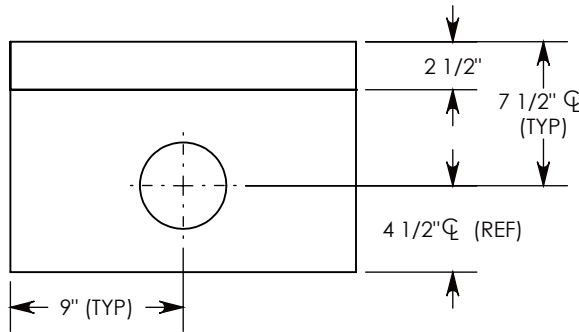
**OPTIONAL PENTAHEAD SOCKET-EQUIPPED LIFTING TOOL**



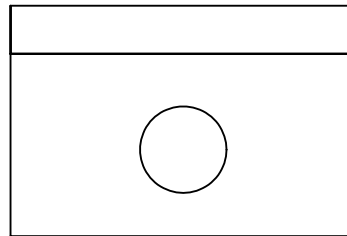
3/8"-16 UNC X 1.5" LG PENTA HD BOLT (P/N: PTA.38-1.5) FOR SECURING THE COVER. BOLT HOLE IS USED FOR COVER LIFT OPERATIONS. SEE NOTE 2



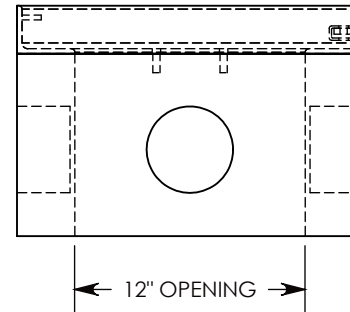
COVER SHOWN IN THIS VIEW



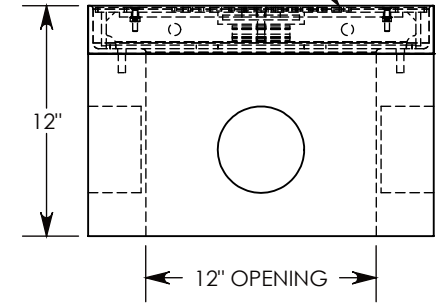
**SIDE "A" HLR**



**SIDE "B" (HLR)**



**SIDE "C"**



**SIDE "D"**

**NOTE 1:** FOR PVC SIZES SMALLER THAN 4", USE CONCAST RC41 (REDUCING COUPLER).

**NOTE 2:** FOR ADDED SECURITY, REPLACE PENTAHEAD BOLTS WITH SURELOCK BOLTS AND ORDER UNDER P/N: FHRSL-18-18-12

H2O RATED - 32,000 LB. PER AXLE LOAD.

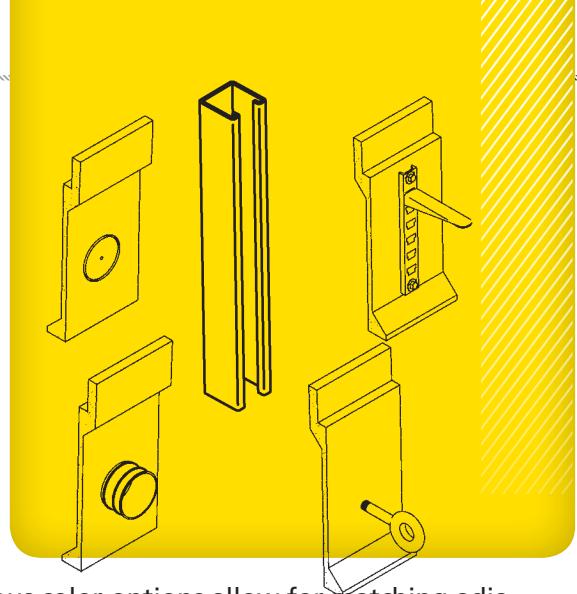
<b>DRAWN BY: ROBIN FLINT</b>	
<b>DATE: 8/26/2013</b>	<b>REVISION LEVEL: 0</b>
<b>WEIGHT: 190 LBS. W/COVER</b>	<b>MATERIAL: NOTED</b>

1010 NORTH STAR DRIVE  
P.O. BOX 69  
ZUMBROTA, MN 55992-0069

<b>DESCRIPTION:</b> <b>HEAVY TRAFFIC HANDHOLE</b>		
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL: ± 1/8" ANGULAR: ± 2°	CONTACT INFORMATION: EMAIL: INFO@CONCASTINC.COM PHONE: (507) 732-4095 FAX: (507) 732-4094	SHEET 1 OF 1
<b>PART NUMBER:</b> <b>FHR-18-18-12</b>		

## Quazite® Box Options:

Quazite® features several different options and accessories for its boxes, including cable racks, unistrut racks, pulleys, knockouts, coiling brackets, and terminators. Knockouts are pre-scored at the factory, allowing for easy break out without the need for special tools. Pulleys feature a forged-steel eye-nut and a steel-reinforcing plate that sits against the wall on the box.



The standard color for QUAZITE® products is concrete gray. Various color options allow for matching adjacent materials or special identification of enclosures. Some commonly requested colors include:

Color Sample	Description	Part No. Code
	Brick Red	R
	Forest Green	G
	Light Green	F
	Cement Gray	C
	Charcoal Gray	D
	Black	B
	Pecan	P
	International Orange	A
	Purple	N (non-potable water)

Note: Printed colors do not exactly represent product colors. Contact your local QUAZITE® representative for other special colors.

When ordering, the color of the box and cover should be designated in the 6th digit of the part number. For example, a forest green PG1730BA18 box or cover would be ordered as PG173GBA18.

### Adjust-to-Grade Option

An ideal solution when installation can't wait, but the final grade isn't yet known or repaving may be necessary. Adjust-to-grade is available for FRP boxes, sizes 30" x 48" and larger. Tilting up to four inches in any direction can be accomplished in just minutes. There's no grouting necessary, and adjustments can be made during installation or any time afterward.

# Quazite® Catalog Numbering System for Boxes and Covers

## Polymer Concrete

NUMBERING SYSTEM KEY

1 Weight	2 Style	3,4,5,6 Size	7 Item - Covers	8 Item - Covers	9 Cover Variation	10 Cover Variation
L (LW PC)	A (Special Covers)	0608	C (Standard)	A (Standard)	0 (Standard Cover)	0 (Standard Cover)
P (PC)	C (Box Straight Sides w/ 3/4" cover)	0818	**H (H.D. 22,500# Test)	C (Overlapping)	A (Aluminum)	1 (Opens Over 90°)
	D (Flared Box w/1° Taper w/2" or 3" cover)	0914	S (Steel Cover)	G (Gasketed)	B (Captive Bolt)	2 (Opens Under 90°)
	G (Box Straight Sides 1 1/2", 1 1/16", 2", or 3" cover)	0915	W (Non-Bolt down Cover)	***H (33,750# Test)	D (Deep C'Bores for Locking Cylinders)	M (Metal Locator)
	R (Round Enclosure)	1015		J (Grade Adjustable Frame)	G (Galvanized)	R (Rockwell Touch Reader)
	T (Flared Box w/2" or 3" cover)	1016		S (Split Cover)	K (6"x9" Polymer Drop in Lid)	
	X (Replacement Cover or PX box 3/4" Cover)	1118		T (Torsion Cover)	L (7"x13 1/2" Polymer Drop in Lid)	<b>Markers</b>
		1212			P (CI 6"x 9" Meter Lid)	G (Gas)
		1324			Q (CI 9" x 12" Meter Lid)	P (Power)
		1730			R (CI 4 1/2" x 7 1/2" Meter Lid)	S (Sanitary)
		2042			S (Thru Slot 1/2" x 1")	T (Telephone)
		2424			T (1"x 4" Pull Slot)	W (Water)
		2436			V (CI 4 7/8" x 4 7/8" Vented Meter Lid)	
		2700				
		2733	<b>Item - Boxes</b>	<b>Item - Boxes</b>	<b>Box Depth</b>	<b>Box Depth</b>
		3048	B (Box Open Base)	A (Tier 22)	1	2
		3060	D (Solid Base)	B (Std. Mouseholes)	1	8
		3660	E (Extension)	C (Divided)	2	4
		3672	J (Footed Box)	G (Gasketed)	3	6
		3943	R (Extension w/ Solid Base)	L (Tier 8)		
		4848				
		4872	Z (Assembly)			
		4896		5	0	0
		*		6	0	0
				7	0	0

\* Designates a special color - R=Red, G=Green, etc.

\*\* This load is tested over a 10"x10" area

\*\*\* This load is tested over a 10"x20" area

L = Lightweight

P = Standard



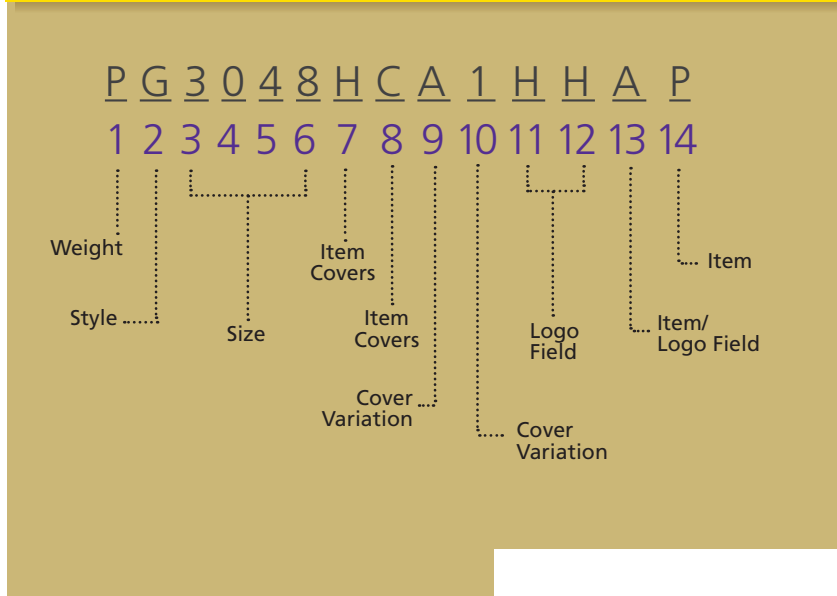
11, 12 Logo Field | 13 Item / Logo Field | 14 Item

11, 12 Logo Field	13 Item / Logo Field	14 Item
09 = Blank	1-9 (for 3 Digit Logos)	
17 = Electric		
29 = Lighting	A (Cast Part for 2 Digit Logos)	A (See Reference Chart Below)
84 = Power	B (3/8" Hex Bolts)	B (3/8" Hex Bolts)
Other logos are available.	C (1/2" Coil Lg. Penta Head)	C (1/2" Coil Lg. Penta head)
	H (3/8" Lag Bolt)	H (3/8" Lag Bolt)
	J (1/2" Hex Bolts)	J (1/2" Hex Bolts)
	K (1/2" Lag Bolts)	K (1/2" Lag Bolt)
	P (Penta Head)	P (Penta Head)
	R (3/8" Sm. Penta Head)	R (3/8" Sm. Penta Head)
	S (1/2" Lg. Penta Head)	S (1/2" Lg. Penta Head)
	T (3/8" Lg. Penta Head)	T (3/8" Lg. Penta Head)
	(See Reference Chart Below)	(See Reference Chart Below)
H (Box with 3/8" Lag Nut)		
K (Box with 1/2" coil/ Lag Nut)		

Penta Head Bolt Reference Chart

Item 13 OR Item 14	Part No.	Length	Thread Size	Application
P	80023	1.50"	3/8-16 UNC	PC0608, PC0818, PC1012, PC1118, PC1212, PC1324, PC1730
P	80022	1.75"	3/8-16 UNC	PR2700, PR3900
P	80026	2.50"	3/8-16 UNC	PG1015, PG1118
P	80027	2.75"	3/8-16 UNC	PG2424, PT1324, PT1730
P	80028	3.00"	3/8-16 UNC	PG1324, PG1730
P	80032	4.00"	3/8-16 UNC	PG2436, PG3048, PG3636
P	80122	1.75"	1/2-13 UNC	PG3660
P	80124	2.25"	1/2-13 UNC	PR2200
P	80126	2.75"	1/2-13 UNC	LE1324, LE1730
P	80129	3.50"	1/2-13 UNC	PG3660 (Overlapping)
P	80131	4"	1/2-13 UNC	PG3060, PG3672, PG4848, PG4872, PG4896
P	80132	5"	1/2-13 UNC	PG3060 (Overlapping)

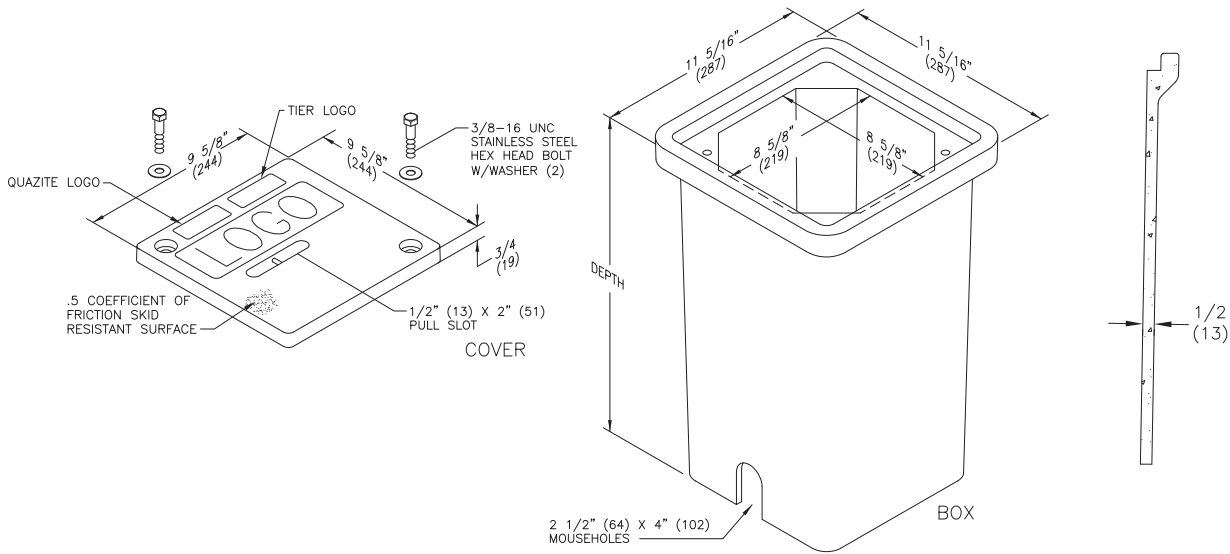
Sample Part Number





# Dimensions / Data

## 8" x 8" PC Style Polymer Concrete (Stackable) Assembly



ENCLOSURE DRAWINGS

### Covers

DESCRIPTION	TIER	DESIGN / TEST LOAD #	WEIGHT #	PALLET QTY	PART NO.
W/ 2 Bolts	15	15,000 / 22,500	6	36	PC0808HA00
Gasketed W/ 2 Bolts	15	15,000 / 22,500	6	36	PC0808HG00
W/ 2 Bolts	22	22,500 / 33,750	6	36	PC0808HH00

### Boxes

DESCRIPTION	DEPTH	TIER	DESIGN / TEST LOAD #	WEIGHT #	PALLET QTY	PART NO.
Standard Open Bottom	12"	22	22,500/33,750	25	36	PC0808BA12
	18"	22	22,500/33,750	36	24	PC0808BA18
Solid Bottom	18"	22	22,500/33,750	42	24	PC0808DA18

To order boxes with 2 standard mouseholes, replace the letter "A" with the letter "B"  
 To order gasketed boxes, replace the letter "A" with the letter "G"

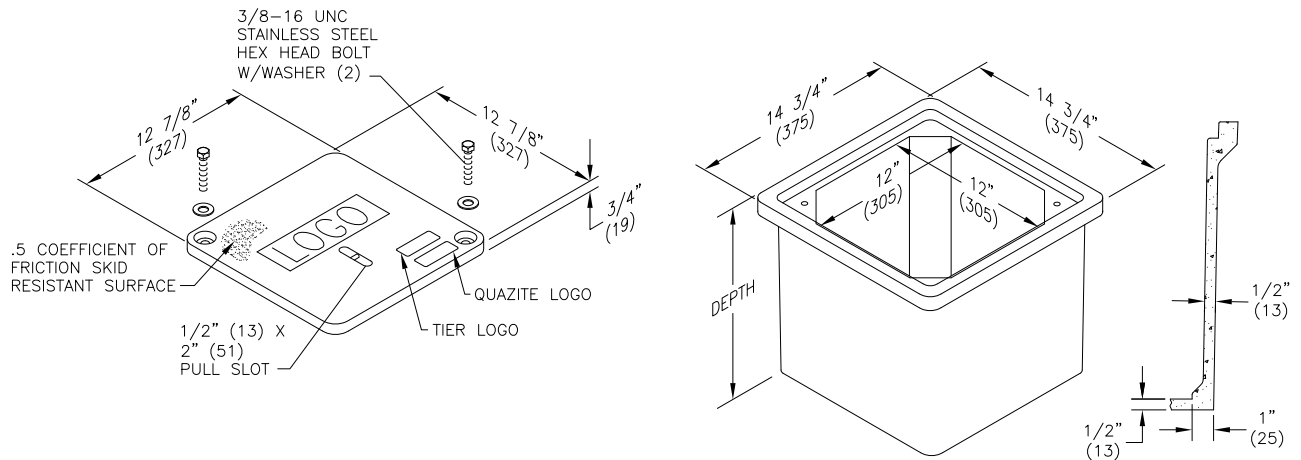
NOTE: Gasketed covers and bolt grommets must be used with a gasketed box. Gaskets reduce the inflow of fluids but do not make the enclosure water tight.





# Dimensions / Data

## 12" x 12" PC Style Polymer Concrete (Stackable) Assembly



### Covers

	DESCRIPTION	TIER	DESIGN / TEST LOAD #	WEIGHT #	PALLET QTY	PART NO.
UL	W/ 2 Bolts	8	8,000 / 12,000	12	60	PC1212CA00
UL	W/ 2 Bolts	15	15,000 / 22,500	12	60	PC1212HA00
UL	No Bolts	8	8,000 / 12,000	12	60	PC1212WA00

To order gasketed covers, replace the letter "A" with the letter "G"  
 Gasketed covers are with 4 bolts

### Boxes

	DESCRIPTION	DEPTH	TIER	DESIGN / TEST LOAD #	WEIGHT #	PALLET QTY	PART NO.
UL	Standard Open Bottom	12"	15	15,000 / 22,500	36	30	PC1212BA12
UL	Solid Bottom	12 1/2"	15	15,000 / 22,500	41	30	PC1212DA12

To order gasketed boxes, replace the letter "A" with the letter "G"  
 Gaskets reduce the inflow of fluids but do not make the enclosure water tight.  
 NOTE: Gasketed covers and bolt grommets must be used with a gasketed box.  
 Gaskets reduce the inflow of fluids but do not make the enclosure water tight.

ENCLOSURE DRAWINGS

# **500 VA XFMR & FUSES**

**Operations & Maintenance Manual  
December 2015**

## The SBE - Encapsulated Series

The SBE Encapsulated industrial control transformers are epoxy encapsulated to seal the transformer windings against moisture, dirt and industrial contaminants. Extra deep, molded terminal barriers reduce the chance of electrical failure as the result of arcing or frayed lead wires. The rugged construction and proven reliability of the SBE design is uniquely suited for all industrial environments.

### Features

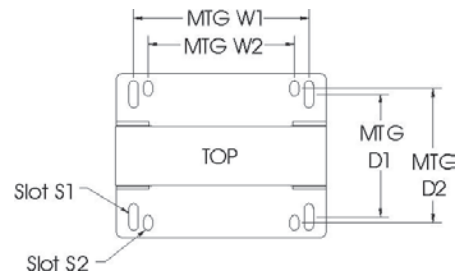
- 50 - 1000 VA, 50/60 Hz – suitable for worldwide applications.
- Interleaved copper windings reduce I<sup>2</sup>R losses and maximize efficiency.
- 55°C Rise, 105°C insulation system to minimize heat
- Epoxy encapsulated to protect cores and coils against moisture, dirt, and other contaminants.
- Meets or Exceeds NEMA Standard ST 1 and ANSI C89.1 for load inrush capability.
- Integrally molded, flame retardant (IEC 707 / ISO Class 1210) Terminal Blocks provide greater terminal contact area and improved conductivity.
- Heavy gauge steel mounting plate
- Mounting dimensions are compatible with similar control transformers.
- **Secondary fuse holders (FB2X) included for 13/32 x 1- 1/2 cartridges (fuses not included).**
- **Factory-installed fuse holders are available (See W, WA & WB options).**
- 10 + 2 year warranty



### Related Products

- Linear Power Supplies
- DIN Rail DC Power Supplies
- Constant Voltage Transformers
- Line Reactors

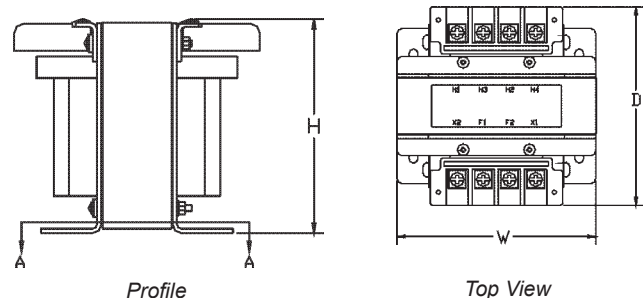
### SBE Mounting Profiles



Mounting Dimensions

### Accessories

Catalog Number	Description
FBP	Primary "CC" Rejection Type Fuse Holder (Finger Safe covers not available)
FB2	Secondary Fuse Holder only (Glass or Ceramic, 1/4" x 1 1/4" fuse)
FB2X	Secondary Fuse Holder only included where applicable. Not sold separately. (Midget Cartridge Type, 13/32" x 1 1/2" fuse)
FBPC1	Primary "CC" Rejection Type Fuse Holder and Finger Safe Cover Kit
IP20	IEC Touchproof Cover Kit
SBEDIN	IEC Fuse Holder Adaptor Kit
W	Factory installed Primary Fuse Holder with Midget Type (no covers)
WA	Factory installed Fuse Holder with Glass/Ceramic Type and Covers
WB	Factory installed Fuse Holder with Midget Type and Covers



Profile

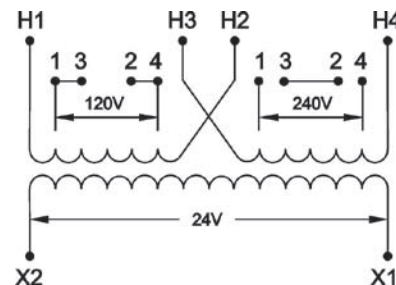
Top View

## SBE Encapsulated Series Selection Tables

### Group 1 – 120 x 240 Volt Primary, 24 Volt Secondary, 60 Hz



VA	Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050E	2.72	3.01	3.99	2.51 / NA	2.02 / NA	.20 x .33 / .20 x .33	3
75	E075E	2.96	3.39	4.36	2.81 / 2.50	2.10 / NA	.20 x .50 / .20 x .50	4
100	E100E	2.96	3.39	4.61	2.81 / 2.50	2.37 / NA	.20 x .50 / .20 x .50	5
150	E150E	3.89	4.5	4.48	3.74 / 3.12	2.56 / 2.87	.20 x .65 / .20 x .33	8
200	E200E	3.89	4.5	4.79	3.74 / 3.12	2.87 / 3.18	.20 x .65 / .20 x .33	10
250	E250E	3.89	4.5	5.21	3.74 / 3.12	3.29 / 3.61	.20 x .65 / .20 x .33	11
300	E300E	4.53	5.25	5.09	4.38 / 3.75	3.10 / NA	.31 x .71 / .31 x .71	12
350	E350E	4.53	5.25	5.53	4.38 / 3.75	3.54 / NA	.31 x .71 / .31 x .71	15
500	E500E	4.53	5.25	6.31	4.38 / 3.75	4.33 / NA	.31 x .85 / .31 x .85	19
750	E750E	5.56	6.38	6.93	5.32 / 4.37	4.25 / 5.75	.31 x .85 / .31 x .85	31



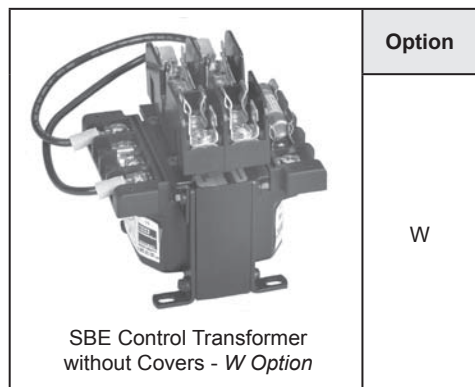
Note: Includes FB2X Secondary fuse holder.

### Group 1A – Factory Installed Primary Fuse Holder Class "CC" and:

- W - Secondary Fuse Holder (Midget Cartridge, 13/32" x 1 1/2" fuse) supplied, no covers
- WA - Secondary Fuse Holder (Glass or Ceramic - Type 3AG, 1/4" x 1 1/4" fuse type)
- WB - Secondary Fuse Holder (Midget Cartridge, 13/32" x 1 1/2" fuse)

VA	Primary Fuse Holder Class "CC"			Dimensions						
	W Option - Midget Type Catalog Number	WA Option - Type 3AG w/ Covers Catalog Number	WB Option - Midget Type w/ Covers Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050EW	E050EWA	E050EWB	4.18	3.01	3.99	2.51 / NA	2.02 / NA	.20 x .33 / .20 x .33	3
75	E075EW	E075EWA	E075EWB	4.41	3.39	4.36	2.81 / 2.50	2.10 / NA	.20 x .50 / .20 x .50	4
100	E100EW	E100EWA	E100EWB	4.41	3.39	4.61	2.81 / 2.50	2.37 / NA	.20 x .50 / .20 x .50	5
150	E150EW	E150EWA	E150EWB	5.36	4.5	4.48	3.74 / 3.12	2.56 / 2.87	.20 x .65 / .20 x .33	8
200	E200EW	E200EWA	E200EWB	5.36	4.5	4.79	3.74 / 3.12	2.87 / 3.18	.20 x .65 / .20 x .33	10
250	E250EW	E250EWA	E250EWB	5.36	4.5	5.21	3.74 / 3.12	3.29 / 3.61	.20 x .65 / .20 x .33	11
300	E300EW	E300EWA	E300EWB	5.99	5.25	5.09	4.38 / 3.75	3.10 / NA	.31 x .71 / .31 x .71	12
350	E350EW	E350EWA	E350EWB	5.99	5.25	5.53	4.38 / 3.75	3.54 / NA	.31 x .71 / .31 x .71	15
500	E500EW	NA	E500EWB	5.99	5.25	6.31	4.38 / 3.75	4.33 / NA	.31 x .85 / .31 x .85	19
750	E750EW	NA	E750EWB	7.01	6.38	6.93	5.32 / 4.37	4.25 / 5.75	.31 x .85 / .31 x .85	31

Notes: WA and WB suffix include Finger Safe covers. Fuses not included. FB2 sold separately for W option. Secondary fusing assembly required.



Option	Secondary Fusing	
WA	Glass/ Ceramic - Type 3AG (FB2)	
WB	Midget Type (FB2X)	

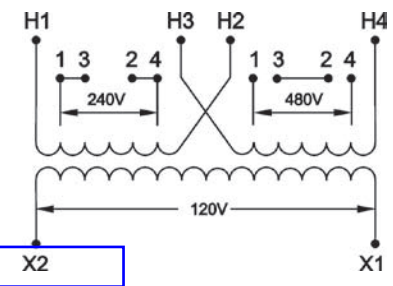
## SBE Encapsulated Series Selection Tables

E500

**Group 2 – 220 x 440 Volt Primary, 110 Volt Secondary, 50/60 Hz**  
**230 x 460 Volt Primary, 115 Volt Secondary, 50/60 Hz**  
**240 x 480 Volt Primary, 120 Volt Secondary, 60 Hz**



VA	Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050	2.72	3.01	3.99	2.51 / NA	2.02 / NA	.20 x .33 / .20 x .33	3
75	E075	2.96	3.39	4.36	2.81 / 2.50	2.10 / NA	.20 x .50 / .20 x .50	4
100	E100	2.96	3.39	4.61	2.81 / 2.50	2.37 / NA	.20 x .50 / .20 x .50	5
150	E150	3.89	4.5	4.48	3.74 / 3.12	2.56 / 2.87	.20 x .65 / .20 x .33	8
200	E200	3.89	4.5	4.79	3.74 / 3.12	2.87 / 3.18	.20 x .65 / .20 x .33	10
250	E250	3.89	4.5	5.21	3.74 / 3.12	3.29 / 3.61	.20 x .65 / .20 x .33	11
300	E300	4.53	5.25	5.09	4.38 / 3.75	3.10 / NA	.31 x .71 / .31 x .71	12
350	E350	4.53	5.25	5.53	4.38 / 3.75	3.54 / NA	.31 x .71 / .31 x .71	15
500	E500	4.53	5.25	6.31	4.38 / 3.75	4.33 / NA	.31 x .85 / .31 x .85	19
750	E750	5.56	6.38	6.93	5.32 / 4.37	4.25 / 5.75	.31 x .85 / .31 x .85	31
1000	E1000	5.56	6.38	7.36	5.32 / 4.37	4.68 / 6.18	.31 x .85 / .31 x .85	36



Note: Includes FB2X Secondary fuse holder.

### Group 2A – Factory Installed Primary Fuse Holder Class "CC" and:

- W - Secondary Fuse Holder (Midget Cartridge, 13/32" x 1 1/2" fuse) supplied, no covers
- WA - Secondary Fuse Holder (Glass or Ceramic - Type 3AG, 1/4" x 1 1/4" fuse type)
- WB - Secondary Fuse Holder (Midget Cartridge, 13/32" x 1 1/2" fuse)

VA	Primary Fuse Holder Class "CC"			Dimensions						
	W Option - Midget Type Catalog Number	WA Option - Type 3AG w/ Covers Catalog Number	WB Option - Midget Type w/ Covers Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050W	E050WA	E050WB	4.18	3.01	3.99	2.51 / NA	2.02 / NA	.20 x .33 / .20 x .33	3
75	E075W	E075WA	E0750WB	4.41	3.39	4.36	2.81 / 2.50	2.10 / NA	.20 x .50 / .20 x .50	4
100	E100W	E100WA	E100WB	4.41	3.39	4.61	2.81 / 2.50	2.37 / NA	.20 x .50 / .20 x .50	5
150	E150W	E150WA	E150WB	5.36	4.5	4.48	3.74 / 3.12	2.56 / 2.87	.20 x .65 / .20 x .33	8
200	E200W	E200WA	E200WB	5.36	4.5	4.79	3.74 / 3.12	2.87 / 3.18	.20 x .65 / .20 x .33	10
250	E250W	E250WA	E250WB	5.36	4.5	5.21	3.74 / 3.12	3.29 / 3.61	.20 x .65 / .20 x .33	11
300	E300W	E300WA	E300WB	5.99	5.25	5.09	4.38 / 3.75	3.10 / NA	.31 x .71 / .31 x .71	12
350	E350W	E350WA	E350WB	5.99	5.25	5.53	4.38 / 3.75	3.54 / NA	.31 x .71 / .31 x .71	15
500	E500W	E500WA	E500WB	5.99	5.25	6.31	4.38 / 3.75	4.33 / NA	.31 x .85 / .31 x .85	19
750	E750W	E750WA	E750WB	7.01	6.38	6.93	5.32 / 4.37	4.25 / 5.75	.31 x .85 / .31 x .85	31
1000	E1000W	E1000WA	E1000WB	7.01	6.38	7.36	5.32 / 4.37	4.68 / 6.18	.31 x .85 / .31 x .85	36

Notes: WA and WB suffix include Finger Safe covers. Fuses not included.  
W option for secondary fusing requires assembly (FB2 sold separately).

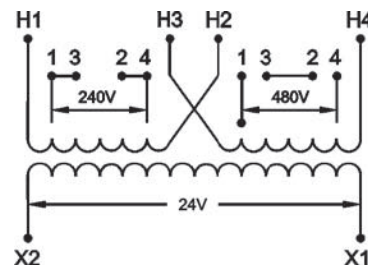
<p>SBE Control Transformer without Covers - W Option</p>	Option	<p>SBE Control Transformer with Covers - WA &amp; WB Option</p>	Option	Secondary Fusing	
	W		WA	Glass/ Ceramic - Type 3AG (FB2)	
			WB	Midget Type (FB2X)	

## SBE Series Selection Tables - continued

### Group 3 – 240 x 480 Volt Primary, 24 Volt Secondary, 60 Hz



VA	Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050D	2.72	3.01	3.99	2.51/NA	2.02/NA	.20 x .33	3
100	E100D	2.96	3.39	4.61	2.81/2.50	2.37/NA	.20 x .50	5
250	E250D	3.89	4.5	5.21	3.74/3.12	3.29/3.61	.20 x .65	11
500	E500D	4.53	5.25	6.31	4.38/3.75	4.33/NA	.31 x .71	19

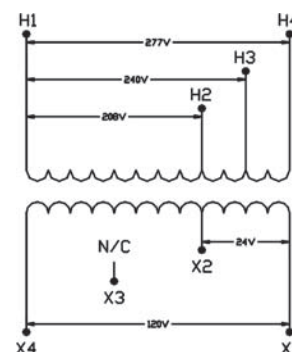


Note: Includes FB2X Secondary fuse holder.

