MECHANICAL SYSTEM

Volume VII

Operations & Maintenance Manual

TIGERFLOW SERIES WHS-1000 DUPLEX HOT WATER HEATING SYSTEM

Operations & Maintenance Manual
December 2015

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

INSTALLATION, OPERATION & INSTALLATION

DATE:	6/18/15
JOB#:	**510000315**
SUBMITTAL#:	15-48988-R2
QUOTE#:	15-48988-R5
JOB NAME:	EMJT Fixed Fire Suppression Denver, CO
CONTRACTOR:	Braconier Plumbing & Heating Company, Inc.
ENGINEER:	Barnard Inc.
REPRESENTATIVE:	Unit Process Company Everett, WA

(1) **TIGERFLOW** Series WHS-11000, Model DVMV-25GF-C-S6-VM-HVAC, engineered packaged duplex hot water heating system consisting of:

- (2) Lochinvar Model CHN1442, 1,440,000 BTU, **85% efficient boiler** with common gas line connection, circulating pump, communication cables - **(vent piping by others)**
- (2) Grundfos Series CR, Model CR64-2, cast iron, stainless fitted, mechanical seal, vertical-multistage pumps each coupled to a **25 hp, 3600 rpm, 480/3/60** odp **premium** efficient motor – **Class 250 rated**

  Condition Point: 320 gpm @ 200’ tdh (each)
- (2) 3” Val-Matic wafer-style, non-slam check valves – **Class 125 rated**
- (2) 4” Val-Matic wafer-style, non-slam check valves – **Class 250 rated**
- (2) 4” x 4” Taco, Model SD040040-4A suction diffusers – **Class 250 rated**
- (2) 1” relief valve at each boiler set at – **Class 125 rated**
- (2) 4” Taco circuit setter balancing valve – **Class 125 rated**
- (2) 3” Taco circuit setter balancing valve – **Class 125 rated**
- (1) 4” Taco Model AC4, ASME Code, air separator less strainer – **Class 125 rated**
- (1) 5” Taco Model AC05-250, ASME Code, air separator less strainer – **Class 250 rated**
- **(3) ½” Valmatic VMC-22 auto air vent – Class 250 rated**
- **(1) Alfa Laval, Model AQ4MFD Plate and frame heat exchanger 304 plate – Class 250 rated**
- (3) ¾” Model 15A air vent

(2) Taco Model CA-1400-125P, 370 gallon, ASME expansion tank – **Class 250 rated**

(1) Taco Model CAX-42, 11 gallon, ASME expansion tank – **Class 125 rated**

(4) 3" Bray 31H isolation lug style butterfly valves – **Class 250 rated**

(4) 4" Bray 43 isolation lug style butterfly valves – **Class 250 rated**

(1) 6" Bray 43 isolation lug style butterfly valves – **Class 250 rated**

(2) 2" Ball valves for gas

(1) Chemical shot feeder

(1) 1" FEBCO Model 860 backflow preventer

(2) 1-1/2" Stainless steel water make-up lines with PRV and strainer – **Class 250 rated**

(1) 1" Black water make-up lines with PRV and strainer

(5) 9" Scale-type thermometer with well

(10) 2 ½" Diameter glycerin-filled gauges with gauge cocks

(1) UL Listed, **NEMA 4**, **TIGER's EYE Mark VI, E-Series** Solid State, Power and Control Panel
(·) UL/C-UL 508 Label
(·) Micro Controller:
-Memory Non-Volatile - no battery backup required
-Multi Level Security Passwords
(·) Touch screen operator interface **Red Lion Model R-6 with 6" color screen**
Functions Included:
-Best efficiency control (Combination Flow & Pid Pressure)
-End of curve protection
-Transmitter failure alarms
-Automatic system status
-H-O-A selector
-ETM's
-Individual transmitter status
-Flow readout in gpm
-Pump, motor, drive status
-Automatic alternation of equal sized pumps
-32-bit RISC micro-controller
-USB port
-RS-232, RS-485, RS-422 communication ports
(1) Thru-door control power disconnect
(1) 24 Volt UL/C-UL, CE Approved Switching Power Supply
(1) 120 Volt used control circuit transformer
(1) Power on light
(2) Common auxiliary alarm contacts
(2) Pump fail D-P switches
(2) Boiler flow switches
(·) BACnet Communication
(2) RTD's with sensing wells

(1) 3 hp starter panel

(1) Single power input lug box

(2) **Danfoss Series VLT-HVAC, variable speed drives with PWM, NEMA I, 5% line**

reactors, manual by-pass and fused disconnects

(1) Data industrial 225BR paddlewheel flow sensor with hot tap **- for remote mounting**

(1) Endraus Hauser Model PMD-75 differential pressure transmitter **- for remote mounting**

(1 set) 6” Type 304 Schedule 40 steel suction and discharge headers

(·) Split skid – Must fit through 5’ x 7’ opening

(·) Seismic Calculations with Colorado PE Stamp

(·) Factory startup and commissioning by a service technician plus all travel expenses – (1) 8-hour day – Requires 3-week advance notice

(1) Steel system skid with all necessary pipe supports, tubing and wiring for complete package

(·) Unit to be factory painted with machine grade **gray** finish coat

System to be completely, electrically and hydrostatically tested before shipment

(·) All welding to be done by ASME Section 9 certified welders

(·) Unit to be factory painted with machine grade finish coat

TIGERFLOW Systems, LLC complies with the Buy American Requirement of Section 1605 of the American Recovery & Reinvestment Act of 2009. Public Law 111-5 (ARRA) for manufactured goods. Systems are manufactured in Dallas, TX, USA.

Each **TIGERFLOW** package system is UL/C-UL listed as a system, so meeting OSHA and Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 (National Electric Code) Article 90-7; City of Los Angeles Approval Code #M-980006; CMR 248 Massachusetts State Plumbing Code Approval #P3-0910-108.

TIGERFLOW
Engineered Systems to the World

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

START-UP PRE-CHECKS

PRE-CHECK: NO POWER IS REQUIRED FOR THESE CHECKS

1. Water to system suction and discharge piped correctly: _________
2. Unit is anchored and grouted? _________
3. Sensing lines attached? _________
4. Control panel: Wiring (no loose wires)? _________
5. Temperature probes piped to drain? _________
6. Voltage: _________

   System: _________
7. Check motor wiring (no loose wires) _________
8. Tank feed line piping, shut valves (if required) _________
9. Visible leaks: If so list _________
10. Verify that the voltage on the panel and the incoming power are correct. _________

Contractor: ____________________________________ Date: ______________________

If you have questions, contact your local Representative or Keith Pirtle at
TIGERFLOW Systems, LLC at (214) 337-8780

START-UP TEST PROCEDURES

PRE-CHECK: NO POWER IS REQUIRED FOR THESE CHECKS

1. Water to system suction and discharge piped correctly: _________
2. Unit is anchored and grouted? _________
3. Sensing lines attached? _________
4. Control panel wiring (no loose wires) _________
5. Temperature probes (piped to drain)? _________
6. Voltage: _________

   System: _________
7. Check motor wiring (no loose wires) _________
8. Tank feed line piped, valves open (if required) _________

TURN WATER SUPPLY ON:

9. Open all valves: check for leaks _________
10. Bleed PRV's (if constant speed system) _________
11. Bleed sensing lines _________

TURN ON POWER:

12. Verify voltage on panel and system _________
13. Check **TIGER'S EYE** program on panel; password "1865") _________
14. Check rotation on each pump _________

2001945

CAUTION: WHEN CHANGING ROTATION MAKE SURE ALL POWER IS OFF

15. Always start pumps with suction valves open, discharge valves closed.

16. Start Pump #1: Open discharge valve and allow flow to remove air from system, then bring back down to small flow.

17. Adjust PRV's to get the desired flow and psi. (if constant speed system)

18. When all adjustments are made, turn the system to auto position.

19. Unit is ready for operation.

START-UP TECHNICIAN: ______________________________ DATE: ____________________

WITNESS: _________________________________ DATE: ____________________

If you have questions, contact your local Representative or Keith Pirtle at
TIGERFLOW Systems, Inc. at (214) 337-8780

PERRY JOHNSON REGISTRARS, INC.

Certificate of Registration

Perry Johnson Registrars, Inc., has audited the Quality Management System of:

TIGERFLOW Systems, LLC
4034 Mint Way, Dallas, TX 75237 United States

(Hereinafter called the Organization) and hereby declares that Organization is in conformance with:

ISO 9001:2008

This Registration is in respect to the following scope:

Manufacturer of Engineered Packaged Pumping Systems for Plumbing, Municipal, Fire Protection, and HVAC Industries

This Registration is granted subject to the system rules governing the Registration referred to above, and the Organization hereby covenants with the Assessment body duty to observe and comply with the said rules.

Terry Boboige, President

Perry Johnson Registrars, Inc. (PJR)
755 West Big Beaver Road, Suite 1340
Troy, Michigan 48084
(248) 358-3388

PERRY JOHNSON REGISTRARS, INC.

UKAS MANAGEMENT SYSTEMS 0105

ANAB ACCREDITED

The use of the UKAS accreditation symbol is in respect to the activities covered by the Accreditation Certificate Number 0105.

The validity of this certificate is dependent upon ongoing surveillance.

Effective Date:	Expiration Date:	Certificate No.:
July 29, 2014	July 28, 2017	C2014-01875

NITW.E190152
Industrial Control Panels

Page Bottom

Industrial Control Panels

See General Information for Industrial Control Panels

TIGERFLOW SYSTEMS INC, DBA TIGERFLOW E190152
4034 MINT WAY
DALLAS, TX 75237 USA

Industrial control panels.

Last Updated on 1998-03-28

Questions? Print this page Terms of Use Page Top

QCZJ.E181112
Packaged Pumping Systems

Page Bottom

Packaged Pumping Systems

See General Information for Packaged Pumping Systems

TIGERFLOW SYSTEMS INC, DBA TIGERFLOW E181112
4034 MINT WAY
DALLAS, TX 75237 USA

Packaged pumping systems, Cat. Nos. CBF-11000, DSP-6000, ES3000, HTS-8000, SW510000, VMS-4000, VTP-5000, WHS-9000.

Last Updated on 2000-07-25

Questions? Print this page Terms of Use Page Top

TIGERFLOW®
Engineered Systems to the World

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

WARRANTY

Each **TIGERFLOW** system is warranted for a period of (18) months from the date of shipment or (12) months from the date of start-up, whichever occurs first. The system is warranted against failure due to defects in material, design and/or workmanship. The equipment must be installed, maintained and operated in accordance with industry standard practice and factory's recommendations.

TIGERFLOW'S obligation and/or responsibility is limited to, at its opinion, repairing or replacing the defective item(s). The item(s) will be repaired/replaced at no charge, F.O.B. factory, plus all freight and handling charges.

TIGERFLOW reserves the right to inspect and examine any or all suspected warranty item(s) and shall have full authority for final determination. Item(s) must be sent back to the factory, freight prepaid. All item(s) returned for inspection require a return material authorization (RMA) number issued by the factory.

TIGERFLOW is not responsible for any and all labor charges, rigging charges, transportation charges, mechanical seals, gauges, and damage or wear caused by the liquid being pumped.

TIGERFLOW disclaims all other warranties. There are no other warranties, either expressed or implied.

TIGERFLOW disclaims any and all liability for damages to property, loss of time, loss of income, loss of profits. **TIGERFLOW** disclaims any liability for incidental, liquidated or consequential damages.

TIGERFLOW'S maximum liability shall not in any case exceed the price for the items claimed to be defective.

There are no warranties that extend beyond those outlined in this agreement.

TIGERFLOW
Engineered Systems to the World

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

INSTALLATION & STORAGE

UPON ARRIVAL:
System should be inspected upon arrival – any freight damage or missing equipment should be noted on the freight bill of lading at this time. Spare parts, miscellaneous equipment should be stored in a protected location.

STORAGE:
The system must be covered to protect from: damage, contamination, etc. Do not remove crating or plastic covering (unless for inspection of possible freight damage). System must be stored in a dry environmentally controlled location (40º F min - 104º f max.).

EXTENDED STORAGE:
All rotating equipment should be turned by hand (if possible) at least once every 30 days. Care should be taken to ensure condensation and dirt are removed.

LOCATION:
System should be stored for ease of access, rigging, maintenance and visual inspection.

FOUNDATION:

SLAB ON GRADE:
System should be mounted on slab on grade with a minimum concrete weight of 2-1/2 times the weight of the system.

ALL FLOORS OTHER THAN "SLAB ON GRADE":
In addition, the system should be mounted on a concrete welded pouring form inertia base with a minimum of 1-1/2" deflection springs. Install flex-connectors on system suction, discharge, and tank feed connection (if applicable).

LEVELING:
Systems should be level, so that skid surface is above and parallel with concrete. Shim anchors and system unit until it is correct and level.

ANCHOR BOLTS:
System must be anchored to foundation and/or inertia base with proper size anchor bolts per anchor bolt manufacturer's or engineer's recommendation.

GROUTING:
After anchor bolts and leveling processes have been completed, the system skid must be poured with a good grade of non-ferrous and non-shrink grout.

PIPING:
System suction, discharge and tank feed connection (if applicable) should have flex connectors installed. Pumping system must not support any of the building piping. No strain of any kind may be imposed on the pumping system. All piping should be level.

DRAIN:
Over-temperature purge line, packing gland lines (if applicable), etc., must be run to floor drain.

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

Suggested Factory Maintenance Program

1. Lubrication of motor shall be every 5000 hours of use, or every 3 months.
   Type of grease: Shell Dolium R (Factory installed) or Chevron SRI

   Note: Apply grease until new grease appears between shaft and housing.
   DO NOT OVER-GREASE.

2. **When unit is in danger of freezing, take precautions to prevent pumps from being below freezing outside temperature. When precautions cannot be provided, you should drain the pump.**

3. Inspect pumps regularly for leaky seals or gaskets and loose or damaged components. Replace or repair as required.

4. The PRVs do not require regular maintenance. PRVs will only require maintenance if they start to operate improperly.

5. No preventative maintenance is required on control system.

6. No preventative maintenance is required on the temperature probes.

7. No regular maintenance is required on the isolation valves.

COPPER-FIN II HEAT EXCHANGER

Operations & Maintenance Manual
December 2015

COPPER-FIN II®

Installation & Operation Manual
Models: 402 - 2072

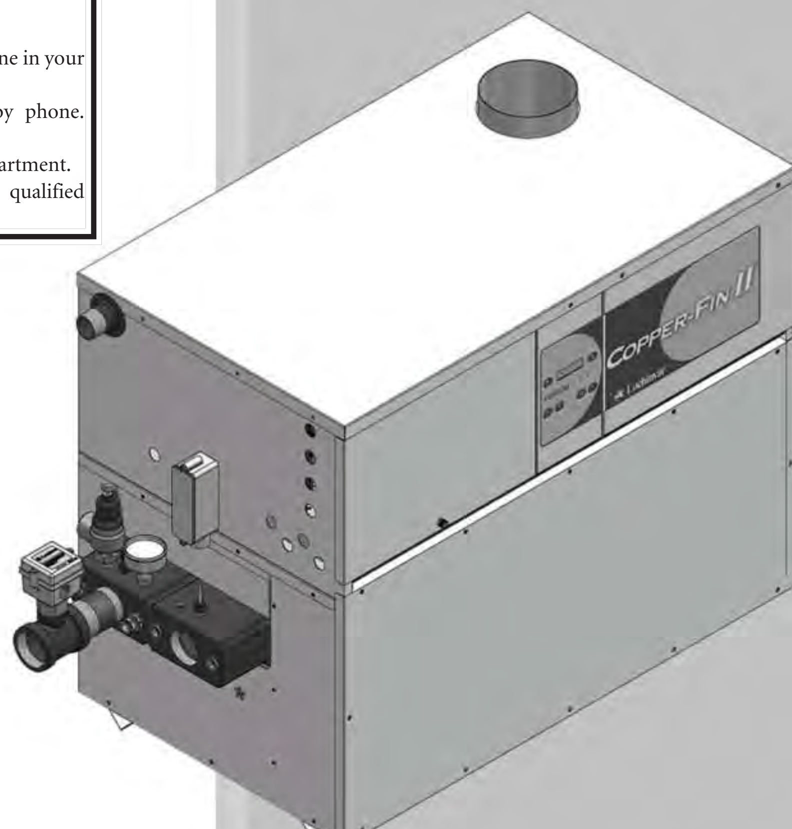
WARNING: If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

-- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

-- WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a near by phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

-- Installation and service must be performed by a qualified installer, service agency, or the gas supplier.



DESIGN CERTIFIED®

CERTIFIED®

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

⚠ WARNING:

This manual supplies information for the installation, operation, and servicing of the appliance. It is strongly recommended that this manual and the Copper-fin II Service Manual be reviewed completely before proceeding with an installation. Perform steps in the order given. Failure to comply could result in severe personal injury, death, or substantial property damage.

Save this manual for future reference.

Contents

Hazard definitions

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels or to important information concerning the life of the product.

⚠ DANGER DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

NOTICE NOTICE indicates special instructions on installation, operation, or maintenance that are important but not related to personal injury or property damage.

Please read before proceeding

Special instructions

NOTICE This is a gas appliance and should be installed by a licensed electrician and/or certified gas supplier. Service must be performed by a qualified service installer, service agency or the gas supplier.

⚠ WARNING If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury, or death.

This appliance MUST NOT be installed in any location where gasoline or flammable vapors are likely to be present, unless the installation is such to eliminate the probable ignition of gasoline or flammable vapors.

⚠ WARNING Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual for assistance or additional information, consult a qualified installer, service agency or the gas supplier.

Checking equipment –

Upon receiving equipment, check for signs of shipping damage. Pay particular attention to parts accompanying the appliances which may show signs of being hit or otherwise being mishandled. Verify total number of pieces shown on packing slip with those actually received. In case there is damage or a shortage, immediately notify the carrier.

Do not use this appliance if any part has been under water. The possible damage to a flooded appliance can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

NOTICE The ceramic fiber material used in this appliance is an irritant; when handling or replacing the ceramic materials it is advisable that the installer follow these safety guides.

REMOVAL OF COMBUSTION CHAMBER LINING OR BASE PANELS:

- Avoid breathing dust and contact with skin and eyes.
  - Use NIOSH certified dust respirator (N95). This type of respirator is based on the OSHA requirements for cristobalite at the time this document was written. Other types of respirators may be needed depending on the job site conditions. Current NIOSH recommendations can be found on the NIOSH website at http://www.cdc.gov/niosh/homepage.html. NIOSH approved respirators, manufacturers, and phone numbers are also listed on this website.
  - Wear long-sleeved, loose fitting clothing, gloves, and eye protection.
- Apply enough water to the combustion chamber lining to prevent airborne dust.
- Remove the combustion chamber lining from the appliance and place it in a plastic bag for disposal.

- NIOSH stated First Aid:
  Eye: Irrigate immediately.
  Breathing: Fresh air.

⚠ WARNING The combustion chamber insulation in this appliance contains ceramic fiber material. Ceramic fibers can be converted to cristobalite in very high temperature applications. The International Agency for Research on Cancer (IARC) has concluded, "Crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1)." Normal operating temperatures in this appliance are below the level to convert ceramic fibers to cristobalite. Abnormal operating conditions would have to be created to convert the ceramic fibers in this appliance to cristobalite.

The ceramic fiber material used in this appliance is an irritant; when handling or replacing the ceramic materials it is advisable that the installer follow these safety guidelines.

Warranty –

Factory warranty (shipped with unit) does not apply to units improperly installed or improperly operated.

Experience has shown that improper installation or system design, rather than faulty equipment, is the cause of most operating problems.

1. Excessive water hardness causing a lime/scale build-up in the copper tube is not the fault of the equipment and is not covered under the manufacturer's warranty (see Water Treatment and Water Chemistry).

2. Excessive pitting and erosion on the inside of the copper tube may be caused by too much water velocity through the tubes and is not covered by the manufacturer's warranty (see Boiler Flow Rates and Temperature Rise for flow requirements).

Please read before proceeding

Safety information

⚠ Owner warning –

The information contained in this manual is intended for use by qualified professional installers, service technicians, or gas suppliers.

NOTICE Consult and follow all local Building and Fire Regulations and other Safety Codes that apply to this installation. Consult local gas utility company to authorize and inspect all gas and flue connections.

A gas appliance that draws combustion air from the equipment room where it is installed must have a supply of fresh air circulating around it during burner operation for proper gas combustion and proper venting.

⚠ WARNING Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

Prevention of freezing –

Heat exchangers and headers damaged by freezing are not covered by warranty.

See Section 7, Operating Information - Freeze Protection for more information.

Codes –

The equipment shall be installed in accordance with those installation regulations in force in the local area where the installation is to be made. These shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made. In the absence of such requirements, the installation shall conform to the latest edition of the National Fuel Gas Code, ANSI Z223.1. Where required by the authority having jurisdiction, the installation must conform to American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers, ASME CSD-1. All boilers conform to the latest edition of the ASME Boiler and Pressure Vessel Code, Section IV. Where required by the authority having jurisdiction, the installation must comply with the Canadian Gas Association Code, CAN/CGA-B149.1 and/or B149.2 and/or local codes. This appliance meets the safe lighting performance criteria with the gas manifold and control assembly provided, as specified in the ANSI standards for gas-fired hot water boilers, ANSI Z21.13 and gas water heaters, ANSI Z21.10.3.

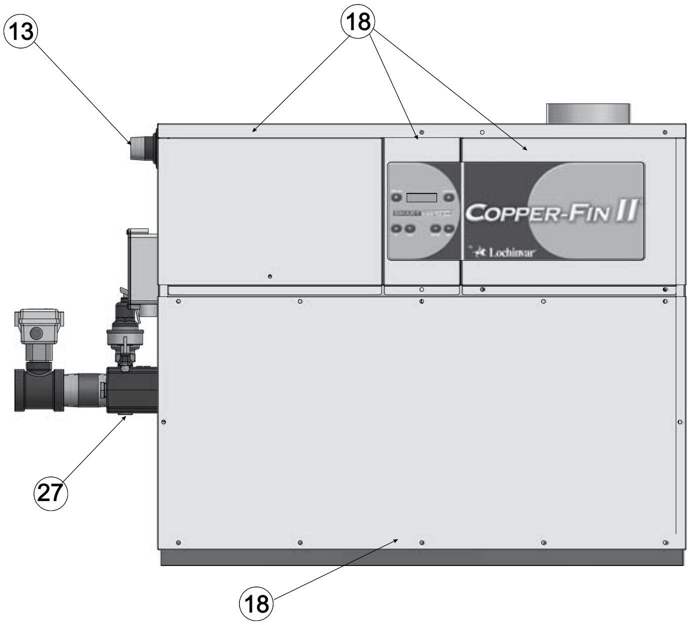
⚠ WARNING To minimize the possibility of serious personal injury, fire or damage to your unit, never violate the following safety rules.

1. This unit is only for use with the type of gas indicated on the rating plate.
2. If you smell gas
   - shut off gas supply
   - do not try to light any appliance
   - do not touch any electrical switch; do not use any phone in your building
   - immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions
   - if you cannot reach your gas supplier, call the fire department
3. Boilers and water heaters are heat producing appliances. To avoid damage or injury, do not store materials against the appliance or the vent-air intake system. Use proper care to avoid unnecessary contact (especially children) with the appliance and vent-air intake components.
4. Never cover your unit, lean anything against it, store trash or debris near it, stand on it or in any way block the flow of fresh air to your unit.
5. UNDER NO CIRCUMSTANCES MUST FLAMMABLE MATERIALS SUCH AS GASOLINE OR PAINT THINNER BE USED OR STORED IN THE VICINITY OF THIS APPLIANCE, VENT-AIR INTAKE SYSTEM OR ANY LOCATION FROM WHICH FUMES COULD REACH THE APPLIANCE OR VENT-AIR INTAKE SYSTEM.
6. Appliance surfaces become hot during operation. Be careful not to touch hot surfaces. Keep all adults, children, and animals away from operation of the hot unit. Severe burns can occur.
7. You must take adequate care to prevent scald injury when storing water at elevated temperatures for domestic use.
8. This unit must have an adequate supply of fresh air during operation for proper gas combustion and venting.
9. Make sure all exhaust venting is properly installed and maintained. Improper venting of this unit could lead to increased levels of carbon monoxide.
10. Do not use this boiler if any part has been under water. Immediately call a qualified service technician to replace the boiler. The possible damage to a flooded boiler can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.
11. Do not alter this unit in any way. Any change to this unit or its controls can be dangerous.

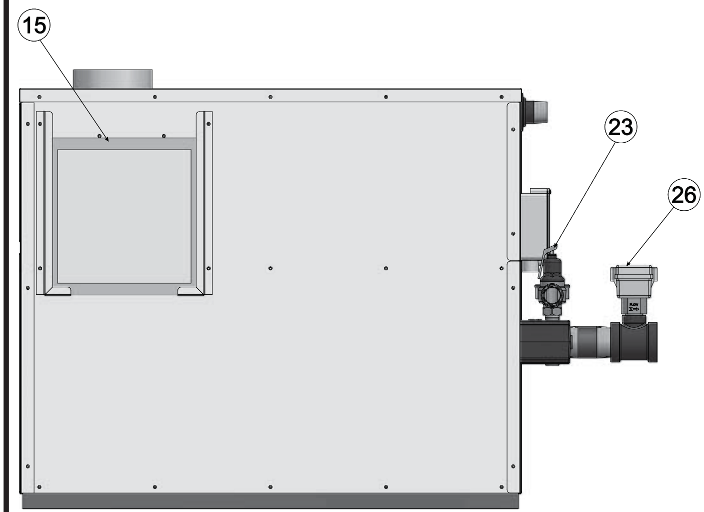
The Copper-fin II - How it works...

1. **Heat exchanger**
   The heat exchanger allows system water to flow through specially designed tubes for maximum heat transfer. The glass lined headers and copper fined tubing are encased in a jacket that contains the combustion process.
2. **Heat exchanger access cover**
   The heat exchanger access cover is a galvanized steel door which allows access for service, maintenance, and removal of the heat exchanger from inside the combustion chamber.
3. **Blower**
   The blower pulls in and injects air into the individual burners along with gas from the gas manifold where the mix is burned inside the combustion chamber.
4. **Gas valve**
   The gas valves (reference) have a dual purpose; changing the gas supply pressure to manifold pressure, and the reference side of the gas valve is designed to allow chamber pressure to change the volume of gas through the valve and measured as net manifold pressure. This is not a design to compensate for gas supply pressure issues.
5. **System / tank temperature sensor (not shown)**
   When connected, this sensor can be used as a system sensor or a tank sensor.
6. **Outlet/limit temperature sensor**
   This sensor monitors the outlet water temperature. If selected as the controlling sensor and a system supply sensor is not connected, the appliance will maintain set point by adjusting the firing rate of the unit according to this sensor.
7. **Inlet temperature sensor**
   This sensor monitors inlet water temperature. If selected as the controlling sensor and a system return sensor is not connected, the appliance will maintain set point by adjusting the firing rate of the unit according to this sensor.
8. **Temperature and pressure gauge (boilers only)**
   The temperature and pressure gauge monitors the outlet temperature of the appliance as well as the system water pressure.
9. **Electronic display**
   The electronic display consists of 6 buttons and a two-line 16-character liquid crystal display used to monitor the operation of the heater as well as enter and view the programming of the main control board.
10. **Burner**
    The burner is a ported stainless steel construction which uses a gas air mix to operate at a fixed input. Banks of burners turn on or off to vary the firing rate.
11. **Water outlet (system supply)**
    The water outlet is a 2 or 2 1/2" (depending on model) pipe connection that supplies water to the system with connections for a flow switch (see #26), a relief valve (see #23), and a temperature and pressure gauge (boilers only) (see #8).
12. **Water inlet (system return)**
    The water inlet is a 2 or 2 1/2" (depending on model) pipe connection that receives water from the system and delivers it to the heat exchanger.
13. **Gas supply pipe**
    The gas supply pipe on this appliance is 1 1/4 or 2" (depending on model) diameter NPT. Please reference the National Fuel Gas Code charts for connection details.
14. **SMART SYSTEM Control Module**
    The SMART System Control Module is the main control for the appliance. This module contains the programming that operates the blower, gas valve, and pumps in addition to other programmable features.
15. **Air intake**
    Fresh air for combustion is drawn through a filter provided at the air intake, located at either the rear or right side of the appliance.
16. **Line voltage terminal strip**
    The line voltage terminal strip provides a location to connect all of the line voltage (120 VAC) contact points to the unit.
17. **Low voltage connection board(s)**
    The low voltage connection board provides a location to connect all of the low voltage devices to the appliance. This is where most of the external safety controls are connected.
18. **Front doors - upper and lower**
    The front doors provide access to the gas train as well as the blower, burners and other key components for service and maintenance.
19. **Hot surface igniter (HSI)**
    The hot surface igniter is a device that is used to ignite the air/gas mixture as well as monitor the performance of the flame during operation. This device acts as a flame sense electrode.
20. **Flame inspection window (sight glass)**
    The flame inspection windows, located on either side of the appliance, allow for visual inspection of the burners and flame during operation.
21. **Gas shut off valve (downstream test cock) (boiler only)**
    The downstream test cock is provided in the gas train to ensure complete shut off of the gas to the burner in case of maintenance, inspection, or testing of the valve.
22. **Manual reset high limit sensor**
    This device monitors the outlet water temperature to ensure safe operation. If the temperature exceeds its setting (field adjustable), it will break the control circuit, shutting the appliance down. Manual reset is performed through the display.
23. **Relief valve**
    The relief valve is a safety device that ensures the maximum pressure of the appliance is not exceeded. Boilers operate on pressure only and are shipped from the factory at a rating of 50 PSI. Water heaters operate on temperature and pressure and are shipped standard as 150 PSI and 210°F (98.9°C).
24. **Power switch**
    The power switch is used to engage and disengage power to the appliance on the 120 VAC circuit.
25. **Air pressure switch**
    The air pressure switch is a safety device which ensures proper blower operation. The air pressure switch is wired in series with the low voltage control circuit in such a way that if the fan does not engage or shuts down prematurely the device will break the control circuit and the unit will shut down.
26. **Flow switch**
    The flow switch is a safety device that ensures flow through the heat exchanger during operation. This appliance is low mass and should never be operated without flow. The flow switch makes contact when flow is detected and allows the unit to operate. If flow is discontinued during operation for any reason the flow switch will break the control circuit and the unit will shut down.
27. **Drain port(s)**
    The drain ports are located underneath the front header.
28. **Manual shutoff valve (not shown)**
    Manual valve used to isolate the unit from the gas supply.

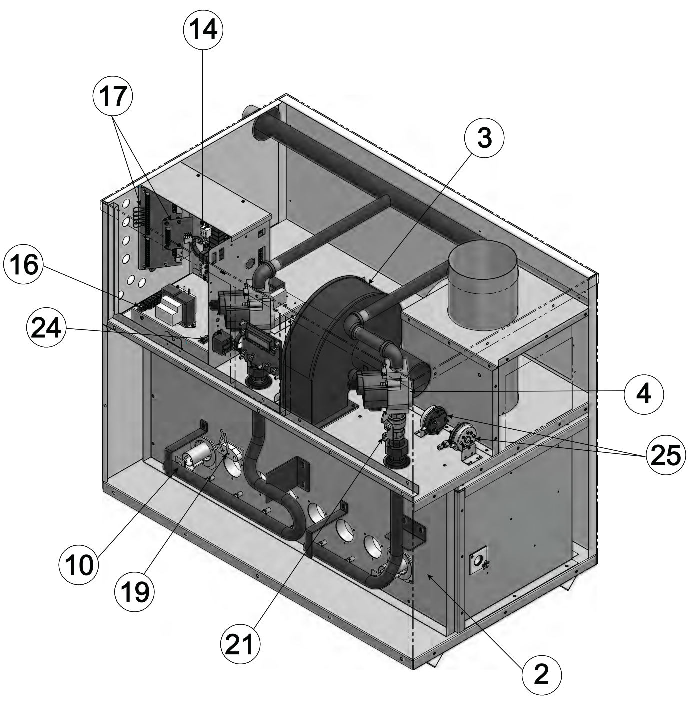
The Copper-fin II - How it works...



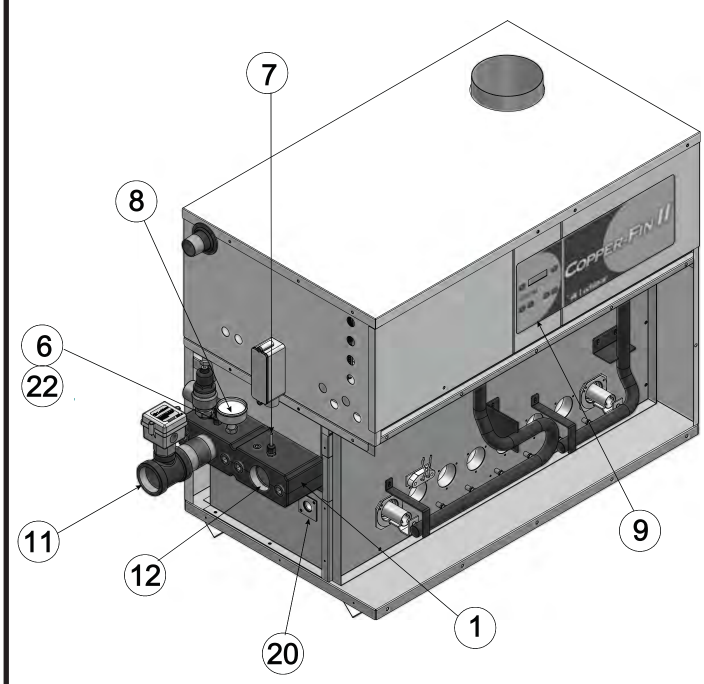
Models 402 - 752 Front View



Models 402 - 752 Rear View

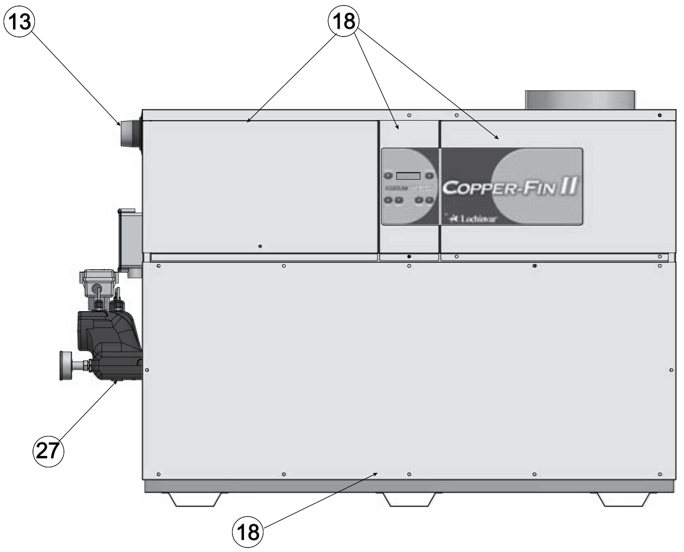


Models 402 - 752 Right Side (inside unit)

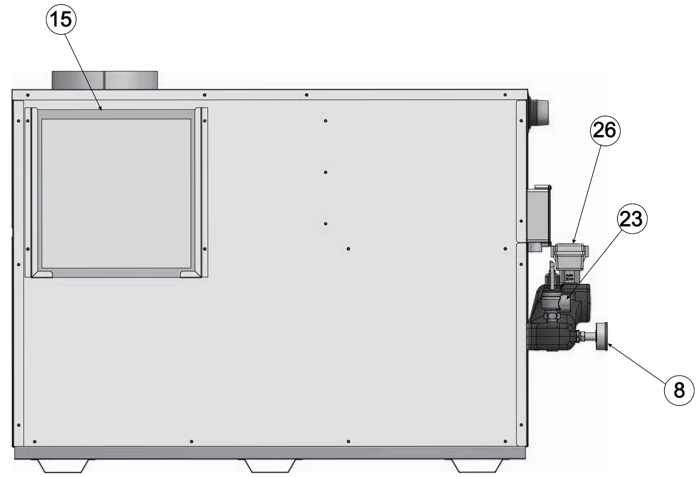


Models 402 - 752 Left Side (inside unit)

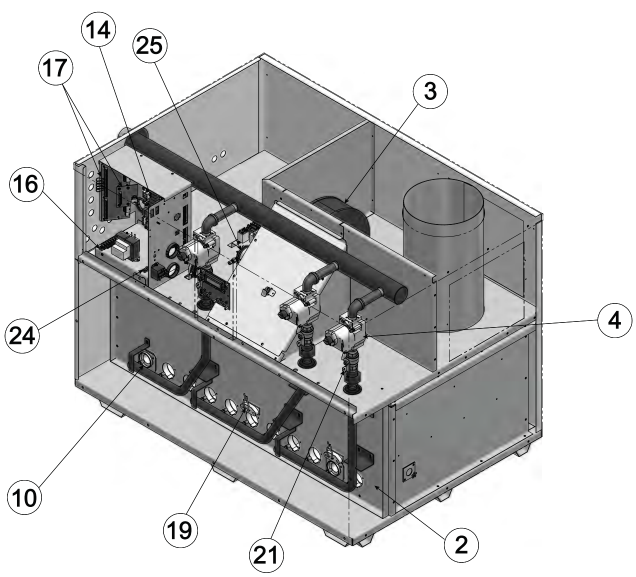
The Copper-fin II - How it works... *(continued)*



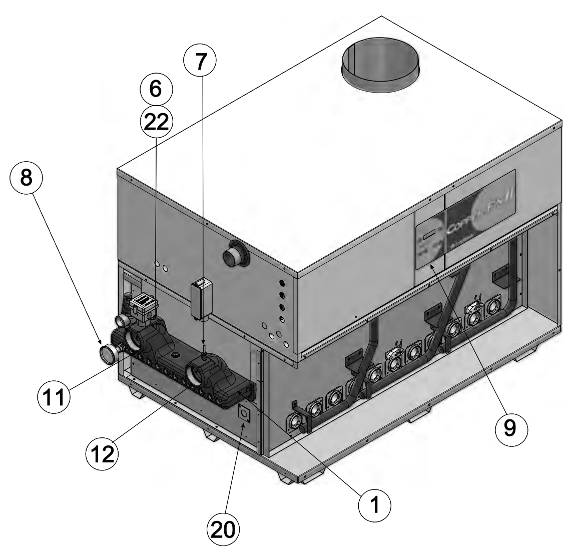
Models 992 - 2072 Front View



Models 992 - 2072 Rear View



Models 992 - 2072 Right Side (inside unit)



Models 992 - 2072 Left Side (inside unit)

Ratings

LOW LEAD CONTENT

HLW

H

Model Number Note: Change "N" to "L" for L.P. gas models.	Copper-fin II AHRI Rating: Input MBH (Note 4) Min	Input MBH (Note 4) Max	Gross Output MBH (Note 1)	Net AHRI Ratings Water, MBH (Note 2)	Other Specifications: Appliance Water Content Gallons	Water Connections	Gas Connections	Air / Vent Sizes (Note 3)
CFN0402	250	399	339	295	1.8	2"	1-1/4"	6"
CFN0502	250	500	425	370	1.9	2"	1-1/4"	6"
CFN0652	250	650	553	481	2.0	2"	1-1/4"	8"
CFN0752	250	750	638	555	2.4	2"	1-1/4"	8"
CFN0992	360	990	842	732	3.3	2-1/2"	2"	10"
CFN1262	360	1260	1071	931	3.5	2-1/2"	2"	12"
CFN1442	360	1440	1224	1064	3.7	2-1/2"	2"	12"
CFN1802	360	1800	1530	1330	4.1	2-1/2"	2"	12"/14"
CFN2072	630	2070	1760	1530	4.3	2-1/2"	2"	12"/14"
CHN0402	250	399	339	295	1.8	2"	1-1/4"	6"
CHN0502	250	500	425	370	1.9	2"	1-1/4"	6"
CHN0652	250	650	553	481	2.0	2"	1-1/4"	8"
CHN0752	250	750	638	555	2.4	2"	1-1/4"	8"
CHN0992	360	990	842	732	3.3	2-1/2"	2"	10"
CHN1262	360	1260	1071	931	3.5	2-1/2"	2"	12"
CHN1442	360	1440	1224	1064	3.7	2-1/2"	2"	12"
CHN1802	360	1800	1530	1330	4.1	2-1/2"	2"	12"/14"
CHN2072	630	2070	1760	1530	4.3	2-1/2"	2"	12"/14"

NOTICE Maximum allowed working pressure is located on the rating plate.

Notes:

1. The ratings are based on standard test procedures prescribed by the United States Department of Energy.
2. Net AHRI ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pickup. Ratings are based on a piping and pickup allowance of 1.15.
3. Copper-fin II's require special gas venting. Use only the vent materials and methods specified in the Copper-fin II Installation and Operation Manual.
4. The Copper-fin II is orificed for operation up to 2000 feet altitude, and including up to 4,500 feet, with no field adjustments. The appliance will de-rate by 4% for each 1000 feet above sea level up to 4,500 feet. Consult the factory for installations above 4,500 feet elevation.

1 Determine unit location

Location of unit

This unit meets the safe lighting performance criteria with the gas manifold and control assembly provided, as specified in the ANSI standards for gas-fired units, ANSI Z21.13/CSA 4.9 and ANSI Z21.10.3/CSA 4.3 - latest edition.

1. Maintain all clearances from combustible construction when locating appliance. See Clearances from Combustible Construction, this page.
2. Locate the appliance so that if water connections should leak, water damage will not occur. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the unit. The pan must not restrict combustion airflow. Under no circumstances is the manufacturer to be held responsible for water damage in connection with this unit, or any of its components.
3. The appliance must be installed so that the ignition system components are protected from water (dripping, spraying, rain, etc.,) during appliance operation and service (circulator replacement, control replacement, etc.,).
4. Appliances located in a residential garage and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit must be installed so that all burners and burner ignition devices have a minimum clearance of not less than 18" (46 cm) above the floor. The appliance must be located or protected so that it is not subject to physical damage by a moving vehicle.
5. **DO NOT** install this appliance in any location where gasoline or flammable vapors are likely to be present.
6. The appliance must be installed on a level floor.
7. Combustible floor installation:
   a. Models 402 - 752 **require** an approved floor kit for installation on combustible flooring (reference Table 1A).
   b. Models 992 - 2072 are approved for installation on combustible flooring without a floor kit. ***Note:*** Concrete block over wood flooring is not considered non-combustible.
8. DO NOT install this appliance directly on carpeting or other combustible material.
9. Maintain required clearances from combustible surfaces, reference the *Indoor Clearances from Combustible Construction Section*, this page.
10. For outdoor models, you must install an optional vent cap. Instructions for mounting the vent cap are included in the venting section of this manual. Do not install outdoor models directly on the ground. You must install the outdoor unit on a concrete, brick, block, or other non-combustible pad. Outdoor models have additional special location and clearance requirements. See Outdoor Installation Venting, page 30. A wind proof cabinet protects the unit from weather.

Indoor clearances from combustible construction

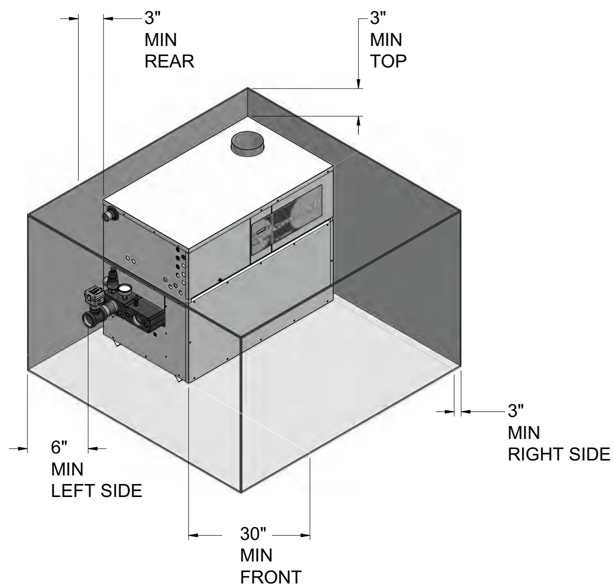
Maintain minimum specified clearances for adequate operation. Allow sufficient space for servicing pipe connections, pump and other auxiliary equipment, as well as the unit. See rating plate for specific service clearance requirements.

Right Side	3" (7.5 cm)
Rear	3" (7.5 cm) (3" min. from any surface)*
Left Side	6" (15 cm) (24" (0.61 m) suggested for service)
Front	Alcove* (30" (0.76m) suggested for service)
Top	3" (7.5 cm)
Flue	1" (25.4 mm)
Hot Water Pipes	1" (25.4 mm)

*An Alcove is a closet without a door. Thirty-six inches (36") to rear required for outdoor installation.

Note: No additional clearance is needed on the right side of the unit for the observation port. An observation port is located on both the right and left side of the unit.

Figure 1-1_Indoor clearances from combustible construction



NOTICE Clearances from combustible construction are noted on the appliance rating plate.

TABLE - 1A COMBUSTIBLE FLOOR KITS	
Model	**Kit Number**
402	CFK3301
502	CFK3302
652	CFK3303
752	CFK3304

Freeze protection

Although these units are CSA International design-certified for outdoor installations, such installations are not recommended in areas where the danger of freezing exists. You must provide proper freeze protection for outdoor installations, units installed in unheated mechanical rooms or where temperatures may drop to the freezing point or lower. If freeze protection is not provided for the system, a low ambient temperature alarm is recommended for the mechanical room. Damage to the unit by freezing is non-warrantable.

1 Determine unit location

Anytime the inlet temperature drops below 45°F, the control turns on the pump contact. If the inlet temperature is below 37°F, and the unit is in the ON Mode, the first stage will fire.

Location

Locate indoor boilers and water heaters in a room having a temperature safely above freezing [32°F (0°C)].

⚠ CAUTION

A mechanical room operating under a negative draft pressure may experience a down draft in the flue of a boiler when it is not firing. The cold outside air pulled down the flue may freeze a heat exchanger. This condition must be corrected to provide adequate freeze protection.

Hydronic systems anti-freeze

Freeze protection for a heating boiler or hot water supply boiler using an indirect coil can be provided by using hydronic system antifreeze. Follow the appliance manufacturers instructions. Do not use undiluted or automotive type antifreeze (see page 47).

Outdoor boiler installation

Adequate hydronic system antifreeze must be used. A snow screen should be installed to prevent snow and ice accumulation around the unit or its venting system.

Combustion and ventilation air

Provisions for combustion and ventilation air must be in accordance with Air for Combustion and Ventilation, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of the local building codes.

Provide properly-sized openings to the equipment room to assure adequate combustion air and proper ventilation when the unit is installed with conventional venting or sidewall venting.

Combustion air options

⚠ CAUTION

Under no circumstances should the equipment room ever be under a negative pressure. Particular care should be taken where exhaust fans, attic fans, clothes dryers, compressors, air handling units, etc., may take away air from the unit.

This unit has four combustion air options.

1. Outside Combustion Air, No Ducts

You can direct outside combustion air to this unit using either one or two permanent openings (see FIG. 1-2).

One Opening

The opening must have a minimum free area of one square inch per 3000 Btu input (7 cm^2 per kW). You must locate this opening within 12" (30 cm) of the top of the enclosure.

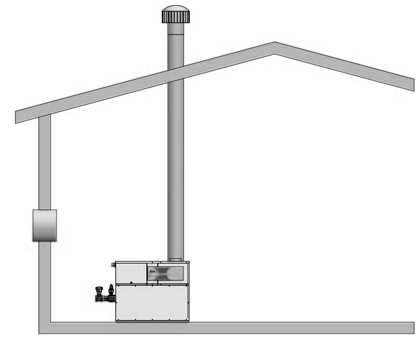


Figure 1-2_*Outside Combustion Air - Single Opening*

Two Openings

The combustion air opening must have a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm^2 per kW). You must locate this opening within 12" (30 cm) of the bottom of the enclosure (see FIG. 1-3).

The ventilation air opening must have a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm^2 per kW). You must locate this opening within 12" (30 cm) of the top of the enclosure.

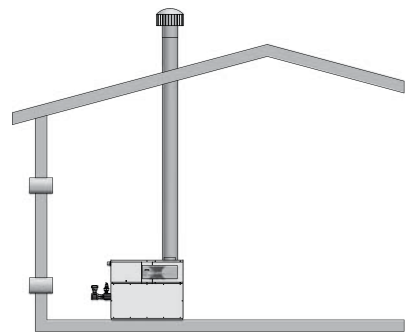


Figure 1-3_*Outside Combustion Air - Two Openings*

2. Outside Combustion Air, Using Ducts

You can direct outside combustion air to this unit using two air ducts to deliver the air to the boiler room (see FIG. 1-5).

Each of the two openings must have a minimum free area of one square inch per 2000 Btu input (11cm^2 per kW).

3. Combustion Air from Interior Space

You can direct combustion air to this unit using air from an adjoining interior space. You must provide two openings from the boiler room to the adjoining room (see FIG. 1-4).

Each of the two openings must have a net free area of one square inch per 1000 Btu input (22cm^2 per kW), but not less than 100 square inches (645cm^2).

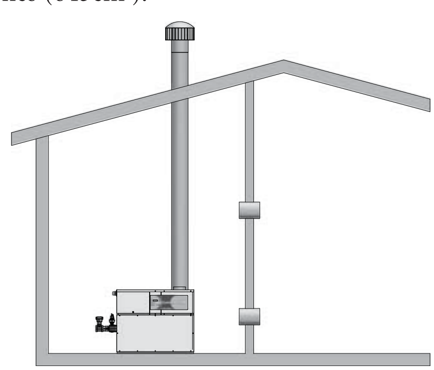


Figure 1-4_*Combustion Air from Interior Space*

1 Determine unit location *(continued)*

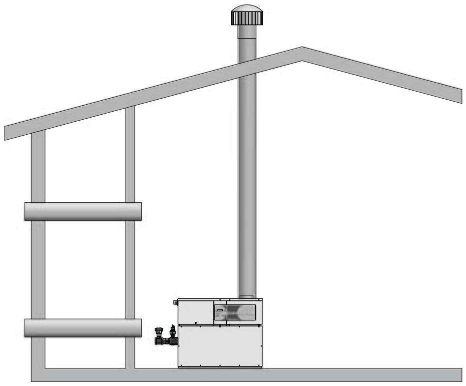


Figure 1-5*_Outside Combustion Air Through Ducts*

All dimensions are based on net free area in square inches. Metal louvers or screens reduce the free area of a combustion air opening a minimum of approximately 25%. Check with louver manufacturers for exact net free area of louvers. Where two openings are provided, one must be within 12" (30 cm) of the ceiling and one must be within 12" (30 cm) of the floor of the equipment room. Each opening must have a minimum net free area as specified in TABLE 1C, page 11. Single openings shall be installed within 12" (30 cm) of the ceiling.

⚠ CAUTION The combustion air supply must be completely free of any flammable vapors that may ignite or chemical fumes which may be corrosive to the appliance. Common corrosive chemical fumes which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as Freon, trichlorethylene, perchlorethylene, chlorine, etc. These chemicals, when burned, form acids which quickly attack the heat exchanger finned tubes, headers, flue collectors, and the vent system. The result is improper combustion and a non-warrantable, premature unit failure.

4. Outside Combustion Air - Using Direct Venting

With this option, you can connect combustion air vent piping directly to the unit. See the information under Direct Venting starting on page 26 for specific information regarding this option.

TABLE - 1C
MINIMUM RECOMMENDED COMBUSTION AIR SUPPLY TO EQUIPMENT ROOM

Model Number	*Outside Air from 2 Openings Directly from Outdoors		*Outside Air from 1 Opening Directly from Outdoors, in²	Inside Air from 2 Ducts Delivered from Outdoors		Inside Air from 2 Ducts Delivered from Interior Space	
	Top Opening, in²	Bottom Opening, in²		Top Opening, in²	Bottom Opening, in²	Top Opening, in²	Bottom Opening, in²
402	100 (645 cm²)	100 (645 cm²)	133 (858 cm²)	200 (1291 cm²)	200 (1291 cm²)	400 (2581 cm²)	400 (2581 cm²)
502	125 (806 cm²)	125 (806 cm²)	167 (1077 cm²)	250 (1613 cm²)	250 (1613 cm²)	500 (3226 cm²)	500 (3226 cm²)
652	163 (1052 cm²)	163 (1052 cm²)	217 (1400 cm²)	325 (2097 cm²)	325 (2097 cm²)	650 (4194 cm²)	650 (4194 cm²)
752	188 (1213 cm²)	188 (1213 cm²)	250 (1613 cm²)	375 (2420 cm²)	375 (2420 cm²)	750 (4839 cm²)	750 (4839 cm²)
992	248 (1600 cm²)	248 (1600 cm²)	330 (2129 cm²)	495 (3194 cm²)	495 (3194 cm²)	990 (6388 cm²)	990 (6388 cm²)
1262	315 (2032cm²)	315 (2032cm²)	420 (2710 cm²)	630 (4065 cm²)	630 (4065 cm²)	1260 (8130 cm²)	1260 (8130 cm²)
1442	360 (2323cm²)	360 (2323cm²)	480 (3097 cm²)	720 (4646 cm²)	720 (4646 cm²)	1440 (9291 cm²)	1440 (9291 cm²)
1802	450 (2903cm²)	450 (2903cm²)	600 (3871 cm²)	900 (5807 cm²)	900 (5807 cm²)	1800 (11614 cm²)	1800 (11614 cm²)
2072	518 (3342cm²)	518 (3342cm²)	690 (4452 cm²)	1035 (6678 cm²)	1035 (6678 cm²)	2070 (13356 cm²)	2070 (13356 cm²)

*Outside air openings shall directly communicate with the outdoors. When combustion air is drawn from the outside through a duct, the net free area of each of the two openings must have twice (2 times) the free area required for Outside Air/2 Openings. The above requirements are for the boiler only; additional gas fired appliances in the equipment room will require an increase in the net free area to supply adequate combustion air for all appliances.

1 Determine unit location

Exhaust fans

Any fan or equipment which exhausts air from the boiler room may deplete the combustion air supply and/or cause a down draft in the venting system. Spillage of flue products from the venting system into an occupied living space can cause a very hazardous condition that must be immediately corrected. If a fan is used to supply combustion air to the boiler room, the installer must make sure that it does not cause drafts which could lead to nuisance operational problems with the boiler.

Vertical DirectAire™, Horizontal DirectAire™, and Direct Vent venting systems have specific requirements for combustion air ducts from the outside which are directly connected to the unit. See the requirements for combustion air duct in the venting section.

NOTICE Use of filters having MERV (*Minimum Efficiency Reporting Value*) ratings higher than 4 is not recommended. Higher efficiency low-micron filters can limit combustion air leading to either nuisance problems or potential component damage if used over prolonged periods of time. Filters having a MERV rating of 5 to 6 may be used on a limited basis during the construction phase of a project provided they are replaced once filter loading becomes apparent. After the construction phase is completed, it is recommended that the filter be changed to a 4 or lower MERV disposable type filter.

Combustion air filter

This unit has a standard air filter located at the combustion air inlet. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The filter size on Models 402 - 752 is 12" x 12" x 1" (30.5cm x 30.5cm x 2.5cm) and 16" x 16" x 1" (40.6cm x 40.6cm x 2.5 cm) on Models 992 - 2072. You can find these commercially available filters at any home center or HVAC supply store.

For convenience and flexibility, you can direct the combustion air inlet from either the back or right side of the unit. To arrange the combustion air inlet for side entry, follow the steps below:

1. Remove the metal panel from the unit's side wall (see FIG. 1-6).
2. Remove screws from the air filter/bracket assembly.
3. Move the filter/bracket assembly from the rear of unit to the side opening (see FIG. 1-7).
4. Attach filter/bracket assembly to the unit's side using the pre-drilled screw holes.
5. Attach the metal panel to the rear combustion air opening to seal it off.

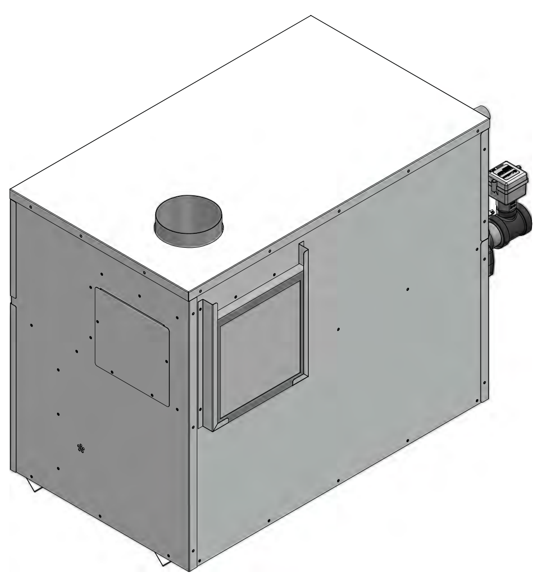


Figure 1-6*_Metal Panel Covering Side Combustion Air Inlet*

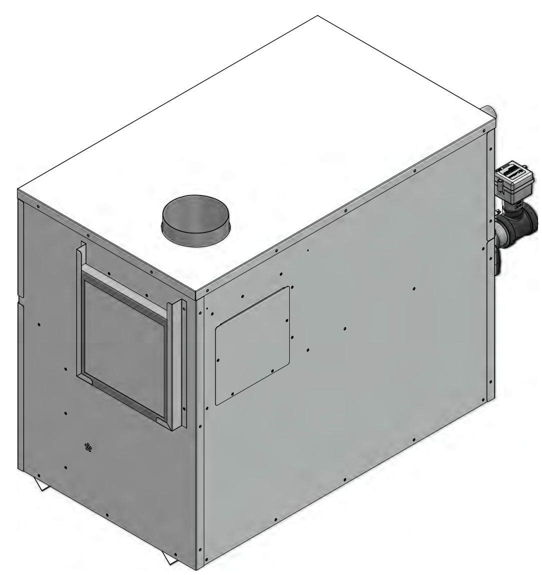


Figure 1-7*_Moving Air Filter / Bracket Assembly from Rear of Unit to Side*

NOTICE During construction the air filter should be checked more frequently to ensure it does not become clogged with combustion dirt and debris.

CAUTION Sustained operation of an appliance with a clogged filter may result in nuisance operational problems, bad combustion, and non-warrantable component failures.

2 Venting

BEFORE YOU BEGIN

Identify your appliance's vent system:

This manual covers venting requirements for CAT I models and CAT IV vent materials. Be sure to correctly identify the type of vent system your appliance requires before proceeding.

C(F,H) (N,L)0402
C(F,H) (N,L)0502
C(F,H) (N,L)0652
C(F,H) (N,L)0752
C(F,H) (N,L)0992
C(F,H) (N,L)1262
C(F,H) (N,L)1442
C(F,H) (N,L)1802
C(F,H) (N,L)2072

Venting options:

A B C D = B-Vent Material CAT I

E = Direct Vent Options CAT IV

F = Outdoor Vent Option

⚠ DANGER Failure to use correct venting materials can result in loss of life from flue gas spillage into working or living space.

Venting Category Definitions: **(Reference National Fuel Gas Code ANSI Z223.1)**

CAT I: Negative pressure non-condensing

An appliance that operates with a non-positive vent static pressure with a vent gas temperature that avoids excessive condensate production in the vent.

CAT IV: Positive pressure condensing

An appliance that operates with a positive vent static pressure with a vent gas temperature that may cause excessive condensate production in the vent.

CAT IV Flue pipe materials

The following manufacturers supply flue materials suitable for these models when installed as CAT IV. All materials are made with AL29-4C stainless steel.

Heat-Fab Inc., Saf-T CI Vent with AL29-4C stainless steel

Protech Systems Inc., Fas N Seal Vent with AL29-4C stainless steel

Metal-Fab Inc., Corr/Guard Vent with AL29-4C stainless steel

Or other listed Category IV vent systems suitable for a condensing, positive pressure, gas fired appliance.

A Category IV flue **MUST** have all vent joints and seams sealed gastight and have provisions for a drain to properly collect and dispose of condensate that may occur in the venting system.

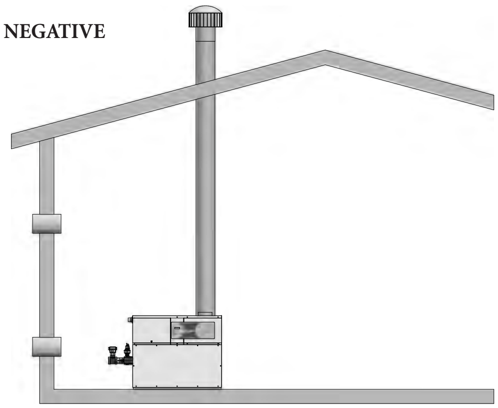
2 Venting

Vent system options: (Note: Installations shown below are representative, actual installations may vary from those shown.)

A

This option uses a vertical rooftop flue termination with air supplied from the equipment room - see page 16.

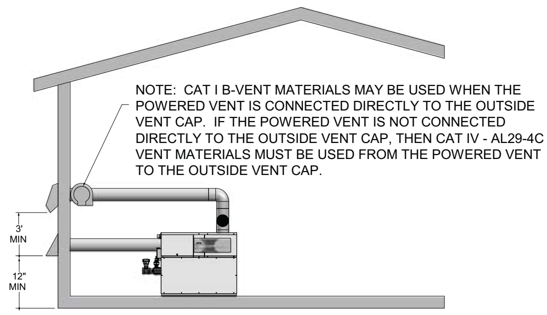
CONVENTIONAL NEGATIVE DRAFT VENTING



D

This option uses a powered vent assembly to exhaust the flue products out a sidewall with air supplied by a pipe from the sidewall - see page 25.

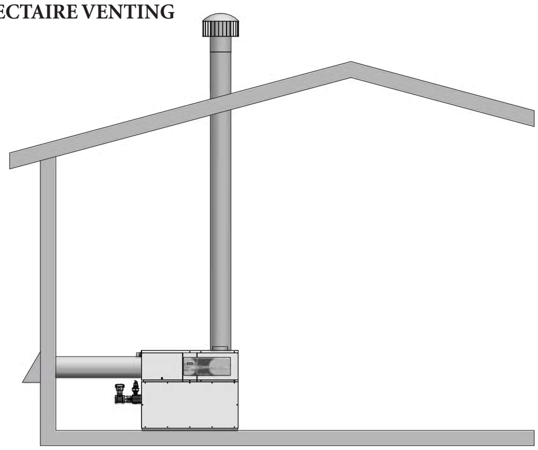
HORIZONTAL DIRECTAIRE VENTING



B

This option uses a vertical conventional vent for flue products with air supplied by a pipe from the sidewall or rooftop - see page 19.

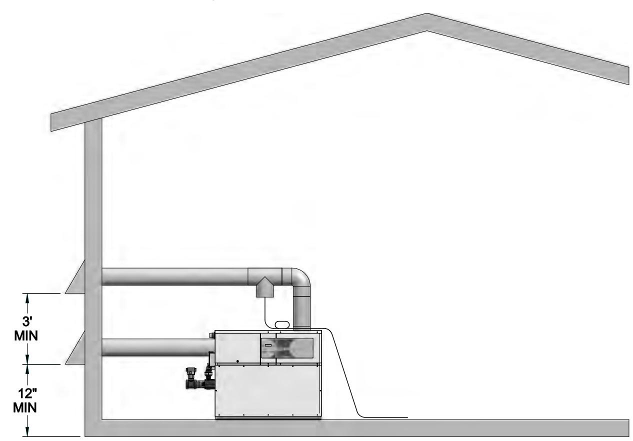
VERTICAL DIRECTAIRE VENTING



E

This option uses a sealed AL29-4C flue and a separate combustion air pipe to the outdoors. This system terminates both the flue and combustion air inlet in the same pressure zone - see page 26.

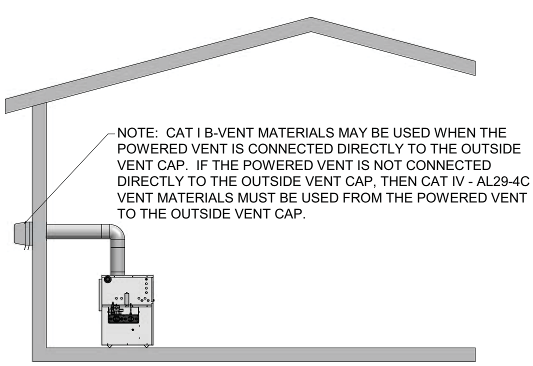
DIRECT VENT



C

This option uses a powered vent assembly to exhaust the flue products out a sidewall vent termination with air supplied from the equipment room - see page 22.

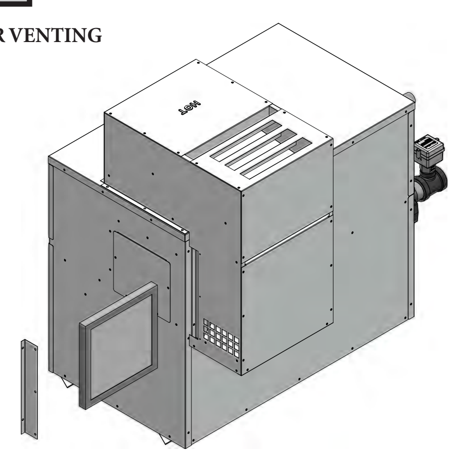
SIDEWALL VENTING



F

This option uses the installation of a special air inlet / vent cap on top of the unit - see page 30.

OUTDOOR VENTING



2 Venting *(continued)*

General information

You must supply adequate combustion and ventilation air to this unit. You must provide minimum clearances for the vent terminal from adjacent buildings, windows that open, and building openings. Follow all requirements set forth in the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment or applicable local building codes. Vent installations for connection to gas vents or chimneys must be in accordance with “Venting of Equipment” of the above-mentioned standards.

NOTICE Examine the venting system at least once each year. Check all joints and vent pipe connections for tightness. Also check for corrosion or deterioration. If you find any problems, correct them at once.

Venting support

Support horizontal portions of the venting system to prevent sagging. Provide an upward slope of at least 1/4 inch per foot (21mm/m) on all horizontal runs from the unit to the vertical flue run or to the vent terminal on sidewall venting installations.

Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney. The weight of the venting system must not rest on the unit. Provide adequate support of the venting system. Follow all local and applicable codes. Secure and seal all vent connections. Follow the installation instructions from the vent material manufacturer.

Barometric damper location

Any venting system option that requires a barometric damper must adhere to the following directions for optimum performance. The preferred location for the barometric damper is in a tee or collar installed in the vertical pipe rising from the unit’s flue outlet. The barometric damper MUST NOT be installed in a bull head tee installed on the unit’s flue outlet. The tee or collar containing the barometric damper should be approximately three feet vertically above the connection to the unit’s flue outlet. This location ensures that any positive velocity pressure from the unit’s internal combustion fan is dissipated and the flue products are rising due to buoyancy generated from the temperature of the flue products. Adjust the weights on the damper to ensure that draft is maintained within the specified range.

TABLE - 2A
FLUE AND AIR INLET PIPE SIZES

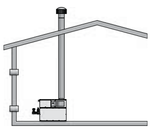
MODEL	FLUE SIZE	AIR INLET SIZE	MODEL	FLUE SIZE	AIR INLET SIZE*
402	6"	6"	992	10"	10"
502	6"	6"	1262	12"	12"
652	8"	8"	1442	12"	12"
752	8"	8"	1802	14"	12"
--	--	--	2072	14"	12"

*Minimum diameter for air inlet pipe. Installer may increase diameter one pipe size for ease of installation, if needed.

2 Venting

A

Conventional negative draft venting - see page 14.



NOTICE Before installing a venting system, follow requirements found in the General Venting section.

This option uses Type-B double-wall flue outlet piping. The blower brings in combustion air. The buoyancy of the heated flue products cause them to rise up through the flue pipe. The flue outlet terminates at the rooftop.

Negative draft

The negative draft in a conventional vent installation must be within the range of 0.02 to 0.08 inches w.c. to ensure proper operation. Make all draft readings while the unit is in stable operation (approximately 2 to 5 minutes).

Connect the flue vent directly to the flue outlet opening on the top of the unit. No additional draft diverter or barometric damper is needed on single unit installations with a dedicated stack and a negative draft within the specified range of 0.02 to 0.08 inches w.c. If the draft in a dedicated stack for a single unit installation exceeds the maximum specified draft, you must install a barometric damper to control draft. Multiple unit installations with combined venting or common venting with other Category I negative draft appliances require each boiler to have a barometric damper installed to regulate draft within the proper range.

Do not connect vent connectors serving appliances vented by natural draft (negative draft) to any portion of a mechanical draft system operating under positive pressure. Connecting to a positive pressure stack may cause flue products to be discharged into the living space causing serious health injury.

Flue outlet piping

With this venting option, you must use Type-B double-wall vent materials. Vent materials must be listed by a nationally-recognized test agency for use as vent materials. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Use the National Fuel Gas Code venting tables for double-wall vent to properly size all vent connectors and stacks. Follow the vent manufacturer's instructions when installing Type-B vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors. Locate the unit as close as possible to a chimney or gas vent.

Avoid long horizontal runs of the vent pipe, 90° elbows, reductions and restrictions.

No additional draft diverter or barometric damper is required on single unit installations with a dedicated stack and a negative draft maintained between 0.02 to 0.08 inches w.c.

Common Venting Systems

You can combine the flue with the vent from any other negative draft, Category I appliance. Using common venting for multiple negative draft appliances requires you to install a barometric damper with each unit. This will regulate draft within the proper range. You must size the common vent and connectors from multiple units per the venting tables for Type-B double-wall vents in the latest edition of the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CGA-B149 Installation Code.

Common venting systems may be too large when an existing unit is removed.

At the time of removal of an existing appliance, the following steps shall be followed with each appliance remaining connected to the common venting system placed in operation, while other appliances remaining connected to the common venting system are not in operation.

1. Seal any unused opening in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch. Make sure there is no blockage or restriction, leakage, corrosion and other unsafe conditions.
3. If possible, close all building doors and windows. Close all doors between the space in which the appliances remaining connected to the common venting system are located and other building spaces.

2 Venting *(continued)*

4. Turn on clothes dryers and any other appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan.
5. Close fireplace dampers.
6. Place in operation the unit being inspected. Follow the lighting instructions. Adjust thermostat so unit will operate continuously.
7. Test for spillage at the draft hood/relief opening after 5 minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.
8. After making sure that each appliance remaining connected to the common venting system properly vents when tested as above, return doors, windows, exhaust fans, fireplace dampers and other gas burning appliances to their previous conditions of use.
9. Correct any improper operation of the common venting system so that the installation conforms to the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment. When resizing any portion of the common venting system, resize to approach the minimum size as determined using the appropriate tables of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment.

Masonry chimney installations

A masonry chimney must be properly sized for the installation of a high efficiency gas-fired appliance. Venting of a high efficiency appliance into a cold or oversized masonry chimney can result in operational and safety problems. Exterior masonry chimneys, with one or more sides exposed to cold outdoor temperatures, are more likely to have venting problems. The temperature of the flue products from a high efficiency appliance may not be able to sufficiently heat the masonry structure of the chimney to generate proper draft. This will result in condensing of flue products, damage to the masonry flue/tile, insufficient draft and possible spillage of flue products into an occupied living space. Carefully inspect all chimney systems before installation.

⚠ WARNING Do not vent this unit into a masonry chimney without a sealed stainless steel liner system. Any breaks, leaks, or damage to the masonry flue/tile will allow the flue products to leak from the chimney and into occupied living spaces. This could cause serious injury or death due to carbon monoxide poisoning and other harmful flue products.

NOTICE Check with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion-resistant liner system.

Inspection of a masonry chimney

A masonry chimney must be carefully inspected to determine its suitability for the venting of flue products. A clay-tile-lined chimney must be structurally sound, straight and free of misaligned tile, gaps between liner sections, missing sections of liner or any signs of condensate drainage at the breaching or clean out. If there is any doubt about the condition of a masonry chimney, it must be relined with a properly-sized and approved chimney liner system. An unlined masonry chimney must not be used to vent flue products from this high-efficiency unit. An unlined chimney must be relined with an approved chimney liner system when a new appliance is being attached to it. Metallic liner systems (Type-B double-wall or flexible or rigid metallic liners) are recommended. Consult with local code officials to determine code requirements or the advisability of using or relining a masonry chimney.

Vertical vent termination clearances and location

The vent terminal should be vertical and exhaust outside the building at least 2 feet (0.61m) above the highest point of the roof within a 10 foot (3.05m) radius of the termination.

The vertical termination must be a minimum of 3 feet (0.91m) above the point of exit.

A vertical termination less than 10 feet (3.05m) from a parapet wall must be a minimum of 2 feet (0.61m) higher than the parapet wall.

Keep the vent cap clear of snow, ice, leaves, and debris to avoid blocking the flue.

2 Venting

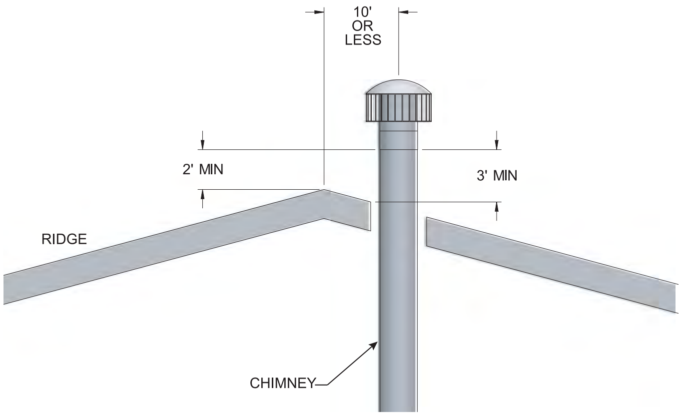


Figure 2-1_Vent Termination from Peaked Roof - 10 ft. or Less From Ridge

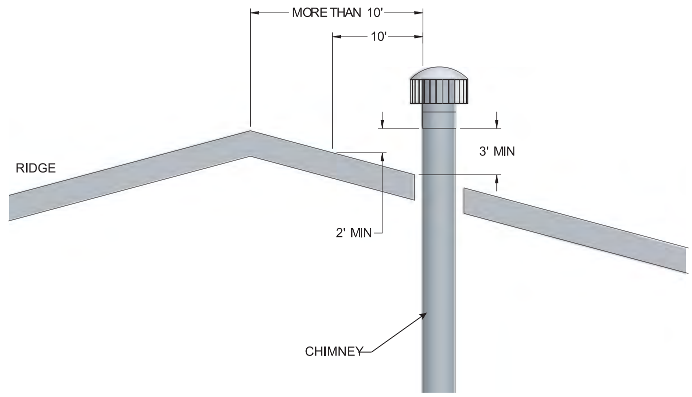


Figure 2-2_Vent Termination from Peaked Roof - 10 ft. or More From Ridge

NOTICE Vent terminations are not shown in FIG.'s 2-1 thru 2-4. Make sure all vertical vents are installed with vent terminations recommended by the vent manufacturer.

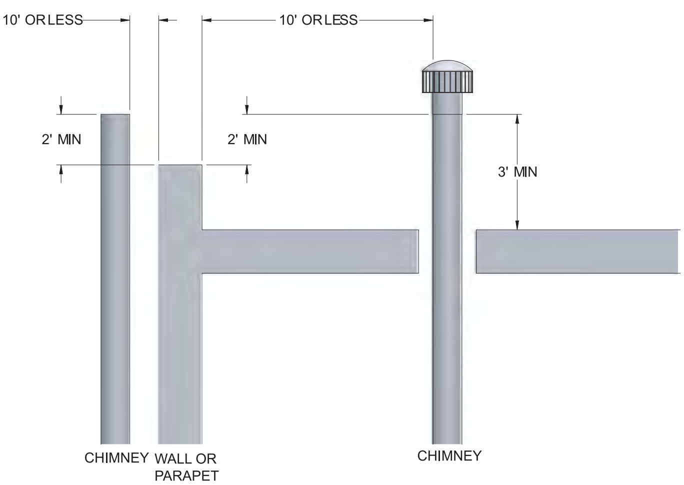


Figure 2-3_Vent Termination from Flat Roof - 10 ft. or Less From Parapet Wall

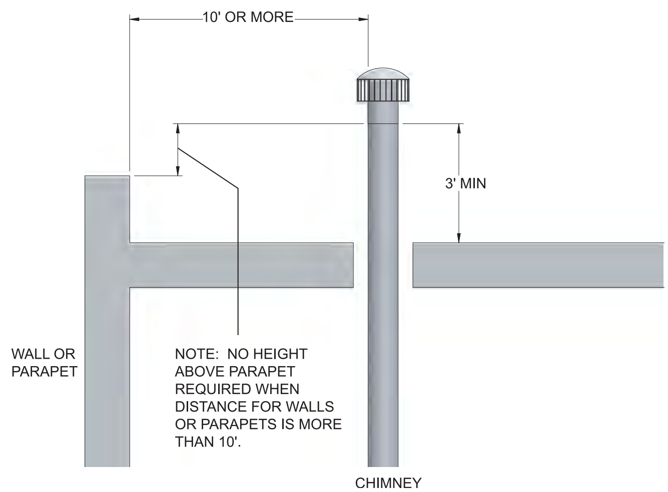
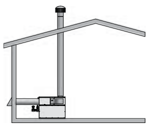


Figure 2-4_Vent Termination from Flat Roof - 10 ft. or More From Parapet Wall

2 Venting *(continued)*

Vertical DirectAire™ venting - see page 14.

B



NOTICE Before installing a venting system, follow requirements found in the General Venting section.

The Vertical DirectAire™ vent system is the same as the Conventional Negative Draft vent system, except it pulls combustion air from the outdoors through a separate air inlet pipe. Follow all requirements in the Conventional Negative Draft Venting section on page 16.

The Vertical DirectAire™ vent system requires you to install two pipes directly to the unit; one vertical pipe with a rooftop termination for the flue products and one pipe for combustion air. For this venting option, you must purchase the DV box adapter from the appliance manufacturer. The DV box attaches to the air inlet of the unit. The pipe for combustion air attaches to the DV box (see FIG. 2-11 on page 28). Reference page 28 for a list of approved air intake materials.

Combustion air inlet piping

⚠ WARNING Locate and install the combustion air inlet cap correctly. Failure to do so can allow the discharge of flue products to be drawn into the combustion process. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

The sidewall or vertical rooftop DirectAire™ combustion air supply system has specific material and installation requirements. The air inlet pipe connects directly to the unit to supply combustion air. In most installations, the combustion air inlet pipe will be a dedicated system with one air inlet pipe per unit. You can combine multiple air inlets if the guidelines in Combined Air Inlet Points, page 20 are followed. The air inlet pipe will be connected to a combustion air inlet cap as specified in this section.

For normal installations, this system uses a single-wall pipe to supply combustion air from outdoors directly to the unit.

In cold climates, use a Type-B double-wall vent pipe or an insulated single-wall pipe for combustion air. This will help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

Length of air inlet pipe

The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Do not exceed the limits for the combustion air inlet piping lengths.

Sidewall air inlet

The sidewall air inlet cap is supplied in the Sidewall Air Inlet Kit. Order the kit from the appliance manufacturer. This sidewall cap supplies combustion air for a single unit only. See Table 2B, page 21, for kit numbers.

Locate the unit as close as possible to the sidewall where you will install the combustion air supply system.

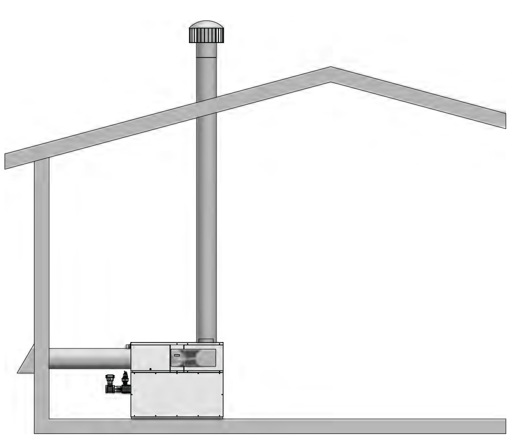


Figure 2-5*_Sidewall Combustion Air Inlet*

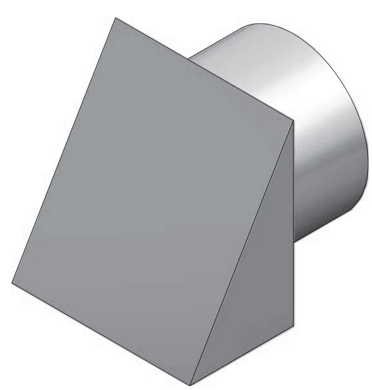


Figure 2-6*_Air Inlet Cap for Sidewall Termination*

2 Venting

To prevent recirculation of flue products from an adjacent vent cap into the combustion air inlet, follow all applicable clearance requirements in the latest edition of the National Fuel Gas Code and/or CAN/CGA-B149 Installation Code and instructions in the Installation and Operation Manual.

Clearances

You must install the combustion air inlet cap at least one foot (0.30m) above ground level and above normal snow levels.

The point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination if it is located within 10 feet (3.05m) of the flue outlet. Make sure to properly install the air inlet cap assembly on the air inlet pipe.

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Vertical Rooftop Air Inlet

Use the vertical air inlet terminations available from the appliance manufacturer, recommended and/or supplied by the vent manufacturer, or use two 90° elbows as described on page 29.

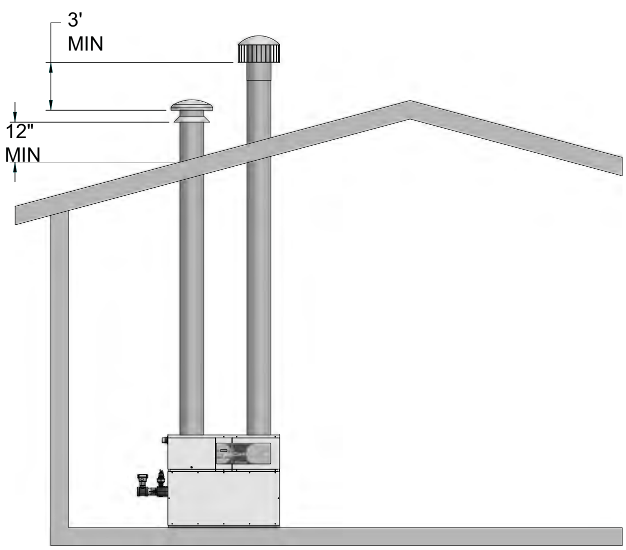


***Figure 2-7**_Rooftop Combustion Air Inlet*

You must locate the air inlet termination elbow at least 12" (30cm) above the roof or above normal snow levels.

If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (vent cap).

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Combined air inlet points

The air inlet pipes from multiple boilers can be combined to a single common connection if the common air inlet pipe has a cross sectional area equal to or larger than the total area of all air inlet pipes connected to the common air inlet pipe.

Example: Two 10" air inlet pipes (78.5 in^2 area each) have a total area of 157 in^2 and will require a 15" (176.7 in^2 area) common air inlet pipe.

The air inlet point for multiple boiler air inlets must be provided with an exterior opening which has a free area equal to or greater than the total area of all air inlet pipes connected to the common air inlet. This exterior opening for combustion air must connect directly to the outdoors. The total length of the combined air inlet pipe must not exceed a maximum of 50 (15.2m) equivalent feet. Subtract 5 feet (1.5m) for each 90° elbow in the air inlet pipe. You must deduct the restriction in area provided by any screens, grills or louvers installed in the common air inlet point. These are common on the sidewall air inlet openings. Screens, grills or louvers installed in the common air inlet can reduce the free area of the opening from 25% to 75% based on the materials used.

You can terminate the combustion air pipe either horizontally with a sidewall air inlet or vertically with a rooftop air inlet. The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m).

2 Venting *(continued)*

⚠ WARNING

Only use a sidewall air inlet cap supplied by the appliance manufacturer or a rooftop air inlet cap supplied by either the vent or appliance manufacturer. Using any other air inlet cap for single unit installations or using a common air inlet cap for multiple units with insufficient free area and/or protections from wind and weather may result in operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

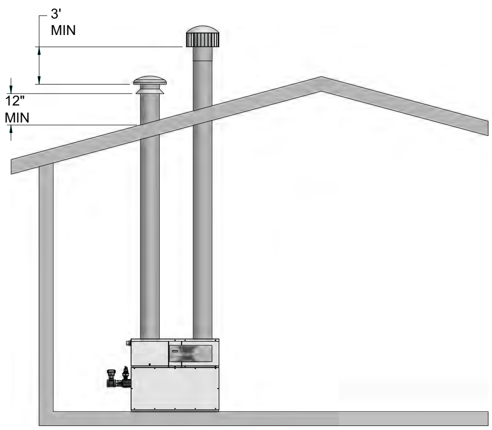


***Figure 2-8**_Vertical DirectAire™ Installation w/Rooftop Combustion Air Inlet*

For single unit installations with sidewall air inlet you must order the sidewall air inlet kit from the appliance manufacturer. The part number for each SVK kit is listed by unit size in Table 2B.

For single unit installations with rooftop air inlet (see FIG. 2-8), you must order the rooftop air inlet kit from the appliance manufacturer. The part number for each VDK kit is listed by unit size in Table 2B. Purchase the flue pipe, rooftop flue termination, and air inlet pipe locally.

There is no vent kit for combined air supply systems for multiple units. Make sure the air inlet cap is properly sized. You must purchase this cap locally.

Venting of flue products

For venting flue products vertically to the outdoors, follow all requirements in the installation instructions for conventional venting in this manual.

Follow all clearance requirements in Vertical Vent Termination Clearances and Location on page 17.

A barometric damper is not required in the flue on Vertical DirectAire™ installations if the draft is within the negative 0.02 to 0.08 inches w.c. required for proper operation. If the draft exceeds this range, install a barometric damper.

TABLE - 2B DIRECTAIRE KITS		
MODEL	HORIZONTAL KIT*	VERTICAL KIT*
402	SVK3047	VDK3026
502	SVK3047	VDK3026
652	SVK3048	VDK3027
752	SVK3048	VDK3027
992	SVK3040	VDK3023
1262	SVK3041	VDK3024
1442	SVK3041	VDK3024
1802	SVK3041	VDK3024
2072	SVK3041	VDK3024
*The SVK kits include a DV box adapter and sidewall air inlet cap. The VDK kits include a DV box adapter and a rooftop air inlet cap.		

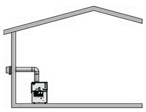
2 Venting

Sidewall venting - see page 14.

C

NOTICE Before installing a venting system, follow all requirements found in the General Venting section.

This option uses a powered vent assembly which pulls the flue products out of the stack. This fan generates a negative draft at the unit. Combustion air is drawn from the equipment room (see Combustion and Ventilation Air on 10).



Sidewall with fan

The sidewall fan can be mounted on the inside/outside (depending upon model) with a sidewall vent hood installed on the exterior wall. The sidewall fan and accessories are included in a venting kit provided by the appliance manufacturer. See Table 2C on page 24 for kit numbers.

The venting kit includes the sidewall fan, vent hood, tapered vent adapter, barometric damper (992 - 2072 Models), proving switch and all necessary relays to interlock with the heaters control system. The tapered vent adapter reduces the vent size at the inlet to the fan. There should be no reduction in vent diameter from the unit's flue outlet to the sidewall fan. The barometric damper must be installed on the flue and adjusted to supply a negative draft within the range of 0.04 to 0.08 inches w.c. while unit is operating.

Flue outlet piping

With this venting option, you must use Type-B double-wall (or equivalent) vent materials. Vent materials must be listed by a nationally-recognized test agency for use as vent materials. Make the connections from the unit vent to the sidewall fan/cap as direct as possible with no reduction in diameter. Use the National Fuel Gas Code venting tables for double-wall vent to properly size all vent connectors and stacks. Follow the vent manufacturer's instructions when installing Type-B vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls.

The maximum installed length of sidewall vent pipe with an induced draft fan must not exceed 100 feet (30.5m). Subtract 5 feet (1.5m) for each 90° elbow. Subtract 2.5 feet (0.7m) for each 45° elbow.

Sidewall venting termination

The sidewall vent cap must be installed on an exterior sidewall. The sidewall fan/powered sidewall vent cap and accessories are included in a venting kit which is furnished by the appliance manufacturer in accordance with CSA International requirements. This venting kit includes the powered sidewall fan/cap, proving switch and all necessary relays to interlock with the heaters control system.

The sidewall fan/powered vent cap must be interlocked with the units control system to start the fan on a call for heat and prove fan operation before the boiler fires. Plug-in and terminal strip connections are provided on the unit for easy connection of the factory supplied vent kit and control package for the sidewall vent fan. See the installation instructions provided with the vent kit.

Sidewall vent termination clearances and location

Locate the bottom of the vent terminal at least 12 inches (30cm) above grade and above normal snow levels. Locate the bottom of the vent terminal at least 7 feet (2.13m) above grade when located adjacent to public walkways. Do not terminate directly above a public walkway.

Do not terminate the venting system in a window well, stairwell, alcove, courtyard, or other recessed area. Do not terminate the venting system below grade.

Locate vent termination at least 3 feet (0.91m) from an inside corner of an L-shaped structure.

Provide a minimum clearance of 4 feet (1.2m) horizontally from electric meters, gas meters, regulators, and relief equipment. Never locate vent cap above or below electric meters, gas meters, regulators, and relief equipment unless a 4 foot (1.2m) horizontal clearance is maintained.

2 Venting *(continued)*

Terminate the venting system at least 3 feet (0.9m) above any forced air inlet within 10 feet (3.05m).

Terminate the venting system at least 4 feet (1.2m) below, 4 feet (1.2m) beside, or 1 foot (30cm) above any door, window, or gravity air inlet into any building.

Locate vent termination at least 8 feet (2.4m) horizontally from any combustion air intake located above the sidewall termination cap.

⚠ CAUTION Units which are shut down or will not operate may experience freezing due to convective air flow in the flue pipe, through the air inlet, or from negative pressure in the equipment room. In cold climates, operate the pump continuously to help prevent freezing of boiler water. Provide proper freeze protection. See Freeze Protection, page 47.

Sidewall venting without fan

For Models 402 - 752 which are approved for sidewall venting without an external power vent fan, you must install specific vent kits and venting materials (reference Table 2C on page 24 for kit numbers).

The following is a detailed explanation of Sidewall Venting Without an External Power Vent Fan installation requirements.

Flue outlet piping

Venting Guidelines

If using this venting option, a sealed AL29-4C venting system for flue products is required on all models of this appliance. This venting system operates with a positive pressure in the vent. The internal combustion air blower generates this positive pressure which operates the combustion process and also exhausts the flue products from the building.

This vent system has specific vent material and installation requirements. Only use listed sealed AL29-4C vent system materials. Follow all installation requirements. See Table 2A for proper pipe size for your unit. A list of sealed AL29-4C flue pipe manufacturers is located on page 15.

Seal all vent joints and seams gas-tight.

Drain tee installation

A drain tee must be installed in the vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee must be installed as the first fitting after the horizontal ell on the top of the unit (see FIG. 2-9). Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (7.6cm) diameter circular trap loop in the drain tubing. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon wire ties. Use caution not to collapse or restrict the condensate drain line with the nylon wire ties. The condensate drain must be routed to a suitable drain for disposal of condensate that may occur in the direct vent system. Refer to the condensate drain installation instructions as supplied by the manufacturer of the vent material.

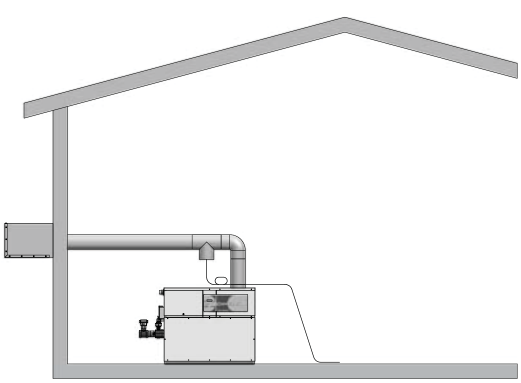


***Figure 2-9**_Sidewall Vent - Models 402 - 752 (Only)*

2 Venting

⚠ WARNING Do not combine the flue from this unit with the vent from any other appliance. Do not combine flues from multiple appliances into a common vent. The flue from this unit must be a dedicated stack.

Connect the flue vent directly to the flue outlet opening on the top of the unit. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Provide adequate clearance to combustibles for the vent connector and firestop. Follow the vent manufacturer's instructions when installing sealed AL29-4C vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors.

Locate the unit as close as possible to chimney or gas vent. When a vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

The installed length of flue from the unit to the outside point of termination must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Sidewall vent termination clearances and location

Follow all sidewall venting termination information for clearances and location under Sidewall Vent Termination Clearances and Location on page 22.

TABLE - 2C
SIDEWALL VENT KITS

MODEL	KIT (W/POWER FAN ASSY.)	MAX. VENT LENGTH	VENT TERMINATION ONLY (MODELS 402 - 752)	MAX. VENT LENGTH
402	SVK3006	100 ft.	SVK3043	50 ft.
502	SVK3006	100 ft.	SVK3043	50 ft.
652	SVK3008	100 ft.	SVK3044	50 ft.
752	SVK3008	100 ft.	SVK3044	50 ft.
992	SVK3009*	100 ft.	N/A	N/A
1262	SVK3010*	100 ft.	N/A	N/A
1442	SVK3010*	100 ft.	N/A	N/A
1802	SVK3012*	100 ft.	N/A	N/A
2072	SVK3012*	100 ft.	N/A	N/A

*These kits include a barometric damper.

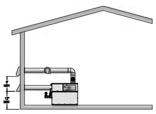
2 Venting *(continued)*

Horizontal DirectAire™ venting (Powered Venting) - see page 14.

D

NOTICE Before installing a venting system, follow all requirements found in the General Venting section.

The Horizontal DirectAire™ vent system is the same as the Sidewall Venting system, except it pulls combustion air from the outdoors through a sidewall air inlet. Follow all requirements in Sidewall Venting section on page 22.



The Horizontal DirectAire™ vent system requires you to install two pipes directly to the unit; one pipe for flue products and one for combustion air. Install both pipes horizontally with a sidewall termination point. For this venting option, you must purchase the DV box accessory from the appliance manufacturer. The DV box attaches to the air inlet of the unit. The pipe for combustion air attaches to the DV box (see FIG. 2-11 on page 28). Reference page 28 for a list of approved air intake materials.

Make vent connection directly to the top of the unit. No additional draft diverter or barometric damper is required on single unit installations with a dedicated stack and a negative draft maintained between 0.04 to 0.08 inches w.c.

The Horizontal DirectAire™ combustion air supply system has specific vent material and installation requirements. The air inlet pipe connects directly to the boiler to supply combustion air. The combustion air inlet pipe is a dedicated system with one air inlet pipe per boiler. You must connect the air inlet pipe to a combustion air inlet cap as specified in this section.

Combustion air supplied from outdoors must be free of contaminants (see the Combustion and Ventilation Air section on page 10).

You must order the Horizontal DirectAire™ Vent Kit for sidewall installation from the appliance manufacturer. See Table 2D for kit numbers. Each kit includes a sidewall powered vent cap fan, proving switch, controls, combustion air inlet cap to supply air to a single unit, the transition adapter to attach the field supplied single wall air inlet pipe to the unit and installation instructions. Purchase flue pipe and air inlet pipe locally.

The sidewall air inlet cap supplied in the Horizontal DirectAire™ Vent Kit is used to supply combustion air to a single boiler. Combustion air supply pipes from multiple units can not be combined into a single air inlet pipe and inlet point.

⚠ WARNING Only use the sidewall air inlet cap recommended by the appliance manufacturer. Using another sidewall air inlet cap may result in operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

Venting of flue products

For venting flue products horizontally, follow all requirements in the installation instructions for sidewall venting.

Termination point for the flue products must follow the clearance requirements in the Sidewall Venting Termination section on page 22.

For proper operation, a barometric damper is provided for Horizontal DirectAire™ installations. The damper will help to ensure a draft between negative 0.04 to 0.08 inches w.c.

TABLE - 2D
HORIZONTAL DIRECTAIRE™ KITS

MODEL	KIT	MODEL	KIT
402	HDK3031	992	HDK3026*
502	HDK3031	1262	HDK3027*
652	HDK3032	1442	HDK3027*
752	HDK3032	1802	HDK3028*
--	--	2072	HDK3028*

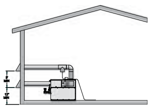
*These kits include a barometric damper.

2 Venting

E

Direct venting - see page 14.

NOTICE Before installing a venting system, follow all requirements found in the General Venting section.



This option uses sealed AL29-4C vent materials for the flue outlet piping and separate combustion air inlet piping. This system terminates both the flue and combustion air inlet in the same pressure zone. The flue outlet and combustion air intake may terminate at either a sidewall or the rooftop.

To use the optional Direct Vent system, you must install specific vent kits and venting materials. The following is a detailed explanation of Direct Vent installation requirements, including the components used and vent kit part numbers (reference Table 2E on page 27 for kit numbers).

Flue outlet piping

Venting Guidelines

If using this venting option, a sealed AL29-4C venting system for flue products is required on all models of this appliance. This venting system operates with a positive pressure in the vent. The internal combustion air blower generates this positive pressure which operates the combustion process and also exhausts the flue products from the building.

This vent system has specific vent material and installation requirements. Only use listed sealed AL29-4C vent system materials. Follow all installation requirements. See Table 2A, page 15 for proper pipe size for your unit.

Seal all vent joints and seams gas-tight.

Drain tee installation

A drain tee must be installed in the vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee must be installed as the first fitting after the horizontal ell on the top of the unit (see FIG. 2-9 on page 23). Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (7.6cm) diameter circular trap loop in the drain tubing. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon wire ties. Use caution not to collapse or restrict the condensate drain line with the nylon wire ties. The condensate drain must be routed to a suitable drain for disposal of condensate that may occur in the direct vent system. Refer to the condensate drain installation instructions as supplied by the manufacturer of the vent material.

⚠ WARNING Do not combine the flue from this unit with the vent from any other appliance. Do not combine flues from multiple appliances into a common vent. The flue from this unit must be a dedicated stack.

Connect the flue vent directly to the flue outlet opening on the top of the unit. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Provide adequate clearance to combustibles for the vent connector and firestop. Follow the vent manufacturer's instructions when installing sealed AL29-4C vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors. Locate the unit as close as possible to chimney or gas vent.

When a vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

The installed length of flue from the unit to the outside point of termination must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Vertical DV venting termination

You must use the vent termination recommended by the vent manufacturer for vertical direct vent terminations. Follow all vertical venting termination information for clearances and location under the Vertical Vent Termination Clearances and Location section on pages 17 - 18.

2 Venting *(continued)*

Masonry chimney installation

Do not use a standard masonry chimney to directly vent the combustion products from this unit.

To use a masonry chimney, the chimney must use a sealed, corrosion-resistant liner system. Sealed, corrosion-resistant liner systems (single-wall, double-wall, flexible, or rigid) must be rated for use with a high efficiency, positive pressure vent system.

Corrosion-resistant chimney liner systems are typically made from a high grade stainless steel such as AL29-4C. The liner must be properly sized and fully sealed throughout the entire length. Both the top and bottom of the masonry chimney must be capped and sealed to provide a dead air space around the liner.

⚠ WARNING Do not vent this unit into a masonry chimney without a sealed stainless steel liner system. Any breaks, leaks, or damage to the masonry flue/tile will allow the positive-pressure flue products to leak from the chimney and into occupied living spaces. This could cause serious injury or death due to carbon monoxide poisoning and other harmful flue products.

NOTICE Check with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion-resistant liner system.

Horizontal DV venting termination

Horizontal venting uses the unit's internal combustion air blower to force the flue products out of the horizontally-terminated flue.

You must purchase a horizontal direct vent kit from the appliance manufacturer to ensure proper operation. When installing the vent cap, the wall opening must provide an air space clearance of 2 inches (5.1cm) around the flue pipe. The diameter of the opening for installation of the sidewall cap will be 4 inches (10.2cm) larger (minimum) than the nominal diameter of the installed vent pipe to the horizontal vent cap.

Install the horizontal vent cap from the outside. Mount the vent cap to the wall using four screws or wall anchors. Seal under the screw heads with caulking. Install the Category IV vent pipe from the unit to the vent cap. See detailed instructions packed with the horizontal direct vent kit.

Horizontal Vent Termination Clearances and Location

Follow all sidewall venting termination information for clearances and location under Sidewall Vent Termination Clearances and Location, page 22.

TABLE - 2E
DIRECT VENT KITS

MODEL	HORIZONTAL KIT*	VERTICAL KIT*	MODEL	HORIZONTAL KIT*	VERTICAL KIT*
402	DVK3004	VDK3026	992	DVK3000	VDK3023
502	DVK3004	VDK3026	1262	DVK3001	VDK3024
652	DVK3005	VDK3027	1442	DVK3001	VDK3024
752	DVK3005	VDK3027	1802	DVK30000	VDK3024
--	--	--	2072	DVK30000	VDK3024

*These kits include a DV box adapter, air inlet cap, and a sidewall vent termination. The VDK kits include a DV box adapter and an air inlet cap.

Combustion air inlet piping

The Direct Vent system requires the installation of a pipe to supply combustion air from the outdoors directly to the unit. Make sure the combustion air inlet is in the same pressure zone as the vent terminal.

In cold climates, use a Type-B double-wall vent pipe or an insulated single wall pipe for combustion air. This will help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

⚠ CAUTION Units that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe.

2 Venting

Length of air inlet pipe

The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.
Do not exceed the limits for the combustion air inlet piping lengths.

Connecting the air inlet pipe to the unit

Connect the air inlet piping directly to the unit by attaching it to the DV box adapter. The DV box adapter is included in the direct vent kits. The combustion air inlet area of the unit is located at the right rear corner of the unit. This unit uses a simple air filter to ensure clean air is used for the combustion process. Attach the DV box adapter over the air filter (see FIG. 2-11). Align screw holes on the DV box adapter with the screw holes surrounding the air filter hanger. Insert sheet metal screws and tighten firmly.

For venting versatility, you can move the air filter assembly and DV box adapter to the right side of the unit. Remove the metal panel on the unit's right side (see FIG. 2-12). Remove the filter/bracket assembly from the rear of the unit. Attach the filter/bracket assembly and DV box adapter to the right side opening using the pre-drilled screw holes. Make sure you attach the metal panel to the rear combustion air opening of the unit.

The DV box adapter has an air inlet pipe mounting ring. Connect combustion air inlet piping to the direct vent box mounting ring.

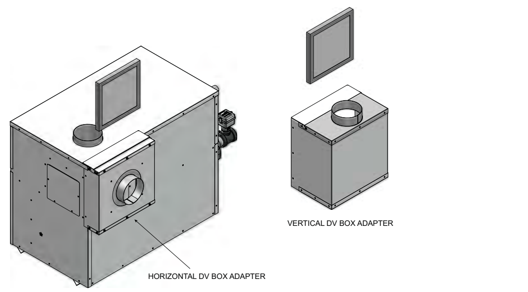


***Figure 2-11**_Attaching DV Box Adapter to Unit*

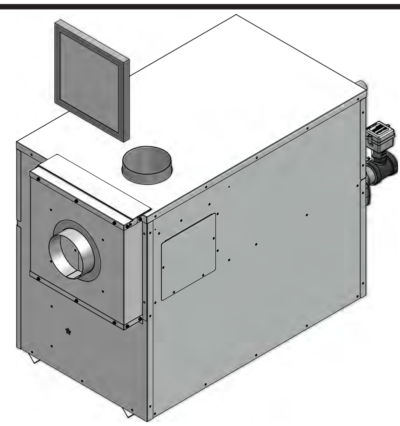


***Figure 2-12**_Moving Air Filter Assembly & DV Box Adapter*

Air inlet piping materials

The air inlet pipe(s) must be sealed. Select air inlet pipe material from the following specified materials.

- PVC, CPVC, or ABS*
- Dryer vent or sealed flexible duct (not recommended for rooftop air inlet)
- Galvanized steel vent pipe with joints and seams sealed as specified below
- Type-B double-wall vent with joints and seams sealed as specified below.

* Plastic pipe may require an adapter (not provided) to transition between the air inlet connection on the unit and the plastic air inlet pipe.

⚠ WARNING Use only vent or air intake materials specified in this manual. Follow vent pipe manufacturer's instructions. Failure to do so can result in property damage, personal injury, or death. Mixing of venting materials will void the warranty and certification of this unit.

Sealing Type-B double-wall vent pipe or galvanized vent pipe

Follow the steps below to properly seal Type-B double-wall vent pipe or galvanized vent pipe.

1. Seal all joints and seams of the air inlet pipe using either aluminum foil duct tape meeting UL Standard 723 or 181 A-P or a high quality UL Listed silicon sealant such as those manufactured by Dow Corning or General Electric.
2. On horizontal runs, do not install vent pipe with seams pointing down. Position vent pipe so that the seams are on the top side of the vent pipe.
3. Secure all joints with a minimum of three sheet metal screws or pop rivets. Apply aluminum foil duct tape or silicone sealant to all screws or rivets installed in the vent pipe.
4. Ensure that the air inlet pipes are properly supported.

Sealing PVC, CPVC, ABS, dryer vent, and flex duct vent pipe

1. Clean the PVC, CPVC, or ABS air inlet pipe using the pipe manufacturer's recommended solvents. Seal the pipe joints using standard commercial pipe cement.

2 Venting *(continued)*

2. For PVC, CPVC, ABS, dryer vent, or flex duct air inlet piping, use a silicone sealant to ensure a proper seal at the unit inlet and the air inlet cap.
3. For Dryer vent or flex duct, also use a screw-type clamp to attach the inlet vent material to the unit inlet and the air inlet cap. Properly sealing the air inlet pipe ensures that combustion air will be free of contaminates and supplied in proper volume.
4. Ensure that the air inlet pipes are properly supported.

⚠ WARNING Properly seal all joints and seams in the inlet vent piping system. Failure to do so may result in flue gas recirculation, spillage of flue products, and carbon monoxide emissions. Carbon monoxide poisoning can cause severe personal injury or death.

Vertical and sidewall combustion air inlet

NOTICE To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

⚠ WARNING Locate and install the combustion air inlet termination correctly. Failure to do so can allow the discharge of flue products to be drawn into the combustion process. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

You must locate the combustion air cap and the flue gas outlet on the same rooftop surface (vertical direct vent system) or sidewall surface (horizontal direct vent system) and in the same pressure zone as the vent termination. Follow all clearance requirements listed on this page.

Purchase and assemble the combustion air inlet cap to protect the air inlet from wind and weather.

Alternatively, assemble the combustion air inlet cap for vertical rooftop air inlet from items purchased locally. The air inlet cap consists of two 90° elbows installed to the air inlet pipe (see FIG. 2-13). Install the first 90° elbow on the rooftop at the highest vertical point of the air inlet pipe. Install the second 90° elbow on the horizontal outlet of the first elbow. The outlet of the second 90° elbow will be pointing down. You may use a 90° elbow and a 90° straight elbow to make this assembly. If you use a straight piece of pipe between the two 90° elbows, it should not exceed 6" (51mm) in length.

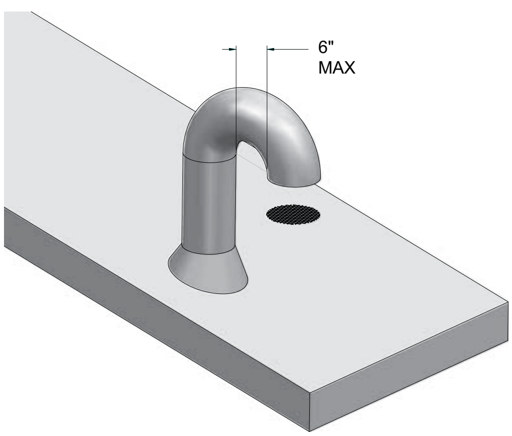


Figure 2-13*_Vertical Rooftop Air Inlet*

For horizontal direct vent termination of combustion air, you must use the termination cap from the appliance manufacturer. The sidewall air inlet cap is available as part of a direct vent kit. See Table 2E, page 27 for Horizontal Direct Vent Kits.

Vertical Combustion Air Inlet Clearances

You must locate the air inlet termination elbow at least 12" (30cm) above the roof or above normal snow levels.

If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (vent cap).

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Horizontal combustion air inlet clearances

You must locate the horizontal air inlet termination point at least 12" (30cm) above grade and above normal snow levels.

If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (vent cap). Do not install the horizontal combustion air inlet cap above the flue outlet.

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Multiple sidewall direct vent installations

You must locate the horizontal air inlet termination points at least 12" (30cm) above grade and above normal snow levels. The combustion air inlet caps for multiple appliance installations must maintain the same minimum clearance from the closest flue vent cap as specified in single appliance installations. You may install multiple flue outlet caps side-by-side and multiple combustion air inlet caps side-by-side, but the air inlet must always be at least 3 feet (0.91m) horizontally and 3 feet (0.91m) below the closest flue outlet. Do not install combustion air inlet caps above the flue outlets.

Maintain all clearances and installation requirements for multiple appliance installations.

2 Venting

F Outdoor installation - see page 14.

NOTICE Before installing a venting system, follow all requirements found in the General Venting section.

Units are self-venting and can be used outdoors when installed with the optional outdoor cap. This cap mounts directly to the top of the unit and covers the flue outlet and combustion air inlet openings. No additional vent piping is required.

⚠ WARNING Only install outdoor models outdoors and only use the vent cap supplied by the appliance manufacturer. Personal injury or product damage may result if any other cap is used or if an outdoor model is used indoors. Properly install all covers, doors and jacket panels to ensure proper operation and prevent a hazardous condition.

Combustion air supply must be free of contaminants (see Combustion and Ventilation Air, page 10). To prevent recirculation of the flue products into the combustion air inlet, follow all instructions in this section.

Outdoor vent/air inlet location

Keep venting areas free of obstructions. Keep area clean and free of combustible and flammable materials. Maintain a minimum clearance of 3" (76mm) to combustible surfaces and a minimum of 36" (915mm) clearance to the air inlet. To avoid a blocked air inlet or blocked flue condition, keep the outdoor cap air inlet, flue outlet and drain slot clear of snow, ice, leaves, debris, etc.

Do not install outdoor models directly on the ground. You must install the outdoor unit on a concrete, brick, block, or other non-combustible pad.

Do not locate unit so that high winds can deflect off of adjacent walls, buildings or shrubbery causing recirculation. Recirculation of flue products may cause operational problems, bad combustion or damage to controls. Locate unit at least 3 feet (0.91m) from any wall or vertical surface to prevent wind conditions from affecting performance.

Multiple unit outdoor installations require 48" (1.22m) clearance between each vent cap. Locate outdoor cap at least 48" (1.22m) below and 48" (1.22m) horizontally from any window, door, walkway or gravity air intake.

Locate unit at least 10 feet (3.05m) away from any forced air inlet.

Locate unit at least 3 feet (0.91m) outside any overhang.

Clearances around outdoor installations can change with time. Do not allow the growth of trees, shrubs or other plants to obstruct the proper operation of the outdoor vent system.

Do not install in locations where rain from building runoff drains will spill onto the unit.

Flue gas condensate can freeze on exterior walls or on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition. Some discoloration to exterior building or unit surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The outdoor vent cap kit

The optional outdoor vent cap kit is available from the appliance manufacturer. The outdoor cap part numbers are listed by model number. See Table 2F for kit numbers.

Install the outdoor vent cap on the rear of the unit. Complete installation instructions are included with the outdoor vent cap kit.

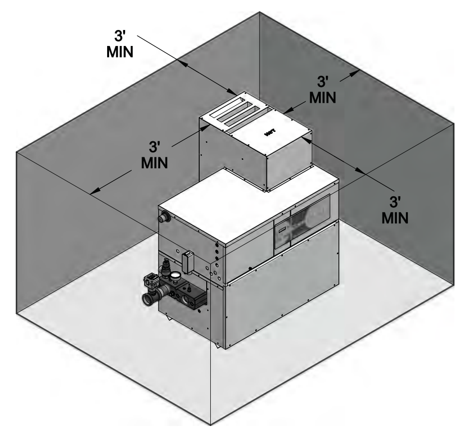


***Figure 2-14**_Outdoor vent cap installed*

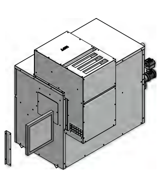


TABLE - 2F OUTDOOR VENT CAP KITS					
MODEL	KIT* WITHOUT PUMP COVER	KIT* WITH PUMP COVER	MODEL	KIT* WITHOUT PUMP COVER	KIT* WITH PUMP COVER
402	ODK3748	ODK3052	992	ODK3036	ODK3049
502	ODK3748	ODK3052	1262	ODK3064	ODK3065
652	ODK3749	ODK3053	1442	ODK3037	ODK3050
752	ODK3749	ODK3053	1802	ODK30002	ODK30001
--	--	--	2072	ODK30002	ODK30001

*These kits include an outdoor vent cap and gasket.

3 Gas connections

Connecting to gas supply

Verify that the appliance is supplied with the type of gas specified on the rating plate. This appliance is configured for operation up to 4,500 feet altitude. Consult factory for installations above 4,500 feet elevation.

Inlet gas pressure: Measured at the inlet pressure tap on the appliance gas manifold. The pressure tap is located upstream of the combination gas valve(s) (FIG. 3-3 on page 33).

See Table 3A for maximum and minimum inlet pressures. Do not exceed the maximum. Minimum inlet pressure is for the purpose of input adjustment.

TABLE 3A INLET GAS PRESSURE				
MODEL	NATURAL		LP	
	Max. w.c.	Min. w.c.	Max. w.c.	Min. w.c.
402 - 2072	14.0	4.5	14.0	8.0

Manifold pressure: The gas regulator on the unit's combination gas valve is adjustable to supply proper manifold pressure for normal operation. See the Copper-fin II Service Manual for net manifold pressure settings.

If you must adjust regulator pressure, follow the instructions under Gas Manifold Pressure Adjustment in the Copper-fin II Service Manual. Do not increase regulator pressure beyond specified pressure setting.

Gas pressure test

1. The appliance must be disconnected from the gas supply piping system during any pressure testing of that system at a test pressure in excess of 1/2 PSIG (3.5 kPa).

2. The appliance must be isolated from the gas supply piping system by closing a manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 PSIG (3.5 kPa).

3. The appliance and its gas connection must be leak tested before placing it in operation.

Gas piping

To safely operate this unit, you must properly size the gas supply piping. See Tables 3B through 3D for piping and fitting requirements. Gas pipe size may be larger than heater connection.

For ease of service, install a union.

Install a manual main gas shutoff valve, outside of the unit gas connection within six feet of the unit in accordance with the requirements of the National Fuel Gas Code, ANSI Z223.1.

You must provide a sediment trap (drip leg) in the inlet of the gas connection to the unit.

NOTICE It is the installer's responsibility to supply the sediment trap (drip leg).

CAUTION Do not block access to the electrical cover plate when installing the sediment trap. The sediment trap must be a minimum of 12 inches from the appliance.

The combination gas valves have an integral vent limiting device and do not require venting to atmosphere, outside the building. The unit will not operate properly if the reference hose is removed or a vent to atmosphere is installed.

Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.

Gas connection

All gas connections must be made with pipe joint compound resistant to the action of liquefied petroleum (L.P.) and natural gases. All piping must comply with local codes and ordinances. Piping installations must comply with approved standards and practices.

1. Make sure gas line is a separate line direct from the meter unless the existing gas line is of sufficient capacity. Verify pipe size with your gas supplier.

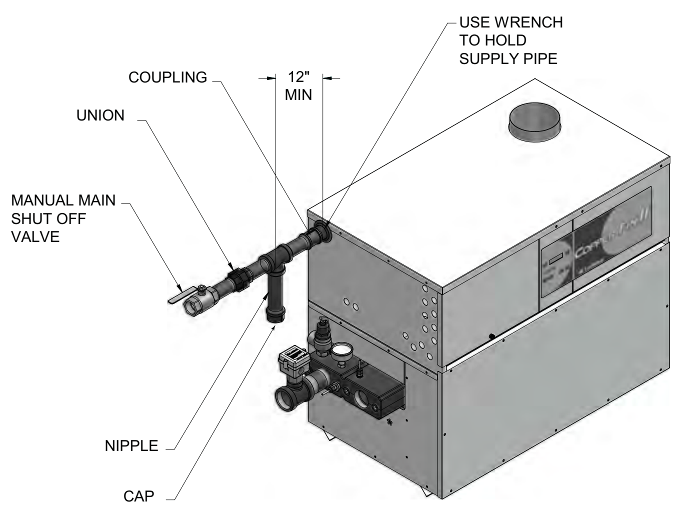


Figure 3-1_*Gas Line Connection*

NOTICE If an inline high gas pressure regulator is used, it MUST BE of the lockup type and be located a minimum of 10 feet from the appliance. Failure to do so may result in insufficient gas volume supplied to the appliance.

3 Gas connections

2. Use new, properly threaded black iron pipe free from chips. If you use tubing, make sure the ends are cut square, deburred and clean. Make all tubing bends smooth and without deformation. Avoid flexible gas connections. Internal diameter of flexible lines may not provide unit with proper volume of gas.
3. Install a manual main gas shutoff valve at the unit's gas inlet, outside of the unit.
4. Run pipe or tubing to the unit's gas inlet. If you use tubing, obtain a tube to pipe coupling to connect the tubing to the unit's gas inlet.
5. Install a sediment trap in the supply line to the unit's gas inlet (see FIG. 3-1).
6. Apply a moderate amount of good quality pipe compound (do not use Teflon tape) to pipe only, leaving two end threads bare.
7. Remove seal over gas inlet to unit.
8. Connect gas pipe to inlet of unit. Use wrench to support gas manifold on the unit.
9. For L.P. gas, consult your L.P. gas supplier for expert installation.
10. Ensure that all air is completely bled from the gas line before starting the ignition sequence. Start up without properly bleeding air from the gas line may require multiple reset functions of the ignition control module to achieve proper ignition.

⚠ WARNING Do not have any open flame in proximity to the gas line when bleeding air from the gas line. Gas may be present.

Gas train and controls

NOTICE The gas train and controls assembly provided on this unit have been tested under the applicable American National Standard to meet minimum safety and performance criteria such as safe lighting, combustion and safety shutdown operation.

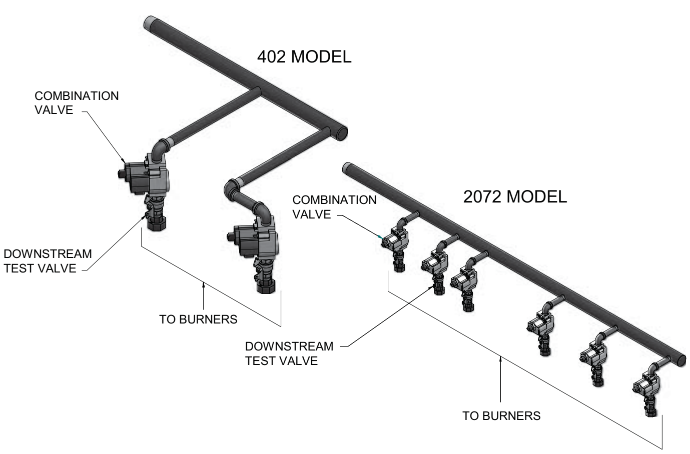


***Figure 3-2**_Typical Boiler Gas Train Drawing*

TABLE 3B
SUGGESTED GAS PIPE SIZE FOR SINGLE UNIT INSTALLATIONS

MODEL	Distance from Meter (in feet)				
	0 - 50	51 - 100	101-200	201-300	301-500
402	1 1/4"	1 1/4"	1 1/2"	2"	2"
502	1 1/4"	1 1/2"	2"	2"	2 1/2"
652	1 1/2"	2"	2"	2 1/2"	2 1/2"
752	1 1/2"	2"	2"	2 1/2"	3"
992	2"	2"	2 1/2"	2 1/2"	3"
1262	2"	2 1/2"	2 1/2"	3"	3"
1442	2 1/2"	2 1/2"	3"	3"	3 1/2"
1802	2 1/2"	3"	3"	3 1/2"	3 1/2"
2072	2 1/2"	3"	3"	3 1/2"	4"

For each elbow or tee, add equivalent straight pipe to total length from Table 3C.

TABLE - 3C
FITTINGS TO EQUIVALENT STRAIGHT PIPE

Diameter Pipe (inches)	3/4	1	1 1/4	1 1/2	2	3	4	5
Equivalent length of Straight Pipe (feet)	2	2	3	4	5	10	14	20

Water heater models do not have downstream test valves, but the rest of the gas train is represented by FIG. 3-2.

Combination gas valves

These units fire in multiple stages of burner input. Each stage of burner operation has a combination gas valve(s) to cycle the gas supply on and off and regulate gas to the burners. Each combination valve consists of a gas regulator and two valve seats to meet the requirements for redundant gas valves. The valve has a gas control knob that must remain in the open position at all times when the unit is in service. The gas control valve has pressure taps located on the inlet and discharge sides of the valve. Manifold pressure is adjusted using the regulator located on the valve. A manifold gas pressure tap for each burner stick is located on the discharge side of the valve.

The manifold pressure is preset at the factory and adjustment is not usually required. If you must adjust regulator pressure, follow the instructions in the Copper-fin II Service Manual.

Venting of combination gas valves

The combination gas valve/regulator used on all units is equipped with an integral vent limiting orifice per ANSI Z21.78. The vent limiter ensures that the volume of gas emitted from the valve in the event of a failed gas diaphragm does not exceed the maximum safe leakage rate allowed by agency requirements.

3 Gas connections *(continued)*

Combination gas valve/regulators equipped with integral vent limiters are not required to have vent or relief lines piped to the outdoors. The termination of the vent limited opening on the combination gas valve/regulator complies with the safety code requirements of CSD-1, CF-190(a) as shipped from the appliance manufacturer without the installation of additional vent lines.

Checking gas supply pressure

Use the following procedure to check gas supply pressure.

1. Turn the main power switch to the "OFF" position.
2. Turn gas valve knobs to the "OFF" position.
3. Shut off gas supply at the field-installed manual gas cock in the gas piping to the unit. If fuel supply is L.P. gas, shut off gas supply at the tank.
4. Remove the 1/8" hex plug, located on the "inlet" side of the gas valve. You may also use a tapping on the field-installed main manual gas cock or gas piping. Install a fitting in the inlet pressure tapping suitable to connect to a manometer or magnehelic gauge. Range of scale should be 14" w.c. or greater to check inlet pressure.
5. Turn on gas supply at the manual gas cock, turn on L.P. gas at the tank if required.
6. Turn the power switch to the "ON" position.
7. Turn the gas valve knobs to the "ON" position. Set the electronic temperature control or thermostat to call for heat.
8. Observe the gas supply pressure as all burners are firing. Ensure that inlet pressure is within the specified range. See Connecting To Gas Supply, page 31 for minimum and maximum gas supply pressures.
9. If gas pressure is out of range, contact gas utility, gas supplier, qualified installer or service agency to determine necessary steps to provide proper gas pressure to the control.
10. If gas supply pressure is within normal range, turn the power switch to the "OFF" position.
11. Turn gas valve knobs to the "OFF" position.
12. Shut off gas supply at the manual gas cock in the gas piping to the unit. If fuel supply is L.P. gas, shut off gas supply at the tank.
13. Remove the manometer and related fitting from the "inlet" side of the gas valve, replace 1/8" hex plug in gas valve and tighten.
14. Turn on gas supply at the manual valve, turn on L.P. gas at the tank if required.
15. Turn the power switch to the "ON" position.
16. Turn the gas valve knob to the "ON" position.
17. Set the electronic temperature control or thermostat to call for heat.

⚠ WARNING After completing any testing on the gas system, leak test all gas connections. Apply a soap/water solution to all gas connections while main burners are operating. Bubbles forming indicate a leak. Repair all leaks at once. Do not operate this unit with a leak in the gas train, valves or related piping.

Check burner performance by cycling the system while you observe burner response. Burners should ignite promptly. Flame pattern should be stable, see Burner Flames in the Copper-fin II Service Manual. Turn system off and allow burners to cool, then cycle burners again to ensure proper ignition and flame characteristics.

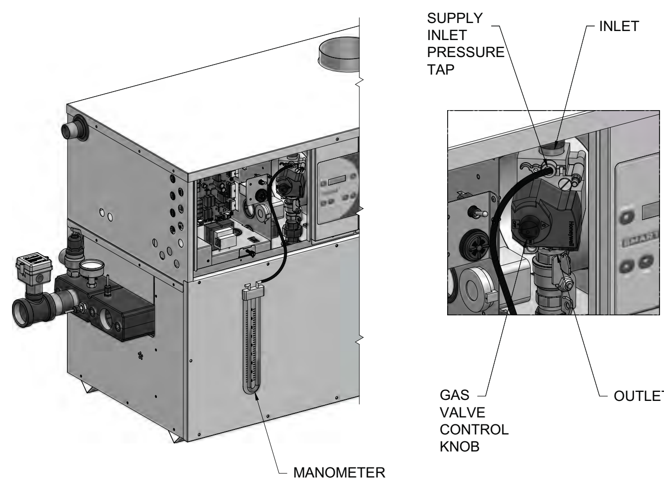


***Figure 3-3**_Measuring Gas Supply Pressure at Combination Gas Valve*

TABLE - 3D
Capacity of Schedule 40 Metallic Pipe in Cubic Feet of Natural Gas Per Hour
(based on .60 specific gravity, 0.30" w.c. pressure drop)

Pipe Size (Inches)	Length of Pipe in Straight Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2	131	90	72	62	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/4	273	188	151	129	114	104	95	89	83	79	70	63	58	N/A
1	514	353	284	243	215	195	179	167	157	148	131	119	109	102
1 1/4	1,060	726	583	499	442	400	368	343	322	304	269	244	224	209
1 1/2	1,580	1,090	873	747	662	600	552	514	482	455	403	366	336	313
2	3,050	2,090	1,680	1,440	1,280	1,160	1,060	989	928	877	777	704	648	602
2 1/2	4,860	3,340	2,680	2,290	2,030	1,840	1,690	1,580	1,480	1,400	1,240	1,120	1,030	960
3	8,580	5,900	4,740	4,050	3,590	3,260	3,000	2,790	2,610	2,470	2,190	1,980	1,820	1,700
4	17,500	12,000	9,660	8,270	7,330	6,640	6,110	5,680	5,330	5,040	4,460	4,050	3,720	3,460

4 Water connections

Inlet and outlet connections

For ease of service, install unions on the water inlet and water outlet of the unit. The connection to the unit marked “Inlet” on the header should be used for return from the system. The connection on the header marked “Outlet” is to be connected to the supply side of the system.

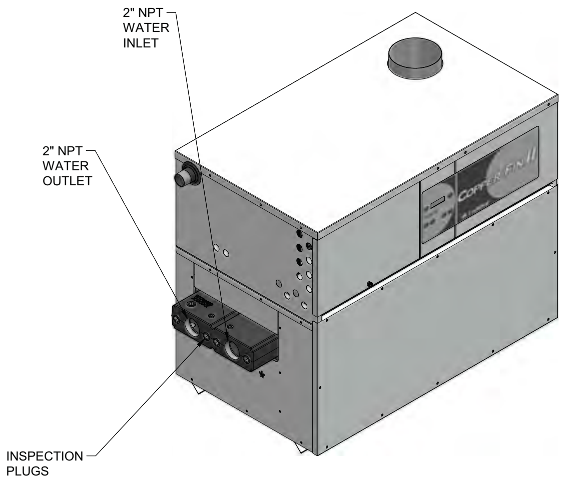


***Figure 4-1**_Water Connections - Models 402 - 752*

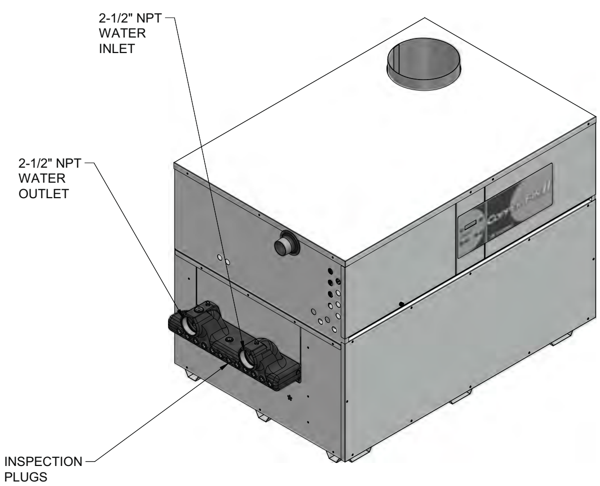


***Figure 4-2**_Water Connections - Models 992 - 2072*

Heat exchanger

This appliance uses a finned copper tube heat exchanger to maximize the heat transfer process. The heat exchanger is mounted in the inner jacket of the appliance. A series of “V” shaped baffles are installed between the individual tubes to control the movement of the flue products over the finned copper surface and increase heat transfer. Water enters the heat exchanger and makes two passes over the area exposed to direct heat from the burner. A circulating pump MUST be installed to ensure proper water flow over the heat transfer surfaces during burner operation. Water temperatures in the heat exchanger are determined by water flow.

Initial set-up of maximum water flow

On initial start-up of the Copper-fin II, the maximum water flow to the heat exchanger must be checked and manually limited with a valve or bypass before normal operation begins.

⚠ CAUTION An appliance allowed to operate at return temperatures below the specified minimum setting may experience problems with the operating controls, safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion and possible flue gas spillage. Sustained operation at lower than specified water temperatures (140°F) may cause hazardous conditions that may result in personal injury or non-warrantable damage to the appliance.

Water flow switch

A water flow switch is factory installed in the outlet on all heating boilers and water heaters. The flow switch must prove water flow before a trial for ignition can begin. The flow switch requires a minimum flow of 15 - 18 GPM on Models 402 - 752 and 26 GPM on Models 992 - 2072 to make the flow switch and start burner operation. A water flow switch meets most code requirements for a low water cutoff device on boilers requiring forced circulation for operation. A fault message, **Flow Sw/LWCO** will be indicated in the Operator Interface on a low water flow condition as sensed by the flow switch.

Low water cutoff (if equipped)

If this boiler is installed above radiation level, a low water cutoff device must be installed at the time of boiler installation. An electronic low water cutoff is available as a factory supplied option on all models. The low water cutoff should be inspected every 6 months. A fault message, **Flow Sw/LWCO** will be indicated in the Operator Interface on a low water condition as sensed by the low water cutoff.

4 Water connections *(continued)*

Relief valve

This unit is supplied with a relief valve(s) sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV ("Heating Boilers"). The relief valve(s) is installed in the vertical position and mounted in the hot water outlet. No valve is to be placed between the relief valve and the unit. To prevent water damage, the discharge from the relief valve shall be piped to a suitable floor drain for disposal when relief occurs. No reducing couplings or other restrictions shall be installed in the discharge line. The discharge line shall allow complete drainage of the valve and line. Relief valves should be manually operated at least once a year.

⚠ CAUTION Avoid contact with hot discharge water.

Heating boiler installations

Piping of the boiler system

The drawings in this section show typical boiler piping installations, see FIG.'s 4-3 through 4-6. Before beginning the installation, consult local codes for specific plumbing requirements. The installation should provide unions and valves at the inlet and outlet of the boiler so it can be isolated for service. An air separation device must be supplied in the installation piping to eliminate trapped air in the system. Locate a system air vent at the highest point in the system. The system must also have a properly sized expansion tank installed. Typically, an air charged diaphragm-type expansion tank is used. The expansion tank must be installed close to the boiler and on the suction side of the system pump to ensure proper operation.

⚠ CAUTION The boiler system should not be operated at less than 12 PSIG.

Hot water piping must be supported by suitable hangers or floor stands, **NOT** by the boiler. Copper pipe systems will be subject to considerable expansion and contraction. Rigid pipe hangers could allow the pipe to slide in the hanger resulting in noise transmitted into the system. Padding is recommended on rigid hangers installed with a copper system. The boiler pressure relief valve must be piped to a suitable floor drain. See the *Relief Valve* section on this page.

⚠ CAUTION A leak in a boiler "system" will cause the "system" to intake fresh water constantly, which will cause the tubes to accumulate a lime/scale build up. This will cause a non-warrantable failure.

Water connections (heating boilers only)

Models 402 - 752 have 2" NPT inlet and outlet connections and Models 992 - 2072 have 2 1/2" NPT inlet and outlet connections.

⚠ CAUTION Field installed reducing bushings must not be used.

Any reduction in pipe size may decrease flow resulting in high water temperatures, boiler noise, flashing to steam, and non-warrantable heat exchanger damage.

The boiler may be installed with a primary/secondary piping system provided to the boiler. It is important to guarantee that adequate flow is provided to properly dissipate heat from the boiler and also ensure that flow through the boiler does not exceed the maximum recommended flow rate of 55 GPM for Models 402 - 752 and 90 GPM for Models 992 - 2072 for a boiler equipped with a copper heat exchanger.

Boiler circulator requirements

This is a low mass, high efficiency hot water boiler which must have adequate flow for quiet, efficient operation. Pump selection is critical to achieve proper operation. A pump should be selected to achieve proper system design water temperature rise. Pipe diameter and length are critical to ensure proper flow through the boiler. A System Temperature Rise Chart (Table 4C on page 38) is provided to assist in proper pump selection. This table provides GPM and boiler head-loss at various temperature rises for each model based on Btu/hr input. Temperature rise is the difference in boiler inlet temperature and boiler outlet temperature while the boiler is firing at full rate.

Example: The boiler inlet temperature is 160°F (71.1°C) and the boiler outlet temperature is 180°F (82.2°C). This means that there is a 20°F (11.1°C) temperature rise across the boiler. The boiler temperature rise is visible in the Operator Interface on the boiler's front control panel.

Circulator pump specifications

1. Maximum operating pressure for the pump must exceed system operating pressure.
2. Maximum water temperature should not exceed the nameplate rating.
3. Cast iron circulators may be used for closed loop systems.
4. A properly sized expansion tank must be installed near the boiler and on the suction side of the pump.

Circulator pump operation (heating boilers only)

The boiler pump must run when the boiler is firing. Separate supply circuits can be provided or the two circuits (pump and controls) can be combined for connection to one circuit, properly sized for both.

Pump delay operation

A pump delay operation feature is provided. The boiler's circulating pump will cycle on at each call for heat, before the burner fires. The pump will continue to operate while the burner is firing. The pump will run for a 30 second period after the temperature set point is satisfied. This timing is selectable from the Operator Interface. This timing will remove any of the residual heat from the combustion chamber before turning the pump off. See the wiring diagram in Section 9 of this manual.

4 Water connections

Pump Maintenance: Inspect the pump every six (6) months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by the pump manufacturer.

The boiler is recommended for installation in a primary/ secondary piping system. This type of system uses a separate boiler circulating pump to supply flow to and from the boiler only. The secondary pump is sized based on the head loss of the boiler and related pipe and fittings in the secondary loop only.

A properly sized primary system pump provides adequate flow to carry the heated boiler water to radiation, air over coils, etc. The fittings that connect the boiler to the primary system should be installed a maximum of 12 inches (0.30m) (or 4 pipe diameters) apart to ensure connection at a point of zero pressure drop in the primary system. There should be a minimum of 10 pipe diameters of straight pipe before and after the boiler secondary loop connections to prevent turbulent flow at the secondary loop connections. The secondary loop piping to and from the boiler must have a fully ported ball valve installed in both the supply and return side piping. The ball valves must be fully ported having the same inside diameter as the installed piping. The ball valve in the piping supplying water to the boiler will only be used as a service valve. The ball valve installed in the discharge from the boiler back to the primary system will be used to adjust boiler flow and temperature rise to ensure proper performance.

The boiler primary piping system must have a circulator installed in the main system loop to carry the heated boiler water to the point of use in the main system.

Multiple boilers may also be installed with a primary/secondary manifold system. Multiple boilers should be connected to the common manifold in reverse return to assist in balancing flow to multiple boilers.

The installer must ensure that the boiler has adequate flow without excessive temperature rise. Low system flow can result in overheating of the boiler water which can cause short burner cycles, system noise, relief valve discharge and in extreme cases, a knocking flash to steam. These conditions indicate the need to increase boiler flow to and from the boiler. This is generally accomplished by either increasing the size of the boiler pump or by increasing the diameter of the piping that connects the boiler to the primary system. A larger diameter pipe reduces head loss and increases flow.

⚠ CAUTION At no time should the system pressure be less than 12 PSIG.

Minimum boiler water temperatures

Inlet water temperatures below the specified minimum of 140°F (60°C) can excessively cool the products of combustion resulting in condensation on the heat exchanger. Condensation on the heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components. See the Low Temperature Bypass Requirements section for boiler system applications below the minimum specified temperature.

Low Temperature Return Water Systems

Any non-condensing boiler will develop operational problems when exposed to inlet water temperatures below 140°F. Lochinvar offers a low temperature protection valve (LTV) that is factory preset to maintain 140°F inlet water to the boiler regardless of the system return water temperature. See Table 4A for available valve kits.

TABLE 4A
LTV VALVE KITS

MODEL	LTV VALVE KIT
402 - 752	VAL3048
992 - 2072	VAL3047

Low temperature bypass requirements

To prevent condensation problems, a boiler MUST NOT be operated (other than for brief periods during initial system startup) with an inlet water temperature of less than 140°F (60°C). If normal system return temperatures are less than the required 140°F (60°C) boiler inlet requirement, a method of low return water temperature protection **MUST BE** provided to protect the boiler.

For Example: *Night Setback* of the system loop water temperature, *Night Shutdown* and *Weekend Shutdown* of the entire boiler / heating system, and Indoor / Outdoor Air Reset of the system loop water temperature. If any of these control functions are being utilized, some type of low return water protection **MUST BE** provided.

If the boiler heating system will be used on a Water Source Heat Pump System, Radiant Floor Heating System, Snow Melting Heating System, etc., some type of low return water protection must be provided.

Condensation can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the vent system and related components.

To prevent system return water temperature below 140°F (60°C) from entering the boiler inlet, an electrically actuated 3-way mixing valve (VAL30002) is available, consult manufacturer for kit availability (see FIG. 4-5 on page 41). By using this valve, the SMART SYSTEM control will bypass outlet water back into the inlet of the boiler to maintain the inlet temperature above 140°F (60°C).

A fast acting, self contained mixing valve, set to 140°F (60°C), may also be used. The installation of this valve must be done as shown in FIG. 4-5. This arrangement will maintain the required flow through the boiler.

4 Water connections *(continued)*

When a mixing valve is used, an optional system return sensor should be installed into the system return piping. This will allow the display of the actual system return temperature, and will also allow control of the system return temperature when the SMART SYSTEM control is programmed for inlet temperature control. As always, installation of the system supply sensor is strongly recommended as well. This will reduce the potential for short cycling of the boiler, and provide more responsive temperature regulation, even when the SMART SYSTEM control is programmed for inlet temperature control.

⚠ CAUTION A boiler allowed to operate at set point temperatures below the specified minimum settings may experience operational problems with the operating controls and safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion and possible flue gas spillage. Operation at lower than specified water temperatures may cause hazardous conditions that result in non-warrantable damage to the appliance.

Three way valves in system

The installation of a three way valve on this boiler is not generally recommended because most piping methods allow the three way valve to vary flow to the boiler. This boiler is a low mass, high efficiency appliance which **requires a constant water flow rate for proper operation.** Low flow rates can result in overheating of the boiler water which can cause short burner cycles, system noise, relief valve discharge and in extreme cases, a knocking flash to steam. These conditions can cause operational problems and non-warrantable failures of the boiler.

Radiant floor and snow melt heating systems

This type of heating boiler application operates in a low temperature range which requires a boiler bypass as described under the Low Temperature Bypass Requirements section. A non-metallic rubber or plastic tubing installed in a radiant (in floor) system must have an oxygen barrier to prevent oxygen from entering the system through the walls of the installed tubing. Excessive oxygen absorption into the system will result in an accelerated rate of corrosion causing a sludge buildup. This excessive corrosion will also damage the boiler and system components. Sludge formed as the result of excessive oxygen in the system can restrict water flow resulting in a premature boiler failure. Any boiler damage due to excessive oxygenation is non-warrantable.

TABLE - 4B
MAXIMUM FLOW FOR HEATING BOILER

The maximum flow rate through the boiler with a copper heat exchanger must not exceed the following:

Model	Maximum Flow
402, 502, 652, and 752	55 GPM
992, 1262, 1442, 1802, and 2072	90 GPM

If higher flow rates are required through the boiler, an optional Cupro-Nickel heat exchanger is available. Consult the factory for specific application requirements.

Low system water volume

System run time is very important to the overall operating efficiency of the boiler. Short cycling of the boiler creates problems with condensation in the vent stack, condensation on the heat exchanger, system temperature spikes, and mechanical component failures. To prevent short cycling of the boiler, it is important to limit the boiler cycles to six or fewer per hour.

A buffer tank is an effective way to enhance a small system load and increase heating system efficiency (see FIG. 4-6 on page 42 of this manual). Buffer tanks add water volume to the system and act as a flywheel to absorb the additional Btu's provided by the boiler when only a single zone of a large system is calling for heat.

To calculate the proper buffer tank size for a multiple zone system:

$$\frac{\textbf{(Run Cycle) (Output - Minimum System Load)}}{\textbf{(Temp. Rise) (8.33) (60 Min.)}}$$

CFN2072

Min. Load = 100,000 Btu/Hr

Min. Boiler Output = 850,000 Btu/Hr

Cycle Time = 10 Min

Temp. Rise = 38

(10)(850,000 – 100,000) / (38)(8.33)(60) = 395 Gallons

4 Water connections

TABLE - 4C
SYSTEM TEMPERATURE RISE CHART
Temperature Rise and Head Loss Based on Boiler Output in Btu/hr

Btu/hr		30°F ΔT		35°F ΔT		40°F ΔT		45°F ΔT		50°F ΔT		55°F ΔT		60°F ΔT	
Input	Output	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd
399,999	339,999	23	1.1	19	0.7	--	--	--	--	--	--	--	--	--	--
500,000	425,000	28	1.6	24	1.2	21	0.7	19	0.7	--	--	--	--	--	--
650,000	552,500	37	3.0	31	2.2	28	1.6	24	1.2	22	0.9	20	0.7	18	0.6
750,000	637,500	42	4.1	36	2.8	32	2.3	28	1.6	25	1.3	23	1.1	21	0.7
990,000	841,500	55	2.6	48	2.3	42	1.5	37	1.4	33	1.0	30	0.9	28	0.9
1,260,000	1,071,000	71	4.4	61	3.6	53	2.7	48	2.3	42	1.7	39	1.5	35	1.2
1,440,000	1,224,000	81	6.3	70	5.0	61	3.8	54	2.7	48	2.3	44	2.0	40	1.8
1,800,000	1,530,000	102*	11.8	87	9.0	76	6.6	68	5.6	61	4.4	55	2.6	50	3.0
2,070,000	1,759,500	--	--	100*	10.1	87	9.0	78	7.6	70	6.2	64	5.4	58	4.6

*Cupro-Nickel Heat Exchanger Required at Flows Above 55 GPM on Models 402 - 752 and above 90 GPM on Models 992 - 2072.

TABLE - 4D
BOILER TEMPERATURE RISE AT MAXIMUM FLOW
Temperature Rise at Full Rate Fire, 55 and 90 GPM Maximum Flow

Model	Temperature Rise °F
402	12 @ 55 GPM
502	15 @ 55 GPM
652	20 @ 55 GPM
752	23 @ 55 GPM
992	19 @ 90 GPM
1262	24 @ 90 GPM
1442	27 @ 90 GPM
1802	34 @ 90 GPM
2072	39 @ 90 GPM

Boiler bypass requirements

The installer must ensure that the boiler is supplied with adequate flow without excessive temperature rise. It is recommended that this boiler be installed with a bypass in the piping if the maximum recommended flow rate is exceeded. The bypass will help to ensure that the boiler can be supplied with adequate water flow. Flow rates exceeding the maximum recommended flow will result in erosion of the boiler tubes. A typical bypass with a valve as shown in FIG. 4-5 will allow control of boiler flow.

Temperature / pressure gauge

This boiler is equipped with a dial type temperature / pressure gauge. This gauge is factory installed in the outlet side of the boiler piping. The gauge has one scale to read system pressure and a separate scale to read water temperature in degrees Fahrenheit. The temperature / pressure gauge is provided to meet code requirements. Water temperatures can be more accurately monitored from the data provided in the digital display in the Operator Interface.

Typical heating boiler installations

General plumbing rules:

1. Check all local codes.
2. For serviceability of boiler, always install unions.
3. Always pipe pressure relief valve to an open drain.
4. Locate system air vents at highest point of system.
5. Expansion tank must be installed near the boiler and on the suction side of the system pump.
6. Support all water piping.

Installation with a chilled water system

Pipe refrigeration systems in parallel. Install duct coil downstream at cooling coil. Where the hot water heating boiler is connected to a heating coil located in the air handling units which may be exposed to refrigeration air circulation, the boiler piping system must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

The coil must be vented at the high point and hot water from the boiler must enter the coil at this point. Due to the fast heating capacity of the boiler, it is not necessary to provide a ductstat to delay circulator operation. Also, omit thermostat flow checks as the boiler is cold when heating thermostat is satisfied. This provides greater economy over maintaining standby heat.

DHW installation

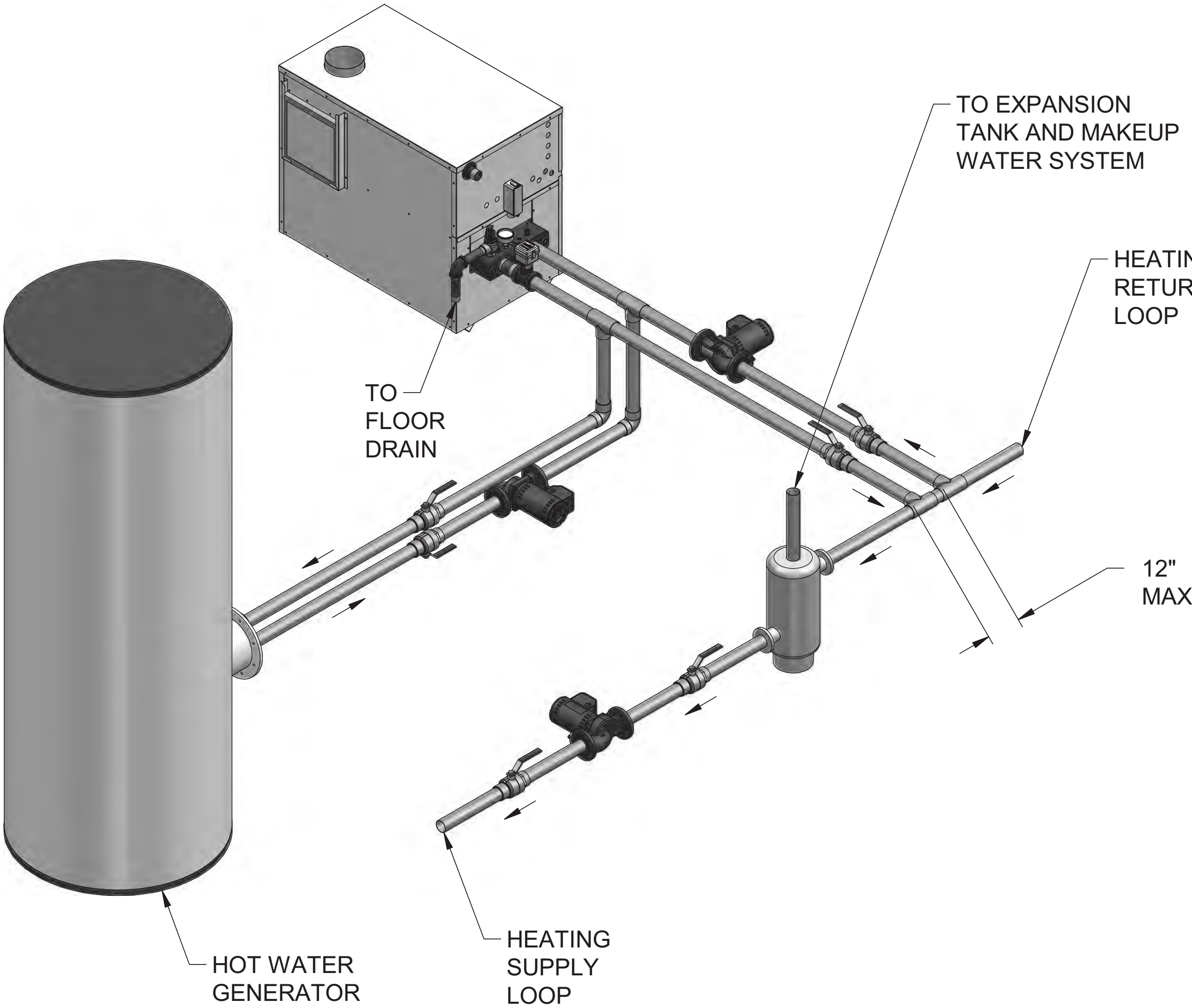
Boilers may be utilized with a Hot Water Generator tank for domestic hot water. When used for DHW, either a tank thermostat or sensor must be installed in a bulbwell within the tank and connected back to the unit in order for the controller to regulate water temperature and a pump for DHW. Pumps used for DHW purposes should be sized to provide adequate flow to the boiler when in DHW Mode. Reference FIG. 4-3 shown with a Hot Water Generator for DHW on page 39 for a typical DHW piping scheme.