### Group 4 – 208/240/277 Volt Primary, 120/24 Volt Secondary, 60 Hz



VA	Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050JL	2.72	3.01	3.99	2.51/NA	2.02/NA	.20 x .33	3
100	E100JL	2.96	3.39	4.61	2.81/2.50	2.37/NA	.20 x .50	5
250	E250JL	3.89	4.5	5.21	3.74/3.12	3.29/3.61	.20 x .65	11
500	E500JL	4.53	5.25	6.31	4.38/3.75	4.33/NA	.31 x .71	19

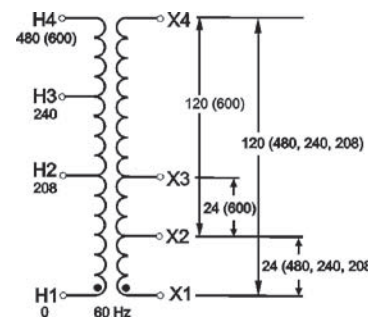


Note: Will only accept one FB2 secondary fuse holder. Will not accept FB2X secondary fuse holder.

### Group 5 – 208/240/480/600 Volt Primary, 120/24 Volt Secondary, 60 Hz 200/230/460/575 Volt Primary, 115/23 Volt Secondary, 60 Hz



VA	Catalog Number	Height (inch)	Width (inch)	Depth (inch)	Mtg Width W1 / W2	Mtg Depth D1 / D2	Slot Size S1 / S2	Approx. Ship Weight (lbs)
50	E050JN	2.96	3.39	4.36	2.81/2.50	2.10/NA	.20 x .50	4
100	E100JN	3.89	4.5	4.48	3.74/3.12	2.56/2.87	.20 x .65	8
150	E150JN	3.89	4.5	5.21	3.74/3.12	3.29/3.61	.20 x .65	11
250	E250JN	4.53	5.25	5.53	4.38/3.75	3.54/NA	.31 x .71	15
500	E500JN	5.56	6.38	6.93	5.32/4.37	4.25/5.75	.31 x .85	30



Note: Will only accept one FB2 secondary fuse holder. Will not accept FB2X secondary fuse holder.



# USCC & USM

## 24, 48 & 600 VOLT/ULTRASAFE™ FUSEHOLDERS



### ULTRASAFE MODULAR FUSE HOLDERS

Ferraz Shawmut ULTRASAFE™ modular 24, 48 and 600 volt Fuse Holders introduce a new level of safety for Class CC (USCC) and Midget 1-1/2" x 13/32" (USM) as well as DC rated fuses up to 30 amperes. ULTRASAFE holders qualify as "finger safe" under IEC and DIN standards to an IP20 grade of protection, including fuse changing (with the flick of a finger). ULTRASAFE holders are available in 1, 2, 3 or 4 poles, with or without blown-fuse indicators in each pole. AC indicators are orange and DC are red. The multi-pole units can also be made up by ordering pin-tie handles for field assembly. ULTRASAFE holders save up to 15% mounting space and any combination can be snapped onto 35mm DIN rail for extra savings in panel building time. ULTRASAFE holders with Class CC fuses chosen for Type "2" protection give one of the safest protection packages in the industry. Ultrasafe body material is tough and durable polyamide, with exceptional insulating properties.

#### HIGHLIGHTS:

- Finger Safe
- Optional Indicator Lights
- DIN Rail Mount
- Compact Footprint
- Quick, Easy Fuse Change

#### APPLICATIONS:

- All circuits up to 600 volts for motors, control circuits, transformers, etc.
- Non-load disconnect
- 12, 24 and 48 volt DC circuits

#### RECOMMENDED FUSE USAGE

**USCC** ..... use with **ATDR\***, **ATMR**, **ATQR**

**USM** ..... use with **ATQ**, **ATM\***, **A6Y-2B**, **A25Z-2**, **TRM**, **OTM**, **A15QS-2**, **GFN**, **GGU**, **A60Q-2**

\* Recommended for DC Applications DCT

#### Ratings

- **600VAC, 30A**  
Min. voltage to operate indicator light:  
90VAC 115 VDC  
[Less than 0.7 mA leakage current at 600V]
- Special Indicator for 24VDC, 30A
- Special Indicator for 48VDC, 30A
- Short Circuit Current Rating: Class CC 200kA, Midget Fuse 100kA
- 800VAC, 1000VDC 30A ratings on USM without indicators

#### Approvals

- All Ultrasafe Fuse Holders meet the requirements of UL512
- UL Listed Class CC Guide IZLT, File E52283
- UL Recognized Component Midget Guide IZLT2, File E52283
- CSA Certified Class CC & Midget C22.2, Class 6225 File 32169
- IEC 269 690VAC, 32A Midget version only.



# USCC & USM

## 24, 48 & 600 VOLT/ULTRASAFE™ FUSEHOLDERS

### For use with Class CC Fuses

CATALOG NO.	DESCRIPTION
USCC1	1 pole
USCC1I	1 pole with indicator
USCC2	2 pole
USCC2I	2 pole with indicators
USCC3	3 pole
USCC3I	3 pole with indicators
USCC3IN	3 pole with indicators and a 4th neutral pole
USCC3N	3 pole with a 4th neutral pole
USCC4	4 pole
USCC4I	4 pole with indicators

### For use with Midget (1-1/2" x 13/32") Fuses

USM1	1 pole
USM1I	1 pole with indicator
USM2	2 pole
USM2I	2 pole with indicators
USM3	3 pole
USM3I	3 pole with indicators
USM3IN	3 pole with indicators and a 4th neutral pole
USM3N	3 pole with a 4th neutral pole
USM4	4 pole
USM4I	4 pole with indicators

### Special Indicator Options For use with Low Voltage DC Rated Class CC & Midget Fuses

### Neutral Link Pole

USN	1 Pole with Integral Neutral Link
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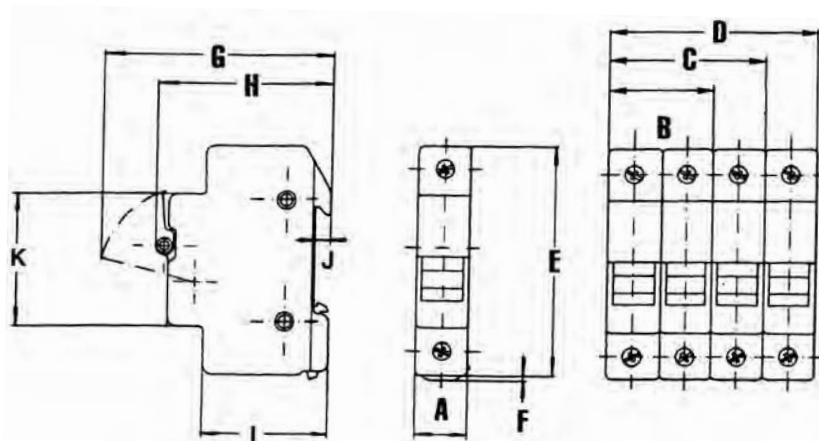
### Accessories

USPTH2	Pin-tie handle for 2 poles
USPTH3	Pin-tie handle for 3 poles
USPTH4	Pin-tie handle for 4 poles

PART NUMBER	INDICATOR TYPE	OPERATING VOLTAGE	LEAKAGE CURRENT
USM1I-DC24	LED	12 to 24 VDC	10mA max.(@24vdc)
USM1I-DC24P	LED	20 to 24 VDC	1mA max.(@24vdc)
USM1I-DC48	LED	35 to 48 VDC	10mA max.(@48vdc)
USCC1I-DC24	LED	12 to 24 VDC	10mA max.(@24vdc)
USCC1I-DC48	LED	35 to 48 VDC	10mA max.(@48vdc)

### Dimensions

DIMENSION	mm	In
A	17.5	0.69
B	35.0	1.38
C	52.5	2.07
D	70.0	2.76
E	78.0	3.07
F	2.5	0.10
G	78.0	3.07
H	59.0	2.32
I	42.5	1.67
J	5.0	0.20
K	45.0	1.77



**Terminal screws:** Phillips/slot head

**Suggested screw torque:** 14.75 in.-lbs.

**Connector type:** Pressure plate

**Wire range:** #6 to #14 (solid/stranded Cu)

**Load-break disconnect:** No



# ATQR

## TIME DELAY/CLASS CC



### TAKE *CONTROL* OF FAULT CURRENTS HEADED FOR YOUR *CONTROL* TRANSFORMER

ATQR small-dimension fuses feature time delay characteristics ideally suited for the high inrush currents of control transformers, solenoids, and similar inductive loads. The newest member of our Amp-trap 2000® family of fuses - ATQR fuses provide superior protection for the branch circuits of electrical distribution systems.

#### Features/Benefits

- **Time delay** for control transformer inrush loads without nuisance opening
- **Highly current limiting** for low peak let-thru current
- **Rejection-style design** prevents replacement errors (when used with recommended fuse blocks)
- **High-visibility orange label** ensures instant recognition, and simplifies replacement
- **Metal-embossed date and catalog number** for traceability and lasting identification
- **Fiberglass body** provides dimensional stability in harsh industrial settings
- **High-grade silica filler** ensures fast arc quenching and high current limitation

#### HIGHLIGHTS:

- Time Delay
- Best Choice for Small Transformer Protection
- Most Current-Limiting

#### APPLICATIONS:

- Control Transformers
- Solenoids
- Inductive Loads
- Lighting, Heating & General-purpose Loads

#### Ratings

- **AC:** 1/10 to 30A 600VAC, 200kA I.R.
- **DC:** 1/10 to 30A300VDC, 100kA I.R.

#### Approvals

- UL Listed to Standard 248-4
- DC Listed to UL Standard 248
- CSA Certified to Standard C22.2 No. 248.4



# TIME DELAY/CLASS CC FUSES

ATQR

## Standard Fuse Ampere Ratings, Catalog Numbers

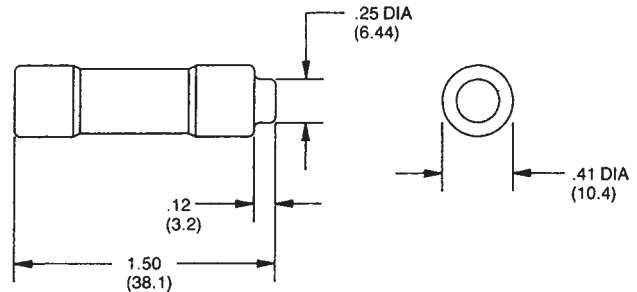
AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER
1/10	ATQR1/10	8/10	ATQR8/10	2-8/10	ATQR2-8/10	7-1/2	ATQR7-1/2
1/8	ATQR1/8	1	ATQR1	3	ATQR3	8	ATQR8
3/16	ATQR3/16	1-1/8	ATQR1-1/8	3-2/10	ATQR3-2/10	9	ATQR9
2/10	ATQR2/10	1-1/4	ATQR1-1/4	3-1/2	ATQR3-1/2	10	ATQR10
1/4	ATQR1/4	1-4/10	ATQR1-4/10	4	ATQR4	12	ATQR12
3/10	ATQR3/10	1-1/2	ATQR1-1/2	4-1/2	ATQR4-1/2	15	ATQR15
4/10	ATQR4/10	1-6/10	ATQR1-6/10	5	ATQR5	17-1/2	ATQR17-1/2
1/2	ATQR1/2	1-8/10	ATQR1-8/10	5-6/10	ATQR5-6/10	20	ATQR20
6/10	ATQR6/10	2	ATQR2	6	ATQR6	25	ATQR25
3/4	ATQR3/4	2-1/4	ATQR2-1/4	6-1/4	ATQR6-1/4	30	ATQR30
		2-1/2	ATQR2-1/2	7	ATQR7		



## Recommended ATQR Class CC Primary Fuses For Single Phase Control Transformers

TRANS VA	PRIMARY		ATOR AMPS	TRANS VA	PRIMARY		ATOR AMPS
	VOLTS	FLA			VOLTS	FLA	
25	600	0.04	1/10	300	600	0.50	1-1/8
	480	0.05	1/10		480	0.63	1-1/2
	240	0.10	2/10		240	1.25	2-1/2
	208	0.12	1/4		208	1.44	3
	120	0.21	4/10		120	2.5	5*
50	600	0.08	1/4	500	600	0.83	1-1/2
	480	0.10	1/4		480	1.04	2
	240	0.21	4/10		240	2.08	4*
	208	0.24	1/2		208	2.40	6*
	120	0.42	6/10		120	4.17	10*
75	600	0.13	1/4	750	600	1.25	2-1/2
	480	0.16	3/10		480	1.56	3
	240	0.31	1/2		240	3.13	7*
	208	0.36	3/4		208	3.61	8*
	120	0.63	1		120	6.25	15*
100	600	0.17	3/10	1000	600	1.67	3
	480	0.21	4/10		480	2.08	4*
	240	0.42	6/10		240	4.16	10*
	208	0.48	1		208	4.81	12*
	120	0.83	1-1/2		120	8.33	20*
150	600	0.25	1/2	1500	600	2.50	5*
	480	0.31	1/2		480	3.13	7*
	240	0.63	1		240	6.25	10
	208	0.72	1-1/2		208	7.21	20*
	120	1.25	2-1/2		120	12.5	25*
200	600	0.33	1/2	2000	600	3.33	8*
	480	0.42	6/10		480	4.17	10*
	240	0.83	1-1/2		240	8.33	20+*
	208	0.96	2		208	9.62	20+*
	120	1.67	3				
250	600	0.42	6/10	3000	600	5.00	12+*
	480	0.52	1-1/8		480	6.25	15+*
	240	1.04	2		240	12.5	30+*
	208	1.2	3				
	120	2.08	4*		5000	600	8.33
			480	10.4		25+*	

## Dimensions



## Recommended Fuse Blocks for Class CC Fuses

Number of Poles	ULTRASAFE™ Indicating Fuse Holder	Screw with Double Quick Connects	Pressure Plate with Double Quick Connects	Copper Box Connector
<b>ADDER</b>		30310R	30320R	30350R
<b>1</b>	USCC1I	30311R	30321R	30351R
<b>2</b>	USCC2I	30312R	30322R	30352R
<b>3</b>	USCC3I	30313R	30323R	30353R

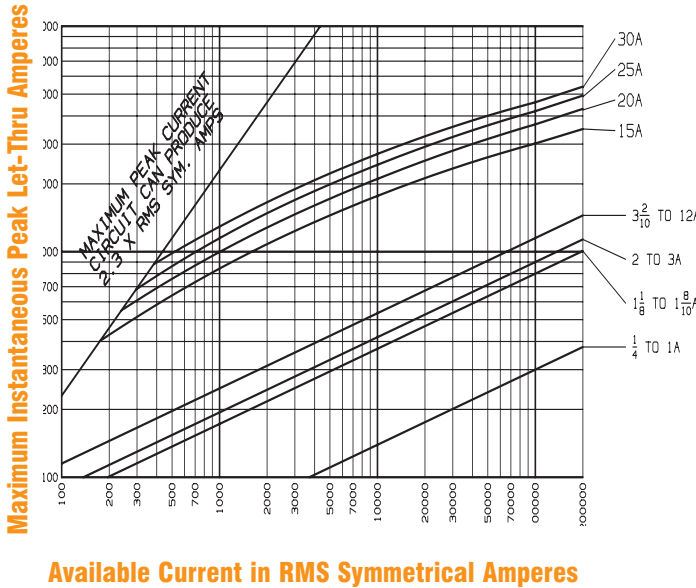
Primary fuses - If primary FLA is less than 2 amps, fuse may be 300% max. (500% for motor control). If primary FLA exceeds 2 amps but is less than 9 amps, fuse may not exceed 167% of primary FLA unless secondary protection is used, when it may be increased to 250%. Fuse sizes shown are based on approx. 40 x FLA for .01 sec.

- \* Secondary protection is required for these ratings.
- + Fuse will withstand 30 x FLA for .01 second
- ++ Fuse will withstand 25 x FLA for .01 second

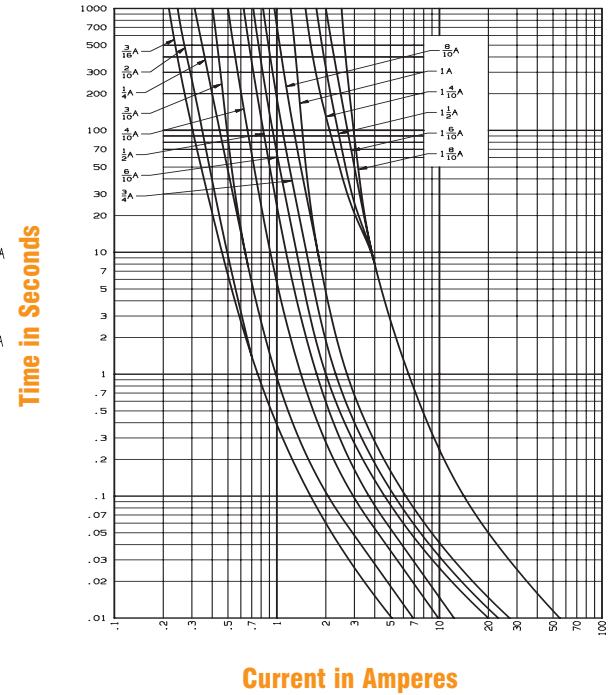
# TIME DELAY/CLASS CC FUSES

ATQR

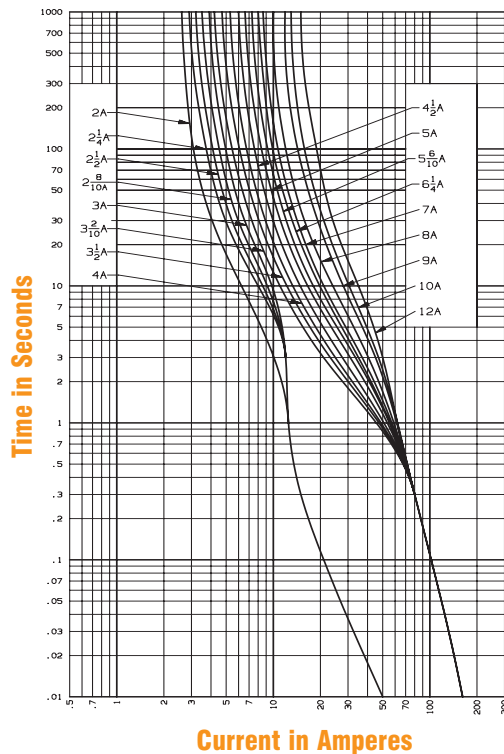
Peak Let-Through Current Data—ATQR 1/4 to 30, 600 Volts AC



Melting Time-Current Data ATQR 3/16 to 1-8/10, 600 Volts



Melting Time-Current Data ATQR 2 to 30, 600 Volts AC



AMP-TRAP 2000®

# ATDR

## TIME DELAY/CLASS CC



### THE BEST PROTECTION FOR TODAY'S SMALL MOTORS.

Amp-trap 2000® ATDR small-dimension fuses can provide IEC Type 2 “no damage” protection to your facility’s increasingly sensitive branch circuit components and small motors – minimizing the risk of fault-related damage. ATDR Class CC fuses deliver the best time delay characteristics in their class with excellent cycling ability for small motor loads.

A

#### Features/Benefits

- **Time delay** for motor starting inrush currents without nuisance opening
- **Highly current limiting** for low peak let-thru current
- **Improved cycling ability** for frequent motor starts/stops without nuisance fuse opening
- **Rejection-style design** prevents replacement errors (when used with recommended fuse blocks)
- **High-visibility orange label** ensures instant recognition, simplifies replacement
- **Metal-embossed date and catalog number** for traceability and lasting identification
- **Fiberglass body** provides dimensional stability in harsh industrial settings
- **High-grade silica filler** ensures fast arc quenching and optimum current limitation

#### HIGHLIGHTS:

- Time Delay
- Best Choice for Small Motor Protection
- Highly Current-Limiting
- AC & DC Rated

#### APPLICATIONS:

- Small Motors
- Contactors
- Lighting, Heating & General Loads
- Branch Circuit Protector

#### Ratings

- **AC:** 1/4 to 30A  
600VAC, 200kA I.R.
- **DC:** 1/4 to 30A  
300VDC, 100kA I.R.

#### Approvals

- UL Listed to Standard 248-4 File 2137
- CSA Certified to Standard C22.2 No. 248.4
- DC Listed to UL Standard 248



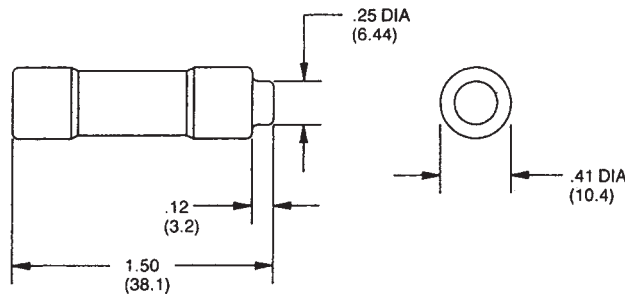
# TIME DELAY/CLASS CC FUSES

ATDR

## Standard Fuse Ampere Ratings, Catalog Numbers

AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER
1/4	ATDR1/4	1-1/2	ATDR1-1/2	3	ATDR3	6	ATDR6	12	ATDR12
1/2	ATDR1/2	1-6/10	ATDR1-6/10	3-2/10	ATDR3-2/10	6-1/4	ATDR6-1/4	15	ATDR15
8/10	ATDR8/10	1-8/10	ATDR1-8/10	3-1/2	ATDR3-1/2	7	ATDR7	17-1/2	ATDR17-1/2
1	ATDR1	2	ATDR2	4	ATDR4	7-1/2	ATDR7-1/2	20	ATDR20
1-1/8	ATDR1-1/8	2-1/4	ATDR2-1/4	4-1/2	ATDR4-1/2	8	ATDR8	25	ATDR25
1-1/4	ATDR1-1/4	2-1/2	ATDR2-1/2	5	ATDR5	9	ATDR9	30	ATDR30
1-4/10	ATDR1-4/10	2-8/10	ATDR2-8/10	5-6/10	ATDR5-6/10	10	ATDR10		

## Dimensions



## Small Motor Fuse Protection, 600 Volts AC or Less

MOTOR FULL LOAD AMPERES	ATDR RATING*	
	MINIMUM DUTY	NORMAL DUTY
.71 - .89	1-1/4	1-6/10
.90 - 1.19	1-6/10	2
1.20 - 1.34	2	2-1/2
1.35 - 1.79	2-1/2	3
1.80 - 2.25	3	4
2.26 - 2.69	4	5
2.70 - 2.90	4	6
2.91 - 3.20	5	6
3.21 - 3.75	5	7
3.76 - 4.50	6	8
4.51 - 5.34	8	10
5.35 - 5.69	10	12
5.70 - 6.70	12	12
6.71 - 7.79	12	15
7.80 - 8.88	15	17-1/2
8.89 - 11.1	17-1/2	20
11.2 - 13.3	20	25
13.4 - 15.2	25	30

## Recommended Fuse Blocks for Class CC Fuses

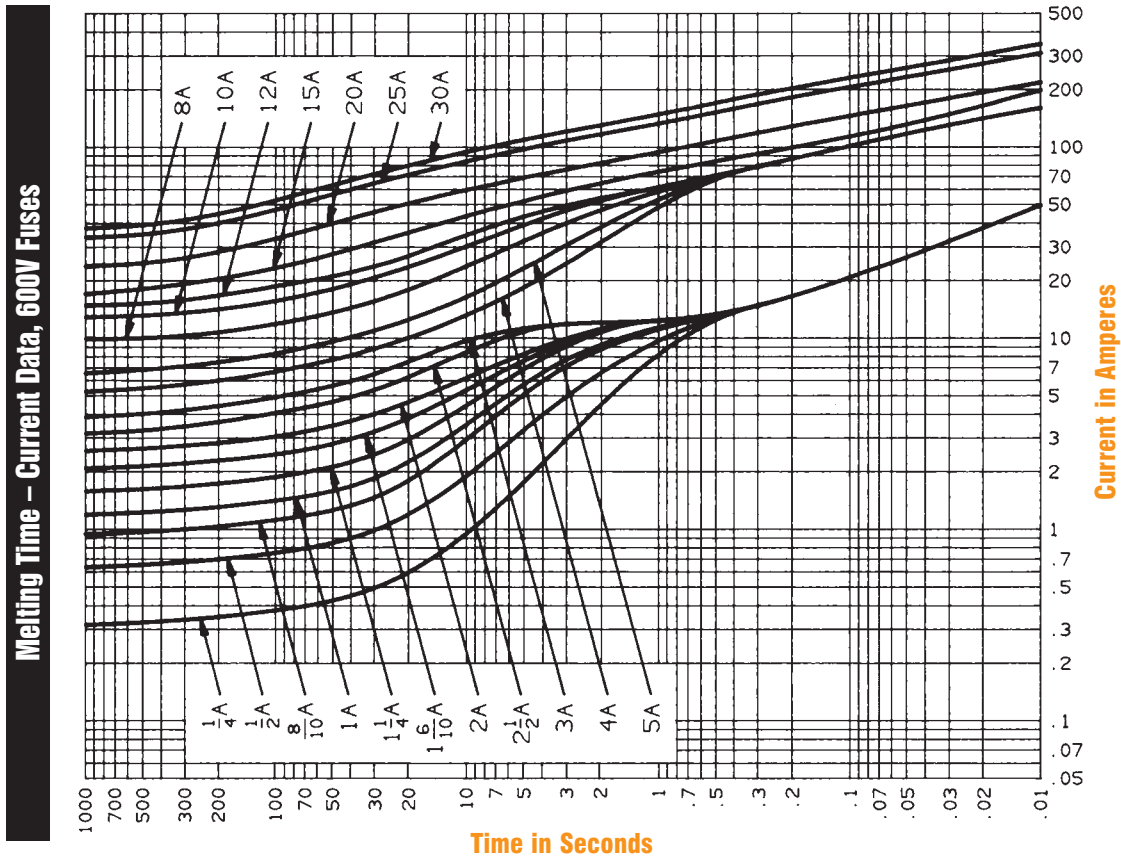
Number of Poles	CATALOG NUMBER			
	ULTRASAFE™ Indicating Fuse Holder	Screw Connector w/ Double Quick Connects	Pressure Plate Connector w/ Double Quick Connects	Copper Box Connector
<b>ADDER</b>				
<b>1</b>	USCC1I	30310R	30320R	30350R
<b>2</b>	USCC2I	30311R	30321R	30351R
<b>3</b>	USCC3I	30312R	30322R	30352R
		30313R	30323R	30353R

\* The National Electrical Code allows time-delay Class CC fuses to be sized at up to 400% (maximum) of motor FLA, if needed.

# TIME DELAY/CLASS CC FUSES

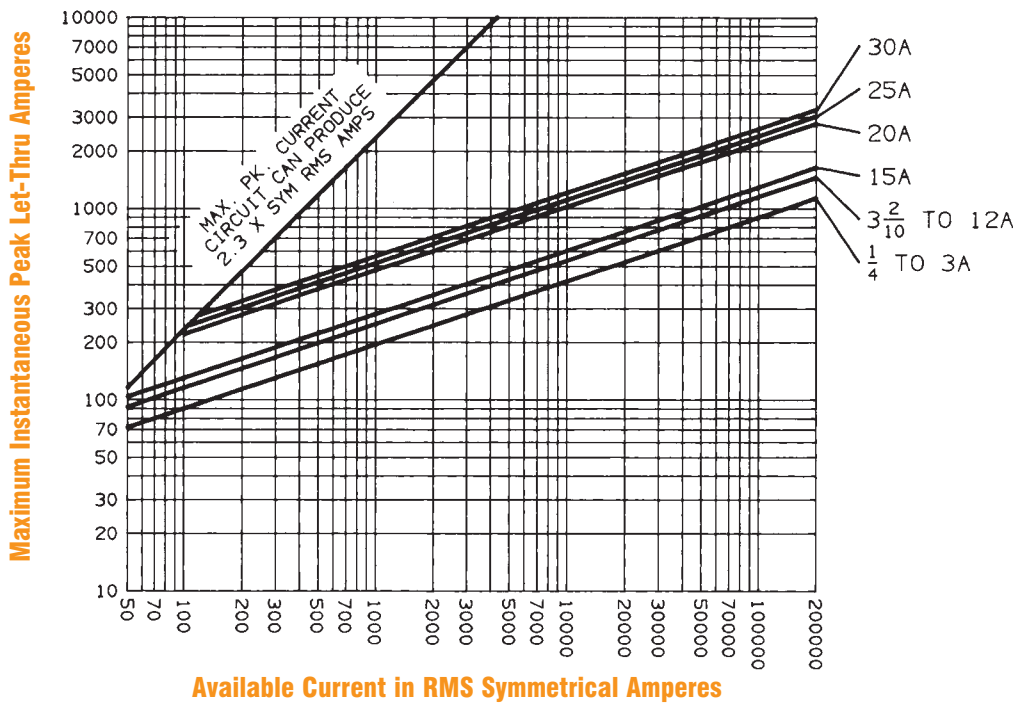
ATDR

ATDR1/4 to 30



**A**

**Peak Let-Thru Current Data – ATDR1/4 to 30, 600 Volts AC**



# **ELECTRICAL WIRE & CABLE**

**Operations & Maintenance Manual  
December 2015**



Eisenhower/Johnson Memorial Tunnel Fire Suppression System  
Wire

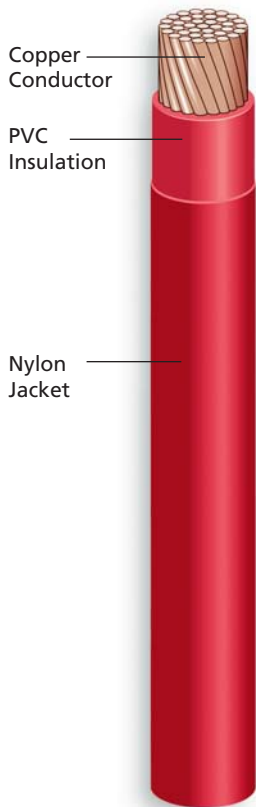
1. Wire and Fiber	1
a. Encore XHHW	2
b. Encore Bare Copper	3
c. Cerrowire XHHW	4
d. Cerrowire Bare Copper	5
e. Southwire XHHW	7
f. Southwire Bare Copper	9
g. Anixter THHN	12
h. Anixter XHHW 2	14
i. Anixter TFN/TFN	16
j. Anixter PVC-Nylon	17
k. Hitachi Multimode Fiber	19
l. Altos Multimode Fiber	20
m. Belden Multi Conductor	24
2. Wire Accessories	28
a. Thomas and Bets Sta-Kon	29
b. Thomas and Bets Lugs	35
c. Ideal Terminations	39
d. 3M Scotchlock	44
3. Wire Pulling Lubricant	47
a. Polywater	48
b. Dyna-Blue	55
c. Ideal	60



# THHN / MTW / THWN-2 COPPER CONDUCTOR

TYPE THHN / MTW / THWN-2 COPPER CONDUCTOR

800.962.9473



## Engineering Specifications:

### Standards:

Underwriters Laboratories Standard UL-83, UL-1063, UL-758  
 AWM Spec 1316, 1317, 1318, 1319, 1320, 1321  
 ASTM Stranding Class B3, B8, B787  
 Federal Specification A-A-59544  
 Canadian Standards Association C22.2 No. 75  
 NEMA WC70/ICEA S-95-658



Listed Solid E-123774  
 Stranded E-156879

### Construction:

#### Conductors:

Solid, uncoated copper conductors per ASTM-B3  
 Stranded, uncoated copper conductors per ASTM-B3, ASTM-B787 and ASTM-B8

#### Insulation:

Color-coded Polyvinyl Chloride (PVC), heat- and moisture-resistant, flame-retardant compound per UL-1063 and UL-83

#### Applications:

Type THHN-THWN-2 building wire is intended for general purpose applications as defined by the National Electrical Code (NEC). Suitable for new construction or rewiring for 600-volt applications. When used as type THHN or THWN-2, the conductor is suitable for use in wet or dry locations at temperatures not to exceed 90°C or not to exceed 75°C in oil or coolants. When used as type MTW, conductor is suitable for use in dry locations at 90°C, or not to exceed 60°C in wet locations or where exposed to oils or coolants. When used as type AWM temperatures should not exceed 105°C in dry locations.

#### Features:

Slick, Nylon outer jacket for easy pulling. VW-1 rated 14 AWG - 1 AWG. 1/0 AWG and larger is rated for CT use. 6 AWG and larger is rated for sunlight resistance in all colors. All sizes are rated "Gasoline and oil resistant II."

#### Jacket:

A tough, polyamide, Nylon outer covering per UL-1063 and UL-83.

Size (AWG or kcmil)	Number of Strands	Conductor Size (mm <sup>2</sup> )	Insulation Thickness (inches)		Outside Diameter		Allowable Ampacities*			Approx. Net Weight (lbs./1000 ft.)	Standard Packaging
			PVC	Nylon	(inches)	(mm)	60°C	75°C	90°C		
14	Solid	2.08	.015	.004	.101	2.57	15	15	15	15	2000 carton (4x500), 2500' reels
12	Solid	3.31	.015	.004	.120	3.05	20	20	20	23	2000 carton (4x500), 2500' reels
10	Solid	5.26	.020	.004	.149	3.78	30	30	30	37	1000 carton (2x500), 2500' reels
14	19	2.08	.015	.004	.109	2.77	15	15	15	17	2000 carton (4x500), 2500' reels
12	19	3.31	.015	.004	.127	3.23	20	20	20	24	2000 carton (4x500), 2500' reels
10	19	5.26	.020	.004	.160	4.07	30	30	30	38	1000 carton (2x500), 2500' reels
8	19	8.37	.030	.005	.212	5.39	40	50	55	63	500' 1000' 2500' 5000' reels
6	19	13.3	.030	.005	.248	6.30	55	65	75	95	500' 1000' 2500' 5000' 25,000' reels
4	19	21.2	.040	.006	.317	8.06	70	85	95	153	500' 1000' 2500' 5000' 20,000' reels
3	19	26.7	.040	.006	.344	8.74	85	100	110	189	500' 1000' 2500' 5000' 15,000' reels
2	19	33.6	.040	.006	.375	9.53	95	115	130	234	500' 1000' 2500' 5000' 14,000' reels
1	19	42.4	.050	.007	.435	11.05	110	130	150	299	500' 1000' 2500' 5000' 22,000' reels
1/0	19	53.5	.050	.007	.474	12.04	125	150	170	372	500' 1000' 2500' 5000' 16,000' reels
2/0	19	67.4	.050	.007	.518	13.16	145	175	195	462	500' 1000' 2500' 5000' 14,000' reels
3/0	19	85.0	.050	.007	.568	14.43	165	200	225	572	500' 1000' 2500' 5000' 12,000' reels
4/0	19	107	.050	.007	.624	15.85	195	230	260	712	500' 1000' 2500' 5000' 9000' reels
250	37	127	.060	.008	.678	17.23	215	255	290	851	500' 1000' 2500' 4000' 8500' reels
300	37	152	.060	.008	.730	18.55	240	285	320	1010	500' 1000' 3500' 7500' reels
350	37	177	.060	.008	.777	19.74	260	310	350	1170	500' 1000' 3000' 6000' reels
400	37	203	.060	.008	.821	20.86	280	335	380	1330	500' 1000' 3000' 5000' reels
500	37	253	.060	.008	.902	22.91	320	380	430	1650	500' 1000' 2500' 4000' reels
600	61	304	.070	.009	1.051	26.70	355	420	475	1985	500' 1000' 2000' 3000' reels
750	61	380	.070	.009	1.156	29.37	400	475	535	2455	500' 1000' 1500' 2500' reels
1000	61	507	.070	.009	1.310	33.28	455	545	615	3252	500' 1000' 2000' reels

\*Allowable ampacity shown above is per the National Electrical Code. The above data is approximate and subject to normal manufacturing tolerances.

#### PRINT LEGEND:

SOLID CONDUCTOR SIZES 14 AWG THROUGH 10 AWG: E123774 (size) AWG TYPE THHN OR THWN-2 GR II VW-1 600 VOLTS (UL) OR AWM OR C-(UL) TYPE T90 NYLON OR TWN 75 FT1. DATE/TIME/OPER/QC  
 STRANDED CONDUCTOR SIZES 14 AWG THROUGH 8 AWG: E156879 (size) AWG TYPE MTW OR THHN OR THWN-2 GR II VW-1 600 VOLTS (UL) OR AWM OR C-(UL) TYPE T90 NYLON OR TWN 75 FT1 DATE/TIME/OPER/QC  
 STRANDED CONDUCTORS-SIZES 6 AWG THROUGH 1 AWG: E156879 (size) TYPE MTW OR THHN OR THWN-2 GR II SUN RES VW-1 600 VOLTS (UL) OR AWM OR C(UL) TYPE T90 NYLON OT TWN 75 FT1 DATE/TIME/OPER/QC  
 CONDUCTOR SIZES 1/0 AWG THROUGH 1000 KCMIL: E156879 (size) TYPE MTW OR THHN OR THWN-2 GR II SUN-RES FOR CT USE (UL) OR C(UL) TYPE T90 NYLON OR TWN 75 FT1 DATE/TIME/OPER/QC

# SIMpull THHN® CABLE



600 Volt

Copper Conductor

Thermoplastic Insulation/  
SIM® Nylon Sheath

Heat, Moisture, Gasoline,  
and Oil Resistant<sup>1</sup> Rated  
MTW and THWN-2\*

Sizes Through 500 kcmil  
Listed T90 Nylon or TWN 75

Sizes Through 500  
kcmil Listed FT1

Size 1/0 and Larger Listed  
for CT Use

Black Sizes Listed  
Sunlight Resistant

Patented SIM Technology®  
for Easier Pulling

## APPLICATIONS Suitable for use as follows:

Southwire SIMpull THHN® or THWN-2\* conductors are primarily used in conduit and cable trays for services, feeders, and branch circuits in commercial or industrial applications as specified in the National Electrical Code®<sup>2</sup>. When used as Type THHN, or T90, conductor is suitable for use in dry locations at temperatures not to exceed 90°C. When used as Type THWN-2\* or TWN75, conductor is suitable for use in wet or dry locations at temperatures not to exceed 90°C or not to exceed 75°C when exposed to oil or coolant. When used as Type MTW, conductor is suitable for use in wet locations or when exposed to oil or coolant at temperatures not to exceed 60°C or dry locations at temperatures not to exceed 90°C (with ampacity limited to that for 75°C conductor temperature per NFPA 79). Voltage for all applications is 600 volts. This cable may be installed without the need for pulling lubricant.

## STANDARDS & REFERENCES

Southwire SIMpull THHN® or THWN-2\* or MTW (also AWM) meets or exceeds all applicable ASTM specifications, UL Standard 83, UL Standard 1063 (MTW), CSA, Federal Specification A-A-59544, and requirements of the National Electrical Code®.

## CONSTRUCTION

Southwire SIMpull THHN® or THWN-2\* or MTW copper conductors are annealed (soft) copper, compressed strand, insulated with a tough heat and moisture resistant polyvinyl chloride (PVC), over which a SIM (SLIKQWIK® Infused Membrane) nylon (polyamide) or UL-listed equal jacket is applied. Available in black, white, red, blue, green, yellow, brown, orange and gray. Grounds available in sizes 8 AWG and larger in green. Some colors subject to economic order quantity. Conductor sizes 2 AWG and larger listed and marked sunlight resistant in black only. Sizes 14-10 AWG not available with SIM Technology® No Lube® jacket.

<sup>1</sup>Oil and gasoline resistant II as defined by Underwriters Laboratories

<sup>2</sup>2008 Edition

\*Rated -2 for 8 AWG and larger only



NoLube®



RoHS Compliant





# COPPER CONDUCTORS

SIMpull THHN® CABLE

## WEIGHTS, MEASUREMENTS AND PACKAGING

CONDUCTOR		INSULATION THICKNESS (mils)	JACKET THICKNESS (mils)	NOMINAL O.D. (mils)		APPROX. NET WEIGHT PER 1000 ft (lbs)		ALLOWABLE AMPACITIES*			STANDARD PACKAGE
SIZE (AWG or kcmil)	NUMBER OF STRANDS			SOL.	STR.	SOL.	STR.	60°C	75°C	90°C	
14**	19	15	4	102	109	15	16	15	15	15	DNF
12**	19	15	4	119	128	23	24	20	20	20	DNF
10**	19	20	4	150	161	37	38	30	30	30	DQF
8	19	30	5	--	213	--	62	40	50	55	F
6	19	30	5	--	249	--	95	55	65	75	E
4	19	40	6	--	318	--	152	70	85	95	C
3	19	40	6	--	346	--	188	85	100	110	BC
2	19	40	6	--	378	--	234	95	115	130	C
1	19	50	7	--	435	--	299	110	130	150	B
1/0	19	50	7	--	474	--	371	125	150	170	B
2/0	19	50	7	--	518	--	461	145	175	195	B
3/0	19	50	7	--	568	--	574	165	200	225	B
4/0	19	50	7	--	624	--	717	195	230	260	B
250	37	60	8	--	694	--	850	215	255	290	B
300	37	60	8	--	747	--	1011	240	285	320	B
350	37	60	8	--	797	--	1173	260	310	350	B
400	37	60	8	--	842	--	1333	280	335	380	B
500	37	60	8	--	926	--	1653	320	380	430	B
600	61	70	9	--	1024	--	1985	355	420	475	C
750	61	70	9	--	1126	--	2462	400	475	535	C
1000	61	70	9	--	1275	--	3254	455	545	615	C

Solid construction available in sizes 14 through 10 AWG as Types THHN or THWN or AWM only. Sizes 14 through 6 AWG also suitable for 105°C appliance wiring material (AWM). Sizes 14 and 12 AWG contain four 500 ft. spools per carton. Size 10 AWG contains two 500 ft. spools per carton.  
 \*\* Sizes 14 - 10 AWG not available with patented SIM Technology® No Lube® jacket.  
 \*Allowable ampacities shown are for general use as specified by the National Electrical Code®, 2008 Edition, section 310.15. Unless the equipment is marked for use at higher temperatures, the conductor ampacity shall be limited to the following:  
 60°C – When terminated to equipment for circuits rated 100 amperes or less or marked for size 14 through 1 AWG conductors. MTW wet locations or when exposed to oil or coolant.  
 75°C – When terminated to equipment for circuits rated over 100 amperes or marked for conductors larger than size 1 AWG. THWN-2 when exposed to oil or coolant. MTW dry locations.  
 90°C – THHN dry locations. THWN-2 wet or dry locations. For ampacity derating purposes.

### STANDARD PACKAGE CODES

- B – 1000 ft. reel
- C – 500 ft. reel
- D – 2500 ft. spool
- E – 1000 ft. spool
- F – 500 ft. spool
- N – 2000 ft. carton
- Q – 350 ft. carton



- 90°C Dry—75°C Wet/600 Volts
- Gasoline and Oil Resistant II
- Machine Tool Wire (Stranded): 90°C Dry
- Appliance Wire: 105°C Dry

- 14 AWG—10 AWG rated THHN/THWN: 90°C Dry, 75° Wet
- 8 AWG—2 AWG rated THHN/THWN-2: 90°C Dry or Wet

# THHN/THWN-2

## Vinylon® PVC/Nylon

### 14 AWG—2 AWG

#### APPLICATIONS

- 600 volt building wire for use in commercial and industrial applications as specified in the NEC®
- 14 AWG-2 AWG is marked VW-1
- 8 AWG-2 AWG in black; Rated sunlight resistant

#### CONDUCTORS

- Solid conductors: Uncoated copper per ASTM-B3
- Stranded conductors: Uncoated copper per ASTM-B3, ASTM-B787

#### INSULATION

- Color coded, heat and moisture resistant PVC (polyvinyl chloride)

#### JACKET

- Nylon (polyamide), clear on 14 AWG-2 AWG colors
- Nylon on 8 AWG-2 AWG black

#### INDUSTRY STANDARDS

- UL 83: File No. E15119
- UL 1063 (MTW): File No. E85964
- AWM: File No. E11829
- Canadian Standard C22.2 No. 75 and CSA Bulletin No. 1451
- ASTM: B3, B8, B787
- WC70/ICEA S-95-658
- Federal Specification A-A-59544
- NFPA70: National Electrical Code®

#### SURFACE PRINT

- Sample: CERRO WIRE VINYLON-A 2 AWG (UL) MTW OR THWN-2 OR THHN OR GASOLINE AND OIL RESISTANT II OR AWM SUNLIGHT RESISTANT 600V—C(UL) TWN75 OR T90 NYLON VW-1

Product Code	Conductors		Covering		Approx O.D. Inches	Allowable Ampacities*			Approx Net Wt. lbs./m ft.
	AWG Size	No. of Strands	PVC Ins. Mils.	Nylon Jkt. Mils.		60°C **	75°C ***	90°C ****	
112-14XX	14	SOL	15	4	0.104	15	15	15	15
112-16XX	12	SOL	15	4	0.120	20	20	20	23
112-18XX	10	SOL	20	4	0.151	30	30	30	37
112-34XX	14	19	15	4	0.110	15	15	15	16
112-36XX	12	19	15	4	0.130	20	20	20	24
112-38XX	10	19	20	4	0.165	30	30	30	39
112-40XX	8	19	30	5	0.217	40	50	55	63
112-42XX	6	19	30	5	0.253	55	65	75	96
112-44XX	4	19	40	6	0.322	70	85	95	153
112-45XX	3	19	40	6	0.350	85	100	110	190
112-46XX	2	19	40	6	0.380	95	115	130	233

XX Color Add Code (see chart)

\* Per Table 310-16 NEC®

\*\* For termination to equipment for circuits rated 100 amperes or less, or marked for size 14 through 1 AWG conductors. Also for MTW used in wet locations or exposed to oil or coolant.

\*\*\* For termination to equipment for circuits rated over 100 amperes or marked for conductors larger than 1 AWG. Also for THWN-2 exposed to oil or coolant and MTW in dry locations.

\*\*\*\* For THHN used in dry locations and THWN-2 used in wet or dry locations. For ampacity derating purposes.



Cerro Wire Inc.  
 1099 Thompson Road, SE | Hartselle, AL 35640  
 Phone 800.523.3869 | Fax 877.877.9563  
 www.cerrowire.com

- 90°C Dry—75°C Wet/600 Volts
- Gasoline and Oil Resistant II
- Machine Tool Wire (Stranded): 90°C Dry
- Appliance Wire: 105°C Dry

- 14 AWG—10 AWG rated THHN/THWN: 90°C Dry, 75° Wet
- 8 AWG—2 AWG rated THHN/THWN-2: 90°C Dry or Wet

# THHN/THWN-2

## Vinylon<sup>®</sup> PVC/Nylon

### 14 AWG—2 AWG

#### APPLICATIONS

- 600 volt building wire for use in commercial and industrial applications as specified in the NEC<sup>®</sup>
- 14 AWG-2 AWG is marked VW-1
- 8 AWG-2 AWG in black; Rated sunlight resistant

#### CONDUCTORS

- Solid conductors: Uncoated copper per ASTM-B3
- Stranded conductors: Uncoated copper per ASTM-B3, ASTM-B787

#### INSULATION

- Color coded, heat and moisture resistant PVC (polyvinyl chloride)

#### JACKET

- Nylon (polyamide), clear on 14 AWG-2 AWG colors
- Nylon on 8 AWG-2 AWG black

#### INDUSTRY STANDARDS

- UL 83: File No. E15119
- UL 1063 (MTW): File No. E85964
- AWM: File No. E11829
- Canadian Standard C22.2 No. 75 and CSA Bulletin No. 1451
- ASTM: B3, B8, B787
- WC70/ICEA S-95-658
- Federal Specification A-A-59544
- NFPA70: National Electrical Code<sup>®</sup>

#### SURFACE PRINT

- Sample: CERRO WIRE VINYLON-A 2 AWG (UL) MTW OR THWN-2 OR THHN OR GASOLINE AND OIL RESISTANT II OR AWM SUNLIGHT RESISTANT 600V—C(UL) TWN75 OR T90 NYLON VW-1

#### Color Available (Product Code 6th and 7th Digits)

AWG Size	Black 01	White 02	Red 03	Blue 04	Green 05	Orange 06	Yellow 07	Brown 08	Purple 09	Grey 10	Pink 11
14 solid	X	X	X	X	X	X	X	X	X	X	X
12 solid	X	X	X	X	X	X	X	X	X	X	X
10 solid	X	X	X	X	X	X	X	X	X	X	X
14 strand	X	X	X	X	X	X	X	X	X	X	X
12 strand	X	X	X	X	X	X	X	X	X	X	X
10 strand	X	X	X	X	X	X	X	X	X	X	X
8 strand	X <sup>1</sup>	X	X	X	X	X	X	X	X <sup>2</sup>	X	
6 strand	X <sup>1</sup>	X	X	X	X	X	X	X	X <sup>2</sup>	X	
4 strand	X <sup>1</sup>	X	X	X	X	X	X	X		X	
3 strand	X <sup>1</sup>	X	X	X	X	X	X	X		X	
2 strand	X <sup>1</sup>	X	X	X	X	X	X	X		X	

- 1 Only black 8 AWG and larger rated sunlight resistant
- 2 Not available in 5000' reels

Package Code	J	J	J	K	M	P	10	13	15	18
Size	500' spool 1000' ctn	500' spool 2000' ctn	500' reel	1000' reel	2500' reel	5000' reel	10000' reel	13000' reel	15000' reel	18000' reel
14,12 Solid and Strand		X			X					
10 Solid and Strand	X				X					
8 strand			X <sup>5</sup>	X <sup>5</sup>	X <sup>5</sup>	X <sup>4</sup>	X <sup>1</sup>			
6 strand			X <sup>5</sup>	X <sup>5</sup>	X <sup>5</sup>	X <sup>4</sup>	X <sup>1</sup>			
4 strand			X <sup>3</sup>	X <sup>3</sup>	X <sup>1</sup>	X <sup>4</sup>				X <sup>1</sup>
3 strand			X <sup>1</sup>	X <sup>1</sup>	X <sup>1</sup>	X <sup>4</sup>			X <sup>1</sup>	
2 strand			X <sup>3</sup>	X <sup>2</sup>	X <sup>1</sup>	X <sup>4</sup>		X <sup>1</sup>		

- 1 Available in black only
- 2 Available in black and green only
- 3 Available in black, white, red, and green only
- 4 Available in all colors except purple and pink
- 5 Available in all colors except pink



Cerro Wire Inc.

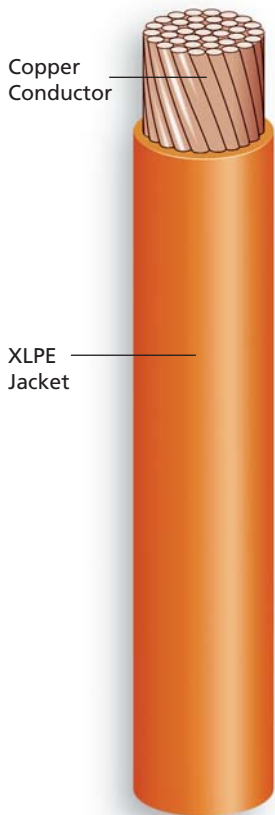
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# XHHW-2 / RW90 COPPER CONDUCTOR

XHHW-2 / RW90 COPPER CONDUCTOR



## Engineering Specifications:

### Standards:

Underwriters Laboratories Standard UL-44  
Canadian Standard C22.2 No. 38



Listed E-177544

Institute of Electrical and Electronics Engineers IEEE 1202  
Federal Specification A-A-59544  
NEMA WC-70/ICEA S-95-658  
NFPA 70: National Electrical Code

### Construction:

#### Conductors:

Stranded, uncoated bare copper per ASTM-B3, ASTM-B787 and ASTM-B8

#### Insulation:

Cross-linked polyethylene (XLPE) insulation per UL-44

#### Applications:

Type XHHW-2 conductors are primarily used in conduit or other recognized raceways for services, feeders, and branch-circuit wiring, as specified in the National Electrical Code (NEC). XHHW-2 conductors may be used in wet or dry locations at temperatures not to exceed 90°C. XHHW-2 conductors are rated for 600 volts. Suitable for use in low-leaking circuits requiring a dielectric constant of 3.5 or less. Compound is rated sunlight resistant in all colors. All cables comply with UL's VW-1 (Vertical-Wire) Flame Test. Cables pass IEEE 1202/CSA (70,000 BTU/hr) cable tray flame test. 1/0 AWG and larger may be used in cable tray in accordance with the National Electrical Code.

800.962.9473

Size (AWG or kcmil)	Number of Strands	Insulation Thickness XLPE (inches)	Outside Diameter		Allowable Ampacities**			Approx. Net Weight (lbs./1000 ft.)	Standard Packaging
			(inches)	(mm)	60°C	75°C	90°C		
14	19	.030	.131	3.33	15	15	15	18	2000' carton (4x500), 2500' reels
12	19	.030	.149	3.79	20	20	20	25	1000' carton (2x500), 2500' reels
10	19	.030	.172	4.37	30	30	30	40	500' spools, 2500' reels
8	7*	.045	.236	6.00	40	50	55	67	500' 1000' 2500' 5000' reels
6	7*	.045	.274	6.96	55	65	75	100	500' 1000' 2500' 5000' reels
4	7*	.045	.322	8.18	70	85	95	150	500' 1000' 2500' 5000' reels
3	7*	.045	.350	8.89	85	100	110	205	500' 1000' 2500' 5000' reels
2	7*	.045	.382	9.71	95	115	130	230	500' 1000' 2500' 5000' reels
1	19	.055	.431	10.95	110	130	150	291	500' 1000' 2500' 5000' reels
1/0	19	.055	.470	11.94	125	150	170	362	500' 1000' 2500' 5000' reels
2/0	19	.055	.514	13.06	145	175	195	445	500' 1000' 2500' 5000' reels
3/0	19	.055	.564	14.33	165	200	225	564	500' 1000' 2500' 5000' reels
4/0	19	.055	.620	15.75	195	230	260	707	500' 1000' 2500' 5000' reels
250	37	.065	.672	17.07	215	255	290	836	500' 1000' 2500' 4000' reels
300	37	.065	.724	19.39	240	285	320	996	500' 1000' 3500' reels
350	37	.065	.771	19.59	260	310	350	1155	500' 1000' 3000' reels
400	37	.065	.815	20.71	280	335	380	1315	500' 1000' 3000' reels
500	37	.065	.896	22.76	320	380	430	1632	500' 1000' 2500' reels
600	61	.080	1.026	26.06	355	420	475	1950	500' 1000' 2000' reels
750	61	.080	1.128	28.66	400	475	535	2440	500' 1000' 1500' reels
1000	61	.080	1.277	32.44	455	545	615	3230	500' 1000' reels

\*8 AWG-2 AWG: 19/w is available by request.

\*\*Allowable ampacity shown above is per the National Electrical Code. The above data is approximate and subject to normal manufacturing tolerances.

#### PRINT LEGEND:

STRANDED CONDUCTORS 14 AWG THROUGH 1 AWG.

E177544 (size) TYPE XHHW-2 GASOLINE AND OIL RESISTANT II VW-1 600 VOLTS XLPE (UL) OR C-(UL) TYPE RW 90 XLPE. DATE/TIME/OPER/QC

STRANDED CONDUCTORS 1/0 AWG THROUGH 1000 KCMIL.

E177544 (size) TYPE XHHW-2 GASOLINE AND OIL RESISTANT II VW-1 600 VOLTS XLPE (UL) FOR CT USE OR IEEE 1202 OR C-(UL) TYPE RW90 XLPE FT4 DATE/TIME/OPER/QC



# SOFT-DRAWN BARE COPPER CONDUCTORS

SOFT-DRAWN BARE COPPER CONDUCTORS



## Engineering Specifications:

### Standards:

ASTM-B3 for soft-drawn solid copper wire  
 ASTM-B8 for soft-drawn concentric lay stranded copper wire  
 ASTM-B787 for 19-wire combination unilay stranded wire

### Construction:

Soft-Drawn Solid or Stranded, Annealed Bare Copper

### Applications:

Copper conductors are used in overhead electrical transmission and distribution systems for grounding electrical systems, and where high-conductivity and flexibility are required for equipment and circuit grounding.

### Features:

Highest conductivity per unit area of all common commercial metals. Excellent corrosion resistance. Flexible; easily worked and formed into place. Packaged on non-returnable spools for easy transportation to job sites and to provide adequate footage for mass installations. Good fatigue resistance; not subject to breaks due to nicks or cuts when terminating. Totally recyclable with high scrap value.

800.962.9473

Size (AWG or kcmil)	Number of Strands	Outside Diameter		Area (cmils)	Soft-Drawn (Annealed)		Approx. Net Weight (lbs./1000 ft.)	Standard Packaging
		(inches)	(mm)		Rated Strength (lbs)	DC Resistance Ohms/1000 ft. @ 20°C		
14	Solid	.0641	1.628	4,110	124	2.57	12.4	2000' reels
12	Solid	.0808	2.052	6,530	197	1.62	19.8	1250' reels
10	Solid	.1019	2.588	10,380	314	1.019	31.4	800' reels
8	Solid	.1285	3.264	16,510	479	.6407	50	500' 1000' 2500' 5000' reels
6	Solid	.162	4.115	26,240	762	.4031	79.5	315' 500' 1000' 2500' 5000' reels
4	Solid	.2043	5.189	41,740	1214	.2535	126.4	200' 500' 1000' 2500' 5000' reels
2	Solid	.2576	6.543	66,360	1930	.1594	212.8	125' 500' 1000' 5000' reels
8	7	.1460	3.71	16,510	498	.6408	51	500' 1000' 2500' 5000' reels
6	7	.1840	4.67	26,240	795	.4030	81	315' 500' 1000' 2500' 5000' reels
4	7	.2320	5.89	41,740	1,320	.2530	129	200' 500' 1000' 2500' 5000' reels
3	7	.2600	6.60	52,620	1,670	.2010	162	500' 1000' 5000' reels
2	7	.292	7.42	66,360	2,110	.1590	205	125' 500' 1000' 2500' 5000' reels
1	7	.328	8.33	83,690	2,552	.1270	258	500' 1000' 5000' reels
1/0*	19	.360	9.14	105,600	3,221	.1022	326	500' 1000' 2500' 5000' reels
2/0*	19	.404	10.26	133,100	4,060	.08108	411	500' 1000' 2500' 5000' reels
3/0*	19	.454	11.53	167,800	5,118	.06431	518	500' 1000' 2500' 5000' reels
4/0*	19	.510	12.95	211,600	6,459	.05099	653	500' 1000' 2500' 5000' reels
250	37	.5420	13.77	250,000	7,942	.0423	772	500' 1000' 4000' reels
300	37	.5940	15.09	300,000	9,164	.0353	926	500' 1000' 3500' reels
350	37	.6410	16.28	350,000	10,685	.0302	1081	500' 1000' 3000' reels
400	37	.6850	17.40	400,000	13,435	.0264	1235	500' 1000' 3000' reels
500	37	.7660	19.46	500,000	15,242	.0212	1544	500' 1000' 2500' reels
600	61	.8930	22.68	600,000	18,300	.01798	1883	500' 1000' 2000' reels
750	61	.9980	25.35	750,000	22,894	.01438	2316	500' 1000' 1500' reels
1000	61	1.152	29.26	1,000,000	30,500	.01079	3088	500' reels

The above data is approximate and subject to normal manufacturing tolerances.  
 \*Note: 1/0 - 4/0 Bare Copper available in 7/w construction.

- 90°C Dry or Wet
- 600 volts
- 1/0 and larger rated for CT use
- Sunlight Resistant
- Gasoline and Oil Resistant I & II

# COPPER XHHW-2

## Polytherm Cross-Linked Polyethylene (XLP) Insulated Copper Conductors

### APPLICATIONS

- For use in conduit or other recognized raceways for service, feeder, and branch circuit applications as specified in the NEC®.
- Good choice for industrial applications where better insulation toughness and resistance to moisture and heat is desired.
- For use in wet or dry locations at temperatures up to 90°C.
- Sunlight resistant

### CONDUCTORS

- Stranded conductors: Uncoated, soft copper per ASTM-B8 (2 AWG and 250 MCM-750 MCM), and ASTM-B787 (1 AWG-4/0)

### INSULATION

- XLP (cross-linked polyethylene)

### INDUSTRY STANDARDS

- UL 44—File No. E63539
- CSA LL 82214
- ASTM-B3
- ASTM-B8
- ASTM-B787
- Federal Specification: A-A-59544
- NFPA70: National Electrical Code®
- NEMA WC70/ICEA S-95-658

### SURFACE PRINT

- Sample: 2 AWG XHHW-2 600V SUN-RES GASO-LINE & OIL RESISTANT I & II (UL) E63539/XLPE RW90 (-40°C) CSA LL 82214

Product Code Number	Conductors		Insulation Thickness Mils.	Approx O.D. Inches	Allowable Ampacities*			Approx Net Wt. lbs./m ft.
	AWG Size	No. of Strands			60°C **	75°C ***	90°C ****	
117-4000	8	7	45	0.240	40	50	55	65
117-4200	6	7	45	0.280	55	65	75	97
117-4400	4	7	45	0.330	70	85	95	148
117-4500	3	7	45	0.353	-	-	110	180
117-4600	2	7	45	0.390	95	115	130	229
117-4700	1	19	55	0.450	110	130	150	293
117-5000	1/0	19	55	0.489	125	150	170	364
117-5200	2/0	19	55	0.530	145	175	195	449
117-5400	3/0	19	55	0.550	165	200	225	559
117-5600	4/0	19	55	0.640	195	230	260	698
117-6000	250	37	65	0.710	215	255	290	834
117-6400	300	37	65	0.760	-	-	320	995
117-6800	350	37	65	0.820	260	310	350	1152
117-7200	400	37	65	0.860	280	335	380	1309
117-8000	500	37	65	0.950	320	380	430	1622
117-8400	600	61	80	1.040	355	420	475	1947

\*\* Per Table 310-16 NEC®

\*\*\* For termination to equipment for circuits rated 100 amperes or less, or marked for size 14 through 1 AWG conductors.

\*\*\*\* For termination to equipment for circuits rated over 100 amperes or marked for conductors larger than 1AWG.

\*\*\*\*\* Wet or dry locations.



Cerro Wire Inc.

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- 90°C Dry or Wet
- 600 volts
- 1/0 and larger rated for CT use
- Sunlight Resistant
- Gasoline and Oil Resistant I & II

# COPPER XHHW-2

## Polytherm Cross-Linked Polyethylene (XLP) Insulated Copper Conductors

### APPLICATIONS

- For use in conduit or other recognized raceways for service, feeder, and branch circuit applications as specified in the NEC®.
- Good choice for industrial applications where better insulation toughness and resistance to moisture and heat is desired.
- For use in wet or dry locations at temperatures up to 90°C.
- Sunlight resistant

### CONDUCTORS

- Stranded conductors: Uncoated, soft copper per ASTM-B8 (2 AWG and 250 MCM-750 MCM), and ASTM-B787 (1 AWG-4/0)

### INSULATION

- XLP (cross-linked polyethylene)

### INDUSTRY STANDARDS

- UL 44—File No. E63539
- CSA LL 82214
- ASTM-B3
- ASTM-B8
- ASTM-B787
- Federal Specification: A-A-59544
- NFPA70: National Electrical Code®
- NEMA WC70/ICEA S-95-658

### SURFACE PRINT

- Sample: 2 AWG XHHW-2 600V SUN-RES GASO-LINE & OIL RESISTANT I & II (UL) E63539/XLPE RW90 (-40°C) CSA LL 82214

Package Code	K	R	M	P
AWG Size	1000' reel	2000' reel	2500' reel	5000' reel
8 stranded	X			X
6 stranded	X			X
4 stranded	X			X
3 stranded	X			X
2 stranded	X			X
1 stranded	X			X
1/0	X			X
2/0	X			X
3/0	X			X
4/0	X			X
250 MCM	X		X	
350 MCM	X		X	
400 MCM	X	X		
500 MCM	X		X	
600 MCM	X	X		



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- Meets or exceeds:  
ASTM B-3  
ASTM B-8  
ASTM B-787

# BARE COPPER

## Soft Drawn Bare Copper Wire

### APPLICATIONS

- For use in overhead transmission and distribution applications.
- For use in grounding applications.

### CONDUCTORS

- Solid conductors: Uncoated copper per ASTM-B3
- Stranded conductors 8 AWG-2 AWG and 250 MCM-500 MCM uncoated copper per ASTM-B3 and ASTM-B8
- Stranded conductors 1 AWG-4/0 AWG, uncoated copper conductors per ASTM-B3 and ASTM-B787

### INDUSTRY STANDARDS

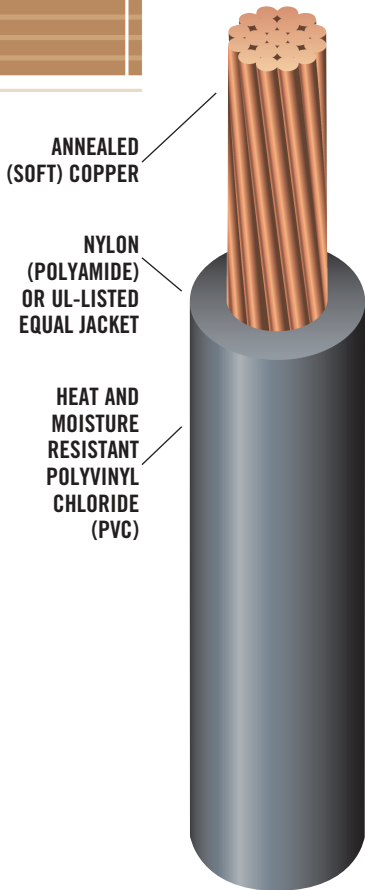
- ASTM-B3
- ASTM-B8
- ASTM-B787

Product Code Number	AWG Size	Class B Strand		Approx O.D. Inches	Approx Net Wt. lbs./m ft.
		No. of Strands	Diam. Each Inches		
050-2000	8	SOL	.1285	.1285	50
050-2215	6	SOL	.1620	.1620	79
050-2200	6	SOL	.1620	.1620	79
050-2400	4	SOL	.2043	.2043	126
050-2600	2	SOL	.2576	.2576	201
050-4000	8	7	.0486	.146	50
050-4200	6	7	.0612	.184	80
050-4400	4	7	.0772	.232	127
050-4600	2	7	0.974	.292	202
050-5000	1/0	19	.0807, .0591	.360	323
050-5200	2/0	19	.0906, .0663	.404	404
050-5400	3/0	19	.1017, .0745	.454	509
050-5600	4/0	19	.1142, .0836	.510	643

Package Code	D	H	I	J	K
AWG Size	125' spool	200' spool	315' spool	500' spool	1000' reel
8 solid				X	
6 solid (050-2200)					X
6 solid (050-2215)			X		
4 solid		X		X	X
2 solid	X				
8 stranded				X	X
6 stranded			X		X
4 stranded		X			X
2 stranded	X				X
1/0				X	X
2/0				X	X
3/0				X	X
4/0				X	X



# XHHW



ANNEALED  
(SOFT) COPPER

NYLON  
(POLYAMIDE)  
OR UL-LISTED  
EQUAL JACKET

HEAT AND  
MOISTURE  
RESISTANT  
POLYVINYL  
CHLORIDE  
(PVC)

600 Volt

Copper Conductor

Cross-Linked  
Polyethylene (XLP)  
Insulation

High-Heat and Moisture  
Resistant

Sizes 14 Through 8 AWG  
Also Rated SIS

Black Sizes 2 AWG  
and Larger Sunlight  
Resistant

## APPLICATIONS Suitable for use as follows:

- Southwire Type XHHW-2 conductors are primarily used in conduit or other recognized raceways for services, feeders, and branch circuit wiring, as specified in the National Electrical Code<sup>1</sup>
- XHHW-2 conductors may be used in wet or dry locations at temperatures not to exceed 90°C
- Voltage rating for XHHW-2 conductors is 600 volts

## STANDARDS & REFERENCES

Southwire Type XHHW-2 conductors meet or exceed UL Standard 44; ASTM B3, B8; Federal Specification A-A-59544, and requirements of the National Electrical Code<sup>®</sup>. Type XHHW-2 meets and exceeds all construction requirements of ICEA S-95-658 (NEMA WC 70) - Nonshielded 0 - 2 kV Cables, with testing frequencies based on UL requirements.