4 Water connections *(continued)*

***Figure 4-3**_Primary/Secondary Piping of a Single Boiler w/DHW*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
1	55	2

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2



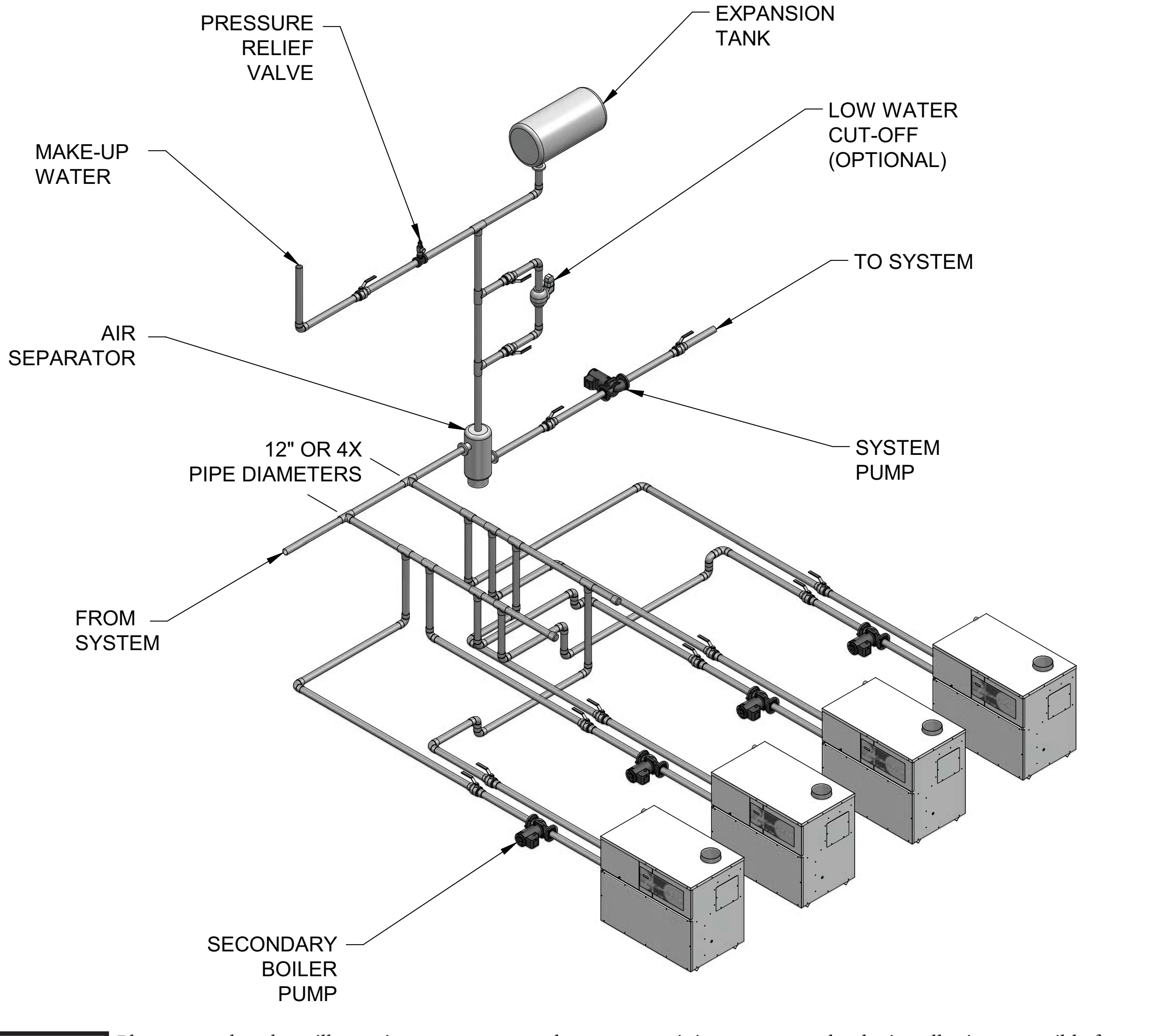
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

4 Water connections

***Figure 4-4**_Primary/Secondary Piping of Multiple Boilers*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
2	110	3
3	165	3 1/2
4	220	4
5	275	5
6	330	5
7	385	6
8	440	6

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	8
8	720	8



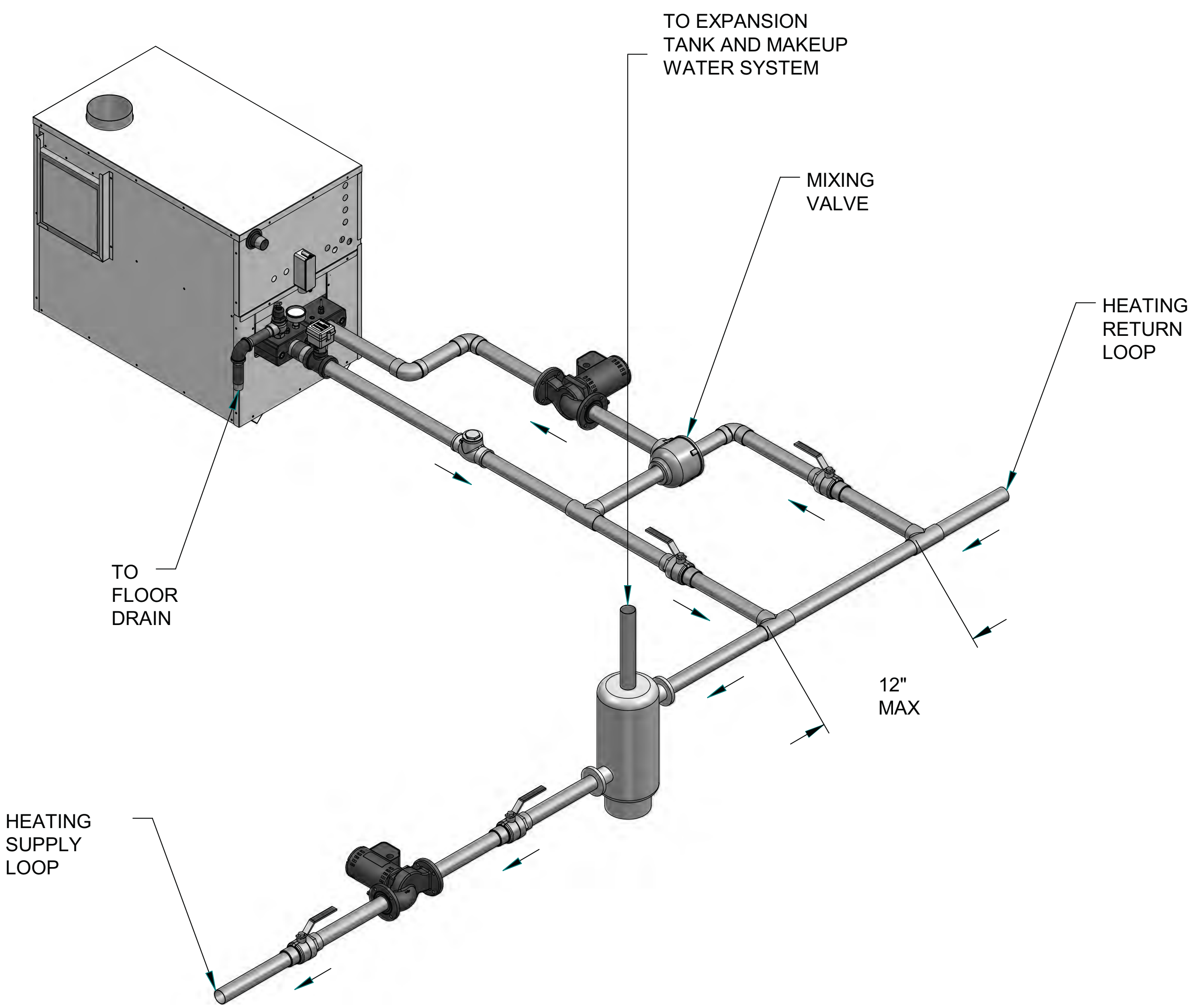
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

4 Water connections *(continued)*

***Figure 4-5**_Boiler with Low Temperature Bypass Piping - Using a Low Temperature Valve Required for Systems Operating at less than 140°F (60°C) Return Water Temperatures from the Heating Return Loop*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
1	55	2

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2



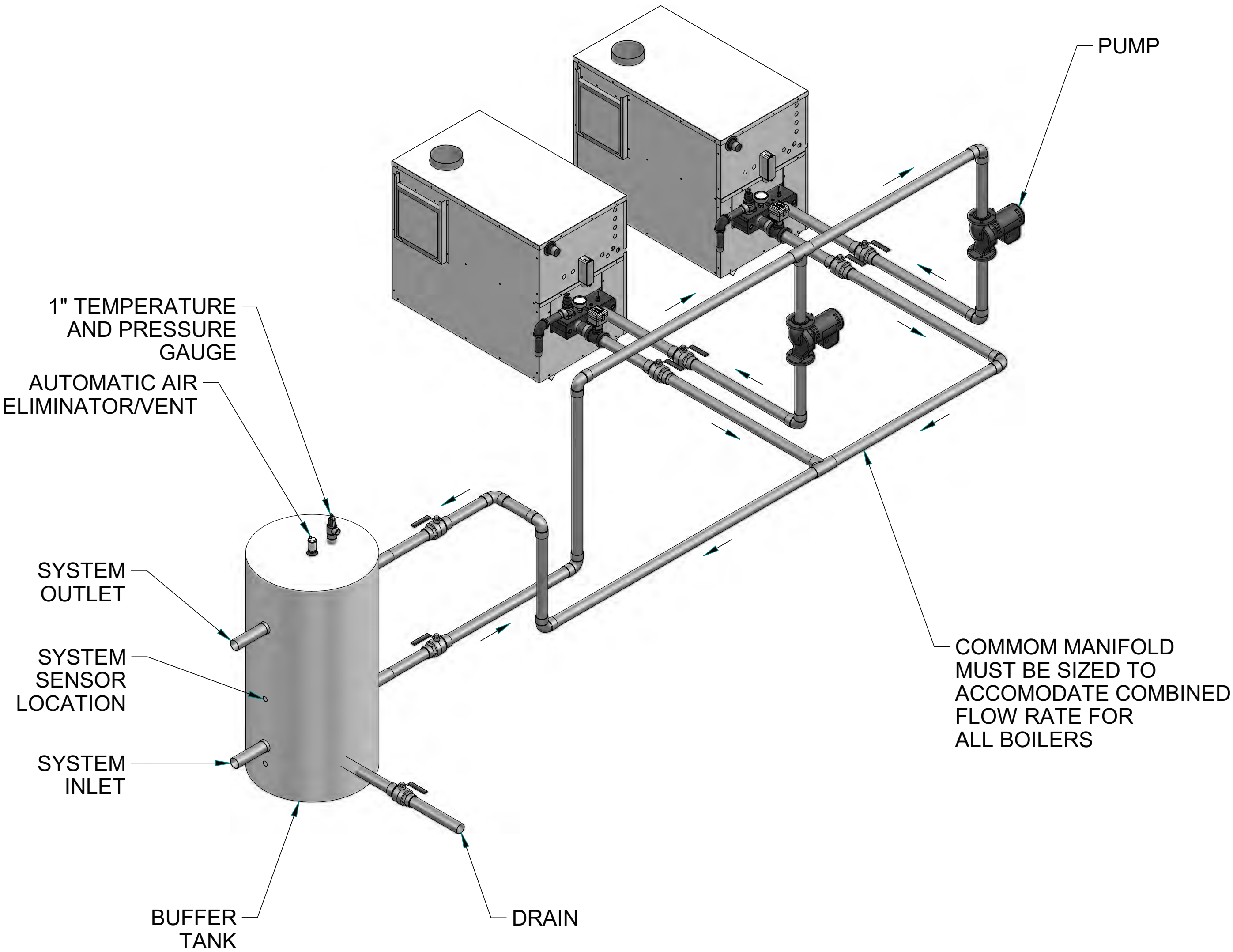
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

4 Water connections

Figure 4-6_Primary/Secondary Piping with Buffer Tank

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
2	110	3
3	165	3 1/2
4	220	4
5	275	5
6	330	5
7	385	6
8	440	6

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	8
8	720	8



NOTICE

The Inlet/Outlet System tappings are shown in the optional location on the side of the tank for pictorial purposes. The standard location for the system tappings is 180° from the recirculation tappings.

NOTICE

Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

5 Electrical connections

Boiler operating control module

The operating control for the appliance is the SMART SYSTEM control module. It is located on the inside of the control panel, behind the front access door. Access to adjust the temperature set point and other user adjustable points is made through the Operator Interface located on the front access door. The outlet sensor is installed in the outlet side of the heat exchanger top header. The inlet sensor is located on the inlet side of the heat exchanger top header.

The operating sensor, inlet or outlet, is selectable from the screen in the Operator Interface.

The exact temperature set point is based on the system's requirements. Set the control set point(s) to the desired operating water temperature.

The maximum temperature set point that can be programmed into the control module from the Operator Interface on a heating boiler is 220°F (104.4°C). The manual reset high limit control for a heating boiler is adjustable up to a fixed maximum setting of 230°F (110°C).

The maximum temperature set point for a water heater is 190°F (88°C). The auto reset high limit is fixed at 200°F (93°C), and the adjustable manual reset high limit has a maximum setting of 230°F (110°C).

A 120 VAC, 15 Amp, 1 ph, 60 Hz circuit is required for operation of the appliance controls.

The appliance, when installed, must be electrically grounded in accordance with the requirements of the authority having jurisdiction or in the absence of such requirements, with the latest edition of the National Electrical Code ANSI/NFPA No. 70. When the unit is installed in Canada, it must conform to the CAE C22.1, Canadian Electrical Code, Part I and/or local Electrical Codes. Multiple units connected in a Cascade must be grounded to the same ground connection.

1. All wiring between the appliance and field installed devices shall be made with type T wire [63°F (35°C) rise].
2. All line voltage wire exterior to the appliance must be enclosed in approved conduit or approved metal clad cable.
3. The circulating pump must run continuously when the appliance is being fired.
4. To avoid serious damage, DO NOT energize the appliance until the system is full of water. Ensure that all air is removed from the heat exchanger and piping before beginning initial operation. Serious damage may result if the appliance is operated without proper flow.
5. Provide the appliance with proper overload protection.

TABLE - 5A
AMP DRAW DATA

Model	Controls	Blower	Pump FLA*	Approximate Total Amps @ 120 VAC
402	3.6	2.7	5.8	12.1
502	3.6	2.7	5.8	12.1
652	5.4	3.4	5.8	14.6
752	5.4	3.4	5.8	14.6
992	7.3	3.2	7.4	17.9
1262	7.3	3.2	7.4	17.9
1442	7.3	6.7	7.4	21.4
1802	7.3	6.7	7.4	21.4
2072	7.3	6.7	7.4	21.4

*Standard Pump Supplied with Water Heaters Only

⚠ WARNING ELECTRICAL SHOCK HAZARD – For your safety, turn off electrical power supply before making any electrical connections to avoid possible electric shock hazard. Failure to do so can cause severe personal injury or death.

NOTICE Wiring must be N.E.C. Class 1.

If original wiring as supplied with the boiler must be replaced, use only type 105°C wire or equivalent.

Boiler must be electrically grounded as required by National Electrical Code ANSI/NFPA 70 – latest edition.

⚠ CAUTION Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.

Installation must comply with:

1. National Electrical Code and any other national, state, provincial, local codes, or regulations.
2. In Canada, CSA C22.1 Canadian Electrical Code Part 1, and any local codes.

5 Electrical connections

Line voltage connections

1. Connect 120 VAC power wiring to the line voltage terminal strip in the junction box, as shown in FIG. 5-1.
2. Provide and install a fused disconnect or service switch (15 AMP recommended) as required by the code (see FIG. 5-1).
3. To activate a system pump, wire as shown in FIG. 5-1. If the motor is larger than 1 HP, you must install a contactor.
4. When connecting power to units which are to be cascaded, each unit must be connected to the same ground connection.

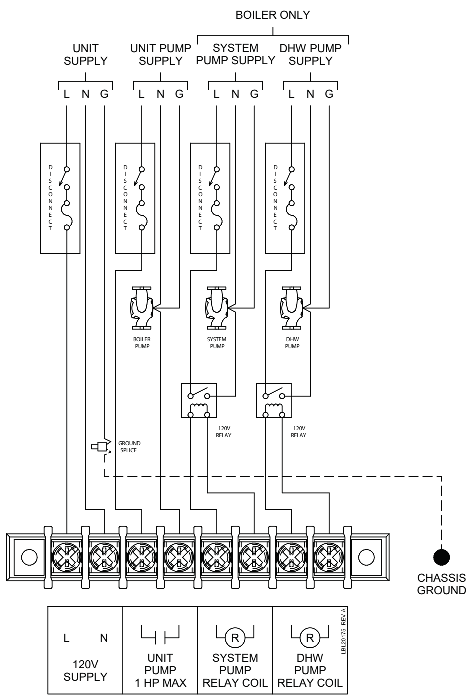


Figure 5-1_*Line Voltage Field Wiring Connections*

Low voltage connections

1. Route all low voltage wires through the knockouts on the left side of the heater, as shown in FIG. 5-2.
2. Connect low voltage wiring to the low voltage connection board as shown in FIG. 5-4 on page 46 of this manual and the heater wiring diagram.

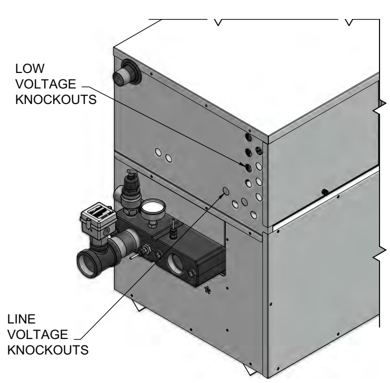


Figure 5-2_*Routing Field Wiring*

EMS or remote thermostat connection

An EMS, remote thermostat or other remote temperature control may be connected to the boiler (see FIG. 5-3). Follow the manufacturer's instructions supplied with the remote temperature control for proper installation and adjustment. Connection of a set of dry switching contacts or a remote on/off thermostat to the low voltage connection board will allow the unit to be switched on and off by making or breaking a 24 VAC control circuit. Remove the factory jumper between the Staging S1 terminals on the low voltage connection board and connect the remote temperature control in its place, see FIG. 5-4 on page 46.

Ensure that all wiring used to connect the switching contacts of the remote temperature controller to the connection board are a minimum of 18 gauge and have a maximum installed length of 300 feet (91.4m). Set the SMART SYSTEM control to a set point temperature slightly higher than the setting of the remote temperature control. This will ensure that the remote temperature controller functions as the operating control for the heater.

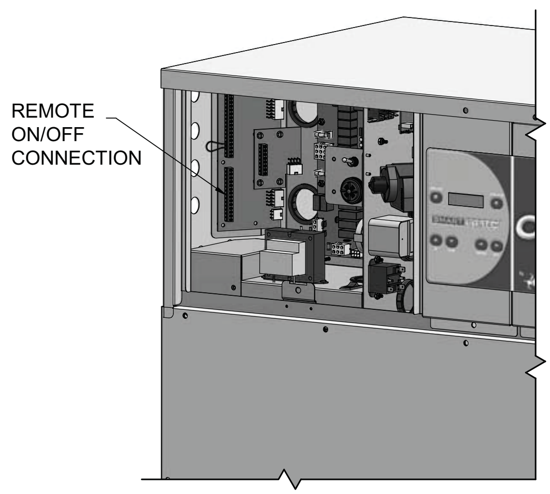


Figure 5-3_*Remote ON/OFF Wire Connection*

DHW (Domestic Hot Water) thermostat

Connect the DHW tank thermostat (FIG. 5-4) to the tank thermostat terminals on the connection board.

DHW tank sensor

If a tank sensor is used, it must be connected to the tank sensor terminals on the low voltage connection board. The correct Lochinvar sensor (TST20015) MUST BE USED.

5 Electrical connections *(continued)*

Louver relay

When the heater is to control combustion air louvers, a field provided 24VAC louver relay must be installed. Connect the Louver Relay Coil terminals to the louver relay coil.

Louver proving switch

The operation of a louver proving switch needs to be verified before the boiler fires. Remove the jumper wire from these terminals and connect them to the normally open contacts on its proving switch (FIG. 5-4).

System supply sensor (recommended use)

1. By installing the system supply sensor into the supply of the primary loop, the temperature of the primary supply can be controlled. The SMART SYSTEM control automatically detects the presence of this sensor, and controls the boiler firing rate to maintain the system supply temperature to the set point (if the outlet sensor control is currently selected).

2. Connect these terminals to the system supply sensor (FIG. 5-4).

System return sensor (optional use)

1. By installing the system return sensor into the return of the primary loop, the temperature of the primary return can be sensed when a 3-way valve or other device is installed ahead of the heater inlet. The SMART SYSTEM control automatically senses the presence of this sensor. If the inlet sensor is selected as the controlling sensor, the SMART SYSTEM control will adjust the firing rate to hold the system return temperature to the set point. In this case, a system supply sensor must be installed for proper operation.

2. Connect these terminals to the system return sensor (FIG. 5-4).

Boiler Management System (BMS)

1. An external control may be connected to control either the firing rate or the set point of the appliance (boiler or water heater). Connect the 0 - 10 VDC terminals to the 0 - 10 VDC output of the external control. The SMART SYSTEM control can be programmed to use the enable output of the Boiler Management System, or use the voltage signal to enable the heater. Connect the Staging S1 or tank thermostat terminals to the enable output of the BMS, when used.

2. Make sure the ground terminal is connected to the ground output terminal of the external control, and the 0 - 10 V BMS IN terminal is connected to the 0 - 10 VDC terminal of the external control.

Runtime contacts

The SMART SYSTEM control closes a set of dry contacts whenever the burner is running. This is typically used by Building Management Systems to verify that the boiler is responding to a call for heat.

3-way valve out

An electric 3-way mixing valve may be used when the return temperature to the heater is less than 140°F (60°C). Connect the Open output to the Open terminal on the 3-way valve. Connect the Close output to the Close terminal on the valve and the COM output to the 24VAC terminal on the valve.

0 - 10V rate out

A 0 - 10VDC signal is available to allow a Building Management System (BMS) to monitor the firing rate of the heater. Make sure the (-) terminal is connected to the (-) or common terminal of the external control, and the (+) terminal is connected to the (+) or Vdc terminal of the external control.

0 - 10V system pump in

A 0 - 10VDC input is available so that the boiler can monitor the speed of a variable speed system pump. This allows the boiler to anticipate changes in the heat load as the system flow changes. Connect the (-) terminal to the (-) or common terminal on the system pump VFD drive, and the (+) terminal to the (+) or 0 - 10VDC terminal on the system pump VFD drive. A 0 - 020mA signal may also be used, by adding a 500 ohm resistor between the (+) and (-) terminals.

Sequencer

The individual stages in the heater can be controlled separately with an external sequencer. Connect the Staging S1 terminals to the first stage contacts on the sequencer, the Staging S2 terminals to the second stage contacts, and so forth. Note that the sequencer must enable the stages in order, with Stage 1 first, Stage 2 second and so on.

Alarm contacts

The SMART SYSTEM control closes another set of contacts whenever the heater is locked out or the power is turned off. This can be used to turn on an alarm, or signal a Building Management System that the boiler is down.

5 Electrical connections

Wiring of the cascade

When wiring the heaters for Cascade operation, select one heater as the Leader. The remaining heaters will be designated as Members. See page 50 Configuration of the Cascade for a detailed explanation of this procedure.

On boilers, connect the system supply sensor and outdoor air sensor (if used) to the Leader boiler. The location of the system supply sensor should be downstream of the boiler connections in the main system loop (FIG.'s 4-3 and 4-6). The system supply sensor should be wired to the low voltage connection board at the terminals marked for the system supply sensor (see FIG. 5-4). The Leader control will use the water temperature at the system supply sensor to control the operation of the Cascade.

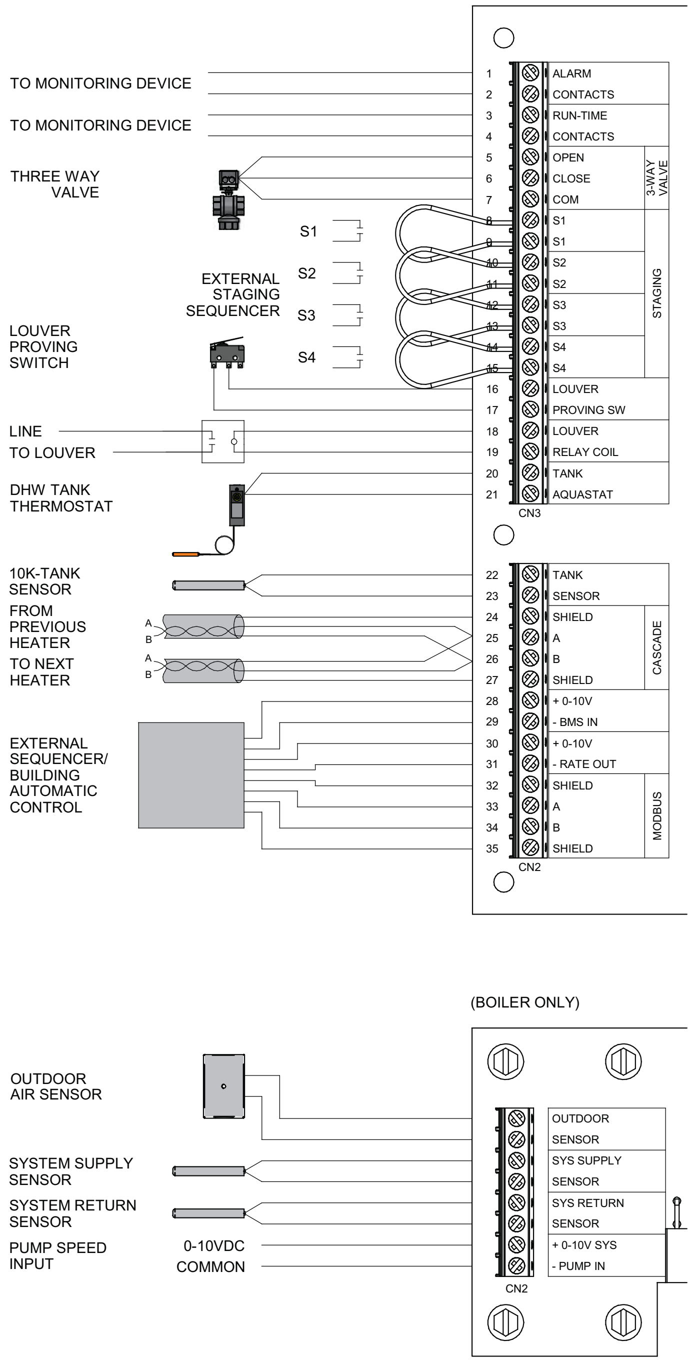
If outdoor air reset is desired, the outdoor air sensor should be wired to the low voltage connection board at the terminals marked for the outdoor air sensor (FIG. 5-4). If the outdoor air sensor is connected, the Leader control will calculate the water temperature set point based on the programmed reset curve parameters. If the outdoor air sensor is not connected, the Leader control will maintain the space heating (SH) set point that is programmed into the control.

If a Thermostat, Zone Control enable output, or Building Management System enable output are available, it should be wired to the low voltage connection board on the Leader boiler at the Staging S1 terminals. If the boilers are to run continuously, leave the jumper wire between these terminals. This will initiate a call for heat on the Cascade. Also, leave the jumpers on the Staging S1 terminals of all the Member heaters. This will allow them to run independently should the Leader heater fail.

On water heaters, connect the tank thermostat or BMS enable output to the low voltage connection board on the Leader heater, at the terminals marked for the tank Aquastat. If a tank sensor is used, connect this sensor to the low voltage connection board on the Leader heater, at the terminals marked for the tank sensor.

Communication between the Leader heater and the Member heaters is accomplished by using shielded, 2-wire twisted pair communication cable. Connect one of the twisted pair wires to terminal A on each of the low voltage connection boards, and the other wire of the twisted pair to terminal B on each of the low voltage connection boards. Connect the shield wire to the shield ground terminal on all of the heaters. If more than two heaters are on the Cascade, daisy chain the wiring from the Cascade terminals on the second heater to the Cascade terminals on the third heater, then from the third to the forth, and so on. The connections can be made in any order, regardless of the addresses of the heaters. Try to keep each cable as short as possible.

***Figure 5-4**_Low Voltage Field Wiring Connections*



6 Start-up

Check/control water chemistry

⚠ CAUTION Do not use petroleum-based cleaning or sealing compounds in the boiler system. Damage to elastomer seals and gaskets in the system could occur, resulting in substantial property damage.

Hardness less than 7 grains

1. Consult local water treatment companies for hard water areas (above 7 grains hardness).

Chlorine concentration less than 200 ppm

1. Do not fill boiler or operate with water containing chlorine in excess of 200 ppm.
2. Filling with chlorinated fresh water should be acceptable since drinking water chlorine levels are much lower.
3. Do not use the boiler to directly heat swimming pool or spa water.

Test/replace freeze protection fluid

1. For systems using freeze protection fluids, follow fluid manufacturer's instructions.
2. Freeze protection fluid must be replaced periodically due to degradation of inhibitors over time. Follow all fluid manufacturer's instructions.

Freeze protection (when used)

1. Determine freeze protection fluid quantity using system water content, following fluid manufacturer's instructions. Appliance water content is listed on page 8. Remember to include expansion tank water content.
2. Local codes may require a backflow preventer or actual disconnect from city water supply.
3. When using freeze protection fluid with automatic fill, install a water meter to monitor water makeup. Freeze protection fluid may leak before the water begins to leak, causing concentration to drop, reducing the freeze protection level.

Fill and test water system

1. Fill system only after ensuring the water meets the requirements of this manual.
2. Close manual and automatic air vents and boiler drain valve.
3. Fill to correct system pressure. Correct pressure will vary with each application.
   a. The minimum cold water fill pressure should be 12 PSI.
   b. Pressure will rise when boiler is turned on and system water temperature increases.
4. At initial fill and during boiler startup and testing, check system thoroughly for any leaks. Repair all leaks before proceeding further.

⚠ WARNING Eliminate all system leaks. Continual fresh makeup water will reduce boiler life. Minerals can build up in the heat exchanger, reducing heat transfer, overheating the heat exchanger, and causing heat exchanger failure.

Purge air from water system

1. Purge air from system:
   a. Connect a hose to the purge valve (see purge/drain valves, in the piping diagrams on pages 39 - 42). Route the hose to an area where water can drain and be seen.
   b. Close the boiler or system isolation valve between the purge valve and fill connection to the system.
   c. Close zone isolation valves.
   d. Open quick-fill valve on cold water makeup line.
   e. Open purge valve.
   f. One zone at a time, open the isolation valves. Allow water to run through the zone, pushing out the air. Run until no noticeable air flow is present. Close the zone isolation valves and proceed with the next zone. Follow this procedure until all zones are purged.
   g. Close the quick-fill water valve and purge valve and remove the hose. Open all isolation valves. Watch that system pressure rises to correct cold-fill pressure.
   h. After the system has operated for a while, eliminate any residual air by using the manual air vents located throughout the system.
   i. If purge valves are not installed in the system, open the manual air vents in the system one at a time, beginning with the lowest floor. Close the vent when water squirts out. Repeat with remaining vents.
2. Open automatic air vent (diaphragm-type or bladder-type expansion tank systems only) one turn.
3. Open other vents:
   a. Starting on the lowest floor, open air vents one at a time until water squirts out.
   b. Repeat with remaining vents.
4. Refill to correct pressure.

Check for gas leaks

⚠ WARNING Before starting the boiler, and during initial operation, smell near the floor and around the boiler for gas odorant or any unusual odor. Remove the front access panel and smell the interior of the boiler enclosure. Do not proceed with startup if there is any indication of a gas leak. Use an approved leak detection solution. Repair any leaks at once.

⚠ WARNING Propane boilers only – Your propane supplier mixes an odorant with the propane to make its presence detectable. In some instances, the odorant can fade, and the gas may no longer have an odor. Before startup (and periodically thereafter), have the propane supplier verify the correct odorant level in the gas.

6 Start-up

Check thermostat circuit(s)

1. Disconnect the two external wires connected to the enable terminals on the connection board.
2. Connect a voltmeter across these two incoming wires. Close each thermostat, zone valve, and relay in the external circuit one at a time and check the voltmeter reading across the incoming wires.
3. There should NEVER be a voltage reading.
4. If a voltage does occur under any condition, check and correct the external wiring. (This is a common problem when using 3-wire zone valves.)
5. Once the external thermostat circuit wiring is checked and corrected if necessary, reconnect the external thermostat circuit wires to the connection board. Allow the boiler to cycle.

Check vent and air piping

Inspect vent piping and air piping for signs of deterioration from corrosion, physical damage or sagging. Verify air piping and vent piping are intact and correctly installed per this manual.

Placing the boiler in operation

Boiler operational checks

1. Turn the boiler main power switch to the "ON" position.
2. Verify operation of the SMART SYSTEM control module and Operator Interface.
3. Program the adjustable points from the Operator Interface.
4. Push the reset for the low water cutoff (if equipped).
5. Ensure that maximum flow to the boiler does not exceed 55 GPM on Models 402 - 752 and 90 GPM on Models 992 - 2072. Verify by checking temperature rise while burner is firing at 100% of rated input.
6. Install a manometer on the gas supply to the boiler and verify minimum gas supply pressure as the burner fires at 100% of rated input.
7. Verify operation of safeties as necessary (low water cutoff, high limit, gas pressure, etc.,).
8. Verify that all adjustable points in the Operator Interface are set as required.
9. Once the boiler analysis is complete, test the safety shutoff device by turning the manual shutoff valve to the OFF position and ensuring that the boiler shuts down and registers an alarm. Open the manual shutoff valve and reset the control.
10. Place the boiler back into normal operation.

Boiler operation

11. Boiler should begin the start-up process for the sequence of operation.
12. The boiler will ignite at the proper ignition speed and will stage to meet the system demand.
13. Ensure that inlet water temperature does not fall below the specified minimum for the boiler.
14. Based on system demand, boilers may run for an extended period of time at a reduced rate of input to maximize efficiency.
15. As system demand is satisfied, the burner will cycle off and the combustion air blower will run for a post purge operation before the boiler shuts down.

Start the boiler

Read and follow the Lighting Instructions in FIG. 6-1, on page 49.

If boiler does not start correctly

1. Check for loose connections, blown fuse or service switch off?
2. Is external limit control (if used) open? Is boiler water temperature above 200°F (93.3°C)?
3. Is thermostat set below room temperature?
4. Is gas turned on at meter or boiler?
5. Is incoming gas pressure less than 4.5" water column?

If none of the above corrects the problem, refer to the Troubleshooting Section of the Copper-fin II Service Manual.

> ⚠ **WARNING** The venting system must be installed so that it will prevent flue gas spillage and carbon monoxide emissions, which will result in severe personal injury or death.

Set space heating operation (boiler only)

Determine controlling sensor

For space heating systems, the temperature control can be based on one of four sensors; the **inlet, outlet, system supply sensor, or system return sensor**. The SMART SYSTEM control is programmed at the factory to control the temperature of the outlet sensor. The control will automatically switch to the system supply sensor once it is connected. If it is desired to base the temperature control on the inlet sensor, the appropriate parameter must be changed in the control. See the Copper-fin II Service Manual for a detailed explanation of this procedure. The control will automatically switch to the system return sensor once it is connected. It is recommended that a system supply sensor be installed even when using the inlet sensor as the controlling sensor.

Verify space heat circulator mode

The Space Heating Mode controls both the system (primary) pump (if connected), and the boiler (secondary) pump. When the SMART SYSTEM control receives a space heating call for heat, it turns on the system pump. If the boiler is not heating an indirect DHW (Domestic Hot Water) tank, it also turns on the boiler pump. After the space heating call for heat ends, the system pump continues to run for a short period of time. If the boiler pump was running, it continues to run for a short period of time as well. These pump delays are factory set to 30 seconds. If different delays are desired, the appropriate parameters in the control must be changed. See the Copper-fin II Service Manual for a detailed explanation of this procedure.

Set space heating set point temperature

The UP and DOWN keys may be used during normal operation to adjust the space heating set point temperature (see FIG. 7-1 on page 56 of this manual). Once the desired temperature is displayed, press the ENTER/RESET key to save the new setting. If the ENTER/RESET key is not pressed, the new setting will be used for the current heating cycle only. The old setting will become active after the current heating cycle ends.

6 Start-up *(continued)*

Figure 6-1_*Lighting Instructions*

FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

A. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.

B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

FOR YOUR SAFETY
"WHAT TO DO IF YOU SMELL GAS"

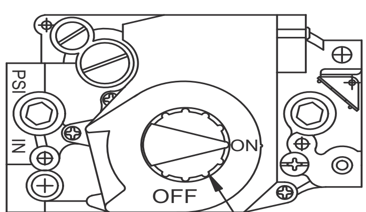
- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to turn the gas control knob. Never use tools. If the knob will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

OPERATING INSTRUCTIONS

1. STOP! Read the safety information above on this label.
2. Turn off all electric power to the appliance.
3. Open control access panel.
4. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.



GAS CONTROL KNOB
SHOWN IN THE "ON" POSITION

5. Push in gas control knob slightly and turn clockwise  to "OFF."

   NOTE: On the 36C valve, knob cannot be turned to "OFF" unless knob is pushed in slightly. Do not force.

6. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, STOP! Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step".
7. Turn gas control knob counterclockwise  to "ON."
8. Replace control access panel.
9. Turn on all electric power to the appliance.
10. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. Turn off all electric power to the appliance if service is to be performed.
2. Open control access panel.
3. Push in gas control knob slightly and turn clockwise  to "OFF". Do not force.
4. Replace control access panel.

LBL2084 REV D

6 Start-up

Set DHW operation

Verify DHW circulator mode (boiler only)

The DHW Mode is programmed to heat an indirect domestic hot water tank. When the tank thermostat or tank sensor calls for heat, the SMART SYSTEM control will turn on the DHW pump and turn off the boiler pump (if running). If the system pump is running, it will remain on. When the DHW call for heat ends, and there is no space heating call for heat, the DHW pump will continue to run for a period of time. This pump delay is set at the factory to 30 seconds. If a shorter or longer delay is desired, the appropriate parameter in the control must be changed. See the Copper-fin II Service Manual for a detailed explanation of this procedure. If there is an active space heating call for heat, then the boiler pump will be turned on and the DHW pump will be turned off.

Set outlet target temperature (boiler only)

When in the DHW Mode, the control will modulate to maintain the outlet temperature to a set point. This set point is set at the factory to 180°F (82.2°C). If a different set point is desired, the appropriate parameter in the control must be changed. See the Copper-fin II Service Manual for a detailed explanation of this procedure.

Set tank target temperature

If a tank sensor is used, the tank set point can be adjusted by pressing either the UP or DOWN key. A menu will appear on the LCD display. Press the DOWN key to select the tank set point, and press ENTER. Use the UP and DOWN keys to adjust the set point. Press the ENTER key again to save the new set point and return to the normal display.

Set clock

The SMART SYSTEM control has a built-in clock that it uses for its night setback feature and for logging events. This clock must be set when the appliance is installed, and anytime the appliance has been powered off for more than one month. Use the following procedure to set the clock:

1. Press and hold the MENU key (FIG. 7-1) for at least 5 seconds.
2. The display changes to ready “ENTER MENU CODE”, with four (4) zeros below it.
3. Change the zeros to match the user code (factory set at “0704”). Use the UP and DOWN keys to increment or decrement the flashing digit, and the NEXT and PREVIOUS keys to select which digit flashes.
4. Press the ENTER key.
5. The display changes to read USER CODE for a few seconds, then displays a menu.
6. Press the ENTER key.
7. Press the UP key twice to display “A3 DATE AND TIME”.
8. Press the ENTER key once.
9. The date and time are displayed as “YY:MM:DD W hh:mm”, where:
   mm: minutes
   hh: hour (24 hour time; e.g., 2:00 PM = 14:00)
   W: day of the week (1 = Sunday, 2 = Monday, 3 = Tuesday, etc.,)
   YY: year
   MM: month
   DD: date

NOTICE The internal clock does not adjust for Daylight Savings Time and therefore, will require a manual adjustment.

Use the UP and DOWN keys to increment or decrement the flashing number, and the NEXT and PREVIOUS keys to select which number flashes.

10. Press the ENTER key to save the setting.
11. Press the MENU key twice to exit the Programming Mode.

Configuration of the cascade

When installed in a Cascade system, the individual controls must be programmed for cascade operation. This is accomplished by accessing the control parameters.

Input the Installer code as described in the Copper-fin II Service Manual. Once the control parameters have been accessed, use the DOWN arrow key to select the H Control Mode parameters. Press the ENTER key to access these parameters. Use the UP arrow key to access parameter H4 Cascade. Press the ENTER key to access this parameter. Use the DOWN arrow key to select Enable. Press the ENTER key to program this into the control. Press the EXIT key, then press the DOWN key until I Cascade is selected.

Press the ENTER key to select the parameter I1 BLR Address. Press the ENTER key to access this parameter. Each unit in the Cascade system must be programmed with its own address. The unit designated as the Leader will have an address of 0. The remaining units in the Cascade will be Members and have addresses from 1 - 7. Use the UP and DOWN arrow keys to select the appropriate address. Press the ENTER key to program this into the control.

Press the MENU key twice to exit the control parameters. Repeat this procedure for all appliances in the Cascade, designating the Leader control and the Member controls.

7 Operating information *(continued)*

General

How the appliance operates

The Copper-fin II uses a copper finned tube heat exchanger to transfer heat from the flue products to the water. An electronic control module monitors various inputs to initiate a call for heat. The blower provides both primary and secondary air to the burner and forces the flue products out of the combustion chamber and into the vent system. The control module regulates the blower speed and firing stages, based upon the heat demand. Gas valves regulate the amount of gas supplied for the firing stages, which is then mixed with the combustion air supplied to the burner.

NOTICE If an inline high gas pressure regulator is used, it MUST BE of the lockup type and be located a minimum of 10 feet from the appliance. Failure to do so may result in insufficient gas volume supplied to the appliance.

NOTICE If a pressure drop of more than 2" water column occurs between Standby (static) Mode and Operating (dynamic) Mode, a gas volume problem exists. Contact the gas utility, gas supplier, qualified installer, or service agency to determine the necessary steps to provide the proper gas volume to the appliance.

How the control module operates

The SMART SYSTEM control module receives input from appliance sensors and external devices. The control module activates and controls the blower and gas valves to regulate heat input and switches the boiler, Domestic Hot Water (DHW), and system pumps on and off as needed. The user programs the module to meet system needs by adjusting control parameters. These parameters set operating temperatures and appliance operating modes. Boiler operation can be based on boiler outlet water temperature, boiler inlet water temperature, system supply temperature, or system return temperature, depending on the parameter setting. Water heater operation can be based on a tank sensor or a tank thermostat.

Control inputs and outputs

Staging S1 - S4

The S1 input tells the boiler to provide water for space heating. The S2 - S4 inputs are used when a sequencer controls the boiler.

Tank Aquastat

This input tells the boiler to provide water for heating a domestic hot water tank.

0 - 10V input (set point or power)

The Copper-fin II can be controlled by a Building Management System (BMS) using a 0 - 10 VDC signal. The control can be configured by the installer to use this signal to either control set point or firing rate.

DHW priority (boiler only)

The SMART SYSTEM control module allows connection of a DHW thermostat or tank sensor to the low voltage connection board. When the DHW thermostat or tank sensor calls for heat, the module activates the DHW pump, shuts down the boiler pump, and immediately sets the target outlet water temperature to 180°F (82.2°C). This provides automatic priority heat allocation to the indirect water heater for maximum response and recovery. The DHW pump continues for 30 seconds after the heating cycle to deliver the most possible heat.

DHW / SH (space heating) cycling (boiler only)

If an indirect DHW call for heat is received while a space heating call is in progress, the control will start the DHW pump and shut the boiler pump off. The system pump will remain on. If the space heating call is still active while the DHW call is in operation, the control will wait for 30 minutes (time adjustable by installer) then it will switch back to the space heating demand. The control will switch back and forth until one of the heat demands end.

Programmable controlling sensor (boiler only)

The control module is programmed to use the outlet sensor as the control sensor by default. If a system supply sensor is connected, the control automatically uses it as the control sensor. The control sensor can be changed by the installer to the inlet sensor. In this case, if a system return sensor is installed, the control automatically uses it as the control sensor. If the inlet sensor is chosen as the controlling sensor, it is recommended that the system supply sensor be installed for the best system performance.

Anti-cycling (boiler only)

After the set point has been satisfied, the control will delay the next burner cycle for a set time period (time is adjustable by the installer). The time delay will be bypassed if the system return temperature drops too far during the delay.

Boiler, system, and DHW pump control

When a space heating call for heat starts and no DHW call is on, the system and boiler pumps are turned on. As long as the space heating call for heat is on, the system pump will remain on. If a DHW call for heat is on, the boiler pump will wait to turn on until just before the DHW pump turns off. After the space heating call for heat ends, both pumps will run for an additional period of time.

When a DHW call for heat starts, the DHW pump is turned on. If a space heating call for heat was on, the boiler pump will turn off a few seconds after the DHW pump turns on.

7 Operating information

Temperature control

Firing rate

Depending upon the model, the Copper-fin II is capable of staging its firing rate from a minimum of 25% to a maximum of 100%. The firing rate is dictated by the call for heat (i.e., space heating or domestic hot water), the heating load, ramp delay (if enabled), and various other temperature limitations.

Ramp delay (boiler only)

For systems with lower flow, the SMART SYSTEM can limit the firing rate (when enabled) when a space heating call for heat starts, or when switching from a DHW call for heat to a space heating call for heat. There are six (6) limits that can be programmed, as well as six (6) time intervals corresponding to each limit. The sixth limit will also limit the firing rate for the rest of the call for heat.

Gradient limiting

If during operation of the heater the outlet water temperature is rising too quickly, the control will reduce the firing rate to its lowest setting.

Outdoor air reset (boiler only)

With the outdoor air sensor connected, the control module will calculate the set point based on the programmed reset curve. The installer can change the slope of the reset curve by several adjustable parameters. The user can limit the maximum set point for the system using the space heating set point.

Boost function (boiler only)

If outdoor air reset is active, and a space heating demand has been active continuously for a set period of time (time adjustable by installer) and there has been no DHW demands, the control may be programmed to increase the set point by a fixed number of degrees (adjustable by installer). This process will repeat until the space heating demand ends, the set point reaches the programmed set point or a maximum of 20 increases has occurred. Once the system heat demand is satisfied, the set point will revert to the value determined by the reset curve.

Night setback

The controller may be programmed to reduce the space heating (boilers) and tank set points during a certain time each day. A start and stop time can be programmed for each day of the week.

Protection features

Outlet temperature, and temperature rise limiting

The outlet temperature is monitored by the boiler outlet temperature sensor. When the outlet temperature exceeds 230°F (110°C) (boilers) or 190°F (88°C) (water heaters), the unit will reduce the firing rate. If the outlet water temperature exceeds 235°F (113°C) (boilers) or 200° (93°C) (water heaters) the control will shut the unit down until it cools off.

The control monitors the temperature difference between the inlet and the outlet sensor. If this difference exceeds the first limit the control will turn off stages. If the temperature difference exceeds a second limit the control will shut the unit down. The unit will restart automatically once the temperature difference has dropped 10°F (6°C) and the minimum off time has expired.

Freeze protection

DO NOT install the appliance in a room likely to freeze.

The following integral feature of the SMART SYSTEM control module provides some protection for the appliance only -- not for the system.

- The SMART SYSTEM control module provides freeze-up protection as follows when the appliance water temperature drops below 45°F (7.2°C):
- Below 45°F (7.2°C), the appliance and system pumps operate constantly.
- Below 37°F (2.7°C), the appliance turns on.
- Appliance and pumps turn off if appliance water temperature rises above 45°F (7.2°C).

⚠ CAUTION This feature of the SMART SYSTEM control module does not eliminate the possibility of freezing. The installer must still use recognized design, installation and maintenance practice to prevent freeze potential for the appliance and system.

High limit operations

When outlet temperature exceeds 240°F (116°C) (boilers) or 210°F (99°C) (water heaters), high limit action occurs. The appliance shuts down until the outlet water cools down and the RESET button on the Operator Interface is pressed.

7 Operating information *(continued)*

Low water cutoff protection

1. The SMART SYSTEM control module uses temperature sensing of both inlet and outlet areas of the heat exchanger. If the flow rate is too low or the outlet temperature too high, the control module modulates and shuts the appliance down. This along with the flow switch, ensures appliance shutdown in the event of low water or low flow conditions.

2. Some codes and jurisdiction may accept these integral features of the control in lieu of requiring an additional limit control or low water cutoff. Consult local jurisdiction to determine. Contact manufacturer for low water cutoff kit availability.

Monitor external limits

Connections are provided on the connection board for external limits such as a louver proving switch. The SMART SYSTEM will shut off the burner and inhibit relighting whenever any of these external limits open.

Run-time and alarm outputs

The appliance provides dry contacts for indicating when the appliance is running, and when it is unable to operate.

Run-time and cycle counting

The control uses two timers to monitor the total hours of burner operation. One timer monitors the time the appliance is firing under 50% of rate. The other timer monitors the time the appliance is firing over 50% rate.

The control uses four (4) ignition counters to monitor the amount of appliance cycles. The first counter counts all ignitions of the control. The second counter counts only ignition attempts that have failed. The third and fourth counters are the same as the first and second respectively, but can be reset by the installer.

Service reminder

The control can be programmed for service reminder notification. This notification will become active when either a set time frame has expired, or a set amount of running hours or cycles has expired (all adjustable by the installer). The display will alternate the standard text on the display screen with Service Due every 5 seconds. The service reminder notification can be reset by the installer.

Error logging

The control will hold in memory the last 10 error codes as well as the last 10 turn-off functions. The date and time of the occurrence will be recorded as well. Only the 10 most current occurrences will be held in memory.

Boiler temperature regulation

Operating temperature (target)

The SMART SYSTEM control module senses water temperature and regulates appliance firing and firing rate to achieve a target temperature. The target temperature can be set between 70°F (21°C) and 220°F (104°C) (boilers) or between 60°F (16°C) and 190°F (88°C) (water heaters).

- Target temperature is fixed when the outdoor sensor is not installed (boilers).
- Target temperature is calculated as described under “Outdoor Air Reset Operation” and “Boost Function” when the outdoor sensor is connected (boilers).

Outdoor reset operation, if used (boilers only)

Target temperature with outdoor reset

This feature improves the system’s efficiency as the outdoor temperature warms up.

See the Copper-fin II Service Manual to change the settings.

Reset curve

The reset curve looks at outdoor air temperature and adjusts the set point.

Cascade

When multiple appliances are installed, they can be wired together in a cascade sequence. A maximum of eight appliances can be controlled from a single control. In this application one appliance would be designated as the Leader control and all others would be designated as Member controls. The set point or firing rate can be controlled by the 0 - 10V input as well.

Once the Leader appliance receives a call for heat from a BMS, tank sensor, or external thermostat, the control will determine what the set point will be. A fixed temperature set point can be programmed into the control. See Copper-fin II Service Manual to program the set point.

On boilers, if the water temperature at the system sensor is less than the set point + the turn-off offset - the off-on differential, then the control will initiate a call for heat on the Cascade (see the Copper-fin II Service Manual for an explanation of the offset and differential). The Leader will energize the lead appliance on the Cascade. For a new startup this will be the Leader appliance.

On water heaters, if the water temperature at the tank sensor is less than the tank set point - the off differential, then the control will initiate a call for heat on the Cascade.

7 Operating information

The appliance will fire at its ignition speed and will then stage its firing rate to maintain the set point. If the first appliance reaches 100% of its firing rate, the Leader will calculate at what point the second appliance could fire at its minimum firing rate. At this point, the Leader will fire the second appliance on the Cascade. For a new startup, this would be the first Member appliance. The appliance will fire at its ignition speed and will then staging its firing rate to maintain the set point.

If the set point still cannot be met, the Leader will continue firing more Members until either the heat demand is met or all appliances on the Cascade are firing. As the heat demand decreases, the last appliance on will stage down to its minimum firing rate. Once the demand for that appliance is 0% it will shut down. As the heat demand decreases further, the second to last appliance will stage down and shut off. This will continue until the demand is satisfied and all appliances are shut off.

Sequence of the cascade

To equalize the run time of all appliances on the Cascade, the firing sequence will automatically be changed at set intervals.

For the first 24 hours after initializing the Cascade, the sequence will be changed every hour. After that the sequence will be changed once every 24 hours. The switching on/off sequence will be as follows:

DAY	SWITCHING ON SEQUENCE
Start	L-M1-M2-M3-M4-M5-M6-M7
+ 1 hour	M1-M2-M3-M4-M5-M6-M7-L
+ 2 hour	M2-M3-M4-M5-M6-M7-L-M1

DHW, Night Setback, and Ramp Delay operation with cascade

For indirect DHW operation any boiler(s) in the Cascade can be selected to provide heat for a DHW call. Select a boiler to be designated as the DHW boiler. Connect the tank thermostat or tank sensor to the corresponding terminals on the low voltage connection board. When the boiler receives a DHW call, the Leader control will take that boiler out of the Cascade sequence. If another boiler is available, the Leader will start it up to take its place.

The DHW boiler will adjust its set point to the programmed outlet set point and will adjust its firing rate to maintain this. Once the DHW call has been satisfied, the Leader control will place that boiler back into the Cascade sequence.

Switching of the boiler between DHW operation and SH operation when there is a call for both does not occur. The boiler will provide heat for the DHW demand until it is satisfied.

Night Setback operation of the boilers or water heaters within the Cascade is available. Programming of the Space Heating (SH) Night Setback will be done through the Leader boiler. Refer to the Copper-fin II Service Manual for information regarding Night Setback.

Ramp Delay operation of the boilers as described in the Copper-fin II Service Manual is available when the boilers are part of a Cascade system.

7 Operating information *(continued)*

Sequence of operation

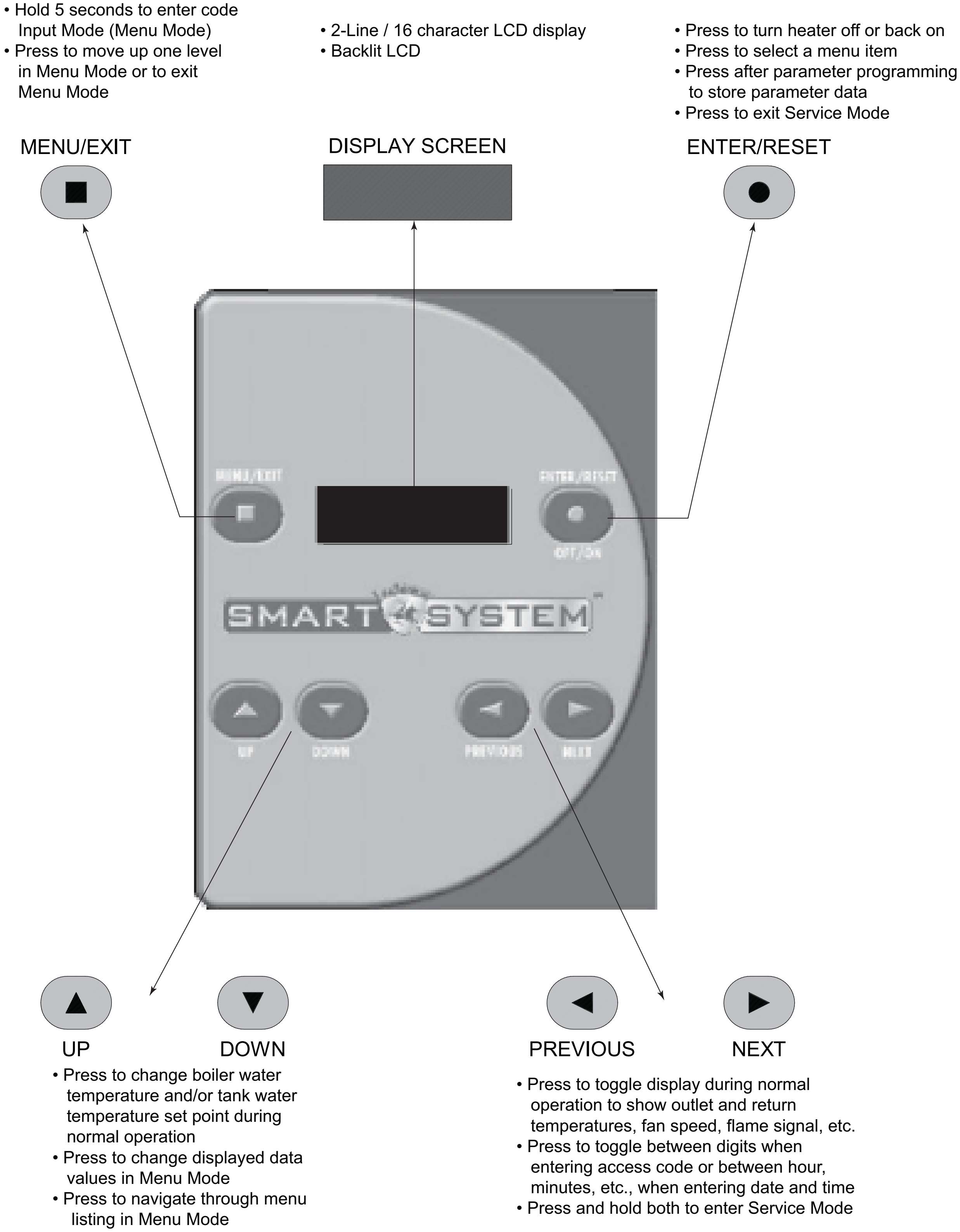
OPERATION	DISPLAY
1. The manual reset high limit must be closed before any action will take place.	HTR: Standby OUT: 123.8F(129)
2. Upon a call for heat the control turns on the appropriate pumps (system and boiler pumps for space heating; DHW pump for DHW call). The flow switch and low water cutoff (if equipped) must close.	HTR: Standby OUT: 123.8F(129)
3. • If the unit is equipped with a proof of closure valve, the proof of closure switch must be closed. The proof of closure valve is then energized. The gas pressure switch(es) (if equipped) must close. • If the contact for the louvers is closed, the louver proving, and auto reset high limit (water heater only) inputs must close. • If the air pressure switch is open, the prepurge cycle then begins by starting the combustion blower. Once started, the air pressure switch must close.	HTR: Standby OUT: 123.8F(129)
4. After prepurge, the blower slows down and the hot surface ignitor (HSI) is energized.	HTR: PREPURGE OUT: 123.9F(129)
5. Once the HSI is hot, the trial for ignition begins with the opening of the gas valve.	HTR: IGNITION OUT: 123.9F(129)
6. If the SMART SYSTEM control does not sense flame, then it will lock out.	HTR: POSTPURGE, LOCKOUT OUT: 123.9F(129)
7. If the SMART SYSTEM control senses flame, it will fire the burner to maintain the set point. The firing rate will stage as required to hold the actual temperature at the set point. If the boiler lights due to a space heating call for heat, and the ramp delay function is active (default is disabled), the staging will be held to a series of increasing limits after the burner has lit.	HTR: RUN STG: 1 OUT: 124.8F(129)
8. If the space heating call for heat is active, and a DHW call for heat becomes active, the control will turn on the DHW pump and then turn off the boiler pump (boiler and DHW pump operation briefly overlap to ensure that flow is maintained throughout the unit). This will divert the hot water away from the heating zone(s) and send it to the DHW tank instead. The control will then modulate to maintain the outlet temperature to the DHW boiler set point.	HTR: DHW STG 123 OUT: 177.8(180)
9. If the DHW call for heat remains active for more than 30 minutes, and the space heating call for heat is also on, then the control will turn on the boiler pump, turn off the DHW pump and resume firing based on the space heating set point (boiler and DHW pump operation briefly overlap to ensure that flow is maintained throughout the unit). As long as both the space heating and DHW calls for heat remain active, the control will switch back and forth between the two modes until one of them is satisfied.	HTR: RUN STG 12 OUT: 123.0F(129)
10. Once both calls for heat are satisfied, the control will turn off the burner. The blower will remain on for the postpurge cycle. Any pumps that are running will continue to run for their respective pump delay times, then turn off.	HTR: POSTPURGE OUT: 127.4F(129)
11. Boiler pump off, system pump continues its delay if longer.	HTR: Standby OUT: 124.7F(129)
12. System pump off.	HTR: Standby OUT: 122.9F(129)

7 Operating information

Copper-fin II control module

Use the control panel (FIG. 7-1) to set temperatures, operating conditions, and monitor appliance operation.

Figure 7-1_*Control Panel - Operator Interface*



7 Operating information *(continued)*

Access modes

User

The user can adjust the space heating target temperature and the tank target temperature (if a tank sensor is used) by using the UP and DOWN buttons (FIG. 7-1) at any time during normal operation. By entering the USER code (0704), the user can also change temperature units, time and date, and night setback settings. In User Mode, the following parameters can be viewed but not changed:

- Boiler outlet water target temperature in DHW Mode
- Appliance model number
- Software version
- Total operating hours
- Total cycles

Installer

Most parameters are available only to the installer, accessible only by entering the installer access code, see the Copper-fin II Service Manual.

Saving parameters *(reference the Parameter Table in the Copper-fin II Service Manual)*

To save parameters and exit programming:

Press the ENTER/RESET button, then the MENU/EXIT button 3 times.

To keep parameter settings only for a current operating cycle:

Press the MENU/EXIT button 3 times after making all desired parameter changes.

To enter a parameter and continue programming:

Press the MENU/EXIT button 1 time to return to the parameter listings; press again to return to the menu listings. Remember to press the ENTER/RESET button when finished programming in order to save the changes made.

See the Copper-fin II Service Manual for a detailed description of parameters and access modes.

7 Operating information

Status display screens

Status Display Screens		
By using the Previous/Next (◀, ▶) arrow keys on the SMART SYSTEM display panel, you can navigate through the 11 display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen #	**Display Shows**	**Description**
Screen #1 Line 1	**HTR: OFF**	The unit has been turned OFF by the Enter/Reset button on the SMART SYSTEM display panel.
	HTR: STAND-BY	The unit has not received a call for heat from a remote thermostat nor has it received a call for heat from a DHW thermostat.
	HTR: SETPOINT MET	The unit has met the water temperature set point, but is still receiving a call for heat from either a remote thermostat, a DHW thermostat, or a BMS.
	HTR: PRE-PURGE	The unit has initiated the pre-purge upon a call for heat.
	HTR: IGNITER * ON	The unit has begun the heatup time prior to the trial for ignition. Display will show IGNITOR A or IGNITOR B depending on which stage has priority.
	HTR: RUN STG ** Or HTR: DHW STG ****	The unit has fired and is running at the displayed number of stages (1,2,3,4)
	HTR: POST-PURGE	The call for heat has been satisfied and the unit runs the fan for an additional post-purge period to clear the combustion chamber and vent system of residual flue products.
	HTR: SERVICE MODE	The unit has been placed in a temporary mode that will allow the unit to fire for the purpose of combustion analysis.
Screen #1 Line 2	**OUT: ***F (***)**	When the outlet sensor has been selected as the control sensor (default), the control will display the outlet temperature as well as the set point in parenthesis.
	OUT: ***F	If the outlet sensor has not been selected as the control sensor or a system supply sensor is connected, only the outlet temperature will be displayed.
	OUT: OPEN	The control does not detect the outlet sensor.
	OUT: SHORTED	The outlet sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #2.		

7 Operating information *(continued)*

Status Display Screens *(cont'd)*		
By using the Previous/Next (◀, ▶) arrow keys on the SMART SYSTEM display panel, you can navigate through the 11 display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen #	**Display shows:**	**Description**
Screen #2 Line 1	**INLET: ***F (***)**	When the inlet sensor has been selected as the control sensor, the control will display the inlet temperature as well as the set point in parenthesis.
	INLET: ***F	If the inlet sensor has not been selected as the control sensor or a system return sensor is connected, only the inlet temperature will be displayed.
	INLET: OPEN	The control does not detect the inlet sensor.
	INLET: SHORTED	The inlet sensor wires or the sensor itself has become shorted.
Screen #2 Line 2	**RISE: ***F**	The difference between the inlet temperature and the outlet temperature is displayed.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #3.		
Screen #3 Line 1	**SYSSUP: ***F (***)**	When the system supply sensor has been selected as the control sensor, the control will display the system supply temperature as well as the set point in parenthesis.
	SYSSUP: ***F	If the system supply sensor has not been selected as the control sensor, only the system supply temperature will be displayed.
	SYSSUP: OPEN	The control does not detect the system supply sensor.
	SYSSUP: SHORTED	The system supply sensor wires or the sensor itself has become shorted.
Screen #3 Line 2	**SYSRTN: ***F (***)**	When the system return sensor has been selected as the control sensor, the control will display the system return temperature as well as the set point in parenthesis.
	SYSRTN: ***F	If the system return sensor has not been selected as the control sensor, only the system return temperature will be displayed.
	SYSRTN: OPEN	The control does not detect the system return sensor.
	SYSRTN: SHORTED	The system return sensor wires or the sensor itself has become shorted.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #4.		
Screen #4 Line 1	**OUTDOOR: ***F**	The control will display the outdoor air temperature as sensed by the outdoor air sensor.
	OUTDOOR: OPEN	The control does not detect the outdoor air sensor.
	OUTDOOR: SHORTED	The outdoor air sensor wires or the sensor itself has become shorted.
Screen #4 Line 2	**TANK: ***F**	The control will display the tank temperature as sensed by the tank sensor.
	TANK: OPEN	The control does not detect the tank sensor.
	TANK: SHORTED	The tank sensor wires or the sensor itself has become shorted.

7 Operating information

Status Display Screens *(cont'd)*		
By using the Previous/Next (◀, ▶) arrow keys on the SMART SYSTEM display panel, you can navigate through the 11 display screens. Each screen will contain two (2) viewable items. The following is a description of the individual items and what they can display:		
Screen	**Display shows:**	**Description**
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #5.		
Screen #5 Line 1	**0 – 10V BMS: **.*V**	The control displays the BMS voltage input from 0 to 10 volts.
Screen #5 Line 2	**STG DEMAND: ******	The control displays the number of stages being called by the control.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #6.		
Screen #6 Line 1	**FAN SPEED: *****	The control will display either OFF, LOW, or HIGH depending upon fan speed requirements of number of stages firing.
Screen #6 Line 2	**0 – 10V RATE: **.*V**	The control will display 0 to 10 volts based upon the number of stages firing.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #7.		
Screen #7 Line 1	**SH CFH: *****	The control will display either ON or OFF based upon a demand (call for heat) for space heating.
Screen #7 Line 2	**WHR CFH: *****	The control will display either ON or OFF based upon a demand (call for heat) for DHW (domestic hot water).
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #8.		
Screen #8 Line 1	**SYS PUMP: *****	The control will display either ON or OFF based upon system pump requirements upon demand for space heating.
Screen #8 Line 2	**SYSPUMPSPD: **.*V**	The control will display the 0 – 10V input voltage from the system pump based upon system pump speed.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #9.		
Screen #9 Line 1	**UNIT PUMP: *****	The control will display either ON or OFF based upon unit pump requirements upon demand for space heating.
	UNIT PUMP: DELAY	The control will display delay in unit pump operation after the space heating requirements have been satisfied.
Screen #9 Line 2	**DHW PUMP: *****	The control will display either ON or OFF based upon unit pump requirements upon demand for DHW.
	DHW PUMP: DELAY	The control will display delay in unit pump operation after the DHW requirements have been satisfied.

7 Operating information *(continued)*

Status Display Screens *(cont'd)*

Operation of the cascade

The boiler designated as the Leader will have two additional display screens that can be viewed. These screens will provide information regarding the operation of the Cascade. Each screen will contain two viewable items. The following is a description of the individual items and what they can display:

Screen	Display shows:	Description
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #10.		
Screen #10 Line 1	**FLM SIG – A: **.* µA**	The control displays the igniter flame signal of igniter A in microamps.
Screen #10 Line 2	**FLM SIG – B: **.* µA**	The control displays the igniter flame signal of igniter B in microamps.
Press the Next ▶ arrow key on the SMART SYSTEM display to access Screen #11.		
Screen #11 Line 1	**IGN * AMPS: *.* A**	The control displays the current of either igniter A or B.
Screen #11 Line 2	**MIX VAL POS: ** %**	The control displays the mixing valve percentage open to the system.

8 Domestic water heaters

This section applies only to those appliances used to supply domestic hot water, installed with a storage tank(s). A circulating pump MUST be installed in the piping assembly to the storage tank and valves used to control water velocity through the appliance. Proper water velocity is important for correct operation of your water heater.

This section contains specific instructions for those appliances used to supply domestic hot water. All warnings, cautions, notes and instructions in the general installation and operation sections apply to these instructions. Water heaters are designed for installation with a storage tank. The operation of the circulating pump, proper sizing of the piping between the tank and heater and the control of water velocity, as explained in this section, are important for correct operation of your water heater.

NOTICE

To ensure proper velocity through the heat exchanger, it is necessary to regulate the temperature rise across the heat exchanger from inlet to outlet. This must be done on initial installation and periodically rechecked. With the correct temperature rise across the heat exchanger when the water heater is firing at 100% of rated input, you may be assured of the proper velocity in the tubes. This will yield long life and economical operation from your water heater.

Excessive lime/scale build-up in the heat exchanger tubes is a result of restricted flow and too little velocity in the tubes. Excessive pitting or erosion in the tube is caused by high water flow and too much velocity through the tubes. Care should be taken to measure temperature rise and maintain velocity as follows:

Initial set-up of maximum water flow

On initial start-up of the Copper-fin II the maximum water flow through the heat exchanger must be manually set before normal operation begins.

TABLE - 8A
MAXIMUM WATER FLOW

⚠ CAUTION: The maximum flow rate through a Copper-fin II water heater with a copper heat exchanger must be set to provide and not exceed the following flow:

Model	Maximum Flow
402, 502, 652, and 752	55 GPM
992, 1262, 1442, 1802, and 2072	90 GPM

If higher flow rates are required through the water heater, an optional Cupro Nickel heat exchanger is available. Consult the factory for specific application requirements.

The heat exchanger is capable of operating within the design flow rates required for the water heater, storage tank(s), and connecting piping. Erosion of the finned copper tubes may occur if the flow rate exceeds the maximum allowable flow rate through the water heater. The maximum flow rate through the water heater must be adjusted. Maximum flow on Models 402 - 752 is 55 GPM and 90 GPM on Models 992 - 2072. Flow rate can be determined by measuring the temperature rise through the water heater when it is firing at full rate input.

TABLE - 8B
TEMPERATURE RISE AT FULL RATE FIRE
55 AND 90 GPM FLOW

Model	Temperature Rise °F
402	12
502	15
652	20
752	23
992	19
1262	24
1442	27
1802	34
2072	39

1. The pump must run continuously when the burner is firing.

2. With the pump running and the burner in the water heater in the off cycle, the inlet water temperature and outlet water temperature readings on the Operator Interface should read approximately the same temperatures. Water Temperature Rise on the Operator Interface should read near zero.

3. Turn the water heater on and allow time for the temperature to stabilize. The Service Mode can be used to force the water heater to run at full fire. See the Copper-fin II Service Manual for a detailed explanation of the Service Mode. Check the water temperature rise in the Operator Interface when the burner is firing at 100% of rated input.

4. Compare the water temperature rise in the Operator Interface with the required temperature rise. Should adjustment be needed, proceed as follows.

8 Domestic water heaters *(continued)*

If the temperature rise is too high, the water velocity is too low, adjust as follows:

1. Check for restrictions in the outlet of the water heater.
2. Be sure all valves are open between the water heater and the storage tank. Ensure that all ball valves are fully ported.
3. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction.
4. Check diameter and length of the piping between the storage tank and water heater against the head capacity of the circulating pump.
5. Be sure the pipes between the water heater and storage tank are not less than 2 or 2 1/2 inch (63.5mm) diameter (depending on model). To increase flow and decrease temperature rise, increase the piping to 3 inch (76.2mm) diameter (depending on model) to decrease head loss in the piping to the storage tank.
6. Common manifold piping for multiple unit installations will require larger minimum pipe sizes and tank circulating tappings to ensure proper flow.

If the temperature rise is too low, the water velocity is too high, adjust as follows:

1. Temperature rise can be increased by slowly closing the field-installed ball valve in the outlet piping from the water heater to the storage tank to achieve the proper temperature rise.
2. Sustained high water velocity and low temperature rise may result in pitting or erosion of the copper tubes in the heat exchanger. This is a non-warrantable failure. Temperature rise must be properly adjusted to achieve the specified flow rate.
3. Once temperature rise has been properly set, return to normal operation.

⚠ CAUTION Temperature rise cannot be adjusted when the burner is firing at less than 100% of rated input.

Water chemistry

NOTICE Water temperature rise and maximum flow data is based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm.

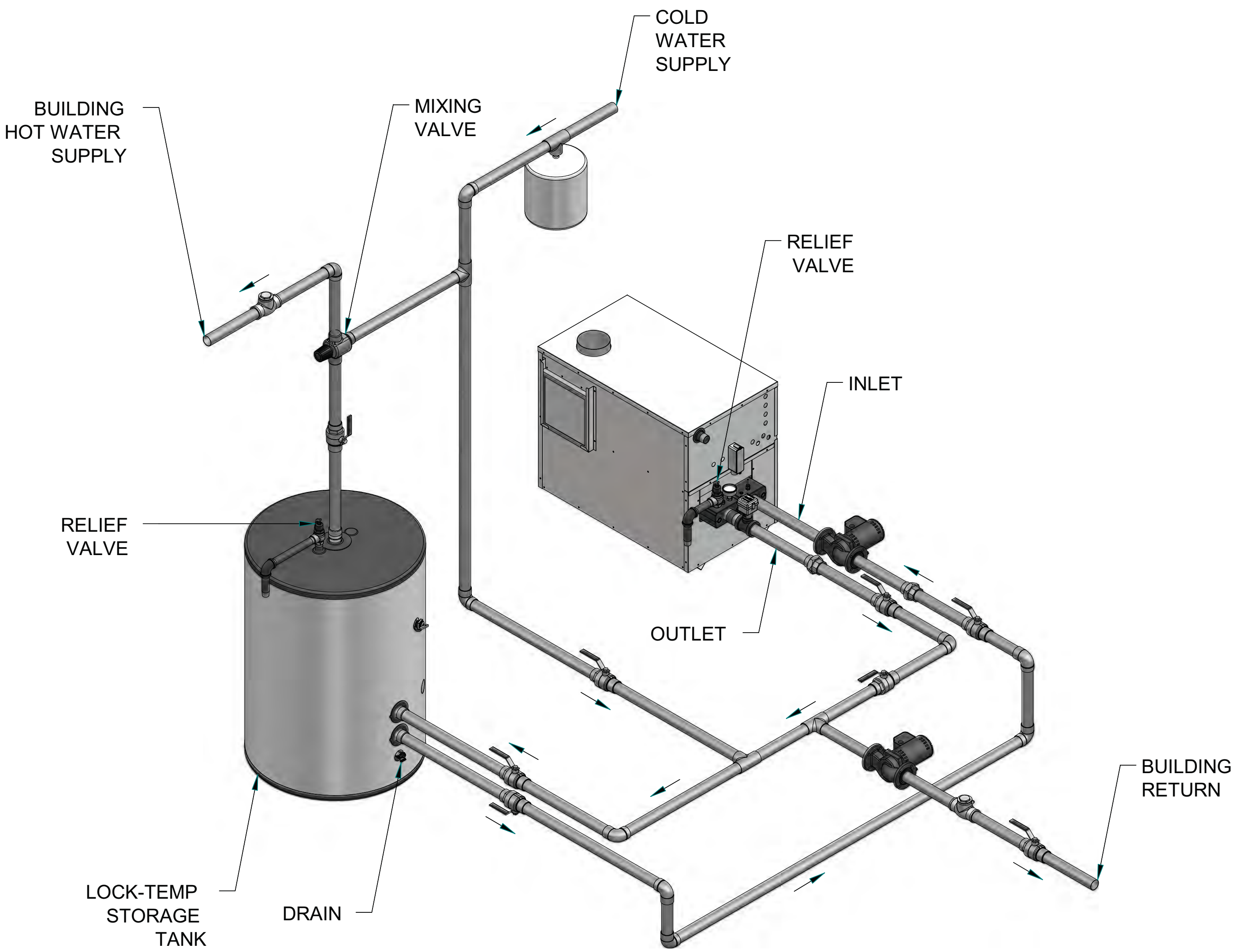
The required temperature rise and the standard circulating pump are sized based on the heating of potable water with a hardness of 5 to 25 grains per gallon and a total dissolved solids not exceeding 350 ppm. Consult the manufacturer when heating potable water exceeding these specifications. Heating of high hardness and/or high total dissolved solids water may require a larger circulating pump, an optional Cupro Nickel heat exchanger and a revised temperature rise specification based on the water chemistry of the water to be heated. Water with a hardness of less than 5 grains per gallon will usually have a pH which can be aggressive and corrosive causing non-warrantable damage to the heater, pump, and associated piping. Corrosion due to water chemistry generally shows up first in the hot water system because heated water increases the rate of corrosive chemical reactions.