## CONSTRUCTION

- Southwire Type XHHW-2 copper conductors are annealed (soft) copper. Insulation is an abrasion, moisture, and heat resistant cross-linked polyethylene (XLP)
- Sizes 14, 12, and 10 AWG available in black, white, red, blue, yellow, green, orange, brown, purple, and gray
- Conductor sizes 2 AWG and larger listed and marked sunlight resistant in black only
- Colors available in sizes 8 AWG and larger
- Not CT rated
- Southwire Type XHHW-2 copper conductors are also available in sizes 1/0 AWG and larger rated for cable tray use and sunlight resistant
- Specify XHHW-2 for CT use when requesting quote or ordering

## SPECIFICATIONS

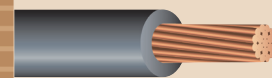
### RECOMMENDED SAMPLE SPECIFICATIONS

Conductors shall be UL-listed Type XHHW-2, suitable for operation at 600 volts or less in wet or dry locations, at temperatures not to exceed 90°C. Conductors shall be annealed copper, as manufactured by Southwire Company or approved equal.

### ALTERNATE CABLE TRAY (SPECIAL ORDER) RECOMMENDED SAMPLE SPECIFICATIONS

Conductor shall be UL-listed Type XHHW-2 rated for cable tray use and sunlight resistance. (Conductor printed "For CT use") Also, suitable for operation at 600 volts or less in wet or dry locations, at temperatures not to exceed 90°C. Conductors shall be annealed copper, as manufactured by Southwire Company or approved equal.

<sup>1</sup> 2008 Edition.



## COPPER CONDUCTORS

XHHW

WEIGHTS, MEASUREMENTS AND PACKAGING								
CONDUCTOR		INSULATION THICKNESS (mils)	NOMINAL O.D.	ALLOWABLE AMPACITIES*			APPROXIMATE NET WEIGHT PER 1000 ft (lbs)	APPROXIMATE NET WEIGHT PER 1000 ft (lbs)
SIZE/CONST. (AWG or kcmil)	NUMBER OF STRANDS			60°C	75°C	90°C		
14	7	30	130	15	15	15	18	A
12	7	30	147	20	20	20	26	A
10	7	30	171	30	30	30	40	A
8	7	45	232	40	50	55	66	B
6	7	45	267	55	65	75	99	B
4	7	45	314	70	85	95	149	B
2	7	45	370	95	115	130	230	B
1	19	55	434	110	130	150	292	B
1/0	19	55	473	125	150	170	363	B
2/0	19	55	517	145	175	195	452	B
3/0	19	55	567	165	200	225	565	B
4/0	19	55	623	195	230	260	705	B
250	37	65	691	215	255	290	835	B
300	37	65	744	240	285	320	995	B
350	37	65	794	260	310	350	1155	B
400	37	65	839	280	335	380	1314	B
500	37	65	923	320	380	430	1633	B
600	61	80	1029	355	420	475	1966	C
700	61	80	1098	385	460	520	2283	C
750	61	80	1131	400	475	535	2441	C
1000	61	80	1280	455	545	615	3230	C

\*Allowable Ampacities:  
 Allowable ampacities shown are for general use as specified by the National Electrical Code®, 2008 Edition, section 310.15 unless the equipment is marked for use at higher temperatures the conductor ampacities shall be limited to the following:  
 60°C - When terminated to equipment for circuits rated 100 amperes or less or marked for 14 through 1 AWG conductors.  
 75°C - When terminated to equipment for circuits rated over 100 amperes or marked for conductors larger than 1 AWG.  
 90°C - Wet or dry locations. For ampacity derating purposes

**STANDARD PACKAGE CODES**  
 A – 2500 ft. reel  
 B – 1000 ft. reel  
 C – 500 ft. spool

# Bare Copper Wire and Cable

Bare Copper Conductor. Solid and Stranded .



## APPLICATIONS

Solid and stranded (classes AA and A) bare copper are suitable for overhead transmission and distribution applications. Stranded conductor of greater flexibility (classes B and C) are suitable for uninsulated hook up, jumpers, and grounds in electrical construction. Soft Drawn copper is unilay construction.

## SPECIFICATIONS

Southwire's bare copper wire and cable meets or exceeds the following ASTM specifications:

- B-1 Hard-Drawn Copper Wire.
- B-2 Medium-Hard Copper Wire.
- B-3 Soft or Annealed Copper Wire.
- B-787 19 Wire Combination Unilay-Stranded Soft copper wire.
- B-8 Concentric-Lay-Stranded Hard, Medium-Hard or Soft Copper Conductor.

## CONSTRUCTION

Bare copper, solid or stranded. Available in tempers hard, medium-hard, or soft. Stranded conductors are concentrically stranded in hard and medium-hard tempers and are Combination Unilay stranded in the soft-drawn temper.

# Bare Copper

Size (AWG)	Weight Per 1000 ft. (lbs.)	Diameter (mils)	Circular Mil Area (cmils)	Hard-Drawn		Medium-Hard Drawn		Soft-Drawn (Annealed)		Allowable Ampacity <sup>+</sup>
				Rated Strength (lbs.)	DC Resistance Ohms/1000 ft. @ 20°C	Rated Strength (lbs.)	DC Resistance Ohms/1000 ft. @ 20°C	Rated Strength (lbs.)	DC Resistance Ohms/1000 ft. @ 20°C	
<b>SOLID</b>										
14	12.4	64.1	4110	213.5	2.626	166.6	2.613	124.2	2.525	--
13	15.7	72	5180	268.0	2.083	208.8	2.072	156.6	2.003	--
12	19.8	80.8	6530	336.9	1.652	261.2	1.643	197.5	1.588	--
11	24.9	90.7	8230	422.9	1.310	327.6	1.303	249.0	1.260	--
10	31.4	101.9	10380	529.2	1.039	410.4	1.033	314.0	.999	--
9	39.6	114.4	13090	661.2	.824	514.2	.820	380.5	.792	--
8	50	128.5	16510	826.0	.653	643.9	.650	479.8	.628	95
7	63	144.3	20820	1030.0	.518	806.6	.515	605.0	.498	105
6	79.4	162	26240	1280.0	.411	1010.0	.409	762.9	.395	125
5	100.2	181.9	33090	1591.0	.326	1265.0	.324	961.9	.313	145
4	126.3	204.3	41740	1970.0	.258	1584.0	.257	1213.0	.249	170
3	159.3	229.4	52620	2439.0	.205	1984.0	.204	1530.0	.197	195
2	200.9	257.6	66360	3003.0	.163	2450.0	.162	1929.0	.156	225
1	253.3	289.3	83690	3688.0	.129	3024.0	.128	2432.0	.124	260

<sup>+</sup> Ampacity based on 75°C conductor temperature; 25°C ambient temperature; 2 ft./sec. wind in sun.

# Bare Copper

Size (AWG or kcmil)	Stranding	Stranding Class	Weight Per 1000 ft. (lbs.)	Diameter (mils)		Hard-Drawn		Medium-Hard Drawn		Soft-Drawn (Annealed)		Allowable Ampacity <sup>+</sup>
				Individual Wires	Complete Cable	Rated Strength	DC Resistance Ohms/1000 ft. @ 20°C	Rated Strength	DC Resistance Ohms/1000 ft. @ 20°C	Rated Strength	DC Resistance Ohms/1000 ft. @ 20°C	
<b>STRANDED</b>												
8	7	B	51	49	146	777	.6663	610	.6629	499	.6408	95
6	7	B	81	61	184	1228	.4191	959	.4169	794	.4030	130
4	7	A, B	128.9	77	232	1938	.2636	1505	.2622	1320	.2534	170
3	7	A, B	162.5	87	260	2433	.2090	1885	.2079	1670	.2010	200
2	7	A, B	204.9	97	292	3050	.1660	2360	.1650	2110	.1578	230
1	7	A	258.4	109	328	3801	.1316	2955	.1309	2552	.1252	265
1/0	7	A, AA	326.1	123	368	4752	.1042	3705	.1037	3221	.1002	310
1/0	19	B	326.1	75	373	4752	.1042	3705	.1037	3221	.1002	310
2/0	7	A, AA	410.9	138	414	5926	.08267	4640	.08224	4062	.07949	355
2/0	19	B	410.9	84	418	6690	.08267	4765	.08224	4024	.07949	355
3/0	7	A, AA	518.1	155	464	7366	.06556	5812	.06522	5118	.06304	410
4/0	7	A, AA	653.3	174	522	9154	.05199	7278	.05172	6459	.04999	480
4/0	19	B	653.3	106	528	9617	.05199	7479	.05172	6453	.04999	480
250	19	A	771.9	115	574	11360	.04400	8836	.04378	7627	.04231	530
250	37	B	771.9	82	575	11600	.04400	8952	.04378	7940	.04231	530
300	19	A	926.2	126	628	13510	.03667	10530	.03648	9160	.03526	590
350	19	A	1080.6	136	679	15590	.03143	12200	.03127	10680	.03022	650
500	37	A, B	1543.8	116	814	22510	.02200	17550	.02189	15240	.02116	810
600	37	A, AA	1852.5	127	891	27020	.01834	21060	.01825	18300	.01763	910
750	61	A, B	2315.6	111	998	34090	.01467	26510	.01459	22890	.01410	1040
1000	61	A, B	3087.5	128	1152	45030	.01100	35100	.01094	30500	.01058	1240

<sup>+</sup>Ampacity based on 75°C conductor temperature; 25°C ambient temperature; 2 ft./sec. wind in sun.



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IN ★ THE  
USA**

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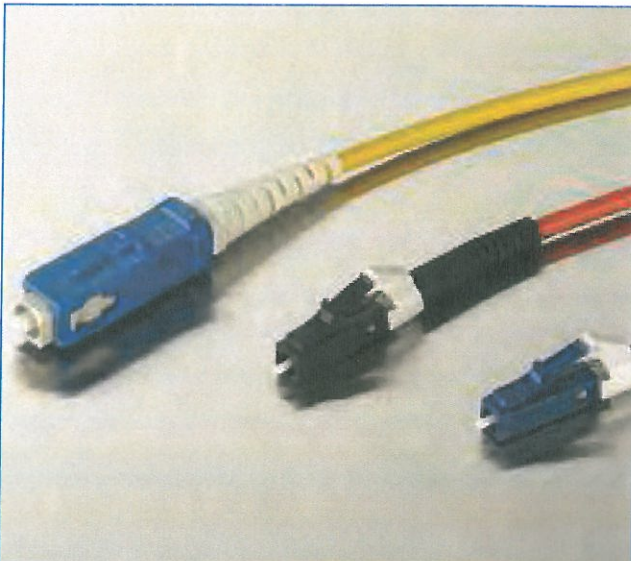
# Anaerobic-Cure Connectors

A LANscape®  
Solutions Product

## features and benefits |

<b>Quick-cure epoxy</b>	No lamps or ovens needed
<b>Minimal tools and no index matching gel</b>	Low installation cost
<b>Hand polished for minimum insertion loss</b>	Reliability and optical performance

Corning Cable Systems Anaerobic-Cure Connectors offer optical performance in a fast, easy field-termination solution designed for fiber-to-the-workstation applications for single-mode and multimode connections. This connector combines the quick-cure convenience of anaerobic adhesive with the performance of epoxy and polish connectors. Ideal for enterprise networks and any installations requiring field-installed connectors, the anaerobic cure technology enables fiber optic networks to be installed cost effectively with minimal tools. Installation of the connector can be accomplished in minutes with the anaerobic adhesive two-part epoxy process. The adhesive is first injected into the connector ferrule and then the fiber is dipped into the primer and inserted into the connector. Curing takes only one minute without the use of lamps or ovens. With the hand-polish process, an average insertion loss of 0.2 dB is achieved.



Anaerobic-Cure Connectors | Photo LAN611



TKT-ANAEROBIC2 Installation Tool Kit | Photo LAN395



# Anaerobic-Cure Connectors

A LANscape®  
Solutions Product

## specifications |

**Intermateability** Compliant with TIA/EIA 604-2 (ST® Compatible Connector), 604-3 (SC), 604-4 (FC) and 604-10 (LC)

	Multimode	Single-mode
<b>Insertion Loss</b>	0.2 dB average 0.75 dB maximum	0.2 dB average 0.75 dB maximum
<b>Reflectance</b>	≤ -26 dB	≤ -40 dB
<b>Temperature Cycling</b>	≤ 0.3 dB change, -40° to +75°C; 21 cycles	same

## ordering information |

Part Number	Description
<b>Multimode</b>	
<b>95-051-52-SP</b>	ST Compatible 50 µm Multimode Connector with ceramic ferrule and metal hardware; single pack
<b>95-051-52-SP-X</b>	ST Compatible 50 µm LOMMF* Connector with ceramic ferrule and metal hardware; single pack
<b>95-101-52-SP</b>	ST Compatible 62.5 µm Multimode Connector with ceramic ferrule and metal hardware; single pack
<b>95-051-41-SP</b>	SC 50 µm Multimode Connector with ceramic ferrule; single pack
<b>95-051-41-SP-X</b>	SC 50 µm LOMMF* Connector with ceramic ferrule; single pack
<b>95-101-41-SP</b>	SC 62.5 µm Multimode Connector with ceramic ferrule; single pack
<b>95-051-61-SP</b>	FC 50 µm Multimode Connector with ceramic ferrule; single pack
<b>95-051-61-SP-X</b>	FC 50 µm LOMMF* Connector with ceramic ferrule; single pack
<b>95-101-61-SP</b>	FC 62.5 µm Multimode Connector with ceramic ferrule; single pack
<b>95-051-98-SP</b>	LC 50 µm Multimode Connector with ceramic ferrule; single pack
<b>95-051-98-SP-X</b>	LC 50 µm LOMMF* Connector with ceramic ferrule; single pack
<b>95-101-98-SP</b>	LC 62.5 µm Multimode Connector with ceramic ferrule; single pack

\* LOMMF = Laser-optimized multimode fiber.

# Anaerobic-Cure Connectors

A LANscape®  
Solutions Product

## ordering information | (continued)

Part Number	Description
<b>Single-mode</b>	
<b>95-201-52-SP</b>	ST® Compatible Single-mode Connector with ceramic ferrule and metal hardware; single pack
<b>95-201-41-SP</b>	SC Single-mode Connector with ceramic ferrule and composite hardware; single pack
<b>95-201-61-SP</b>	FC Single-mode Connector with ceramic ferrule and composite hardware; single pack
<b>95-201-98-SP</b>	LC Single-mode Connector with ceramic ferrule and composite hardware; single pack
<b>Boot Color</b>	
All SC, FC and ST® Compatible Connectors come with 3 mm, 2 mm and 900 µm boots. LC connectors come with 3 mm, 900 µm and combination 2 mm/1.6 mm boots.	
50 µm	Black only
Laser-optimized multimode fiber	Aqua only
62.5 µm	Beige
Single-mode	Blue
<b>Accessories</b>	
<b>TKT-ANAEROBIC2</b>	Installation Kit for Anaerobic-Cure and Anaerobic-Cure Glass-Insert Connectors; includes consumables for 500 connectors
<b>TKT-ANAEROBIC2-C</b>	Anaerobic-Cure and Anaerobic-Cure GIC Consumables Kit; includes adhesive and polishing papers for 500 connectors
<b>3201031-01</b>	Jacket Retention Crimp Tool for SC, FC and ST Compatible Connectors
<b>3201032-01</b>	LC Crimp Tool
<b>2104459-01</b>	LC Polishing Puck
<b>2104020-01</b>	Universal Polishing Puck
<b>1101045-01</b>	Anaerobic Adhesive, Primer and Syringe Tips
<b>CLEANER-UNIV-CASS</b>	Universal Connector Cleaning Cassette
<b>TRIGGER-BP-D</b>	LC/MU Duplex Trigger
<b>95-400-03-BP</b>	SC Duplex Clip

PRETERMINATED SYSTEMS | CABLES | CONNECTORS | CABLE ASSEMBLIES | HARDWARE | SPlice CLOSURES | TEST EQUIPMENT | SPlice EQUIPMENT | TRAINING |

## THHN/THWN-2

**Product Description**

Solid or stranded  
PVC insulation  
Nylon jacket  
90°C dry (THHN)  
90°C wet (THWN-2, 8 AWG and larger)  
75°C wet (THWN)  
600 V

**Applications**

General purpose wiring for new construction or modernizing existing systems. Suitable for lighting and power in residential, commercial and industrial buildings. Also recommended for power control circuits, machine tools, appliances and relay panels. The overall nylon jacket is abrasion resistant with slippery surface, for easy pulling in conduits. Highly resistant to acids, alkalis, chemicals, oil, gasoline, grease and flame.

**Specifications**

- CONDUCTOR: Solid or stranded annealed copper per applicable ASTM standard
- INSULATION: Polyvinyl Chloride (PVC) sheathed with nylon meeting the requirements of the applicable UL standard
- STANDARDS: UL 83 Thermoplastic Wire and Cable, UL 1063 MTW, UL 758 AWM, Federal Specification A-A-59544. Sizes 1/0 and larger are marked "for CT use". Cable is sunlight-resistant in 1/0 and larger (black only)
- AMPACITY: Based on not more than three conductors in raceway or cable or earth with an ambient temperature of 30°C per 2008 NEC Table 310.16
- TEMPERATURE: THHN 90°C dry, THWN-2 90°C wet/dry, THWN 75°C wet, MTW 90°C dry, 60°C wet/oil, AWM 105°C dry
- VOLTAGE: 600 V

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Unless otherwise specifically permitted in the NEC, the overcurrent protection shall not exceed 15 A for 14 AWG, 20 A for 12 AWG and 30 A for 10 AWG copper. Diameters, weights and additional listings may vary among manufacturers.

Part No.	Conductor Size AWG/kcmil	No. of Strands	Insulation Thickness (in.)	Overall Jacket Thickness (in.)	Nom. O.D. (in.)	Approx. Wt. lb./1,000 ft.	Ampacity 90°C THHN	Ampacity 75°C THHN
6F-1401	14	Solid	0.015	0.004	0.110	16	25	20
6F-1201	12	Solid	0.015	0.004	0.130	24	30	25
6F-1001	10	Solid	0.020	0.004	0.160	38	40	35
6G-1401	14	19	0.015	0.004	0.120	16	25	20
6G-1201	12	19	0.015	0.004	0.140	25	30	25
6G-1001	10	19	0.020	0.004	0.170	39	40	35
6G-0801	8	19	0.030	0.005	0.230	66	55	50
6G-0601	6	19	0.030	0.005	0.250	98	75	65
6G-0401	4	19	0.040	0.006	0.330	115	95	85
6G-0301	3	19	0.040	0.006	0.360	190	110	100
6G-0201	2	19	0.040	0.006	0.390	235	130	115
6G-0101	1	19	0.050	0.007	0.450	300	150	130
6G-1011	1/0	19	0.050	0.007	0.500	370	170	150
6G-2021	2/0	19	0.050	0.007	0.540	460	195	175
6G-3031	3/0	19	0.050	0.007	0.600	570	225	200
6G-4041	4/0	19	0.050	0.007	0.660	710	260	230
6G-2501	250	37	0.060	0.008	0.720	845	290	255
6G-3001	300	37	0.060	0.008	0.770	1,020	320	285
6G-3501	350	37	0.060	0.008	0.830	1,165	350	310
6G-4001	400	37	0.060	0.008	0.870	1,325	380	335
6G-5001	500	37	0.060	0.008	0.960	1,640	430	380
6G-6001	600	61	0.070	0.009	1.060	2,005	475	420
6G-7501	750	61	0.070	0.009	1.170	2,480	535	475
6G-10001	1000	61	0.070	0.009	1.320	3,300	615	545

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## XHHW-2

**Product Description**

Solid or stranded  
XLP insulation/jacket  
90°C wet/dry  
600 V

**Applications**

General purpose wiring for control, switchboard, lighting and power circuits in residential and commercial buildings and industrial plants, and for utility substations, meters and generating plants.

**Specifications**

- CONDUCTOR: Class B stranded, annealed, bare copper
- INSULATION: Cross-Linked Polyethylene (XLP)
- STANDARDS: Listed Type XHHW-2 per UL 44 Thermoset-Insulated Wires and Cables, meets construction requirements of ICEA S-95-658 (NEMA WC 70), conforms to Federal Specification A-A-59544
- AMPACITY: Based on not more than three conductors in raceway or cable or earth with an ambient temperature of 30°C per 2008 NEC Table 310.16
- TEMPERATURE: 90°C
- VOLTAGE: 600 V

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Unless otherwise specifically permitted in the NEC, the overcurrent protection shall not exceed 15 A for 14 AWG, 20 A for 12 AWG and 30 A for 10 AWG copper. Diameters and weights may vary among manufacturers. CT rated material available in sizes 1/0 and larger.

Part No.	Conductor Size AWG/kcmil	No. of Strands	Insulation Thickness (in.)	Nom. O.D. (in.)	Approx. Wt. lb./1,000 ft.	Amps per Conductor
6L-1401	14	Solid	0.030	0.130	17	25
6L-1201	12	Solid	0.030	0.150	26	30
6L-1001	10	Solid	0.030	0.170	38	40
6M-1401	14	7	0.030	0.140	18	25
6M-1201	12	7	0.030	0.160	27	30
6M-1001	10	7	0.030	0.180	40	40
6M-0801	8	7	0.045	0.240	66	55
6M-0601	6	7	0.045	0.280	96	75
6M-0401	4	7	0.045	0.320	145	95
6M-0201	2	7	0.045	0.380	225	130
6M-0101	1	7	0.055	0.440	290	150
6M-1011	1/0	19	0.055	0.480	360	170
6M-2021	2/0	19	0.055	0.520	450	195
6M-3031	3/0	19	0.055	0.580	555	225
6M-4041	4/0	19	0.055	0.630	700	260
6M-2501	250	37	0.065	0.700	830	290
6M-3001	300	37	0.065	0.750	990	320
6M-3501	350	37	0.065	0.800	1,150	350
6M-4001	400	37	0.065	0.850	1,310	380
6M-5001	500	37	0.065	0.930	1,620	430
6M-7501	750	61	0.080	1.040	2,445	535
6M-10001	1000	61	0.080	1.290	3,240	615

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TFN and TFFN



**Product Description**

Fixture wire  
 Solid or stranded  
 PVC insulation  
 Nylon jacket  
 90°C, 600 V

**Applications**

These wires are recommended in most types of industrial and commercial applications where resistance to mechanical abuse is required. The nylon jacket has excellent resistance to abrasion, chemicals, gas and oil.

**Specifications**

- CONDUCTOR: Stranded, annealed copper per ASTM B-3
- INSULATION: Polyvinyl Chloride (PVC)
- OVERALL JACKET: Nylon
- STANDARDS: Meets requirements of UL 66 for Type TFN or TFFN fixture wire
- AMPACITY: Based on Table 402.5 of the 2008 NEC
- TEMPERATURE: 90°C
- VOLTAGE: 600 V

Diameters and weights may vary among manufacturers.

Part No.	Type	Conductor Size AWG/kcmil	No. of Strands	Insulation Thickness (in.)	Overall Jacket Thickness (in.)	Nom. O.D. (in.)	Approx. Wt. lb./1,000 ft.	Amps per Conductor
6F-1801	TFN	18	Solid	0.015	0.004	0.084	9	6
6F-1601	TFN	16	Solid	0.015	0.004	0.094	12	8
6G-1801	TFFN	18	16	0.015	0.004	0.088	9	6
6G-1601	TFFN	16	26	0.015	0.004	0.101	13	8

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# Product Data Sheet

## PVC-Nylon/PVC Shielded



### Product Description

PVC-nylon insulation  
Shielded  
PVC jacket  
90°C, 600 V

### Applications

Designed for power and control, telemetering, relay control, traffic control, switching, lighting and signal transmission. May be used in Class I, Div. 2 and Class II, Div. 2 Hazardous Locations per NEC Art. 501 and 502. These cables also conform to Art. 392 "Cable Trays" and Art. 336 "Power and Control Tray Cable."

### Specifications

- CONDUCTORS: Class B stranded bare copper per UL 83 and 62
- INSULATION: Polyvinyl Chloride (PVC) per UL 62 for Type TFFN (16 AWG) or UL 83 for Type THWN or THHN wire, nominal thickness is 15 mils
- INSULATION JACKET: Each insulated conductor is jacketed with nylon meeting UL 62 for Type TFFN or UL 83 for Type THWN or THHN wire, minimum thickness is 4 mils
- COLOR CODE: ICEA Method 1, Table E-2 (formerly K-2)
- ASSEMBLY: Conductors are cabled with fillers where necessary to make round
- SHIELD: Aluminum/Mylar helically applied with tinned copper drain wire
- OVERALL JACKET: Sunlight-resistant Polyvinyl Chloride (PVC) per UL 1277
- STANDARDS: Meets UL 1277 requirements for Type TC cables having THWN or THHN (TFFN) conductors, cables are listed for direct burial and meet the IEEE 1202, IEE 383 and UL 1685. 70,000 Btu/hr flame tests
- AMPACITY: Based on not more than three conductors in raceway or cable or earth with an ambient temperature of 30°C per NEC Table 310.16, the values have been derated where applicable
- TEMPERATURE: 90°C
- VOLTAGE: 600 V



# Product Data Sheet

Diameters and weights may vary among manufacturers. Other conductor counts available upon request. Unless otherwise specifically permitted in the NEC, the overcurrent protection shall not exceed 15 A for 14 AWG and 20 A for 12 AWG. All part numbers require color code designation. See Color Code Chart in the Technical Information section. For Method 1, Table E-1 color code add -1 to Part No. (e.g. 2A-1602S-1).

Part No.	Conductor Size AWG	No. of Conductors	Overall Jacket Thickness (in.)	Nom. O.D. (in.)	Approx. Wt. lb./1,000 ft.	Amps per Conductor
2A-1602S	16	2	0.045	0.310	58	18
2A-1603S	16	3	0.045	0.325	73	18
2A-1604S	16	4	0.045	0.350	87	14
2A-1605S	16	5	0.045	0.380	102	14
2A-1607S	16	7	0.045	0.415	122	12
2A-1402S	14	2	0.045	0.330	75	25
2A-1403S	14	3	0.045	0.350	94	25
2A-1404S	14	4	0.045	0.380	115	20
2A-1405S	14	5	0.045	0.415	130	20
2A-1407S	14	7	0.045	0.450	167	17
2A-1202S	12	2	0.045	0.375	102	30
2A-1203S	12	3	0.045	0.395	130	30
2A-1204S	12	4	0.045	0.430	160	24
2A-1205S	12	5	0.045	0.470	184	24
2A-1207S	12	7	0.045	0.510	237	21

# Tight Buffered

2 through 144 fibers

**HITACHI**  
Inspire the Next

## Product Highlights

- RoHS & REACH compliant.
- All Multimode, and singlemode cables (except OM1) utilize bend-insensitive optical fibers.
- UV resistant jacket.
- Tight buffered construction.
- Each fiber is color coded for easy identification.
- Dry, super absorbent polymers (SAPs) eliminate water migration in cable interstices.
- Suitable for lashed aerial, duct, underground conduit and indoor riser applications.
- 900 um buffered design recommended for easy termination.
- For cables with fiber counts of 36 to 144, fibers are segregated into 12-fiber bundles identified by color-coded binders.

## Options

- Low smoke zero halogen available.
- OS2 optical fibers with enhanced bend-insensitive performance are available.
- OM4 optical fibers with extended 10 gigabit Ethernet distances are available.



6-fiber



12-fiber



48-fibers (4 Bundles of 12-fibers)

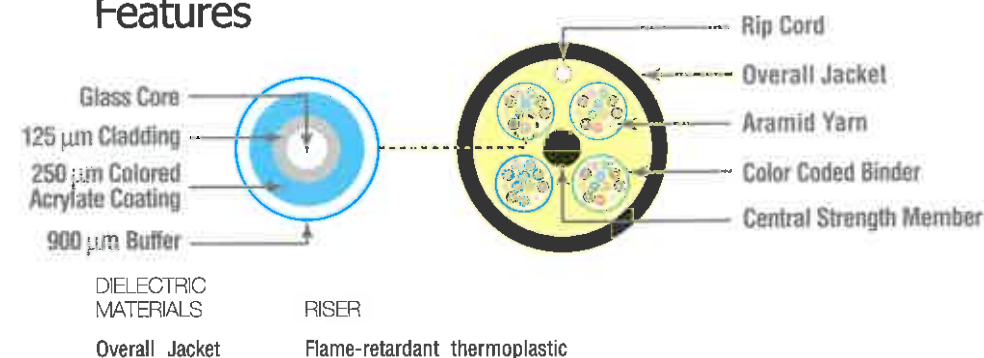
Diagram scale approx. 2:1

## I/O Tight Buffered (Riser)

(UL) OFNR c(UL) OFNR FT4

FIBER COUNT	62.5 UM OM1	50 UM OM2	50 UM OM3	50 UM OM4	8.3 UM OS2
2	61345-2	61347-2	61348-2	61893-2	61349-2
4	61345-4	61347-4	61348-4	61893-4	61349-4
6	61345-6	61347-6	61348-6	61893-6	61349-6
8	61345-8	61347-8	61348-8	61893-8	61349-8
10	61345-10	61347-10	61348-10	61893-10	61349-10
12	61345-12	61347-12	61348-12	61893-12	61349-12
24	61345-24	61347-24	61348-24	61893-24	61349-24
36	61345-36	61347-36	61348-36	61893-36	61349-36
48	61345-48	61347-48	61348-48	61893-48	61349-48
72	61345-72	61347-72	61348-72	61893-72	61349-72
96	61345-96	61347-96	61348-96	61893-96	61349-96
144	61345-144	61347-144	61348-144	61893-144	61349-144

## Features



# Tight Buffered

## I/O Tight Buffered (Riser)

(UL) OFNR c(UL) OFNR FT4

FIBER COUNT	CABLE O.D.		RECOMMENDED MAXIMUM LOADS				CABLE WEIGHT	
	in.	mm	INSTALL		OPERATION		lbs/1000 ft	kg/1000m
			lbs-f	N	lbs-f	N		
2	.190	4.83	128	570	84	285	12.6	18.8
4	.190	4.83	128	570	84	285	13.9	20.7
6	.190	4.83	128	570	84	285	15.1	22.5
8	.230	5.84	160	712	80	356	20.0	29.8
10	.230	5.84	160	712	80	356	21.3	31.7
12	.230	5.84	160	712	80	356	22.5	33.5
24	.350	8.89	238	1282	144	641	52.4	78.1
36	.424	10.77	600	2671	200	892	63.0	93.8
48	.488	11.38	600	2671	200	890	77.0	144.4
72	.555	14.10	600	2671	200	890	131.0	194.9
96	.64	16.26	600	2671	200	890	196.8	292.9
144	.78	19.81	600	2671	200	890	222.5	331.2

## Cable Temperature Ranges

Operating: 32°F To 158°F (0°C To 70°C)  
 Storage: -40°F To 158°F (-40°C To 70°C)  
 Installation: 32°F To 140°F (0°C To 60°C)

## Optical Specifications

TIA/EIA-568-C.3

Fiber type	Max. Attenuation		Min OFL Bandwidth		Min EMBc Bandwidth		Gb Ethernet distance		10 Gb Ethernet distance	
	(dB/km)		(MHz-km)		(MHz-km)		(m)		(m)	
	850nm (MM)	1300nm (MM)	850nm (MM)	1300nm (MM)	850nm (MM)	1300nm (MM)	850nm (MM)	1300nm (MM)	850nm (MM)	1300nm (MM)
OM1	3.5	1.0	200	500	220	N/A	300	550	33	N/A
OM2	3.5	1.0	700	500	950	N/A	750	550	150	N/A
OM3	3.25	1.0	1500	500	2000	N/A	1000	550	300	N/A
OM4	3.0	1.0	3500	500	4700	N/A	1100	550	550	N/A
OS2	0.5	0.5	N/A	N/A	N/A	N/A	> 25,000	> 40,000	10,000 - 25,000	40000

Hitachi Cable America reserves the right to revise any specifications

## Mechanical Specifications

- Bend radius, no load = 10x cable overall diameter
- Bend radius, load = 20x cable overall diameter

plus  
**CORNING®**  
ClearCurve® Optical Fiber



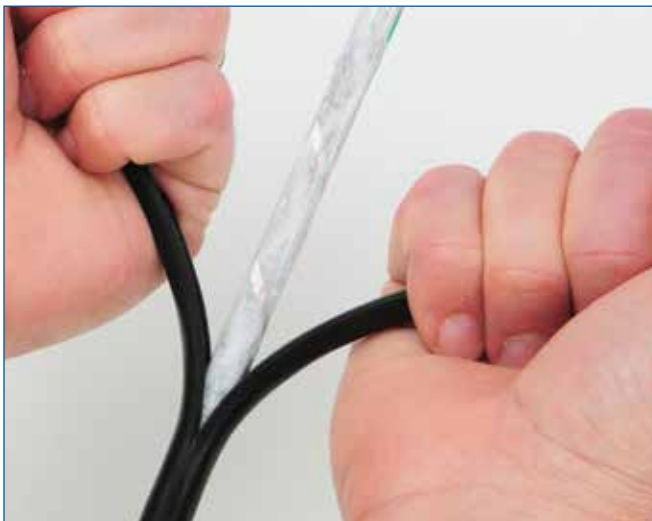
# ALTOS® Cable with FastAccess™ Technology

A LANscape®  
Solutions Product

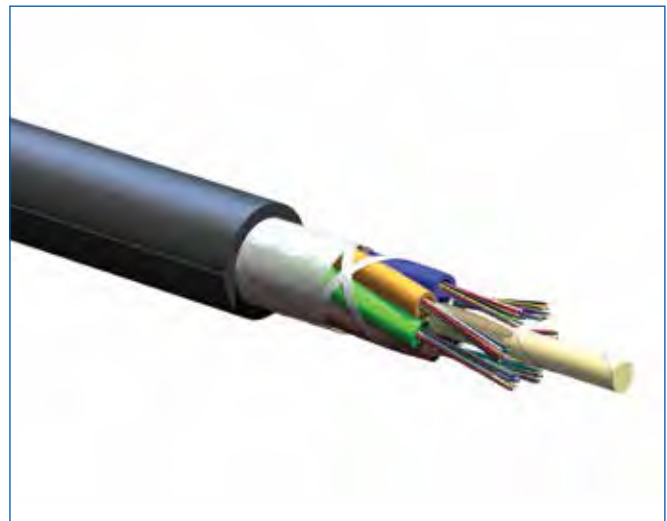
## features and benefits |

<b>Contains FastAccess Technology</b>	Innovative cable jacket feature reduces cable end access time by up to (will vary by installer) 50 percent and reduces overall risk of inadvertent fiber damage as well as risk to installers from sharp cable access tools
<b>Medium-density polyethylene jacket</b>	Rugged and durable, while providing superior protection against UV radiation, fungus, abrasion and other environmental factors.
<b>Fully waterblocked loose tube all-dielectric gel-free design</b>	Simple access and no clean up
<b>Industry-standard performance</b>	Meets the requirements of Telcordia GR-20, Issue 3 and ICEA S-87-640
<b>Available in 62.5 µm, 50 µm, single-mode and hybrid versions</b>	Ready for any application including Gigabit Ethernet and 10 Gigabit Ethernet

Corning Cable Systems ALTOS® Cable with FastAccess™ Technology is an all-dielectric gel-free cable designed for outdoor and limited indoor use for campus backbones in lashed aerial and duct installations. The innovative FastAccess Technology combined with the all-dielectric gel-free loose tube design simplifies removal of the cable jacket reducing cable end access time by up to 50 percent. Equally important is the overall reduction in risk of inadvertent fiber damage and risk to installers from sharp cable access tools. The cable is fully waterblocked using craft-friendly, water-swellable materials, which means no clean up is required. The flexible buffer tubes are easy to route in closures, and the SZ-stranded, loose tube design isolates fibers from installation and environmental rigors while allowing easy midspan access. The all-dielectric gel-free cable construction requires no bonding or grounding, and these cables have a medium-density polyethylene jacket that is rugged, durable, and easy to handle. A variety of fiber types are available including 62.5 µm, 50 µm, single-mode and hybrid versions, as well as fibers with Gigabit Ethernet and 10 Gigabit Ethernet performance.



ALTOS Cable with FastAccess Technology, All-Dielectric, Gel-Free | Photo LAN2866

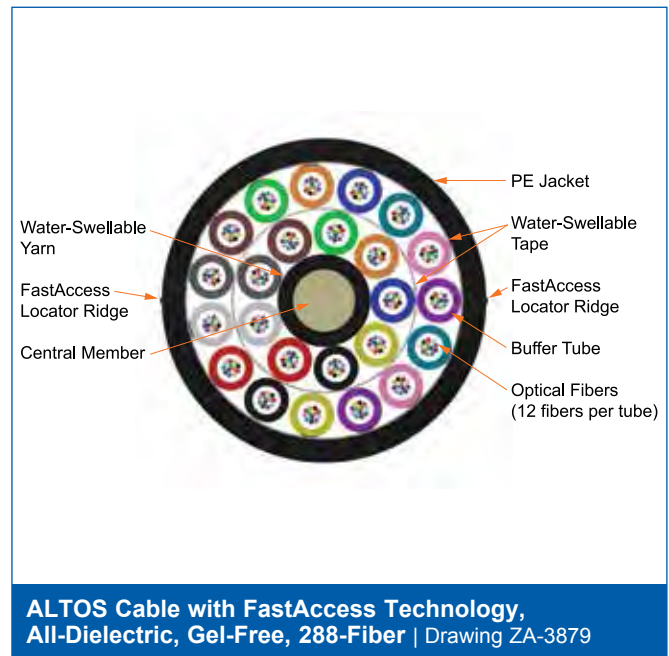
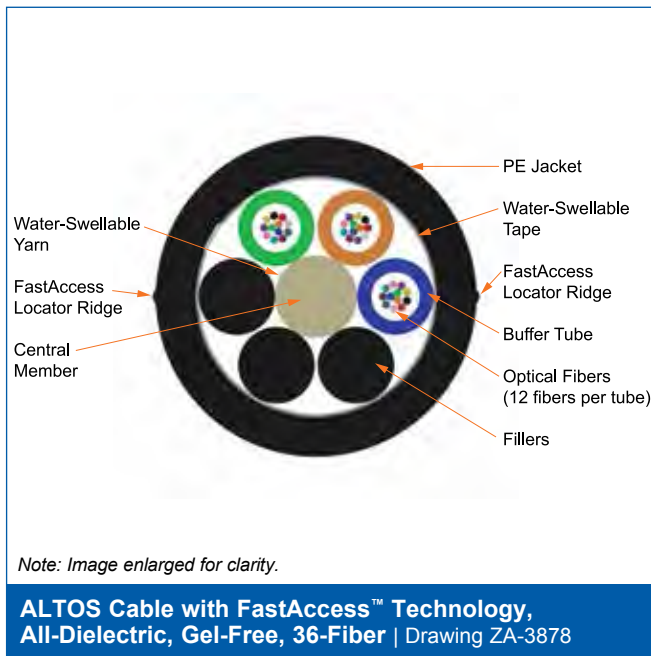


ALTOS Cable with FastAccess Technology, All-Dielectric, Gel-Free | Photo LAN2962



# ALTOS® Cable with FastAccess™ Technology

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## specifications |

**Maximum Tensile Loads**    Short-Term:    2700 N (600 lbf)  
    Long-Term:     890 N (200 lbf)

**Temperatures**                    Storage:        -40° to +70°C (-40° to +158°F)  
    Installation:   -30° to +70°C (-22° to +158°F)  
    Operation:     -40° to +70°C (-40° to +158°F)

**Common Installations**        Outdoor lashed aerial and duct; indoor when installed according to National Electrical Code® (NEC®) Article 770

**Design and Test Criteria**        ANSI/ICEA S-87-640

*Corning Cable Systems recommends storing cable in a proper temperature environment prior to installation to allow the cable temperature to meet installation temperature range specifications for best installation results.*

Fiber Count	Maximum Fibers per Tube	Number of Tube Positions	Number of Active Tubes	Central Member	Nominal Cable Weight kg/km (lb/1000 ft)	Nominal Outside Diameter mm (in)	Minimum Bend Radius Loaded cm (in)	Minimum Bend Radius Installed cm (in)
2-72	12	6	1-6	Dielectric	73 (49)	10.5 (0.41)	15.8 (6.2)	10.5 (4.1)
73-96	12	8	7-8	Dielectric	98 (66)	12.2 (0.48)	18.3 (7.2)	12.2 (4.8)
97-144	12	12	9-12	Dielectric	162 (109)	15.8 (0.62)	23.7 (9.3)	15.8 (6.2)
145-216	12	18	13-18	Dielectric	147 (99)	16.0 (0.63)	24.0 (9.4)	16.0 (6.3)
217-288	12	24	19-24	Dielectric	196 (131)	18.2 (0.72)	27.3 (10.7)	18.2 (7.2)

## transmission performance |

Optical Fiber Type (µm)	62.5 Multimode	50 Multimode	50 Multimode	50 Multimode	50 Multimode	Single-mode*
ISO/IEC 11801 Nomenclature	OM1	OM2	OM3	OM4	OM4	OS2
Fiber Code	K	T	T	T	T	E
Performance Option Code	30	31	80	90	91	01
Wavelength (nm)	850/1300	850/1300	850/1300	850/1300	850/1300	1310/1383/1550
Maximum Attenuation (dB/km)	3.4/1.0	3.0/1.0	3.0/1.0	3.0/1.0	3.0/1.0	0.4/0.4/0.3
Minimum Over Filled Launch (OFL) Bandwidth (MHz•km)	200/500	700/500	1500/500	3500/500	3500/500	- / - / -
Minimum Effective Modal Bandwidth (EMB) (MHz•km)	220/ -	950/ -	2000/ -	4700/ -	5350/ -	- / - / -
Serial 1 Gigabit Ethernet Distance (m)	300/550	750/600	1000/600	1000/600	1000/600	5000 / - / -
Serial 10 Gigabit Ethernet Distance (m)	33/ -	150/ -	300/ -	550† / -	600‡ / -	10000/ - /40000

\* ITU 652.D compliant.

† Assumes 1.0 dB maximum total connector/splice loss.

‡ Assumes 0.7 dB maximum total connector/splice loss.

**Notes:**

- 1) Improved attenuation and bandwidth options available.
- 2) Bend-insensitive single-mode fibers available on request.
- 3) Contact Corning Cable Systems Customer Service Representative for additional information.

# ALTOS® Cable with FastAccess™ Technology

A LANscape®  
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ordering information | Contact Customer Service at 800-743-2671 for non-standard offerings.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	U	4	-	T	4	7	<input type="checkbox"/>	<input type="checkbox"/>	D	2	0
1	2	3	4	5	6		7	8	9	10	11	12	13	14

## |1-3

Select fiber count.

Standard offerings:

012	048	096	216
024	060	144	288
036	072	192	

## |4

Select fiber type  
(see Transmission  
Performance table).

## |5 / 12

Defines cable type.

U/D = ALTOS®  
Gel-free Cable

## |6

Defines outer jacket.

4 = All-dielectric

## |7

Defines fiber placement.

T = 12 fibers/buffer tube  
(standard)

## |8

Defines length markings.

4 = Markings in feet  
(standard)

## |9

Defines special jacket  
feature.

7 = ALTOS Cable with  
FastAccess™ Technology

## |10-11

Select performance  
option code (see  
Transmission  
Performance table).

## |13-14

Defines special  
requirements.  
20 = No special  
requirements

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# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

CORNING

Corning Cable Systems ALTOS® Cable with FastAccess™ Technology is an all-dielectric gel-free cable designed for outdoor and limited indoor use for campus backbones in lashed aerial and duct installations. The innovative FastAccess Technology feature combined with the all-dielectric gel-free loose tube design simplifies removal of the cable jacket reducing cable end access time by at least 50 percent. Equally important is the overall reduction in risk of inadvertent fiber damage and risk to installers from sharp cable access tools. The cable is fully waterblocked using craft-friendly, water-swellaible materials, which means no clean up is required. The flexible buffer tubes are easy to route in closures, and the SZ-stranded, loose tube design isolates fibers from installation and environmental rigors while allowing easy midspan access. The all-dielectric gel-free cable construction requires no bonding or grounding, and these cables have a medium-density polyethylene jacket that is rugged, durable, and easy to handle. A variety of fiber types are available including 62.5 μm and 50 μm, single-mode and hybrid versions, as well as fibers with Gigabit and 10 Gigabit Ethernet performance.



## Features and Benefits

### Contains FastAccess™ Technology

Innovative cable jacket feature reduces cable end access time by at least 50 percent and reduces overall risk of inadvertent fiber damage as well as risk to installers from sharp cable access tools

### Medium-density polyethylene jacket

Rugged, durable and easy to strip while providing superior protection against UV radiation, fungus, abrasion and other environmental factors

### Fully waterblocked loose tube all-dielectric gel-free design

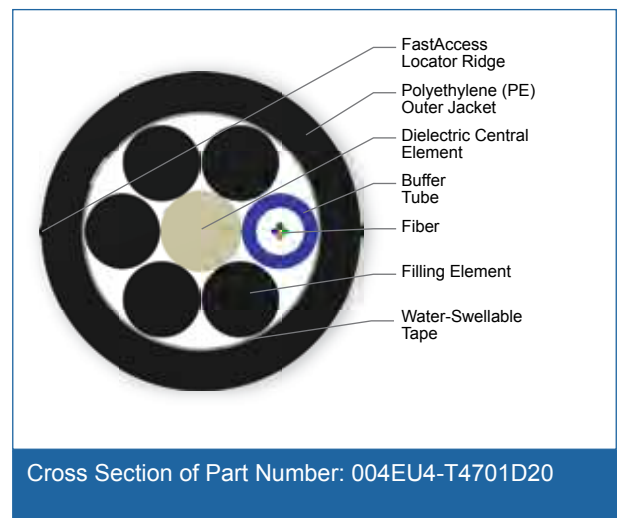
Simple access and no clean up

### Industry-standard performance

Meets the requirements of Telcordia GR-20, Issue 3 and ICEA S-87-640

### Available in 62.5 μm, 50 μm, single-mode and hybrid versions

Ready for any application including Gigabit Ethernet and 10 Gigabit Ethernet



# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

CORNING

## Standards

**Common Installations** Outdoor lashed aerial and duct; indoor when installed according to National Electrical Code® (NEC®) Article 770

**Design and Test Criteria** ANSI/ICEA S-87-640

## Specifications

General Specifications	
Environment	Outdoor
Application	Aerial, Duct
Cable Type	Loose Tube
Product Type	Dielectric
Fiber Category	Single-mode (OS2)

Temperature Range	
Storage	-40 °C to 70 °C (-40 °F to 158 °F)
Installation	-30 °C to 70 °C (-22 °F to 158 °F)
Operation	-40 °C to 70 °C (-40 °F to 158 °F)

Cable Design	
Central Element	Dielectric
Fiber Count	4
Fiber Coloring	Blue, Orange, Green, Brown
Fibers per Tube	4
Number of Tube Positions	6
Number of Active Tubes	1
Buffer Tube Color Coding	Blue
Buffer Tube Diameter	2.5 mm (0.1 in)
Number of Filling Elements	5
Tape	Water-swellable
Number of Ripcords	1
Outer Jacket Material	Polyethylene (PE)



# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

CORNING

## Cable Design

Outer Jacket Color	Black
Maximum Fibers per Tube	12

## Mechanical Characteristics Cable

Max. Tensile Strengths, Short-Term	2700 N (600 lbf)
Max. Tensile Strengths, Long-Term	890 N (200 lbf)
Weight	73 kg/km (49 lb/1000 ft)
Nominal Outer Diameter	10.5 mm (0.41 in)
Min. Bend Radius Installation	158 mm (6.2 in)
Min. Bend Radius Operation	105 mm (4.1 in)

## Chemical Characteristics

RoHS	Free of hazardous substances according to RoHS 2002/95/EG
------	---

## Fiber Specifications

### Optical Characteristics (cabled)

Fiber Type	Single-mode
Fiber Core Diameter	8.2 μm
Fiber Category	OS2
Fiber Code	E
Performance Option Code	01
Wavelengths	1310 nm / 1383 nm / 1550 nm
Maximum Attenuation	0.4 dB/km / 0.4 dB/km / 0.3 dB/km
Serial 1 Gigabit Ethernet	5000 m / - / -
Serial 10 Gigabit Ethernet	10000 m / - / 40000 m

\* ITU-T G.652 D compliant.

\* Meets 0.75 ns optical skew when used in all Corning Cable Systems Plug & Play™/Pretium EDGE® Systems Solutions.

- Notes:
- 1) Improved attenuation and bandwidth options available.
  - 2) Bend-insensitive single-mode fibers available on request.
  - 3) Contact a Corning Cable Systems Customer Care Representative for additional information.

# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)



## Ordering Information

Part Number	004EU4-T4701D20
Product Description	ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology, 4 F, Single-mode (OS2)



Corning Cable Systems LLC • PO Box 489 • Hickory, NC 28603-0489 USA

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# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

CORNING

Corning Cable Systems ALTOS® Cable with FastAccess™ Technology is an all-dielectric gel-free cable designed for outdoor and limited indoor use for campus backbones in lashed aerial and duct installations. The innovative FastAccess Technology feature combined with the all-dielectric gel-free loose tube design simplifies removal of the cable jacket reducing cable end access time by at least 50 percent. Equally important is the overall reduction in risk of inadvertent fiber damage and risk to installers from sharp cable access tools. The cable is fully waterblocked using craft-friendly, water-swellaible materials, which means no clean up is required. The flexible buffer tubes are easy to route in closures, and the SZ-stranded, loose tube design isolates fibers from installation and environmental rigors while allowing easy midspan access. The all-dielectric gel-free cable construction requires no bonding or grounding, and these cables have a medium-density polyethylene jacket that is rugged, durable, and easy to handle. A variety of fiber types are available including 62.5 µm and 50 µm, single-mode and hybrid versions, as well as fibers with Gigabit and 10 Gigabit Ethernet performance.



## Features and Benefits

### Contains FastAccess™ Technology

Innovative cable jacket feature reduces cable end access time by at least 50 percent and reduces overall risk of inadvertent fiber damage as well as risk to installers from sharp cable access tools

### Medium-density polyethylene jacket

Rugged, durable and easy to strip while providing superior protection against UV radiation, fungus, abrasion and other environmental factors

### Fully waterblocked loose tube all-dielectric gel-free design

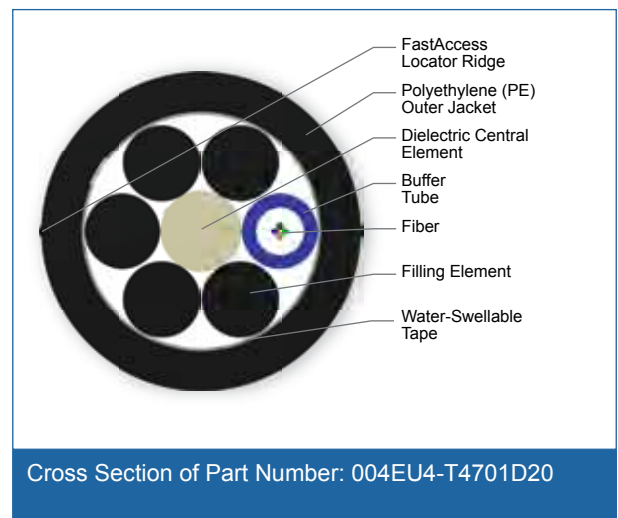
Simple access and no clean up

### Industry-standard performance

Meets the requirements of Telcordia GR-20, Issue 3 and ICEA S-87-640

### Available in 62.5 µm, 50 µm, single-mode and hybrid versions

Ready for any application including Gigabit Ethernet and 10 Gigabit Ethernet



# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

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## Standards

**Common Installations** Outdoor lashed aerial and duct; indoor when installed according to National Electrical Code® (NEC®) Article 770

**Design and Test Criteria** ANSI/ICEA S-87-640

## Specifications

General Specifications	
Environment	Outdoor
Application	Aerial, Duct
Cable Type	Loose Tube
Product Type	Dielectric
Fiber Category	Single-mode (OS2)

Temperature Range	
Storage	-40 °C to 70 °C (-40 °F to 158 °F)
Installation	-30 °C to 70 °C (-22 °F to 158 °F)
Operation	-40 °C to 70 °C (-40 °F to 158 °F)

Cable Design	
Central Element	Dielectric
Fiber Count	4
Fiber Coloring	Blue, Orange, Green, Brown
Fibers per Tube	4
Number of Tube Positions	6
Number of Active Tubes	1
Buffer Tube Color Coding	Blue
Buffer Tube Diameter	2.5 mm (0.1 in)
Number of Filling Elements	5
Tape	Water-swellable
Number of Ripcords	1
Outer Jacket Material	Polyethylene (PE)

# ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess™ Technology

4 F, Single-mode (OS2)

CORNING

## Cable Design

Outer Jacket Color	Black
Maximum Fibers per Tube	12

## Mechanical Characteristics Cable

Max. Tensile Strengths, Short-Term	2700 N (600 lbf)
Max. Tensile Strengths, Long-Term	890 N (200 lbf)
Weight	73 kg/km (49 lb/1000 ft)
Nominal Outer Diameter	10.5 mm (0.41 in)
Min. Bend Radius Installation	158 mm (6.2 in)
Min. Bend Radius Operation	105 mm (4.1 in)

## Chemical Characteristics

RoHS	Free of hazardous substances according to RoHS 2002/95/EG
------	---

## Fiber Specifications

### Optical Characteristics (cabled)

Fiber Type	Single-mode
Fiber Core Diameter	8.2 μm
Fiber Category	OS2
Fiber Code	E
Performance Option Code	01
Wavelengths	1310 nm / 1383 nm / 1550 nm
Maximum Attenuation	0.4 dB/km / 0.4 dB/km / 0.3 dB/km
Serial 1 Gigabit Ethernet	5000 m / - / -
Serial 10 Gigabit Ethernet	10000 m / - / 40000 m

\* ITU-T G.652 D compliant.

\* Meets 0.75 ns optical skew when used in all Corning Cable Systems Plug & Play™/Pretium EDGE® Systems Solutions.

- Notes:
- 1) Improved attenuation and bandwidth options available.
  - 2) Bend-insensitive single-mode fibers available on request.
  - 3) Contact a Corning Cable Systems Customer Care Representative for additional information.

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## 7934A Multi-Conductor - DataTuff® Waterblocked Enhanced Category 5e



For more Information  
please call

1-800-Belden1



### Description:

24 AWG Bonded-Pairs solid bare copper conductors, polyolefin insulation, polymer gel waterblocked, sun res LLPE jacket. Sequential marking at two foot intervals.

### Usage (Overall)

**Suitable Applications:**

Industrial Ethernet, Harsh Environments, 200MHz Category 5e, Gigabit Ethernet, 100Base TX, 100BaseVG ANYLAN, 155A TM, 622A TM, NTSC/PAL Component or Composite Video, AES/EBU Digital Audio, AES51, RS-422, RJ-45 Compatible, Burial, Halogen Free

### Physical Characteristics (Overall)

#### Conductor

**AWG:**

# Pairs	AWG	Stranding	Conductor Material
4	24	Solid	BC - Bare Copper

#### Insulation

**Insulation Material:**

Insulation Material
PO - Polyolefin

#### Outer Jacket

**Outer Jacket Material:**

Outer Jacket Material
LLPE - Linear Low Density Polyethylene

**Outer Jacket Ripcord:**

No

#### Overall Cable

**Overall Nominal Diameter:**

0.230 in.

#### Pair

**Pair Color Code Chart:**

Number	Color
1	White/Blue Stripe & Blue
2	White/Orange Stripe & Orange
3	White/Green Stripe & Green
4	White/Brown Stripe & Brown

### Mechanical Characteristics (Overall)

**Storage Temperature Range:**

-40°C To +85°C

**Installation Temperature Range:**

-25°C To +75°C

**Operating Temperature Range:**

-40°C To +75°C

**Bulk Cable Weight:**

30 lbs/1000 ft.

**Max. Recommended Pulling Tension:**

40 lbs.

**Min. Bend Radius (Install)/Minor Axis:**

1 in.

## 7934A Multi-Conductor - DataTuff® Waterblocked Enhanced Category 5e

### Applicable Specifications and Agency Compliance (Overall)

#### Applicable Standards & Environmental Programs

Other Standards:	11801 Category 5
EU CE Mark:	Yes
EU Directive 2000/53/EC (ELV):	Yes
EU Directive 2002/95/EC (RoHS):	Yes
EU RoHS Compliance Date (mm/dd/yyyy):	08/02/2005
EU Directive 2002/96/EC (WEEE):	Yes
EU Directive 2003/11/EC (BFR):	Yes
CA Prop 65 (CJ for Wire & Cable):	Yes
MII Order #39 (China RoHS):	Yes
Other Specification:	NEMA WC-63.1 Category 5e, UL verified to Category 5e, EtherNet/IP Compliant

#### Suitability

Suitability - Outdoor:	Yes
Suitability - Burial:	Yes - Telcordia, IEC, ICEA
Sunlight Resistance:	Yes - UL
Oil Resistance:	Yes - UL
Non-halogenated:	Yes

#### Plenum/Non-Plenum

Plenum (Y/N):	No
---------------	----

### Electrical Characteristics (Overall)

#### Nom. Mutual Capacitance:

Capacitance (pF/ft)

15

Maximum Capacitance Unbalance (pF/100 m): 150

#### Nominal Velocity of Propagation:

VP (%)

70

#### Maximum Delay:

Delay (ns/100 m)

538 @ 100MHz

#### Max. Delay Skew:

Delay Skew (ns/100 m)

45

#### Maximum Conductor DC Resistance:

DCR @ 20°C (Ohm/100 m)

9.38

#### Max. Operating Voltage - UL:

Voltage

300 V RMS

#### Maximum DCR Unbalanced:

DCR Unbalance @ 20°C (%)

3

### Electrical Characteristics-Premise (Overall)

#### Premise Cable Electrical Table 1:



## 7934A Multi-Conductor - DataTuff® Waterblocked Enhanced Category 5e

Freq. (MHz)	Max. Attenuation (dB/100 m)	Min. NEXT (dB)	Min. PSNEXT (dB)	Min. ACR (dB)	Min. PSACR (dB)	Min RL (dB)	Min. SRL (dB)
1	2.000	65.3	62.3	63.0	60.0	20.000	23.0
4	4.100	56.3	53.3	51.0	49.0	23.600	23.0
8	5.800	51.8	48.8	46.0	43.0	25.400	24.5
10	6.500	50.3	47.3	43.0	41.0	26.000	25.0
16	8.200	47.3	44.3	39.0	36.0	26.000	25.0
20	9.300	45.8	42.8	36.5	33.5	26.000	25.0
25	10.400	44.3	41.3	33.9	30.9	25.500	24.3
31.25	11.700	42.9	39.9	31.0	28.0	25.000	23.6
62.5	17.000	38.4	35.4	22.0	19.0	23.500	21.5
100	22.000	35.3	32.3	14.0	11.0	22.500	20.1
155	28.100	32.5	29.5	4.4	1.4	15.800	
200	32.000	30.8	27.8	4.0	1.0	15.000	

**Premise Cable Electrical Table 2:**

Freq. (MHz)	Input (Unfitted) Imp. (Ohms)	Fitted Impedance	Min. ELFEXT (dB)	Min. PSELFEXT (dB)
1	100 ± 15	102.5 ± 7.5	63.8	60.8
4	100 ± 15	102.5 ± 7.5	51.7	48.7
8	100 ± 15	101 ± 6	45.7	42.7
10	100 ± 15	101 ± 6	43.8	40.8
16	100 ± 15	101 ± 6	39.7	36.7
20	100 ± 15	101 ± 6	37.7	34.7
25	100 ± 15	101 ± 6	35.8	32.8
31.25	100 ± 15	101 ± 6	33.9	30.9
62.5	100 ± 15	101 ± 6	27.8	24.8
100	100 ± 15	101 ± 6	23.8	20.8
155	100 ± 25	100 ± 15	19.9	16.9
200	100 ± 25	100 ± 15	17.7	14.7

### Notes (Overall)

**Notes:** U. S. Patents 5606151 and 5734126. EtherNet IP is a trademark of ControlNet International Ltd. under license by DeviceNet Vendor Association, Inc. Operating Temperature subject to length de-rating.

**Notes (Cont'd.):** Cable passes -40C Cold Bend per UL 1581. Waterblocking Material: Polymer Gel.

### Related Documents:

No related documents are available for this product

### Put Ups and Colors:

Item #	Putup	Ship Weight	Color	Notes	Item Desc
7934A 0101000	1,000 FT	24.000 LB	BLACK	C	4 PR #24 PP LLDPE

**Notes:**  
C = CRATE REEL PUT-UP.

Revision Number: 0    Revision Date: 02-03-2009

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## 7934A Multi-Conductor - DataTuff® Waterblocked Enhanced Category 5e

determining the applicability of legislation and regulations based on their individual usage of the product.  
Belden declares this product to be in compliance with EU LVD (Low Voltage Directive 73/23/EEC), as amended by directive 93/68/EEC.

# SECTION 2

## Wire and Cable Accessories

### Experience the Sta-Kon® advantage!

Thomas & Betts developed the first tool-applied solderless terminals and connectors more than 70 years ago in response to industry awareness of the need for better performance of electrical systems.

#### Key Features and Benefits

- Metal insulation grip sleeve is included on all nylon terminal for strain relief
- Long barrel selective annealed
- UL® Listed E9808 unless otherwise specified



#### Deep Internal Serrations

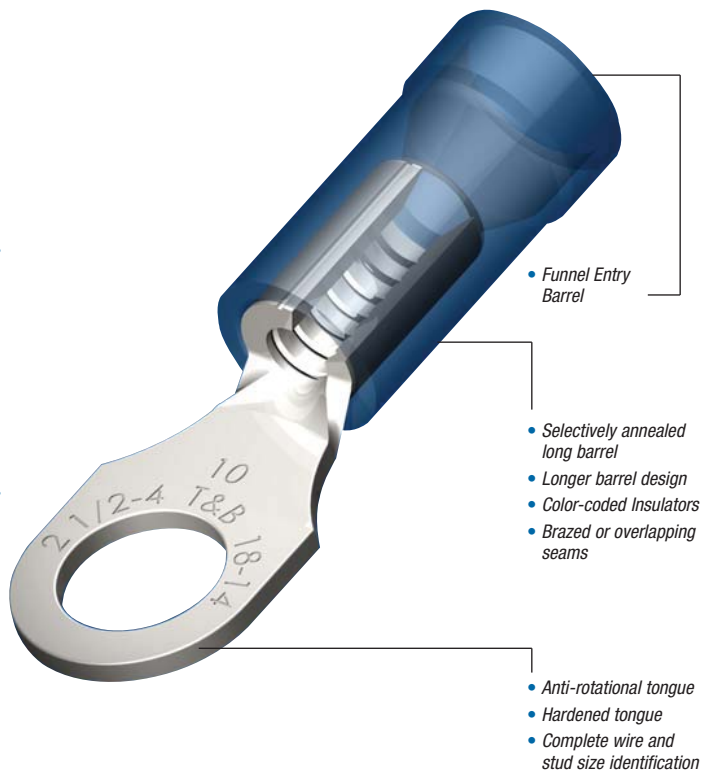
After the insertion of a wire into the terminal's barrel, a deep, serrated interior ensures a large area of contact that lowers the resistance of a connection. With the mechanical force of the tool, the wire strands cold flow into the serrated interior. This guarantees electrical resistance lower than the wire to which it is applied. This feature also prevents pullout from vibration and mechanical strain. Deep internal serrations can be compared to the effective holding power of a well-treaded tire on a wet highway.

#### Funneled Terminal Barrel Entry

This feature makes wire insertion faster and easier. A funneled barrel eliminates wire strand "hang up" upon insertion into the terminal's barrel. The loss of even a couple of wire strands can have negative results on electrical efficiency and resistance to mechanical strain.

#### Sta-Kon® Long Barrel Design

If lowering electrical resistance, preventing wire pullout, eliminating a "missed" crimp, and an insulator that stays on the barrel during installation are your goals, then you must design a terminal with a long barrel. Most competitive barrel lengths range from 20–50% shorter than Sta-Kon® terminals. The results are usually a stream of electrical failure, rework, and added expense. This also provides the insulator with additional surface area, holding tight to the barrel. Many competitive insulators come off during crimping due to a limited barrel length.



## Nylon-Insulated Ring Terminals

### Sta-Kon® Rings, Forks and Locking Forks

- Complete line of installing tools engineered to match tool with terminal
- First to gain military approval for pressure connections... many styles available for military applications
- Sta-Kon® products exceed test specification requirements of military, UL®, and CSA
- Tefzel® and Nylon Terminals provided with extra metal sleeve to grip insulation
- Vinyl insulated and bare Sta-Kon® terminals feature brazed seam wire barrels that can be crimped at any place on the barrel circumference
- Can be installed with crimping tools having a single indenter or double indenter (recommended for solid wire)
- Serrated barrel increases grip on wire
- Wire range identification on the tongue of each terminal
- Can be installed with crimping tools having a single indenter or double indenter (recommended for solid wire)
- Constructed of electrolytic copper for high conductivity
- Wire range identification on the tongue of each terminal

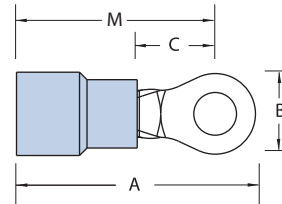


### Listing

Sta-Kon® Rings, Forks and Locking Forks are tested and listed to UL® 486A/B, two-way splices to UL 486C, disconnects to UL 310, and all applicable products to CSA 22.2.



### Nylon-Insulated Ring Terminals



CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RZ22-2**	100	26-22	.083	#2	ERG2006	.57	.14	.13	.49	.02
RZ22-4**	100	26-22	.083	#4		.65	.21	.20	.54	
RZ22-6**	100	26-22	.083	#6		.65	.21	.20	.54	
RZ22-8**	100	26-22	.083	#8		.75	.25	.23	.62	
RZ22-10**	100	26-22	.083	#10		.75	.25	.23	.62	
RAX23*	1,000	26-24	.125	#2	WT145A	.66	.14	.14	.59	
RAX43*	1,000	26-24	.125	#4		.74	.20	.19	.64	
RAX63*	1,000	26-24	.125	#6		.84	.25	.22	.72	
RAX83*	1,000	26-24	.125	#8		.84	.25	.22	.72	
RAX103*	1,000	26-24	.125	#10		.84	.25	.24	.72	
RA18-4	100	22-16	.136	#4	ERG2001	.72	.23	.14	.59	.03
RA323	1,000	22-16	.136	#4		.72	.23	.14	.59	
RA333	1,000	22-16	.136	#6		.72	.23	.14	.59	
RA18-6	100	22-16	.136	#6		.86	.26	.25	.71	

\* Not listed by UL or CSA

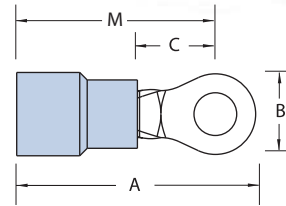
\*\* CSA Listed only

CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RA853	1,000	22-16	.136	#6	WT145A	.86	.26	.25	.71	.02
RA18-8	100	22-16	.136	#8		.89	.26	.25	.71	
RA833	1,000	22-16	.136	#8		.86	.26	.25	.71	
RA863	1,000	22-16	.136	#8		.89	.26	.25	.71	
RA18-10	100	22-16	.136	#10		.89	.31	.25	.71	
RA873	1,000	22-16	.136	#10		.89	.31	.25	.71	
RA18-14	100	22-16	.136	1/4"		1.10	.46	.31	.84	
RA713	1,000	22-16	.136	1/4"		1.10	.46	.31	.84	
RA18-516	100	22-16	.136	5/8"		1.10	.46	.31	.84	
RA723	1,000	22-16	.136	5/8"		1.10	.46	.31	.84	
RA18-38	100	22-16	.136	3/8"	ERG2001	1.20	.53	.35	.87	.03
RA733	1,000	22-16	.136	3/8"		1.20	.53	.35	.87	
RA18-12	100	22-16	.136	1/2"		1.30	.72	.50	.92	
RA753	1,000	22-16	.136	1/2"		1.30	.72	.50	.92	

Tefzel® is a trademark of DuPont.