8 Domestic water heaters

***Figure 8-1**_Typical Water Heater Piping with Storage Tank*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
1	55	2

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2



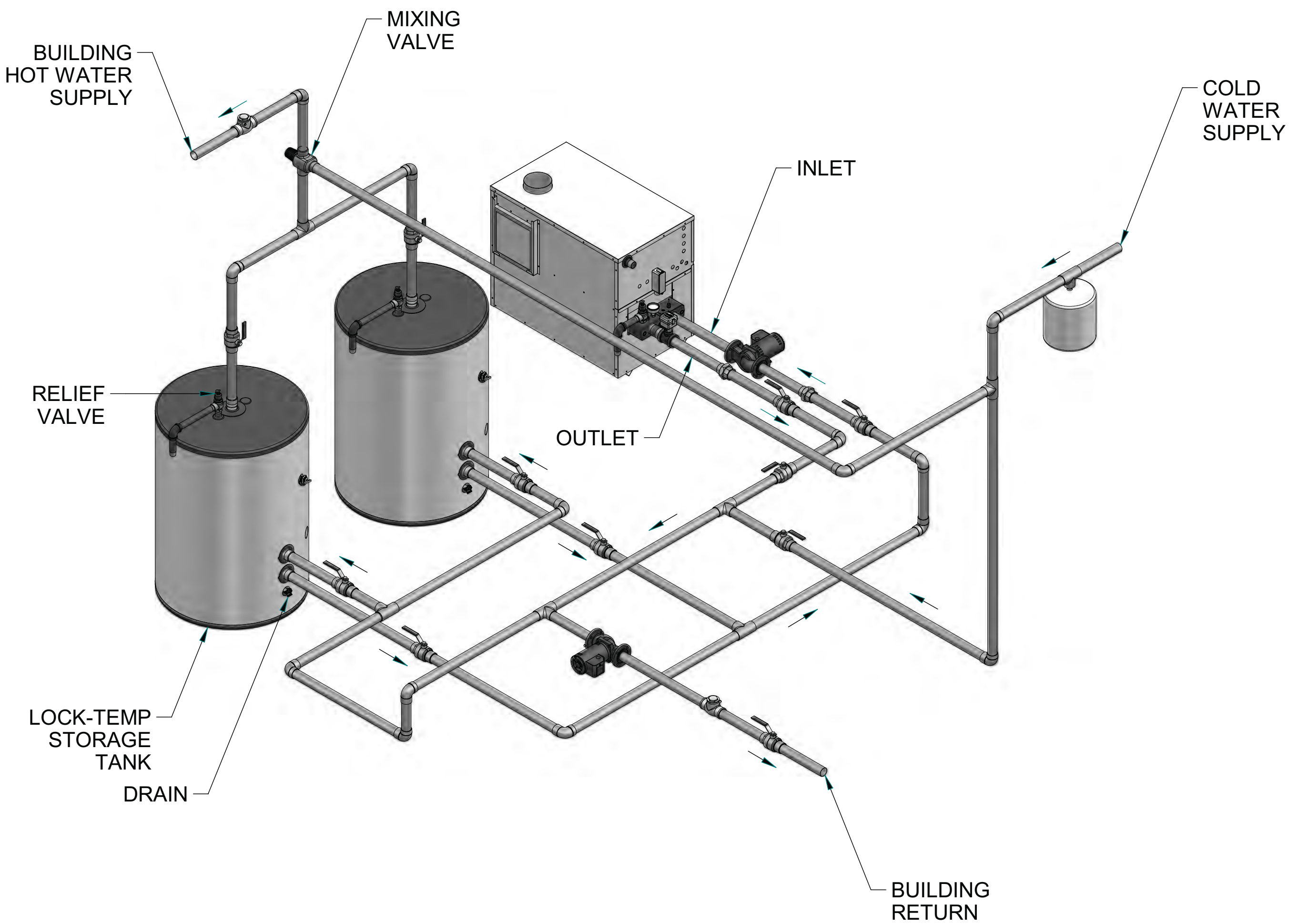
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

8 Domestic water heaters *(continued)*

***Figure 8-2**_Single Water Heater Piping with Two Storage Tanks*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
1	55	2

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
1	90	2 1/2



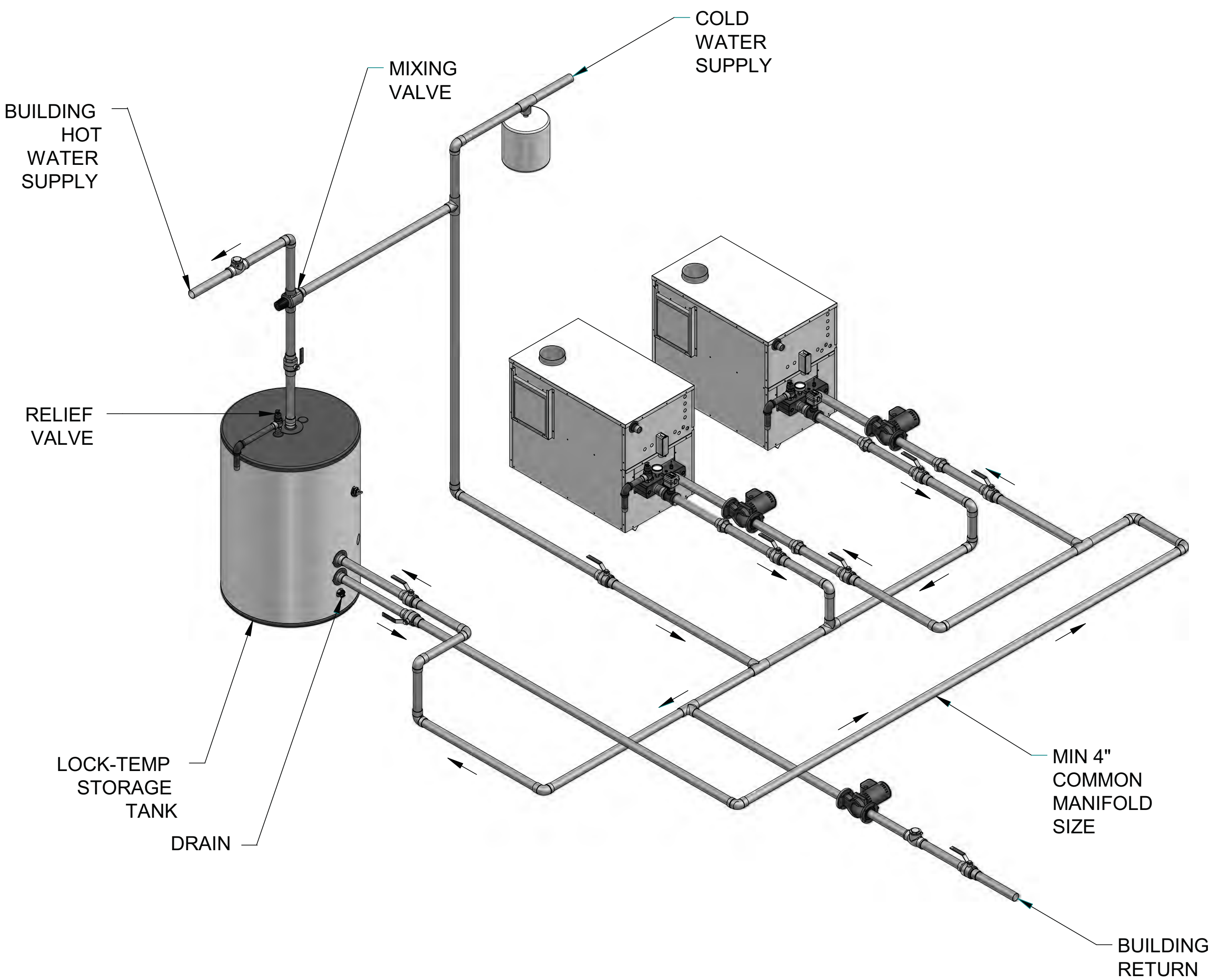
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

8 Domestic water heaters

***Figure 8-3**_Multiple Water Heater Piping with a Single Storage Tank*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	GPM	Diameter (in.)
2	110	3
3	165	3 1/2
4	220	4
5	275	5
6	330	5
7	385	6
8	440	6

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	GPM	Diameter (in.)
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	7
8	720	7



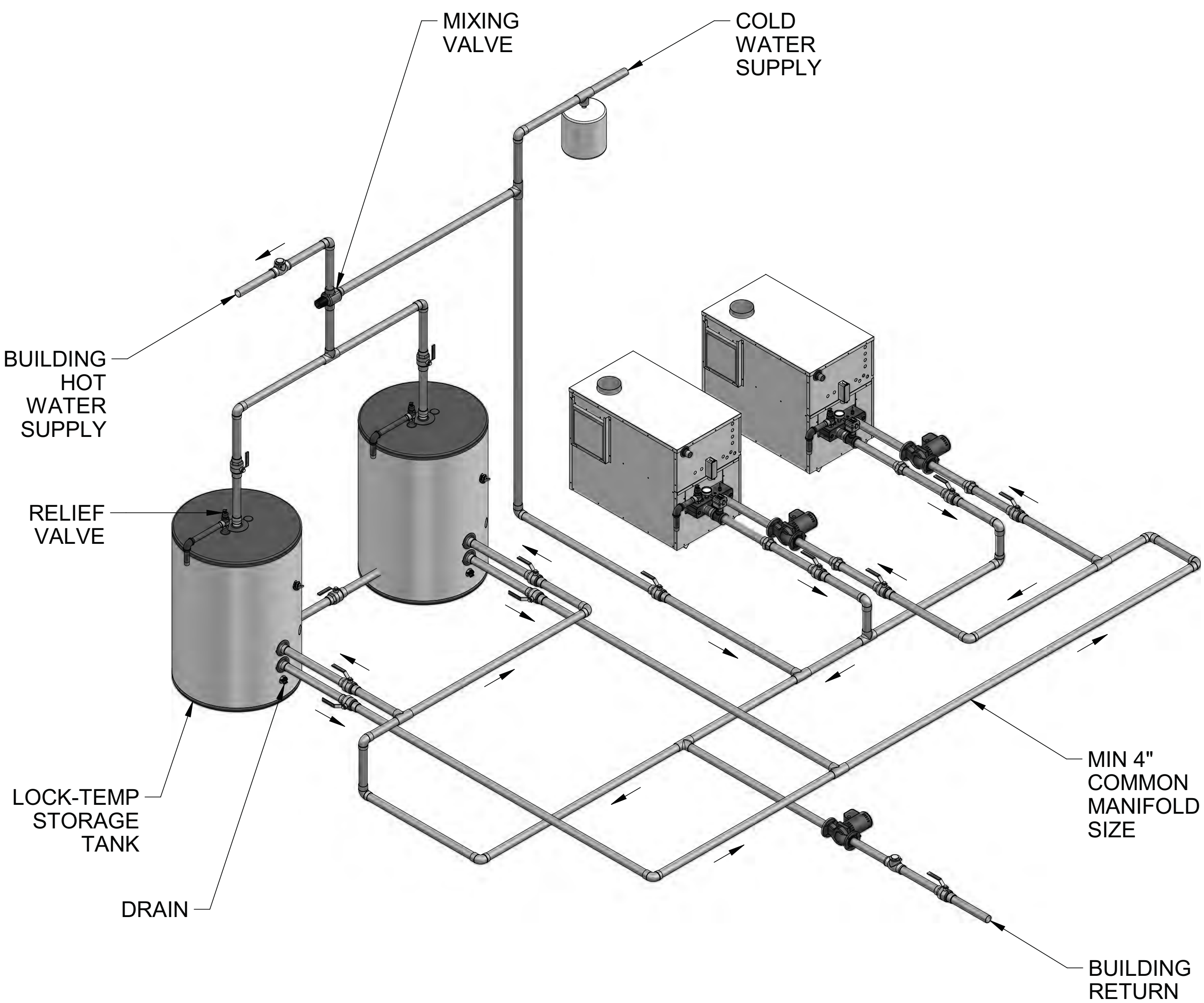
NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

8 Domestic water heaters *(continued)*

***Figure 8-4**_Multiple Water Heater Piping with Multiple Storage Tanks*

COMMON MANIFOLD SIZE (Min.) Models: 402, 502, 652, & 752		
Number of Units	**GPM**	**Diameter (in.)**
2	110	3
3	165	3 1/2
4	220	4
5	275	5
6	330	5
7	385	6
8	440	6

COMMON MANIFOLD SIZE (Min.) Models: 992, 1262, 1442, 1802 & 2072		
Number of Units	**GPM**	**Diameter (in.)**
2	180	4
3	270	5
4	360	6
5	450	6
6	540	6
7	630	7
8	720	7



NOTICE Please note that these illustrations are meant to show system piping concept only, the installer is responsible for all equipment and detailing required by local codes.

8 Domestic water heaters

TABLE 8C COMMON WATER MANIFOLD SIZE FOR MULTIPLE WATER HEATER INSTALLATIONS		
Pipe sizing chart provides minimum pipe size for common manifold piping to ensure adequate flow.		
Number of Water Heaters	**Common Manifold Size (Min.) Models**	
	402 - 752	**992 - 2072**
1	2"	2 1/2"
2	3"	4"
3	3 1/2"	5"
4	4"	6"
5	5"	6"
6	5"	6"
7	6"	7"
8	6"	7"

Pump operation

1. The water heater must have a properly sized circulating pump. This pump is sized to circulate water between the heater and the storage tank only.

2. The pump is sized to the heater input and water chemistry specifications noted in the Water Chemistry section on page 63.

3. The diameter and length of the piping installed between the storage tank(s) and water heater must be properly sized based on the capacity of the circulating pump.

4. The pump must run continuously when the water heater is energized. This is the standard operating system for a water heater.

A pump delay control function with an all bronze pump is installed as standard equipment on all water heater systems. The pump will operate only while there is a "Call for Heat" and for a timed period after the water temperature set point is satisfied to remove any residual heat from the combustion chamber.

5. Lubricate pump to manufacturer's recommendations. Pump damage due to inadequate lubrication is non-warrantable.

The tank sensor must be installed in the tapping provided in the lower 25% of the storage tank to achieve proper operation. As shipped from the factory, the tank sensor is in the literature package shipped with the unit. Placing the sensor in the tapping provided on the storage tank will improve temperature response and prevent short cycles of operation.

The standard circulating pump on this water heater is sized based on installation of a single storage tank and heater in close proximity. If the number of fittings and straight pipe exceeds the specified maximum equivalent number of straight feet for a specified diameter of pipe, non-warrantable operational problems may be experienced.

402 - 752 Models
1/4 HP, 120 VAC, 5.8 Amps

992 - 2072 Models
1/2 HP, 120 VAC, 7.4 Amps

The standard pump selection is based on the following pipe and fittings from the water heater to the storage tank:

6 - 90° elbows	2 - ball valves
2 - unions	1 - cold water tee

Not more than 45 feet of straight pipe.
For every elbow and tee in excess of those shown above, DEDUCT 6.5 FEET from the maximum allowable straight pipe in the heater to tank circulating loop.

TABLE D MINIMUM PUMP PERFORMANCE		
Based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm. See *Water Chemistry* section on page 63.		
Model	**GPM**	**Ft. Hd.**
402 - 502 - 652 - 752	55	10
992 - 1262 - 1442 - 1802 - 2072	90	15

When installing multiple water heaters and/or multiple storage tanks, the diameter of the inter-connecting pipe and all fittings must be increased. An increase in pipe diameter will decrease head loss in the system piping and ensure proper flow. Proper pipe size between the heater and storage tank **MUST** be maintained to ensure that the standard pump supplied on the water heater will maintain desired flow.

When DHW Night Setback is enabled, the system pump output can be used to control a building circulation pump. The pump output will be on during the time Night Setback is not active and will be off when Night Setback is active. A field installed contactor must be used when controlling a circulation pump larger than 1/6 HP.

Heat exchanger

On all models, header inspection plugs in the heat exchanger can be removed for field inspection and cleaning of copper tubes. The heat exchanger may be removed from the unit.

8 Domestic water heaters *(continued)*

Thermostat adjustment procedure

1. Press the UP or DOWN key to view the set point setting.

2. Press either the UP or DOWN key to increase or decrease the displayed set point value.

3. Press the ENTER key to permanently store the new set point into the control module's memory.

Failure to press the ENTER key after changing the display value will result in the set point reverting back to its previous value after the current heat demand ends.

The control may be adjusted any time regardless of call for heat status. When pressing the UP or DOWN key to enter any new set points, the control module will immediately begin controlling based on the new set point.

Minimum water temperatures (domestic hot water use)

Domestic water temperatures:

This high efficiency water heater should be operated at a temperature setting high enough to prevent condensing of the products of combustion on the unit's heat exchanger or in the attached venting system. Use extreme caution when storing water at elevated temperatures. A water temperature setting maintained above the dew point of the products of gas combustion should prevent condensate formation and ensure proper performance of the venting system. The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F (60°C). Storing the water at a higher temperature and thermostatically mixing the water will increase the available quantity of mixed hot water, greatly reducing the possibility of condensate formation on the heat exchanger or in the venting system and help prevent the growth of water borne bacteria.

NOTICE

Adequate care **MUST** be taken to prevent a potential scald injury when storing water at elevated temperatures for domestic use.

Inlet water temperatures below the specified minimum recommendations can excessively cool the products of combustion resulting in condensation on the heat exchanger. Condensation on the heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components.

⚠ CAUTION

An appliance allowed to operate at return temperatures below the specified minimum setting may experience problems with the operating controls, safety switches, obstruction of the flue gas passages on the heat exchanger, incomplete combustion, and possible flue gas spillage. Sustained operation at lower than specified water temperatures may cause hazardous conditions that may result in personal injury or non-warrantable damage to the appliance.

The maximum temperature set point that can be programmed into the control module from the Operator Interface for water heater operation is 190°F (88°C). The control is factory pre-set at approximately 120°F (49°C). Facilities with small children or invalids may require 120°F (49°C) or a lower temperature setting to reduce risk of scald injury. Some states may require a lower temperature setting. Check with your gas supplier for local requirements governing the temperature setting. Remember, no water heating system will provide exact temperature at all times. Allow a few days of operation at this setting to determine the correct temperature setting consistent with your needs.

NOTICE

1. This water heater, when set at the lower temperature setting, is not capable of producing hot water of sufficient temperature for sanitizing purposes.

2. Higher stored water temperature increases the ability of the water heater to supply desired quantities of hot water, however remember --

⚠ CAUTION

Hotter water increases the risk of scald injury.

8 Domestic water heaters

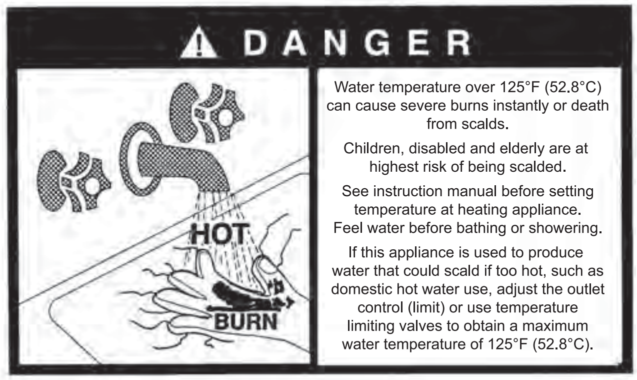


***Figure 8-5**_Danger Warning*

Location of Cold Water Supply Piping Connections

Incorrect piping of the cold water supply to the system may result in excessive low temperature operation causing condensate formation on the primary heat exchanger and operational problems. The cold water supply piping must be installed in the discharge piping from the heater to the storage tank. This allows the cold water to be tempered in the storage tank before entering the heater. See typical installation drawings provided in this manual for correct piping (FIG.'s 8-1 thru 8-4). Higher water temperatures reduce the volume of condensate formed.

⚠ CAUTION Setting the temperature selector to higher settings provides hotter water, which increases the risk of scald injury.

⚠ WARNING Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

Optional adjustable auxiliary high water temperature limit control

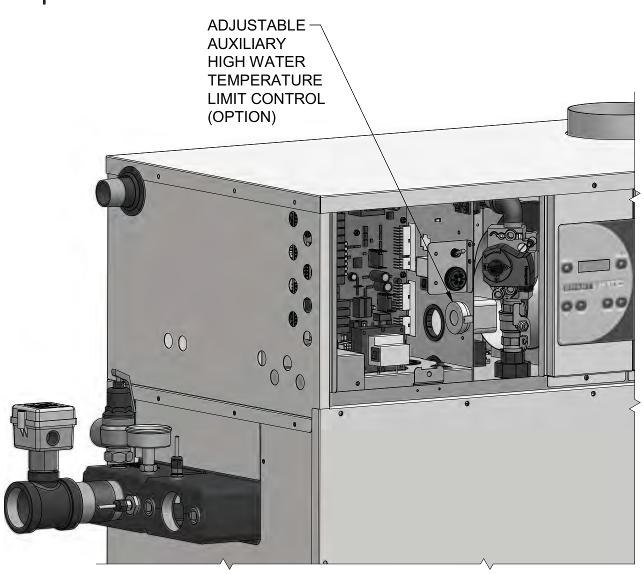


***Figure 8-6**_Adjustable Auxiliary High Water Temperature Limit Control*

A high limit control is located on the inside of the left front panel, as shown in FIG. 8-6. The setting of this control knob limits maximum discharge water temperature. The water heater temperature limit control is adjustable up to a maximum setting of 210°F (99°C). This water heater also includes a fixed high water temperature limit control set to 200° (93.3°C). The RESET key on the display must be pushed whenever water temperature has exceeded the set point of the limit. The temperature of the water in the heat exchanger must drop a minimum of 15°F (8.3°C) below the setting of the high limit control before the reset function can be activated. A high limit message will be shown in the Operator Interface when water temperature exceeds the high water temperature limit control set point.

NOTICE The high limit control will not reset until the water temperature has dropped below the set point of the high limit.

Optional relief valve

This water heater is normally supplied with a temperature and pressure relief valve sized in accordance with applicable codes. Units may be supplied with an optional pressure only relief valve. When a water heater is equipped with this optional relief valve and is piped to a separate storage vessel, the storage vessel must have a properly installed temperature and pressure relief valve which complies with local codes.

Thermal expansion

A relief valve that discharges periodically may be due to thermal expansion in a closed system. A water heater installed in a closed system, such as one with a backflow preventer or check valve installed in the cold water supply, shall be provided with means to control expansion. Contact the water supplier or local plumbing inspector on how to correct this situation. Never plug or cap the relief valve discharge.

Cathodic protection

Hydrogen gas can be produced in a hot water system that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To prevent the possibility of injury under these conditions, we recommend the hot water faucet be open for several minutes at the kitchen sink before you use any electrical appliance which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipe as the hot water begins to flow. There should be no smoking or open flames near the faucet at the time it is open.

9 Maintenance

Maintenance and annual startup

***Table 9A**_Service and Maintenance Schedules*

Service technician (see the following pages for instructions)	
ANNUAL START-UP	**General:** • Address reported problems • Inspect interior; clean and vacuum if necessary; • Check for leaks (water, gas, flue, condensate) • Examine venting system • Check system water pressure/system piping/expansion tank • Check control settings • Check igniter • Check wiring and connections • Check flue gas passageways • Flame inspection (stable, uniform) • Inspect and clean the burner • Check manifold gas pressure • Perform start-up checkout and performance verification per Section 6 in the Copper-fin II Installation and Operation Manual. **If combustion or performance indicate need:** • Clean heat exchanger with a stiff bristle brush • Remove and clean burners using water. Dry before re-assembling. • Clean the blower wheel with a brush and vacuum. Do not let dirt from cleaning get pulled into the blower.

Owner maintenance (see the Copper-fin II User's Information Manual for instructions)	
Daily	• Check appliance area • Check pressure/temperature gauge
Monthly	• Check vent piping • Check air piping • Check relief valve • Replace combustion air filter **Note:** More frequent replacement may be necessary in dirty environments.
Periodically	• Test low water cutoff (if used) • Reset button (low water cutoff)
Every 6 months	• Check appliance piping (gas and water) for leaks • Operate relief valve
End of season months	• Shut appliance down (unless boiler used for domestic hot water)

9 Maintenance

⚠ WARNING Follow the service and maintenance procedures given throughout this manual and in component literature shipped with the appliance. Failure to perform the service and maintenance could result in damage to the appliance or system. Failure to follow the directions in this manual and component literature could result in severe personal injury, death, or substantial property damage.

⚠ WARNING The appliance should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the appliance designated in Table 9A and explained on the following pages must be performed to assure maximum appliance efficiency and reliability. Failure to service and maintain the appliance and system could result in equipment failure.

⚠ WARNING Electrical shock hazard – Turn off power to the appliance before any service operation on the appliance except as noted otherwise in this instruction manual. Failure to turn off electrical power could result in electrical shock, causing severe personal injury or death.

Address reported problems

1. Inspect any problems reported by the owner and correct before proceeding.

Inspect appliance area

1. Verify that appliance area is free of any combustible materials, gasoline and other flammable vapors and liquids.

Inspect appliance interior

1. Remove the outer access panels and inspect the interior of the appliance.
2. Vacuum any sediment from inside the appliance and components. Remove any obstructions.

Check all piping for leaks

⚠ WARNING Eliminate all system or appliance leaks. Continual fresh makeup water will reduce appliance life. Minerals can build up in sections, reducing heat transfer, overheating heat exchanger, and causing heat exchanger failure. Leaking water may also cause severe property damage.

1. Inspect all water and gas piping and verify to be leak free.
2. Look for signs of leaking lines and correct any problems found.
3. Check gas line using the procedure found in *Section 3 - Gas Connections* of the Copper-fin II Installation and Operation Manual.

Flue vent system and air piping

1. Check for gastight seal at every connection, seam of air piping, and vent piping periodically inspected by a qualified service agency.

⚠ WARNING Venting system must be sealed gastight to prevent flue gas spillage and carbon monoxide emissions, which will result in severe personal injury or death.

Check water system

1. Verify all system components are correctly installed and operational.
2. Check the cold fill pressure for the system. Verify it is correct (must be a minimum of 12 PSI).
3. Watch the system pressure as the boiler heats up (during testing) to ensure pressure does not rise too high. Excessive pressure rise indicates expansion tank sizing or performance problem.
4. Inspect automatic air vents and air separators. Remove air vent caps and briefly press push valve to flush vent. Replace caps. Make sure vents do not leak. Replace any leaking vents.

Check expansion tank

1. Expansion tanks provide space for water to move in and out as the heating system water expands due to temperature increase or contracts as the water cools. Tanks may be open, closed, diaphragm or bladder type. See *Section 4 - Water Connections* of the Copper-fin II Installation and Operation Manual for suggested best location of expansion tanks and air eliminators.

9 Maintenance *(continued)*

Check relief valve

1. Inspect the relief valve and lift the lever to verify flow. Before operating any relief valve, ensure that it is piped with its discharge in a safe area to avoid severe scald potential. Read *Section 4 - Water Connections* of the Copper-fin II Installation and Operation Manual before proceeding further.

⚠ WARNING Safety relief valves should be re-inspected AT LEAST ONCE EVERY THREE YEARS, by a licensed plumbing contractor or authorized inspection agency, to ensure that the product has not been affected by corrosive water conditions and to ensure that the valve and discharge line have not been altered or tampered with illegally. Certain naturally occurring conditions may corrode the valve or its components over time, rendering the valve inoperative. Such conditions are not detectable unless the valve and its components are physically removed and inspected. This inspection must only be conducted by a plumbing contractor or authorized inspection agency – not by the owner. Failure to re-inspect the boiler relief valve as directed could result in unsafe pressure buildup, which can result in severe personal injury, death, or substantial property damage.

⚠ WARNING Following installation, the valve lever must be operated AT LEAST ONCE A YEAR to ensure that waterways are clear. Certain naturally occurring mineral deposits may adhere to the valve, rendering it inoperative. When manually operating the lever, water will discharge and precautions must be taken to avoid contact with hot water and to avoid water damage. Before operating lever, check to see that a discharge line is connected to this valve directing the flow of hot water from the valve to a proper place of disposal. Otherwise severe personal injury may result. If no water flows, valve is inoperative. Shut down the appliance until a new relief valve has been installed.

2. After following the above warning directions, if the relief valve weeps or will not seat properly, replace the relief valve. Ensure that the reason for relief valve weeping is the valve and not over-pressurization of the system due to expansion tank waterlogging or undersizing.

Inspect/replace hot surface igniter

This unit uses a proven SMART SYSTEM control module and a hot surface igniter. The SMART SYSTEM control module is not repairable. Any modification or repairs will invalidate the warranty.

⚠ WARNING Do not attempt to repair a faulty hot surface igniter or control module. Any modification or repairs may create hazardous conditions that result in property damage, personal injury, fire, explosion and/or toxic gases.

A faulty hot surface igniter or control module must be replaced with an identical part. A specification igniter and control module for this specific unit is available from your local distributor. **Do not use general purpose field replacement control modules or igniters.**

Ignition system checkout

1. Turn off gas supply to unit.
2. Turn electric power on.
3. Adjust the set point on the temperature control to a setting above water temperature or to the highest safe setting.
4. The igniter will cycle on trial for ignition.
5. The control module will lock out and turn the alarm light on.
6. Adjust the Set Point Differential and High-Fire Offset to the desired settings.
7. Turn on gas supply.
8. Press the RESET button at the electronic display panel to reset the control module.
9. If ignition system fails to operate properly, repair work must be performed by a qualified service person or installer.

Check all wiring

1. Inspect all wiring, making sure wires are in good condition and securely attached.

Check control settings

1. Set the SMART SYSTEM control module display to Parameter Mode and check all settings. See Section 1 of this manual. Adjust settings if necessary. See Section 1 of this manual for adjustment procedures.
2. Check settings of external limit controls (if any) and adjust if necessary.

9 Maintenance

Perform start-up and checks

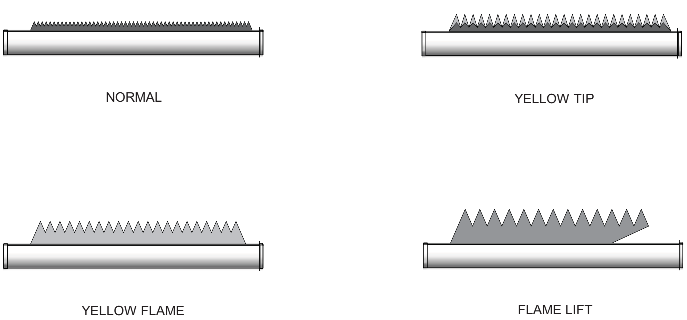
1. Start appliance and perform checks and tests specified in *Section 7 - Start-up* of the Copper-fin II Installation and Operation Manual.
2. Verify cold fill pressure is correct and that operating pressure does not go too high.

Check burner flame

Visually check main burner flames at each start-up after long shutdown periods or at least every six months. A burner viewport is located on the burner mounting flange.

⚠ WARNING The area around the burner viewport is hot and direct contact could result in burns.

Figure 9-2*_Flame Pattern Illustration*



Normal Flame: A normal flame at 100% of burner input is blue, with slight yellow tips, a well defined flame and no flame lifting.

Yellow Tip: Yellow tipping can be caused by blockage or partial obstruction of air flow to the burner.

Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner or excessive gas input. This condition MUST be corrected immediately.

Lifting Flames: Lifting flames can be caused by over firing the burner, excessive primary air or high draft.

If improper flame is observed, examine the venting system, ensure proper gas supply and adequate supply of combustion and ventilation air.

Check flue gas passageways

Any sign of soot around the inner jacket, outer jacket, flue pipe connections, burner or in the areas between the fins on the copper heat exchanger indicates a need for cleaning. The following cleaning procedure must only be performed by a qualified serviceman or installer. Proper service is required to maintain safe operation. Properly installed and adjusted units seldom need flue cleaning.

NOTICE All gaskets/sealants on disassembled components or jacket panels must be replaced with new gaskets/sealants on reassembly. Gasket and sealant kits are available from your distributor.

⚠ CAUTION When a Category IV vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

Inspect and clean burner

1. Turn off main power to unit.
2. Turn off main manual gas shutoff to unit.
3. Remove the front outer jacket panels.
4. Disconnect manifold from gas train using union(s) just below each gas valve(s).
5. Remove mounting screws from manifold mounting brackets. Pull the manifold/orifice assembly away from burners. Repeat for each manifold assembly.
6. Remove two mounting screws from burner and slide burner out toward front of unit. Use caution to prevent damage to burners, refractory, hot surface igniter or wiring.
7. Remove soot from burners with a stiff bristle brush.

   Dirt may be removed from burner ports by rinsing the burner thoroughly with water. Drain and dry burners before re-installing. Damaged burners must be replaced.

When installed in a dusty and dirty location, the burners may require cleaning on a 3 to 6 month schedule or as needed, based on severity of contamination. Contaminants can be drawn in with the combustion air. Non combustible particulate matter such as dust, dirt, concrete dust or dry wall dust can block burner ports and cause non-warrantable failure. The standard inlet air filter will help eliminate dust and dirt from entering the unit. Use extreme care when operating a unit for temporary heat during new construction. The burners could require a thorough cleaning before the unit is placed in service.

9 Maintenance *(continued)*

Inspect and clean the heat exchanger

1. While burners are removed, check the heat exchanger surface for sooting. If present, heat exchanger must be cleaned and problem corrected. Proceed as follows.
2. Remove gas manifold(s)/orifice assemblies as described in steps 1 through 5 in Burner Removal and Cleaning, page 74.
3. Disconnect wiring from the hot surface igniter and hose from the burner pressure tap.
4. Remove inner jacket panel mounting screws and slide door assembly out toward front of the unit. Use caution to prevent damage to the refractory and hot surface igniter.
5. Check "V" baffles and frame runners along front and back edges of heat exchanger. Remove and clean if necessary.
6. Remove soot from heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.
7. The heat exchanger can be removed by sliding towards the front of the unit. Once the heat exchanger is removed from the unit, a garden hose can be used to wash the tubes to ensure that all soot is removed from the heat exchanger surfaces. Note: Do not wet the unit's refractory.
8. Ensure that all burner ports are cleaned to remove any soot. See Burner Removal and Cleaning, page 74.
9. Carefully reinstall the heat exchanger, "V" baffles, and frame runners if removed from the unit. Note: Make sure frame runners seal securely where they contact the front and rear compartment refractory.
10. Carefully reinstall inner jacket panels, burners, manifolds, wires and hoses. Use new gasket material to ensure a proper air seal.
11. Reassemble all gas and water piping. Test for gas leaks.

NOTICE

Upon completion of any testing on the gas system, leak test all gas connections with a soap and water solution while main burners are operating. Do not spray soap and water solution on the SMART SYSTEM control module housing. The use of an excessive amount of soap and water solution can damage the control. Immediately repair any leak found in the gas train or related components. Do not operate an appliance with a leak in the gas train, valves, or related piping.

12. Reassemble outer jacket panels.
13. Cycle unit and check for proper operation.

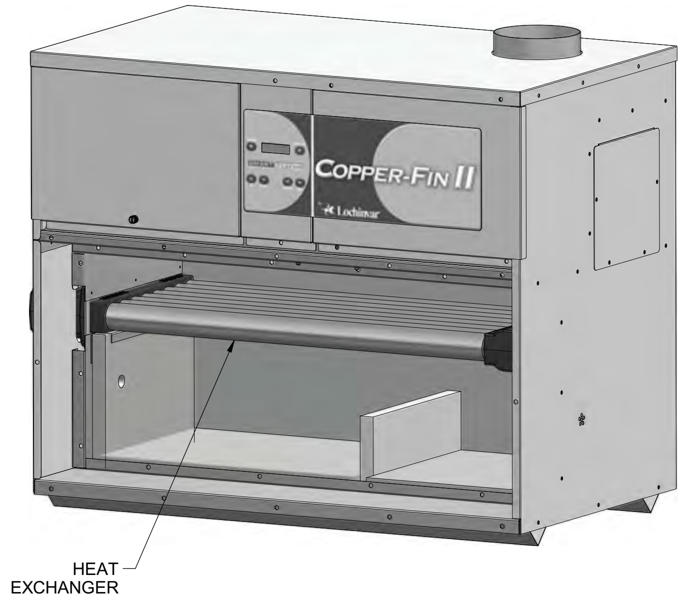


***Figure 9-3**_Location of the Heat Exchanger Inside Jacket*

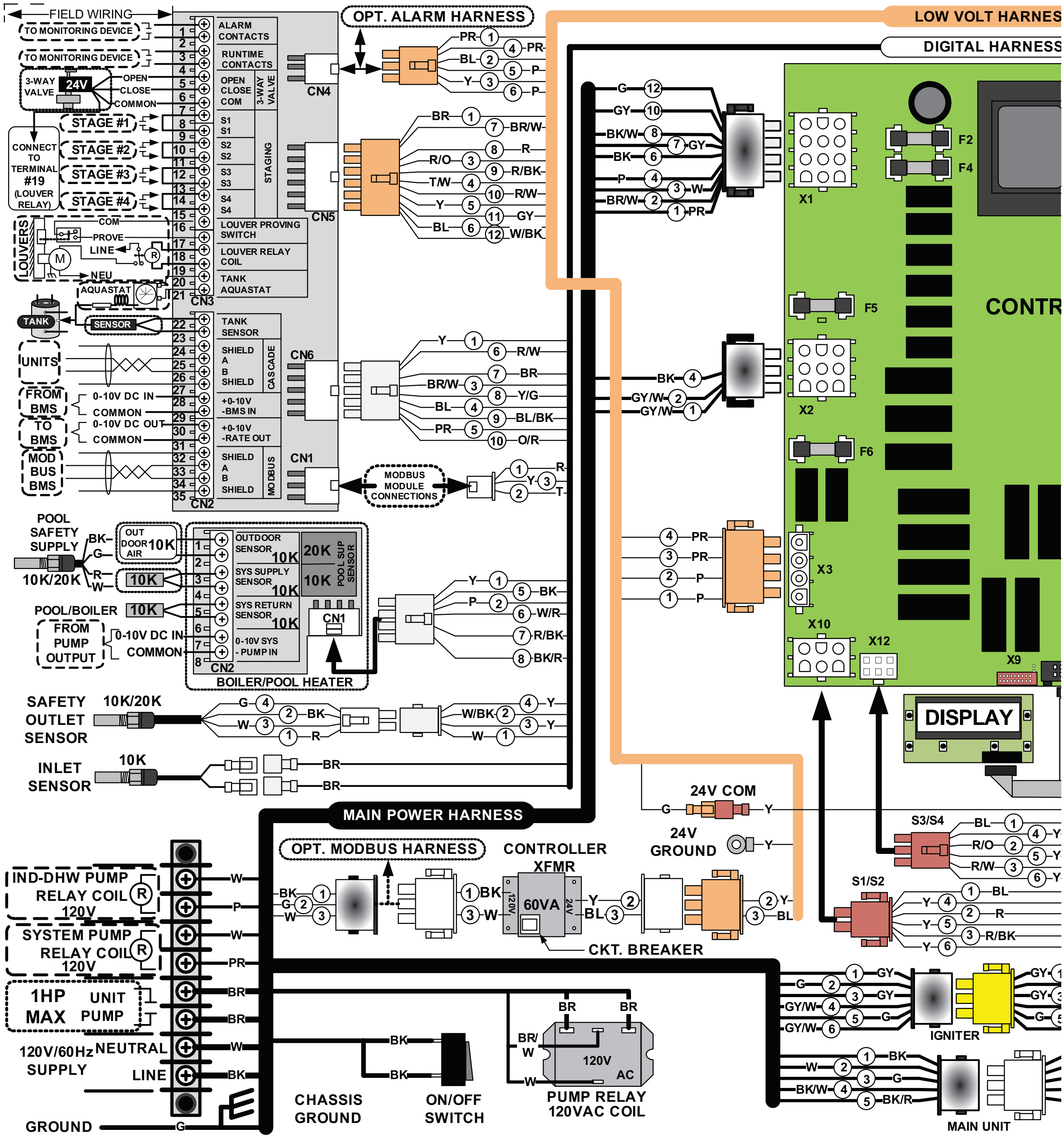
Review with owner

1. Review the Copper-fin II User's Information Manual with the owner.
2. Emphasize the need to perform the maintenance schedule specified in the Copper-fin II User's Information Manual (and in this manual as well).
3. Remind the owner of the need to call a licensed contractor should the appliance or system exhibit any unusual behavior.
4. Remind the owner to follow the proper shutdown procedure and to schedule an annual start-up at the beginning of the next heating season.

Oiled bearing circulators

Inspect the pump every six (6) months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by the pump manufacturer.

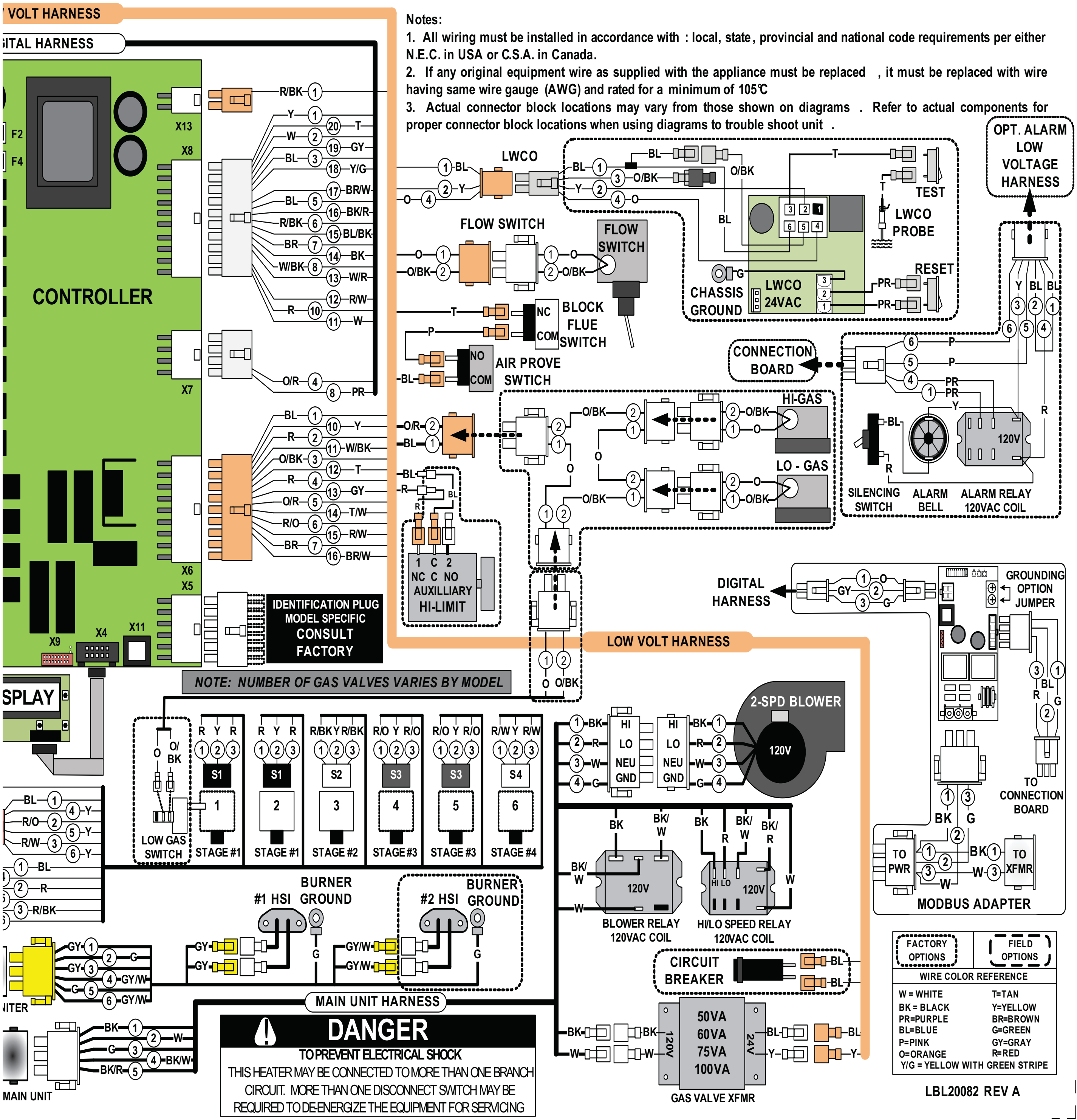
10 Connection diagram



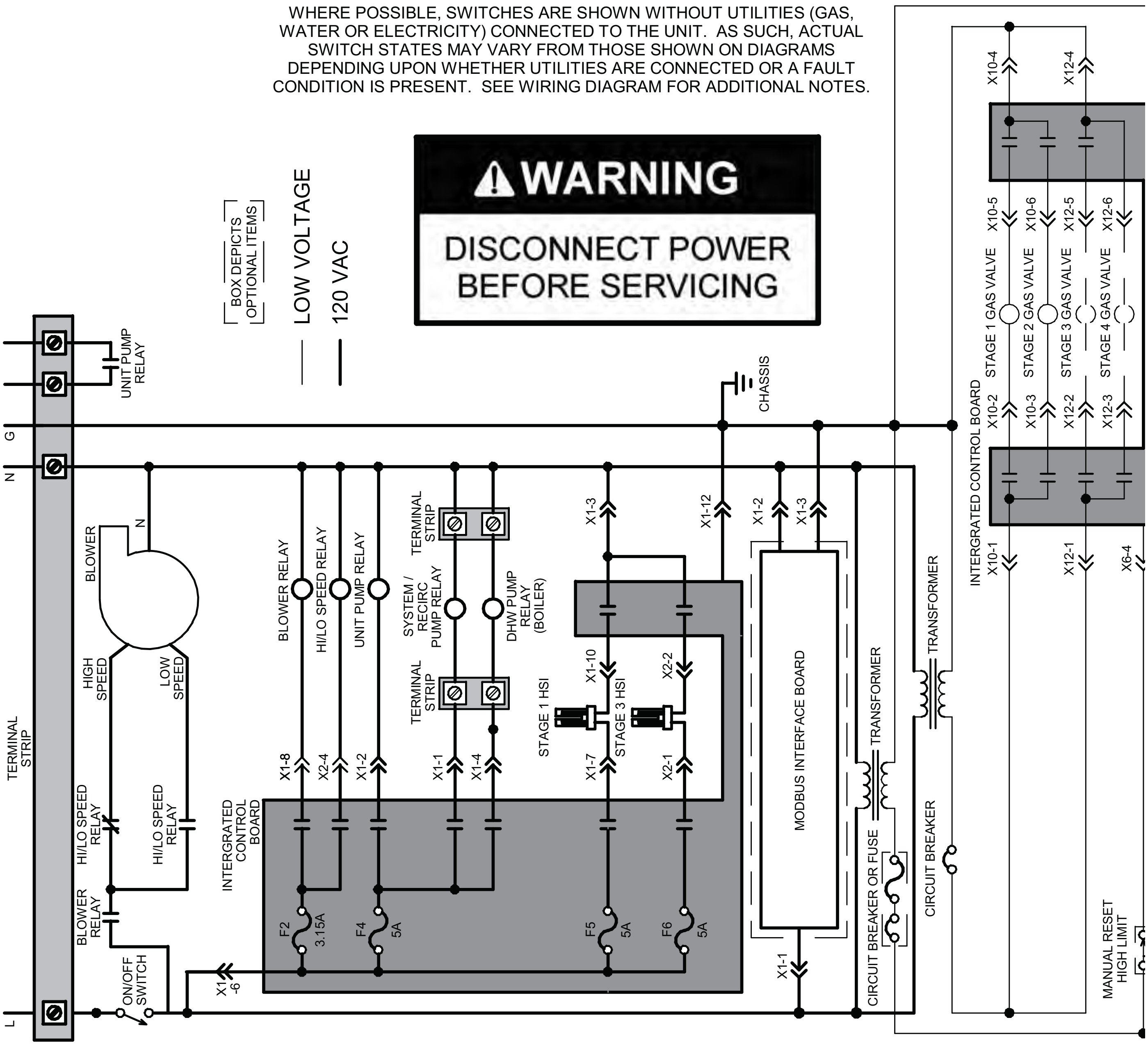
10 Connection diagram *(continued)*

Notes:

1. All wiring must be installed in accordance with : local, state, provincial and national code requirements per either N.E.C. in USA or C.S.A. in Canada.
2. If any original equipment wire as supplied with the appliance must be replaced , it must be replaced with wire having same wire gauge (AWG) and rated for a minimum of 105℃
3. Actual connector block locations may vary from those shown on diagrams . Refer to actual components for proper connector block locations when using diagrams to trouble shoot unit .

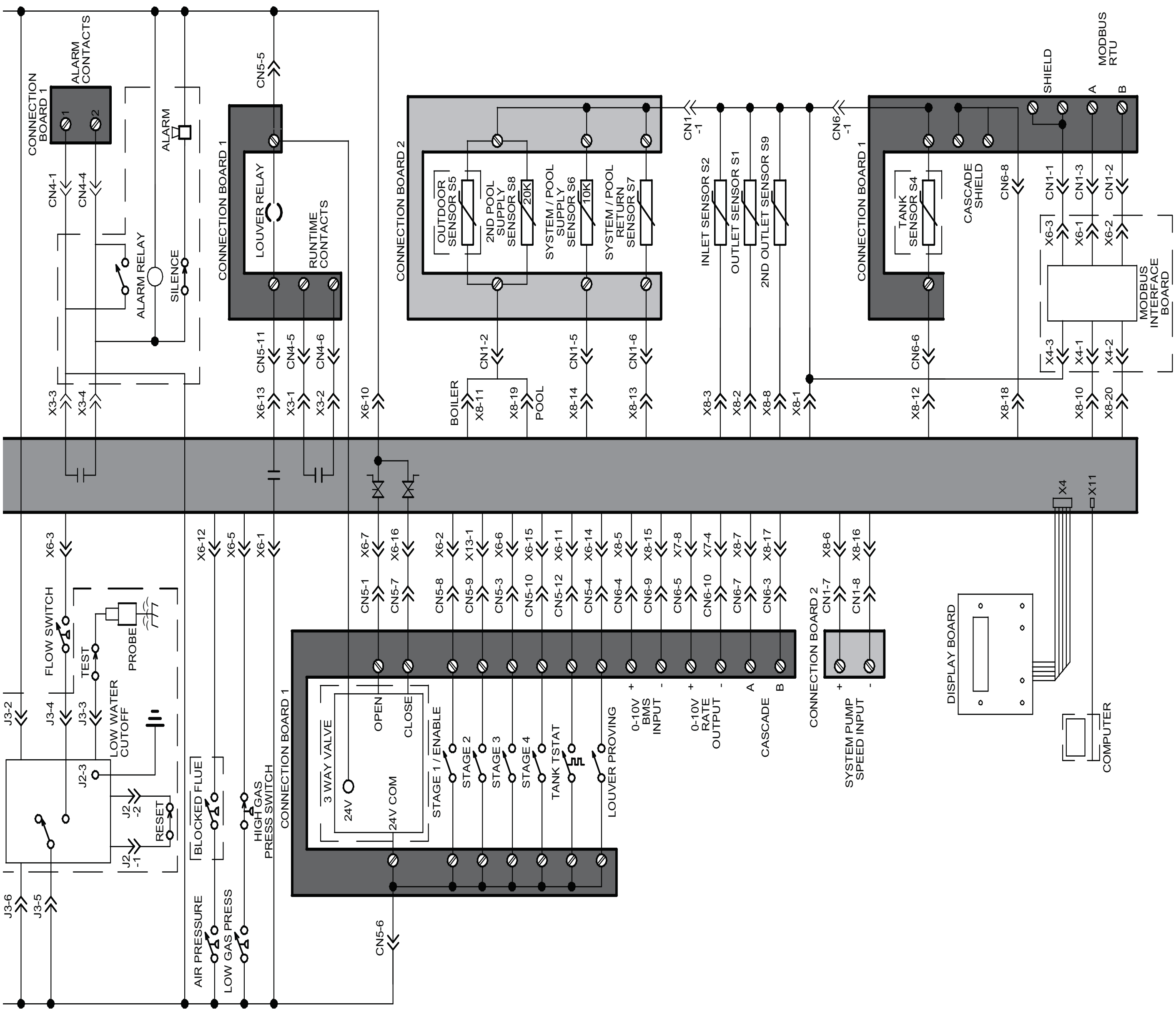


11 Ladder diagram



MECH - 93

11 Ladder diagram *(continued)*



LBL20083 REV B

__Revision Notes:__ Revision A (ECO #C08226) initial release.

Revision B (ECO C09691) reflects the update of AHRI and ASME logos on page 8.

Revision C (ECO C11124) reflects the modification of ignition timing information on pages 55 and 58 as well as the addition of VAL30002 in Table 4A on page 36.

Revision D (ECO C11706) reflects the update of heat exchanger information on page 68 and system return sensor information on page 45.

Revision E (ECO C12972) reflects the addition of the CSA Low Lead Content logo.

Revision F (ECO C16918) reflects the update of the ratings tables on page 8 as well as changes made to Table 3D - Gas Piping Chart on page 33 (R6621).

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters
300 Maddox Simpson Parkway
Lebanon, TN 37090
615-889-8900 / Fax: 615-547-1000
www.Lochinvar.com

CFX-CHX-I-O Rev F
01/15

ARMSTRONG VERTICAL IN_LINE PUMPS

Operations & Maintenance Manual
December 2015

ARMSTRONG

SERIES 4360 IN-LINE PUMPS
INSIDE MECHANICAL SEAL | 3D | SUBMITTAL

File No: 43.611
Date: NOV. 26, 2014
Supersedes: 43.611
Date: MAR. 15, 2012

Job: ______________________________

____

Engineer: ______________________________

Contractor: ______________________________

Representative: ______________________________

Ordered by: ______________________ Date: __________

Submitted by: ______________________ Date: __________

Approved by: ______________________ Date: __________

PUMP DESIGN DATA

No. of pumps: __________ Tag: __________

Capacity: ______ USgpm (L/s) Head: __________ ft (m)

Liquid: __________ Viscosity: __________

Temperature: ________ °F (°C) Specific Gravity: __________

Suction: 3"(75mm) Discharge: 3"(75mm)

MOTOR DESIGN DATA

HP: ______ RPM: ______ Frame size: ______ Enclosure: ______

Volts: __________ Hertz: 60 Hz Phase: 3

Efficiency*: ☐ Standard ☐ Energy EFF 12.11

☐ NEMA premium 12.12

* Frame 56 motors: Standard Efficiency only.
JM motors: 12.11 or 12.12

MATERIALS OF CONSTRUCTION

PART NAME	■ BRONZE FITTED		■ ALL IRON		■ ALL BRONZE	
Casing	Cast iron		Cast iron		Bronze	
Impeller	Bronze		Cast iron		Bronze	
Companion flanges	Cast iron		Cast iron		Bronze	
Pump/motor bracket	Cast iron		Cast iron		Bronze	
Motor frame	☐ 56c	☐ JM	☐ 56c	☐ JM	☐ 56c	☐ JM
Stub shaft	Stainless steel	NA	Stainless steel	NA	Stainless steel	NA
Shaft sleeve	NA	Bronze	NA	St Steel	NA	Bronze

OPTIONAL EQUIPMENT

MECHANICAL SEAL DATA

Seal Type: 2A
Secondary Seal: EPDM
Spring: Stainless steel
Stationary Seat: Silicone carbide
Rotating Hardware: Stainless steel

MAXIMUM PUMP OPERATING CONDITIONS

ANSI 125

175 psig at 150°F (12 bars at 65°C)

140 psig at 250°F (10 bars at 121°C)

ANSI 250

300 psig at 150°F (20 bars at 65°C)

250 psig at 250°F (17 bars at 121°C)

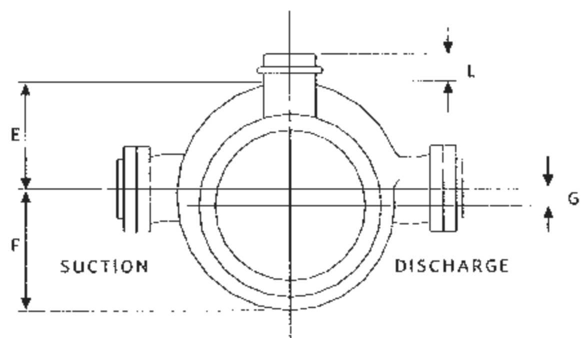
FLUID TYPE	ALL GLYCOLS > 30% WT CONC		ALL OTHER NON-POTABLE FLUIDS		POTABLE (DRINKING) WATER	
Temperature	up to 200°F (93°C)	over 200°F (93°C)	up to 200°F (93°C)	over 200°F (93°C)	up to 200°F (93°C)	over 200°F (93°C)
Rotating Face	Silicone carbide		Resin bonded carbon	Antimony loaded carbon	Resin bonded carbon	
Seat Elastomer	EPDM (L-cup)	EPDM (O-ring)	EPDM (L-cup)	EPDM (O-ring)	EPDM (L-cup)	EPDM (O-ring)
Material Code	SCsc L EPSS 2A	SCsc O EPSS 2A	C-sc L EPSS 2A	ACsc O EPSS 2A	C-sc L EPSS 2A	C-sc O EPSS 2A

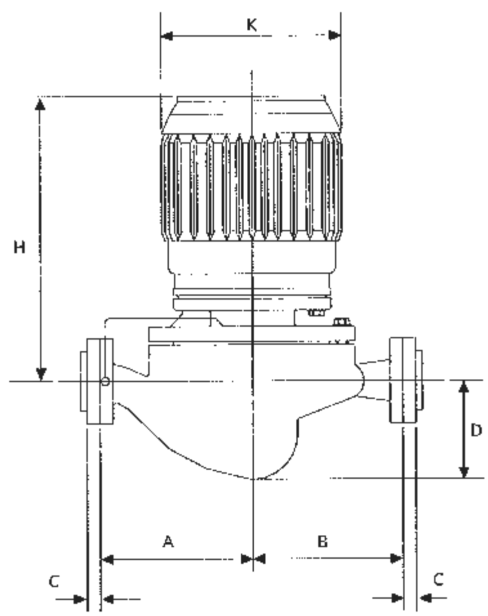
2

MOTOR	HORSEPOWER @ RPM		MAX. DIMENSIONS INCHES (mm)					SHIP. WEIGHT lbs (kg)	
FRAME	3500	1750	G	H		K	L	ODP	TEFC
				SINGLE PHASE	THREE PHASE	MAX	MAX		
56C	–	0.75	0	13.63 (346)	13.88 (353)	7.50 (191)	1.00 (25)	117 (53.1)	117 (53.1)
143JM	–	1	0	14.44 (367)	13.81 (351)	7.50 (191)	2.25 (57)	133 (60.3)	135 (61.2)
145JM	–	1.5	0	15.44 (393)	14.81 (376)	7.50 (191)	2.25 (57)	139 (63.0)	143 (64.9)
145JM	–	2	0	15.44 (393)	14.81 (376)	7.50 (191)	2.25 (57)	142 (64.4)	146 (66.2)
182JM	–	3	0	–	15.56 (395)	9.50 (241)	3.75 (95)	144 (65.3)	183 (83.0)
182JM	5	-	0	–	15.56 (395)	9.50 (241)	3.75 (95)	145 (65.8)	196 (88.9)
184JM	7.5	–	0	–	16.56 (421)	9.50 (241)	3.75 (95)	158 (71.7)	229 (103.9)
213JM	10	–	0	–	18.13 (461)	10.75(273)	5.13 (130)	198 (89.8)	250 (113.4)
215JM	15	–	0	–	19.63 (499)	10.75(273)	5.13 (130)	237 (107.5)	343 (155.6)

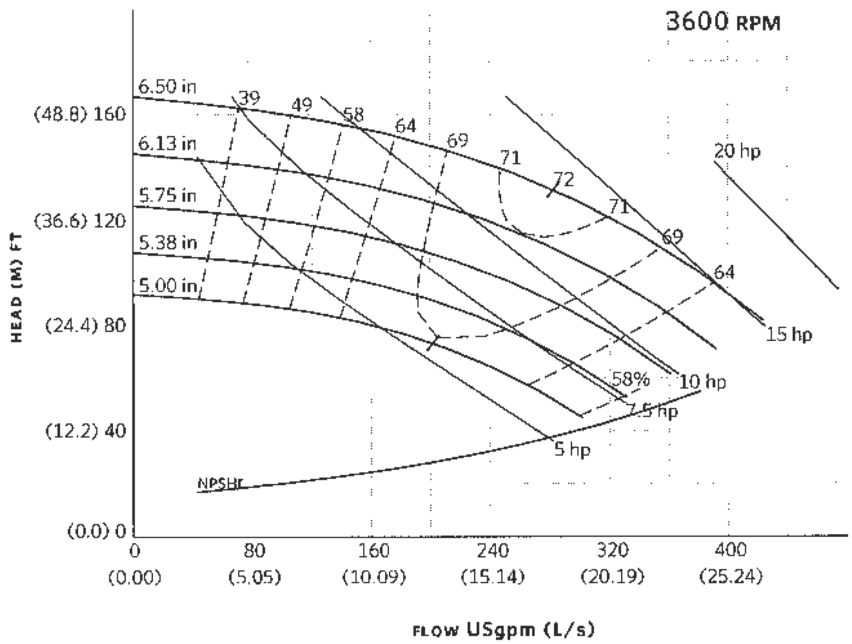
PUMP DIMENSIONS
INCHES (mm)

A	B	C	D	E	F
9.00 (227)	9.00 (227)	1.00 (25)	4.50 (114)	5.88 (149)	5.00 (127)



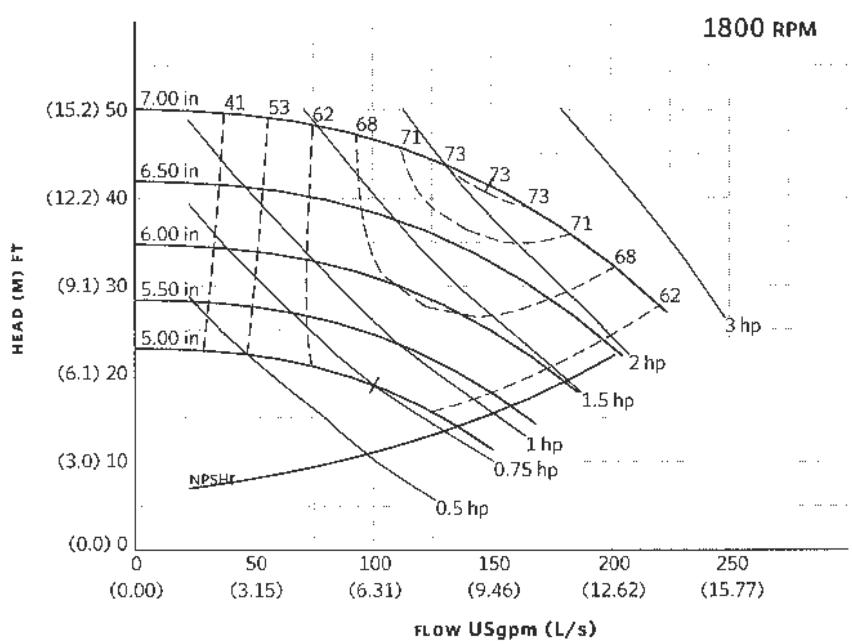


SERIES 4360 PERFORMANCE CURVES



Curve number
PT43-0-0-3600
Series
4360
Size
3D
RPM
3600
BHP based on shown Fluid's sp. gr.
Availability
4360 all ratings

Performance guaranteed only at operating point indicated
Curve shown for clear, cold water – SP. GR. 1.0000



Curve number
PT42-0-0-1800
Series
4360
Size
2D
RPM
1800
BHP based on shown Fluid's sp. gr.
Availability
4360 all ratings

Performance guaranteed only at operating point indicated
Curve shown for clear, cold water – SP. GR. 1.0000

Performance curves are for reference only.
Confirm current performance data with Armstrong ACE Online selection software.

TORONTO

23 BERTRAND AVENUE
TORONTO, ONTARIO
CANADA
M1L 2P3
+416 755 2291

BUFFALO

93 EAST AVENUE
NORTH TONAWANDA, NEW YORK
U.S.A.
14120-6594
+716 693 8813

BIRMINGHAM

HEYWOOD WHARF, MUCKLOW HILL
HALESOWEN, WEST MIDLANDS
UNITED KINGDOM
B62 8DJ
+44 (0) 8444 145 145

MANCHESTER

WENLOCK WAY
MANCHESTER
UNITED KINGDOM
M12 5JL
+44 (0) 8444 145 145

BANGALORE

#59, FIRST FLOOR, 3RD MAIN
MARGOSA ROAD, MALLESWARAM
BANGALORE, INDIA
560 003
+91 (0) 80 4906 3555

SHANGHAI

NO. 1619 HU HANG ROAD, XI DU TOWNSHIP
FENG XIAN DISTRICT, SHANGHAI
P.R.C
201401
+86 21 3756 6696

ARMSTRONG INTEGRATED
ESTABLISHED 1934

ARMSTRONGINTEGRATED.COM

MAKING
ENERGY
MAKE
SENSE™

COMMERCIAL PUMPS

Series 4300, 4360 & 4380 Vertical In-Line Pumps

INTRODUCTION

This document contains specific information regarding the safe installation, operating and maintenance of Vertical In-Line pumps and should be read and understood by installing, operating and maintenance personnel. The equipment supplied has been designed and constructed to be safe and without risk to health and safety when properly installed, operated and maintained. The instructions following must be strictly adhered to. If clarification is needed on any point please contact Armstrong quoting the equipment serial number.

WARNING SYMBOLS

Safety instruction where an electrical hazard is involved.

Safety instruction where non-compliance would affect safety risk.

A Safety instruction relating to safe operation of the equipment. (ATTENTION)

INSTRUCTIONS FOR SAFE USE

No installation of this equipment should take place unless this document has been studied and understood. Handling, transportation and installation of this equipment should only undertaken by trained personnel with proper use of lifting equipment. See later diagrams for lifting advice. Refer to the pump nameplate for pump speed, pressure and temperature limitations. The limits stated must not be exceeded without written permission from Armstrong.

TEMPERATURE

Where under normal operating conditions the limit of 68°C/155°F (Restricted Zone) for normal touch, or 80°C/176°F (Unrestricted Zone) for unintentional touch, may be experienced, steps should be taken to minimize contact or warn operators/users that normal operating conditions will be exceeded. In certain cases where the temperature of the pumped liquid exceeds the above stated temperature levels, pump casing temperatures may exceed 100°C/212°F and not withstanding pump insulation techniques appropriate measures must be taken to minimize risk for operating personnel.

NOISE LEVELS A

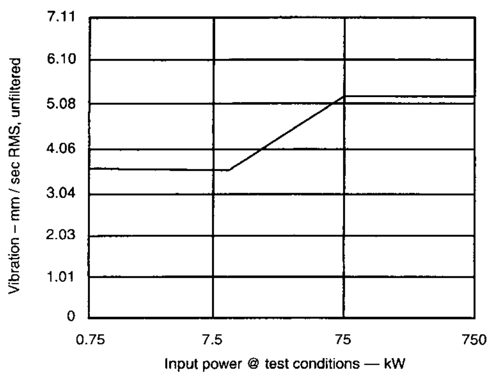
Typical Pumping Unit Sound Pressure Level, Decibels, A-Weighted, at 1 m (3 ft.) from unit.

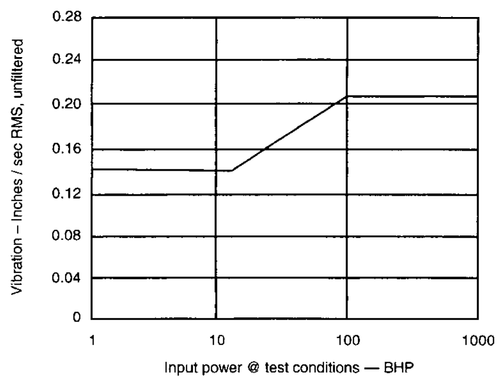
	1200 rpm				1800 rpm				3600 rpm			
Frame	ODP		TEFC		ODP		TEFC		ODP		TEFC	
Designation	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A
140	0.75 - 1	59	0.75 - 1	58	1 - 3	64	1 - 2	64	1.5 - 3	70	1.5 - 2	79
180	1.5 - 2	61	1.5 - 2	61	3 - 5	66	3 - 5	68	5 - 7.5	74	3 - 5	82
210	3 - 5	66	3 - 5	65	7.5 - 10	70	7.5 - 10	73	10 - 15	76	7.5 - 10	85
250	7.5 - 10	70	7.5 - 10	69	15 - 20	74	15 - 20	78	20 - 25	78	15 - 20	88
280	15 - 20	75	15 - 20	74	25 - 30	74	25 - 30	82	30 - 40	80	25 - 30	89
320	25 - 30	77	25 - 30	77	40 - 50	78	40 - 50	83	50 - 60	83	40 - 50	94
360	40 - 50	80	40 - 50	80	60 - 75	80	60 - 75	89	75 - 100	88	60 - 75	95
400	60 - 75	82	60 - 75	84	100 - 125	83	100	92	125 - 150	92	100	96
440	100 - 125	85	100 - 125	88	150 - 200	87	125 - 150	96	200 - 250	95	125 - 150	98

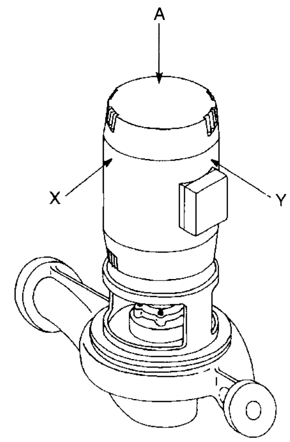
Select Armstrong Installation & Operation (I&O) Guides are now posted in our Wiki site. Visit the Armstrong Wiki site at Hhttp://www.armstrongpumps.com/wiki.htmlH and share your ideas on best practices for the installation and operation of Armstrong products.

VIBRATION LEVELS

Armstrong Vertical In-Line pumps are designed to meet vibration levels set by Hydraulic Institute Standard HI Pump Vibration 9.6.4. Standard levels are as detailed below:







Vertical In-Line

STORAGE

Pumps not immediately placed into service, or removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is ready to connect to the piping.

Rotate the shaft periodically (at least monthly) to keep rotating element free and bearings fully functional.

For long term storage (longer than 3 months), the pump must be placed in a vertical position in a dry environment.

Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rustproofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

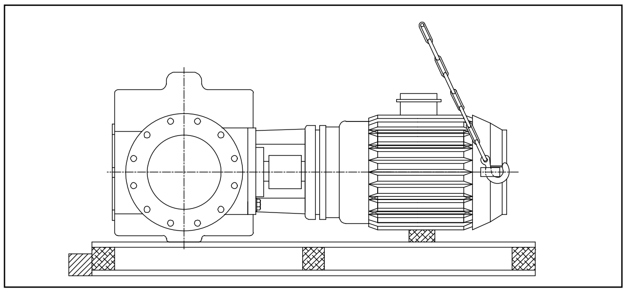
UNCRATING

Armstrong Vertical In-Line pumps are thoroughly inspected before shipment to assure they meet with your order requirements.

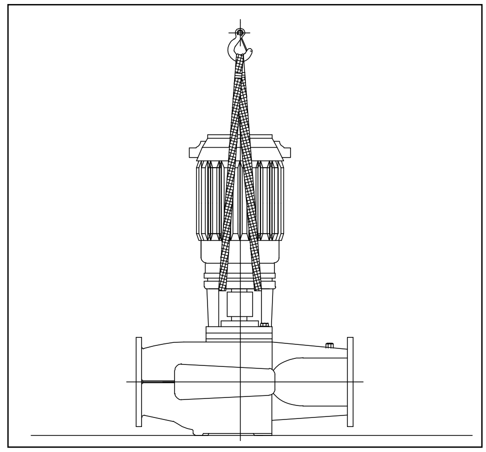
After removing the pump from the crate, make sure the equipment is in good order and that all components are received as called for on the packing list. Any shortages or damage should be reported immediately. Use extreme care in handling the unit, placing slings and hooks carefully so that stress will not be imposed on the pump. NEVER PLACE CABLE SLINGS AROUND THE PUMP SHAFT. The eye bolts or lifting lugs on the motor are intended for lifting only the motor and not the complete unit.

HANDLING LARGE VIL UNITS

One effective way of lifting a large Series 4300 unit from the shipment pallet following uncovering the unit is to place lifting hooks through the motor lifting rings or straps around the upper part of the motor and carefully lift sufficiently to stand the pump vertically. Lift only sufficiently to remove the pallet then lower onto a flat surface. The pump and motor unit will free-stand on the casing ribs. Remove the coupling guard and place (2) lifting straps through the pump/motor pedestal, one on each side of the motor shaft and secure to the lifting device. With the straps in place, using a spacer bar if necessary to protect the motor fan cover, the whole assembly can now be lifted securely and placed in position in the piping.



Secure pallet and lift pump vertical using motor eye-bolts lift only to clear pallet then sit on the flat surface



Remove coupling guard and place lifting straps on each side of coupling, use spacer bar if necessary to protect motor fan cover.

IMPORTANT:
Do not run the pump for any length of time under very low flow conditions or with the discharge valve closed. To do so could cause the water in the casing to reach super heated steam conditions and will cause premature failure and could cause serious and dramatic damage to the pump and surrounding area.

INSTALLATION

1. LOCATION

- In open systems, locate the unit as close as practical to the liquid being pumped, with a short, direct suction pipe. Ensure adequate space is left above and around the unit for operation, maintenance, service and inspection of parts.
- In closed systems, where possible, the pumps should be installed immediately downstream of the expansion tank / make-up connection. This is the point of zero pressure change and is necessary for effective pump operation. Do not install more than one expansion tank connection into any closed hydronic system.
- Electric motor driven pumps should not be located in damp or dusty location without special protection.
- Airflow into the motor and/or motor fan should not be obstructed.

2. INSTALLATION

- *When installing vertical in-line pumps, an important consideration to accrue full added-value from the pump design is to ensure that the pump is pipe-mounted and free to 'float' with any movement, expansion and contraction of the piping. Should any vertical in-line pump use supports to the structure it is imperative that no pipe strain is imposed on the pump flanges. Tell-tale pieces of equipment such as springs or 'waffle' style neoprene isolation pads that distort with pressure to indicate added piping weight, should be used under pump supports should the pump not be truly pipe mounted.*
- Various installation arrangements are detailed on Pages 7 & 8:
  - 2.1 Vertical In-Line pumps may be installed directly in the system piping with no additional support. Pipe hangers are simply sized for the additional weight of the pumping unit. Many pumps are installed in this manner and are mounted at sufficient height to take zero floor space. (Fig. 2.1)
  - 2.2 Piping in many mechanical rooms is hung close to the ceiling and larger pumps are mounted near ground level for ease of maintenance. Fig 2.2 illustrates such an arrangement with the piping supported at the ceiling and the VIL unit installed with an Armstrong Suction Guide and triple function Flo-Trex valve. Many very large VIL pumps are installed in this manner.
  - 2.3 Should additional space saving be required the discharge spool piece and Flo-Trex valve may be replaced by a long-radius elbow and the Flo-Trex valve field converted to a straight-through valve and installed in the vertical discharge pipe. (Fig 2.3)

2.4 Fig 2.4 illustrates a similar arrangement to Fig 2.2 with additional floor mounted pipe-stools isolated from the structure by ‘waffle’ style neoprene isolation pads under the Armstrong Suction Guide and Flo-Trex Valve.

2.5 Floor mounted saddle supports (Fig. 2.5) are typical for condenser water pumps where cooling tower base is near mechanical room elevation.