## Nylon-Insulated Ring Terminals

### Nylon-Insulated Ring Terminals (continued)



CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RB14-4	100	18-14	.162	#4		.72	.26	.14	.59	
RB1323	1,000	18-14	.162	#4		.72	.26	.14	.59	
RB14-6	100	18-14	.162	#6		.89	.31	.25	.71	
RB853	1,000	18-14	.162	#6		.89	.31	.25	.71	
RB1333	1,000	18-14	.162	#6		.74	.26	.14	.59	
RB14-8	100	18-14	.162	#8		.89	.31	.25	.71	
RB863	1,000	18-14	.162	#8		.89	.31	.25	.71	
RB14-10	100	18-14	.162	#10		.89	.31	.25	.71	
RB873	1,000	18-14	.162	#10	ERG2001	.89	.31	.25	.71	.03
RB14-14	100	18-14	.162	1/4"		1.08	.47	.31	.81	
RB713	1,000	18-14	.162	1/4"		1.08	.47	.31	.81	
RB14-516	100	18-14	.162	5/16"		1.08	.47	.31	.84	
RB723	1,000	18-14	.162	5/16"		1.08	.47	.31	.84	
RB14-38	100	18-14	.162	3/8"		1.17	.53	.35	.87	
RB733	1,000	18-14	.162	3/8"		1.17	.53	.35	.87	
RB14-12	100	18-14	.162	1/2"		1.25	.72	.50	.90	
RB753	1,000	18-14	.162	1/2"		1.25	.72	.50	.90	

CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RC10-6	50	12-10	.210	#6		1.00	.37	.27	.81	
RC333	500	12-10	.210	#6		1.00	.37	.27	.81	
RC10-8	50	12-10	.210	#8		1.00	.37	.27	.81	
RC863	500	12-10	.210	#8		1.00	.37	.27	.81	
RC10-10	50	12-10	.210	#10		1.00	.37	.27	.81	
RC363	500	12-10	.210	#10		1.00	.37	.27	.81	
RC10-14	50	12-10	.210	1/4"	ERG2001	1.12	.53	.32	.86	.04
RC713	500	12-10	.210	1/4"		1.12	.53	.32	.86	
RC10-516	50	12-10	.210	5/16"		1.21	.53	.31	.94	
RC703	500	12-10	.210	5/16"		1.21	.53	.31	.94	
RC10-38	50	12-10	.210	3/8"		1.27	.59	.35	.98	
RC733	500	12-10	.210	3/8"		1.27	.59	.35	.98	
RC10-12	50	12-10	.210	1/2"		1.37	.72	.52	1.02	
RC753	500	12-10	.210	1/2"		1.37	.72	.52	1.02	

Sta-Kon Terminal Products and Tools

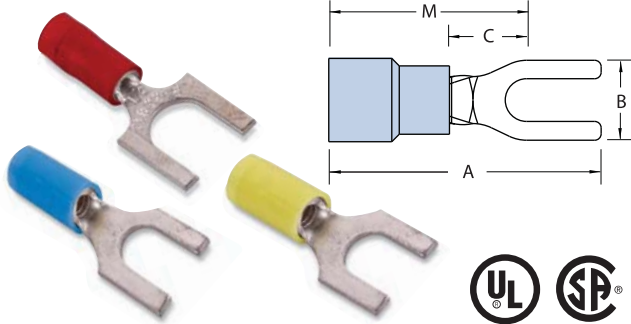


## Nylon-Insulated Fork Terminals

- Fork terminals enable easy installation because the mounting screw does not have to be completely removed
- Brazed seam barrel is serrated for high pull-out value. Terminal is high conductivity electrolytic copper, electro-tin plated. Insulation is color-coded
- Vinyl insulated fork terminals have extra-long PVC insulation sleeve for protection and stress relief at wire's flex point
- Suffix "X" indicates an expanded insulation support, meaning a wider wire entry to accommodate heavy wall insulation



### Nylon-Insulated Fork



CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.		
						A	B	C	M			
RA18-6F	100	22-16	.136	#6		.83	.25	.25	.71	.02		
RA1103	1,000	22-16	.136	#6		.83	.25	.25	.71			
RA18-8F	100	22-16	.136	#8		.86	.31	.25	.71			
RA1123	1,000	22-16	.136	#8		.86	.31	.25	.71			
RA18-10F	100	22-16	.136	#10		.86	.31	.25	.71			
RA1153	1,000	22-16	.136	#10		.86	.31	.25	.71			
RA18-14F	100	22-16	.136	1/4"		.95	.44	.31	.70			
RA1163	1,000	22-16	.136	1/4"		.95	.44	.31	.70			
RB14-6F	100	18-14	.162	#6	ERG 2001	.87	.31	.25	.71		.03	
RB1113	1,000	18-14	.162	#6		.87	.31	.25	.71			
RB14-8F	100	18-14	.162	#8		.87	.31	.25	.71			
RB1123	1,000	18-14	.162	#8		.87	.31	.25	.71			
RB14-10F	100	18-14	.162	#10		.87	.38	.25	.71			
RB1153	1,000	18-14	.162	#10		.87	.38	.25	.71			
RB14-14F	100	18-14	.162	1/4"		.95	.44	.28	.74			
RB1163	1,000	18-14	.162	1/4"		.95	.44	.28	.74			
RB1103	1,000	18-14	.162	#6		.74	.28	.16	.60			
RB1124	1,000	18-14	.190	#8		.95	.31	.25	.79			
RB1154	1,000	18-14	.190	#10		.95	.31	.25	.79			
RC10-6F	50	12-10	.210	#6			.97	.31	.27	.81		.04
RC1113	500	12-10	.210	#6			.97	.31	.27	.81		
RC10-8F	50	12-10	.210	#8			1.00	.37	.27	.81		
RC1123	500	12-10	.210	#8			1.00	.37	.27	.81		
RC10-10F	50	12-10	.210	#10		1.00	.37	.27	.81			
RC1153	500	12-10	.210	#10		1.00	.37	.27	.81			
RC10-14F	50	12-10	.210	1/4"		1.12	.50	.27	.86			
RC1163	500	12-10	.210	1/4"		1.12	.50	.27	.86			
RC1124	1,000	12-10	.250	#8		1.10	.37	.27	.91			
RC1154	1,000	12-10	.250	#10		1.10	.37	.27	.91			

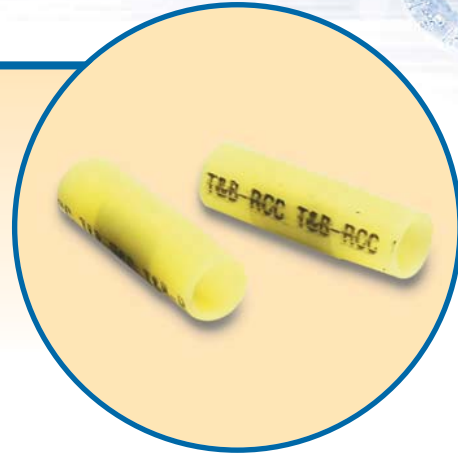
### Splices

#### Butt Splices

- Wires are butted together and crimped at each end of the splice
- Available either non-insulated or insulated with nylon or PVC
- Nylon insulated splices meet or exceed the requirements of MIL-T-7928
- Color-coded according to wire size

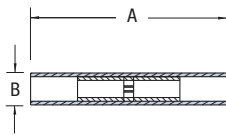
#### Parallel Splices

- Wires are laid side by side in the connector, and the connection is made in one crimp
- Offer advantages in simplicity of installation and small size
- One crimp completes the splice



Sta-Kon® Terminal Products and Tools

### Nylon-Insulated Butt Splices



CAT. NO.	PKG. QTY.	MAX INS. DIA.	WIRE RANGE	REC. TOOL	DIMENSIONS	
					A	B
2RA18	100	.115	22-18	ERG2001	1.19	.18
RAA21	1,000	.115	22-18		1.19	.18
2RB14	100	.148	16-14		1.19	.21
RBB21	1,000	.148	16-14		1.19	.21
2RC10	50	.210	12-10	ERG2007	1.26	.28
RCC21	500	.210	12-10		1.26	.28
2RD8	25	.340	8	TBM6S	1.69	.36
RDD27	200	.340	8		1.69	.36
2RE6	20	.420	6	TBM6S	1.85	.45
REE28	200	.420	6		1.85	.45
2RF4	15	.510	4	TBM6S	1.85	.52



All of the above information, including drawings, illustrations and graphic designs, reflects our present understanding and is to the best of our knowledge and belief correct and reliable. Users, however, should independently evaluate the suitability of each product for the desired application. Under no circumstances does this constitute an assurance of any particular quality or performance. Such an assurance is only provided in the context of our product specifications or explicit contractual arrangements. Our liability for these products is set forth in our standard terms and conditions of sale. Raychem, TE (logo) and Tyco Electronics are trademarks of the Tyco Electronics group of companies and its licensors. UniShield is a trademark of General Cable Technologies Corporation.

**Energy Division - a pioneer in the development of economical solutions for the electrical power industry. Our product range includes: Cable accessories, connectors & fittings, electrical equipment, instruments, lighting controls, insulators & insulation enhancement and surge arresters.**

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Our commitment. Your advantage.



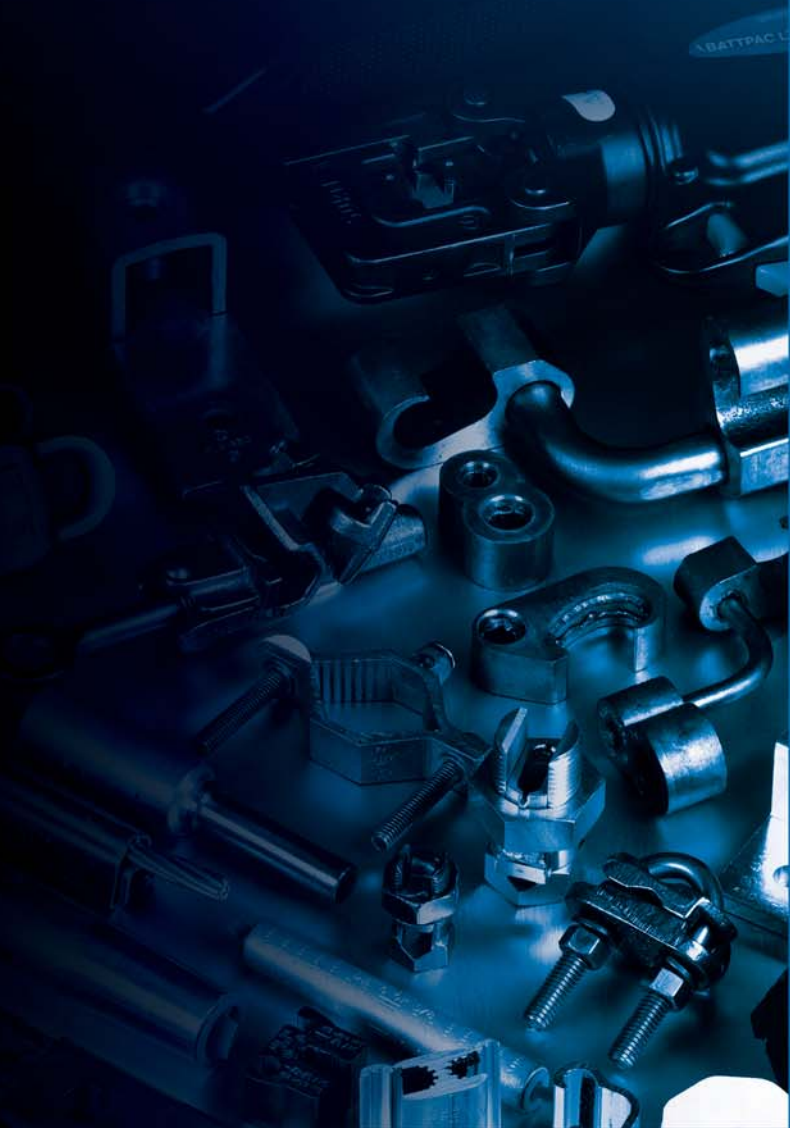
## In This Section...

### *Blackburn® Compression*

Compression Connectors — Quick Reference.....	C-2
Color-Coded Compression Connectors.....	C-3–C-10
Tool and Die Index for Color-Coded Compression Connectors.....	C-11–C-14



**Blackburn® Compression**



# Thomas & Betts

**United States**  
 Tel: 901.252.8000  
 800.816.7809  
 Fax: 901.252.1354

**Technical Services**  
 Tel: 888.862.3289

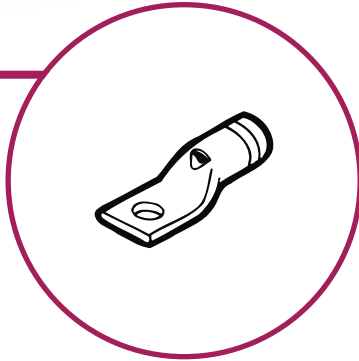
[www.tnb.com](http://www.tnb.com)

E - 1,175

### Type CTL

Copper Short Barrel Connectors

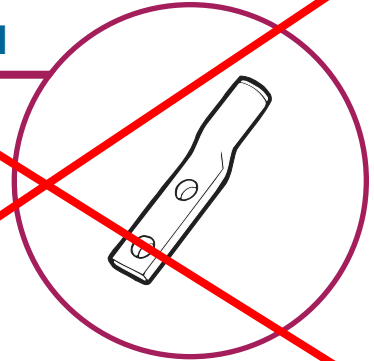
See Pages C-3-C-5



### Type CTL-L, LCN

Copper Long Barrel Connectors

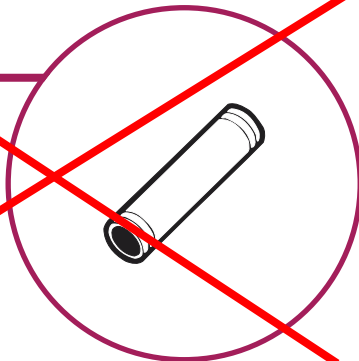
See Pages C-5-C-6



### Type CSP, CU

Copper Compression Splices

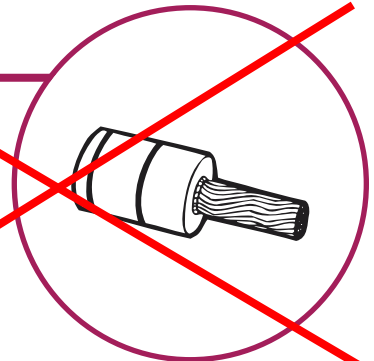
See Page C-7-C-8



### Type PA

Pin Adapter Terminals

See Page C-8



### Type ATL

Aluminum Compression Connectors

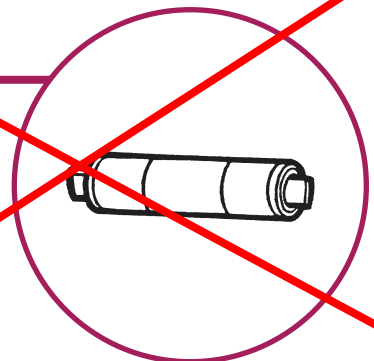
See Pages C-9-C-10



### Type ASP

Aluminum Splices

See Page C-10





Specially designed for industrial and building applications.

### Type CTL — Copper One-Hole Lugs, Short Barrel

#### Copper Compression Connectors

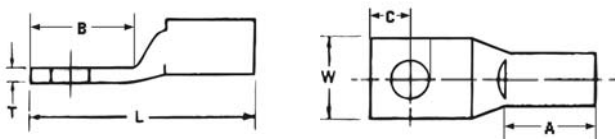
- For use with copper conductor: AWG stranded, flexible cable, welding cable and portable cord
- Specially designed for industrial and building applications
- Made of high-conductivity seamless copper tubing
- Tin-plated for corrosion resistance
- Specially chamfered barrel for ease of installation
- Color-coded for matching die identification
- Can be used for high voltage application up to 35 kV provided proper high voltage insulation techniques are used
- UL® Listed for AWG conductor when installed with Blackburn, Burndy, T&B or Anderson tools
- Comply with Subpart 111.60-17 of Federal Register's Coast Guard Electrical Engineering Rules and Regulations

#### Short Barrel Connectors

- Short barrel connectors designed for regular-duty applications
- Ideal for confined areas



Blackburn® Compression



CAT. NO.	CONDUCTOR SIZE (CU)	STUD SIZE	DIMENSIONS (IN.)						DIE COLOR CODE
			A	B	C	L	W	T	
CTL8-10	8 Str.	10	13/32	1/2	7/32	17/32	3/8	1/16	RED
CTL8-14		1/4	13/32	19/32	1/4	13/16	7/16	1/16	
CTL8-516		5/16	13/32	5/8	9/32	15/32	9/16	1/16	
CTL6-10	6 Str. or #6 Weld	10	7/16	17/32	7/32	17/32	7/16	1/16	BLUE
CTL6-14		1/4	7/16	17/32	7/32	17/32	7/16	1/16	
CTL6-516		5/16	7/16	21/32	9/32	13/32	19/32	1/16	
CTL6-38		3/8	7/16	21/32	9/32	13/32	19/32	1/16	
CTL4-10	4 Str.	10	1/2	19/32	1/4	13/8	17/32	3/32	GRAY
CTL4-14		1/4	1/2	19/32	1/4	13/8	17/32	3/32	
CTL4-516		5/16	1/2	21/32	5/16	13/32	19/32	1/16	
CTL4-38		3/8	1/2	21/32	5/16	13/32	19/32	1/16	
CTL2-14	2 Str. or #3 Weld	1/4	19/32	21/32	1/4	1 1/2	9/16	3/32	BROWN
CTL2-516		5/16	19/32	7/8	3/8	1 3/32	9/16	3/32	
CTL2-38		3/8	19/32	29/32	3/8	1 1/4	9/16	3/32	
CTL2-12		1/4	19/32	1 1/8	1/4	1 3/8	3/4	1/8	
CTL1-14	1 Str. or #2 Weld	1/4	19/32	21/32	1/4	1 1/2	21/32	3/32	GREEN
CTL1-516		5/16	19/32	7/8	3/8	1 3/32	21/32	3/32	
CTL1-38		3/8	19/32	29/32	3/32	1 1/4	21/32	3/32	
CTL1-12		1/2	19/32	1 1/4	1/2	2 3/32	3/4	3/32	
CTL10-516	1/0 Str. or #1 Weld	5/16	11/16	7/8	3/8	1 13/16	3/4	1/8	PINK
CTL10-38		3/8	11/16	29/32	3/8	1 1/8	3/4	1/8	
CTL10-12		1/2	11/16	1 1/4	1/2	2 3/8	3/4	1/8	
CTL20-38	2/0 Str. or 1/0 Weld	3/8	13/16	29/32	3/8	2 1/32	13/16	1/8	BLACK
CTL30-38	3/0 Str. or 2/0 Weld	1/2	13/16	1 1/4	1/2	2 1/32	13/16	1/8	ORANGE
CTL30-12		1/2	13/16	1 1/4	1/2	2 1/32	29/32	1/8	
CTL40-38	4/0 Str. or 3/0 Weld	3/8	15/16	29/32	3/8	2 2/32	1 1/32	1/8	PURPLE
CTL40-12		1/2	15/16	1 1/4	1/2	2 1/2	1 1/32	1/8	
CTL250-12	250 kcmil or 4/0 Weld	1/2	1 1/32	1 1/4	1/2	2 1/32	1 1/8	1/8	YELLOW
CTL300-12	300 kcmil	1/2	1 1/32	1 1/4	1/2	2 5/32	1 3/16	5/32	WHITE
CTL350-12	350 kcmil	1/2	1 1/32	1 1/4	1/2	2 7/32	1 11/32	5/32	RED
CTL400-12	400 kcmil	1/2	1 1/32	1 1/4	1/2	3 1/16	1 13/32	5/32	BLUE
CTL400-58		5/8	1 1/32	1 3/16	5/8	3 1/2	1 13/32	5/32	
CTL500-12	500 kcmil	1/2	1 13/32	1 1/4	1/2	3 3/4	1 13/32	7/32	BROWN
CTL500-58		5/8	1 13/32	1 3/16	5/8	3 3/16	1 13/32	7/32	
CTL600-58	600 kcmil	5/8	1 3/16	1 3/16	5/8	3 3/32	1 3/4	7/32	GREEN
CTL750-58	750 kcmil	5/8	1 1/2	1 3/16	5/8	3 25/32	1 29/32	1/4	BLACK
CTL1000-58	1,000 kcmil	5/8	1 3/4	1 3/16	5/8	4 1/2	2 1/4	9/32	N/A





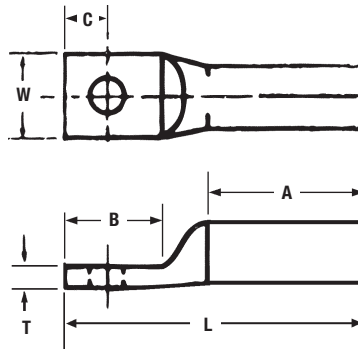
Ideal for industrial, oil rig, mining, welding and transportation electrical termination applications.

### Type CTL — Copper One-Hole Lugs, Long Barrel

- For use with copper conductor: AWG stranded, flexible cable, welding cable and portable cord
- Specially designed for industrial and building applications
- Made of high-conductivity seamless copper tubing
- Tin plated for corrosion resistance
- Specially chamfered barrel for ease of installation
- Color-coded for matching die identification
- Can be used for high-voltage application up to 35 kV provided proper high-voltage insulation techniques are used
- UL® Listed for AWG conductor when installed with Blackburn, Burndy, T&B or Anderson tools
- Comply with Subpart 111.60-17 of Federal Register's Coast Guard Electrical Engineering Rules and Regulations

#### Long Barrel Connectors

- Ideal for industrial, oil rig, mining, welding and transportation electrical termination applications
- Heavy-duty design permits additional crimp for added mechanical strength



CAT. NO.	CONDUCTOR SIZE AWG	FLEXIBLE CONDUCTOR	STUD	DIMENSIONS (IN.)							DIE COLOR
CTL8L-14	8 Str.	8	37/24		25/32	5/8	1/4	1 1/8	1 1/2	1/8	RED
CTL6L-14	6 Str.	6	61/24	1/4	25/32	5/8	1/4	1 1/8	1 1/2	1/8	BLUE
CTL4L-14	4 Str.	5	91/24		25/32	5/8	1/4	1 1/8	1 1/2	3/16	GRAY
CTL2L-516	2 Str.	3	125/24		1/2	3/4	3/8	2 1/2	3 1/2	3/16	BROWN
CTL1L-516	1 Str.	2	150/24	3/16	1 1/2	1 1/2	3/8	2 3/4	3 1/2	3/16	GREEN
CTL10L-516	1/0 Str.	1	225/24		1 3/4	1 3/4	3/8	2 3/4	3 1/2	3/16	PINK
CTL20L-38	2/0 Str.	1/0	275/24		1 3/4	2 1/2	3/8	2 1/4	3 1/2	3/16	BLACK
CTL30L-12	3/0 Str.	2/0	325/24		1 1/2	1 1/4	1/2	2 1/8	2 3/4	1/8	ORANGE
CTL40L-12	4/0 Str.	—	—		1 1/2	1 1/4	1/2	2 1/8	2 3/4	1/8	PURPLE
CTL250L-12	250 kcmil	3/0	450/24	1/2	1 1/2	1 1/4	1/2	3 1/8	3 1/2	1/8	YELLOW
CTL300L-12	300 kcmil	4/0	550/24		1 3/4	1 1/4	1/2	3 1/8	3 1/2	1/8	WHITE
CTL350L-12	350 kcmil	263	650/24		1 3/4	1 1/4	1/2	3 1/8	3 1/2	5/16	RED
CTL400L-58	400 kcmil	313	775/24		1 3/4	1 1/8	3/8	4 1/8	4 1/2	5/16	BLUE
CTL500L-58	500 kcmil	373	925/24		2 1/4	1 1/8	3/8	4 1/8	4 1/2	3/16	BROWN
CTL600L-58	600 kcmil	444	1100/24		2 1/4	1 1/8	3/8	4 1/8	4 1/2	3/16	GREEN
CTL750L-58	750 kcmil	535	1325/24		2 1/4	1 1/8	3/8	4 1/8	4 1/2	1/4	BLACK
CTL1000L-58	1000 kcmil	646	1600/24		2 1/4	1 1/8	3/8	5 1/8	5 1/2	3/16	N/A
		777	1925/24								


Blackburn® Compression

## Wing-Nut® Wire Connectors

- Three color-coded models cover a full range of wire sizes from 18 to 6 AWG
- Specially designed contoured wings provide a secure grip for extra leverage on maximum wire combinations
- Live-action spring expands to accept wire shape and size with no pre-twisting required
- Square-wire spring threads directly onto conductors for fast, secure connections
- Deep skirt helps protect against flash-over and turned-back strands for maximum dielectric protection
- Tough, UL 94V-2 flame-retardant shell rated at 105°C (221°F)
- UL Listed to 486C and CSA Certified to C22.2 #188; comply with Federal Specification W-S-610E



Wire Connectors

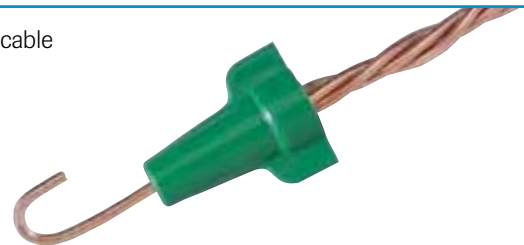
Model	Color	Wire Combination Range	Wire Combination Range (mm)	Quantity	Cat. No.
451®	Yellow	600V* 18 to 10 AWG Min. 2 #18 Max. 3 #12	600V* ,75mm <sup>2</sup> to 6,0mm <sup>2</sup> Min. 2-,75mm <sup>2</sup> Max. 3-4,0mm <sup>2</sup>	Box of 100	<b>30-451</b>
				Jar of 225	<b>30-451J</b>
				Jar of 500	<b>30-651J</b>
				Carton of 1,000	<b>30-551</b>
				Keg of 5,000 (10 bags, 500 ea.)	<b>30-651</b>
				Barrel of 35,000	<b>30-851</b>
452®		600V* 18 to 8 AWG <b>Min. 2 #18</b> <b>Max. 4 #10</b>	600V* ,75mm <sup>2</sup> to 10,0mm <sup>2</sup> Min. 2-,75mm <sup>2</sup> Max. 4-6,0mm <sup>2</sup>	Box of 100	<b>30-452</b>
				Jar of 300	<b>30-452J</b>
				Jar of 500	<b>30-652J</b>
				Carton of 1,000	<b>30-552</b>
				Keg of 5,000 (10 bags, 500 ea.)	<b>30-652</b>
				Barrel of 25,000	<b>30-852</b>
454®	Blue	600V* 14 to 6 AWG Min. 3 #12 Max. 1 #6 & 2 #8	600V* 2,5mm <sup>2</sup> to 16,0mm <sup>2</sup> Min. 3-4,0mm <sup>2</sup> Max. 2-16,0mm <sup>2</sup> w/1-4,0mm <sup>2</sup>	Box of 25	<b>30-454</b>
				Carton of 250	<b>30-554</b>
				Keg of 1,000 (10 bags, 100 ea.)	<b>30-654</b>
				Barrel of 10,000	<b>30-854</b>

\*1,000V maximum in fixtures and signs



## Greenie® Grounding Wire Connectors

- Designed for making ground connections and bonding non-metallic sheathed cable
- Contoured wings for maximum leverage
- Live-action, square-wire spring provides superior grounding connections
- Tough, UL 94V-2 flame-retardant shell
- UL Listed to 467 and CSA Certified to C22.2 #188; comply with Federal Specification W-S-610E



Model	Color	Wire Combination Range	Wire Combination Range (mm)	Quantity	Cat. No.
92®	Green	14 to 10 Min. 2 #14 Max. 4 #12	2,5mm <sup>2</sup> to 6,0mm <sup>2</sup> Min. 2-2,5mm <sup>2</sup> Max. 2-4,0mm <sup>2</sup> w/1-2,5mm <sup>2</sup>	Box of 100	<b>30-092</b>
				Jar of 150	<b>30-092J</b>
				Carton of 1,000	<b>30-192</b>
				Keg of 5,000 (10 bags, 500 ea.)	<b>30-292</b>
				Barrel of 25,000	<b>30-992</b>

**Greenie® Grounding Connector fully meets the intent of the N.E.C. and specifically aids in compliance with the following:**

### ARTICLE 250: GROUNDING








- 250-146 Connecting Receptacle Grounding Terminal to Box
- 250-148 Continuity and Attachment of Equipment Grounding Conductors to Boxes
  - (B) Grounding continuity
  - (D) Nonmetallic boxes












# SPRING CONNECTORS

FEATURES	ADVANTAGES	BENEFITS
<b>3M PERFORMANCE PLUS WIRE CONNECTORS (T/R+, T/Y+, O/B+, R/Y+, B/G+)</b>		
Wires feed deeper	Increases level of pull-out	Security
Wide wire ranges	Three connectors replace seven	Saves money and time
Flexible skirt	Covers overstripped wires	Safety
New internal design	Smoother and faster installation	Improves quality and saves time
<b>3M SCOTCHLOK ELECTRICAL SPRING CONNECTORS (Y, R, G, B)</b>		
Soft outer shell	Easy on the fingers	Easy to use
Steel inner shell	No wire poke-through	Safety
Compact design	Fit into tight places	Easy to use
Able to back off	Rewire if needed	Saves time
<b>3M ELECTRICAL SPRING AND GROUNDING CONNECTORS (312, 412, 512, 512G)</b>		
Hard shell	Easy to grip	Easy to use
Wings	Easy to turn	Easy to use
<b>3M HIGHLAND™ WIRE CONNECTORS (H-29, H-30, H-31, H-33, H-35)</b>		
Low price	Economical	Save money

## Specifications for Spring Connectors

Connector	Features/Description	Maximum Voltage Rating	Wire Range* AWG (mm <sup>2</sup> )	Temp. Rating	UL, CSA or CE Certified	Tools
 3M™ Connector O/B+	Flexible skirt w/square wire	600V (1000V in signs, lighting fixtures and luminaries)	2#22-3#12 3#14 (1,0 mm <sup>2</sup> -5,0 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H
 3M™ Connector T/R+	Quick bite, compact size wide wire range	600V (1000V in signs, lighting fixtures and luminaries)	up to 5#12s (2,0 mm <sup>2</sup> -16,0 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H
 3M™ Connector R/Y+	Flexible skirt w/square wire	600V (1000V in signs, lighting fixtures and luminaries)	2#18-2#8 5#12 (2,0 mm <sup>2</sup> -16,0 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H
 3M™ Connector T/Y+	Flexible skirt w/square wire	600V (1000V in signs, lighting fixtures and luminaries)	2#22-3#12 3#14 (1,0 mm <sup>2</sup> -5,0 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H
 3M™ Connector B/G+	Flexible skirt w/square wire	600V (1000V in signs, lighting fixtures and luminaries)	4#14-2#6-3#8 (10,0 mm <sup>2</sup> -31,6 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	—
 3M™ Scotchlok™ Connector R	Insulated w/vinyl skirt and live spring and steel shell	600V (1000V in signs, lighting fixtures and luminaries)	9#18, 4-6#16, 2-5#14, 2-5#12, 1-3#10 (5,0 mm <sup>2</sup> -16,0 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H
 3M™ Scotchlok™ Connector Y	Insulated w/vinyl skirt and live spring and steel shell	600V (1000V in signs, lighting fixtures and luminaries)	5-8#22, 4-6#20, 2-5#18, 2-3#16, 1-3#14, 1-2#12, 1#10 (2,0 mm <sup>2</sup> -17,5 mm <sup>2</sup> )	221°F (105°C)	UL SP CE <sup>†</sup>	WCD-P WCD-H

## Specifications for Spring Connectors

Connector	Features/Description	Maximum Voltage Rating	Wire Range* AWG (mm <sup>2</sup> )	Temp. Rating	UL, CSA or CE Certified	Tools
 3M™ Connector 312	Nylon insulated w/live spring	600V (1000V in signs, lighting fixtures and luminaries)	5-7#22, 3-6#20, 2-6#18 2-6#16, 1-4#14, 1-3#12 (1,5 mm <sup>2</sup> -10,0 mm <sup>2</sup> )	221°F (105°C)	UL SF †	WCD-P WCD-H
 3M™ Connector 412	Nylon insulated w/live spring	600V (1000V in signs, lighting fixtures and luminaries)	5-7#22, 3-6#20, 2-6#18 2-6#16, 1-4#14, 1-4#12 (1,5 mm <sup>2</sup> -10,0 mm <sup>2</sup> )	221°F (105°C)	UL SF †	WCD-P WCD-H
 3M™ Connector 512	Nylon insulated w/live spring	600V (1000V in signs, lighting fixtures and luminaries)	2-10#18, 2-7#16, 1-6#14, 1-5#12, 1-3#10, 1-2#8, 1#6 (2,0 mm <sup>2</sup> -16,0 mm <sup>2</sup> )	221°F (105°C)	UL SF †	WCD-P WCD-H
 3M™ Connector 512G	Nylon insulated grounding connector	600V (1000V in signs, lighting fixtures and luminaries)	2-5#14, 2-5#12, 2-3#10, 1#14 w/1-4#12, 2#14 w/ 1-3#12, 3#14 w/2 or 3 #12, 4#14 w/1#12, 1#14 w/1- 3#10, 2#14 w/1 or 2#10, 3#14 w/1#10, 1#12 w/1 or 2#10, 2#12 w/1#10 (4,0 mm <sup>2</sup> -15,0 mm <sup>2</sup> )	221°F (105°C)	UL SF †	—
 3M Highland™ Connector H-29	Round wire spring	300V	22-16 AWG [Two 22 AWG/One 20 AWG Min.] [Two 16 AWG Max.] (1,5 mm <sup>2</sup> -2,5 mm <sup>2</sup> )	221°F (105°C)	UL SF	—
 3M Highland™ Connector H-30	Round wire spring	300V	22-16 AWG [Two 22 AWG Min.] [Three 16 AWG Max.] (1,5 mm <sup>2</sup> -3,0 mm <sup>2</sup> )	221°F (105°C)	UL SF	—
 3M Highland™ Connector H-31	Round wire spring	600V (1000V in signs, lighting fixtures and luminaries) Depending upon combinations	18-14 AWG [Two 18 AWG Min.] [Two 14 AWG Max.] (2,0 mm <sup>2</sup> -4,0 mm <sup>2</sup> )	221°F (105°C)	UL SF	—
 3M Highland™ Connector H-33	Round wire spring	600V (1000V in signs, lighting fixtures and luminaries) Depending upon combinations	18-12 AWG [Three 18 AWG Min.] [Three 14 AWG Max.] (2,0 mm <sup>2</sup> -0,5 mm <sup>2</sup> )	221°F (105°C)	UL SF	—
 3M Highland™ Connector H-35	Round wire spring	600V (1000V in signs, lighting fixtures and luminaries) Depending upon combinations	18-10 AWG [Three 18 AWG Min.] [Two #10 AWG Max.] (2,5 mm <sup>2</sup> -16,0 mm <sup>2</sup> )	221°F (105°C)	UL SF	—

\*For information on additional Cu wire connections, refer to package or consult 3M technical service.