2.6 Where required, additional floor support may be used as shown in Fig. 2.6. Note that the pump should not be rigidly attached to the column. Leave a small gap between pump and column or install a ‘waffle’ isolation pad under the pump. It is critical that piping be installed in such a manner that the pump does not become a pipe support.

2.7 Fig. 2.7 illustrates stanchion plates at the pump inlet and outlet ports that may be supplied for installation convenience. Isolation pads must be used under the legs and monitored as pipe hangers are adjusted to ensure the pump flanges are not supporting the piping. Bolting to the floor or housekeeping pad is not recommended. If the stanchions are bolted down the bolts must be isolated from the stanchion or an inertia base and flexible pipe connectors used.

2.8 Fig. 2.8 illustrates installations with stanchion plates for seismically active regions. Seismically rated isolation pads or snubbers with bolts isolated from the stanchion plates are installed to restrain the pump during a seismic event. Pipe hangers carry the weight of the equipment as seismic components are designed only to restrain the equipment during a seismic event.

2.9 Close coupled in-line units (Series 4360 & 4380) up to 15 hp / 11 kW may be installed with the shaft horizontal. (Fig. 2.9) For horizontal mounting of large units or Series 4300 Split-Coupled style consult the factory.

2.10 Many Vertical In-Line pumps are piped successfully into grooved piping systems. In-line pumps are supported well by grooved piping however flange adapter locking devices or a welded flange at the pump should be used to prevent the possibility of pipe mounted pumps rotating in the piping. Armstrong offers grooved suction guides with cast-in outlet flanges and triple function Flo-Trex valves with inherent locking devices to prevent this possibility. (Fig. 2.10)

2.11 DO NOT support the unit by the motor eye bolts (Fig. 2.11) or by any other part of the motor.

2.12 Connecting the pump to a permanent rigid base (Fig. 2.12) is not recommended unless isolated from the piping by flexible connectors and the base isolated from the building structure on an inertia base. (Fig. 2.12 is generally acceptable when using plastic piping).

IMPORTANT:
All Series 4300 pumps contain a tapped hole in the motor bracket above the discharge flange (see Fig. 2.13) for draining the well. Pipe this drain hole to a floor drain to avoid overflow of the cavity caused by collecting chilled water condensate or from seal failure.

3. PUMP PIPING - GENERAL

- Never connect a pump to piping, unless extra care is taken to measure and align the piping flanges well. Always start piping from pump.
- Use as few bends as possible and preferably long radius elbows.
- Do not use flexible connectors on the suction or discharge of a vertical in-line pump, unless the pump is rigidly mounted to a foundation.
- Ensure piping exerts no strain on pump as this could distort the casing causing breakage or early failure due to pump misalignment.
- All conecting pipe flanges must be square to the pipework and parallel to the pump flanges.
- Suction and discharge pipes may be increased or decreased at pump nozzle to suit pump capacity and particular conditions of installation. Use eccentric reducers on suction connection with flat side uppermost.
- Layout the suction line with a continual rise towards the pump without high points, thus eliminating possibility of air pockets that may prevent the pump from operating effectively.
- A strainer of three or four times the area of the suction pipe, installed in the suction line, will prevent the entrance of foreign materials into the pump. 3/16” (5 mm) diameter perforations in the strainer is typical.
- In open systems, test suction line for air leaks before starting; this becomes essential with long suction line or static lift.
- Install, at the pump suction, a straight pipe of a length equivalent to 4 or 6 times its diameter; this becomes essential when handling liquids above 120°F (49°C). Armstrong suction guides may be used in place of the straight pipe run and in-line strainer.
- Install an isolation valve in both suction and discharge lines on flooded suction application; these valves are used primarily to isolate the pump for inspection or repair
- Install a non-slam non-return check valve in discharge line between pump and isolation valve to protect pump from excessive back pressure and to prevent water running back through the pump in case of driver failure on open systems. An Armstrong Flo-Trex valve may be used in place of non-return check valve and isolation valve on pump discharge.

A **CAUTION:**
The discharge valve only is to be used to throttle pump flow, not the suction valve. Care must be taken in the suction line layout and installation, as it is usually the major source of concern in centrifugal pump applications

4. ALIGNMENT

- Alignment is unnecessary on close-coupled pumps, Series 4360 & 4380, as there is no shaft coupling.
- Series 4300 units are accurately aligned at the factory prior to being shipped and do not need re-aligning when installed.
- Alignment on a Series 4300 unit may be verified by assuring an equal and parallel gap between coupling halves on both sides of the coupling.

OPERATION

5. STARTING PUMP

- Ensure that the pump turns freely by hand, or with some gentle mechanical help such as a strap or Allen key in coupling bolt.
- Ensure that all protective guarding is securely fixed in position.
- The pump must be fully primed on start up. Fill the pump casing with liquid and rotate the shaft by hand to remove any air trapped in the impeller. On Series 4300 any air trapped in the casing as the system is filled must be removed by the manual air vent in the seal flush line. **ENSURE ENTRAINED AIR IS REMOVED FROM SERIES 4300 PUMPS, PRIOR TO STARTING, THROUGH THE AIR VENT ON THE SEAL FLUSH LINE – OPEN VENT UNTIL CLEAR OF AIR**. Series 4360 & 4380 units are fitted with seal flush/vent lines piped to the pump suction area. When these units operate residual air is drawn out of the pump towards the suction piping.
- "Bump" or energize the motor momentarily and check that the rotation corresponds with the directional arrow on the pump casing.
- To reverse rotation of a three phase motor, interchange any two power leads.
- Start the pump with the discharge valve closed and the suction valve open, then gradually open the discharge valve when the motor is at operating speed. The discharge valve may be "cracked" or open slightly at start up to help eliminate trapped air.
- When stopping the pump: Close the discharge valve and de-energize the motor.
- DO NOT run the pump against a closed discharge valve for an extended period of time. (A few minutes maximum)
- Star-Delta motor starters should be fitted with electronic/mechanical interocks that have a timed period of no more than 40 mili-seconds before switching from star (Starting) to delta (Run) connection yet allow the motor to reach full star (Starting) speed before switching to delta (Run).
- Should the pump be noisy or vibrate on start-up a common reason is overstated system head. Check this by calculating the pump operating head by deducting the suction pressure gauge value from the discharge gauge reading. Convert the result into the units of the pump head as stated on the pump nameplate and compare the values. Should the actual pump operating head be significantly less than the nameplate head value it is typically permissable to throttle the discharge isolation valve until the actual operating head is equal to the nameplate value. Any noise or vibration usually disappears. The system designer or operator should be made aware of this soon as some adjustment may be required to the pump impeller diameter or drive settings, if applicable, to make the pump suitable for the system as installed.

CAUTION:
Check rotation arrow prior to operating the unit. The rotation of all Armstrong Vertical In-Line units is "clockwise" when viewed from the drive end. (Looking from on top of / behind the motor)

6. GENERAL CARE

- Vertical In-Line pumps are built to operate without periodic maintenance, other than motor lubrication on larger units. A systematic inspection made at regular intervals, will ensure years of trouble-free operation, giving special attention to the following:
  - Keep unit clean
  - Provide the motor with correctly sized overload protection
  - Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
  - Avoid operating the unit in overheated surroundings (Above 100ºF/40ºC).

WARNING:
Whenever any service work is to be performed on a pumping unit, disconnect the power source to the driver, LOCK it OFF and tag with the reason. Any possibility of the unit starting while being serviced must be eliminated.

- If mechanical seal environmental accessories are installed, ensure water is flowing through the sight flow indicator and that filter cartridges are replaced as recommended. (See Armstrong files 43.85 & 43.86 for seal environmental instructions).

7. LUBRICATION

Pump
- Lubrication is not required. There are no bearings in the pump that need external lubrication service.
- Large Series 4300 units are installed with a shaft bushing located beneath the impeller that is lubricated from the pump discharge. This bearing is field removable for service on the 20x20x19 size without disturbing the motor or other major pump components.
- Service instructions for the lower bearing is to be found on File No: 43.805.

Motor
- Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated and need no added lubrication. Generally if there are grease fittings evident the motor needs periodic lubrication. None if not.
- Check the lubrication instructions supplied with the motor for the particular frame size indicated on the motor nameplate.

Mechanical Seal
- Mechanical seals require no special attention. The mechanical seal is fitted with a flush line. The seal is flushed from discharge of the pump casing on Series 4300 pumps and is flushed/vented to the suction on close coupled pumps, Series 4360 & 4380.
- The Series 4300 pump is flushed from the pump discharge because the mechanical seal chamber is isolated from the liquid in the pump by a throttle bushing. Because the seal chamber is isolated, seal environmental controls such as filters and separators, when installed in the Series 4300 flush line are very effective, as only the seal chamber needs cleansing, and will prolong seal life in HVAC systems.
- Do not run the pump unless properly filled with water as the mechanical seals need a film of liquid between the faces for proper operation.
- Mechanical seals may 'weep' slightly at start-up. Allow the pump to continue operating for several hours and the mechanical seal to 'seat' properly prior to calling for service personnel.
- The following Armstrong files are available for mechanical seal replacement instructions:
  - Series 4360 & 4380: File 43.81
  - Series 4300: P-Base and TCZ Motor Frames – File 43.84
TC Motor Frame – File 43.88

8. SYSTEM CLEANLINESS
- Before starting the pump the system must be thoroughly cleaned, flushed and drained and replenished with clean liquid.
- Welding slag and other foreign materials, "Stop Leak" and cleaning compounds and improper or excessive water treatment are all detrimental to the pump internals and sealing arrangement.
- Proper operation cannot be guaranteed if the above conditions are not adhered to.

NOTE:
Particular care must be taken to check the following before the pump is put into operation:

A. Pump primed?
B. Rotation OK?
C. Lubrication OK?
D. Pipe work properly supported?
E. Voltage supply OK?
F. Overload protection OK?
G. Is the system clean?
H. Is the area around the pump clean?

WARRANTY
Does not cover any damages to the equipment resulting from failure to observe the above precautions. Refer to Armstrong General Terms and Warranty sheet. Contact your local Armstrong representative for full information.

ARMSTRONG

INSTALLATION LAYOUTS

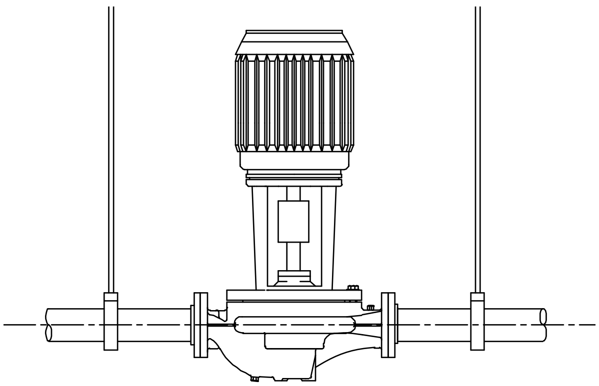


Fig. 2.1 Hanger supported pipe mounted

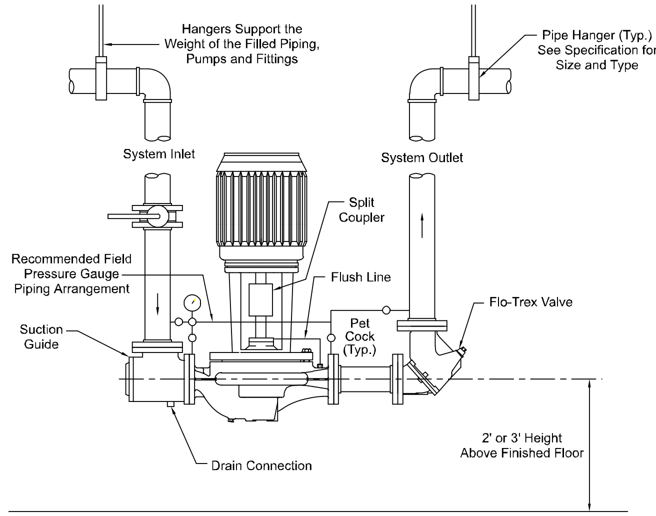


Fig. 2.2 Pipe mounted supported at ceiling

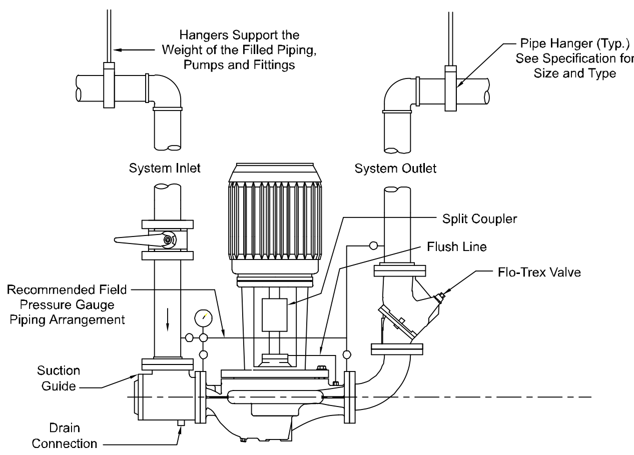


Fig. 2.3 Discharge elbow for minimum footprint

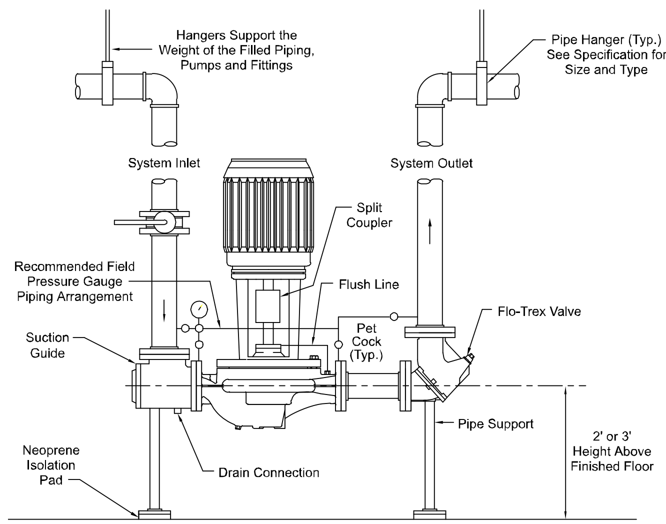


Fig. 2.4 With additional pipe supports

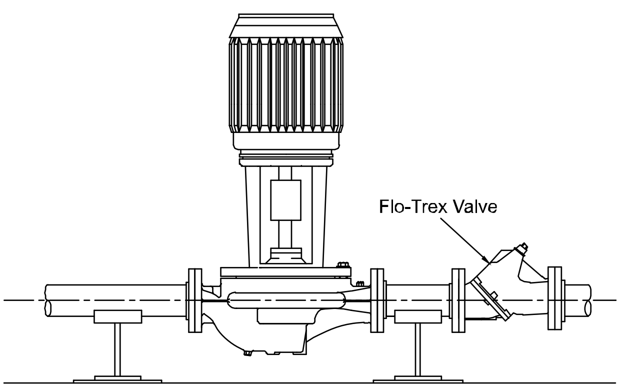


Fig. 2.5 Floor saddle support

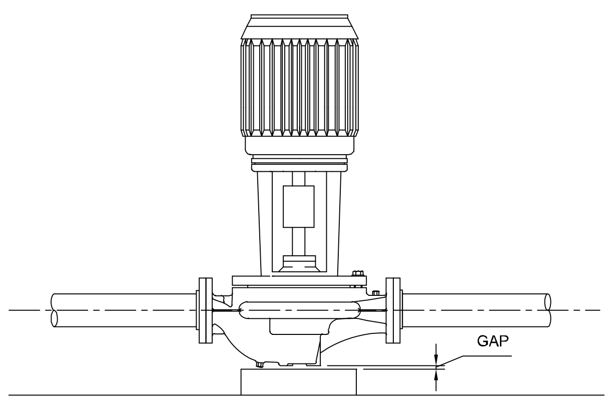


Fig. 2.6 Additional floor support

ARMSTRONG

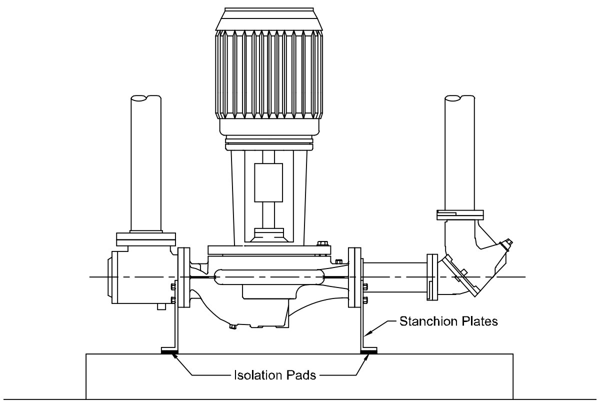


Fig. 2.7 With stanchion plates

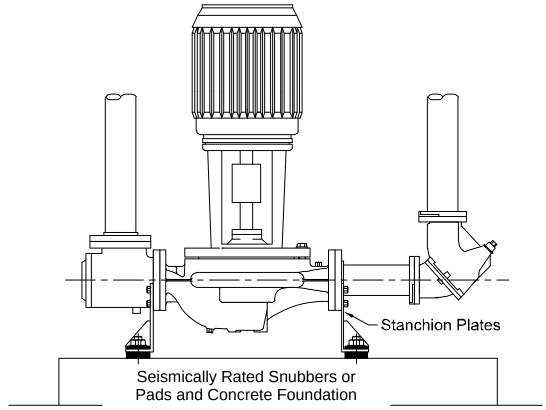


Fig. 2.8 Seismic region installation

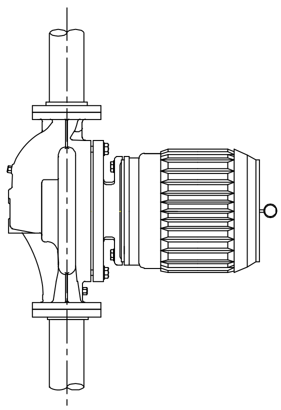


Fig. 2.9 Horizontal mounting –
4360/4380 only to 15 hp (11 kW)

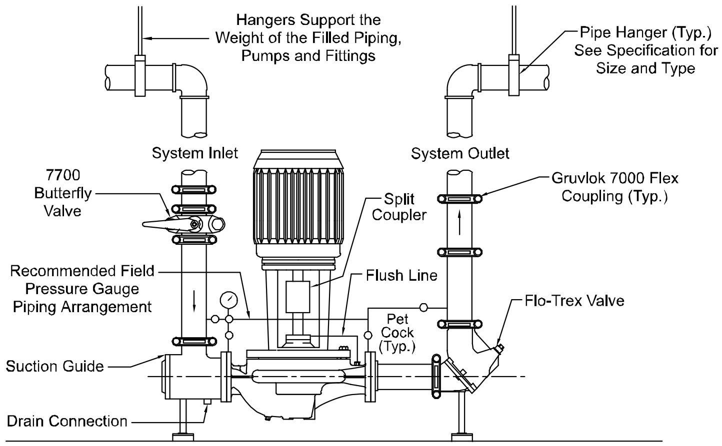


Fig. 2.10 Mounting in grooved pipe systems

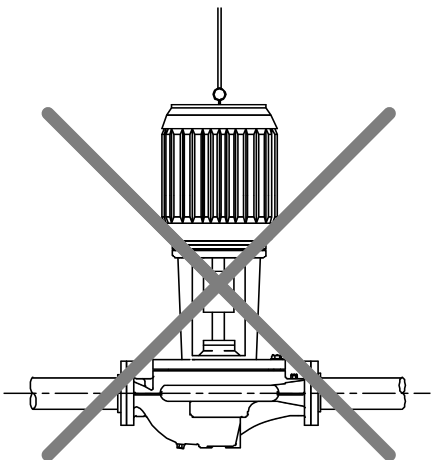


Fig. 2.11 Motor lifting hook supported

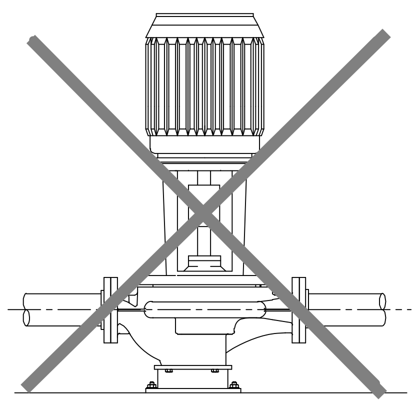


Fig. 2.12 Mounted on rigid base
without flexible connectors

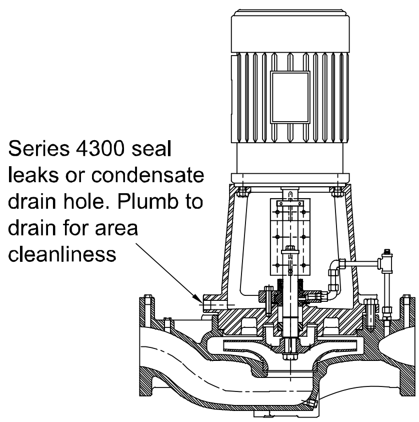


Fig. 2.13 Tapped collection well
on Series 4300

S. A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
T: (416) 755-2291
F (Main): (416) 759-9101

Armstrong Pumps Inc.
93 East Avenue
North Tonawanda, New York
U.S.A. 14120-6594
T: (716) 693-8813
F: (716) 693-8970

Armstrong Holden Brooke Pullen
Wenlock Way
Manchester
United Kingdom, M12 5JL
T: +44 (0) 161 223 2223
F: +44 (0) 161 220 9660

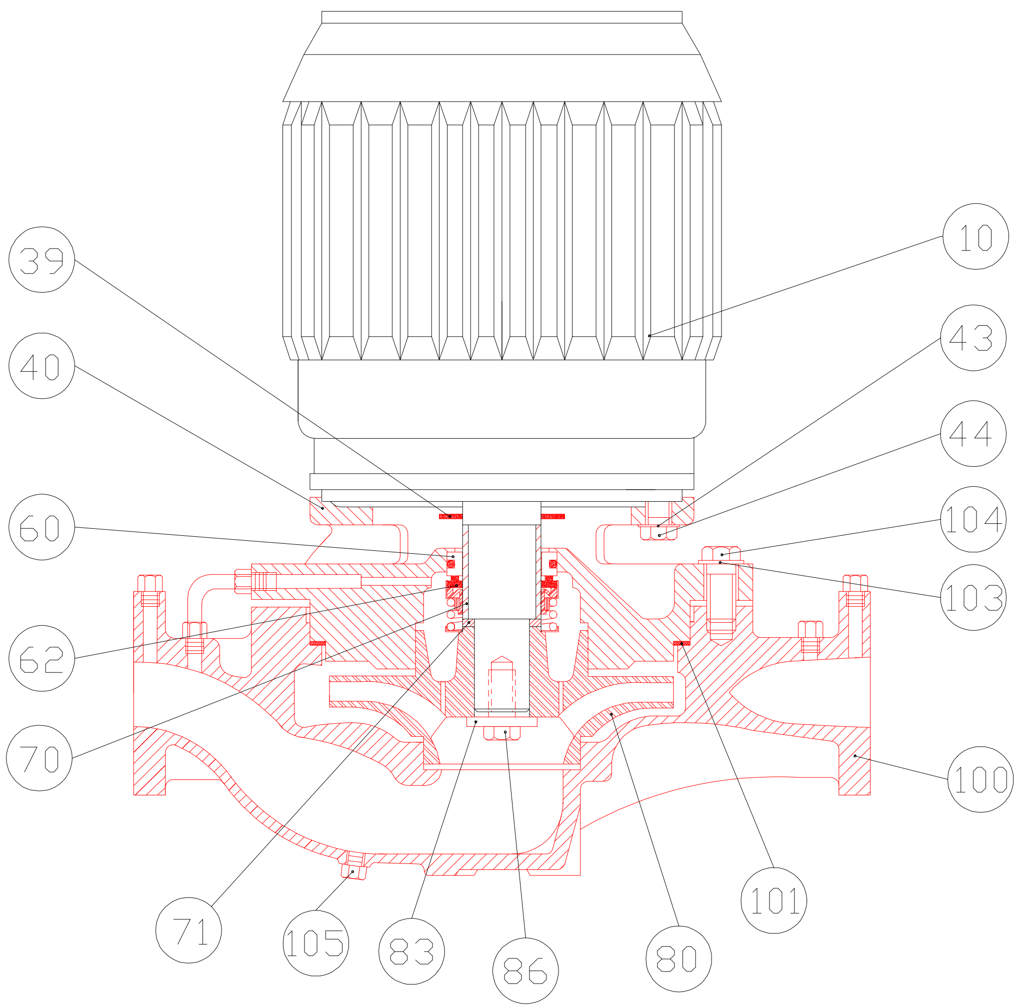
FILE NO:	43.81
DATE:	July 30, 1998
SUPERSEDES:	43.81
SUPERSEDES:	43.82
DATE:	December 15, 1996

SERVICE WORK INSTRUCTIONS

ARMSTRONG®

SERIES 4380 AND 4360

CLOSED COUPLED VERTICAL IN - LINE PUMPS



SERVICING ARMSTRONG SERIES 4380 AND 4360 (JM/JP MOTOR FRAME) PUMPS

Refer, also, to Armstrong Installation & Operating Instructions for series 4360 & 4380 motor mounted pumps: **File Nos: 43.64 & 43.68.**
All component numbers shown in this document refer to the sectional view on front cover

The Series 4360 and 4380 pumps are motor mounted or "close-coupled" type Vertical In Line pumps, on which are mounted vertical ball bearing motors. Each pump and motor unit is pipe mounted and as such relies on the piping only for support. The piping support is designed for the weight of the piping, liquid, pump and motor and other pipe fittings. The pumping unit should not be independently secured to the building structure. If the pump is mounted separately to any structure, the pump must be isolated from the piping with flexible piping connections. For units with larger motors it is advisable to install a permanent device for lifting the rotating assembly out of the pipe mounted casing when servicing the unit.

BREAKDOWN PROCEDURES:

1. ELECTRICAL WIRING

CAUTION
Exercise extreme care when handling power wiring. Ensure that the fuses are removed or breaker disconnected in the power line to the motor. Power disconnect should be within sight of the pump being serviced and tagged with the reason for disconnection.

- If the pump and/or motor assembly is to be serviced on a bench, the motor wiring must be disconnected.

2. ISOLATION VALVES

- If the system is not drained: Ensure that the suction and discharge piping isolation valves are closed. Remove drain plug [105] from the bottom of the casing and drain the pump.

3. PREPARE ASSEMBLY FOR REMOVAL

- Secure the motor [10], by lifting straps, to an overhead chainfall or similar lifting device. The device must be designed to lift the weight of the unit safely. Raise the lifter to bring the lifting straps taut. Disconnect the flush/vent tubing assembly and place carefully to one side. Remove the casing capscrews and washers [103 & 104]. Pry bars may then be inserted between the casing [100] and adapter [40]. Care should be taken not to apply pressure to the outside diameter of the adapter, to prevent possible breakage, outside pressure should be on the casing only.

4. REMOVE ROTATING ASSEMBLY

- The rotating assembly (Motor, adapter and impeller [10, 40 & 80]) may now be lifted out of the casing.

5. ROTATING ASSEMBLY NOTES

- The impeller [80] is fastened directly to the motor shaft and must be removed in order to replace the mechanical seal assembly [60/62]. This may be accomplished on a safe surface near the installation or, more conveniently, on a work bench.

6. IMPELLER CAPSCREW

- The impeller [80] should be prevented from rotating while the impeller capscrew [86] is loosened. A heavy screwdriver may be inserted between the impeller blades to enable the impeller capscrew [86] to be backed off with a socket wrench. Remove the impeller capscrew and washer [86 & 83].

7. PUMP IMPELLER

- Using wheel pullers, with the jaws behind the rear shroud of the impeller [80] (Behind a vane at each side) pull the impeller free of the pump shaft. Impellers that are difficult to remove may be loosened by heating the impeller hub with a torch during the pulling process. Remove the impeller from the motor shaft. Note the impeller key and shaft sleeve spacer [71]. Remove both for storage.

8. REMOVE MECHANICAL SEAL FROM MOTOR SHAFT

- The mechanical seal spring usually comes free with the impeller. The mechanical seal rotating element [62] must be pried loose with pry bars or screwdrivers, placed under each side of the seal drive band. Leverage is applied against the adapter. Once loosened, the seal may be pulled free of the shaft.
  Do not damage the carbon face when removing the rotating assembly. It may be needed for analysis if seal failure investigation is required.

9. REMOVE SEAL SEAT FROM ADAPTER

- The mechanical seal seat [60], usually "O" ring mounted Ni-Resist material, is pried loose from the recess in the adapter. If the seat cannot be removed in this manner, remove the motor capscrews [44] and separate the adapter [40] from the motor [10]. A screwdriver may then be used to push the seat out of the adapter from the rear.

10. REMOVE OLD CASING GASKET

- The former casing gasket [101] should be scraped from the casing and adapter, leaving clean surfaces for the new gasket. (A standard putty knife and wire brush are useful for this purpose)

ASSEMBLY PROCEDURES:

11. REPLACE MECHANICAL SEAL

- Clean the shaft sleeve [70] surface, ensuring all the former seal elastomer pieces have been removed. Inspect for damage. Replace if necessary. (See separate instructions for removal of the shaft sleeve [File No. 6042.25]). Inspect the water slinger [39] and replace if damaged

- Install a new seal seat [60] in the adapter cavity, being sure the lapped (polished) side of the insert is facing up. Ensure that the cavity has been thoroughly cleaned. Lubricate the seat "O" ring with a small amount silicon or glycerine lubricant and press down, straight and even, into the cavity. Do not press the seat in with bare fingers, use a clean cloth or the cardboard disc typically supplied with the seal. Contamination of the polished and lapped seat face could cause leakage. If the adapter was removed from the motor, replace now, taking care that the seal seat is carefully guided over the motor shaft.

- Lubricate the inside of the seal rotating assembly [62] with a small amount of silicon or glycerine lubricant and slide onto the shaft sleeve [70] with a twisting motion, carbon face first, until the carbon face is pressed firmly against the seal seat [60]. Pressing on the seal rotating assembly metal parts, with a screw driver, all the way around the seal, will ensure that the faces are mated properly. Remove the spring retainer from the seal spring and place the seal spring over the seal rotating assembly.

12. REPLACE PUMP IMPELLER

- Install the shaft sleeve spacer [71] and impeller key on the shaft and place the seal spring retainer onto the impeller hub register. Slide the impeller in place on the motor shaft.

- Take care and ensure that the seal spring is kept in place on the seal rotating assembly and fits well into the retainer on the impeller hub.

13. TIGHTEN IMPELLER CAPSCREW

- It is good practice to replace self locking screws, once removed. Install the impeller capscrew and washer [83 & 86]. Hold the impeller the same way as when the capscrew was successfully loosened (Bar or screw driver placed carefully between the impeller blades) and tighten the capscrew with a socket wrench.

14. INSTALL NEW CASING GASKET

- Insert new casing gasket [101] into the gasket cavity in the casing.

15. LOWER ROTATING ASSEMBLY INTO PLACE

- The rotating assembly (Motor, adapter and impeller combination) may now be lowered into place in the casing.

16. CASING CAPSCREWS

- The casing capscrews [104] are now installed and evenly tightened with a wrench. Tighten the capscrews a little at a time, **diagonally** across the casing, to assure even gasket pressure.

Replace the flush/vent tubing assembly

17. ISOLATION VALVES

- Replace the casing drain plug and open the suction and discharge isolation valves.

18. MOTOR WIRING

- The motor conduit and its wiring are now replaced. If the motor is new, double check that the voltage and rpm are identical to the original motor.

- Be sure to check rotation of the motor after rewiring if the motor is three phase and correct if necessary, by switching any two lead wires.

- Ensure that the pump is filled with water before operating to check rotation.

19. CONDUIT BOX COVER

- The conduit box cover is replaced after checking the motor rotation. The pump may now be placed in operation.

S.A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
Tel; (416) 755-2291
Fax: (416) 759-9101

Armstrong Pumps Limited
Peartree Road, Stanway
Colchester, Essex
United Kingdom, C03 5JX
Tel: 01206-579491
Fax: 01206-760532

Armstrong Pumps Inc.
93 East Avenue
Buffalo, New York
U.S.A. 14120-6594
Tel: (716) 693-8813
Fax; (716) 693-8970

Armstrong Darling Inc.
2200 Place Transcanadienne
Montreal, Quebec
Canada, H9P 2X5
Tel: (514) 421-2424
Fax: (514) 421-2436

ARMSTRONG®

FILE NO.:	6040.60
DATE:	August 30, 2000
SUPERSEDES:	6040.60
DATE:	June 20, 2000

SERVICE WORK INSTRUCTIONS
SERIES 4030, 4280, 4360D & 4380 MECHANICAL SEAL KITS

Refer to appropriate Service Work Instructions (SWI) file for breakdown instructions for the pump being serviced. Mechanical seal replacement instructions are included in the pump SWI. The following instructions are included for convenience.

Caution: *Always disconnect power supply from motor before beginning service work.*

Seal Kit Installation Instructions

1. Remove Impeller and Mechanical Seal from pump or motor shaft. The mechanical seal spring usually comes free with the impeller. The mechanical seal rotating element must be pried loose with pry bars or screwdrivers. Once loosened, the seal may be pulled free of the shaft.

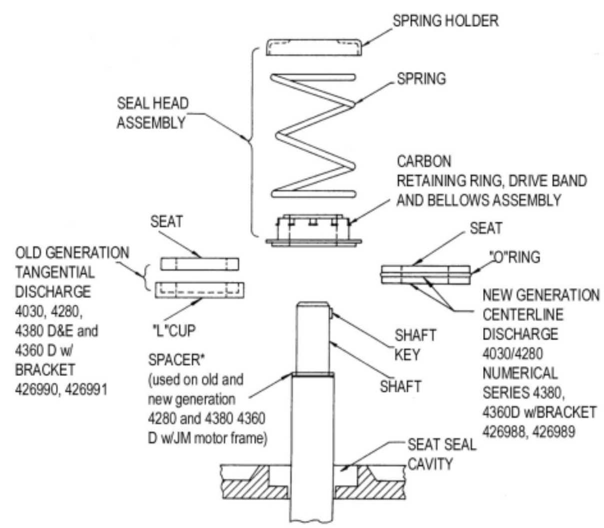
2. When removing impeller and seal from a motor shaft, take care to retrieve the spacer from between the impeller and shaft sleeve. Store for later use.

3. Remove Seal Seat from Adapter. The mechanical seal seat, “O” ring or “L” cup mounted, will be Ceramic or Ni-Resist material, and must be pried loose from the recess in the adapter. If the seat cannot be removed in this manner, separate the adapter from the bearing housing or motor. A screwdriver may then be used to push the seat out of the adapter from the rear.

4. Clean the shaft sleeve surface, ensuring all the former seal elastomeric residue has been removed. Inspect for damage and replace if necessary. (See separate instructions, File No. 6042.25, for removal of the motor shaft sleeve). Inspect the water slinger and replace if damaged.

5. *Ceramic is a suitable replacement for Ni-Resist and is the seal seat of choice. Ceramic is more delicate than Ni-Resist, however, and should be treated accordingly.*

6. Install a new seal seat in the adapter cavity, being sure the lapped (polished) side of the insert is facing up. Ensure that the cavity has been thoroughly cleaned. Lubricate the outside of the seat elastomer (“O” ring, or “L” cup) with a small amount liquid soap, silicon or glycerin lubricant and press down, straight and even, into the cavity. Do not press the seat in with bare fingers, use a clean cloth or the cardboard disc typically supplied with the seal. Contamination of the polished and lapped seat face could cause leakage.



*IMPORTANT: Spacer may come off when old seal kit is removed.
BE SURE IT IS ON WHEN INSTALLING NEW SEAL KIT.

CAUTION
Do not use oil, Vaseline or other petroleum based product for seal elastomer lubrication. Otherwise elastomer swelling may occur causing seal failure.

7. If the adapter was removed, replace now, taking care that the seal seat is carefully guided over the shaft.

8. Lubricate the inside of the seal rotating assembly (The ‘rubber’ bellows) with a small amount of liquid soap, silicon or glycerin lubricant and slide onto the shaft sleeve with a twisting motion, carbon face first, until the carbon face is pressed firmly against the seal seat.

9. Remove the spring retainer from the seal spring and place the seal spring over the seal rotating assembly. Re-install the shaft sleeve spacer and impeller key on the shaft and place the seal spring retainer onto the impeller hub register. Slide the impeller into place on the shaft. Take care and ensure that the seal spring is kept in place on the seal rotating assembly and fits well into the retainer on the impeller hub. Secure impeller and finish reassembling pump.

Seal Kit Part Number (See Note 1)	Seal Size	Used on:	Pump Construction	4030 Frame Size	4280/4380 Motor Frame Size	Seal Construction				
						Type	Elastomer	Trim	Seat Style (See Note 3)	Seat Material
816707-001	0.75	6 Series, 1000D	BF/AB				Buna	Brass	L-Cup	Ceramic
975000-991 (See Note 2)	1.25	4030/4280 Centerline Discharge, 4380 Numerical and 4360D w/Bracket 426988 or 426989	BF/AB/AI	S	56C, 143-215JM	21	**EPDM**	**St. Stl.**	**O-Ring**	**Ceramic**
810150-127						2	Viton			Ni-Resist
810150-137						2	Buna			
810150-128						21	EPDM			Tungsten
975000-993 (See Note 2)	1.625			M	254-326JM, 213-326JP	21	**EPDM**			**Ceramic**
810150-131						21	Viton			Ni-Resist
810150-138						2	Buna			
810150-132						21	EPDM			Tungsten
825458-001 (See Note 2)	1.25	4030/4280 Tangential Discharge, 4380 D & E and 4360D w/Bracket 426990 or 426991	BF/AB/AI	S	56C, 143-215JM	21	**Buna**	**St. Stl.**	**L-Cup**	**Ceramic**
825458-003						21	Viton			
810150-133			BF/AI/AB			2	Buna			Tungsten
811339-000 (See Note 2)	1.625		BF/AB	M	254-326JM, 213-326JP	2	**Buna**	**Brass**		**Ceramic**
811866-000 (See Note 2)			AI			2	Buna	Steel		
819299-000			BF/AB			2	Viton	Brass		
810150-139			BF/AI/AB			2	Buna	St. Stl.		Tungsten

Notes:

1. Seal Kit consists of rotating seal head, spring holder, stationary seal seat with O-ring or L-cup. Pump casing gasket and other minor hardware components possibly required to reassemble the pump are not included. Consult Service Parts Bulletins for more detail.
2. Standard seal used for the pump construction indicated. Other seals listed are optional.
3. O-ring and L-cup style seats are NOT interchangeable between tangential and centerline discharge pumps.

S.A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
Tel: (416) 755-2291
Fax: (416) 759-9101
Visit us at www.armstrongpumps.com

Armstrong Pumps Limited
Peartree Road, Stanway
Colchester, Essex
United Kingdom, C03 5JX
Tel: 01206-579491
Fax: 01206-760532

Armstrong Pumps Inc.
93 East Avenue
Buffalo, New York
U.S.A. 14120-6594
Tel: (716) 693-8813
Fax: (716) 693-8970

Armstrong Darling Inc.
2200 Place Transcanadienne
Montreal, Quebec
Canada, H9P 2X5
Tel: (514) 421-2424
Fax: (514) 421-2436

ARMSTRONG MOTOR MOUNTED PUMPS

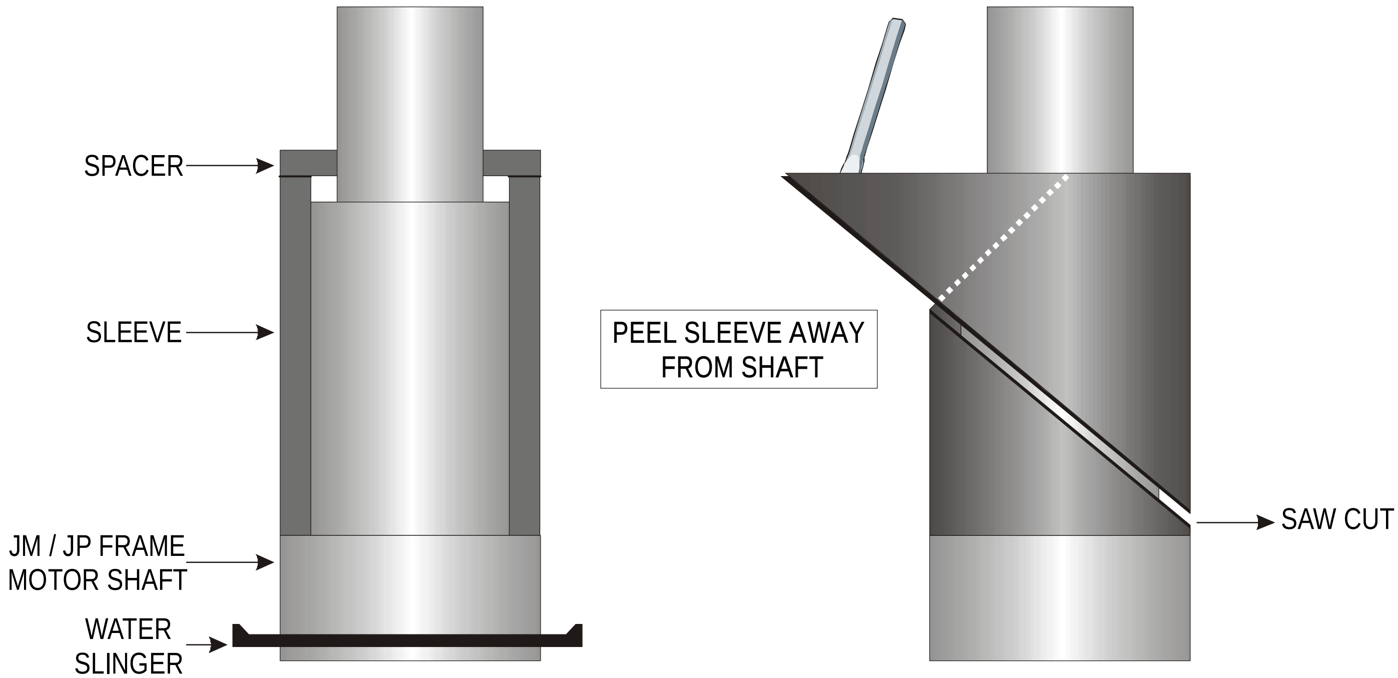
Operations & Maintenance Manual
December 2015

FILE NO.:	6042.25
DATE:	MAY 1, 1997
SUPERSEDES:	NEW
DATE:	NEW

ARMSTRONG®

INSTALLATION AND OPERATING INSTRUCTIONS

MOTOR MOUNTED (CLOSE COUPLED) PUMPS
SHAFT SLEEVE AND SPACER REPLACEMENT
SERIES 4280, 4360D, 4380 AND 4382



See separate instructions to remove the motor from, and replace the motor into, the pumping unit.

Sleeve and spacer replacement procedure:

1) Remove the spacer and water slinger

2) Remove the existing shaft sleeve. Do not heat or hammer sleeve off, or motor damage will occur. Cut the sleeve diagonally, with a hacksaw; a single cut the whole length of the sleeve. Ensure that the cut depth does not damage the shaft. Using a hammer and chisel, carefully peel back the sleeve section until the cut spiral is removed. If well cut, the sleeve removal is not difficult.

3) Stand the motor with the shaft upright. Support, if necessary for safety.

4) Support the shaft sleeve on a suitable metal bar, with insulated handle. (A large round file is ideal) The sleeve beveled end should be close to the motor. Heat the sleeve until dull red. Slide the sleeve, quickly and evenly, over the shaft (Beveled end first) and butt firmly against the motor shaft shoulder.

5) Wait until the sleeve cools and slide the water slinger over the shaft, close to the motor. Place the spacer on top of the sleeve.

The motor is now ready to be used on the pump.

S.A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
Tel; (416) 755-2291
Fax: (416) 759-9101

Armstrong Pumps Limited
Peartree Road, Stanway
Colchester, Essex
United Kingdom, C03 5JX
Tel: 01206-579491
Fax: 01206-760532

Armstrong Pumps Inc.
93 East Avenue
Buffalo, New York
U.S.A. 14120-6594
Tel: (716) 693-8813
Fax; (716) 693-8970
1-800-FLOW-845

Armstrong Darling Inc.
2200 Place Transcanadienne
Montreal, Quebec
Canada, H9P 2X5
Tel: (514) 421-2424
Fax: (514) 421-2436

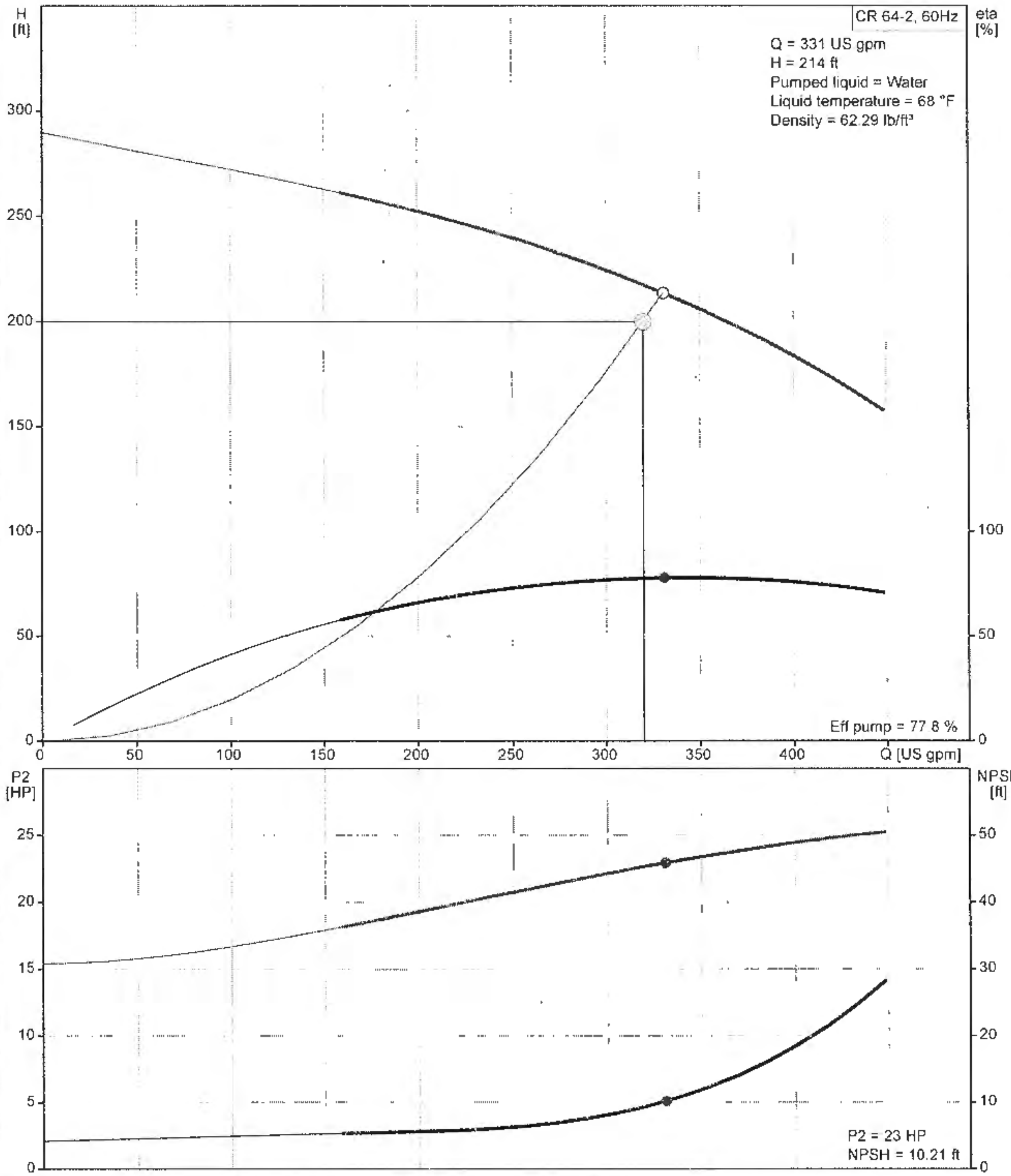
Printed in Canada

GRUNDFOS PUMPS
CR, CRI, CRN, CRT

Operations & Maintenance Manual
December 2015

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

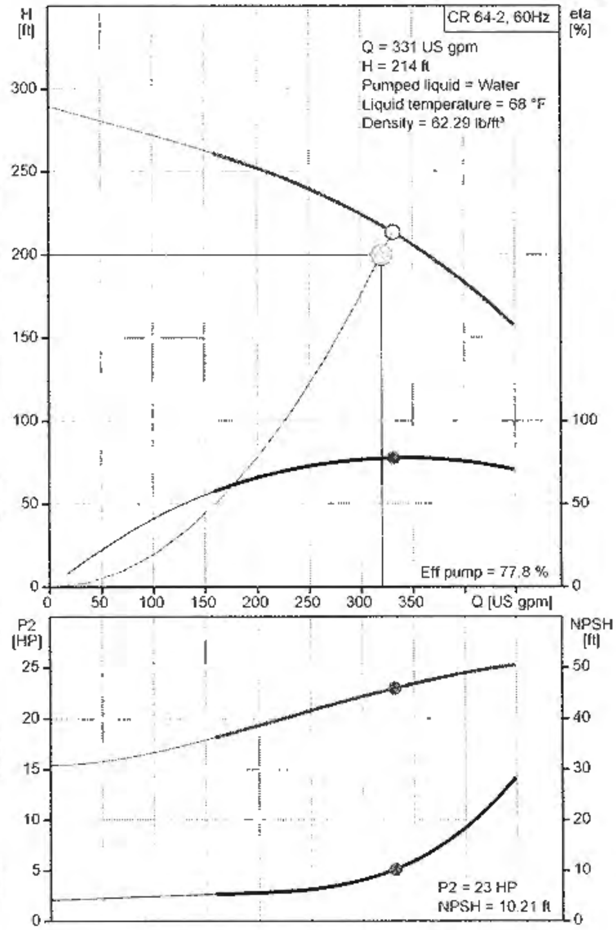
96418917 CR 64-2 60 Hz



GRUNDFOS

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

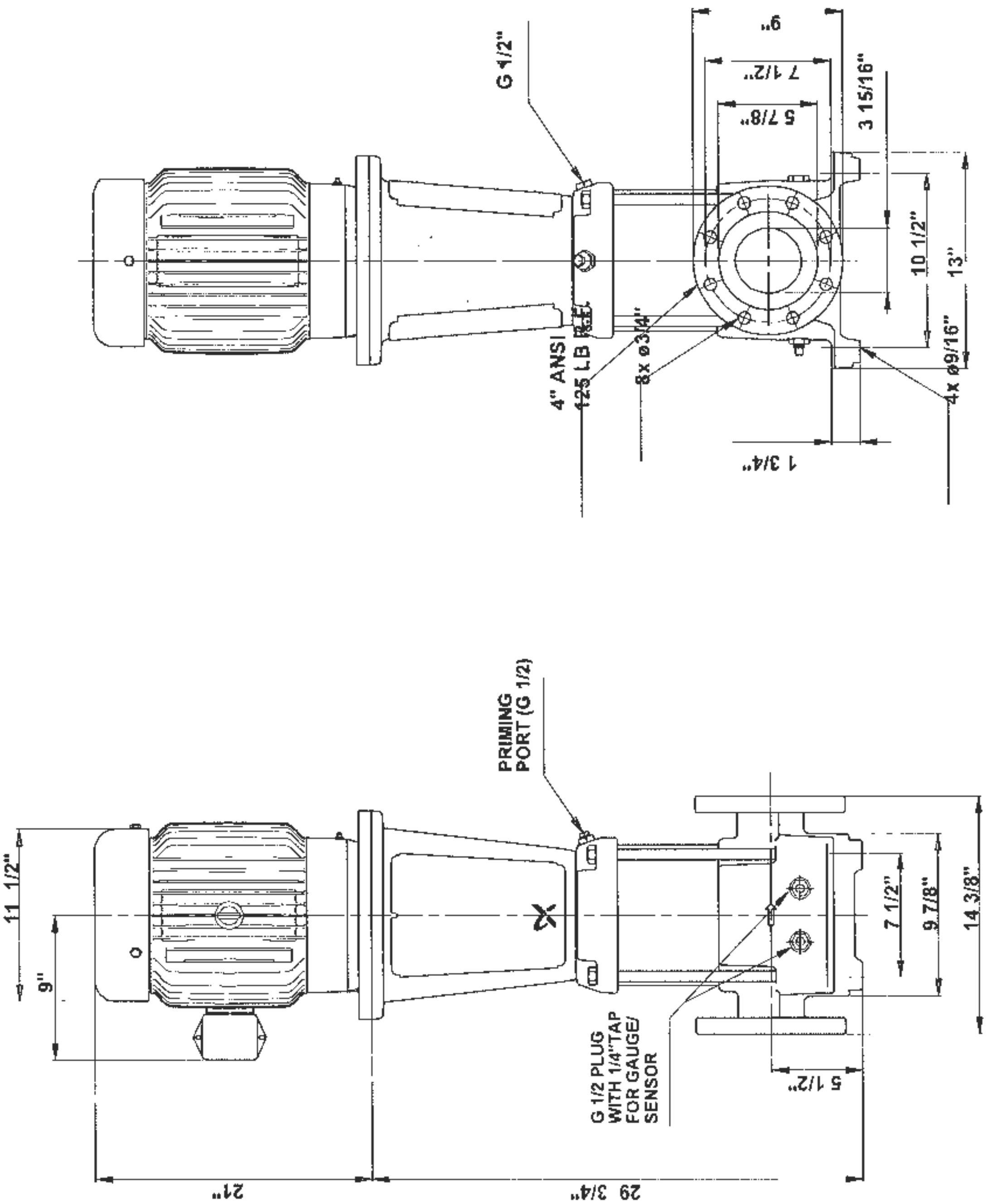
Description	Value
General information:	
Product name:	CR 64-2 A-G-A-V-HQQV
Position	
Product No.:	96418917
EAN:	5700390739591
Price.	On request
Technical:	
Speed for pump data:	3521 rpm
Actual calculated flow:	331 US gpm
Resulting head of the pump:	213 ft
Head max:	290 ft
Impellers:	2
Shaft seal:	HQQV
Approvals on motor nameplate:	UL Recognized Component, CSA
Curve tolerance:	ISO9906:2012 3B
Stages:	2
Pump version:	A
Model:	B
Cooling:	ODP
Materials:	
Pump housing:	Cast iron EN-JS1050 ASTM 80-55-06
Impeller:	Stainless steel DIN W.-Nr. 1.4301 AISI 304
Material code:	A
Code for rubber:	V
Installation:	
Maximum ambient temperature:	104 °F
Max pressure at stated temperature:	232 psi / 194 °F
Flange standard:	ANSI
Connect code:	G
Pipe connection:	4"
Pressure stage:	125 Lb.
Flange size for motor:	284TC
Liquid:	
Pumped liquid:	Water
Liquid temperature range:	-4 .. 194 °F
Liquid temp:	68 °F
Density:	62.29 lb/ft³
Kinematic viscosity:	1 cSt
Electrical data:	
Motor type:	BALDOR
Rated power - P2:	25 HP
KVA code:	G
Phase:	3
Service factor:	1.15
Rated current:	59/29.5 A
Starting current:	372/186 A
Load current:	67.8/33.9 A
Cos phi - power factor:	0,86



Description	Value
Rated speed:	3525 rpm
Insulation class (IEC 85):	F
Motor protection:	NONE
Motor Number:	84Z00021
Others:	
Net weight:	319 lb
Gross weight:	336 lb
Shipping volume:	12.7 ft³
Sales region:	Namreg

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

96418917 CR 64-2 60 Hz



Note! All units are in [mm] unless otherwise stated.
Disclaimer: This simplified dimensional drawing does not show all details.

GRUNDFOS **INSTRUCTIONS**

CR, CRI, CRN, CRT

Installation and operating instructions

US

BE > THINK > INNOVATE >

GRUNDFOS®

LIMITED WARRANTY

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, F.O.B. Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

CR, CRI, CRN, CRT

US

CONTENTS

Warning

Electrical Work: All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Warning

Shock Hazard: A faulty motor or wiring can cause electrical shock that could be fatal, whether touched directly or conducted through standing water. For this reason, proper grounding of the pump to the power supply's grounding terminal is required for safe installation and operation.

In all installations, the above-ground metal plumbing should be connected to the power supply ground as described in Article 250-80 of the National Electrical Code.

1. General

The CR range is based on the inline multistage centrifugal pump first pioneered by Grundfos. CR is available in four basic materials and over one million configurations. CR is suitable for pumping water and water-like liquids in industry, petrochemical, water treatment, commercial buildings, and many other applications. Some of CR's outstanding characteristics are:

- superior efficiency
- reliability
- ease of maintenance
- compact size and small footprint
- quiet operation.

2. Shipment inspection

Examine the components carefully to make sure no damage has occurred to the pump during shipment. Care should be taken to ensure the pump is NOT dropped or mishandled.

2.1 Ensure you have the right pump

Read the pump nameplate to make sure that it is the one you ordered.

- **CR**
  Centrifugal pump with standard cast iron and 304 stainless steel construction
- **CRI**
  Centrifugal pump; all parts in contact with water are 304 stainless steel construction
- **CRN**
  Centrifugal pump; all parts in contact with water are 316 stainless steel construction
- **CRT**
  Centrifugal pump; all parts in contact with water are titanium construction
- **CRE**
  Centrifugal pump with a Grundfos MLE VFD motor attached.

2.2 Checking the condition of the pump

The shipping carton in which your pump arrived is specially designed around your pump during production to prevent damage during shipment. As a precaution, the pump should remain in the carton until you are ready to install it. Examine the pump for any damage that may have occurred during shipping. Examine any other parts of the shipment as well for any visible damage.

Note: If the pump is shipped as a complete unit (motor attached to pump end), the position of the coupling (that connects the pump shaft to the motor shaft) is set at factory specifications. No adjustment is required. If the unit is delivered as a pump end only, follow the adjustment procedures in the section on replacing the motor.

Pump without Motor (CR(I)(N) 1s, 1, 3, 5, 10, 15, and 20 Only): If you purchased a pump without a motor, the shaft seal has been set by the factory. Do not loosen the three set screws on the shaft seal when attaching the motor.

Pump without Motor (CR(N) 32, 45, 64, 90, 120, and 150 Only): If you purchased a pump without a motor, you must install the seal. The seal is protected in its own sub boxing within the pump packaging crate. To protect the shaft and bearings during shipment, a shaft holder protective device is used. This device must be removed prior to installation of the seal. Read the seal installation instructions which are included in the pump package.

2.3 Verifying electrical requirements

Verification of the electrical supply should be made to be certain the voltage, phase and frequency match that of the pump motor. The proper operating voltage and other electrical information can be found on the motor nameplate. These motors are designed to run on –10 % / + 10 % of the nameplate-rated voltage. For dual-voltage motors, the motor should be internally connected to operate on the voltage closest to the 10% rating, i.e., a 208 voltage motor wired per the 208 volt connection diagram. The wiring connection diagram can be found on either a plate attached to the motor or on a diagram inside the terminal box cover. If voltage variations are larger than –10 % / + 10 %, do not operate the pump.

US

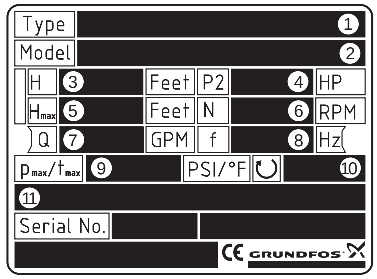
3. Understanding nameplate data

Type key
CR, CRI, CRN 1s, 1, 3, 5, 10, 15, and 20

Example

Type range: **CR 3 -10 A FG A E HQQE**

- CR, CRI, — **CR**
- Rated flow rate in [m^3/h] (x 5 gpm) — **3**
- Number of impellers — **-10**
- Code for pump version — **A**
- Code for pipe connection — **FG**
- Code for materials — **A**
- Code for rubber parts — **E**
- Code for shaft seal — **HQQE**



TM04 3895 0309

Fig. 1 Nameplate

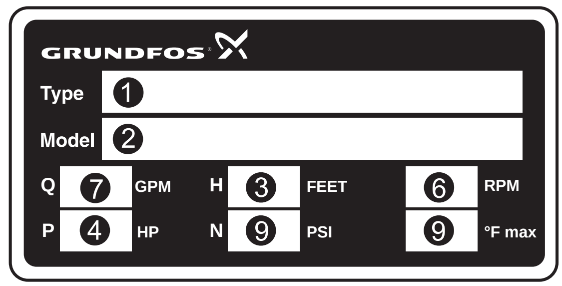
1. Type designation
2. Model, material number, production number
3. Head in feet at nominal flow
4. Nominal motor hp
5. Head at zero flow
6. Rated rpm
7. Nominal flow
8. Rated frequency
9. Maximum pressure and maximum fluid temperature
10. Direction of rotation
11. Production country

CRT 2, 4, 8, and 16

Example

Type range: **CRT 16 -30 /2 U G A AUUE**

- CRT — **CRT**
- Rated flow rate in [m^3/h] (x 5 gpm) — **16**
- Number of stages x 10 — **-30**
- Code for impellers (used only if the pump has fewer impellers than stages) — **/2**
- Code for pump version — **U**
- Code for pipe connection — **G**
- Code for materials — **A**
- Code for shaft seal and rubber parts — **AUUE**



TM04 3894 0309

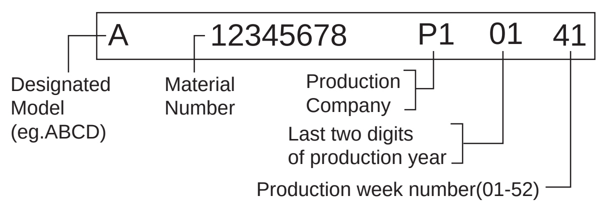
Fig. 2 Nameplate

CR, CRN 32, 45, 64, 90, 120, and 150

Example

Type **C 32 -2 -1 U G A E KUBE**

- CR, CRN — **C**
- Rated flow rate in [m^3/h] (x 5gpm) — **32**
- Number of impellers — **-2**
- Number of reduced diameter impellers — **-1**
- Code for pump version — **U**
- Code for pipe connection — **G**
- Code for materials — **A**
- Code for rubber pump parts — **E**
- Code for shaft seal — **KUBE**



TM04 3904 0409

Fig. 3 Model key

US

3.1 Understanding codes

Example
Pump version: **U FGJ A E HQQE**

A	*Basic pump version
U	*NEMA Version Pump
B	Oversize motor, one flange size bigger
F	CR pump for high temperatures (Cool-Top®)
H	Horizontal version
HS	High pressure pump with over-synchronous speed and reversed direction of rotation
I	Different pressure rating
K	Low NPSH
M	Magnetic drive
P	Undersize motor
R	Horizontal version with bearing bracket
SF	High pressure pump with reversed chamber stack and direction of rotation
T	Oversize motor, two flange sizes bigger
X	**Special version

Pipe connection

A	Oval flange
B	NTP thread
C	Clamp coupling
CA	FlexiClamp
CX	TriClamp
F	DIN flange
G	ANSI flange
J	JIS flange
N	Changed diameter of ports
O	Externally threaded, union
P	PJE coupling
X	Special version

Materials

A	Basic version
A	Carbon-filled graphite PTFE (bearings)
G	Stainless steel parts of 316 SS
GI	Base plate and flanges of 316 SS
I	Stainless steel parts of 304 SS
II	Base plate and flange of 304 SS
K	Bronze (bearings)
S	SiC bearing ring + PTFE neck ring (only CR, CRN 32 to 90
T	Titanium
X	Special version

Code for rubber parts

E	EPDM
F	FXM (Flouraz®)
K	FFKM (Kalrez®)
V	FKM (Viton®)

H Q Q E

Shaft seal

A	O-ring with fixed driver
B	Rubber bellows seal
D	O-ring seal, balanced
E	Cartridge seal with O-ring
H	Balanced cartridge seal with O-ring
K	Cartridge shaft seal with metal bellows
O	Double seal, back to back
P	Double seal, tandem
R	O-ring seal with reduced face
X	Special version

B	Carton, synthetic resin-impregnated
H	Cemented tungsten carbine, embedded
Q	Silicon carbide
U	Cemented tungsten carbide

E	EPDM
F	FXM (Flouraz®)
K	FFKM (Kalraz®)
V	FKM (Viton®)

* In August 2003 the NEMA pump code was discontinued for all material numbers created by GRUNDFOS manufacturing companies in North America. The NEMA version pump code will still remain in effect for existing material numbers. NEMA version pumps built in North America after this change will have either an A or U as the pump version code depending on the date the material number was created.

** If a pump incorporates more than two pump versions, the code for the pump version is X. X also indicates special pump versions not listed above.

US

4. Confirming proper application

Compare the pump's nameplate data or its performance curve with the application in which you plan to install it. Will it perform the way you want it to perform? Also, make sure the application falls within the following limits.

Type	Designed to pump
CR	Hot and chilled water, boiler feed, condensate return, glycols and solar thermal fluids.
CRI/CRN	Deionized, demineralized and distilled water. Brackish water and other liquids unsuitable for contact with iron or copper alloys. (Consult manufacturer for specific liquid compatibilities.)
CRN-SF	High pressure washdown, reverse osmosis, or other high pressure applications.
CRT	Salt water, chloride based fluids and fluids approved for titanium.

5. Checking operating conditions

5.1 Fluid temperatures

Pump	Fluid Temperatures
CR(I)(N) 1s, 3, 5, 10, 15, and 20	–4 to +248 °F (–20 to +120 °C)
*CR(N) 32, 45, 64, and 90	–22 to +248 °F (–30 to +120 °C)
*CR(N) 120 and 150 (up to 60 hp)	–22 to +248 °F (–30 to +120 °C)
CR(N) 120 and 150 (75 and 100 hp)	+32 to +248 °F (0 to +120 °C)
CRT 2, 4, 8, 16	–4 to +248 °F (–20 to +120 °C)
CRN-SF	–4 to +221 °F (–15 to +105 °C)
with Cool-Top™	up to +356 °F (+180 °C)

All motors are designed for continuous duty in +104 °F (+40 °C) ambient air conditions. For higher ambient temperature conditions consult Grundfos.

* xUBE Shaft Seals are recommended for temperatures above +200 °F. Pumps with hybrid shaft KUHE seals can only operate up to +200 °F (+90 °C). Pumps with xUUE shaft seals can be operated down to –40 °F (–40 °C) (where "x" is the seal type).

5.2 Minimum inlet pressures

All CR, CRI, CRN	NPSHR + 2 feet
CRN-SF	29 psi (2 bar)

5.3 Maximum inlet pressures

Pump Type/ Connection	50 Hz Stages	60 Hz Stages	Max. psi/bar
CR, CRI, CRN 1s	2 to 36	2 to 36	145 / 10
		27	217 / 15
CR, CRI, CRN 1	2 to 36	2 to 36	145 / 10
		27	217 / 15
CR, CRI, CRN 3	2 to 29	2 to 15	145 / 10
	31 to 36	17 to 25	217 / 15
CR, CRI, CRN 5	3 to 16	2 to 9	145 / 10
	18 to 36	10 to 24	217 / 15
CR, CRI, CRN 10	1 to 6	1 to 5	116 / 8
	7 to 22	6 to 18	145 / 10
CR, CRI, CRN 15	1 to 3	1 to 2	116 / 8
	4 to 17	3 to 12	145 / 10
CR, CRI, CRN 20	1 to 3	1	116 / 8
	4 to 17	2 to 10	145 / 10
CR, CRN 32	1-1 to 4	1-1 to 2	58 / 4
	5-2 to 10	3-2 to 6	145 / 10
	11 to 14	7-2 to 11-2	217 / 15
CR, CRN 45	1-1 to 2	1-1 to 1	58 / 4
	3-2 to 5	2-2 to 3	145 / 10
	6-2 to 13-2	4-2 to 8-1	217 / 15
CR, CRN 64	1-1 to 2-2	1-1	58 / 4
	2-1 to 4-2	1 to 2-1	145 / 10
	4-1 to 8-1	2 to 5-2	217 / 15
CR, CRN 90	1-1 to 1		58 / 4
	2-2 to 3-2	1-1 to 1	145 / 10
	3 to 6	2-2 to 4-1	217 / 15
CR, CRN 120	1 to 2-1	1-1 to 1	145 / 10
	2 to 5-1	2-2 to 3	217 / 15
	6-1 to 7	4-1 to 5-2	290 / 20
CR, CRN 150	1-1 to 1	1-1	145 / 10
	2-1 to 4-1	1 to 2	217 / 15
	5-2 to 6	3-2 to 4-2	290 / 20
CRT 2	2 to 11	2 to 6	145 / 10
	13 to 26	7 to 18	217 / 15
CRT 4	1 to 12	1 to 7	145 / 10
	14 to 22	8 to 16	217 / 15
CRT 8	1 to 20	1 to 16	145 / 10
CRT 16	2 to 16	2 to 10	145 / 10
CRN-SF	all	all	72 / 5*
			362 / 25**

* while pump is off or during start-up

** during operation

5.4 Maximum operating pressures

at +250 °F (194 °F for CRN-SF)

Pump type/ connection	50 Hz stages	60 Hz stages	Max. psi/bar
CR, CRI, CRN 1s			
Oval flange	1 to 23	1 to 17	232 / 16
FGJ, PJE	1 to 36	1 to 27	362 / 25
CR, CRI, CRN 1			
Oval flange	1 to 23	1 to 17	232 / 16
FGJ, PJE	1 to 36	1 to 27	362 / 25
CR, CRI, CRN 3			
Oval flange	1 to 23	1 to 17	232 / 16
FGJ, PJE	1 to 36	1 to 27	362 / 25
CR, CRI, CRN 5			
Oval flange	1 to 22	1 to 16	232 / 16
FGJ, PJE	1 to 36	1 to 24	362 / 25
CR, CRI 10			
Oval flange CR		1 to 6	145 / 10
Oval flange, CRI	1 to 16	1 to 10	232 / 16
FGJ, GJ, PJE	1 to 16	1 to 10	232 / 16
FGJ, GJ, PJE	17 to 22	12 to 17	362 / 25
CRN 10			
All	1 to 22	1 to 17	362 / 25
CR, CRI 15			
Oval flange	1 to 7	1 to 5	145 / 10
FGJ, GJ, PJE	1 to 10	1 to 8	232 / 16
FGJ, GJ, PJE	12 to 17	9 to 12	362 / 25
CRN 15			
All	1 to 17	1 to 12	362 / 25
CR, CRI 20			
Oval flange	1 to 7	1 to 5	145 / 10
FGJ, GJ, PJE	1 to 10	1 to 7	232 / 16
FGJ, GJ, PJE	12 to 17	8 to 10	362 / 25
CRN 20			
All	1 to 17	1 to 10	362 / 25
CR, CRN 32			
	1-1 to 7	1-1 to 5	232 / 16
	8-2 to 14	6-2 to 11-2	435 / 30
CR, CRN 45			
	1-1 to 5	1-1 to 4-2	232 / 16
	6-2 to 13-2	4-2 to 8-1	435 / 30
CR, CRN 64			
	1-1 to 5	1-1 to 3	232 / 16
	6-2 to 8-1	4-2 to 5-2	435 / 30
CR, CRN 90			
	1-1 to 4	1-1 to 3	232 / 16
	5-2 to 6	4-2 to 4-1	435 / 30
CR, CRN 120			
		1-1 to 3	232 / 16
	1-1 to 5-2	4-2 to 5-2	435 / 30
CR, CRN 150			
		1-1 to 3	232 / 16
	1-1 to 4-2	4-1 to 4-2	435 / 30
CRT 2	2 to 26	2 to 18	305 / 21
CRT 4	1 to 22	1 to 16	305 / 21
CRT 8	1 to 12	1 to 8	232 / 16
	14 to 20	10 to 16	362 / 25
CRT 16	1 to 8	1 to 8	232 / 16
	10 to 16	10 to 12	362 / 25

Consult Grundfos for other working conditions.

US

6. Installing the pump

Warning
Do not energize pump until properly installed.

6.1 Pump location

The pump should be located in a dry, well-ventilated area which is not subject to freezing or extreme variation in temperature.

Care must be taken to ensure the pump is mounted at least 6 inches (150 mm) clear of any obstruction or hot surfaces.

The motor requires an adequate air supply to prevent overheating and adequate vertical space to remove the motor for repair.

For open systems requiring suction lift the pump should be located as close to the water source as possible to reduce piping losses.

6.2 Foundation

Concrete or similar foundation material should be used to provide a secure, stable mounting base for the pump.

See table of bolt hole center line dimensions for the various pump types.

Secure the pump to the foundation using all four bolts and shim pump base to assure the pump is vertical and all four pads on the base are properly supported (uneven surfaces can result in pump base breakage when mounting bolts are tightened).

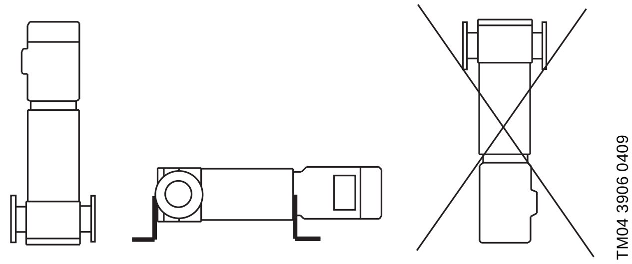


Fig. 4 Pump position

The pump can be installed vertically or horizontally; see fig. 4.

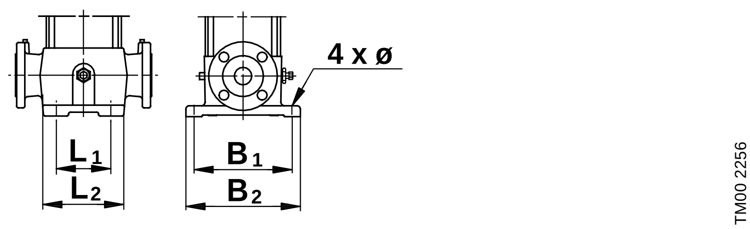
Ensure that an adequate supply of cool air reaches the motor cooling fan. The motor must never fall below the horizontal plane.

Arrows on the pump base show the direction of flow of liquid through the pump.

To minimize possible noise from the pump, it is advisable to fit expansion joints on either side of the pump and anti-vibration mountings between the foundation and the pump.

Note: Care should be taken to ensure that the vent plug is located in the uppermost position.

Isolating valves should be fitted either side of the pump to avoid draining the system if the pump needs to be cleaned, repaired or replaced.