† UL Listed E23438 and CSA Certified LR15503

## Ordering Information for Spring Connectors

Connector	UPC (054007-)	Inner Unit Pack	Case Qty. (connectors) Distributor Order Qty.
3M™ Connector O/B+	43152	100/box	1,000 box
	43153	500/jug	10,000 container
3M™ Connector T/R+	54454*	100/box	1,000 box
	54455*	750/jug	6,000 jug
	54456*	N/A	25,000 keg
3M™ Connector R/Y+	43154	100/box	1,000 box
	43155	500/jug	4,000 container
3M™ Connector T/Y+	55218*	100/box	1,000 box
	55219*	500/jug	10,000 container
3M™ Connector B/G+	43150	50/box	500 box
	43151	250/jug	2,000 container

\*UPC prefix 051128-



## Ordering Information for Spring Connectors

Connector	UPC (054007-)	Inner Unit Pack	Case Qty. (connectors) Distributor Order Qty.
3M™ Scotchlok™ Connector R	20058	100/box	1,000 box
	70489	500/bag	5,000 bag
3M™ Scotchlok™ Connector Y	20041	100/box	1,000 box
	15769	500/bag	10,000 bag
3M™ Connector 312 (Yellow)	08159	100/box	1,000 box
	08160	500/bag	10,000 bag
	53952*	500/jug	10,000 case
3M™ Connector 412 (Tan)	54451*	100/box	1,000 box
	54452*	500/bag	10,000 bag
	54453*	20,000/keg	20,000 keg
	55695*	500/jug	4,000 box
3M™ Connector 512 (Red)	08161	100/box	1,000 box
	08162	500/bag	10,000 bag
	53953*	250/jug	5,000 case
3M™ Connector 512G (Green)	49950	50/box	500 box
	50232	500/bag	10,000 bag
3M Highland™ Connector H-29 (Gray)	43133	100/box	1,000 box
	43134	N/A	1,000 bin
	43135	N/A	25,000 keg (loose)
3M Highland™ Connector H-30 (Blue)	43122	100/box	1,000 box
	43123	N/A	1,000 bin
	43124	N/A	10,000 keg (loose)
3M Highland™ Connector H-31 (Orange)	43117	100/box	1,000 box
	43118	500/bag	10,000 bulk
	43119	N/A	1,000 bin
	43120	N/A	10,000 keg
3M Highland™ Connector H-33 (Yellow)	43136	100/bag	1,000 bag
	43137	N/A	1,000 bin
	43138	500/bag	5,000 bag
	43139	N/A	5,000 keg
3M Highland™ Connector H-35 (Red)	43140	100/box	1,000 box
	43141	N/A	1,000 bulk
	43142	250/bag	2,500 bag

\*UPC prefix 051128-

## Specifications and Ordering Information for Application Tools

Product Number	Description	Application	UPC (054007-)	Inner Unit Pack	Case Qty.
WCD-P	Power driver for wire connectors	Tools for 3M O/B+, R/Y+, 3M Scotchlok Y, R, G and 3M 212, 312, and 512.	49919	N/A	10
WCD-H	Hand driver for wire connectors	Tools for 3M O/B+, R/Y+, 3M Scotchlok Y, R, G and 3M 212, 312, and 512.	49948	N/A	10

# Crimp Sleeve Connectors

## 3M™ Scotchlok™ Insulated Electrical Crimp Sleeve Connectors S-11 and S-31

3M Scotchlok electrical crimp sleeve connectors make fast work of splicing 22 to 10 AWG copper conductors. Smooth flared entry makes wire insertion fast—simply twist conductors together and crimp. The S-11-A and S-31-A are insulated, closed-end crimp sleeve connectors. With a rugged, yet resilient nylon insulator, use these connectors in light fixtures, appliances and other electrical OEM applications.

### Specifications for Crimp Sleeve Connectors (Nylon Insulated)

Product Number	UPC (054007-)	Maximum Voltage Rating*	AWG (mm <sup>2</sup> ) Wire Range O.D.*	Inner Unit Pack	Case Qty.
S-11-A	16732	600V	2#22, 2#18, 2#16 stranded (0,6–2,6 mm <sup>2</sup> )	100/box	1,000
	16733	600V	2#22, 2#18, 2#16 stranded (0,6–2,6 mm <sup>2</sup> )	1,000/bag	10,000
S-31-A	16734	600V	2#18, 3#14 (1,6–6,6 mm <sup>2</sup> )	50/box	500
	16735	600V	2#18, 3#14 (1,6–6,6 mm <sup>2</sup> )	500/bag	5,000



S-11-A



S-31-A



# Scotchlok™ 567

## Self-Stripping Electrical Tap Connectors



### Data Sheet

#### Application

Use 3M™ Scotchlok™ Tap Connector 567 to electrically connect a (tap) wire end to a through (run) wire and insulate the connection.

#### Wire Range

(Tap) 18-14 AWG (.75-1.5 mm<sup>2</sup>):

(Run) 12-10 AWG (4.0 mm<sup>2</sup>)

Solid or stranded copper conductors. For use with common thermoplastic insulated wires such as: T, TF, TFF, TFN, TFFN, AWM, TEW, SAE-GPT with a maximum insulation diameter of (tap) .145 inches (3.5 mm) run .190 inches (4.8 mm).

Maximum recommended current for general purpose applications:

18 AWG - 7 AMPS, 16 AWG - 10 AMPS,

14 AWG-15 AMPS, 12 AWG-20 AMPS,

10 AWG-25 AMPS.

#### Construction

U-contact - Tin plated brass, .03 in. (.8 mm) thick

Insulator - Polypropylene

Color - brown

UL 94-V-2

#### Weight

.0067 lb. (3.0 gm)

#### Recommended Installation Tools

9" Linemans Pliers

3M™ Crimping Tool No. E-9BM

#### Installation Instructions

#### ⚠ WARNING

Turn power off before installing or removing terminal. All electrical work should be done according to appropriate electrical codes.

1. Place unstripped run wire inside run channel.
2. Insert unstripped tap wire completely and check it's position in the inspection port.
3. Hold tool perpendicular to the wires and make the connection by driving the u-contact down flush with the top of the plastic insulator.
4. Close hinged top cover until latched.

#### Regulatory Agencies

UL Listed - Tested per UL Standard 486C

UL file No. E23438

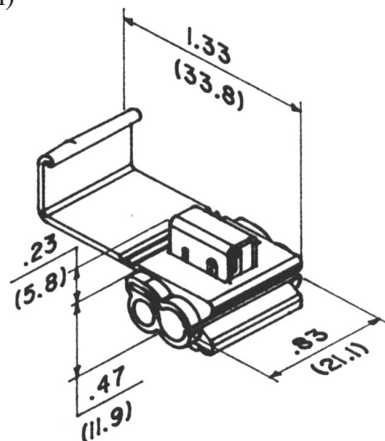
CSA certified - CSA Std. C22.2 No. 0. 188-MI983

CSA File No. LR15503, LR32411

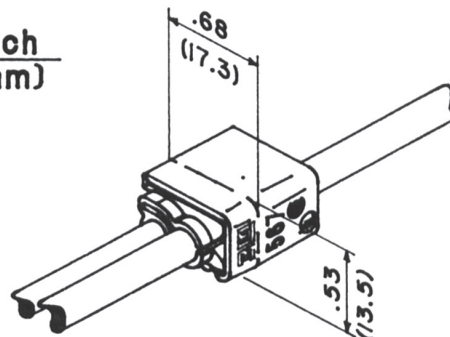
(Voltage rated at 600 volts maximum, building wire:

1000 volts maximum, signs, fixtures and luminaires.

Operating Temperature: 105°C.)



inch  
(mm)




## Engineering Specification

Self-Stripping Electrical Connector (as manufactured by 3M, part No. 567) capable of connecting a tap wire 18-14 AWG solid or stranded copper to a run wire solid or stranded copper. Connector shall be UL Listed and CSA Certified for 600 volts maximum, building wire: 1000 volts maximum, signs, fixtures and luminaires, and temperature rated 105°C maximum.

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# SECTION 3

## Wire Pulling Lubricant

Proven

# Polywater<sup>®</sup> Lubricant J

High Performance Cable Lubricant  
For Heavy Cable Installations



- Maximum Friction Reduction
- Compatible With Most Cables\*
- Temperature Stable
- Non-Combustible Residue
- Specification Grade

- Clean and Non-Staining
- High Cling Factor
- Application System
- UL & CSA Listed
- Available in cold weather (non-freezing) formula

*\*Not recommended for use with LSZH,LSHF jackets unless specifically tested.  
(see [www.polywater.com/LSZH.asp](http://www.polywater.com/LSZH.asp) for current information)*

# Polywater® Cable Lubricant J

**Polywater® Lubricant J** is a high performance, clean, slow-drying, water-based gel lubricant. Lubricant J provides maximum tension reduction in all types of cable pulling. It is especially recommended for long pulls, multiple-bend pulls and pulls in a hot environment. Lubricant J dries to form a thin lubricating film that retains its lubricity for months after use.

**Polywater® J** is a specification-grade lubricant that does not promote flame propagation when used with fire-retardant cables and systems. It is harmless to humans, environmentally safe, compatible with all cable jacket materials, and can be easily applied as part of the unique Polywater® Lubricant Application System.

**Polywater® Lubricant WJ** (winter grade) has the same characteristics as Polywater® Lubricant J and is specially formulated for use in temperatures as low as -20°F (-30°C).

**Front End Pack™** is a conduit-sized polyethylene bag of lubricant. The Front End Pack™ travels through the conduit on the winch line prelubricating the conduit ahead of the cable being pulled.

Package Size	Lubricant J Product #	Winter Grade Lubricant WJ Product #
55-gal drum (208 ℓ)	J-Drum	WJ-Drum
5-gal pail (18.9 ℓ)	J-640	WJ-640
1-gal pail (3.9 ℓ)	J-128	WJ-128
½-gal Front End Pack™ (1.9 ℓ) (in 5-gal. pail)	J-110	WJ-110
1-qt Front End Pack™ (0.95 ℓ) (in 5-gal pail)	J-99	WJ-99
½-gal Front End Pack™ (1.9 ℓ) (in corrugated carton)	J-55	WJ-55
1-qt (0.95 ℓ) squeeze bottle	J-35	WJ-35
1-qt Front End Pack™ (0.95 ℓ) (in corrugated carton)	J-27	WJ-27

## SPECIFICATIONS

- Lubricity:** PVC or LDPE jacketed cable on PVC conduit at 200 lbs/ft (2.91 kN/m) normal pressure; coefficient of dynamic friction <0.15. PVC or LDPE jacketed cable on HDPE innerduct at 200 lbs/ft (2.91 kN/m) normal pressure; coefficient of dynamic friction <0.15.
- Percent non-volatile solids:** 3.5 – 5.5%
- Appearance:** Thick, cream-colored gel material
- Wax, grease, and silicone content:** none
- Temperature use range:** 20°F to 120°F (-5°C to 50°C) for Polywater® Lubricant J, -20°F to 120°F (-30°C to 50°C) for Polywater® Lubricant WJ (winter grade)
- pH:** 7.5 – 9.0
- Cable compatibility:** Passes IEEE 1210 physical and electrical testing on a wide variety of cable materials.
- Polyethylene stress cracking:** No stress cracking on LDPE cable jacket when tested by ASTM D1693
- Cling factor:** Twelve inches of a one-inch diameter cable will hold at least 75 grams of lubricant for one minute when held vertically (at 70°F/20°C).
- Temperature stability:** No phase-out after five freeze/thaw cycles or 24-hour exposure at 120°F (50°C).
- Toxicity:** Non-toxic and non-sensitizing. Industrial use only.
- Clean-up:** Complete clean-up possible with water.
- Flammability:** Lubricant has no flash point and dried residue will not support or spread flame.

To view technical information on our website, go to:

Cable Manufacturer Approvals: [www.polywater.com/electapprovals.pdf](http://www.polywater.com/electapprovals.pdf)

Usage and compatibility: [www.polywater.com/lubeinfo.asp](http://www.polywater.com/lubeinfo.asp)

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Important Notice: The statements here are made in good faith based on tests and observations we believe to be reliable. However, the completeness and accuracy of the information is not guaranteed. Before using, the end-user should conduct whatever evaluations are necessary to determine that the product is suitable for the intended use.

American Polywater expressly disclaims any implied warranties and conditions of merchantability and fitness for a particular purpose. American Polywater's only obligation shall be to replace such quantity of the product proven to be defective. Except for the replacement remedy, American Polywater shall not be liable for any loss, injury, or direct, indirect, or consequential damages resulting from product's use, regardless of the legal theory asserted.  
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# Polywater<sup>®</sup> J

## High Performance Lubricant



### TECHNICAL SPECIFICATION

#### Description:

Polywater<sup>®</sup> Lubricant J is a high-performance cable pulling lubricant proven in the installation of millions of feet (meters) of cable over the last 20 years. Lubricant J provides excellent tension reduction in underground and industrial cable pulls. It is recommended for both communications and electrical cable. Polywater<sup>®</sup> J has excellent shear resistance for effective lubrication under high cable sidewall pressure in conduit bends.

The residue from Polywater<sup>®</sup> J does not propagate flame when used with fire-retardant cable systems. Lubricant J is slow drying. The residue is a thin, slippery film that retains its lubricity for months after use. Its dried residue is non-conductive and non-combustible.

Polywater<sup>®</sup> Lubricant J is a stringy gel. It can be applied by hand or using Polywater's LP Pumps. It is also available in the unique Front End Pack<sup>™</sup> pre-lubrication bags.



#### Friction Testing:

**Lubricity:** Polywater<sup>®</sup> J Lubricant shows superior friction reduction on a variety of jacket types. Typical friction coefficients at 200 lbs/ft (2.91 kN/m) normal pressure are shown. Test results are based on the method described in the white paper, "Coefficient of Friction Measurement on Polywater's Friction Table, 2007" ([polywater.com/FTable.pdf](http://polywater.com/FTable.pdf)). Values are averages based on cable jacket and conduit materials from multiple manufacturers.

Cable Jacket	Conduit Type				
	HDPE	PVC	Steel	FRP	EMT
XLPE	.14	.11	.13	.16	.21
LLDPE	.10	.11	.16	.13	.13
PVC	.11	.11	.13	.16	.11
CPE	.14	.11	.21	.24	.08
HDPE	.05	.09	.13	.13	.13

Coefficient of friction data on additional or specific cable jackets or conduits can be obtained from American Polywater Corporation.

#### Product Benefits:

- Specification grade
- Excellent friction reduction
- High cling factor
- Non-combustible residue
- Clean and non-staining
- Temperature stable

#### End Use:

Suitable for many types of cable installations, including:

- Heavy, underground installations
- Multiple-bend pulls
- Long pulls
- High conduit fill situations

#### Official Approvals:

UL Approved  
CSA Listed



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## Cable Compatibility:

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### Polyethylene Stress Cracking:

Polywater® J shows no stress cracking on LDPE, LLDPE, MDPE, or HDPE cable jacket when tested per IEEE Standard 1210<sup>1</sup>.

### Tensile and Elongation Effects:

LLDPE, XLPE, CPE, PVC and EPR cable jacket materials aged in Polywater® Lubricant J per IEEE Standard 1210<sup>1</sup> meet the tensile and elongation retention requirements of that standard.

### Volume Resistivity:

There are no significant changes in the conductive properties of XLPE and EPR semi-conducting compounds when volume resistivity is tested according to IEEE Standard 1210<sup>1</sup>.

### Building Wire Testing:

THHN and XHHW building wire meet UL tensile, elongation, and voltage withstand requirements after exposure to Polywater® J Lubricant as tested by UL requirements<sup>2</sup>.

### Nuclear Approval:

Polywater® J Lubricant does not contain halogenated compounds, sulfur compounds, or low melting point metals.<sup>3</sup>

### Cable Approvals:

Polywater® J Lubricant is approved by most cable manufacturers. Contact American Polywater for details.

<sup>1</sup> IEEE Std 1210-2004; IEEE Standard Tests for Determining Compatibility of Cable Pulling Lubricants with Wire and Cable.

<sup>2</sup> UL Subject 267, Investigation for Wire-Pulling Compounds.

<sup>3</sup> Nuclear Test Methodology: Leachable Chlorides (ASTM D 512-88), Water Leachable Bromides (ASTM D 1246-88) Halogenated Compounds (ASTM D 808-87) Water Leachable Iodides (ASTM D 1246-88) Sulfur (ASTM D 129-78) Water Leachable Fluorides (ASTM D 1179-88)

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## Performance Properties

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### Cling Factor:

*Cling factor is a measure of the ability to apply the lubricant and have it stay on the jacket while the cable enters the conduit.*

A six-inch length (152 mm) of a one-inch (25 mm) diameter cable will hold at least 50 grams of Polywater® Lubricant J for one minute when held vertically at 70° F (21° C).

### Coatability:

*Coatability is a measure of the lubricant's ability to coat the cable jacket as a thin film for continued lubricity on longer pulls.*

Polywater® J will wet out evenly on cable jacket surfaces. It will not bead up or rub off of the jacket sample. A one-inch (25 mm) diameter XLPE cable dipped six inches (152 mm) into Polywater® J, then withdrawn and held vertically, will retain at least 30 grams of Polywater® Lubricant J for one minute at 70° F (21° C).

### Combustibility:

*Combustibility is a measure of combustion properties of the lubricant residue in a fire situation (with an impinging heat flux).*

Polywater® J has no flash point and its dried residue will not support combustion and spread flame. A 200-gram sample of the J Lubricant, when placed in a one-foot, split metal conduit and fully dried for 24 hours at 105°C, will not ignite and spread a flame more than three inches beyond a point of ignition when subjected to a continuous heat flux of 40 kW/m<sup>2</sup>. The total test time was one-half hour.

*Test method described in "Fire Parameters and Combustion Properties of Cable Pulling Compound Residues," presented to the International Wire & Cable Symposium, 1987.*

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## Physical Properties:

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<u>Property</u>	<u>Result</u>
<b>Appearance:</b>	Cream-colored, stringy gel
<b>Wax, Grease and Silicone Content:</b>	None
<b>Percent Non-Volatile Solids:</b>	4.3
<b>VOC Content:</b>	10 gms/liter 200 gms/liter (wintergrade)
<b>Viscosity:</b>	25,000 – 40,000 cps @10rpm
<b>pH:</b>	7.5 – 9.0

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## Application Properties:

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### Application Systems:

Polywater® J has a stringy gel consistency that makes it easy to lift, carry and hand apply.

Polywater® J can also be pumped directly into the conduit or onto a cable using the Polywater® LP-3 or LP-D5 specialty lubricant pumps. Pumps allow hands-free transfer and consistent application of lubricant. Polywater's low-shear pumps will not change the gel character of Polywater® J lubricant. The LP-3 and LP-D5 pumps support lubricant application rates of 1 to 3 gallons (4 to 11 liters) per minute.

Polywater® LZ **Front End Packs™** are bag packages that "pre-lubricate" the head end of the cable during the pull. The Front End Pack™ attaches to the winch line and pre-lubricates as it goes through the conduit. Two sizes are available to fit 2" and larger conduits.

**Pull-Planner™** Tension Calculation Software is available from Polywater. Pulling tension estimations can ensure the use of appropriate pulling equipment and that the cable is installed within safe limits.

*Polywater® J is also available in a pourable version (lower viscosity) called Polywater® PJ. PJ is primarily for use in underground work where pouring the lubricant into a cable feeder tube is a convenience.*

### Temperature Use Range:

Polywater® J:

20°F to 120°F (-5°C to 50°C).

Polywater® WJ (wintergrade version):

-20°F to 120°F (-30°C to 50°C).

### Temperature Stability:

Polywater® J will not phase-out or separate after five freeze/thaw cycles or 5-day exposure at 120°F (50°C).

### Clean-Up:

Polywater® J is non-staining. Complete clean-up is possible with water.

### Storage and Shelf Life:

Store Polywater® J in a tightly sealed container away from direct sunlight. Lubricant shelf life is one year.

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## Directions for Use:

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Polywater® J Lubricant can be hand applied or pumped onto the cable as it enters the conduit. Polywater® PJ is a thinner gel and can be poured.

For long pulls, place approximately two-thirds of the recommended quantity of lubricant into the conduit using the Front End Packs™ or by pumping.

For Front End Pack™ use, attach the packs of Polywater® J to the winch line or pulling rope in front of the cable using tape or cable ties. Start the pull and slit open the entire length of the pack(s) with a sharp knife as it enters the conduit.

Supplement with direct jacket lubrication as the cable enters the conduit.

Clean-up by wiping off any excess lubricant with a rag.

## Recommended Lubricant Quantity

$$Q = k \times L \times D$$

Where:

Q = quantity in gallons (liters)

L = length of conduit run in feet (meters)

D = ID of the conduit in inches (mm)

k = 0.0015 (0.0008 if metric units)

The quantity that is appropriate for any given pull can vary from this recommendation by 50%, depending on the complexity of the pull. Consider the following factors:

Cable weight and stiffness

*(Increase quantity for stiff, heavy cable)*

Conduit condition

*(Increase quantity for old, dirty or rough conduits)*

Conduit fill

*(Increase quantity for high percent conduit fill)*

Number of bends

*(Increase quantity for pulls with several bends)*

Pulling environment

*(Increase quantity for high temperatures)*

## Model Specification:

The statement below may be inserted into a specific job specification to help maintain engineering standards and ensure project integrity.

The cable pulling lubricant shall be Polywater® J Lubricant. The lubricant shall be UL (or CSA) listed. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes. Lubricant manufacturer must provide cable manufacturer approvals upon request.

Cable jacket compatibility shall be tested by the IEEE 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable. It shall pass physical compatibility tests on LLDPE, XLPE, CPE, PVC and EPR cable jacket or sheath materials. It shall not stress crack polyethylene per ASTM Standard 1693. There shall be no significant changes in the conductive properties of XLPE and EPR semi-conducting compounds when the lubricant's effect on volume resistivity is tested according to IEEE Standard 1210.

A 200-gram sample of the lubricant, when placed in a one-foot, split metal conduit and fully dried for 24 hours at 105 degrees C, shall not spread a flame more than three inches beyond a point of ignition at a continued heat flux of 40 kW / meter<sup>2</sup>. Total time of test shall be one-half hour.

## Order Information:

<u>Cat #</u>	<u>Package Description</u>
	<b>Regular</b>
J-35	1-quart squeeze bottle (0.95 liter)
J-128	1-gallon pail (3.78 liter)
J-640	5-gallon pail (18.9 liter)
J-27	1-quart bag (0.95 liter)
J-99	1-quart bag (0.95 liter) in a pail
J-55	1/2-gallon bag (1.9 liter)
J-110	1/2-gallon bag (1.9 liter) in a pail
J-Drum	55-gallon drum (208 liter)

### Pourable

PJ-128	1-gallon pail (3.78 liter)
PJ-320	2 1/2- gallon jug (9.6 liter)
PJ-640	5-gallon pail (18.9 liter)
PJ-Drum	55-gallon drum (208 liter)

\*\* Wintergrade version Polywater® PJ available (WPJ)

### Wintergrade

WJ-35	1-quart squeeze bottle (0.95 liter),
WJ-55	1/2-gallon bag (1.9 liter)
WJ-110	1/2-gallon bag (1.9 Liter) in a pail
WJ-128	1-gallon pail (3.78 liter)
WJ-640	5-gallon pail (18.9 liter)
WJ-Drum	55-gallon drum (208 liter)

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The statements contained herein are made in lieu of all warranties, express or implied, including, but not limited to, implied warranties of merchantability and fitness for a particular purpose, which warranties are hereby expressly disclaimed. American Polywater's only obligation shall be to replace such quantity of the product proven to be defective. Except for the replacement remedy, American Polywater shall not be liable for any loss, injury or damage, direct or indirect, arising from the use or the failure to properly use these products, regardless of the legal theory asserted.

Makers of Polywater® and Dyna-Blue® Cable Lubricants  
and Pull-Planner™ 3000 Software

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## **POLYWATER LUBRICANTS Electrical Cable Manufacturers' Approvals**

Visit this web address for a free, pre-written model performance spec on Polywater J that is suitable for inclusion in an overall electrical project specification. We've done the work for you!

<http://www.polywater.com/modelspc.html>

A number of cable manufacturers evaluate and/or approve pulling compounds on compatibility with their cable jacket types. Some of these manufacturers maintain written lists of approved products in their applications literature, while others only provide information in response to inquiries.

Cable manufacturer technical contacts who favor American Polywater cable lubricants are provided. Polywater® J cable manufacturer approval letters are available upon request.

Aetna Insulated Wire Co	Dawn Zhoa	757-460-3381 x52
Alcan Cable	Larry Watkins	770-394-9886
American Insulated Wire	Lowell Lisker	401-726-0700
General Cable/BICC Utility Prod	Dan Mainstruck	860-465-8798
Draka Cableteq USA-BIW Cables	Matt Bodziony	800-333-4248 x2321
Brugg Cable	Leonardo di Iulio	41-56-4603-245
Conductores Monterrey (Viakon)	Candelario Saldivar	011-5281-8030-8000
Condumex	Ricardo Marquez	011-5255-587-7011
Hendrix Cable	Ed Laughlin	603-249-1214
Kerite Cable	Robert Fleming	203-881-5380 x458
Nexans Canada Inc.	Douglas Reith	905-944-4335
Okonite Cable	Jim Fitzgerald	201-825-0300 x4337
Pirelli Power Cable Systems	Frank Kuchta	803-951-4010
Rockbestos Surprenant	Robert Konnik	860-653-8340
Southwire Company	Dave Mercier	770-832-4522
Southwire Company	Nick Ware	770-832-5058
Superior Essex Electrical Product	Tim West	770-657-6870

The list above does not include all electrical cable manufacturers. Ask your cable manufacturer if they maintain a list of lubricants approved with their cable.

American Polywater has extensive lubricant compatibility data tested to various NEMA, ICEA, UL and IEEE standards. Please call our Technical Service Department toll-free at 1-800-328-9384 for details, or e-mail us at [custserv@polywater.com](mailto:custserv@polywater.com)



**LOWEST COST**

# **Dyna-Blue<sup>®</sup>**

**Heavy Duty Cable Lubricant**



**With Clingability**



- Clean-Easy to use
- Stays slippery-  
Won't dry out
- Lower cost

- Temperature stable-  
No waste
- Safe-Use with most cables
- UL listed

# Dyna-Blue® Cable Lubricant

Dyna-Blue® Lubricant is a clean, slow-drying, and easy to apply gel lubricant. It is a thick gel with “clingability” for easy handling and application. Dyna-Blue® combines effectiveness with economy. It is a good lubricant for everyday use in general electrical applications.

Dyna-Blue® Lubricant is harmless to humans, environmentally safe, compatible with cable jacket materials and exceptionally easy to work with.

Dyna-Blue® is UL listed.

Package Size	Dyna-Blue® Product Number
55-gallon drum (208 Liter)	<b>D-Drum</b>
5-gallon pail (18.9 Liter)	<b>D-640</b>
1-gallon pail (3.78 Liter) 4/case	<b>D-128</b>
1-quart squeeze bottle (.95 Liter) 12/case	<b>D-35</b>

## Specifications

- Lubricity:** PVC or XLP-jacketed cable on PVC conduit at 200 lbs/ft (2.9 kN/m) normal pressure; coefficient of dynamic friction <.15  
PVC or XLP-jacketed cable on EMT conduit at 200 lbs/ft (2.9 kN/m) normal pressure; coefficient of dynamic friction <.15
- Percent Non-Volatile Solids:** 3.5%
- Appearance:** Thick, light-blue gel material
- Wax, Grease and Silicone Content:** None
- Temperature Use Range:** 20°F - 140°F (-5°C - 60°C)
- pH:** 6.5 to 8.5
- Cable Compatibility:** Passes IEEE 1210 physical and electrical testing on a wide Variety of cable materials.
- Polyethylene Stress Cracking:** No stress cracking on LDPE cable jacket when tested by ASTM D1693.
- Cling Factor:** 12 inches (30 cm) of a 1 inch (2.5 cm) diameter cable will hold at least 75 grams of lubricant for one minute when held vertically (at 70°F/20°C)
- Temperature Stability:** No phase-out after five freeze/thaw cycles or 24-hour exposure at 120°F (50°C).
- Toxicity:** Non-toxic and non-sensitizing. Industrial use only
- Clean-up:** Complete cleanup possible with
- Flammability:** Lubricant has no flash point and dried residue is non-flammable.

To view technical information on our website, go to:

Usage information: [www.polywater.com/lubeinfo.asp](http://www.polywater.com/lubeinfo.asp)

MSDS: [www.polywater.com/dbmsds.html](http://www.polywater.com/dbmsds.html)

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American Polywater expressly disclaims any implied warranties and conditions of merchantability and fitness for a particular purpose. American Polywater's only obligation shall be to replace such quantity of the product proven to be defective. Except for the replacement remedy, American Polywater shall not be liable for any loss, injury, or direct, indirect, or consequential damages resulting from product's use, regardless of the legal theory asserted.

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http://www.polywater.com(URL) fax 1-651-430-3634

# Dyna-Blue<sup>®</sup> Heavy Duty Cable Lubricant



## TECHNICAL SPECIFICATION

### Description:

Dyna-Blue<sup>®</sup> Cable Pulling Lubricant is a clean, slow-drying, easy-to-apply gel lubricant. This thick gel lubricant was developed with “clingability” for easy handling and hand application. Dyna-Blue<sup>®</sup> Lubricant is a good lubricant for everyday use in general electrical and communication applications.

Dyna-Blue<sup>®</sup> Lubricant is popular for commercial and institutional pulling because it is non-staining and easy to clean up in these environments.

Dyna-Blue<sup>®</sup> Cable Pulling Lubricant is slow drying. It effectively reduces friction and continues to lubricate for the full length of the pull. Its dried residue is non-conductive and non-combustible.

Dyna-Blue<sup>®</sup> Cable Pulling Lubricant is harmless to humans, environmentally safe, compatible with cable jacket materials and easy to handle.



### Friction Testing:

**Lubricity:** Dyna-Blue<sup>®</sup> Lubricant shows good friction reduction across a broad class of jacket types. Typical values at 200 lbs/ft (2.91 kN/m) normal pressure are shown. Test results are based on the method described in the white paper, “Coefficient of Friction Measurement on Polywater’s Friction Table, 2007” (polywater.com/FTable.pdf). Values are compiled from testing on multiple cable jacket and conduit materials from multiple manufacturers.

Cable Jacket	Conduit Type		
	EMT	PVC	Steel
XLPE	.18	.08	.18
LLDPE	.14	.11	.17
PVC	.11	.11	.19
CPE	.23	.21	.24
THHN	.23	.09	.21

Coefficient of friction data on additional or specific cable jackets or conduits can be obtained from American Polywater Corporation.

### Product Benefits:

- Excellent cling for easy hand application
- Clean and non-staining
- Good friction reduction
- Compatible with cable jacket materials
- Temperature stable
- Combines effectiveness with economy

### End Use:

Use for all types of cable installations, including:

- General electrical or communication use
- Overhead and vertical installations
- Indoor or building construction
- Heavy cable

### Official Approvals:

UL Approved  
CSA Listed

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## Cable Compatibility:

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### Tensile and Elongation Effects:

XLPE, LLDPE, VLDPE, PVC, and CPE cable jacket materials aged in Dyna-Blue<sup>®</sup> Lubricant per IEEE Standard 1210<sup>1</sup> meet the tensile and elongation retention requirements of that standard.

### Polyethylene Stress Cracking:

Dyna-Blue<sup>®</sup> Lubricant shows no stress cracking on LLDPE, MDPE, or HDPE cable jacket when tested per IEEE Standard 1210<sup>1</sup>.

### Volume Resistivity:

There are no significant changes in the conductive properties of XLPE and EPR semi-conducting compounds when volume resistivity is tested according to IEEE Standard 1210<sup>1</sup>.

### Building Wire Testing:

THHN and XLPE building wire meet UL tensile, elongation, and voltage withstand requirements after exposure to Dyna-Blue<sup>®</sup> Lubricant as tested by UL requirements<sup>2</sup>.

### Cable Approvals:

Dyna-Blue<sup>®</sup> Lubricant is approved by most cable manufacturers. Contact American Polywater for further information.

<sup>1</sup> IEEE Std 1210-2004; IEEE Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.

<sup>2</sup> UL Subject 267, Investigation for Wire-Pulling Compounds.

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## Performance Properties:

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### Cling Factor:

*Cling factor is a measure of the ability to apply the lubricant and have it stay on the jacket while the cable enters the conduit.*

A six-inch length (152 mm) of a one-inch (25 mm) diameter cable will hold at least 75 grams of Dyna-Blue<sup>®</sup> Lubricant for one minute when held vertically at 70°F (21 °C).

### Coatability:

*Coatability is a measure of the lubricant's ability to coat the jacket as a thin film for continued lubricity on longer pulls.*

Dyna-Blue<sup>®</sup> Lubricant will wet out evenly on cable jacket surfaces. It will not bead up or rub off of the jacket sample. A one-inch (25 mm) diameter XLPE cable dipped six inches (152 mm) into the Dyna-Blue<sup>®</sup>, then withdrawn and held vertically, will retain at least 25 grams of Dyna-Blue<sup>®</sup> Lubricant for one minute at 70°F (21 °C).

**Combustibility:** Lubricant has no flash point and dried residue is non-flammable.

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## Physical Properties:

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<u>Property</u>	<u>Result</u>
<b>Appearance:</b>	Thick, light blue gel
<b>Wax, Grease and Silicone Content:</b>	None
<b>Non-Volatile Solids (%):</b>	3.0%
<b>VOC Content:</b>	0 gms/L
<b>Viscosity:</b>	70,000 – 110,000 cps @10rpm
<b>pH:</b>	6.5 – 8.5



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## Application Properties:

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### Application Systems:

Dyna-Blue<sup>®</sup> Lubricant has a thick gel consistency that makes it easy to hand apply.

Dyna-Blue<sup>®</sup> Lubricant can also be pumped directly into the conduit or onto the cable using the Polywater<sup>®</sup> LP-3 or LP-D5 specialty lubricant pumps. Pumps allow hands-free transfer and consistent application of lubricant. However, the thick gel consistency limits the length of the discharge hose and the pumping rate. The LP-3 supports Dyna-Blue<sup>®</sup> Lubricant application rates up to 0.9 gallon (3.5 liters) per minute and LP-D5 supports Dyna-Blue<sup>®</sup> Lubricant application rates of 0.1 to 0.3 gallon (0.4 to 1.2 liters) per minute.

Pull-Planner<sup>™</sup> Tension Calculation Software is available from Polywater. Pulling tension estimations can ensure the use of appropriate pulling equipment and that the cable is installed within safe limits.

### Temperature Use Range:

20° F to 120° F ( -5° C to 50° C).

### Temperature Stability:

No phase-out after five freeze/thaw cycles or 5-day exposure at 120° F (50° C).

### Clean-Up:

Dyna-Blue<sup>®</sup> Lubricant is non-staining. Complete clean-up is possible with water.

### Storage and Shelf Life:

Store Dyna-Blue<sup>®</sup> Lubricant in a tightly sealed container away from direct sunlight. Lubricant shelf life is one year.

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## Directions for Use:

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Dyna-Blue<sup>®</sup> Lubricant can be squeezed, pumped or hand applied directly onto the wire or cable. The thick clingy gel character allows Dyna-Blue<sup>®</sup> to be applied to vertical installations. Conduit should be clean and continuous.

To prelubricate for long or difficult pulls, squirt a liberal amount of Dyna-Blue<sup>®</sup> Lubricant into the conduit before the pull begins and use a mandrel or a swab on the winch line to spread the lubricant during the pull.

Clean-up by wiping off any excess lubricant with a rag.

### Recommended Lubricant Quantity

$$Q = k \times L \times D$$

Where:

Q = quantity in gallons (liters)

L = length of conduit in feet (meters)

D = ID of the conduit in inches (mm)

k = 0.0015 (0.0008 if metric units)

The quantity that is appropriate for any given pull can vary from this recommendation by 50%, depending on the complexity of the pull. Consider the following factors:

Cable weight and jacket hardness  
*(Increase quantity for stiff, heavy cable)*

Conduit type and conditions  
*(Increase quantity for old, dirty or rough conduits)*

Conduit fill  
*(Increase quantity for high percent conduit fill)*

Number of bends  
*(Increase quantity for pulls with several bends)*

Pulling environment  
*(Increase quantity for high temperatures)*

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## Model Engineering Specification:

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*The statement below may be inserted into a specific job specification to help maintain engineering standards and ensure project integrity.*

The cable pulling lubricant shall be Dyna-Blue<sup>®</sup> Lubricant. The cable pulling lubricant shall produce a low coefficient of friction on a wide variety of cable jacket materials. The lubricant shall be UL listed. It shall be easy to handle and adhere well to the cable.

The lubricant shall pass the IEEE 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable. It shall pass physical compatibility tests on LLDPE, XLPE, CPE, and PVC cable jacket or sheath materials. It shall not stress crack polyethylene per ASTM Standard 1693. There shall be no significant changes in the conductive properties of XLPE and EPR semi-conducting compounds when the lubricant's effect on volume resistivity is tested according to IEEE Standard 1210.

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## Order Information:

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<u>Cat #</u>	<u>Package Description</u>
D-35	1-quart squeeze bottle (0.95 liter)
D128	1-gallon pail (3.78 liter)
D-640	5-gallon pail (18.9 liter)
D-Drum	55-gallon drum (208 liter)

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Lit-DBTech/9-08/Internal/9-08

Makers of Polywater<sup>®</sup> and Dyna-Blue<sup>®</sup> Cable Lubricants  
and Pull-Planner<sup>™</sup> 300 Software

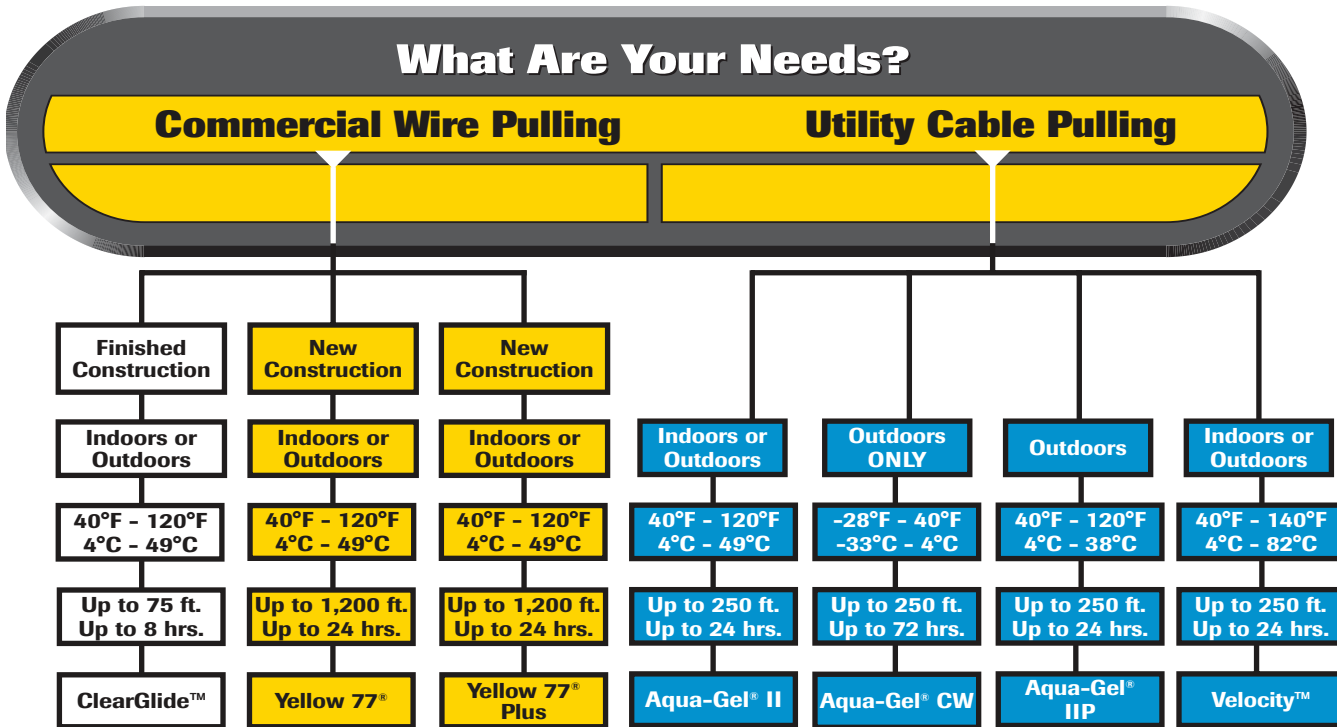


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E - 1,199

## Select-a-Lubricant



## Wire Pulling Lubricant Selection Guide



	Yellow 77® Plus Wire Pulling Lubricant	Aqua-Gel® II Cable Pulling Lubricant	Aqua-Gel® CW Cable Pulling Lubricant
Base	Wax	Polymer	Polymer
Average Coefficient of Friction*	.16	.11	.07
Safe Storage Temperature Range	32°F - 190°F (0°C - 88°C)	32°F - 180°F (0°C - 82°C)	-28°F - 190°F (-33°C - 82°C)
Application Temperature Range	40°F - 100°F (4°C - 38°C)	40°F - 100°F (4°C - 38°C)	-28°F - 40°F (-33°C - 4°C)
COMPATIBILITY (Cable Types):			
Rubber	•	•	•
Neoprene	•	•	•
Nylon	•	•	•
PVC	•	•	•
High-density or cross-linked polyethylene	•	•	•
Low-density polyethylene	•	•	•
Semiconducting jacket	•	•	•
Hypalon	•	•	•

\*Results from Falex Corporation, an independent testing agency specializing in tribology tests, using the Falex-ISC On Disk Tribometer System machine with the ASTM G99 modified method.

## Yellow 77® Plus Wire Pulling Lubricant

- Rapid Glide™ polytetrafluoroethylene additive provides greater lubricity than other wax-based lubricants – great for tough pulls
- Safe to use with all cable types
- Clings to cable throughout long runs, even where moisture is present
- Remains stable in high temperatures – usable from 30°F to 190°F (-1°C to 88°C)
- Dries slowly to a thin, non-conductive film that won't harden in conduit
- Easy to apply by hand or by brush
- Creamy texture applies easily and uniformly
- Homogeneous blend requires no mixing
- Won't dry out – surface coat forms to control evaporation
- Environmentally safe – non-toxic, non-flammable and non-corrosive

Description	Cat. No.
1-qt. Squeeze bottle	31-398
1-gal. Bucket	31-391
5-gal. Bucket	31-395



Lubricants

## Aqua-Gel® CW Cable Pulling Lubricant

- Features the same excellent qualities as Aqua-Gel® II Cable Pulling Lubricant with a lower temperature range for use outdoors in cold weather
- Polymer-based, cold-weather formula remains stable in storage from -28°F to 190°F (-33°C to 82°C)
- Formulated for exterior use in cold weather conditions
- Cleans up easily with soap and water
- Clings to cable throughout long pulls
- Well-suited for hand or poured applications
- Environmentally safe – non-toxic, non-flammable and non-corrosive

Description	Cat. No.
1-qt. Squeeze bottle	31-298
1-gal. Jug	31-291
5-gal. Bucket	31-295
55-gal. Drum	31-3373



## Aqua-Gel® II Cable Pulling Lubricant

- Polymer-based formula provides maximum tension reduction in high-stress electrical and communications cable-pulling operations
- Compatible with all cable types except composite rubber
- Cleans up easily with soap and water
- Clings to cable throughout long pulls
- Remains stable over wide temperature range – usable from 28°F to 180°F (-2°C to 88°C)
- Dries to a semi-fluid film that won't clog conduit
- Easy to apply by hand, brush or pump
- Environmentally safe – non-toxic, non-flammable and non-corrosive
- For outdoor use only

Description	Cat. No.
1-qt. Squeeze bottle	31-378
1-gal. Bucket	31-371
1-qt. Bag (12 bags per bucket)	31-376
1/2-gal. Bag (6 bags per bucket)	31-377
5-gal. Bucket	31-375
55-gal. Drum	31-3855



# **ELECTRICAL SPARE** **PARTS**

**Operations & Maintenance Manual**  
**December 2015**

Eisenhower/Johnson Memorial Tunnel - EJMT  
 ALL RECOMENDED SPARE ELECTRICAL PARTS

System	Part Description	Part #	Quantity Needed for 30-Year System
Electrical- Conduit	3/4" IMC Conduit- Allied	358184	50 Ft
Electrical- Conduit	1" IMC Conduit- Allied	358176	51 Ft
Electrical- Conduit	1 1/4" IMC Conduit- Allied	358119	52 Ft
Electrical- Conduit	3/4" Steel Flex- Southwire	RWS- 3/4	53 Ft
Electrical- Conduit	3/4" Liquid Tight Flex- Southwire	UL-3/4	54 Ft
Electrical- Conduit	1" PVC Conduit- Carlon	S801	55 Ft
Electrical- Conduit Supports	1 5/8 Galvanized Unistrut	P1001 10 PG	10 Ft
Electrical- Conduit Supports	1 5/8 Back TO Back Unistrut	P1000T 10 PG	10 Ft
Electrical- Conduit Supports	7/8 Unistrut	P3300	10 Ft
Electrical- Conduit Supports	3/4 Strut Straps - Unistrut	P1112EG	10 Ft
Electrical- Conduit Supports	1in Strut Straps- Unistrut	P1113EG	10 Ft
Electrical- Conduit Supports	Adjustable Brace- Unistrut	P2815EG	10 Ft
Electrical- Conduit Supports	Four Hole Hinge- Unistrut	P1354EG	10 Ft
Electrical- Conduit Supports	1 1/2 Conduit Clamp- Unistrut	P1115EG	10 Ft
Electrical- Conduit Supports	2 Hole Angle Connector- B Line	B230HDG	2
Electrical- Conduit Supports	3/8 Threaded Rod- Thomas and Betts	R 1038	5 Ft
Electrical- Conduit Supports	3/4 Conduit Strap- Thomas and Betts	HS 402	5
Electrical- Conduit Supports	3/4 Conduit Strap Back- Thomas and Betts	CB202	5
Electrical- Conduit Supports	1in Conduit Strap- Thomas and Betts	HS 403	5
Electrical- Conduit Supports	1in Conduit Strap Back- Thomas and Betts	CB 203	5
Electrical- Conduit Supports	3/4 Conduit Hangers- Arlington	2010	5
Electrical- Conduit Supports	3/8 Beam Clamp- OZ Gedney	IS-502	2
Electrical- Conduit Supports	1/4 Beam Clamp- OZ Gedney	IS-500	2
Electrical- Conduit Fittings	3/4 Conduit Body Cover- Appleton	C75M	0
Electrical- Conduit Fittings	3/4 Neoprene Gasket- Appleton	K75CM	0
Electrical- Conduit Fittings	3/4 Neoprene Gasket- Appleton	GK75N	0
Electrical- Conduit Fittings	3/4 LB Condulet Body- Appleton	LB75M	0
Electrical- Conduit Fittings	1 IN C Condulet Body- Appleton	C100M	0
Electrical- Conduit Fittings	1 IN LB Condulet Body- Appleton	LB100M	0
Electrical- Conduit Fittings	1 IN Condulet Cover- Appleton	K100CM	0
Electrical- Conduit Fittings	1 IN Condulet Gasket- Appleton	GK100N	0
Electrical- Conduit Fittings	3/4 Rigid coupling -Thomas and Betts	LN-102	0
Electrical- Conduit Fittings	1in Rigid coupling -Thomas and Betts	LN-103	0
Electrical- Conduit Fittings	3/4 Union Coupling -Thomas and Betts	EK402	0
Electrical- Conduit Fittings	1in Union Coupling -Thomas and Betts	EK403	0
Electrical- Conduit Fittings	3/4 Expansion Fitting- Crouse-Hinds	XJG24	0
Electrical- Conduit Fittings	1in Expansion Fitting- Crouse-Hinds	XJG34	0
Electrical- Conduit Fittings	1 1/4in Expansion Fitting- Crouse Hinds	XJG54	0
Electrical- Conduit Fittings	3/4 Conduit Hubs- Thomas and Betts	H075TB	0
Electrical- Conduit Fittings	1in Conduit Hubs- Thomas and Betts	H100TB	0
Electrical- Conduit Fittings	3/4in Plastic Bushings- Appleton	PB200D	0
Electrical- Conduit Fittings	1in Plastic Bushings- Appleton	PB300D	0
Electrical- Conduit Fittings	3/4 Straight Flex Connector- Arlington	L422	0
Electrical- Conduit Fittings	3/4 90D Flex Connector- Arlington	852	0
Electrical- Conduit Fittings	3/4 Liquid tight Straight Connector- Appleton	St-75	0
Electrical- Conduit Fittings	3/4 Liquid tight 90D Flex Connector- Appleton	St-9075	0
Electrical- Conduit Fittings	1IN PVC LB Condulet Body- Carln	5133664	0
Electrical- Conduit Fittings	1in PVC Female adapter- Carln	E942F	0
Electrical- Conduit Fittings	1in PVC Male adapter- Carln	E943F	0
Electrical- Conduit Fittings	1in PVC Coupling- Carln	E940F	0
Electrical- Wire	#18 TFN Anixter	6F-1801	0
Electrical- Wire	#16-2 Twisted Pair Anixter	XHHW 16/2 Twisted Pair	0
Electrical- Wire	#14-2 Twisted Pair Anixter	XHHW 14/2 Twisted Pair	0
Electrical- Wire	#16 TFN Anixter	#16 TFN	0
Electrical- Wire	#14 XHHW Southwire	XHHW- #14	0
Electrical- Wire	#12 XHHW Southwire	XHHW- #12	0
Electrical- Wire	#10 XHHW Southwire	XHHW- #10	0
Electrical- Wire	#8 XHHW Southwire	XHHW- #8	0
Electrical- Wire	#6 XHHW Southwire	XHHW-#6	0

Electrical- Wire	#4 XHHW Southwire	XHHW- #4	0
Electrical- Wire	#3 XHHW Southwire	XHHW-#3	0
Electrical- Wire	#3/0 XHHW Southwire	XHHW- #3/0	0
Electrical- Wire	#4/0 XHHW Southwire	XHHW- #4/0	0
Electrical- Wire	#500 XHHW Southwire	XHHW- #500	0
Electrical- Wire	#6 Bare Copper Wire- Southwire	Bare Copper #6	0
Electrical- Wire	#2/0 Bare Copper- Southwire	Bare Copper #2/0	0
Electrical- Wire	#3/0 Bare Copper- Southwire	Bare Copper #3/0	0
Electrical- Wire	4/c 62.5 U MM FO- Anixter	372-COROM1-LTDF-04	0
Electrical- Wire	Single Mode 6-F - Anixter	6-f OS2 8.3 LT Duct Aerial	0
Electrical- Wire	LC Connector- Anixter	95-101-98-SP	0
Electrical- Wire	Cat-5 Cable- Anixter	7934A Belden	0
Electrical- Wire	Sta-Kon Terminals- Thomas and Betts	RC10-6	0
Electrical- Wire	Butt Splices- Thomas and Betts	RCC21	0
Electrical- Wire	Blackburn Compression Connector- Thomas and Betts	CTL	0
Electrical- Wire	One Hole Compression Lugs- Thomas and Betts	CTLA-10 Red	0
Electrical- Wire	One Hole Compression Lugs- Thomas and Betts	CTL2-14 Brown	0
Electrical- Wire	Wire Nut Wire Connector Thomas and Betts	451. 452. 454	0
Electrical- Wire	Scotchlok Self-Stripping Electrical Connectors (3M)	Scotchlok 567	0
Electrical- Grounding	3/4 Grounding Rod (Erico)	613400	0
Electrical- Grounding	3/4 Grounding Clamp (Burdy)	GRC34	0
Electrical- Boxes	Nema 1 4x4x4 - EBOX	444	0
Electrical- Boxes	Nema 6x6x4 EBOX Nema 3R	664	0
Electrical- Boxes	Nema 8x8x4 Nema 1- EBOX	884	0
Electrical- Anchors and Hardware	Steel Hex Nut- LH Dottie	HN12	10
Electrical- Anchors and Hardware	1/2 In Lock Washer- LH Dottie	LW12	10
Electrical- Anchors and Hardware	Fender Washer- LH Dottie	FENW12112	10
Electrical- Anchors and Hardware	3/8 16in Drop in Anchors- LH Dottie	DA38	10
Electrical- Anchors and Hardware	3/8 16in Hex Nuts- LH Dottie	HN38	10
Electrical- Anchors and Hardware	3/8 Lock Washers- LH Dottie	LW38	10
Electrical- Anchors and Hardware	3/8 x 1 1/4 Fender Washer- LH Dottie	FEDW38114	10
Electrical- Anchors and Hardware	3/8 Flat Washer- LH Dottie	FW38	10
Electrical- Anchors and Hardware	1/4-20 Drop in Anchors- LH Dottie	DA25	10
Electrical- Anchors and Hardware	1/4 x 1 Hex Head Bolts- LH Dottie	MB141	10
Electrical- Anchors and Hardware	1/4in Lock Washer- LH Dottie	LW14	10
Electrical- Anchors and Hardware	1/4 x 1 1/4 Fender Washer-LH Dottie	FENW14114	10
Electrical- Anchors and Hardware	1/2 DP Wedge Anchor- LH Dottie	W38241	10
Electrical- Anchors and Hardware	3/8 Machine Screw Anchors- LH Dottie	MA7	10
Electrical- Anchors and Hardware	1/3 Rod Coupling- LH Dottie	RC3	10
Electrical- Anchors and Hardware	14 Machine Screw Anchors- LH Dottie	MA5	10
Electrical- Anchors and Hardware	3/8 Hex Head Bolt- LH Dottie	MB381	10
Electrical- Anchors and Hardware	1/4" Toggle Bolts- LH Dottie	MB38114	10
Electrical- Anchors and Hardware	3/8" 1" Bolts- LH Dottie	TBC42	10
Electrical- Anchors and Hardware	3/8 x 2 1/4 Wdg Anchor- Cully	62236J	10
Electrical- Anchors and Hardware	1/2-13x1-1/4 Rod Cplg- Cully	59608J	10
Electrical- Anchors and Hardware	1/2 Split Lock washer-Cully	40540J	10
Electrical- Anchors and Hardware	Square Washer 7/16	B201ZN(3/8)	10
Electrical- Anchors and Hardware	3/4 Locknut- Thomas and Betts	142-TB	10
Electrical- Anchors and Hardware	1 IN Steel Locknut- Thomas and Betts	143-TB	10
Electrical- Anchors and Hardware	3/4in Grounding Bushing- Thomas and Betts	BG 802	10
Electrical- Anchors and Hardware	1in Grounding Bushing- Thomas and Betts	BG 803	10
Electrical- FOLHD Hanger	ITW Buildex 14-14 x 1-1/4 Screw	1616000	100
Electrical- Panels	Panel EMWH1- Eaton PRL3a Connector Kit	KPRL3ABAFD3	0
Electrical- Panels	Panel EMWH1- Eaton PRL3a Ground Assemblies	5158C05G02	0
Electrical- Panels	Panel EMWH1- Eaton PRL3a Breakers	FD3100 100 Amp	1
Electrical- Panels	Panel EMWH1- Eaton PRL3a Breakers	FD3045 45 Amp	1
Electrical- Panels	Panel EMWH1- Eaton PRL3a Breakers	FD3030 30A	1
Electrical- Panels	Panel EMWH1- Eaton PRL3a Breakers	FD3015 15A	1
Electrical- Panels	Panel EMWH1- Eaton PRL3a Breakers	PROVFD3	1
Electrical- Panels	Panel EMWL1- Eaton PRL1a Connector Kit	KB13SFT	0
Electrical- Panels	Panel EMWL1- Eaton PRL1a Breakers	BAB3100H	1
Electrical- Panels	Panel EMWL1- Eaton PRL1a Breakers	BAB3015H	1



Electrical- Panels	Panel EMWL1- Eaton PRL1a Breakers	BAB1020	1
Electrical- Panels	Panel EMWL1- Eaton PRL1a Breakers	BAB3030H	1
Electrical- Panels	Panel EMWL1- Eaton PRL1a Breakers	PROVFD3	1
Electrical- Panels	Panel EMEL-1- Eaton PRL2a Connector Kit	KB13SFT	0
Electrical- Panels	Panel EMEL-1- Eaton PRL2a Breakers	GHB1020	1
Electrical- Panels	Panel EMEL-1- Eaton PRL2a Breakers	GHB3030	1
Electrical- Panels	Panel EMEL-1- Eaton PRL2a Breakers	PROV	1
Electrical- Transformers	30 KVA XFMR Eaton Custom # V48M28T30EETRUS- Lug Kit	LKS1	0
Electrical- Transformers	500va XFMR Sola	E500	2
Electrical- Transformers	600v Ferraz Shawmut Fuse holder	USCC1I	1
Electrical- Transformers	600v Ferraz Shawmut Fuse holder	USCC2I	1
Electrical- Transformers	ATQR Ferraz Shawmit Fuses	ATQR8/10	2
Electrical- Transformers	ATQR Ferraz Shawmit Fuses	ATDR4	2
Electrical- Safety Switch	600VAC 200A Safety Switch Eaton DH364FGK- Switch Base	70-8266	1
Electrical- Safety Switch	600VAC 200A Safety Switch Eaton DH364FGK- Fuse Base	70-8266-4	1
Electrical- Safety Switch	600VAC 200A Safety Switch Eaton DH364FGK- Line Shield	70-7759-11	1
Electrical- Safety Switch	600VAC 200A Safety Switch Eaton DH364FGK-	70-7833-4	1
Electrical- Safety Switch	600VAC 200A Safety Switch Eaton DH364FGK- Handle	70-7833-2	1
Electrical- Safety Switch	600VAC 30A Safety Switch Eaton DH361FGK - Switch Base	70-7758-12	1
Electrical- Safety Switch	600VAC 30A Safety Switch Eaton DH361FGK - Fuse Base	70-7758-27	1
Electrical- Safety Switch	600VAC 30A Safety Switch Eaton DH361FGK - Line Shield	70-7758-34	1
Electrical- Safety Switch	600VAC 30A Safety Switch Eaton DH361FGK	70-7213	1
Electrical- Safety Switch	600VAC 30A Safety Switch Eaton DH361FGK -Handle	70-7813-2	1
Electrical- Insulation	Roxul Mineral Wool Insulation	AFB	0
Electrical- Insulation	Dow Corning Weatherproof Sealant	791	0
Electrical- Labeling	Wire Marker Books- BizLine	RIMBO-9LT	1 Book
Electrical- Labeling	Wire and Cable Perma Sleeves- Brady	XPS-375-1	0
Electrical- Lighting	4' Strip Fixture- Creative Illumination	602-48-U-T8XV	0
Electrical- Lighting	48" Lamp T8- Creative Illumination	T8	20
Electrical- Lighting	Fixture Ballast- Creative Illumination	XV	4
Electrical- Lighting	Reflector- Creative Illumination	U	0
Electrical- Generator	Gen Set- Spark Ignition, Natural Gas, 60Hz, 350 KW	GFEB	0
Electrical- Generator	KTA19SLBm 530 HO,	ENG	0
Electrical- Generator	Generator - HCI434F, 60Hz, Winding 311- 12 Wire, .8pf	B415-2	0
Electrical- Generator	Exciter/Regulator-PMG, 3 Phase Sensor	B184-2	0
Electrical- Generator	120 VAC Resistive Generator Heater	A292-2	0
Electrical- Generator	Coolant Heater-Dual 208v/3750W	H557-2	0
Electrical- Generator	Sightglass on Radiator	E098-2	0
Electrical- Generator	Engine Governor- Electronic, Isochronous Only	A366-2	0
Electrical- Generator	Engine Starter- 24VDC	A334-2	0
Electrical- Generator	Battery Charging Alternator- Normal Output	A333-2	0
Electrical- Generator	Engine Air Cleaner	D041-2	0
Electrical- Generator	Oil Heater 208/240V 1ph	H479-2	0
Electrical- Generator	Oil Drain	H268-2	0
Electrical- Generator	Engine Coolant Drain	E089-2	0
Electrical- Generator	Battery Rack	F065-2	0
Electrical- Generator	Relays- Genset Status	K631-2	0
Electrical- Generator	Circuit breaker_TM_150A_80% 600/525v	KS63-2	0
Electrical- Generator	Circuit breaker_TM_400A_80% 600/525v	KM43-3	0
Electrical- Generator	GFCI Outlets on Enclosure	K102-2	0
Electrical- Generator	Shunt Trip - 24 VDC Circuit Breaker	KM72-2	0
Electrical- Generator	Aux Contacts- Form C, SPDT, Circuit Breaker	KM69-2	0
Electrical- Generator Heaters	Dual engine water jacket heater	H557-2	0
Electrical- Generator Heaters	Engine Oil Pan Heater	H479	0
Electrical- Generator Relay	Common Alarm Relays	K631	0
Electrical- Remote Annunciator Panel	PCCNet Network Annunciator Panel	0300-5929-02	0
Electrical- Generator Circuit Breaker	LG 400AF/400AT Main Line Circuit Breaker	KM34	0
Electrical- Generator Engine	Diesel Engine Starting Batteries, 8D Lead/Acid Type	908D	0
Electrical- Generator Engine	Kim Battery Warning Pads 120 VAC 75 Watt Each	KB7515	0
Electrical- Generator Engine	Thermostat, On at 40 Deg F, Off at 60 Deg F	DIT46	0
Electrical- Generator Engine	SENS EnerGenius Battery Charger, NFPA-110 Alarms	NRG22-10-RC	0
Electrical- Generator Fuel System	Fuel Strainer- Gaseous 2 IN PT	149-0751	0
Electrical- Generator Fuel System	Flexible Fuel Connection- Gaseous, 2 in NPT	MM-2-15	0

Electrical- Generator Enclosure	Aluminum Weather Protective Enclosure	F200	0
Electrical- Generator Enclosure	Internally Mounted Critical Exhaust Silencer w/ Rain Cap	EXH	0
Electrical- Generator Enclosure	GFCI Outlets on Enclosure	K102	0
Electrical- Generator Enclosure	Extension- Engine Coolant Drain	E089	0
Electrical- Generator Enclosure	Extension- Engine Oil Drain	H268	0
Electrical- Automatic Transfer Switch	ATS Transfer Switch-Onan, PwrCmd, 150 Amp	OTPC150	0
Electrical- Automatic Transfer Switch	ATS Cabinet	B001-7	0
Electrical- Automatic Transfer Switch	ATS Auxiliary Relay Switch Emergency	L102-7	0
Electrical- Automatic Transfer Switch	ATS Auxiliary Relay Switch Normal	L103-7	0

# **SPARE ELECTRICAL PARTS** **PROVIDED**

**Operations & Maintenance Manual**  
**December 2015**

## Sturgeon

Number	System	Part Description	Part #	Manufacturer	Supplier	QTY	Location
1	FOLHD Hanger	FOLHD Hanger			Systems Gro	60	West Fan Deck
2	FOLHD Hanger	ITW Buildex 14-14 x 1-1/4 Screw		ITW	Systems Grou	100	West Fan Deck
3	FPC/RCP Cabinet	ATQR Ferraz Shawmit Fuses	ATQR8/10	ATQR	Sturgeon	60	West Fan Deck
4	FPC/RCP Cabinet	ATQR Ferraz Shawmit Fuses	ATDR4	ATQR	Sturgeon	24	West Fan Deck
5	FPC/RCP Cabinet	Sola 500va XFMR		Sola	Sturgeon	30	West Fan Deck
6	Boiler Room Ligh	4' 32W T8 Lamps		Sola	Sturgeon	34	West Fan Deck
7	Boiler Room Ligh	Fixtures		Sola	Sturgeon	2	West Fan Deck
8	Boiler Room Ligh	Reflectors		Sola	Sturgeon	2	West Fan Deck
9	Boiler Room Ligh	Ballasts		Sola	Sturgeon	5	West Fan Deck



**Sturgeon Electric Company, Inc.**  
12150 East 112<sup>th</sup> Avenue  
Henderson, CO 80640  
303-286-8000  
303-286-1811 fax

Equal Opportunity Employer

October 29, 2015  
Barnard Construction Company  
P.O. Box 99  
Bozeman, MT 59771-0099

Subject: Sole Source and Proprietary Spare Parts

To representatives of CDOT and Barnard Construction Company:

This letter certifies that there are no sole source or proprietary spare parts for Sturgeon Electric Company, Inc. to provide for this project. None of the equipment and/or material provided by Sturgeon on this project is sole source or proprietary.

Sincerely,

**STURGEON ELECTRIC COMPANY, INC.**

A handwritten signature in blue ink, appearing to read "Jason Willis".

Jason Willis  
Project Manager

**ELECTRICAL**  
**CONSUMABLE &**  
**EQUIPMENT SUPPLIER**

**Operations & Maintenance Manual**  
**December 2015**

System	Material Name	Part Description	Part #	Function	Application Rate and Frequency	Manufacturer	Supplier
Electrical- Generator	Cummins Npower Engine Coolant	Ethylene Glycol 50/50-28 Gallon ES Compleat	CC2734	Cool Engine	28 Gallons - Check every 250 Hrs of use or 6 months, change as needed	Cummins	Cummins
Electrical- Generator	Cummins Npower Engine Lube Oil	Ultra Low Ash Lubrication Oil-10 Gallon- Premium Blue SAE 15W-40 Diesel Engine Oil	V705200	Lubricate Engine	10 Gallons-24 Hrs of Use or 1 yr, whichever comes first	Ashland or Comparable	Cummins
System	Equipment Name	Company Contact Information					
Electrical- Generator	Eaton Electrical Gear	Cutler Hammer- 1401 East 33rd Place, Suite F Aurora, CO 80011; Phone- 860-688-7330					
Electrical- Gear	Generator	Cummins Rocky Mountain- 8211 East 96th Ave Henderson, CO 80640; Phone- (800) 927-7201					