Pump type	L1		L2		B1		B2		ø	
	in	mm	in	mm	in	mm	in	mm	in	mm
CR 1s, 1, 3, 5	3 15/16	100	5 11/16	145	7 1/16	180	8 11/16	220	1/2	13
CRI, CRN 1s 1, 3, 5	3 15/16	100	5 7/8	150	7 1/16	180	8 11/16	220	1/2	13
CR 10, 15, 20	5 1/8	130	6 15/16	176	8 7/16	215	10 1/16	256	9/16	13.5
CRN 10, 15, 20	5 1/8	130	7 7/8	200	8 7/16	215	9 3/4	248	1/2	13
CR 32	6 11/16	170	8 3/4	223	9 7/16	240	11 3/4	298	9/16	14
CRN 32	6 11/16	170	8 7/8	226	9 7/16	240	11 3/4	298	9/16	14
CR 45,64	7 1/2	190	9 3/4	248	10 1/2	266	13 1/16	331	9/16	14
CRN 45,64	7 1/2	190	9 7/8	251	10 1/2	266	13 1/16	331	9/16	14
CR(N) 90	7 13/16	199	10 1/4	261	11	280	13 11/16	348	9/16	14
CR(N) 120, 150	10 13/16	275	13 9/16	344	14 15/16	380	18 9/16	472	11/16	18

6.3 Pump mounting

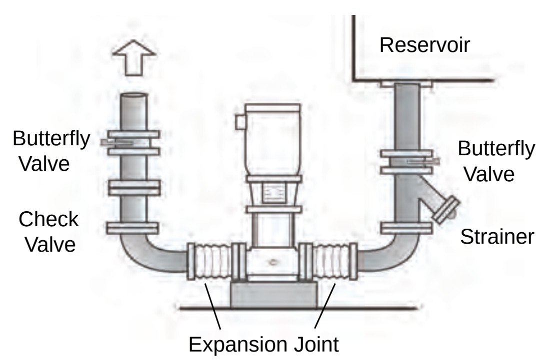
Warning
CR, CRI, CRN pumps are shipped with covered suction and discharge. The covers must be removed before the final pipe flange to pump connections are made.

6.3.1 Recommended installation torques

Model	Recommended foundation torque (ft - lbs)	Recommended flange torque (ft - lbs)
CR, CRI, CRN 1s/1/3/5, and CRT 2/4	30	37 - 44
CR, CRI, CRN 10/15/20, and CRT 8/16	37	44 - 52
CR, CRN 32/45/64/90/ 120/150	52	52 - 59

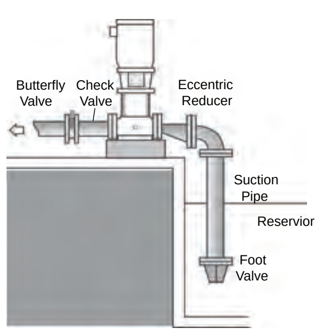
6.4 Suction pipe

The suction pipe should be adequately sized and run as straight and short as possible to keep friction losses to a minimum (minimum of four pipe diameters straight run prior to the suction flange). Avoid using unnecessary fittings, valves or accessory items. Butterfly or gate valves should only be used in the suction line when it is necessary to isolate a pump because of a flooded suction condition. This would occur if the water source is above the pump; see fig. 5 and fig. 6. Flush piping prior to pump installation to remove loose debris.



TM04 3925 0409

Fig. 5 Flooded suction



TM04 3910 0409

Fig. 6 Suction lift*

*The suction pipe should have a fitting on it for priming. CRN-SF pumps cannot be used for suction lift.

6.5 Minimum suction pipe sizes

The following recommended suction pipe sizes are the smallest sizes which should be used with any specific CR pump type.

The suction pipe size should be verified with each installation to ensure good pipe practices are being observed and excess friction losses are not encountered.

High temperatures may require larger diameter pipes to reduce friction and improve NPHSA.

Model	Min. suction pipe size	
CR(I)(N) 1s, 1, 3; CRT 2	1"	Nominal diameter sch 40 pipe
CR(I)(N) 5; CRT 4	1-1/4"	Nominal diameter sch 40 pipe
CR(I)(N) 10, 15, 20; CRT 8, 16	2"	Nominal diameter sch 40 pipe
CR(N) 32	2-1/2"	Nominal diameter sch 40 pipe
CR(N) 45	3"	Nominal diameter sch 40 pipe
CR(N) 64, 90	4"	Nominal diameter sch 40 pipe
CR(N) 120, 150	5"	Nominal diameter sch 40 pipe

6.6 Discharge piping

It is suggested that a check valve and isolation valve be installed in the discharge pipe.

Pipe, valves and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce excessive fluid velocities and pipe friction losses.

Note: Pipe, valves and fittings must have a pressure rating equal to or greater than the maximum system pressure.

Before the pump is installed it is recommended that the discharge piping be pressure checked to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations.

Whenever possible, avoid high pressure loss fittings, such as elbows or branch tees directly on either side of the pump. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump.

Good installation practice recommends the system be thoroughly cleaned and flushed of all foreign materials and sediment prior to pump installation. Furthermore, the pump should never be installed at the lowest point of the system due to the natural accumulation of dirt and sediment. If there is excessive sediment or suspended particles present, it is advised a strainer or filter be used. Grundfos recommends that pressure gauges be installed on inlet and discharge flanges or in pipes to check pump and system performance.

Warning
To avoid problems with waterhammer, fast closing valves must not be used in CRN-SF applications.

6.7 Bypass orifice

A bypass should be installed in the discharge pipe if there is any possibility the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure adequate cooling and lubrication of the pump is maintained. See *6.9 Minimum continuous duty flow rates* for minimum flow rates.

Elbows should be a minimum of 12” from the orifice discharge to prevent erosion.

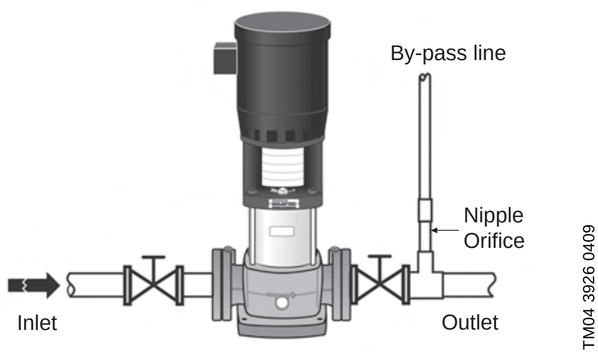


Fig. 7 Recommended bypass arrangement

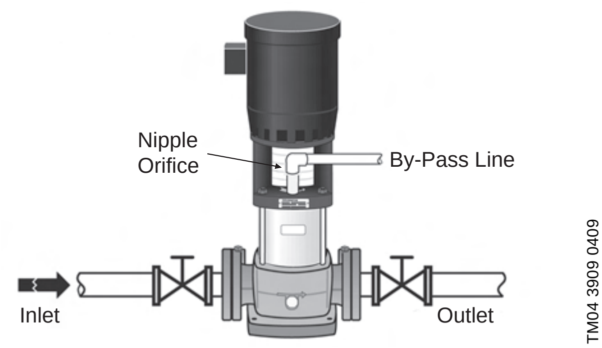


Fig. 8 Optional bypass arrangement

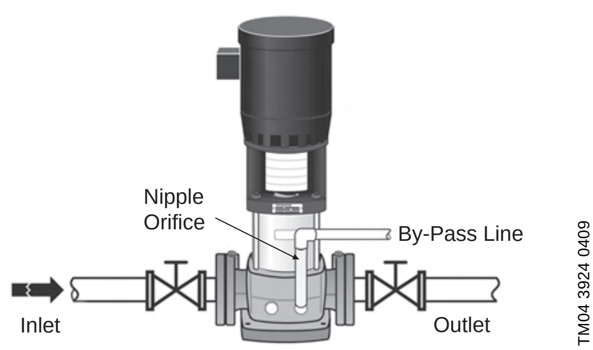
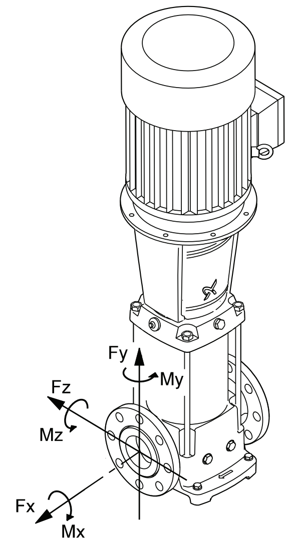


Fig. 9 Optional bypass arrangement for CR(N) 32, 45, 64, and CR 90, 120, and 150 only

6.8 Nozzle loads

If not all loads reach the maximum permissible value stated in the forces and moments tables included here with fig. 10, one of these values may exceed the normal limit. Contact Grundfos for further information.



Y-direction: Direction of chamber stack
Z-direction: 90 ° from inlet/outlet
X-direction: Inlet/outlet

TM04 0346

Fig. 10 Nozzle forces and moments

Flange	CR, CRI, CRN	Forces		
		Y-direction [lb]	**Z-direction [lb]**	**X-direction [lb]**
1-1/4"	1s to 5	171	263	175
2"	10, 15 and 20	303	371	337
2-1/2"	32	382	466	422
3"	45	461	562	506
4"	64 and 90	607	753	674
5" & 6"	120 and 150	607	753	674

Flange	CR, CRI, CRN	Moments		
		Y-direction [ft-lb]	**Z-direction [ft-lb]**	**X-direction [ft-lb]**
1-1/4"	1s to 5	605	715	900
2"	10, 15 and 20	738	848	1,033
2-1/2"	32	793	904	1,106
3"	45	848	959	1,180
4"	64 and 90	922	1,069	1,291
5" & 6"	120 and 150	922	1,069	1,291

6.9 Minimum continuous duty flow rates

Pump Type	min °F to 176 °F (min °C to 80 °C)	at 210°F (at 99°C)	at 248°F (at 120°C)	at 356°F (at 180°C)
CR, CRI, CRN 1s	0.5	0.7	1.2	1.2*
CR, CRI, CRN 1	0.9	1.3	2.3	2.3*
CR, CRI, CRN 3	1.6	2.4	4.0	4.0*
CR, CRI, CRN 5	3.0	4.5	7.5	7.5*
CR, CRI, CRN 10	5.5	8.3	14	14*
CR, CRI, CRN 15	9.5	14	24	24*
CR, CRI, CRN 20	11	17	28	28*
CR, CRN 32	14	21	35	35*
CR, CRN 45	22	33	55	55*
CR, CRN 64	34	51	85	85*
CR, CRN 90	44	66	110	110*
CR, CRN 120	60	90	N/A	N/A
CR, CRN 150	75	115	N/A	N/A
CRT 2	1.3	2.0	3.3	N/A
CRT 4	3.0	4.5	7.5	N/A
CRT 8	4.0	6.0	10	N/A
CRT 16	8.0	0.7	20	N/A

* Grundfos Cool-Top® is only available in the following pump types.

Pump Type	CR 1s	CR 1	CR 3	CR 5	CR 10	CR 15	CR 20	CR 32	CR 45	CR 64	CR 90
Standard (CR)								•	•	•	•
I Version (CRI)	•	•	•	•	•	•	•				
N Version (CRN)	•	•	•	•	•	•	•	•	•	•	•

6.10 Check valves

A check valve may be required on the discharge side of the pump to prevent the pump's inlet pressure from being exceeded.

For example, if a pump with no check valve is stopped because there is no demand on the system (all valves are closed), the high system pressure on the discharge side of the pump will "find" its way back to the inlet of the pump.

If the system pressure is greater than the pump's maximum inlet pressure rating, the limits of the pump will be exceeded and a check valve needs to be fitted on the discharge side of the pump to prevent this condition. **This is especially critical for CRN-SF applications because of the very high discharge pressures involved. As a result, most CRN-SF installations require a check valve on the discharge piping.**

6.11 Temperature rise

It may sometimes be necessary to stop the flow through a pump during operation.

At shut-off, the power to the pump is transferred to the pumped liquid as head, causing a temperature rise in the liquid.

The result is risk of excess heating of and consequent damage to the pump. The risk depends on the temperature of the pumped liquid and for how long the pump is operating without flow; see the following temperature rise chart.

Pump type	Time for temperature rise of 18 °F (10 °C)	
	Seconds	Minutes
CR 1s, 1, 3	210	3.5
CR 5	240	4.0
CR 10	210	3.5
CR 15	150	2.5
CR 20	120	2.0
CR 32, 45, 64, 90, 120, 150	60	1.0

6.12 Conditions/Reservations

The listed times are subject to the following conditions/ reservations:

- No exchange of heat with the surrounding.
- The pumped liquid is water with a specific heat of 1.0 $^{Btu}/_{lb.}$ °F (4.18 $^{kJ}/_{kg}$ °C).
- Pump parts (chambers, impellers and shaft) have the same thermal capacity as water.
- The water in the base and the pump head is not included.

These reservations should give sufficient safety margin against excessive temperature rise.

The maximum temperature must not exceed the pump maximum rating.

6.13 Electrical

Warning

The safe operation of this pump requires that it be grounded in accordance with the national electrical code and local governing codes or regulations. Connect the ground wire to the grounding screw in the terminal box and then to the ACCEPTABLE grounding point. All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

6.14 Motor

Grundfos CR pumps are supplied with heavy-duty 2-pole (3600 rpm nominal), ODP or TEFC, NEMA C frame motors selected to our rigid specifications.

Motors with other enclosure types and for other voltages and frequencies are available on a special-order basis.

CRN-SF pumps are supplied with an IEC (metric) type motor with a reverse thrust bearing.

If you are replacing the pumping unit, but are using a motor previously used on another CR pump, be sure to read *10. Replacing the motor* for proper adjustment of the coupling height.

6.15 Position of Terminal Box

The motor terminal box can be turned to any of four positions in steps of 90°.

To rotate the terminal box, remove the four bolts securing the motor to the pump but do not remove the shaft coupling. Turn the motor to the desired location; replace and securely tighten the four bolts; see fig. 11.

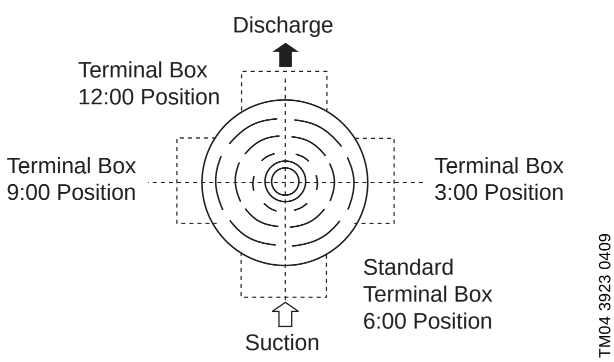


Fig. 11 Motor terminal box positions (top view)

6.16 Field Wiring

Wire sizes should be based on the current carrying properties of a conductor as required by the latest edition of the National Electrical Code or local regulations. Direct on line (D.O.L.) starting is approved due to the extremely fast run-up time of the motor and the low moment of inertia of the pump and motor. If D.O.L. starting is not acceptable and reduced starting current is required, an auto transformer, resistant starter or soft start should be used. It is suggested that a fused disconnect be used for each pump where service and standby pumps are installed.

6.17 Motor protection

6.17.1 Single-Phase Motors

With the exception of 10 HP motors which require external protection, single-phase CR pumps are equipped with multi-voltage, squirrel-cage induction motors with built-in thermal protection.

6.17.2 Three-Phase Motors

CR pumps with three-phase motors must be used with the proper size and type of motor-starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overloads.

A properly sized starter with manual reset and ambient-compensated extra quick trip in all three legs should be used. The overload should be sized and adjusted to the full-load current rating of the motor. Under no circumstances should the overloads be set to a higher value than the full load current shown on the motor nameplate. This will void the warranty.

Overloads for auto transformers and resistant starters should be sized in accordance with the recommendations of the manufacturer.

Three phase MLE motors (CRE-Pumps) require only fuses as a circuit breaker. They do not require a motor starter. Check for phase imbalance (worksheet is provided; see p. 23).
Note: Standard allowable phase imbalance difference is 5%.

6.17.3 CRN-SF

The CRN-SF is typically operated in series with a feed pump. Because the maximum allowable inlet pressure of the CRN-SF increases from 73 psi (when pump is off and during start-up) to 365 psi (during operation), a control device must be used to start the CRN-SF pump one second before the feed pump starts. Similarly, the CRN-SF must stop one second after the feed pump stops. See CRN-SF startup timeline below.

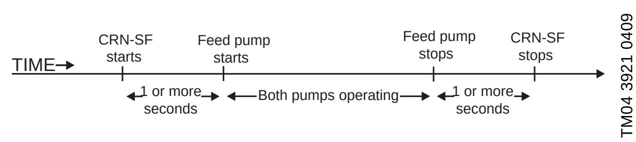


Fig. 12 CRN-SF startup

7. Starting the pump the first time

7.1 Priming

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolation valve(s) and open the priming plug on the pump head; see fig. 13 and fig. 14.

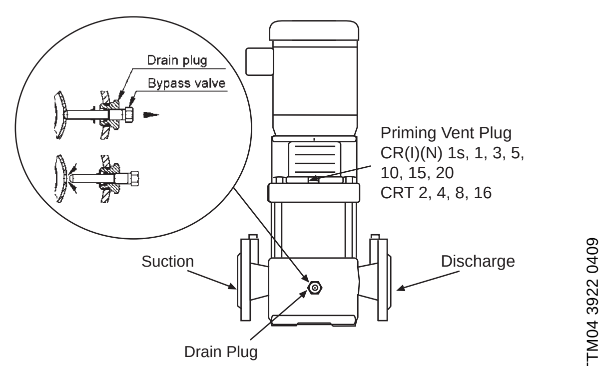


Fig. 13 Plug and valve locations

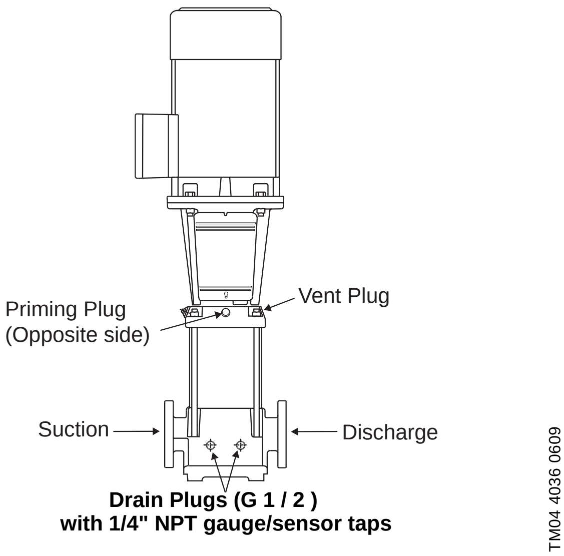


Fig. 14 Plug/valve locations CR(N) 32, 45, 64, 90, 120, 150

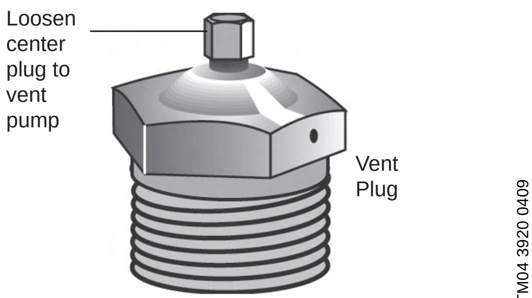


Fig. 15 Vent plug

Gradually open the isolation valve in the suction line until a steady stream of airless water runs out the priming port. Close the plug and securely tighten. Completely open the isolation valves.

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled and vented of air before starting the pump. Close the discharge isolation valve and remove the priming plug. Pour water through the priming hole until the suction pipe and pump are completely filled with water. If the suction pipe does not slope downward from the pump toward the water level, the air must be purged while being filled. Replace the priming plug and securely tighten. For pumps with Cool-Top®, see *14. Startup for Cool-Top®*.

Follow these steps:

1. Switch power off.
2. Check to make sure the pump has been filled and vented.
3. Remove the coupling guard and rotate the pump shaft by hand to be certain it turns freely.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Switch the power on and observe the direction of rotation. When viewed from the top, the pump should rotate counter-clockwise (clockwise for CRN-SF).
6. To reverse the direction of rotation, first switch OFF the supply power.
7. On three-phase motors, interchange any two power leads at the load side of the starter. On single-phase motors, see connection diagram on nameplate. Change wiring as required.
8. Switch on the power and again check for proper motor rotation. Once rotation has been verified, switch off power again. Do not attempt to reinstall the coupling guards with the motor energized. Replace the coupling guard if the rotation is correct. After guards are in place the power can be reapplied. **Note:** CR, CRI, CRN 1s to 5: For these pumps, it is advisable to open the bypass valve during start-up; see fig. 13. The bypass valve connects the suction and discharge sides of the pump, thus making the filling procedure easier. When the operation is stable, the bypass valve must be closed.

US

Caution

Motors should not be run unloaded or uncoupled from the pump at any time; damage to the motor bearings will occur.

Do not start the pump before priming or venting the pump; see fig. 15. Never operate the pump dry.

7.2 Operating Parameters

CR multi-stage centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide years of service. The pumps are water-lubricated and do not require any external lubrication or inspection. The motors may require periodic lubrication as noted in *9. Maintaining the pump's motor*.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient water to circulate through the pump to provide adequate cooling and lubrication of the pump bearings and seals.

7.3 Pump Cycling

Pump cycling should be checked to ensure the pump is not starting more than the following.

Grundfos ML motors:

- 200 times per hour on 1/3 to 5 hp models
- 100 times per hour on 7 1/2 to 15 hp models
- 40 times per hour on 20 to 30 hp models.

Baldor motors:

- 20 times per hour on 1/3 to 5 hp models
- 15 times per hour on 7 1/2 to 15 hp models
- 10 times per hour on 20 to 100 hp models.

Rapid cycling is a major cause of premature motor failure due to increased heat build-up in the motor. If necessary, adjust controls to reduce the frequency of starts and stops.

7.4 Boiler-feed installations

If the pump is being used as a boiler-feed pump, make sure the pump is capable of supplying sufficient water throughout its entire evaporation and pressure ranges. Where modulating control valves are used, a bypass around the pump must be installed to ensure pump lubrication (see "Minimum Continuous Duty Flow Rates").

7.5 Freeze Protection

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolation valves, remove the priming plug and drain plug at the base of the pump. Do not replace the plugs until the pump is to be used again. Always replace the drain plug with the original or exact replacement. Do not replace with a standard plug. Internal recirculation will occur, reducing the output pressure and flow.

8. Preventative pump maintenance

At regular intervals depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operation of all controls. Check unit control cycling twice and adjust, if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.
8. To extend the pump life in severe duty applications, consider performing one of the following actions:
   – Drain the pump after each use.
   – Flush the pump, through system, with water or other fluid that is compatible with the pump materials and process liquid.
   – Disassemble the pump liquid components and thoroughly rinse or wash them with water or other fluid that is compatible with the pump materials and process liquid.

If the pump fails to operate or there is a loss of performance, refer to *Section 15. Diagnosing specific problems*.

9. Maintaining the pump's motor

Warning

Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation, and maintenance of this equipment.

9.1 Motor Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation openings clear.

The following steps should be performed at each inspection:

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper, pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use an Ohmmeter ("Megger") periodically to ensure that the integrity of the winding insulation has been maintained. Record the Ohmmeter readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

9.2 Motor Lubrication

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors without external grease fittings have sealed bearings that cannot be re-lubricated. Motors with grease fittings should only be lubricated with approved types of grease. Do not over-grease the bearings. Over-greasing will cause increased bearing heat and can result in bearing/motor failure. Do not mix petroleum grease and silicon grease in motor bearings.

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearings, the speed at which the bearings operate and the severity of the operating conditions.

Good results can be obtained if the following recommendations are used in your maintenance program. It should also be noted that pumps with more stages, pumps running to the left of the performance curve, and certain pump ranges may have higher thrust loads. Pumps with high thrust loads should be greased according to the next service interval level.

9.3 Recommended lubricant

Severity of service	Ambient temp. (max.)	Environment	Approved types of grease
Standard	+104 °F (+40 °C)	Clean, little corrosion	Grundfos ML motors are greased for life or will have the grease type on the nameplate. Baldor motors are greased with Polyrex EM (Exxon Mobile).
Severe	+122 °F (+50 °C)	Moderate dirt, corrosion	
Extreme	>122 °F (+50°C) or Class H insulation	Severe dirt, abrasive dust, corrosion	

Note: If pump is fitted with a bearing flange that requires grease, see the stickers on either the bearing flange or coupling guards for proper grease type and greasing schedule.

9.4 Motor lubrication schedule (for motors with grease nipples)

New motors that have been stored for a year or more should be regreased according to the following:

NEMA (IEC) Frame Size	Standard Service Interval	Severe Service Interval	Extreme Service Interval	Weight of grease to add [oz (grams)]	Volume of grease to add [in^3 (teaspoons)]
Up through 210 (132)	5500 hrs	2750 hrs	550 hrs	0.30 (8.4)	0.6 (2)
Over 210 through 280 (180)	3600 hrs	1800 hrs	360 hrs	0.61 (17.4)*	1.2 (3.9)
Over 280 up through 360 (225)	2200 hrs	1100 hrs	220 hrs	0.81 (23.1)*	1.5 (5.2)
Over 360 (225)	2200 hrs	1100 hrs	220 hrs	2.12 (60.0)*	4.1 (13.4)

Warning

The grease outlet plug MUST be removed before adding new grease.

9.5 Lubrication Procedure

Caution

To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact Grundfos, the motor manufacturer, or an authorized service center for additional information.

Mixing dissimilar grease is not recommended.

1. Clean all grease fittings. If the motor does not have grease fittings, the bearing is sealed and cannot be greased externally.
2. If the motor is equipped with a grease outlet plug, remove it. This will allow the old grease to be displaced by the new grease. If the motor is stopped, add the recommended amount of grease. If the motor is to be greased while running, a slightly greater quantity of grease will have to be added. **Note:** If new grease does not appear at the shaft hole or grease outlet plug, the outlet passage may be blocked. At the next service interval the bearings must be repacked.
3. Add grease SLOWLY taking approximately one minute until new grease appears at the shaft hole in the endplate or grease outlet plug. Never add more than 1-1/2 times the amount of grease shown in the lubrication schedule.
4. For motors equipped with a grease outlet plug, let the motor run for 20 minutes before replacing the plug.

10. Replacing the motor

If the motor is damaged due to bearing failure, burning or electrical failure, the following instructions detail how to remove the motor for replacement.

Caution

It must be emphasized that motors used on CR pumps are specifically selected to our rigid specifications. Replacement motors must be of the same frame size, should be equipped with the same or better bearings and have the same service factor. Failure to follow these recommendations may result in premature motor failure.

10.1 Disassembly

For disassembly, proceed as follows:

1. Turn off and lock out power supply. The power supply wiring can now be safely disconnected from the motor wires. Remove the coupling guards. **Note:** CR 1s, 1, 3, 5, 10, 15, and 20: do not loosen the three shaft seal securing allen screws.
2. Using the proper metric Allen wrench, loosen the four cap screws in the coupling. Completely remove coupling halves. On CR1s-CR20, the shaft pin can be left in the pump shaft. CR(N)32, 45, 64, 90, 120, and 150 do not have a shaft pin.
3. With the correct size wrench, loosen and remove the four bolts which hold the motor to the pump end.
4. Lift the motor straight up until the shaft has cleared the motor stool.

10.2 Assembly

For assembly, proceed as follows:

1. Remove key from motor shaft, if present, and discard.
2. Thoroughly clean the surfaces of the motor and pump end mounting flange. The motor and shaft must be clean of all oil/grease and other contaminants where the coupling attaches. Set the motor on the pump end.
3. Place the terminal box in the desired position by rotating the motor.
4. Insert the mounting bolts, then diagonally and evenly tighten:
   – for 3/8” bolts (1/2 to 2 hp), torque to 17 ft-lb
   – for 1/2” bolts (3 to 40 hp) torque to 30 ft-lb
   – for 5/8” bolts (50 - 100 hp) torque to 59 ft-lb
   – follow instructions for particular pump model in sections *10.2.1 Torque specifications for CR 1s, 1, 3, and 5* through *10.2.4 CR(N) 32, 45, 64, 90, 120, and 150*.

US

10.2.1 Torque specifications for CR 1s, 1, 3, and 5

Insert shaft pin into shaft hole. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even, and that the motor shaft keyway is centered in the coupling half, as shown in fig. 16.

Tighten the screws to the correct torque; see torque specifications table below.

Torque specifications CR(I)(N) 1s, 1, 3, 5, 10, 15, and 20 CRT 2, 4, 8, and 16	
Coupling bolt size	**Min. torque**
M6	10 ft-lb
M8	23 ft-lb
M10	46 ft-lb

10.2.2 CR 10, 15 and 20

Insert shaft pin into shaft hole. Insert plastic shaft seal spacer beneath shaft seal collar. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even and that the motor shaft key way is centered in the coupling half, as shown in fig. 16. Tighten the screws to the correct torque. Remove plastic shaft seal spacer and hang it on inside of coupling guard.

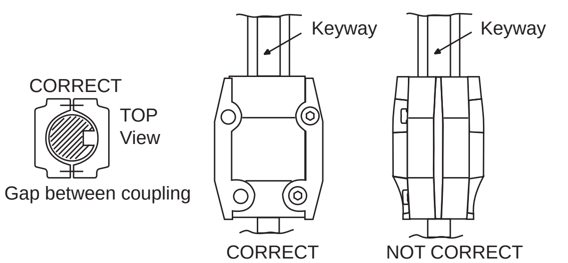


Fig. 16 Coupling adjustment all CR(I)(N)(X)(T)

10.2.3 CRT 2, 4, 8 and 16

Reinstall coupling halves. Make sure the shaft pin is located in the pump shaft. Put the cap screws loosely back into the coupling halves.

Using a large screwdriver, raise the pump shaft by placing the tip of the screwdriver under the coupling and carefully elevating coupling to its highest point; see fig. 17.

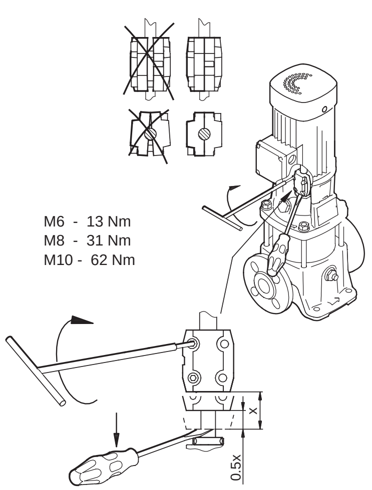


Fig. 17 Coupling adjustment CRT 2, 4, 8, and 16

Note: The shaft can only be raised approximately 0.20 in (5mm). Now lower the shaft halfway back down the distance you just raised it and tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides. When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a criss-cross pattern.

- Note the clearance below the coupling
- Raise the coupling higher, as far as it will go
- Lower it halfway back down (1/2 the distance you just raised it)
- Tighten screws (see torque specifications below)

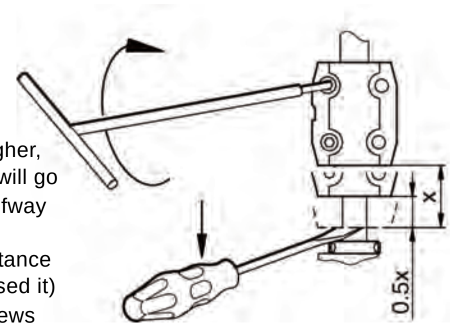


Fig. 18 Coupling adjustment clearance CRT 2, 4, 8, and 16

10.2.4 CR(N) 32, 45, 64, 90, 120, and 150

1. Make sure shaft is all the way down. TIghten the set screws on the mechanical seal.
2. Place the plastic adjustment fork under the cartridge seal collar; see fig. 19.

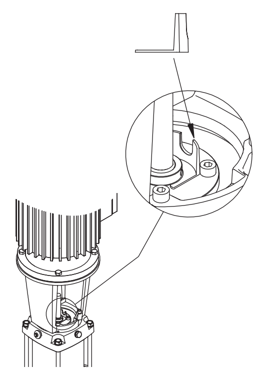


Fig. 19 Coupling adjustment
CR(N) 32, 45, 64, 90, 120, and 150

3. Fit the coupling on the shaft so that the top of the pump shaft is flush with the bottom of the clearance chamber in the coupling; see fig. 20.
   Note: To avoid damaging the coupling halves, ensure that no portion of the keyway on the motor shaft lies within the gap between the two coupling halves.

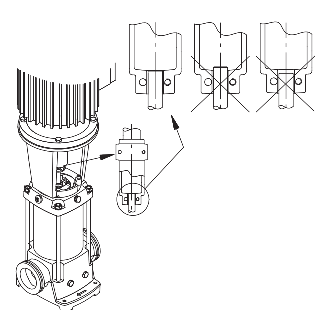
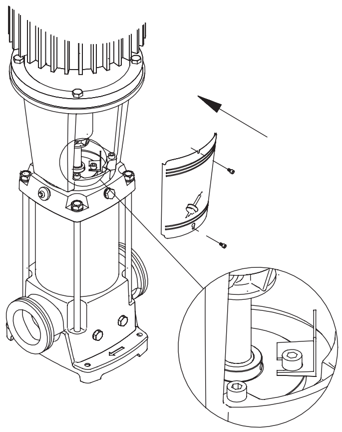


Fig. 20 Coupling adjustment clearance
CR(N) 32, 45, 64, 90, 120, and 150

4. Lubricate the coupling screws with an anti-seize and lubricating compound. Tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides and the motor shaft keyway centered in the coupling half as shown in fig. 16.
5. When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a crisscross pattern.
6. Torque coupling screws to 62 ft.-lbs (75 and 100 hp motors to 74 ft-lbs). Remove the adjustment fork from under the cartridge seal collar and replace it to the storage location; see fig. 21.



TM04 3915 0409

Fig. 21 Adjustment fork storage
CR(N) 32, 45, 64, 90, 120, and 150

7. Check to see that the gaps between the coupling halves are equal. Loosen and readjust, if necessary.
8. Be certain the pump shaft can be rotated by hand. If the shaft cannot be rotated or it binds, disassemble and check for misalignment.
9. Prime the pump.
10. Follow the wiring diagram on the motor label for the correct motor wiring combination which matches your supply voltage. Once this has been confirmed, reconnect the power supply wiring to the motor.
11. Check the direction of rotation, by bump-starting the motor. Rotation must be left to right (counter-clockwise) when looking directly at the coupling.
12. Shut off the power, then re-install the coupling guards. After the coupling guards have been installed the power can be turned back on.

11. Parts List

For each CR pump model Grundfos offers an extensive **Parts List** and diagram of part used in that pump and is recommended to have on hand for future maintenance. In addition, the listings also provide information about prepackaged **Service Kits** for those pump components most likely to exhibit wear over time, as well as the complete Impeller Stack needed to replace the “guts” of each model. These Parts Lists are available separately from the Grundfos literature warehouse or as a set with extensive service instructions in the Grundfos CR **Service Manuals** (for a small charge).

TM04 3917 0409

Fig. 22 Prepackaged impeller stack kits

TM04 3916 0409

Fig. 23 Prepackaged flange kits

12. Spare Parts

Grundfos offers an extensive list of spare parts. For a current list of these parts, refer to: “All Product Spare Parts/Service Kits” Price List, Form #L-SK-SL-002.

US

13. Preliminary electrical tests

Warning

When working with electrical circuits, use caution to avoid electrical shock. It is recommended that rubber gloves and boots be worn, and metal terminal boxes and motors are grounded before any work is done. For your protection, always disconnect the pump from its power source before handling.

13.1 Supply voltage

13.1.1 How to measure the supply voltage

Use a voltmeter, (set to the proper scale) measure the voltage at the pump terminal box or starter.

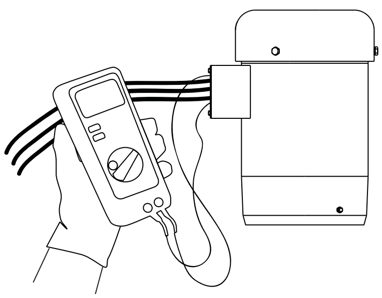
On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units).

On three-phase units, measure between:

– Power leads L1 and L2

– Power leads L2 and L3

– Power leads L3 and L1



TM04 3911 0409

Fig. 24 Measuring supply voltage

13.1.2 What the supply voltage measurement means

When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

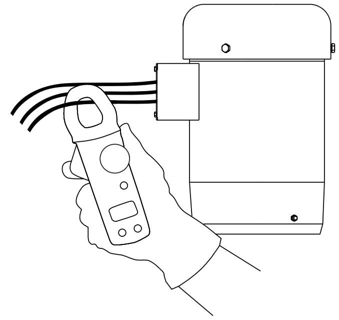
If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

13.2 Current measurement

13.2.1 How to measure the current

Use an ammeter (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information.

Current should be measured when the pump is operating at constant discharge pressure.



TM04 3908 0409

Fig. 25 Measuring current

13.2.2 What the current measurement means

If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following:

– Burned contacts on motor starter.

– Loose terminals in starter or terminal box or possible wire defect.

– Too high or too low supply voltage.

– Motor windings are shorted or grounded. Check winding and insulation resistances.

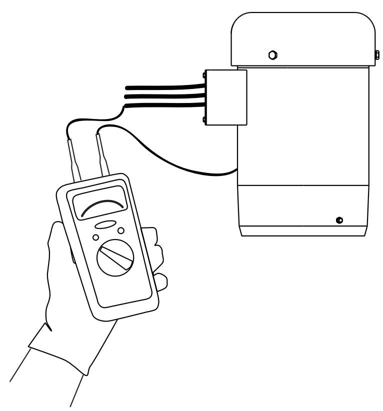
– Pump is damaged causing a motor overload.

13.3 Insulation resistance

13.3.1 How to measure the insulation resistance

Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter.

Measure and record the resistance between each of the terminals and ground.



TM04 3907 0409

Fig. 26 Measuring insulation resistance

13.3.2 What the insulation resistance means

Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, motor should be repaired or replaced.

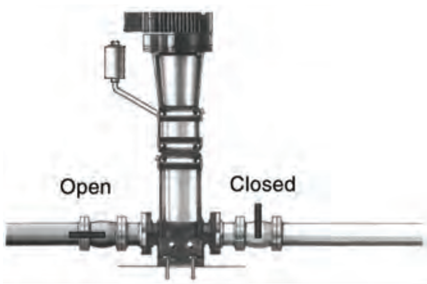
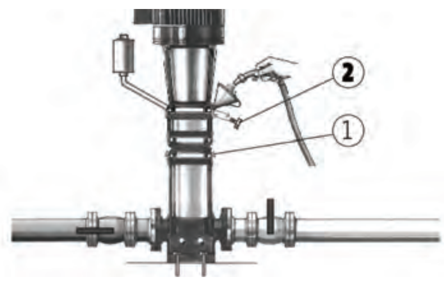
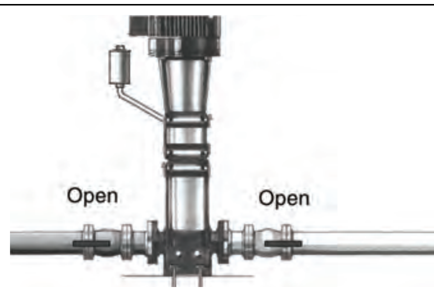
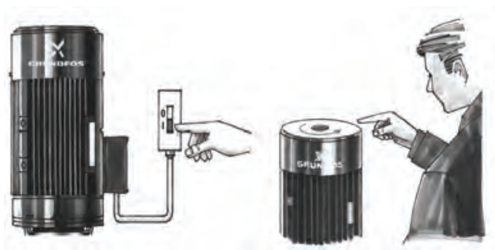
14. Startup for Cool-Top®

Caution ***Do not start the pump until it has been filled with liquid and vented.***

Warning

Pay attention to the direction of the vent hole and take care to ensure that the escaping liquid does not cause injury to persons or damage to the motor or other components. In hot-liquid installations, special attention should be paid to the risk of injury caused by scalding hot liquid. It is recommended to connect a drain pipe to the 1/2" air vent in order to lead the hot water/steam to a safe place.

US

Step		Action
1	 TM02 4151 5001	**Note:** The air-cooled top should only be started up with cold liquid. Close the isolation valve on the discharge side and open the isolation valve on the suction side of the pump.
2	 TM02 4153 1503	Remove the priming plug from the **air-cooled chamber (2)** and slowly fill the chamber with liquid. When the chamber is completely filled with liquid, replace the priming plug and tighten securely.
3	 TM02 5907 4002	Open the isolation valve on the discharge side of the pump. Valve may have to be partially closed when pump is started if no back pressure is present (i.e. boiler not up to pressure).
4	 TM01 41406 3702 TM01 1405 4497	Start the pump and check the direction of rotation. See the correct rotation of the pump on the motor fan cover. If the direction of rotation is wrong, interchange any two of the incoming supply wires. After 3 to 5 minutes, the air vent has been filled with liquid. **Note:** During startup of a cold pump with hot liquid, it is normal that a few drops of liquid are leaking from the sleeve.

15. Diagnosing specific problems

US

Problem		Possible cause	Remedy
The pump does not run.	1.	No power at motor.	Check voltage at motor terminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2.	Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	3.	Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4.	Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	5.	Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	6.	Motor is defective.	Turn off power and disconnect wiring. Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	7.	Defective capacitor (single-phase motors).	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.
	8.	Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
The pump runs but at reduced capacity or does not deliver water.	1.	Wrong rotation.	Check wiring for proper connections. Correct wiring.
	2.	Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump. Long suction lines must be filled before starting the pump.
	3.	Strainers, check or foot valves are clogged.	Remove strainer, screen or valve and inspect. Clean and replace. Reprime pump.
	4.	Suction lift too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data. Reduce suction lift by lowering pump, increase suction line size or removing high friction loss devices.
	5.	Suction and/or discharge piping leaks.	Pump spins backwards when turned off. Air in suction pipe. Suction pipe, valves and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	6.	Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shutoff. Convert measured pressure (in psi) to head (in feet): (Measured psi x 2.31 ft/psi = ___ ft). Refer to the specific pump curve for shutoff head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
	7.	Pump impeller or guide vane is clogged.	Disassemble and inspect pump passageways. Remove any foreign materials found.
	8.	Incorrect drain plug is installed.	If the proper drain plug is replaced with a standard plug, water will recirculate internally. Replace with proper plug.
	9.	Improper coupling setting.	Check/reset the coupling; see page 18.

Problem		Possible cause	Remedy
Pump cycles too much	1.	Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts. Readjust switch or replace if defective.
	2.	Level control is not properly adjusted or is defective.	Check setting and operation. Readjust setting (refer to level control manufacturer's data). Replace if defective.
	3.	Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphragm chamber. Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume. Repair as necessary.
	4.	Tank is too small.	Check tank size and air volume in tank. Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure. Replace tank with one of correct size.
	5.	Pump is oversized.	Install pressure gauges on or near pump suction and discharge ports. Start and run pump under normal conditions, record gauge readings. Convert psi to feet (Measured psi x 2.31 ft/psi = ____ ft) Refer to the specific pump curve for that model, ensure that total head is sufficient to limit pump delivery within its design flow range. Throttle pump discharge flow if necessary.
Fuses blow or circuit breakers or overload relays trip	1.	Tank is too small.	Check voltage at starter panel and motor. If voltage varies more than –10 % / + 10 %, contact power company. Check wire sizing.
	2.	Motor overloads are set too low.	Cycle pump and measure amperage. Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current.
	3.	Three-phased current is imbalanced.	Check current draw on each lead to the motor. Must be within –5 % / + 5 %. If not, check motor and wiring. Rotating all leads may eliminate this problem.
	4.	Motor is shorted or grounded.	Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohmmeter (RX-1). Measure lead-to-ground values with an ohmmeter (RX-100K) or a megaohm meter. Record values. If an open or grounded winding is found, remove the motor, repair and/or replace.
	5.	Wiring or connections are faulty.	Check proper wiring and loose terminals. Tighten loose terminals. Replace damaged wire.
	6.	Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
	7.	Defective capacitor (single-phase motors).	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.
	8.	Motor overloads at higher ambient temperature than motor.	Use a thermometer to check the ambient temperature near the overloads and motor. Record these values. If ambient temperature at motor is lower than at overloads, especially where temperature at overloads is above +104 °F (+40 °C), ambient-compensated heaters should replace standard heaters.

US

16. Worksheet for three-phase motors

Below is a worksheet for calculating current unbalance on a three-phase hookup. Use the calculations below as a guide.

Note: Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source. However, if the reading farthest from the averages moves with the same motor lead, the primary source of unbalance is on the "motor side" of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

Explanation and examples	
Here is an example of current readings at maximum pump loads on each leg of a three-wire hookup. You must make calculations for all three hookups. To begin, add up all three readings for hookup numbers 1, 2, and 3.	**Hookup 1** T1 = 51 amps T2 = 46 amps T3 = 53 amps TOTAL = 150
Divide the total by three to obtain the average.	**Hookup 1** 50 amps 3 ⟌ 150 amps
Calculate the greatest current difference from the average.	**Hookup 1** 50 amps — 46 amps 4 amps
Divide this difference by the average to obtain the percentage of the unbalance. In this case, the current unbalance for **Hookup 1** is 8%.	**Hookup 1** .08 or 8% 50 ⟌ 4.00 amps

Figure here		
Hookup 1 L_1 to T_1 = ___ amps L_2 to T_2 = ___ amps L_3 to T_3 = ___ amps TOTAL = ___ amps	**Hookup 2** L_1 to T_3 = ___ amps L_2 to T_1 = ___ amps L_3 to T_2 = ___ amps TOTAL = ___ amps	**Hookup 3** L_1 to T_2 = ___ amps L_2 to T_3 = ___ amps L_3 to T_1 = ___ amps TOTAL = ___ amps
Hookup 1 ___ amps 3 ⟌ ___ amps	**Hookup 2** ___ amps 3 ⟌ ___ amps	**Hookup 3** ___ amps 3 ⟌ ___ amps
Hookup 1 ___ amps ___ amps ___ amps	**Hookup 2** ___ amps ___ amps ___ amps	**Hookup 3** ___ amps ___ amps ___ amps
Hookup 1 ___ or ___ % ___ ⟌ ___ amps	**Hookup 2** ___ or ___ % ___ ⟌ ___ amps	**Hookup 3** ___ or ___ % ___ ⟌ ___ amps

U.S.A.

GRUNDFOS Pumps Corporation
17100 West 118th Terrace
Olathe, Kansas 66061
Phone: +1-913-227-3400
Telefax: +1-913-227-3500

Canada

GRUNDFOS Canada Inc.
2941 Brighton Road
Oakville, Ontario
L6H 6C9
Phone: +1-905 829 9533
Telefax: +1-905 829 9512

México

Bombas GRUNDFOS de México S.A. de C.V.
Boulevard TLC No. 15
Parque Industrial Stiva
Aeropuerto
Apodaca, N.L.C.P. 66600
Phone: +52-81-8144 4000
Telefax: +52-81-8144 4010

Addresses revised 22.09.2005

ISO 9001 CERTIFIED

L-CR-TL-001 0309	US
Repl. L-CP-TL-003 1205	

BALDOR-RELIANCE
INTEGRAL HORSEPOWER AC
INDUCTION MOTORS

Operations & Maintenance Manual
December 2015

BALDOR • RELIANCE

Integral Horsepower
AC Induction Motors

Installation & Operating Manual

2/09 MN400

Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

www.baldor.com/support/warranty_standard.asp

Safety Notice: This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. When installing, protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Thermostat contacts automatically reset when the motor has slightly cooled down. To prevent injury or damage, the control circuit should be designed so that automatic starting of the motor is not possible when the thermostat resets.**

Safety Notice Continued

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

WARNING: **Pacemaker danger – Magnetic and electromagnetic fields in the vicinity of current carrying carrying conductors and permanent magnet motors can result result in a serious health hazard to persons with cardiac pacemakers, metal implants, and hearing aids. To avoid risk, stay way from the area surrounding a permanent magnet motor.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Use only UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust.**

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo. Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.**

WARNING: **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not over–lubricate motor as this may cause premature bearing failure.**

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Handling The motor should be lifted using the lifting lugs or eye bolts provided.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed).
   The packing provides insulation from temperature changes during transportation.
3. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only.
   A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.

4. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation.

   Do not lift the assembly using the motor lugs or eye bolts provided. Lugs or eye bolts are designed to lift motor only. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Storage

Storage requirements for motors and generators that will not be placed in service for at least six months from date of shipment.

Improper motor storage will result in seriously reduced reliability and failure. An electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to develop rust in the bearings or rust particles from surrounding surfaces may contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failure.

A wooden crate “shell” should be constructed to secure the motor during storage. This is similar to an export box but the sides & top must be secured to the wooden base with lag bolts (not nailed as export boxes are) to allow opening and reclosing many times without damage to the “shell”.

Minimum resistance of motor winding insulation is 5 Meg ohms or the calculated minimum, which ever is greater. Minimum resistance is calculated as follows: **Rm = kV + 1**

where: (Rm is minimum resistance to ground in Meg−Ohms and
kV is rated nameplate voltage defined as Kilo−Volts.)

Example: For a 480VAC rated motor Rm =1.48 meg−ohms (use 5 MΩ).
For a 4160VAC rated motor Rm = 5.16 meg−ohms.

Preparation for Storage

1. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.
2. Store in a clean, dry, protected warehouse where control is maintained as follows:
   a. Shock or vibration must not exceed 2 mils maximum at 60 hertz, to prevent the bearings from brinelling. If shock or vibration exceeds this limit vibration isolation pads must be used.
   b. Storage temperatures of 10°C (50°F) to 49°C (120°F) must be maintained.
   c. Relative humidity must not exceed 60%.
   d. Motor space heaters (when present) are to be connected and energized whenever there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are optional.

   Note: Remove motor from containers when heaters are energized, reprotect if necessary.
3. Measure and record the resistance of the winding insulation (dielectric withstand) every 30 days of storage.
   a. If motor insulation resistance decreases below the minimum resistance, contact your Baldor District office.
   b. Place new desiccant inside the vapor bag and re−seal by taping it closed.
   c. If a zipper−closing type bag is used instead of the heat−sealed type bag, zip the bag closed instead of taping it. Be sure to place new desiccant inside bag after each monthly inspection.
   d. Place the shell over the motor and secure with lag bolts.
4. Where motors are mounted to machinery, the mounting must be such that the drains and breathers are fully operable and are at the lowest point of the motor. Vertical motors must be stored in the vertical position. Storage environment must be maintained as stated in step 2.

5. Motors with anti−friction bearings are to be greased at the time of going into extended storage with periodic service as follows:
   a. Motors marked “Do Not Lubricate” on the nameplate do not need to be greased before or during storage.
   b. Ball and roller bearing (anti−friction) motor shafts are to be rotated manually every 3 months and greased every 6 months in accordance with the Maintenance section of this manual.
   c. Sleeve bearing (oil lube) motors are drained of oil prior to shipment.
      The oil reservoirs must be refilled to the indicated level with the specified lubricant, (see Maintenance). The shaft should be rotated monthly by hand at least 10 to 15 revolutions to distribute oil to bearing surfaces.
   d. “Provisions for oil mist lubrication” – These motors are packed with grease. Storage procedures are the same as paragraph 5b.
   e. “Oil Mist Lubricated” – These bearings are protected for temporary storage by a corrosion inhibitor. If stored for greater than 3 months or outdoor storage is anticipated, connected to the oil mist system while in storage. If this is not possible, add the amount of grease indicated under “Standard Condition” in Section 3, then rotate the shaft 15 times by hand.
6. All breather drains are to be fully operable while in storage (drain plugs removed). The motors must be stored so that the drain is at the lowest point. All breathers and automatic “T” drains must be operable to allow breathing and draining at points other than through the bearings around the shaft. Vertical motors should be stored in a safe stable vertical position.
7. Coat all external machined surfaces with a rust preventing material.
   An acceptable product for this purpose is Exxon Rust Ban # 392.

Non−Regreaseable Motors

Non−regreasable motors with “Do Not Lubricate” on the nameplate should have the motor shaft rotated 15 times to redistribute the grease within the bearing every 3 months or more often.

All Other Motor Types

Before storage, the following procedure must be performed.

1. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each bracket prior to lubricating the motor.
2. The motor with regreasable bearing must be greased as instructed in Section 3 of this manual.
3. Replace the grease drain plug after greasing.
4. The motor shaft must be rotated a minimum of 15 times after greasing.
5. Motor Shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months (see Section 3) to each bearing.
6. Bearings are to be greased at the time of removal from storage.

Removal From Storage

1. Remove all packing material.
2. Measure and record the electrical resistance of the winding insulation resistance meter at the time of removal from storage. The insulation resistance must not be less than 50% from the initial reading recorded when the motor was placed into storage. A decrease in resistance indicates moisture in the windings and necessitates electrical or mechanical drying before the motor can be placed into service. If resistance is low, contact your Baldor District office.
3. Regrease the bearings as instructed in Section 3 of this manual.
4. Reinstall the original shipping brace if motor is to be moved. This will hold the shaft firmly against the bearing and prevent damage during movement.

Section 2
Installation & Operation

Overview Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip−Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non−corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Hazardous Locations are those where there is a risk of ignition or explosion due to the presence of combustible gases, vapors, dust, fibers, or flyings. Facilities requiring special equipment for hazardous locations are typically classified in accordance with local requirements. In the US market, guidance is provided by the National Electric Code.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Mounting The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment Accurate alignment of the motor with the driven equipment is extremely important. The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible.
It is recommended to heat the pulley, sprocket, or gear before installing on the motor shaft.
Forcibly driving a unit on the motor shaft will damage the bearings.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.
5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

WARNING: **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

Guarding Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions. This is particularly important where the parts have surface irregularities such as keys, key ways or set screws. Some satisfactory methods of guarding are:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding during normal service.

Power Connection Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices. Flying leads must be insulated with two full wraps of electrical grade insulating tape or heat shrink tubing.

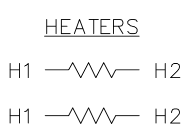
Conduit Box For ease of making connections, an oversize conduit box is provided.
The box can be rotated 360° in 90° increments.
Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

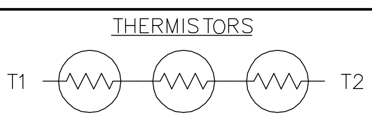
1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
OR
2. AC power is within ±5% of rated frequency with rated voltage.
OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

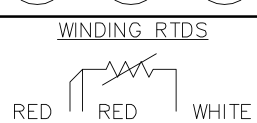
Figure 2-1 Accessory Connections



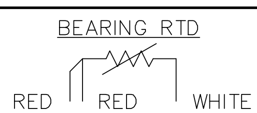
One heater is installed in each end of motor.
Leads for each heater are labeled H1 & H2.
(Like numbers should be tied together).



Three thermistors are installed in windings and tied in series.
Leads are labeled T1 & T2.

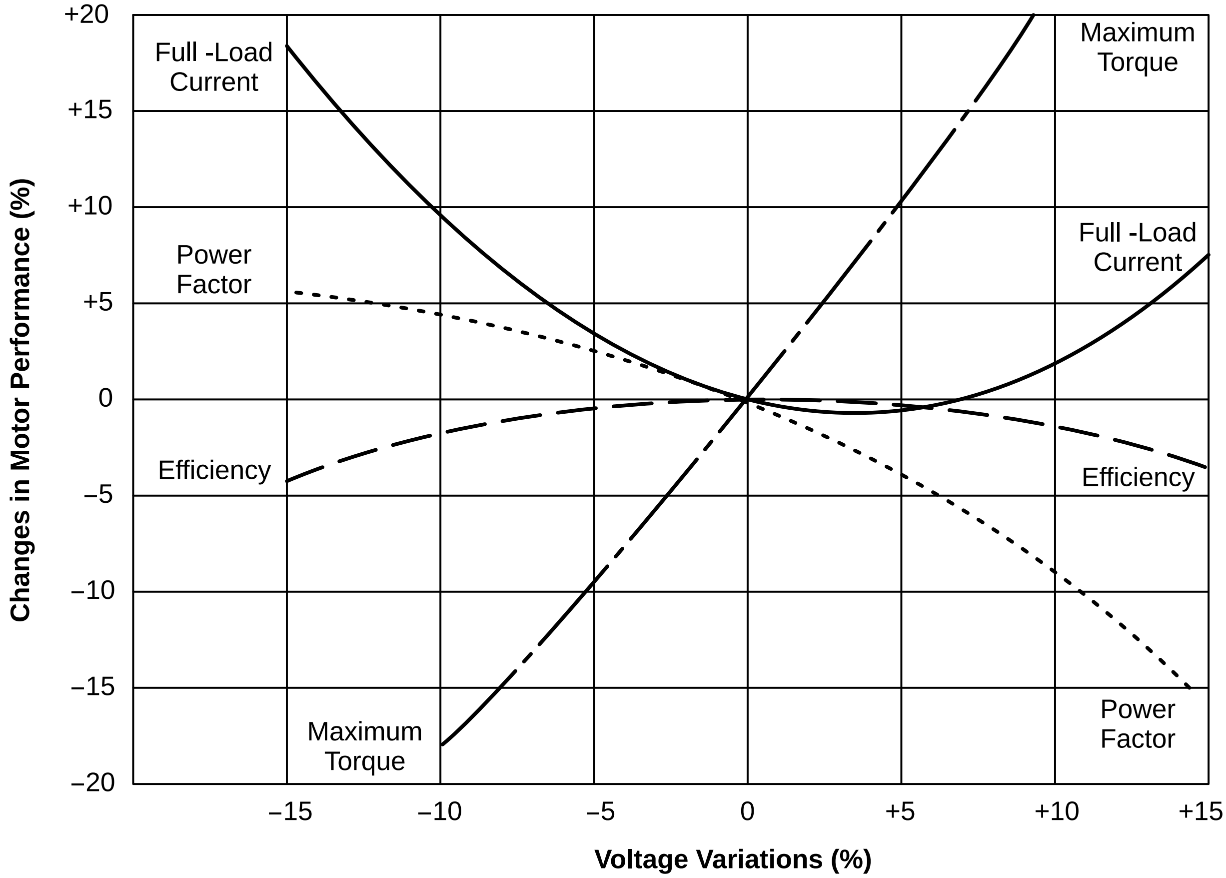


Winding RTDs are installed in windings (2) per phase.
Each set of leads is labeled W1, W2, W3, W4, W5, & W6.



* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE.
* One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE.
* Note RTD may have 2−Red/1−White leads; or 2−White/1−Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



Rotation All three phase motors are reversible. To reverse the direction of rotation, disconnect and lock out power and interchange any two of the three line leads for three phase motors. For single phase motors, check the connection diagram to determine if the motor is reversible and follow the connection instructions for lead numbers to be interchanged. Not all single phase motors are reversible.

Adjustable Frequency Power Inverters used to supply adjustable frequency power to induction motors produce wave forms with lower order harmonics with voltage spikes superimposed. Turn–to–turn, phase–to–phase, and ground insulation of stator windings are subject to the resulting dielectric stresses. Suitable precautions should be taken in the design of these drive systems to minimize the magnitude of these voltage spikes. Consult the drive instructions for maximum acceptable motor lead lengths, and proper grounding.

First Time Start Up Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor District Office or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is **Polyrex EM (Mobil)**. Do not mix greases unless compatibility has been checked and verified.

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<–29° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100–112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315–450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315–450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225–280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: **To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.**

Relubrication Procedure Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: **Do not over–lubricate motor as this may cause premature bearing failure.**

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: **Over–lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.**

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed.
   This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten “Thru Bolts”.
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod−Express.
• When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti−Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:

− Texaco Polystar
− Mobilith SHC−100
− Darmex 707
− Rykon Premium #2
− Pennzoil Pennzlube EM−2
− Darmex 711
− Chevron SRI #2
− Chevron Black Pearl
− Petro−Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

Baldor District Offices

UNITED STATES

ARIZONA

PHOENIX
4211 S 43RD PLACE
PHOENIX, AZ 85040
PHONE: 602-470-0407
FAX: 602-470-0464

ARKANSAS

CLARKSVILLE
1001 COLLEGE AVE.
CLARKSVILLE, AR 72830
PHONE: 479-754-9108
FAX: 479-754-9205

CALIFORNIA

LOS ANGELES
6480 FLOTILLA
COMMERCE, CA 90040
PHONE: 323-724-6771
FAX: 323-721-5859

HAYWARD
21056 FORBES STREET
HAYWARD, CA 94545
PHONE: 510-785-9900
FAX: 510-785-9910

COLORADO

DENVER
3855 FOREST STREET
DENVER, CO 80207
PHONE: 303-623-0127
FAX: 303-595-3772

9980 PARK MEADOWS DRIVE
SUITE 214
LONE TREE, CO 80124-6739
PHONE: 303-339-9629
FAX: 303-339-9633

CONNECTICUT

WALLINGFORD
65 SOUTH TURNPIKE ROAD
WALLINGFORD, CT 06492
PHONE: 203-269-1354
FAX: 203-269-5485

FLORIDA

TAMPA/PUERTO RICO/
VIRGIN ISLANDS
3906 EAST 11TH AVENUE
TAMPA, FL 33605
PHONE: 813-248-5078
FAX: 813-247-2984

GEORGIA

ATLANTA
62 TECHNOLOGY DR.
ALPHARETTA, GA 30005
PHONE: 770-772-7000
FAX: 770-772-7200

5490 MCGINNIS FERRY PLACE
SUITE 133
ALPHARETTA, GA 30005
PHONE: 770-752-4254
FAX: 770-752-4257

ILLINOIS

CHICAGO
4 SAMMONS COURT
BOLINGBROOK, IL 60440
PHONE: 630-296-1400
FAX: 630-226-9420

INDIANA

COLUMBUS
3300 TENTH ST
COLUMBUS, IN 47201
PHONE: 812-378-2556
FAX: 812-378-2555

INDIANAPOLIS
5525 W. MINNESOTA STREET
INDIANAPOLIS, IN 46241
PHONE: 317-246-5100
FAX: 317-246-5110

IOWA

DES MOINES
1800 DIXON STREET, SUITE C
DES MOINES, IA 50316
PHONE: 515-263-6929
FAX: 515-263-6515

KANSAS

5030 BOB BILLINGS PKWY STE B
LAWRENCE, KS 66049
PHONE: 785-749-4339
FAX: 785-749-4217

MARYLAND

BALTIMORE
6660 SANTA BARBARA RD.
SUITE 22-24
ELKRIDGE, MD 21075
PHONE: 410-579-2135
FAX: 410-579-2677

MASSACHUSETTS

BOSTON
6 PULLMAN STREET
WORCESTER, MA 01606
PHONE: 508-854-0708
FAX: 508-854-0291

MICHIGAN

DETROIT
33782 STERLING PONDS BLVD.
STERLING HEIGHTS, MI 48312
PHONE: 586-978-9800
FAX: 586-978-9969

GRAND RAPIDS
668 THREE MILE ROAD NW
GRAND RAPIDS, MI 49504
PHONE: 616-785-1784
FAX: 616-785-1788

MINNESOTA

MINNEAPOLIS
21080 134TH AVE. NORTH
ROGERS, MN 55374
PHONE: 763-428-3633
FAX: 763-428-4551

MISSOURI

ST LOUIS
422 INDUSTRIAL DRIVE
MARYLAND HEIGHTS, MO 63043
PHONE: 314-298-1800
FAX: 314-298-7660

KANSAS CITY
1501 BEDFORD AVENUE
NORTH KANSAS CITY, MO 64116
PHONE: 816-587-0272
FAX: 816-587-3735

NEW YORK

AUBURN
ONE ELLIS DRIVE
AUBURN, NY 13021
PHONE: 315-255-3403
FAX: 315-253-9923

NORTH CAROLINA

GREENSBORO
1220 ROTHERWOOD ROAD
GREENSBORO, NC 27406
PHONE: 336-272-6104
FAX: 336-273-6628

OHIO

CINCINNATI
2929 CRESCENTVILLE ROAD
WEST CHESTER, OH 45069
PHONE: 513-771-2600
FAX: 513-772-2219

CLEVELAND
8929 FREEWAY DRIVE
MACEDONIA, OH 44056
PHONE: 330-468-4777
FAX: 330-468-4778

29525 CHAGRIN BLVD SUITE 208
CLEVELAND, OH 44122
PHONE: 216-360-8296
FAX: 216-360-4172

OKLAHOMA

TULSA
2 EAST DAWES
BIXBY, OK 74008
PHONE: 918-366-9320
FAX: 918-366-9338

OREGON

PORTLAND
20393 SW AVERY COURT
TUALATIN, OR 97062
PHONE: 503-691-9010
FAX: 503-691-9012

PENNSYLVANIA

KING OF PRUSSIA
1060 FIRST AVE STE 400
KING OF PRUSSIA, PA 19406
PHONE: 610-768-8018
FAX: 215-672-5759

PHILADELPHIA
1035 THOMAS BUSCH
MEMORIAL HIGHWAY
PENNSAUKEN, NJ 08110
PHONE: 856-661-1442
FAX: 856-663-6363

PITTSBURGH
159 PROMINENCE DRIVE
NEW KENSINGTON, PA 15068
PHONE: 724-889-0092
FAX: 724-889-0094

TENNESSEE

MEMPHIS
4000 WINCHESTER ROAD
MEMPHIS, TN 38118
PHONE: 901-365-2020
FAX: 901-365-3914

TEXAS

ADDISON
3939 BELT LINE ROAD #250
ADDISON, TX 75001
PHONE: 972-499-7746, 499-7747
FAX: 972-242-1505

DALLAS
3040 QUEBEC
DALLAS, TX 75247
PHONE: 214-634-7271
FAX: 214-634-8874

HOUSTON
4647 PINE TIMBERS
SUITE # 135
HOUSTON, TX 77041
PHONE: 713-895-7062
FAX: 713-690-4540

UTAH

SALT LAKE CITY
2230 SOUTH MAIN STREET
SALT LAKE CITY, UT 84115
PHONE: 801-832-0127
FAX: 801-832-8911

VIRGINIA

RICHMOND
6767 FOREST HILL AVE STE 305
RICHMOND, VA 23225
PHONE: 804-545-6848
FAX: 804-545-6840

WASHINGTON

KIRKLAND, WA
550 KIRKLAND WAY STE 205
KIRKLAND, WA 98033
PHONE: 425-952-5000
FAX: 775-255-8019

WISCONSIN

MILWAUKEE
2725 SOUTH 163RD STREET
NEW BERLIN, WI 53151
PHONE: 262-784-5940
FAX: 262-784-1215

WAUKESHA
N14 W23777 STONE RIDGE DRIVE
SUITE 170
WAUKESHA, WI 53188
PHONE: 262-347-2000
FAX: 262-437-0258

INTERNATIONAL SALES

FORT SMITH, AR
P.O. BOX 2400
FORT SMITH, AR 72902
PHONE: 479-646-4711
FAX: 479-648-5895

CANADA

EDMONTON, ALBERTA
4053-92 STREET
EDMONTON, ALBERTA T6E 6R8
PHONE: 780-434-4900
FAX: 780-438-2600

11428-168 STREET
EDMONTON, ALBERTA T5M 3T9
PHONE: 780-822-7865
FAX: 780-822-7878

MISSISSAUGA, ONTARIO
244 BRITANNIA ROAD EAST
MISSISSAUGA, ONTARIO L4Z 1S6
PHONE: 905-890-5110
FAX: 905-890-5540

OAKVILLE, ONTARIO
2750 COVENTRY ROAD
OAKVILLE, ONTARIO L6H 6R1
PHONE: 905-829-3301
FAX: 905-829-3302

DORVAL, QUEBEC
95 RUE LINDSAY
DORVAL QUEBEC H9P 2S6
PHONE: 514-422-8818
FAX: 514-422-8982

MONTREAL, QUEBEC
1844 WILLIAM STREET
MONTREAL, QUEBEC H3J 1R5
PHONE: 514-933-2711
FAX: 514-933-8639

VANCOUVER,
BRITISH COLUMBIA
1538 KEBET WAY
PORT COQUITLAM,
BRITISH COLUMBIA V3C 5M5
PHONE 604-421-2822
FAX: 604-421-3113

WINNIPEG, MANITOBA
54 PRINCESS STREET
WINNIPEG, MANITOBA R3B 1K2
PHONE: 204-942-5205
FAX: 204-956-4251

AUSTRALIA

UNIT 3, 6 STANTON ROAD
SEVEN HILLS, NSW 2147, AUSTRALIA
PHONE: (61) (2) 9674 5455
FAX: (61) (2) 9674 2495

UNIT 8, 5 KELLETTS ROAD
ROWVILLE, VICTORIA, 3178
AUSTRALIA
PHONE: (61) (3) 9753 4355
FAX: (61) (3) 9753 4366

EL SALVADOR

RESIDENCIAL PINARES DE SUIZA
POL. 15 #44,
NVA. SAN SALVADOR, EL SALVADOR
PHONE: +503 2288-1519
FAX: +503 2288-1518

CHILE

LUIS THAYER OJEDA 166,
OF 402 – PROVIDENCIA
SANTIAGO, CHILE
PHONE: 56-2-290-0762
FAX: 56-2-290-0762

CHINA

5299 BEI SONG ROAD
SONGJIANG
201611 SHANGHAI, CHINA
PHONE: +86 21 5760 5335
FAX : +86 21 5760 5336

UNIT 905, 9TH FLOOR,
TOWER B WANDA PLAZA
NO. 93 JIANGUO ROAD,
CHAOYANG DISTRICT
BEIJING, 100022, CHINA
PHONE +86 (010) 58205516
FAX +86 (010) 58204231

GERMANY

DIESELSTRASSE 22
D-85551 KIRCHHEIM
MUNICH, GERMANY
PHONE: +49 89 90 5080
FAX: +49 89 90 50 8492

HERMANN-HEINRICH-GOSSEN-
STRASSE 3
D-50858 KÖLN, GERMANY
PHONE: 49 2234 37941 0
FAX: 49 2234 37941 64

INDIA

14, COMMERCE AVENUE
MAHAGANESH COLONY
PAUD ROAD
PUNE – 411038
MAHARASHTRA, INDIA
PHONE: 91 20 25452717, 25452718
FAX: 91 20 25452719

ITALY

BALDOR ASR AG
SUCCURSALE DI MENDRISIO
VIA BORROMINI, 20A
CH-6850 MENDRISIO
SWITZERLAND
PHONE: 0041 91 640 99 50
FAX: 0041 91 630 26 33

JAPAN

DIA BLDG 802,
2-21-1 TSURUYA-CHO,
KANAGAWA-KU
YOKOHAMA, 221-0835, JAPAN
PHONE: 81-45-412-4506
FAX: 81-45-412-4507

KOREA

RM 1715, SUSEO TOWER, 725,
SUSEO-DONG, GANGNAM-GU,
SEOUL 135-757 KOREA
TEL : (82) 2 2226 9369
FAX : (82) 2 2226 9368

MEXICO

LEON, GUANAJUATO
KM. 2.0 BLVD. AEROPUERTO
LEÓN 37545, GUANAJUATO, MÉXICO
PHONE: 52 477 761 2030
FAX: 52 477 761 2010

MIDDLE EAST & NORTH AFRICA

VSE INTERNATIONAL CORP.
P. O. BOX 5618
BUFFALO GROVE, IL 60089-5618
PHONE: 847 590 5547
FAX: 847 590 5587

SINGAPORE

18, KAKI BUKIT ROAD 3
#03-09 ENTREPRENEUR
BUSINESS CENTRE
SINGAPORE 415978
PHONE: (65) 6744 2572
FAX: (65) 6747 1708

PANAMA

AVE. RICARDO J. ALFARO
EDIFICIO SUN TOWERS MALL
PISO 2, LOCAL 55
CIUDAD DE PANAMÁ, PANAMÁ
PHONE: +507 236-5155
FAX: +507 261-5355

SWITZERLAND

POSTFACH 73
SCHUTZENSTRASSE 59
CH-8245 FEUERTHALEN
SWITZERLAND
PHONE: +41 52 647 4700
FAX: +41 52 659 2394

TAIWAN

1F, NO 126 WENSHAN 3RD STREET,
NANTUN DISTRICT,
TAICHUNG CITY 408
TAIWAN R.O.C
PHONE: (886) 4 238 04235
FAX: (886) 4 238 04463

UNITED KINGDOM

6 BRISTOL DISTRIBUTION PARK
HAWKLEY DRIVE
BRISTOL BS32 0BF U.K.
PHONE: +44 1454 850000
FAX: +44 1454 859001

VENEZUELA

AV. ROMA. QTA EL MILAGRO. URB.
CALIFORNIA NORTE
CARACAS, 1070 VENEZUELA
PHONE: 58-414-114-8623
FAX: 58-412-322-5790

400-0209

BALDOR ELECTRIC COMPANY
World Headquarters
P.O. Box 2400 Fort Smith, AR 72901–2400
(479) 646–4711   Fax (479) 648–5792
www.baldor.com

MN400
2/09

VALVE-MATIC WAFER SILENT CHECK VALVE

Operations & Maintenance Manual
December 2015

Manual No.
SCV-OM1-2

Wafer and Globe Style Silent Check Valve

Operation, Maintenance and Installation Manual

VAL-MATIC®

VAL-MATIC® VALVE AND MANUFACTURING CORP.

905 RIVERSIDE DR. ELMHURST, IL. 60126
TEL. 630 / 941-7600 FAX. 630 / 941-8042

WAFER ~~AND GLOBE-STYLE~~ SILENT CHECK VALVE OPERATION, MAINTENANCE AND INSTALLATION

INTRODUCTION
This manual will provide you with the information to properly install and maintain the valve to ensure a long service life. The Silent Check Valve is ruggedly constructed with bronze or stainless steel trim to give years of trouble free operation. The valve should be installed in horizontal or vertical pipes carrying clean water. 14" and larger valves should be equipped with special springs for operation in vertical flow down applications.

The Silent Check Valve is designed to open fully to provide flow in the forward direction and close rapidly upon flow reversal. The valves are used to prevent reverse flow through pumps or in piping systems. The size, cold working pressure, and model number are stamped on the nameplate for reference.

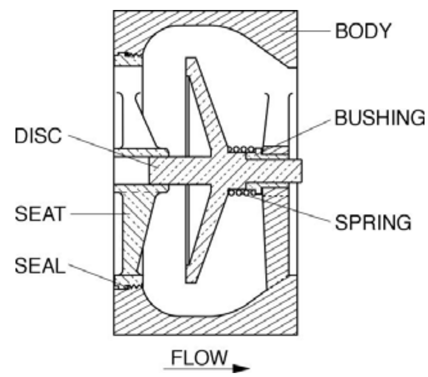
This valve is not intended for fluids containing suspended solids such as wastewater. For wastewater and other high turbidity applications, use Val-Matic Series 500 Swing-Flex® Check Valves.

CAUTION:	**This valve is not intended for fluids containing suspended solids or hazardous fluids.**

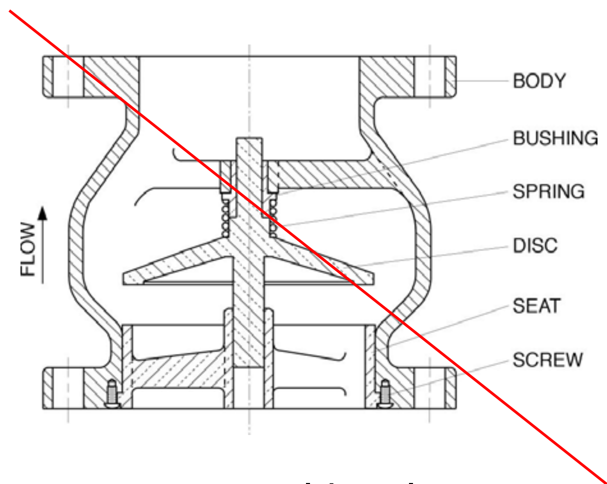
RECEIVING AND STORAGE
Inspect valves upon receipt for damage in shipment. Unload all valves carefully to the ground without dropping. When lifting, the valve should be secured by the body and never lifted by the bronze or stainless steel trim.

The valves should remain crated, clean and dry until installed to prevent weather related damage. For long term storage greater than six months, the rubber surfaces of the seat (when provided) should be coated with a thin film of FDA approved grease such as Lubriko #CW-606. Do not expose rubber seat to sunlight or ozone for any extended period.

DESCRIPTION OF OPERATION
The silent check valve is designed to prevent reverse flow automatically. On pump start-up, the flow of water enters the valve from the seat end (left side in Figure 1) and forces the disc open, allowing the passage of fluid through the valve.



Wafer Style



Globe Style

FIGURE 1. SILENT CHECK VALVES

On pump shut-down, the spring closes the disc before a flow reversal takes place. This type of closure, which prevents flow reversal, is the factor which allows "silent" operation and prevents water hammer associated with check valve slam.

The valve body is supplied with either compact wafer ends as shown in Figure 1 for installation between mating flanges or in a flanged configuration, Figure 2.

The only moving parts in the valve are the plug and spring. The body bushing controls the movement of the plug and assures that the plug contacts the seat evenly. The valve may have an optional resilient seal for drop tight service.

INSTALLATION

The installation of the valve is important for its proper operation. The **flow arrow** on the valve body or nameplate must point in the direction of flow when the system is in operation. The valve can be installed in horizontal or vertical lines with the flow up or down. 14 inch and larger valves may require extra heavy springs for flow down applications; consult the factory.

Three diameters of straight pipe upstream of the valve are recommended to prevent turbulent flow streams through the valve, which can cause vibration and wear.

When installed in horizontal lines, the check valve does not have a specific upward orientation. The valve is usually installed so that the nameplate is visible on the side of the valve for future reference.

MATING FLANGES: The valve should be installed between standard flat-face flanges per ANSI B16.5 or AWWA C207. For globe style silent check valves, the installation requirements are illustrated in Drawing SS-974F on page 3. The mating flange inside diameter must overlap the valve seat to provide proper seat retention. Flanges or pipes having an expanded inside diameter (ductile iron or mortar-lined pipe) cannot be used on the inlet side of the valve. A ring flange having the maximum inside diameter shown on the drawing must be inserted between the valve and mortar-lined pipe. The threaded seat wafer style silent check valves do not require the mating flange to overlap the seat.

<u>CAUTION:</u>	**Mating flanges must be flat faced or damage to the valve may result.**

<u>WARNING:</u>	**Flanges having an expanded inside diameter such as mortar-lined pipe cannot be used on the inlet side of the valve or damage may occur. Seat support rings are needed.**

GASKETS AND BOLTING: The ring-type flange gasket can be rubber or compressed fiber but should be a maximum of 1/16" thick with the diameters shown in Drawing SS-974F. The gasket must overlap the bronze or stainless steel seat to provide a seal between the seat and the body. Flanged valves with ring gaskets should use ASTM A307 Grade B or SAE Grade 2 Carbon Steel bolts. Higher strength bolts should only be used with full-face gaskets.

ADJACENT VALVES: When mating the check valve with butterfly isolation valves, the clearance between the butterfly disc and the fully open check valve stem must be checked. The location of the stem is also shown on the check valve submittal drawings. 10 inch and smaller flanged end check valves have sufficient clearance for most butterfly valves. However, on 12 inch and larger valves, the plug shaft extends beyond the flange face and may interfere with the operation of adjacent valves. A short run of pipe or spacer may be needed between the check valve and the isolation valve.

INSTALLATION: Lower valve over mating flange using slings or chains around the valve body. Lubricate the flange bolts or studs and insert them around the flange. Lightly turn bolts until gaps are eliminated. The tightening of the bolts should then be done in graduated steps using the crossover tightening method. Recommended lubricated torques for use with resilient gaskets (75 durometer) are given in Table 1.

If leakage occurs, allow gaskets to absorb fluid and check torque and leakage after 24 hours. Do not exceed bolt rating or crush gasket more than 50 per cent of its thickness.

125# FLANGE DATA			**250# FLANGE DATA**		
Valve Size (in)	**Bolt Dia. (in)**	**Bolt Torque (ft-lbs)**	**Valve Size (in)**	**Bolt Dia. (in)**	**Bolt Torque (ft-lbs)**
2.5	5/8	25-75	2.5	3/4	25-75
3	5/8	25-75	3	3/4	35-75
4	5/8	30-90	4	3/4	50-150
5	3/4	30-90	5	3/4	70-150
6	3/4	30-90	6	3/4	70-150
8	3/4	40-120	8	7/8	90-200
10	7/8	45-150	10	1	110-300
12	7/8	65-200	12	1 1/8	160-450
14	1	80-250	14	1 1/8	140-450
16	1	90-300	16	1 1/4	180-600
18	1 1/8	100-350	18	1 1/4	190-600
20	1 1/8	120-450	20	1 1/4	220-600
24	1 1/4	150-500	24	1 1/2	350-900
30	1 1/4	180-600	30	1 3/4	500-1500
36	1 1/2	250-750	36	2	700-2000
42	1 1/2	300-900	42	2	800-2500

TABLE 1. FLANGE BOLT TORQUES

<u>CAUTION:</u>	**The use of raised-face flanges or excessive bolt torque may damage valve flanges.**

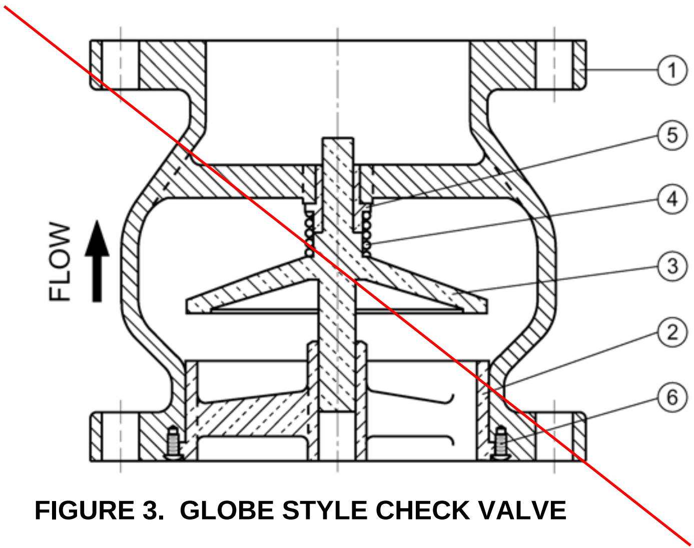


FIGURE 3. GLOBE STYLE CHECK VALVE

VALVE CONSTRUCTION

The standard check valve body (1) is constructed of iron. See the specific Materials List submitted for the order if other than standard iron construction. The internal metal components are bronze or stainless steel. The disc (3) and spring (4) are the only moving parts and require no maintenance or lubrication. The general details of construction are illustrated in Figures 2 and 3.

The body (1) is either compact wafer style to fit between two pipe flanges or flanged style for connection to two pipe flanges. The globe style valve seat (2) is retained in the body (1) with screws (6) to allow assembly in the pipeline. The wafer style valve seat and the 2-1/2" globe style seat are threaded seats where no seat screws (6) are used. The seat screws will not retain the seat against full pressure. The mating flange must properly retain the seat. Do not remove the upstream flange while the pipeline is full of water or the seat (2) may become dislodged from the body.

WARNING:	**Removal of mating flanges without draining the pipeline may cause injury or damage to the valve.**

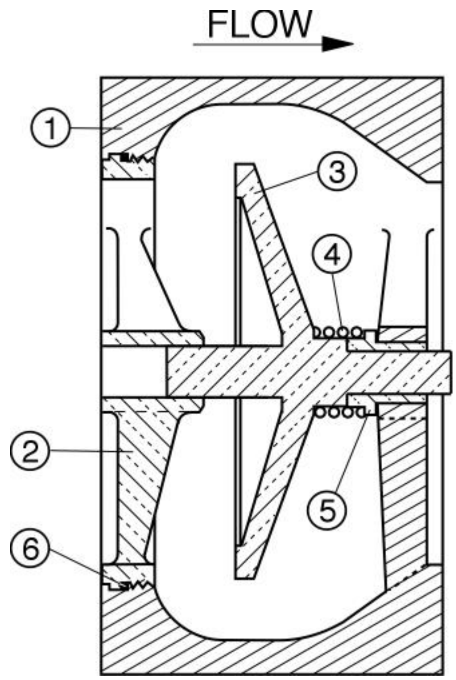


FIGURE 4. WAFER STYLE CHECK VALVE

ITEM	DESCRIPTION	MATERIAL
1	Body	Cast Iron
2	Seat[1]	Bronze or SS
3	Disc[1]	Bronze or SS (Optional Resilient)
4	Spring[1]	Stainless Steel
5	Bushing[1]	Bronze
6[2]	Screw[1]	Stainless Steel
6[3]	O-Ring[1]	EPDM

1. Recommended Spare Part
2. Globe style valve
3. Wafer style valve

TABLE 2. CHECK VALVE PARTS LIST

MAINTENANCE

Silent Check Valves require no scheduled lubrication or maintenance.

INSPECTION: Periodic inspection for leakage can be performed by listening for leakage noise from the valve while the pump is shut down. If leakage is heard, drain the pipeline, remove the valve, and inspect the seating surfaces for wear or mineral deposits. Clean, lap, or repair trim as needed.

TROUBLESHOOTING

Several problems and solutions are presented below to assist you in trouble shooting the valve assembly in an efficient manner.

- Valve Chatters or Vibrates: Verify that velocity is at least 4 feet per second. Noise sounding like rocks in the line can be cavitation due to high velocities, low downstream pressure, or an upstream expanded. Verify that there are three diameters of straight pipe upstream.

- Valve Leakage: Check upstream gasket and flange to verify that inside diameter meets the maximum "A" dimension given in Drawing SS-974. Drain line, remove valve, and inspect seating surfaces. If seat (2) is lifted above flange face, then mating flange and gasket are not securing the seat properly.

- Valve Does Not Pass Flow: Check flow arrow direction on valve body. Verify that downstream isolation valve is open and there is no line blockage downstream.

- Valve Slams: Remove valve and inspect spring. Heavier springs can be furnished for severe high-head applications. Consult factory if the valve is installed in a vertical pipe with the flow downward.

DISASSEMBLY

The valve should be removed from the pipeline for disassembly. A skilled mechanic with proper tools should perform all work on the valve. Refer to Figure 2 or 3.

WARNING:	**The line must be drained before removing the valve or pressure may be released causing injury.**

1. Lay valve on flat surface or bench with the flow arrow facing down. 12" and larger valves require support for the spring during disassembly. Place a 2x4 board across the seat (2) and secure with C-clamps to the valve flange. For the globe style valve, remove the seat retaining screws (6) and seat (2). For the wafer style valve and 2-1/2" globe style valve, unthread the seat (2) from the body (2) in a counterclockwise direction.

2. For the globe style valves, examine narrow flange on the outside diameter of the seat (2). The retaining screws should have left a shallow dimple. If a deep depression is present, the gasket and flange internal diameters should be checked to verify that they are greater than "A" on drawing SS-974.

3. Flip the seat (2) over and inspect the seating surface. Some minor dents and discoloration are normal. Grooves or wear areas will cause leakage and requires seat replacement. Note: Replace seat if the optional resilient seat o-ring is worn or damaged.

4. Lift disc (3) from body. Inspect shafts and seating surfaces for wear. The shaft diameter is normally about 1/32" smaller in diameter than the hole in the seat (2) and bushing (5). Some minor dents and discoloration are normal. Wear areas will cause leakage and require seat replacement. Heavy mineral deposits should be removed with lapping compound or fine sand paper.

5. Remove spring (4) and check for wear or cracks.

6. Remove bushing (5) and inspect for wear. The inside diameter of the bushing should be about 1/32" larger in diameter than the shaft.

REASSEMBLY

All parts must be clean and gasket surfaces should be cleaned with a stiff wire brush in the direction of the serrations or machine marks. Worn parts, gaskets, and seals should be replaced during reassembly.

1. Insert bushing (5) into body (1). The bushing is retained by the spring.

2. Lay spring (4) and disc (3) over bushing (5).

3. Install seat (2) with the retaining screws (6). 12" and larger valves may require a 2x4 board and C-clamps to compress the spring into the body. For the thread seat valves, tighten the seats to the following values:

Threaded Seat Torque	
Valve Size	Torque
2"-3"	25 ft-lbs
4"-10"	50 ft-lbs

4. Install new gaskets and valve. Tighten flange bolts evenly using the crossover tightening method and the torque values given in Table 1 on page 2.

PARTS AND SERVICE

Parts and service are available from your local representative or the factory. Make note of the Valve Size and Model Number located on the valve nameplate and contact:

Val-Matic Valve and Manufacturing Corp.
905 Riverside Drive
Elmhurst, IL 60126
Phone: (630) 941-7600
Fax: (630) 941-8042
www.valmatic.com

A sales representative will quote prices for parts or arrange for service as needed.

LIMITED WARRANTY

All products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment, subject to the limitations below.

If the purchaser believes a product is defective, the purchaser shall: (a) Notify the manufacturer, state the alleged defect and request permission to return the product; (b) if permission is given, return the product with transportation prepaid. If the product is accepted for return and found to be defective, the manufacturer will, at his discretion, either repair or replace the product, f.o.b. factory, within 60 days of receipt, or refund the purchase price. Other than to repair, replace or refund as described above, purchaser agrees that manufacturer shall not be liable for any loss, costs, expenses or damages of any kind arising out of the product, its use, installation or replacement, labeling, instructions, information or technical data of any kind, description of product use, sample or model, warnings or lack of any of the foregoing. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OF USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF THE MANUFACTURER. These products are not manufactured, sold or intended for personal, family or household purposes.

VAL-MATIC® VALVE AND MANUFACTURING CORP.

905 RIVERSIDE DR. ELMHURST, IL. 60126
TEL. 630 / 941-7600 FAX. 630 / 941-8042

TACO SUCTION DIFFUSER REAR STRAINER PULLOUT

Operations & Maintenance Manual
December 2015

Instruction Sheet

302-042

Suction Diffuser “Rear Strainer Pullout” (RSP)

SUPERSEDES: New

EFFECTIVE: June 1, 2007

Plant I.D. 001-3882

LOCATION & INSTALLATION:

1. Locate and install pump per pump manufacturer’s instructions.
   NOTE: When selecting pump location, ensure there is sufficient space available to remove the Suction Diffuser straightening vane assembly and strainer for routine maintenance. Clearance requirements are shown as dimension “C” in Table 1.
2. Mount suction diffuser directly to pump suction flange. Pump and suction diffuser flanges should be aligned before connections are made. Piping should **NEVER** be drawn into place by force. Inlet connection is labeled with the word “SYSTEM” on the flange and outlet flange is labeled “PUMP”.
3. Both suction and discharge piping should be suspended or supported close to the pump so that no pipe weight rests on pump. To support the Suction Diffuser, cut a piece of 1¼" pipe without threads to the approximate length required from one of the bosses provided on the pump connection to the adjustable foot nut. See Figure 1: Piping Diagram.
4. Place pipe on nut and under the boss and turn the nut counter-clockwise until sufficient load is supplied to give maximum support.

MOUNTING:

1. Suction Diffusers can be mounted in a vertical or horizontal position. Bosses are cast into the Suction Diffuser body to accommodate pipe supports for each position.
2. If used in a horizontal position, the pump should be positioned at right angles to the piping.
3. A blow down valve may be installed on the drain connection of the Suction Diffuser.

NOTE: Blow down is **MOST** effective when system connection of the Suction Diffuser is in the 12 o’clock position.

4. When insulating the Suction Diffuser, allowances need to be made for removal of the straightening vane assembly and cleaning of the strainer.

FIGURE 1: PIPING DIAGRAM

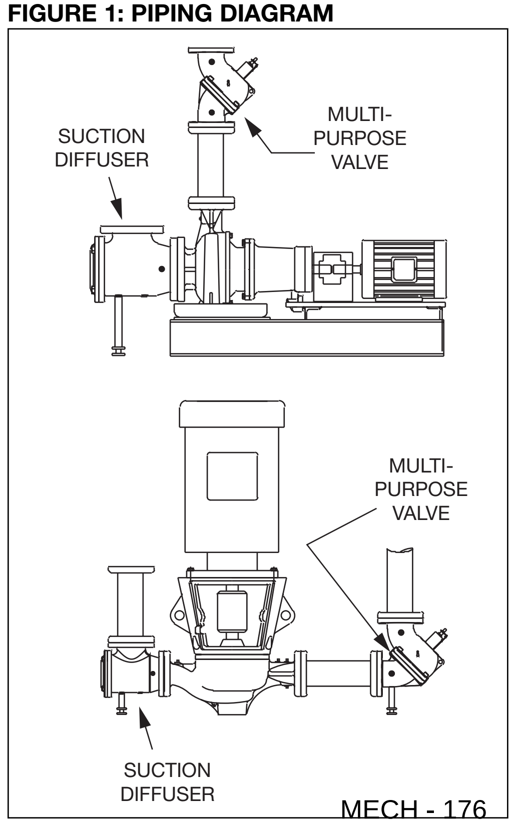


TABLE 1: STRAIGHTENING VANE AND STRAINER CLEARANCE DIMENSION

Model Number	System	Pump	C
SD020015-4	2 Flanged	1½ Flanged	8.49 (216)
SD020020-4	2 Flanged	2 Flanged	8.24 (209)
SD025020-4	2½ Flanged	2 Flanged	
SD030020-4	3 Flanged	2 Flanged	
SD025025-4	2½ Flanged	2½ Flanged	8.97 (228)
SD030025-4	3 Flanged	2½ Flanged	
SD030030-4	3 Flanged	3 Flanged	10.47 (266)
SD040030-4	4 Flanged	3 Flanged	
SD040040-4	4 Flanged	4 Flanged	12.86 (327)
SD050040-4	5 Flanged	4 Flanged	
SD060040-4	6 Flanged	4 Flanged	
SD050050-4	5 Flanged	5 Flanged	15.36 (390)
SD060050-4	6 Flanged	5 Flanged	
SD060060-4	6 Flanged	6 Flanged	19.02 (483)
SD080060-4	8 Flanged	6 Flanged	
SD100060-4	10 Flanged	6 Flanged	
SD080080-4	8 Flanged	8 Flanged	23.79 (604)
SD100080-4	10 Flanged	8 Flanged	
SD120080-4	12 Flanged	8 Flanged	
SD100100-4	10 Flanged	10 Flanged	29.40 (747)
SD120100-4	12 Flanged	10 Flanged	
SD140100-4	14 Flanged	10 Flanged	
SD120120-4	12 Flanged	12 Flanged	33.72 (856)
SD140120-4	14 Flanged	12 Flanged	
SD160120-4	16 Flanged	12 Flanged	

NOTE: Dimensions are in inches. Metric dimensions are in millimeters and are in parentheses ( ).

START-UP STRAINER REMOVAL:

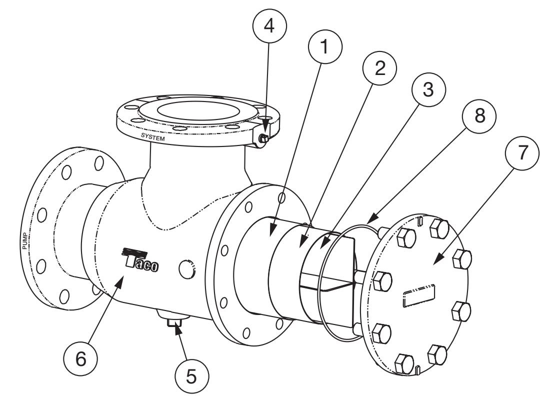
The fine mesh start up strainer should be removed after initial system fluid circulation and proper system cleaning.

1. Shut the pump off and close the service valves to isolate the Suction Diffuser and pump from the system. Allow enough time for the system fluid to cool below 100° F (38° C).
2. Once isolated remove drain plug on bottom of Suction Diffuser and allow system pressure to drop to zero (if installed this may be accomplished by opening the blow down valve).
3. Loosen the cover bolts on the rear of the Suction Diffuser and carefully break it loose from the Suction Diffuser body. Once all drainage has stopped completely remove the bolts and cover from the Suction Diffuser body.
4. Using a pair of pliers remove the vane assembly and strainers from the Suction Diffuser body.
5. Remove the fine mesh start up strainer (if still in place) and discard appropriately.
6. Inspect all components for any damage and replace any damaged components as necessary.
7. Inspect cover "O" ring and replace as necessary.
8. Reinstall vane assembly into Suction Diffuser body. Making sure that the vane assembly is properly seated inside of Suction Diffuser body, reattach the cover and secure in place by tightening the bolts in criss-cross pattern.
9. Open isolation valves slowly while inspecting the "O" ring sealing area for leaks.
10. Return system to normal operating conditions.

CLEANING:

1. It is recommended that valved gauge connections be provided on diffuser inlet and pump suction connections to indicate when cleaning is needed.
2. Note pressure drop when strainer is clean. When the pressure drop increases 100%, remove the strainer and clean.
   NOTE: Follow the same procedures in the START-UP STRAINER REMOVAL section when performing routine maintenance and cleaning of the permanent strainer.

1	Disposable Start-Up Strainer	5	Blow Down Port
2	Permanent Stainless Steel Strainer	6	Ductile Iron Diffuser Body
3	Flow Straightening Vane Assembly	7	Removable Service Cover
4	Metering Port	8	Reusable "O" Ring



LIMITED WARRANTY STATEMENT

Taco, Inc. will repair or replace without charge (at the company's option) any product or part which is proven defective under normal use within one (1) year from the date of start-up or one (1) year and six (6) months from date of shipment (whichever occurs first).

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the local Taco stocking distributor or Taco in writing and promptly deliver the subject product or part, delivery prepaid, to the stocking distributor. For assistance on warranty returns, the purchaser may either contact the local Taco stocking distributor or Taco. If the subject product or part contains no defect as covered in this warranty, the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any Taco product or part not installed or operated in conformity with Taco instructions or which has been subject to misuse, misapplication, the addition of petroleum-based fluids or certain chemical additives to the systems, or other abuse, will not be covered by this warranty.

If in doubt as to whether a particular substance is suitable for use with a Taco product or part, or for any application restrictions, consult the applicable Taco instruction sheets or contact Taco at [401-942-8000].

Taco reserves the right to provide replacement products and parts which are substantially similar in design and functionally equivalent to the defective product or part. Taco reserves the right to make changes in details of design, construction, or arrangement of materials of its products without notification.

TACO OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS IS IN EFFECT ONLY FOR THE DURATION OF THE EXPRESS WARRANTY SET FORTH IN THE FIRST PARAGRAPH ABOVE.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR STATUTORY, OR ANY OTHER WARRANTY OBLIGATION ON THE PART OF TACO.

TACO WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DEFECTIVE PRODUCTS.

This warranty gives the purchaser specific rights, and the purchaser may have other rights which vary from state to state. Some states do not allow limitations on how long an implied warranty lasts or on the exclusion of incidental or consequential damages, so these limitations or exclusions may not apply to you.

DO IT ONCE. DO IT RIGHT.®

TACO, INC., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401) 942-8000 FAX: (401) 942-2360.
TACO (Canada), Ltd., 6180 Ordan Drive, Mississauga, Ontario L5T 2B3. Telephone: 905/564-9422. FAX: 905/564-9436.
Visit our web site at: http://www.taco-hvac.com

BELL & GOSSETT SAFETY RELIEF VALVE

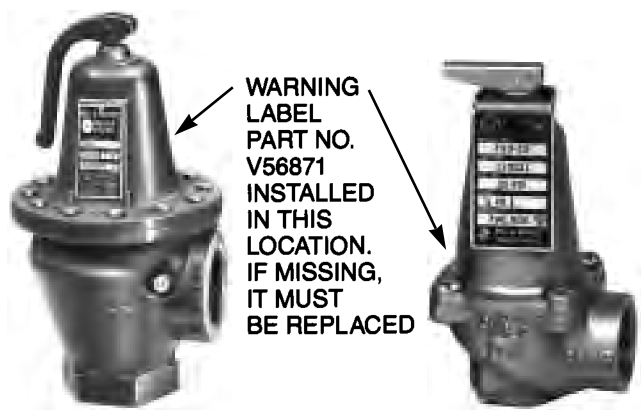
Operations & Maintenance Manual
December 2015

BELL & GOSSETT

INSTRUCTION MANUAL

V55692

REVISION D



B&G ASME Safety Relief Valves

HV

Installation, Operating and Service Instructions

INSTALLER: PLEASE LEAVE THIS MANUAL FOR THE OWNER'S USE.

> ⚠ **SAFETY INSTRUCTION**
>
> This safety alert symbol will be used in this manual to draw attention to safety related instructions. When used, the safety alert symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED! FAILURE TO FOLLOW THE INSTRUCTIONS MAY RESULT IN A SAFETY HAZARD.

DESCRIPTION

B&G diaphragm operated cast iron and diaphragm-assist operated bronze ASME Safety Relief Valves are designed to protect fired and unfired hot water pressure vessels against over pressure conditions. The diaphragm's "oversized" effective area generates a greater operating force which helps to overcome the effects of fouling. These valves feature a unique fail-safe disc with sufficient area to permit the valves to maintain their safety relief function in the event of a diaphragm rupture. These valves are designed, manufactured, tested and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. They are offered in a wide range of capacities to permit a close match with the boiler output rating.

Temperature and Pressure Limits

Maximum operating temperature: 250°F
Maximum operating pressure: 125 psig

INSTALLATION INSTRUCTIONS

> ⚠ **WARNING:** An undersized safety relief valve of inadequate relieving capacity can cause a boiler to explode. Before installing the safety relief valve, check the nameplate to make sure the pipe size, relief (opening) pressure, and BTUH rating are the same as required to protect the system against over pressure. BTUH rating and maximum operating pressure are stamped on the boiler nameplate. Failure to follow these instructions could result in serious personal injury or death and property damage.

> ⚠ **WARNING:** Improper safety relief valve installation can prevent the valve from protecting the system against over pressure conditions. The following instructions must be followed if the safety relief valve is to provide the over pressure protection required. Failure to follow these instructions could result in serious personal injury or death and property damage.

1. Safety relief valves must be installed in the top or side, at the highest practical point, of a boiler or other equipment being protected by the safety relief valve. Do not install the safety relief valve below the lowest permissible water level.
2. Safety relief valves must be installed in an upright position with the stem or spindle in the vertical position. See Figure 1, 2 or 3 for typical installations.
3. Never reduce the inlet or outlet pipe connections to the safety relief valve. Install with pipe the same diameter as the safety relief valve inlet and outlet pipe connections.
4. Do not install any shutoff valves between the safety relief valve and the equipment it is to protect against over pressurization.
5. Do not install any shutoff valves in the discharge piping from the safety relief valve.
6. Do not use pipe threaded on both ends in the drop line between the valve discharge connection and the floor or floor drain.
7. Discharge piping must be as short and as straight as possible. It must be arranged and supported so as to prevent undue stress on the safety relief valve.
8. If elbows are used in the discharge piping, they must be located as close as possible to the safety relief valve outlet.
9. Provisions must be made to assure proper drainage of discharge piping. The size and arrangement of discharge piping must be such that any pressure that may exist or develop will not reduce the relieving capacity below that required to protect the system.
10. Pipe the safety relief valve discharge to approximately 2″ above the floor or to a floor drain. This will decrease the possibility of scalding someone who may be standing nearby, if the safety valve discharges.
11. Apply pipe sealing compounds sparingly to male threads only. Excessive use of pipe sealing compounds may adversely affect the operation of the safety relief valve.

> ⚠ **CAUTION:** The use of Teflon impregnated pipe compound and Teflon tape on pipe threads provides lubricity which can lead to overtightening and breakage. Do not overtighten. Failure to follow these instructions could result in property damage and/or moderate personal injury.

> ⚠ **CAUTION:** System additives may cause premature failure of the safety relief valve components. The compatibility of additives with the safety relief valve must be checked before they are used. Failure to follow these instructions could result in property damage and/or moderate personal injury.

ITT Bell & Gossett
Morton Grove, IL, U.S.A.

INSTALL THE ASME SAFETY RELIEF VALVE AS NOTED:

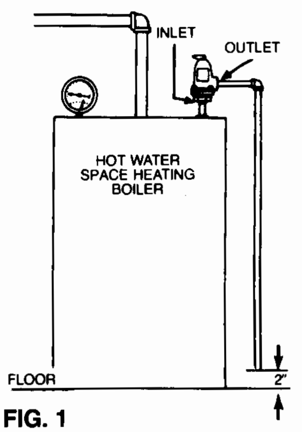
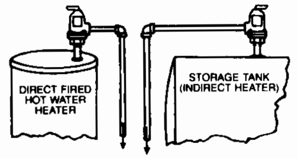


FIG. 1

Protection of Hot Water Space Heating Boilers.

A. PREFERRED METHOD

1. Water Heaters: Directly on the water heater.
2. Storage Tanks with Indirect Heater: Directly on the storage tank.



B. ALTERNATE METHOD

On the hot riser coming out of the water heater or the storage tank.

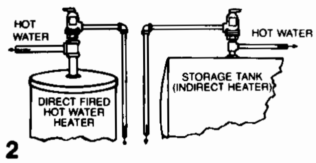


FIG. 2

Protection of Domestic Hot Water Heaters and Tanks.

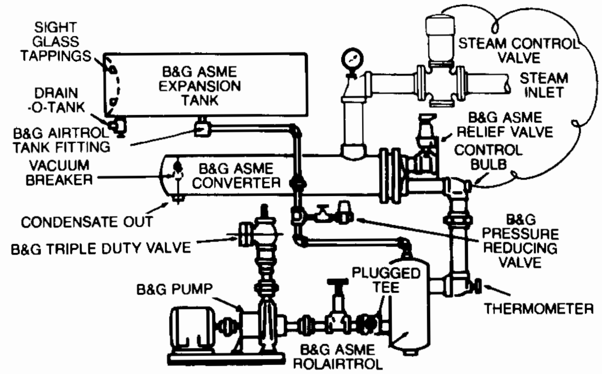


FIG. 3

Protection of Heating Exchanger Systems.

OPERATING INSTRUCTIONS

The safety relief valve is designed to protect a heating system from over pressurization. The safety relief valve does not operate unless there is an over pressure condition.

1. If the safety relief valve discharges periodically, it is an indication that the system has lost its air cushion in the compression or expansion tanks. To determine if this is the case, initiate the following test:
   a. Bladder or diaphragm style pre-charged tanks: Isolate the system from the tank, then bleed the water from the tank. Place a tire-type pressure gauge on the air valve on the tank. If the pressure is zero, the cushion is lost. The absence of the cushion may be from a leaking air valve. To check if this is the case, add some air to the tank and place some liquid on the valve stem area. If the liquid bubbles, the valve is leaking and must be replaced (see Instruction Manual A01500 for valve replacement). If the absence of cushion was not because of the leaking valve, then the bladder or diaphragm is leaking and the bladder must either be replaced (for the "B" Series) or the tank must be replaced (for the "D" Series). See Instruction Manual A01500 for bladder replacement.
   b. Conventional pressure tanks: Shut off the boiler for approximately 30 minutes and check to see that the boiler pressure gauge reading is near the reducing valve setting (if it is not, the reducing valve is not working properly and the setting may need to be readjusted, or the valve needs to be replaced – see Reducing Valve Instruction Manual V55999 under Pressure Setting for setting adjustment. Turn the boiler on. If within 8-9 minutes the pressure gauge at the boiler indicates a value within 10% of the relief valve setting, then the tank is waterlogged and needs to be drained and re-charged (See Instruction Manual S10300 for drain and air-charge procedures).

WARNING: Scale buildup from frequent discharging of safety relief valve can prevent safety relief valve from being able to discharge its rated capacity. The causes of frequent discharging such as a water logged compression tank must be immediately corrected. Failure to follow these instructions could result in serious personal injury or death and property damage.

2. The safety relief valve pressure setting is not field adjustable and must not be tampered with.

WARNING: Attempts to change safety relief valve setting will prevent it from relieving at rated capacity and thus causing the boiler to explode. Do not attempt to adjust the pressure setting of the safety relief valve. Failure to follow these instructions could result in serious personal injury or death and property damage.

SERVICE INSTRUCTIONS

1. The operating condition of the safety relief valve should be checked as follows every 30 days that the boiler, or other system component that the relief valve is protecting is in operation, or after any prolonged period of inactivity:

WARNING: The uncontrolled discharge of hot water from the safety relief valve can be very hazardous and could scald anyone in the vicinity. Make sure that proper discharge piping is in place at all times. Failure to follow these instructions could result in serious personal injury or death and property damage.

a) Shut off the circulating pump and the fuel input to the boiler.
b) Isolate the boiler from the system by closing shutoff valves, leaving the expansion tank valve open and opening the shut off valve installed ahead of the pressure reducing valve.
c) Lift the manual opening lever on top of the relief valve to the full open position and hold it open for at least five seconds or until clean water is discharged.
d) Release the lever and allow the relief valve to snap closed. If the relief valve leaks, operate the manual opening lever several more times to clear the seat of any foreign material that is preventing proper seating.
e) If the relief valve continues to leak, it must be replaced before the boiler is returned to operation.

WARNING: Scale buildup from the continuous discharge of the safety relief valve will prevent the safety relief valve from discharging its rated capacity should an over pressurization condition occur. Immediately shut down the boiler and replace the safety relief valve should this condition occur. Failure to follow these instructions could result in serious personal injury or death and property damage.

f) After it has been determined that the relief valve is not leaking, return the system to operation by reversing the steps in a) and b) above.

2. When the above test is performed, also inspect the safety relief valve for signs of corrosion, damage or scale buildup. Inspect and make sure the discharge line is clear.

WARNING: Corrosion, scale buildup, leakage or damage to safety relief valve are indications the safety relief valve may fail to provide over pressurization protection. Every 30 days the safety relief valve must be inspected and if any of the above conditions are noted it must be replaced. Failure to follow these instructions could result in serious personal injury or death and property damage.

For further information, contact ITT Bell & Gossett, 8200 N. Austin Avenue, Morton Grove, IL 60053,
Phone (847) 966-3700 – Facsimile (847) 966-9052.

PRINTED IN U.S.A. 10-94

ITT Bell & Gossett
Morton Grove, IL, U.S.A.

TACO ½" – 4" ACCU-FLO CIRCUIT SETTER FLOW BALANCING VALVE

Operations & Maintenance Manual
December 2015

Instruction Sheet

402-051

1/2" - 4" ACCU-FLO Circuit Setter Flow Balancing Valve

SUPERSEDES: January 1, 1997 EFFECTIVE: January 1, 2007

PLANT I.D. 001-993

VALVE INSTALLATION

1. The valve may be installed in any position. Place the valve in a position which provides for convenient access to the pressure port connections for the differential pressure gauge hoses, easy access to the memory stop screws, and easy reading of the scale.
2. Caution should be used when sweat style valves are installed to prevent overheating the valve. Use a torch with a sharp pointed flame. Direct the flame with care so that the valve body is not subjected to excessive heat. The valve should be in the closed position during sweating. The use of low temperature solders is recommended. These valves should not be brazed.

VALVE OPERATION

1. For presetting, use the appropriate slide rule setting necessary to achieve the desired pressure drop.
2. To measure flow, connect the TACO PRESSURE GAUGE (No. 779 0-10", 0-100" dual recommended, No. 775 0-135", 0-100' for higher pressure drops as an alternate) to the pressure port connections.

A–Position the meter case in a safe location adjacent to the valve.

CAUTION:

B–Take care in removing the pressure port connection caps on the ACCU-FLO valve, since they will be at the same temperature as the pipeline. There may be some fluid trapped behind the cap. Slowly unscrew the caps and look for continuous leakage. Continuous leakage may indicate a failure of the stem seal in the pressure port connection. Process fluid at temperature and under pressure may be present. If continuous leakage is present, do not remove the cap. Appropriate corrective action must be taken.

C–Connect the gauge hoses to the pressure port connections, the RED hose to the port adjacent to the letter H on the valve body and the YELLOW hose to the other port indicated by the letter L on the valve body.

D–The pressure port connection valves open automatically as the hoses are screwed onto the fitting, allowing fluid to flow into the meter. NOTE: If the hoses are connected one at a time, the second hose will bleed fluid as the first hose is connected and fluid flows into the meter. This will stop as the meter fills one side of the measurement cylinder.

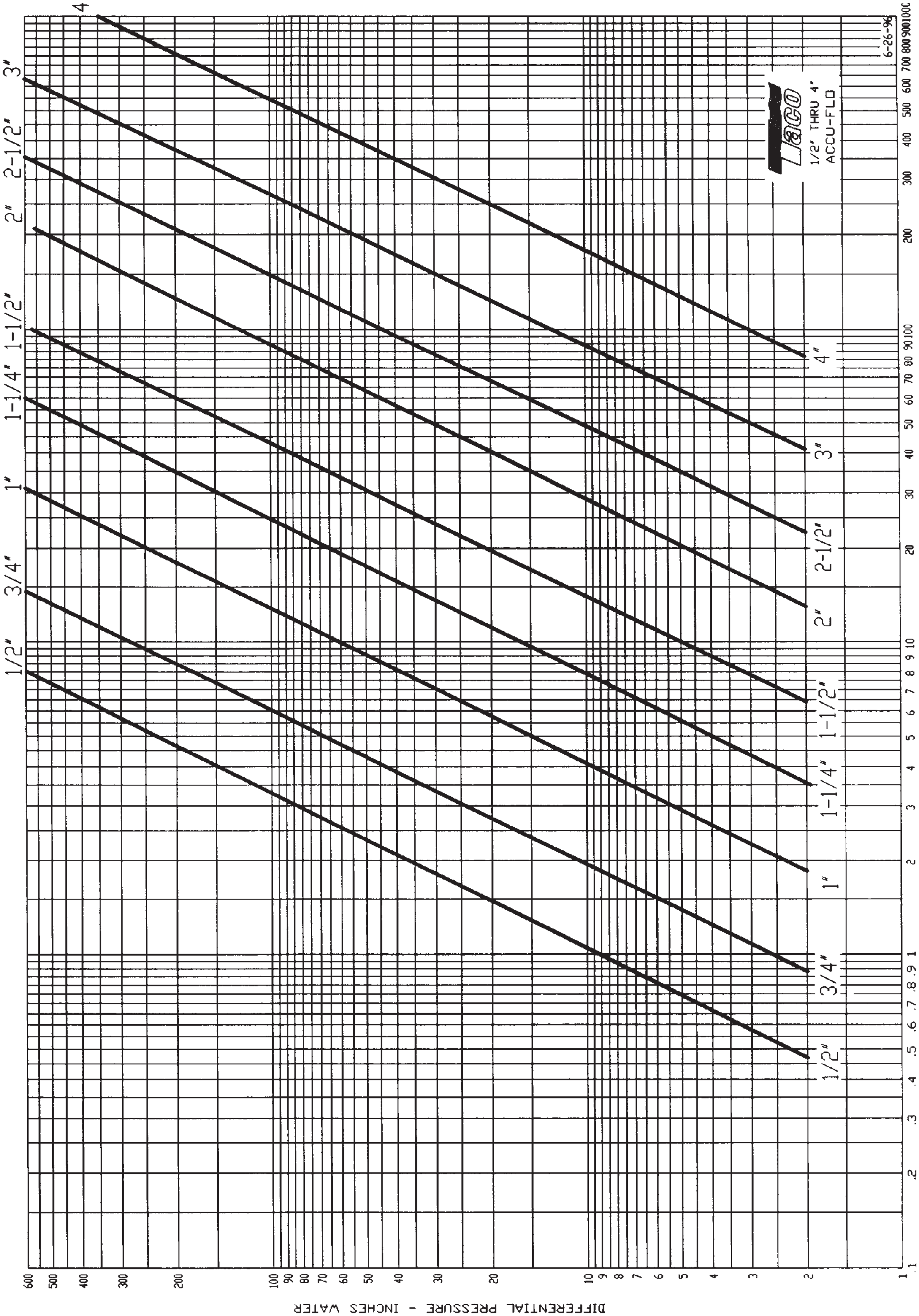
E–Read the pressure drop on the appropriate meter scale. NOTE: If you use a meter graduated in feet of water, convert the reading to inches. Read the flow in gallons per minute on the appropriate slide rule scale.

F–When reading pressure drop, wait a sufficient amount of time to insure that all air has been bled from the hoses and meter. Refer to the gauge operating instructions.

G–Adjust the ACCU-FLO valve by turning the valve stem until the desired pressure drop is achieved. On all valves from 1/2" thru 4", the flow measurement is independent of indicator setting.

H–When the proper setting has been achieved, slightly loosen the two socket head cap screws and rotate the Memory Stop around until it touches the back side of the indicator. Then tighten the screws to securely set the open memory position. The Memory Stop is used to indicate the last set open position. It should not be used as a “hard” stop which can take a lot of force.

I–Review the pressure drop, and if it is correct, remove the hoses and replace the pressure port caps.


1/2" THRU 4" ACCU-FLO
6-26-96
1/2"
3/4"
1"
1-1/4"
1-1/2"
2"
2-1/2"
3"
4"
FLOW - GALLONS/MINUTE
DIFFERENTIAL PRESSURE - INCHES WATER

TACO AIR SEPARATOR

Operations & Maintenance Manual
December 2015

Submittal Data Information

Air Separator

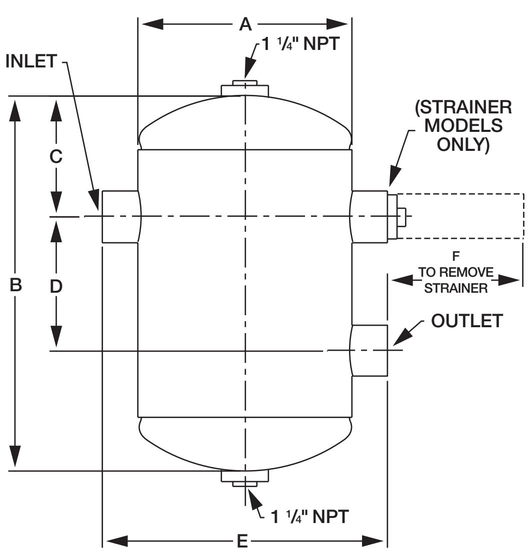
401-001

EFFECTIVE: MAY 31, 2003 | SUPERSEDES: 401-001 DATED AUGUST 5, 1987

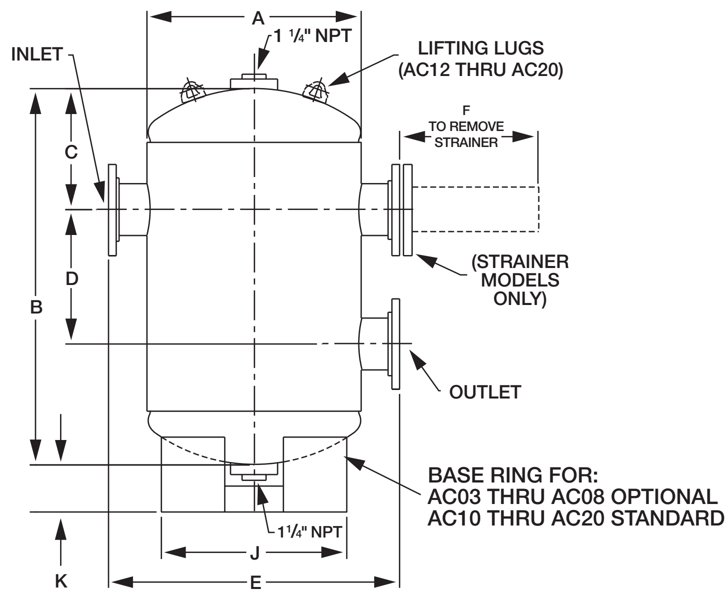
JOB ________________ ENGINEER ________________________ CONTRACTOR ________________________ REP. __________________

ITEM	QUANTITY	MODEL NUMBER	SIZE

DIMENSIONS



AC02F – AC025F



AC03F – AC20F

PIPE SIZE (inches)	PRODUCT NUMBER		A	B MAX	C	D	E	F	J	K	MAX FLOW (gpm)	Strainer Free Area (Sq. In.)	Less Strainer C_v Factor	With Strainer C_v Factor	APPROX SHIPPING WGT.	
	Less Strainer	With Strainer													Less Strainer	With Strainer
2	AC2	AC2F	8.625	18.00	6.31	5.38	10.88	13			80	22	86	72	32	37
2.5	AC25	AC25F	10.750	20.00	7.06	5.88	13.00	16			130	34	122	102	72	78
3	AC3	AC3F	14	27.25	8.00	11.25	20.75	19	12*	6$\frac{3}{4}$*	190	51	190	162	92	120
4	AC4	AC4F	16	31.30	9.32	12.75	25.25	19	12*	6$\frac{3}{4}$*	330	80	325	272	140	176
5	AC5	AC5F	16	31.39	8.82	13.75	25.25	22	12*	6$\frac{3}{4}$*	550	112	510	422	180	228
6	AC6	AC6F	20	34.88	10.06	14.75	29.25	26	16*	6$\frac{1}{2}$*	900	180	750	618	240	290
8	AC8	AC8F	20	45.50	14.06	17.38	29.75	28	16*	6$\frac{1}{2}$*	1500	246	1260	1060	322	416
10	AC10	AC10F	24	47.50	14.81	17.88	34.75	32	20	6$\frac{3}{4}$	2600	392	2000	1670	545	670
12	AC12	AC12F	30	56.94	16.85	23.25	42.00	37	22	7$\frac{1}{2}$	3400	548	2900	2400	860	1060
14	AC14	AC14F	36	65.00	19.88	25.25	48.75	43	24	7$\frac{1}{2}$	4700	732	3500	2850	980	1170
16	AC16	AC16F	36	71.50	21.75	28.00	49.75	44	24	7$\frac{1}{2}$	6000	845	4600	3800	1200	1300
18	AC18	AC18F	42	74.81	22.59	29.63	55.75	51	30	7$\frac{1}{2}$	8000	1125	5900	4900	1648	1764
20	AC20	AC20F	48	82.81	25.28	32.25	62.25	58	36	7$\frac{1}{2}$	10000	1435	7400	6200	2600	3200

Model No. -4 for 125 PSI, Example AC10-4
Model No. -6 for 150 PSI, Example AC10-6

Standard Rated @ 125 PSI @ 375ºF
Designed and Constructed per ASME Section VIII Div. 1

* Optional

All dimensions shown are subject to change and should not be used for pre-piping. Contact your local Taco representative should certified dimensional drawings be required.

Do it Once. Do it Right.

Taco Inc., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401) 942-8000 Fax: 942-2360
Taco (Canada), Ltd., 6180 Ordan Drive, Mississauga, Ontario L5T 2B3 Telephone: (905) 564-9422 Fax: (905) 564-9436
Visit our website at: www.taco-hvac.com

In-Line Air Separators

The AC models of air separators deliver all the quality and performance you expect from Taco products. They are built to last with shell, heads and ANSI flanges with ASME constructed for 125, 150, 250 and 300psi working pressures all while providing outstanding performance in the field, up to a maximum operating temperature of 375˚F. The AC product line is available in standard sizes from 2" through 20" to meet the needs of a broad range of applications with custom unit sizes available up to 36" pipe size.

Do your best work.

Supersedes: 04/01/86

Effective Date: 04/09/13
Printed in USA

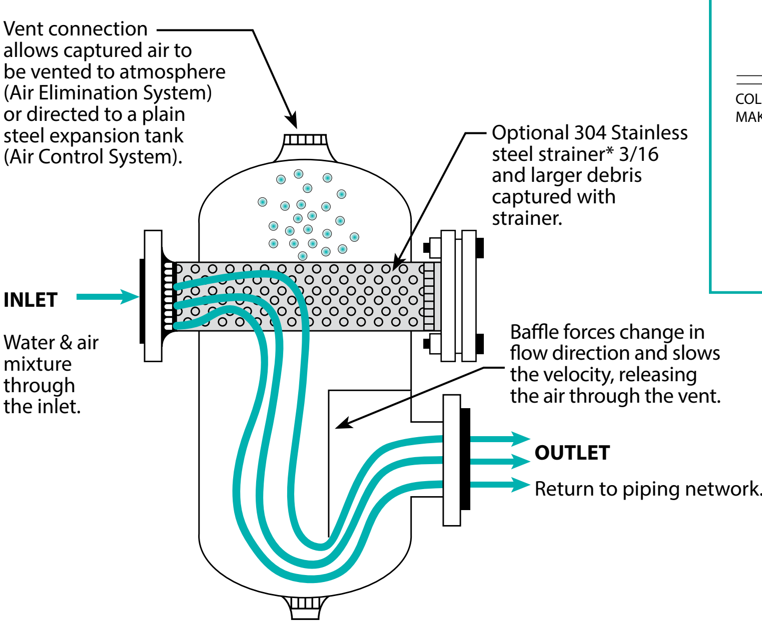
Features & Benefits

Air trapped in the system can produce major problems such as reduced heat transfer, loss of system efficiency, pipe corrosion, pump damage, increased energy consumption and irritating noise. The highly efficient Taco air separator clears the system of free air and reduces un-dissolved sediment to save money, energy and component wear. Unlike many competitive models each unit is designed, constructed and tested to the requirements of Section VIII, Division I of the ASME pressure vessel code as standard.

Designed for use in hydronic heating or cooling systems, Taco's compact, highly efficient air separator provides air separation while minimizing space requirements.

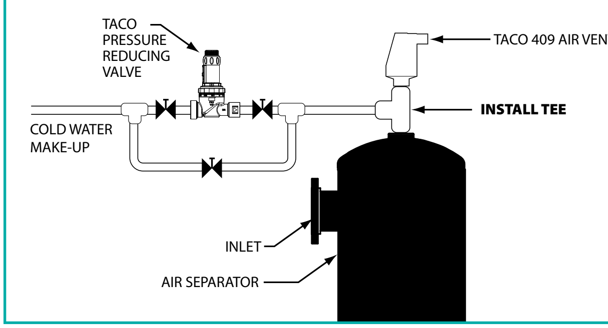
Taco offers these separators with or without strainers, in standard pipe line sizes from 2" to 20" with custom unit sizes up to 36" pipe size. The wide range of separator models have been developed for applications with flowrates up to 12,500 gpm. This wide range of models allows optimum selections with reduced pressure drop requirements. The standard product is designed for working pressures of 125 psi at 375˚F. Optional 150, 250 and 300 psi maximum pressure units, 375˚F maximum temperature units are also available. Taco air separators are manufactured from carbon steel listed in ASME Section II. Consult the factory for higher working pressures, larger sizes or non-standard materials of construction.

Air Separator Flow Pattern



** Provided as standard on F model units*

Recommended/Typical Installation



In-Line ASME Air Separators (AC)

Taco In-Line Air Separators are applied in commercial, institutional and industrial applications for the removal of free air in water or water/glycol systems. The In-Line designed air separator utilizes the advantages resulting from large body diameter in relation to the entering nozzle diameter.

The design of in-line air separators depends upon the **lowering of the system fluid velocity** within the separator, the **change in direction** of fluid flow within the unit, and **buoyant force** direct air to the automatic air vent normally positioned at the top of the separator.

These air separators are designed, built and stamped to the requirements of ASME. The rated working pressure of these units is dependent upon the design pressure of the hydronic system into which they are being installed. Manufacturers offer these unit working pressures of 125, 150, 250 and 300 psi and higher if required.

Optional stainless steel strainers are specified to **capture** and allow the removal of larger debris. (3/16" and larger) These screens are normally specified with 3/16 inch perforations and free area of not less than 5 times the open area of the nozzle to minimize pressure drop. Most manufacturers provide a blowdown connection at the bottom of the unit.

When In-Line Air Separators are installed in conventional **Air Control Systems** with plain steel expansion tanks (Figure A) care must be taken to insure that piping between the air separator and the plain steel expansion tank is pitched at least 3 degrees to facilitate the migration of captured air back into the expansion vessel. Systems with plain steel expansion tanks must not have automatic vents installed as this will lead to the loss of the expansion tank compression cushion.

Air Separator with Plain Steel Expansion Tank

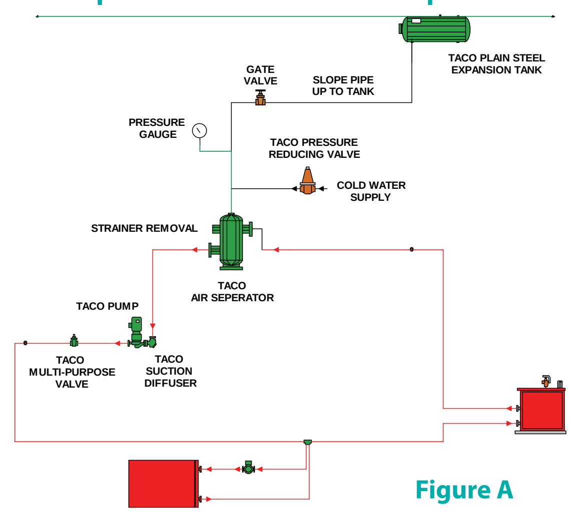


Figure A

When In-Line Air Separators are installed in **Air Elimination Systems** (Figure B) with Captive Air bladder or diaphragm style expansion tanks, automatic air vents should be installed at the top of each separator. As Air Elimination systems have a permanent separation provided by the bladder of diaphragm between the initial tank pre-charge and the system fluid no loss of pre-charge air will occur.

Applications
- **Larger systems**
- **Lower pressure drop**
- **Removal of larger particles**

Air Separator with Captive Air Tank

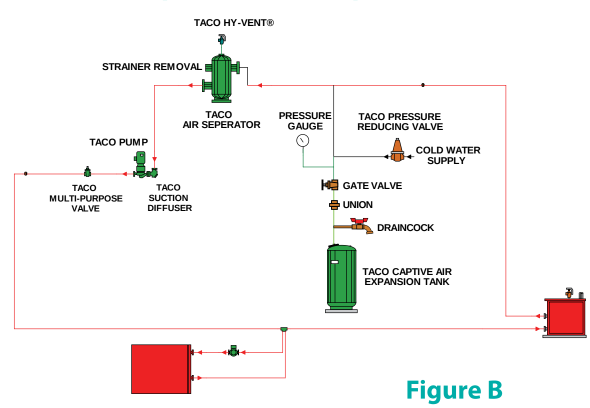


Figure B

Air Control and Elimination

Water contains a certain amount of entrained air. If this air comes out of solution, it can increase corrosion rates of metals within the system. In addition, air can form pockets at the top of pipes and heating units. These air pockets can actually restrict or block flow in a hydronic piping system. This is referred to as "air locking".

The table below shows a solubility curve for air in water. Note that at a fixed pressure, increasing the temperature reduces the amount of air that can be dissolved. For example, at 60 PSIA and 40°F, the water can contain just over 10% air by volume. At 60 PSIA and 200° F, the percentage decreases to just over 4%.

Conversely, at fixed temperature reducing the pressure reduces the amount of air that can be dissolved. For example at 100°F and 80 PSIA the water can contain 8% air by volume. At 100°F and 20 PSIA the percentage decreases to 2%.

Solubility Curve

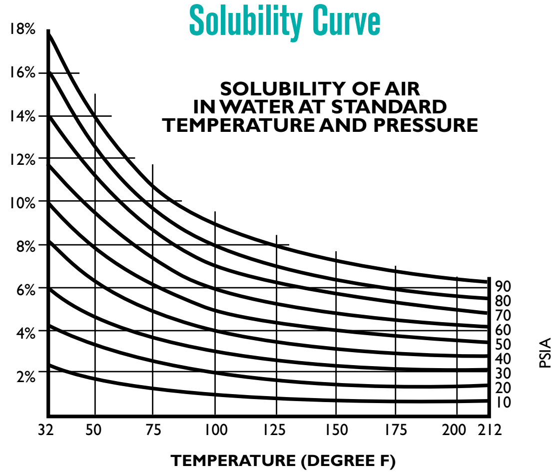


Figure 1

The conclusion is that air is least soluble in water at the highest temperature and lowest pressure. Air separators should therefore be located at these points.

The highest temperature in a system is typically on the discharge of boilers and inlet of chillers. Therefore, the general rule of thumb in hydronic systems is that ***"Air separators should be located downstream of boilers (Figure 2) and upstream of chillers (Figure 3)."***

The lowest pressure in a system is typically at the expansion tank, since this is the point of no pressure change and the location of the fill valve. Therefore, the general rule of thumb in hydronic systems is that ***"Air separators should be located at the expansion tank connection to the system."***

Boiler and Air Separator Location

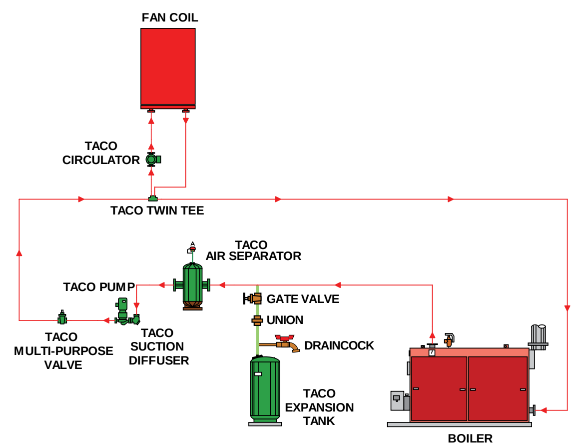


Figure 2

Chiller and Air Separator Location

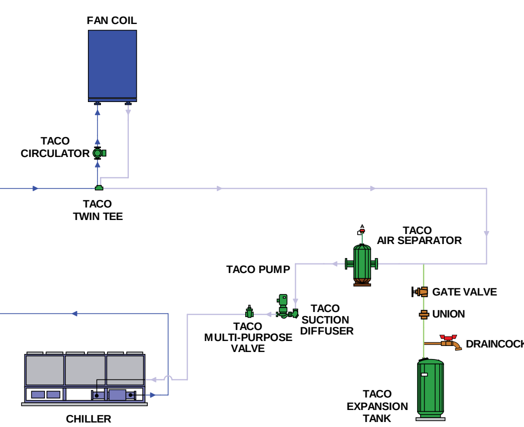


Figure 3

In addition, as water is heated from the fill temperature to the operating temperature, a great deal of air is released. Therefore, the simple act of bringing the water to operating temperature could lead to corrosion and air pockets, both of which should be avoided.

A method of removing this released air from the piping system is therefore required. Enter the air separator. An air separator is a device that is removes the air from the circulating fluid.

There are several types of air separators in use today. Depending upon the type of expansion tank used in the system, the air separator is part of an Air Control System or an Air Elimination System.

Air Control Systems

If a conventional (non-bladder) style expansion tank is used, it is desirable to redirect the separated air to the space above the water level in the expansion tank (Figure 4). The dotted line from the air separator (scoop) to the plain steel tank shows the proper connection, with the air piped from the scoop to the expansion tank through a special tank fitting.

Air Control System

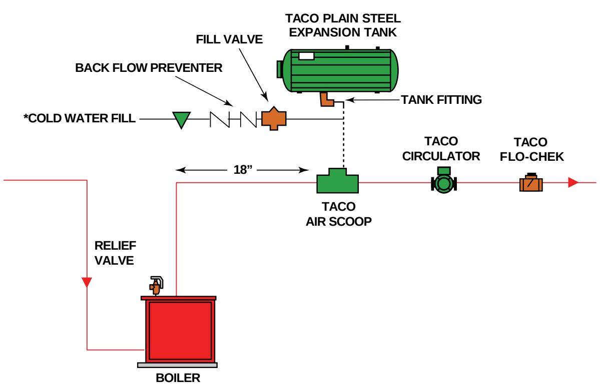


Figure 4

This fitting directs the air to the top portion of the tank, and discourages air from migrating back into the system (See Figure 5), when the system cools on the "off" cycle. Note that since the air is "recycled" to provide a cushion in the expansion tank, this system is called an "Air Control" system.

Note that the circulator is on the supply side of the boiler. This is the proper location, as it results in the highest pressure at the top of the system (if the circulator was on the return side of the boiler, the boiler pressure drop reduce the pressure at the top.) Having a higher pressure at the top keeps air in solution, and helps prevent problems and air binding.

Tank Fitting

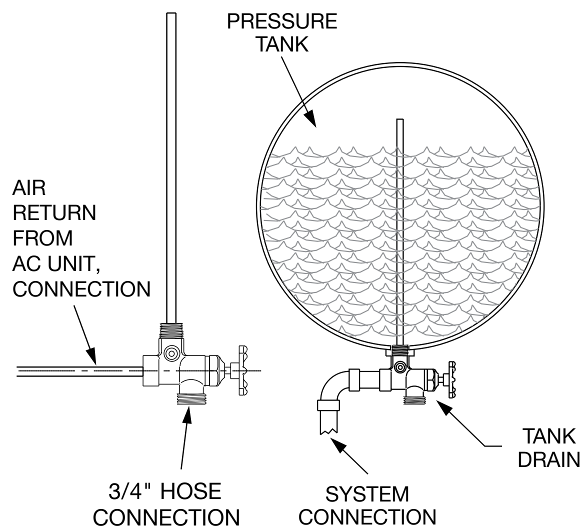


Figure 5

Applications

Air Elimination Systems

If a Captive Air or Bladder Style expansion tank is used, there is no reason to "save" the separated air (Figure 6). Therefore, if an air separator (scoop) is used in an air elimination system rather than an air control system, the separator is fitted with an automatic air vent (Taco's "Hy-Vent®" series), which discharges the separated air to the atmosphere. Note that since the air is eliminated through an air vent this system is called an "Air Elimination" system.

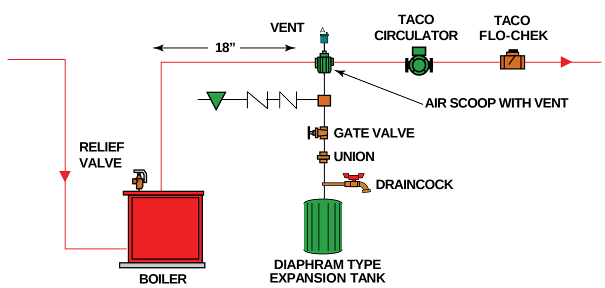


Figure 6

Types of Air Separators

Air Scoop

Taco Air scoops are applied in residential and light commercial applications for the removal of free air in water or water/glycol systems. The body of each air scoop provides an increased cross sectional area and lower velocity within the piping network thereby allowing free air to rise due to buoyant force. To assist with the removal of smaller air bubbles integral baffles are incorporated within most air scoops.

Optimum performance is achieved at line velocities up to 4 ft/sec. However, air scoops have been successfully installed on applications with velocities up to 8 ft/sec. Air scoops are specifically designed for the line size which they are to be installed. These sizes range from1 inch to 4 inch.

Most manufacturers rate their air scoop product lines for 125 psi with a maximum operating temperature of 300˚F. Air scoops are installed in conjunction with an expansion tank and air vent as shown in figure 7.

(See Taco Catalog# 100-7.2 for additional information.)

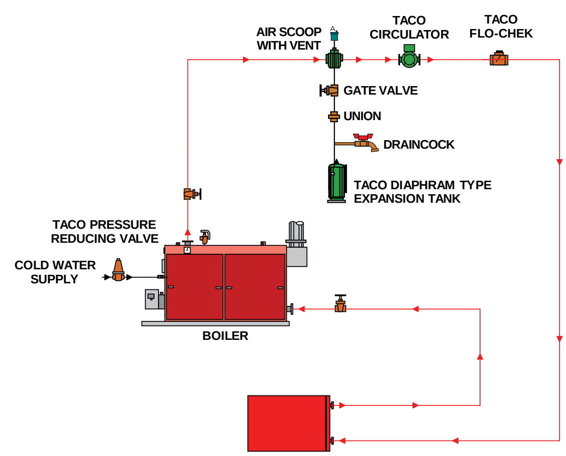


Figure 7

Applications

- **Smaller systems**
- **Lower cost**
- **Compact installation**

VorTech®

Taco VorTech® Air Separators are applied in residential and light commercial applications for the removal of free air in water or water/glycol systems. The body of a VorTech features a primary separation chamber where the process of air elimination is controlled and optimized.

The body of each VorTech is specially designed to direct the flow of the system fluid tangentially exiting at the bottom of the chamber. To assist with the removal of larger air pockets each VorTech incorporates a 300 series stainless bubble breaker cartridge to breakup larger air volumes.

Due to the tangential effect the system fluid with its higher density is pushed to the outside wall of the chamber as the less dense air is directed toward the vortex of the flow and vented from the system.

Optimum performance is achieved at line velocities up to 4 ft/sec. However, VorTech style units have been successfully installed on applications with velocities up to 8 ft/sec. VorTech separators are specifically designed for the line size which they are to be installed. These sizes range from 3/4 inch to 2 inch.

VorTech style separators are rated for 150 psi with a maximum operating temperature of 240°F. VorTech are commonly installed in conjunction with an expansion tank and air vent as shown in Figure 8.

4900 Series Air Separator

Taco 4900 Series Air Separators use a patented, independently proven method for removing gasses from water: the PALL ring process. Inside the 4900, PALL rings accumulate and then completely eliminate micro-bubbles from 15 microns and up. That's bubbles which are 3 times smaller than the nearest competitions scrubbing design. What's more, Taco's unique conical venting chamber with integral shut-off and protective plate keeps waterborne dirt and impurities well clear of the venting mechanisms so that fouling of the vent is eliminated during normal operation.

Applications
- **Smaller systems**
- **Higher efficiencies**
- **Compact installation**

(See Taco Catalog# 100-2.9 for additional information.)

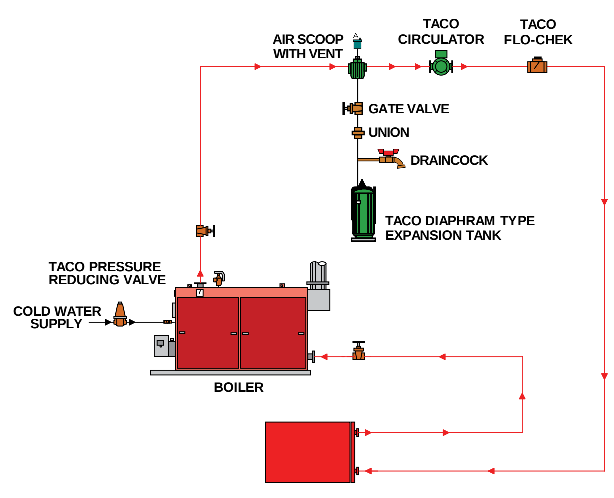


Figure 8

Tangential ASME Air Separators

Taco Tangential Air Separators are applied in commercial, institutional and industrial applications for the removal of free air in water or water/glycol systems. The Tangential design air separators utilize the difference in density to separate free air from system fluid.

System fluid within a tangential air separator is forced to the wall of the separator due to centrifugal force. The less dense air then mirgrates to the center of the separator for venting at the top of the unit. Tangential air separators produce higher pressure drops than in-line or micro-bubble separators due to the vortex development within the unit.

These units are designed, built, tested and stamped to the requirements of ASME. Manufacturers offer tangential separators in working pressures of 125, 150, 250, 300 psi and higher if required.

Optional stainless steel strainers are specified to capture and allow the removal of large debris. These screens are normally specified with 3/16 inch perforations and free area of not less than 5 times the open area of the nozzle to minimize pressure drop. Most manufacturers provide a blowdown connection at the bottom of the unit.

When Tangential Air Separators are installed in conventional Air Control systems with plain steel expansion tanks (Figure 9) care must be taken to insure that piping between the air vent and the plain steel tank is pitched at least 3 degrees to facilitate the migration of captured air back into the expansion vessel. Systems with plain steel expansion tanks must not have automatic air vents installed as this will lead to the loss of the expansion tank compression cushion. When Tangential Air Separators are installed in Air Elimination systems (Figure 10) with Captive Air bladder or diaphragm style expansion tanks, automatic air vents should be installed at the top of each air separator. As Air Elimination systems have a permanent separation provided by the bladder or diaphragm between the initial tank pre-charge and the system fluid no loss of pre-charge will occur.

(See Taco Catalog# 400-3.1 for additional information.)

Air Separator with Plain Steel Expansion Tank

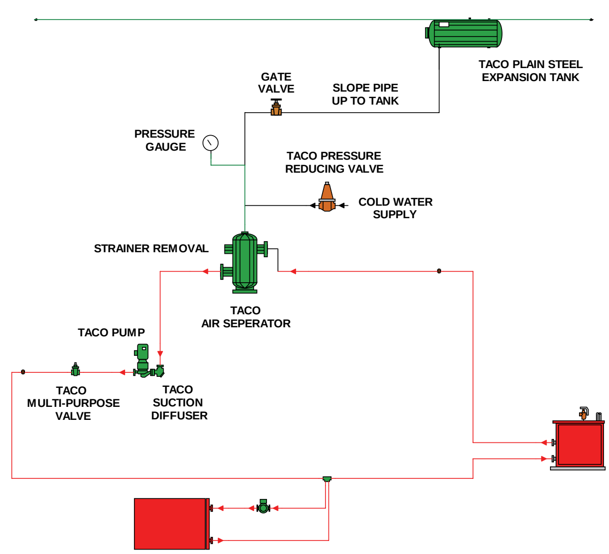


Figure 9

Air Separator with Captive Air Tank

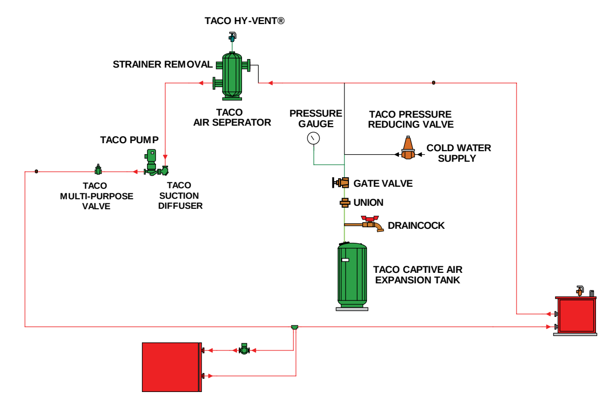
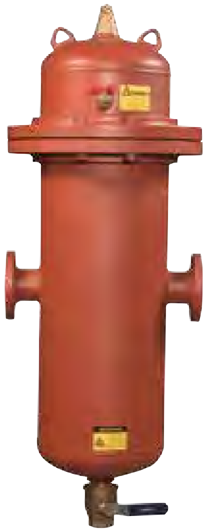


Figure 10

4900 Series High Efficiency Micro-Bubble Air and Dirt ASME Separator

Taco 4900 Series High Efficiency Micro-Bubble Air and Dirt Separators are applied in commercial, institutional and industrial applications for the removal of free and entrained air. The 4900 Series utilize the coalescence of micro air bubbles around PALL rings to separate free air from a system fluid.



The 4900 Series incorporates the highest available **coalescence** surface area available on the market today. This enhanced surface area allows the removal of micro-bubbles as small as 15 microns in diameter. **The 4900 Series separators remove up to 99.6% of the dissolved air through the action of coalescence.** This feature is especially beneficial in correcting problems in air entrained systems.

Units are designed for low Pressure drops typically under 2 PSIG.

An additional feature of the 4900 Series is the capability to remove dirt sizes as small as 5 microns from hydronic systems. **The 4900 Series separators remove up to 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid.** This feature is especially beneficial in correcting problems in air entrained systems.

The 4900 Series has been designed in **two velocity ranges**, a standard product series suitable for line velocity to 4.9 ft/sec. and a high velocity series suitable for line velocities up 11 ft/sec. The performance of the 4900 product line has been independently tested and published. (These test results are available through your local Taco representative.)

These units are designed, built, tested and stamped to the requirements ASME Section VIII, Division 1. Manufacturers offer micro bubble air and dirt separators in working pressures of 125, 150, 250 psi.

When High Efficiency Micro Bubble Air and Dirt Separators are installed in conventional Air Control systems with plain steel expansion tanks (Figure 9) care must be taken to insure that piping between the air vent and the plain steel tank is pitched at least 3 degrees to facilitate the migration of captured air back in the expansion vessel. Systems with plain steel expansion tanks must not have automatic vents installed as this will lead to the loss of the expansion tank compression cushion.

When High Efficiency Micro Bubble Air and Dirt Separators are installed in Air Elimination systems (Figure 10) with Captive Air bladder or diaphragm style expansion tanks, automatic air vents should be installed at the top of each air separator. As Air Elimination systems have permanent separation provided by the bladder or diaphragm between the initial tank pre-charge and the system fluid no loss of pre-charge air will occur.

(See Taco Catalog# 400-1.4 for additional information.)

Applications

- **Larger systems**
- **Higher efficiencies**
- **Higher velocities**
- **Removal of smaller air bubbles, e.g. removal of air in air entrained systems (removes micro air bubbles)**
- **Removal of smaller particles, e.g. cleaning of dirty systems (removes particles and dirt)**

Example 1 [Less Strainer]

Problem:

Select an air separator for a new installation. The system will have better than average maintenance and the primary pumps in the system have suction diffusers with strainer.

Conditions:

Flow rate = 700 gpm
Pipe size = 8″
Velocity = 4.5 fps
Maximum pressure drop = 2 ft.

1. Determine the type of air separator required. For removal of air in a system of this larger flow rate this would require a Taco Air Separator with a model number beginning with "AC".

   For system with better than average maintenance and strainers in the pump suction diffusers select the standard unit without a strainer. No additional letter designation is required.

2. Determine the velocity range of the AC Series that is suitable for these conditions. The recommended velocity range for the standard unit is 10 fps. This would require a unit with a line size of 6″ (7.77 fps)

3. Determine the size of the AC for the specified maximum pressure drop. For a maximum pressure drop of 2 ft. the unit size required is a 6″ (1.8 ft.). **This is Model AC06**.

ACG06-I25R

Example 2 [With Strainer]

Problem:

Select an air separator for an existing installation. The system has less than average maintenance and there are no strainers in the suction diffusers in the orimary pumps.

Conditions:

Flow rate = 230 gpm
Pipe size = 4″
Velocity = 5.8 fps
Maximum pressure drop = 2 ft.

1. Determine the type of air separator required. For removal of air in a system of this larger flow rate would require a Taco AC Series Air Separator with a model number beginning with "AC".

   For a system with less than average maintenance and no strainers in the primary pumps select the unit with removable strainer for easier cleaning. This is a model number ending with an "F".

2. Determine the velocity range of the AC Series that is suitable for these conditions. The recommended velocity range for the AC unit is 10 fps. This would require a unit with a line size of 3″ (9.98 fps).

3. Determine the size of the AC for the specified maximum pressure drop. For a maximum pressure drop of 2 ft. the unit size required is a 4″ (1.6 ft.). **This is Model AC04F**.

AC04F-125

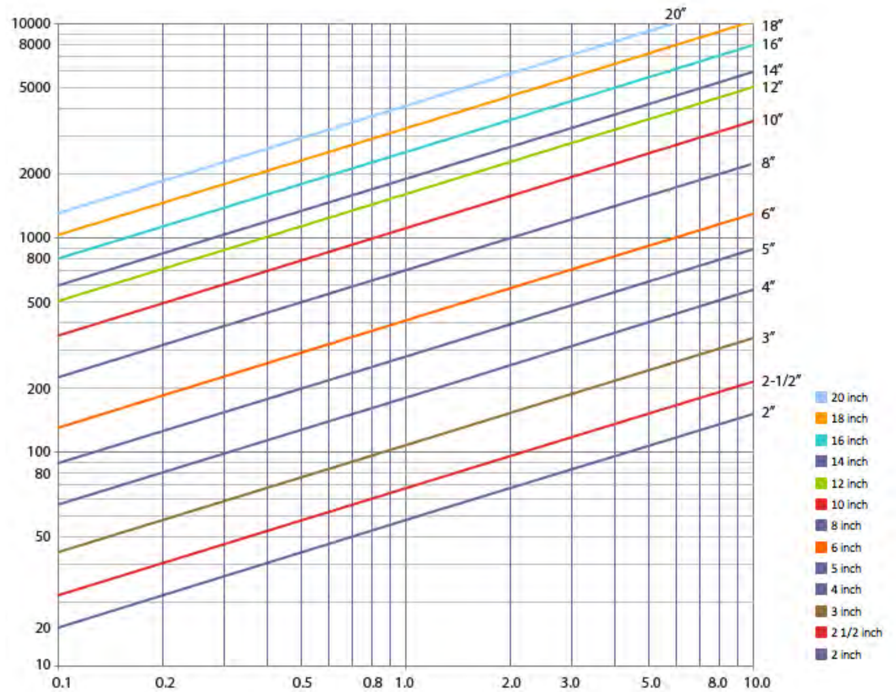
Specifications

Furnish and install as shown on plans an external air separator consisting of a steel tank
_______" diameter X _______" long.

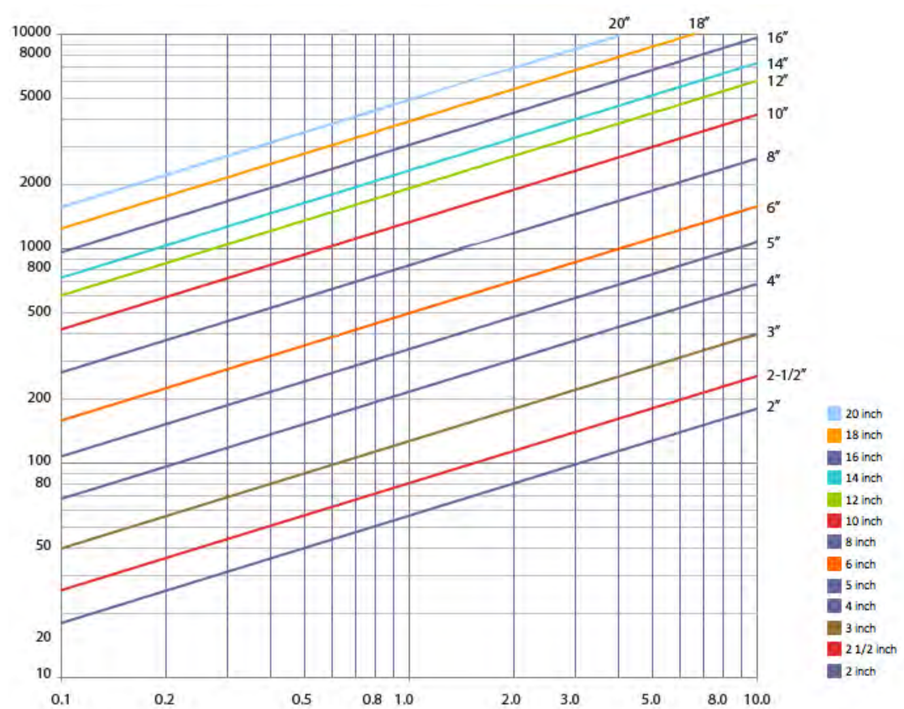
The unit shall have _______" (NPT/flanged) inlet and outlet connections and strainer removal connection where specified. The removable strainer shall be of 304 stainless steel with 3/16" diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. When strainer is specified, installer shall remove and clean strainer after 24 hours operation and after 30 days operation. There shall be a bottom connection for blowdown cleaning. Unit must be designed, constructed and tested in accordance with the ASME Boiler and Pressure Vessel Code and stamped 125, 150, 250 and 300 psig design pressure. Each air separation unit shall be Taco, Inc. Model No. _______________ or equal. ASME B16.5 flanges shall be provided on all units 3" or larger. ASME Code data reports are to be supplied by the air separator manufacturer upon request.

Pressure Drops

Air Separator Pressure Drop WITH Strainer



Air Separator Pressure Drop WITHOUT Strainer



Submittal Data Information
In-Line Air Separators

Submittal Data #401-107 Effective: 03/01/13
[Refer to all other submittals listed at bottom]

Supersedes: New

Pipe Size	Model Number		A Dia.	B Max.	C	D	E	F	G Dia.	H Inch	Max. Flow	Strainer Free Area	C_v Factor	Approx. Wt. (LBS.)	C_v Factor	Approx. Wt. (LBS.)
	Less Strainer	With Strainer														
Inch			Inch	Inch	Inch	Inch	Inch	Inch	Base Ring		GPM	Inch²	Less Strainer		With Strainer	
2	AC02	AC02F	12	22-1/8	13	7-9/16	7	14	-	-	80	31	86	40	72	45
2-1/2	AC025	AC025F	12	22-1/8	13	7-9/16	7	14	-	-	130	38	122	40	102	45
3	AC03	AC03F	14	27-1/4	22	8	11-1/4	24	12	6-1/2	190	51	190	90	162	110
4	AC04	AC04F	16	31-3/8	24	9-5/16	12-3/4	26	12	7	330	80	325	115	272	145
5	AC05	AC05F	16	32-1/2	24	9-3/8	13-3/4	26	12	7	550	112	510	130	422	165
6	AC06	AC06F	20	36-7/8	27	11-1/16	14-3/4	30	16	6-3/4	900	180	750	170	618	215
8	AC08	AC08F	20	45-1/2	27	14-1/16	17-3/8	30	16	6-3/4	1500	246	1260	270	1060	345
10	AC10	AC10F	24	47-3/4	32	14-15/16	17-7/8	36	20	6-3/4	2600	392	2000	350	1670	465
12	AC12	AC12F	30	59-3/4	37	17-5/8	24-1/2	42	24	7-3/4	3400	548	2900	600	2400	775
14	AC14	AC14F	36	68-1/2	44	20-3/4	27	48	30	7-3/4	4700	732	3500	805	2850	1035
16	AC16	AC16F	36	75-1/2	43	22-1/4	31	48	30	7-3/4	6000	845	4600	875	3800	1150
18	AC18	AC18F	48	84-1/4	56	24-5/8	35	64	40	7-3/4	8000	1290	5900	1550	4900	1900
20	AC20	AC20F	48	91	56	26	39	64	40	8 5/8	10000	1435	7400	1700	6200	2150

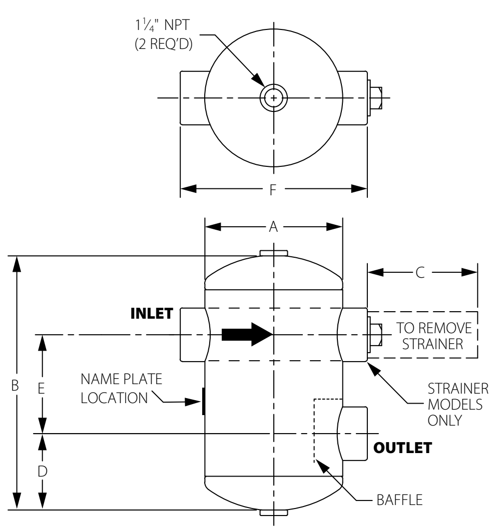
Larger units up to 36" (914 mm) are available. Please Contact the Factory.

SPECIFICATIONS

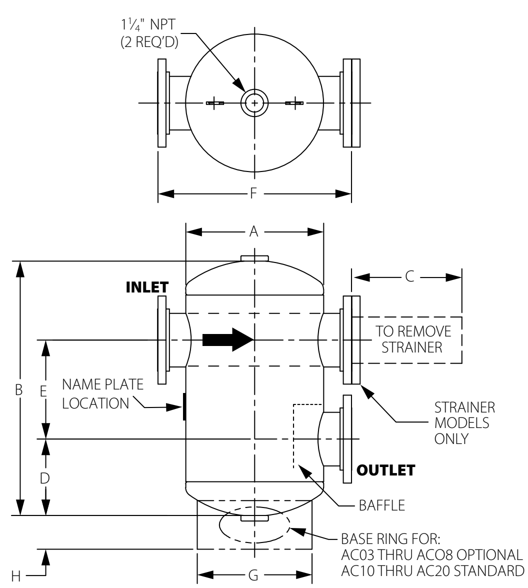
- Designed and constructed per ASME Code Section VIII, Division 1.
- Standard Design Pressure and Temperature
- Construction: Carbon Steel with exterior red oxide primer finish w/ optional 304SS Strainer
- Registered with the National Board of Pressure Vessel Manufacturers
- U-1A Data Report

OPTIONS (Consult Factory)

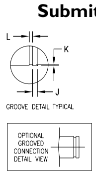
- Higher design pressures and temperatures
- Optional System Connection sizes available
- Larger sizes available up to 36" diameter
- Grooved Connections



(THREADED CONNECTIONS)



(FLANGED CONNECTIONS)



Submittal Sheets Available at www.taco-hvac.com
Grooved Connections
125 PSI @ 375°F Document 401-108
150 PSI @ 375°F Document 401-111

Submittal Sheets Available at www.taco-hvac.com
Flanged Connections
125 PSI @ 375°F Document 401-107
150 PSI @ 375°F Document 401-110
250 PSI @ 375°F Document 401-095
300 PSI @ 375°F Document 401-096

Taco®
Do your **best work.**

Taco Inc., 1160 Cranston Street. Cranston, RI 02920 / (401) 942-8000 / Fax (401) 942-2360
Taco (Canada) Ltd., 8450 Lawson Road, Unit #3, Milton, Ontario L9T 0J8 / (905) 564-9422 / Fax (905) 564-9436
www.taco-hvac.com

VALVE-MATIC AIR RELEASE VALVE

Operations & Maintenance Manual
December 2015

Manual No.
ARSL-OM1-1

Air Release Valve

(Simple Lever Type)
Models 15A, 22, 25
Operation, Maintenance and Installation Manual

VAL-MATIC®

VALVE AND MANUFACTURING CORP.

905 Riverside Dr. ● Elmhurst, IL 60126
Phone (630) 941-7600 ● Fax (630) 941-8042
www.valmatic.com

VAL-MATIC'S AIR RELEASE VALVE
(Simple Lever Type)
OPERATION, MAINTENANCE AND INSTALLATION

INTRODUCTION
This manual will provide you with the information to properly install and maintain the valve to ensure a long service life. The Air Release Valve has been designed with stainless steel trim to give years of trouble-free operation. The Air Release Valve is typically mounted at the high points in a piping system to automatically remove pockets of air as they accumulate. The valve can also be used to slowly release air in tanks and pump casings.

Note: This valve is not intended for fluids containing suspended solids such as wastewater. For waste-water and other high turbidity applications, use Val-Matic Series 48A & 49A Sewage Air Release Valves.

CAUTION:	**This valve is not intended for fuel service or fluids containing suspended solids.**

The valve is a float-operated, resilient-seated valve designed to handle clean fluids. The Maximum Working Pressure and Model No. are stamped on the nameplate for reference.

RECEIVING AND STORAGE
Inspect valves upon receipt for damage in shipment. Handle all valves carefully without dropping. Valves should remain boxed, clean and dry until installed to prevent weather related damage. For long term storage greater than six months, the valve must remain in the box and stored indoors. Do not expose valve to sunlight or ozone for any extended period.

DESCRIPTION OF OPERATION
The Air Release Valve is designed to automatically remove air pockets at the high points in a piping system. The valve, as shipped, is a normally open valve and will slowly vent air through the top orifice. As fluid enters the valve, the float will rise, closing the orifice. As air accumulates in the piping system and enters the valve, the float drops allowing the venting orifice to open.

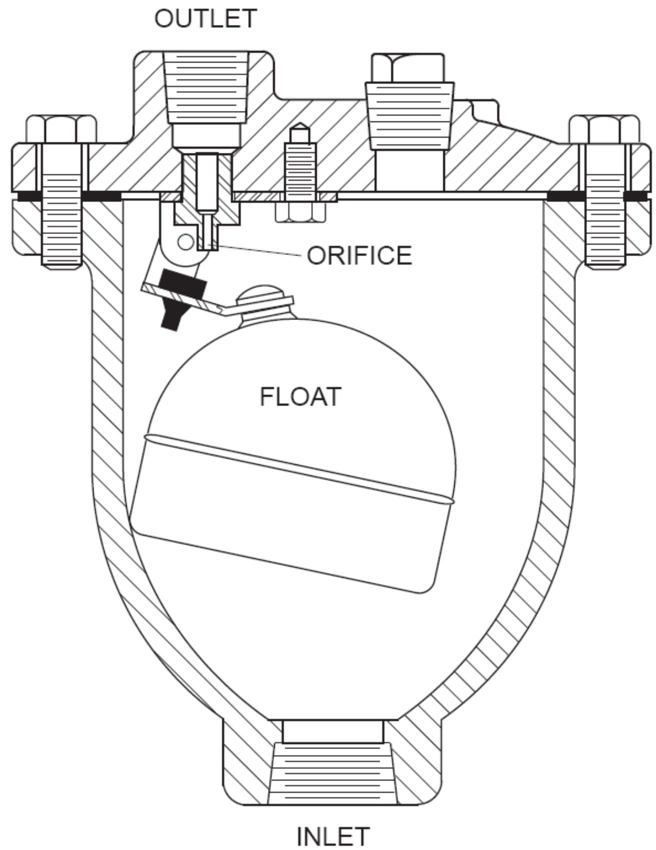


FIGURE 1. Simple Lever AIR RELEASE VALVE

The lever mechanism provides mechanical advantage for the float. During system operation, the pipeline pressure exerts a strong upward force on the sealing component, the orifice button. The lever mechanism magnifies the weight of the float so that the orifice will open under high pipeline pressures. Additional ports are provided for flushing, testing and draining purposes.

INSTALLATION

The installation of the valve is important for its proper operation. Valves must be installed at the system high points in the vertical position with the inlet down. For pipeline service, a vault with freeze protection, adequate screened venting, and drainage should be provided. During closure, some fluid discharge will occur so vent lines should extend to an open drain area in plant service. A shut-off valve should be installed below the valve in the event servicing is required.

CAUTION: **Install valve with "INLET" port down or leakage will occur.**

VALVE CONSTRUCTION

The standard Air Release Valve body and cover are cast iron. See the specific Materials List submitted for the order if other than standard cast iron construction. All internal components are stainless steel with the exception of the orifice button which is resilient. The general details of construction are illustrated in Figure 2. The body (1) is threaded for connection to the pipeline. The seat (4) is threaded into the cast cover (2).

ITEM	DESCRIPTION	MATERIAL
1	Body	Cast Iron
2	Cover	Cast Iron
3	Lever Frame*	Stainless Steel
4	Seat*	Stainless Steel
5	Float*	Stainless Steel
6	Gasket*	Non-Asbestos
7	Cover Bolt	Alloy Steel
10	Float Arm*	Stainless Steel
11	Orifice Button*	Buna-N
12	Pivot Pin*	Stainless Steel
13	Pin Retainer*	Stainless Steel
14	Pipe Plug	Iron
17	Float Retainer*	Stainless Steel
21	Locator*	Stainless Steel
34	Lock Washer*	Stainless Steel

*RECOMMENDED REPAIR PART KIT

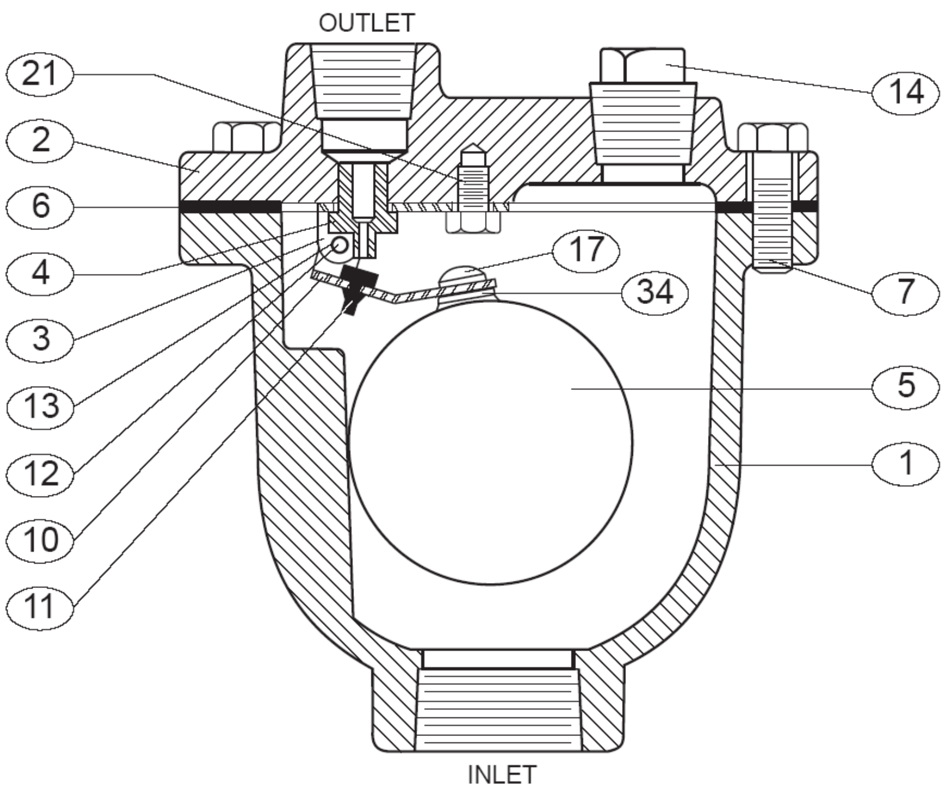


FIGURE 1. Simple Lever AIR RELEASE VALVE

MAINTENANCE

The Air Release Valve requires no scheduled lubrication or maintenance.

INSPECTION: Periodic inspection to verify operation can be performed. A manual drain valve can be installed in the lower drain plug to perform this operation as shown in Figure 3.

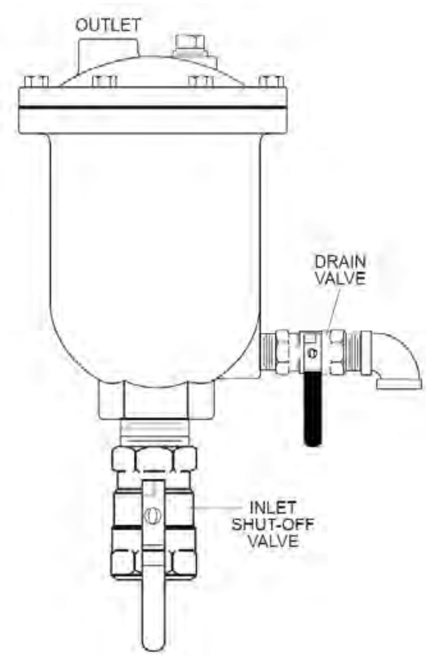


FIGURE 3. INSPECTION PIPING

1. With the inlet shut-off valve open, partially open the drain valve until flow can be heard. If the Air Valve is working properly, water should be exhausted from the drain valve. If air is exhausted, follow steps 2-6.

2. Close the inlet shut-off valve.

3. Slowly open the drain valve to allow the fluid in the valve to drain. If draining is difficult, the orifice may be clogged (valve requires service).

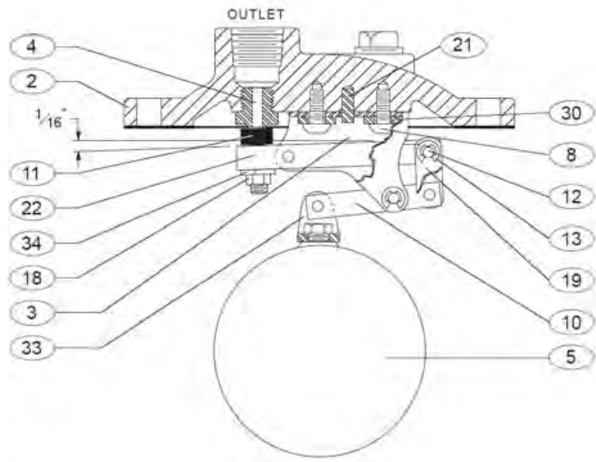
4. Close the drain valve.

5. Slowly crack open the inlet shut-off valve to fill the valve with water. Observe the seating action and verify that the valve closes without leakage.

6. If leakage occurs, the valve should be removed and inspected for wear or possible damage from foreign matter.

SIZE	TORQUE (FT-LBS)
7/16"	30
1/2"	45
7/8"	202

TABLE 2. VALVE COVER BOLT TORQUES



TROUBLESHOOTING

Several problems and solutions are presented below to assist you in troubleshooting the valve assembly in an efficient manner.

•Leakage at Bottom Connection: Tighten valve threaded connection. If leak persists, remove valve and seal threads with thread sealant.

•Leakage at Cover: Tighten bolts per Table 2, replace gasket.

•Valve Leaks when Closed: Flush valve to remove debris. Disassemble and inspect seat, orifice button, and float. NOTE: Many floats contain sand for weight but if water is detected, replace float.

•Valve not Venting Air: Check that operating pressure does not exceed Working Pressure on nameplate. Perform inspection steps 2-6 and disassemble valve if problem persists.

WARNING: The valve must be drained before removing the cover or pressure may be released causing injury.

DISASSEMBLY

The valve can be disassembled without removing it from the pipeline. Or for convenience, the valve can be removed from the line. All work on the valve should be performed by a skilled mechanic with proper tools. No special tools are required.

1. Close inlet shut-off valve. Open drain valve or remove drain plug. Remove the cover bolts (7) on the top cover.

2. Pry cover (2) loose and lift off valve body.

3. Remove the 2 retainer rings (13) and pivot pin (12) that pass through the lever frame (3). The float (5) and float arm (10) will be free from the cover. Disconnect float from float arm (10).

4. To remove lever frame (3), remove hex-head locator (21). Rotate seat (4) counter-clockwise to remove.

5. Remove orifice button (11) from float arm (10).

6. Clean and inspect parts. Note: some floats contain sand for extra weight; if water is detected, replace float. Replace worn parts as necessary.

REASSEMBLY

All parts must be cleaned and gasket surfaces should be cleaned with a stiff wire brush in the direction of the serrations or machine marks. Worn parts, gaskets and seals should be replaced during reassembly. Refer to Figure 2 on page 2.

1. Assemble lever frame (3) to cover. Secure with bolt (21) and washers (30).

2. Apply Loctite PST No. 565 thread sealant to seat (4) and assemble to cover with maximum torque of 10 ft-lbs; DO NOT OVER-TORQUE.

3. Install new orifice button (11) flush to arm (10).

4. Connect arm (10) to float (5) with retainer bolt (17) and lockwasher (34). Install pivot pin (12) and retaining rings (13); rings should snap over pins.

5. Float should move freely pressing the orifice button (11) against the seat (4) when pushed upward. Verify that all retainer rings (13) are properly secured.

6. Lay new cover gasket over body (1) and install cover (2) over bolt holes in body (1).

7. Insert lubricated bolts (7) and tighten to 10-20 ft-lbs.

8. Place valve back in service. Refer to the Installation instructions on page 2. Slowly open inlet isolation valve.

PARTS AND SERVICE

Parts and service are available from your local representative or the factory. Make note of the valve Model No and Working Pressure located on the valve nameplate and contact:

Val-Matic Valve and Mfg. Corp.
905 Riverside Drive
Elmhurst, IL 60126
PH: 630/941-7600
FAX: 630/941-8042

A sales representative will quote prices for parts or arrange for service as needed.

LIMITED WARRANTY

All products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment, subject to the limitations below.

If the purchaser believes a product is defective, the purchaser shall: (a) Notify the manufacturer, state the alleged defect and request permission to return the product; (b) if permission is given, return the product with transportation prepaid. If the product is accepted for return and found to be defective, the manufacturer will, at his discretion, either repair or replace the product, f.o.b. factory, within 60 days of receipt, or refund the purchase price. Other than to repair, replace or refund as described above, purchaser agrees that manufacturer shall not be liable for any loss, costs, expenses or damages of any kind arising out of the product, its use, installation or replacement, labeling, instructions, information or technical data of any kind, description of product use, sample or model, warnings or lack of any of the foregoing. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OF USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF THE MANUFACTURER. These products are not manufactured, sold or intended for personal, family or household purposes.

VAL-MATIC®

VALVE AND MANUFACTURING CORP.

905 Riverside Dr. ● Elmhurst, IL 60126
Phone (630) 941-7600 ● Fax (630) 941-8042
www.valmatic.com

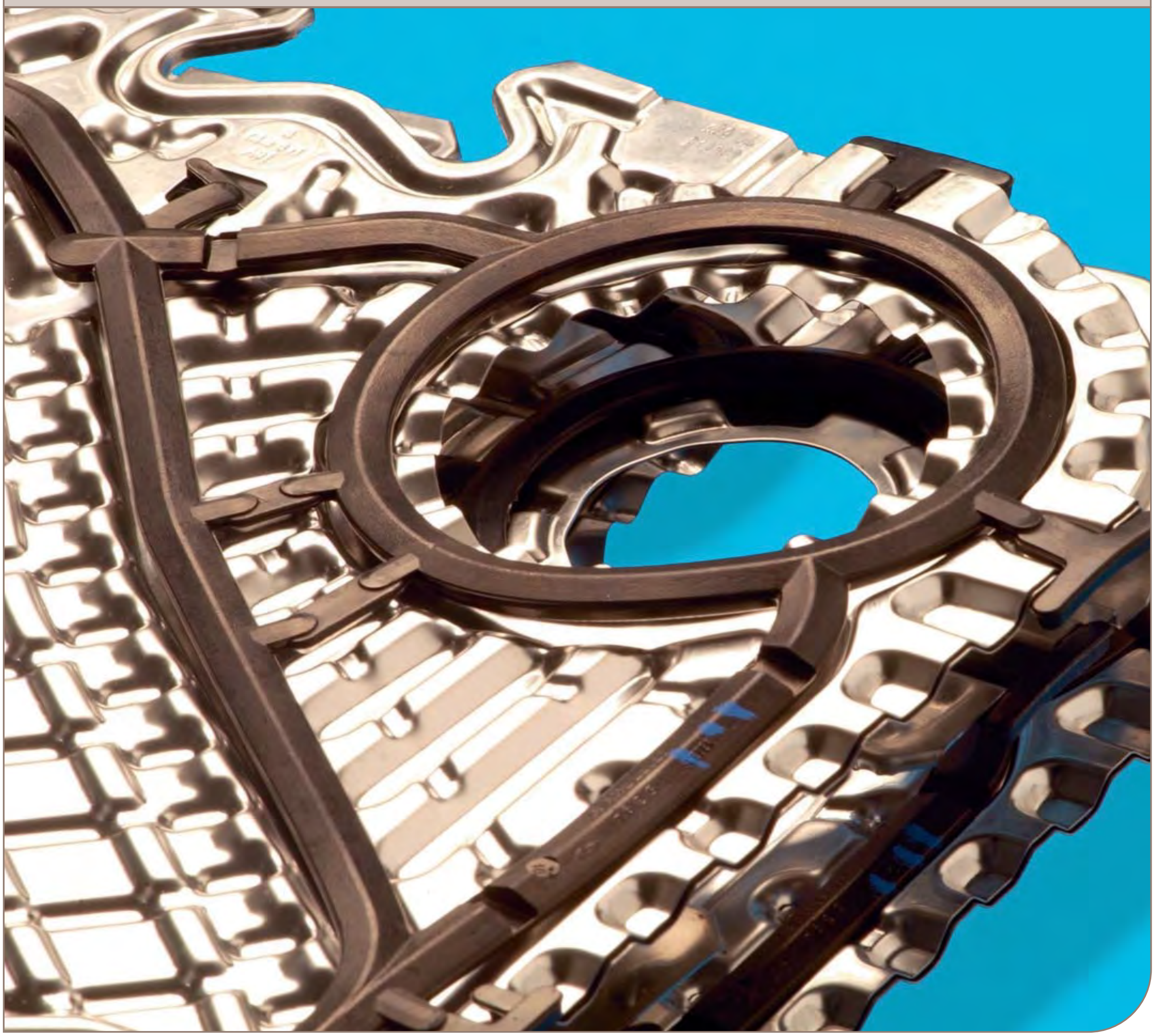
OMD PLATE HEAT EXCHANGER

Operations & Maintenance Manual
December 2015

800-648-3326
www.omdean.com
oliver m. dean, inc.

Plate Heat Exchanger

Operational and Maintenance Manual



NOTICE

TO AVOID HAND INJURIES, PROTECTIVE GLOVES SHOULD ALWAYS BE WORN WHEN HANDLING PLATES.

PROTECTIVE SHROUDS

IT IS THE RESPONSIBILITY OF EACH PERSON OPERATING OR REPAIRING EQUIPMENT TO TAKE THE NECESSARY PRECAUTIONS TO COMPLY WITH ALL APPLICABLE SAFETY REGULATIONS.

ALFA LAVAL PROVIDES PROTECTIVE SHROUDS FOR ALL OUR PLATE HEAT EXCHANGERS. THESE SHROUDS WILL PREVENT POSSIBLE INJURIES AND/OR DAMAGE AS A RESULT OF SUDDEN LEAKAGE FROM THE PLATE PACKAGE.

List of contents

List of contents

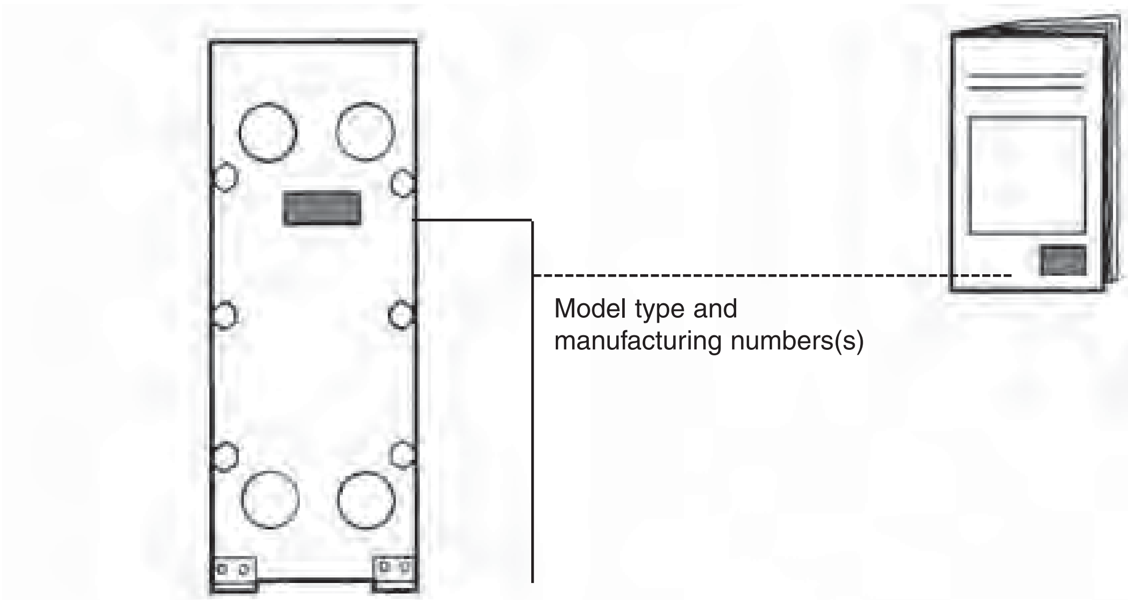
1

To our valued customer:

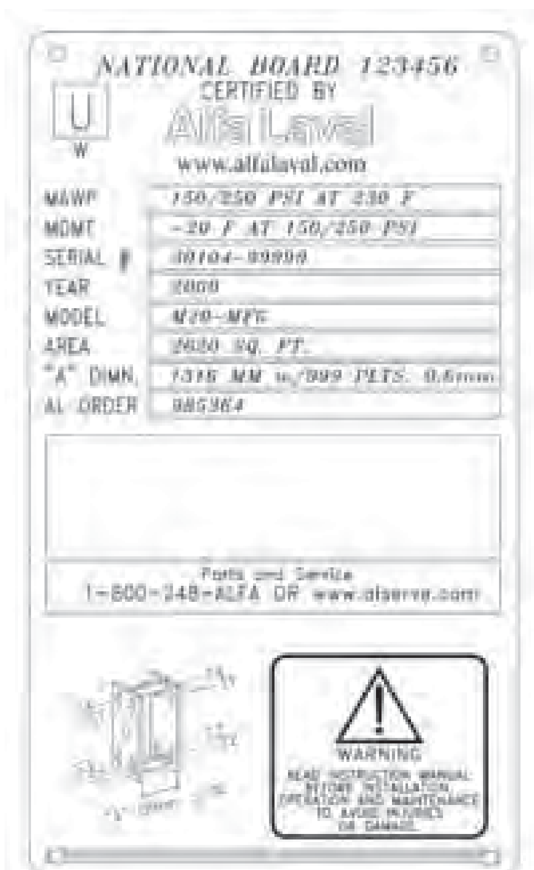
Thank you for purchasing an Alfa Laval Plate Heat Exchanger. As the world's largest manufacturer of Heat Exchangers, we are very proud of our products and services. We value you as our customer and wish to assure your satisfaction. We have prepared this Instruction Manual to assist you with your Alfa Laval Plate Heat Exchanger in various situations. We suggest that you look through it carefully, and, above all, make it readily available to any personnel who may need it for reference.

2

The name plate
- and the identification of the equipment



A name plate like the one shown below is fixed to the apparatus as shown above and it gives the following information



2.1

The name plate
- and the identification of the equipment

2

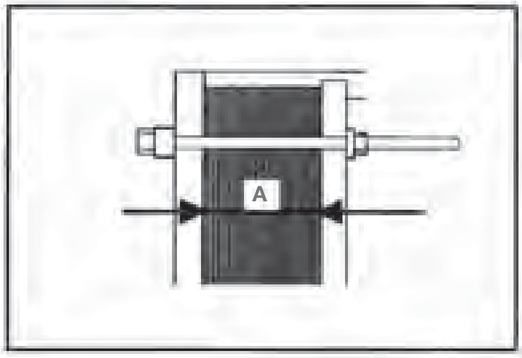
This instruction manual has been issued for many different models of Alfa Laval *industrial* PHEs. There are separate manuals for *industrial, sanitary*, *spiral*, *alfa rex, brazed & evaporator/condensor* heat exchangers.

- WHENEVER USING THE MANUAL, CHECK FIRST THAT THE SERIAL NUMBER ON THE FRONT COVER IS IDENTICAL TO THAT ON THE NAME PLATE OF THE EQUIPMENT.
- IN ALL CORRESPONDENCE WITH ALFA LAVAL, PLEASE REFER TO THE MANUFACTURING SERIAL NUMBER, FOR TRUE IDENTIFICATION OF THE EQUIPMENT.
- WHENEVER CONTACTING ALFA LAVAL ABOUT A PART FOR YOUR PLATE HEAT EXCHANGER, BE SURE TO STATE THE MANUFACTURING SERIAL NO.(S), AND MODEL TYPE.

3 General

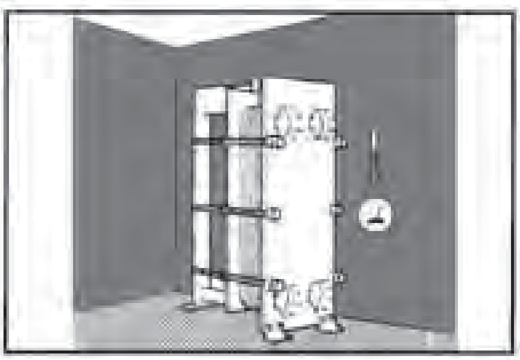
STORAGE

In this section, names of heat exchanger parts are mentioned for the first time. For your information, see Chapters 4A or 4B FUNCTION.



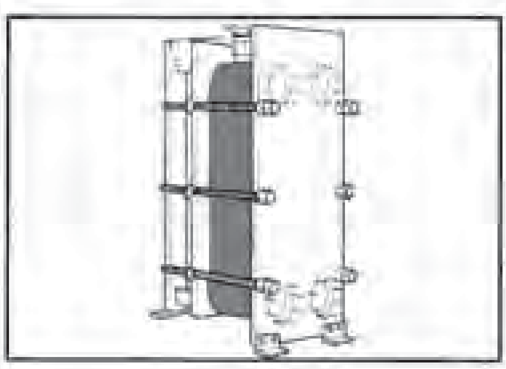
1. Unless otherwise agreed, ALFA LAVAL delivers the plate heat exchanger ready to be put in service upon arrival. This means that the plate package is tightened to its correct measurement A.

Should it be necessary, however, to store the equipment for a longer period (1 month or more) before, certain precautions should be made in order to prevent unnecessary wear of the equipment:



2. Preferably, the heat exchanger should be stored inside, in a room with a temperature around 15 to 20 degrees Celsius (60 to 70 degrees Fahrenheit) and humidity around 70%

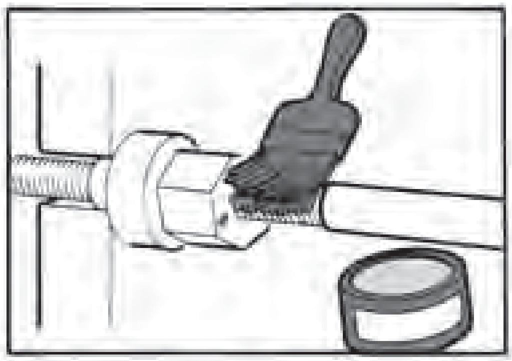
> There should ABSOLUTELY NOT be any OZONE-PRODUCING equipment in the room, like electric motors or arc-welding equipment, since ozone destroys many rubber materials (cracking).
>
> Do not store organic solvents or acids in the room.
>
> Avoid heat or ultraviolet radiation.



3. Wrapping the PHE with a non-transparent plastic film is a good precaution. Use of transparent film can alter paint color if unit is stored in direct sunlight.

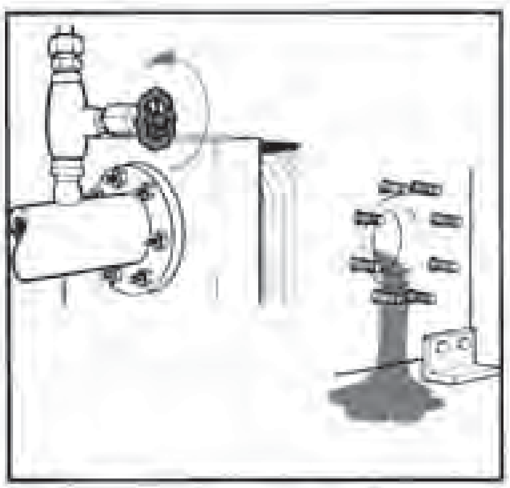
General 3

STORAGE



4. The tightening bolts should be well covered with good rust preventing coating, suitable types (LUBRIPLATE FGL-2 or Equivalent) and if not connected to the pipe system, the connections should be covered.

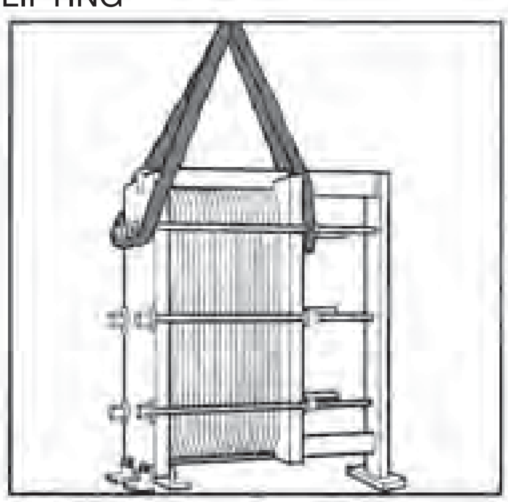
   If the heat exchanger must be stored outdoors, the precautions mentioned above should be taken as far as practical. The need for protection against the climate etc. is of course even more important in this case.



5. If for any reason the heat exchanger is removed from service for a long period, it is advantageous to follow the advice above, even if the equipment is not moved from the location.

   The heat exchanger should be VENTED AND DRAINED, and depending on the media processed, it is recommended to RINSE AND DRY it, before it is stored.

LIFTING



1. Whenever the heat exchanger is lifted, straps should be placed around tightening bolts on both sides of the unit, as shown in picture. If lifting lugs or lifting eyes are provided, always use chains or lifting cables rated above the published weight of the heat exchanger.

NEVER LIFT BY THE CONNECTIONS OR THE STUDS AROUND THEM!

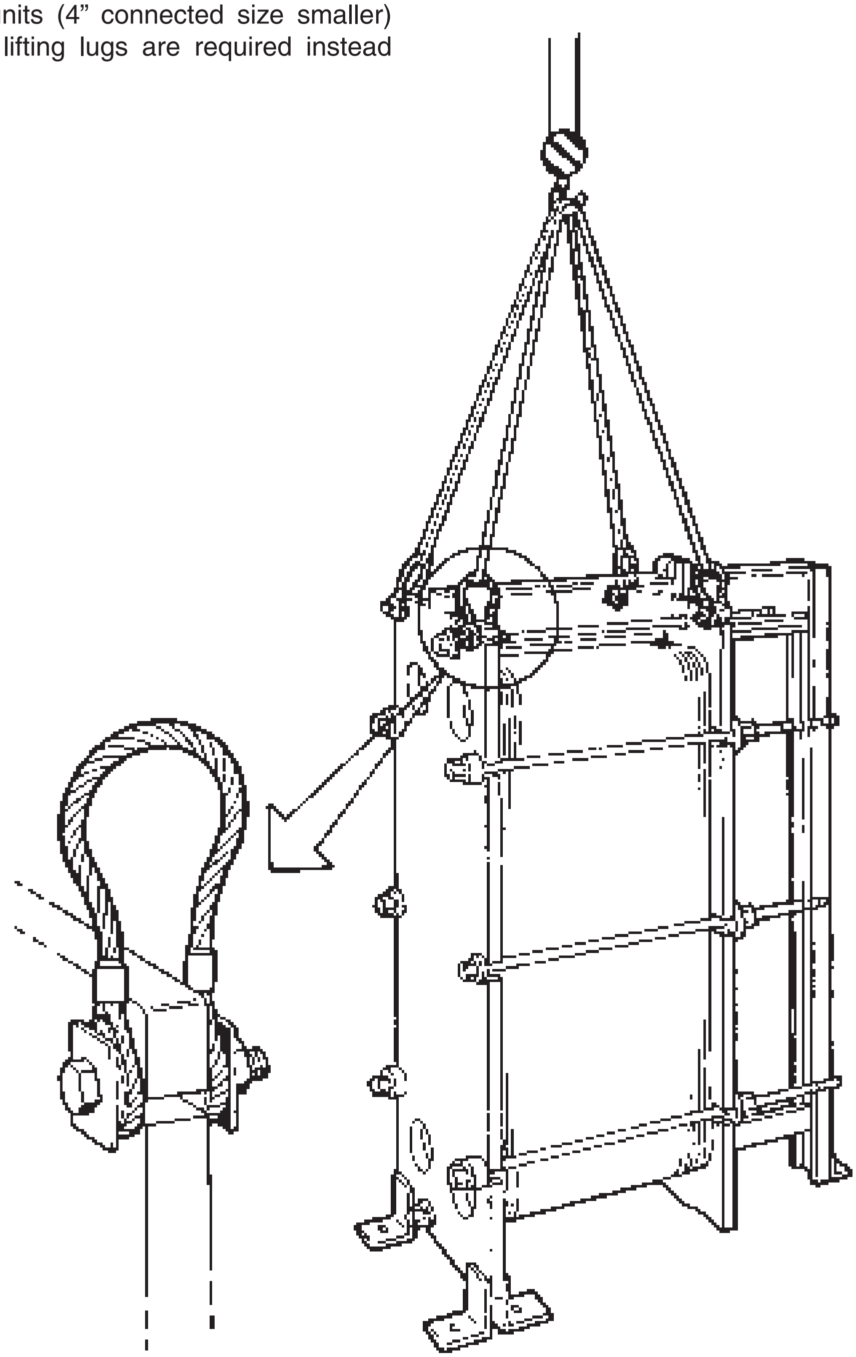
LIFTING CONTINUED

If Lifting Lugs are provided

If you are to lift the heat exchanger itself, straps should be used. They should be placed as shown on the picture.

On smaller units (4” connected size smaller) typically two lifting lugs are required instead of four.

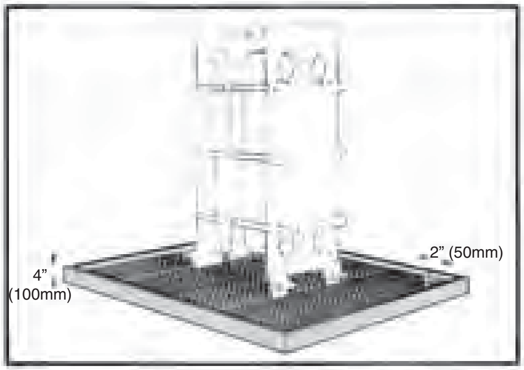
WARNING!
Never lift by the connections or the studs around them.



General

FOUNDATIONS.

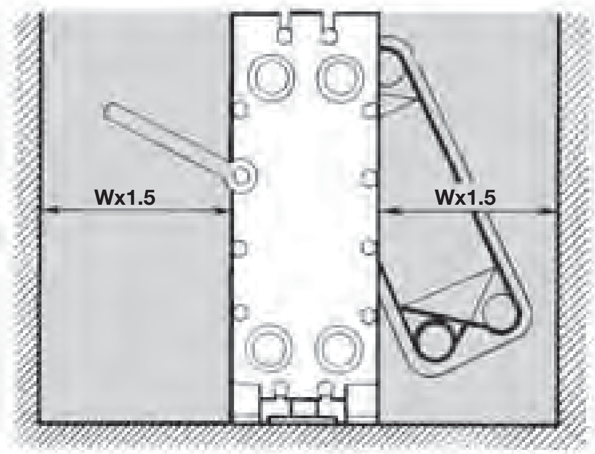
All information necessary for the preparation of the foundation appears on the data sheet provided by ALFA LAVAL.



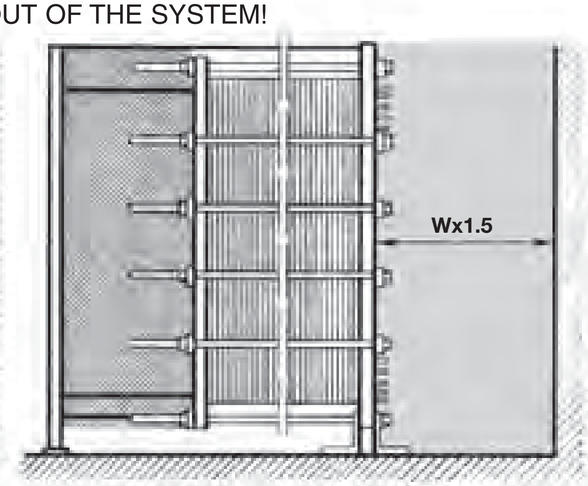
In some cases (installation on board a ship, when processing corrosive liquids, etc.) it may be practical to place the heat exchanger in a DRAINAGE BOX (with capacity for the total volume of the heat exchanger). The outlet of the drainage box should be generously dimensioned, not less than (2") 50 mm diameter.

INSTALLATION.

BEFORE connecting any piping to the heat exchanger, MAKE SURE THAT ALL FOREIGN OBJECTS HAVE BEEN FLUSHED OUT OF THE SYSTEM!



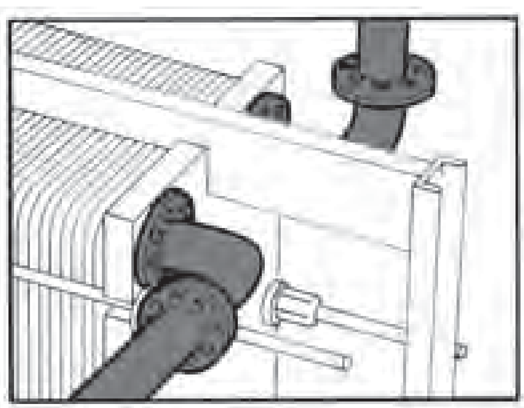
PLEASE OBSERVE THAT
The measurements given in the picture above are recommended by ALFA LAVAL, it is necessary to leave free space around the equipment, to provide access and make future service possible. Except for a place to put the plates, if removed from the heat exchanger, NO FURTHER SPACE is required for servicing the PHE.

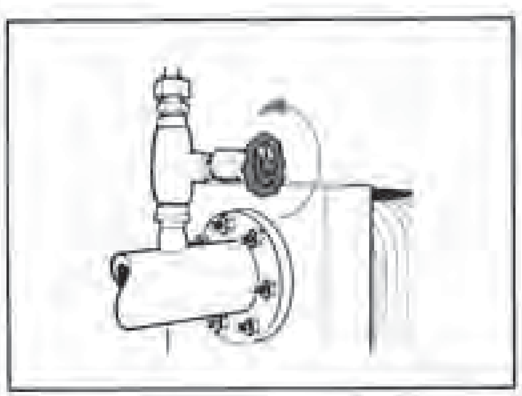


PLEASE OBSERVE THAT
The measurements given in the picture are recommended by ALFA LAVAL, to provide reasonably good working conditions during installation of the heat exchanger as well as for future maintenance and service. If floor space is restricted, the dimensions suggested can be reduced. It is left to the purchaser to decide just how much access space is required.

This field should be kept free from fixed installations.

Recommended free space for opening and closing.





PIPES

Always ensure that no measurable stress is placed on the heat exchanger by the piping system.

SHUT OFF VALVES

To enable the heat exchanger to be opened when necessary shut off valves should be provided on all connections.

PRESSURE RELIEF DEVICES

It is the responsibility of the user to ensure that the required pressure relief devices are properly installed prior to initial operation. Refer to the applicable Code(s) and corresponding Standard(s) for proper size requirements of these pressure relief devices.

CONNECTIONS ON THE PRESSURE PLATE (REAR COVER)

Some plate heat exchangers may also have connections on the pressure plate. In such cases, it is important to check against the drawing or the name plate that the plate pack has been tightened to the right measurement before the piping is connected.

Whenever piping is connected to the pressure plate, a short 90° spool piece shall be installed between the heat exchanger and the piping. These should be directed upwards or sideways. This simplifies pressure plate removal during servicing.

Venting of both sides of the heat exchanger must be provided. This is important and enables air to be drawn from the system during start-up. It also enables air or gas to be removed during operation, and it enables faster drainage.

General

Special Loose Flange Connections

Loose Flanges are provided on certain model types due to interference. When provided these flanges shall be incorporated into the piping.

MODELS WITH BOTH "S" AND "T" PORT CONNECTIONS

M6-FD, M6-MFD, M6-MWFD, M10-BFD, M10-MFD, M10-BWFD, M10-BDFD, M20-MFD*, M20-MWFD*

MODEL TYPES WITH LOOSE FLANGE ON T PORT CONNECTIONS ONLY:

M6-FG, M6-MFG, M6-MWFG, M10-BFG, M10-MFG, M10-BWFG, M10-BDFG, V28-FD*, V45-FD*, M20-MFG, M20-MWFG

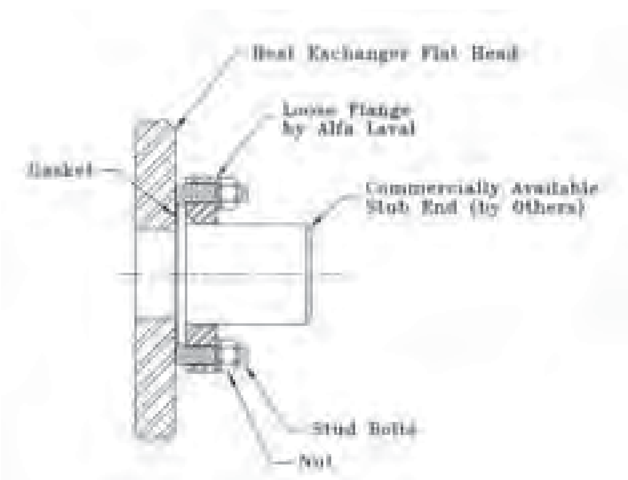
* Loose flange only when design pressures above 230 psi.

Notes:
1) Sports connections on these model types utilized industry standard flanges.
2) Not all exchangers require T port connections.

PIPING CONNECTION

The loose flange is connected to piping by use of a commercially available stub end of same material as the piping.

The stub end is installed as shown and then butt weld to the piping.



4A LIST OF PARALLEL FLOW UNITS

“A” SERIES UNITS:

AM10-FG; AM10-FS

A15-BFL; A15-BFG; A15-BFD; A15-BWFG; A15-BWFD

A20-BFL; A20-BFG; A20-BFD

AM20-FG; AM20-BFG; AM20-WFG; AM20-SFG; AM20-DWFG

AK20-FG; AK20-FD; T200-FG; T200-FD

AX30-BFG; AX30-BFD; AX30-BWFG; AX30-BWFD

A35-HA

“M” SERIES UNITS:

M3-VG

M6-FG; M6-FD; M6-MFG; M6-MFD; M6-MWFD/FG/FDR/FGR

M10-BFM; M10-BFG; M10-BFD; M10-MFG; M10-MFD;

M10-BWFG; M10-BWFD; M10-BWFGR, M10-BWFDR

M15-BFG; M15-BFD; M15-BFS; M15-MFG;

M15-MFD; M15-MFS; MK15-BWFD; MK15-BWFG

M20-MFG; M20-MFM; M20-MFD; M20-MWFG; M20-MWFD

M30-FM; M30-FG; M30-FD

MA30-FD; MA30-FG; MA30-WFG; MA30-WFD

MX25-BFG; MX25-BFD; MX25-BFS

EC500-WTFE; EC500-WTFL

“V” SERIES UNITS:

V8-VG, V13-FG, V13-FD, V20-FG, V20-FD

4A.1

PARALLEL FLOW UNITS

Function

THE MAIN COMPONENTS OF THE PLATE HEAT EXCHANGER AND THEIR FUNCTIONS.

In ALFA LAVAL Plate Heat Exchangers, heat is transferred from one medium to another through thin metal plates which have been pressed into a special pattern.

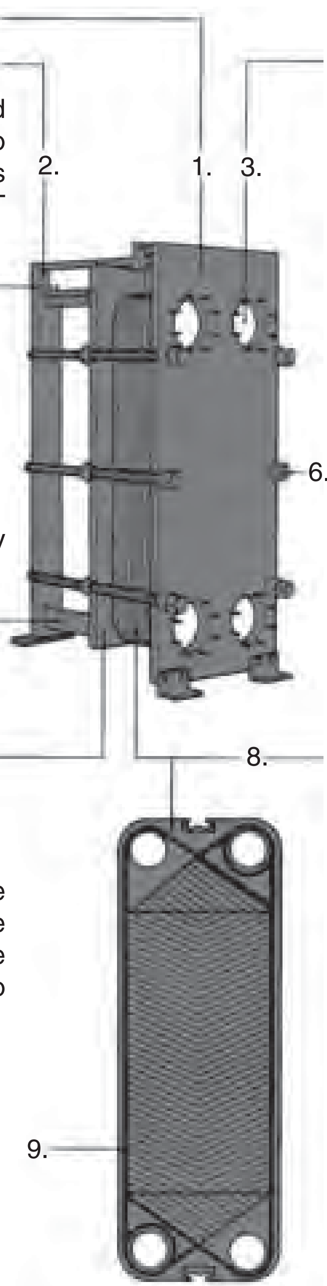
1. FRAME PLATE

2. SUPPORT COLUMN
The two bars are suspended between the FRAME PLATE, to which in most cases the piping is connected, and a SUPPORT COLUMN.

4. CARRYING BAR

5. GUIDING BAR
The plates hang from a CARRYING BAR at the top and are kept in line by a GUIDING BAR at the bottom.

7. PRESSURE PLATE
The pressure plate is hung on the carrying bar and is moveable, as are the heat transfer plates. In some cases piping may be connected to the pressure plate.



3. CONNECTIONS
Holes matching the piping lead through the frame plate, permitting the media to enter into the heat exchanger. Threaded studs around the holes secure the pipes to the equipment. Depending on the application, metallic or rubber-type LININGS may protect the edges of the holes against corrosion.

6. TIGHTENING BOLTS
With the package of thin plates hanging between the frame plate and the pressure plate, a number of TIGHTENING BOLTS are used to press the thin plates together, bringing them into metallic contact, and to compress the gaskets, enough to seal off the narrow passages which have now been formed between the plates.

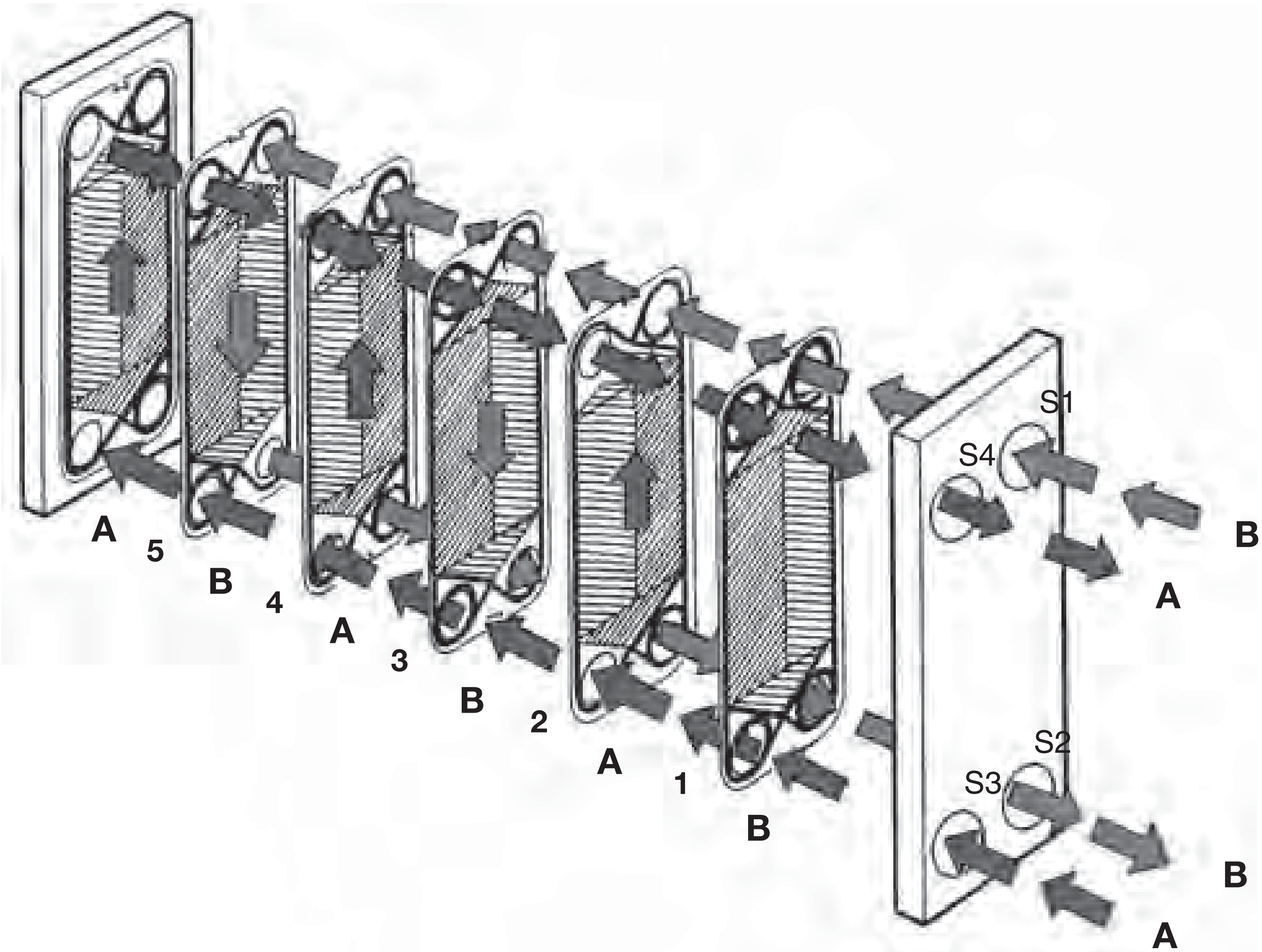
8. CHANNEL PLATES

9. GASKET
These plates are called CHANNEL PLATES. A groove along the rim of the plate and around the ports hold a GASKET, usually made of a rubber-type material.

Heat is transferred through the surface which is contained by the gasket, except for some small areas near the corners.

The number of plates in your heat exchanger is determined by the size of the heat transfer surface required.

How it works



When a package of plates are pressed together, the holes at the corners form continuous tunnels or manifolds, leading the media (which participate in the heat transfer process) from the inlets into the plate pack, where they are distributed in the narrow passages between the plates.

Because of the gasket arrangement on the plates, and the placing of “A” and “B” plates alternately, the two liquids enter alternate passages, e.g. the warm liquid between even number passages, and cold liquid between odd number passages.

Thus the media are separated by a thin metal wall. In most cases the liquids flow in opposite directions.

During the passage through the equipment, the warmer medium will give some of its heat energy to the thin wall, which instantly loses it again to the colder medium on the other side.

The warmer medium drops in temperature, while the colder one is heated up.

Finally, the media are led into similar hole-tunnels at the other end of the plates and discharged from the heat exchanger.

Heat transfer

The purpose of the equipment is to transfer heat from one medium to another. Heat passes very easily through the thin wall separating the two media.

The novel pattern into which the plate material has been formed not only gives strength and rigidity, but greatly increases the rate of heat transfer from the warmer medium to the metal wall and from the wall to the other medium.

This high heat flow through the walls can be seriously reduced by the formation of deposits of various kinds on the wall surfaces.

The pattern of corrugation on Alfa Laval plates mentioned above induces highly turbulent flow. The turbulence gives strong resistance to the formation of deposits on the plate surface; however, it cannot always eliminate fouling.

The deposits may increase the total "wall thickness" substantially, and they consist of materials that have a much lower thermal conductivity than the metal plate. Consequently a layer of deposits can severely reduce the overall heat transfer rate.

The deposits will be considered in the chapter on MAINTENANCE and CLEANING. At this point we will only establish that this fouling is unwanted and can under certain circumstances, be harmful to the heat exchanger because corrosion may occur under the deposits.

Pressure drop

Pressure drops are wasted energy.

All pipe systems and equipment included in them offer resistance to media flowing through them.

Some pressure drop is unavoidable, but for a given PHE it should be kept as close as possible to the designed value.

The formation of deposits on the heat transfer surfaces instantly leads to a reduction of the free space between the plates. This means that more energy is needed to get the desired flow through the equipment.

It is clear that the fouling of the surfaces is undesirable.

Larger particles and fibers may also be drawn into the heat exchanger and clog the passage ways if strainers or other means of protection have not been provided for.

A reduced ability by the heat exchanger to hold the desired temperatures, in combination with an increased pressure drop on any of the media, indicates that fouling or clogging is taking place.

For corrective action, see MAINTENANCE and CLEANING.

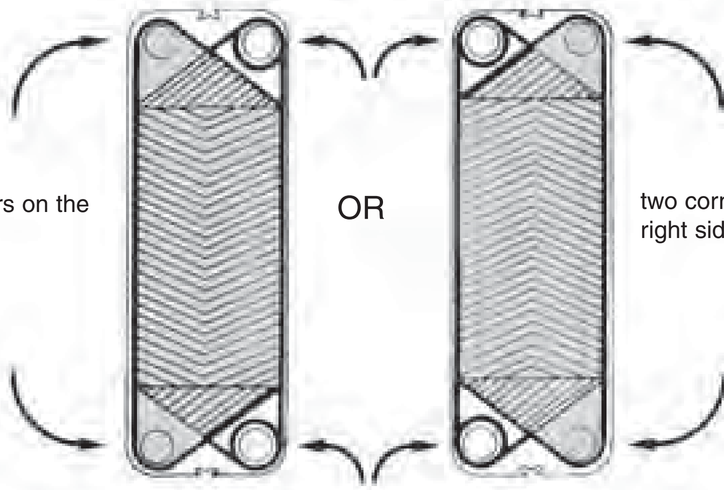
4A PARALLEL FLOW UNITS

Studying the pictures, you will observe that on a plate hanging vertically, the gasket rests in a groove which includes the heat transfer area

and two corners on the left side.

OR

two corners on the right side.

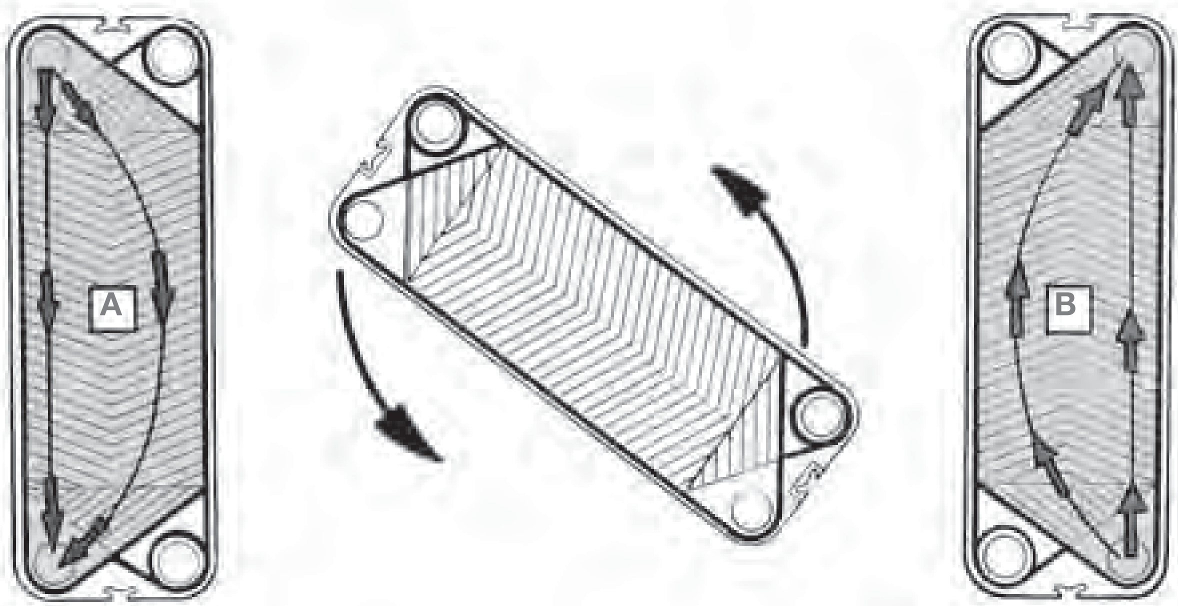


Smaller rings surround the two remaining corners.

We decide that we will name the plates after these two situations.

An A-plate is a plate hanging with the chevron pointing downwards.

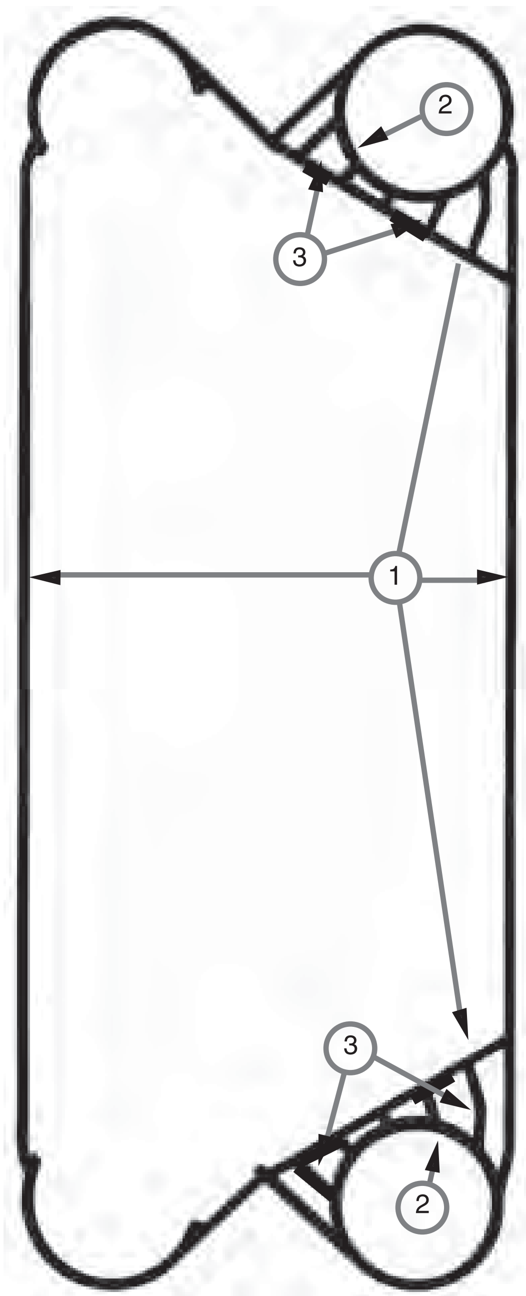
A B-plate is a plate hanging with the chevron pointing upwards.



If we turn an A-plate upside down we will have a B-plate:

Gaskets

The GASKET is molded in one piece. The material is normally an elastomer, selected to suit the actual combination of temperature, chemical environment and possible other conditions that may be present.

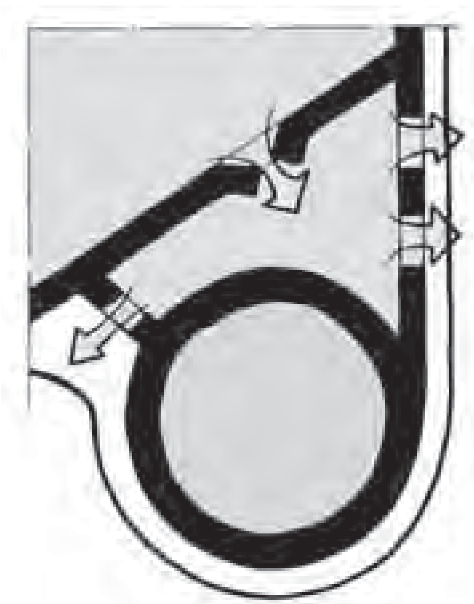


The one-piece gasket consists of:
1. One field gasket
2. Two ring gaskets
3. Links

The field gasket is by far the larger part containing the whole heat transfer area and the two corners connected to it. The ring gaskets seal off the remaining two corners.

These three pieces are held together by a few short links, which have no sealing function at all. Their purpose is simply to tie the pieces together and to add some support in certain areas. On some plate heat exchangers, the gasket is held in place on the plate by means of a suitable cement or glue.

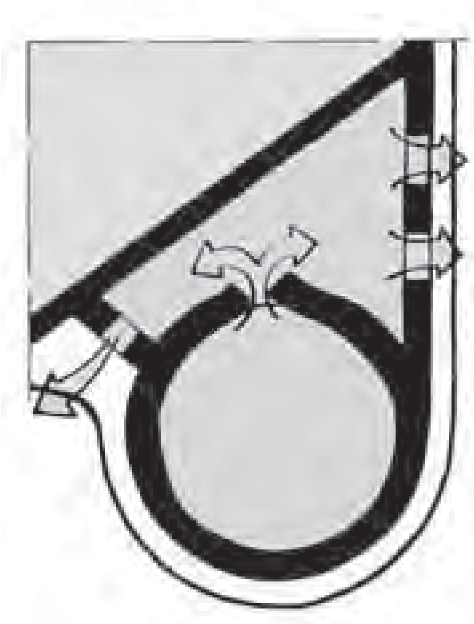
Gaskets



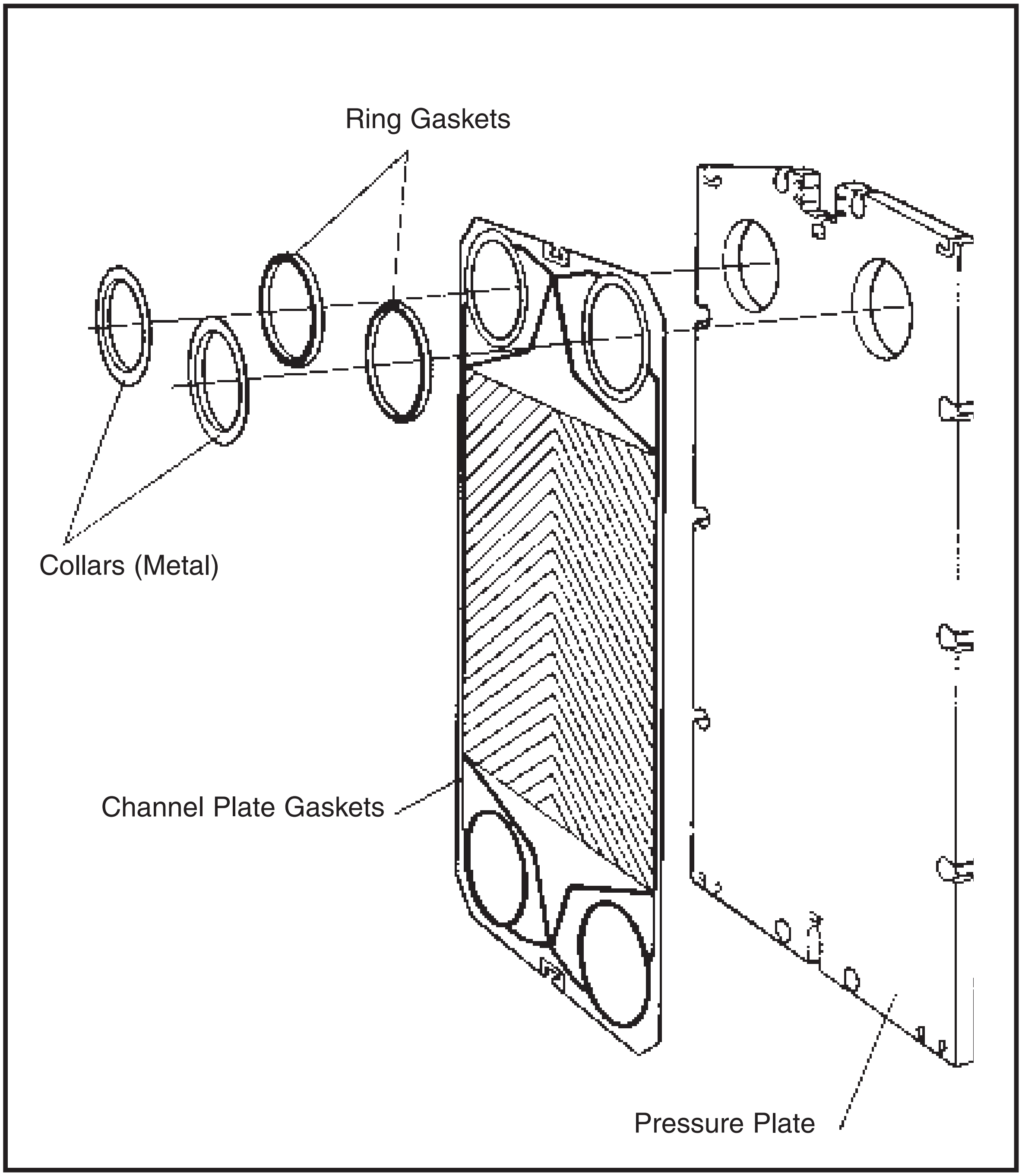
As already demonstrated, the two media are effectively kept apart by the ring and field gaskets. To prevent intermixing of the media in the corner areas where field and ring gaskets are very close to each other, the link pieces have a number of slots which opens the area between the field and ring gaskets to atmosphere. Any leakage of media across either gasket will escape from the heat exchanger through the slots.

It is important that these openings are kept clear. If they are not, there is a risk that should a leak occur in that region of the plate, there might be a local pressure build-up, which could allow one medium to mix with the other.

Care should be taken not to cut or scratch the gaskets while handling plates.



TRANSITION PLATE
M30, MX25, A20-B, AM20, AK20, T200, A15-B, M15, M10, M6



4B List of Diagonal Flow Units

<u>"A" SERIES UNITS:</u>
A10-BFG; A10-BFD
AX35-FG
A45-FG

<u>"P" SERIES UNITS:</u>
P2-FG; P2-VLCH; P2-DWFG
P3-E;P3-EH

<u>"M" SERIES UNITS:</u>
M3-XVG

<u>"V" SERIES UNITS:</u>
V28-FG, V28-FD, V45-FG, V45-FD, V110-FG, V110-FD,
V170-FG, V170-FD, V280-FG, V280-FD

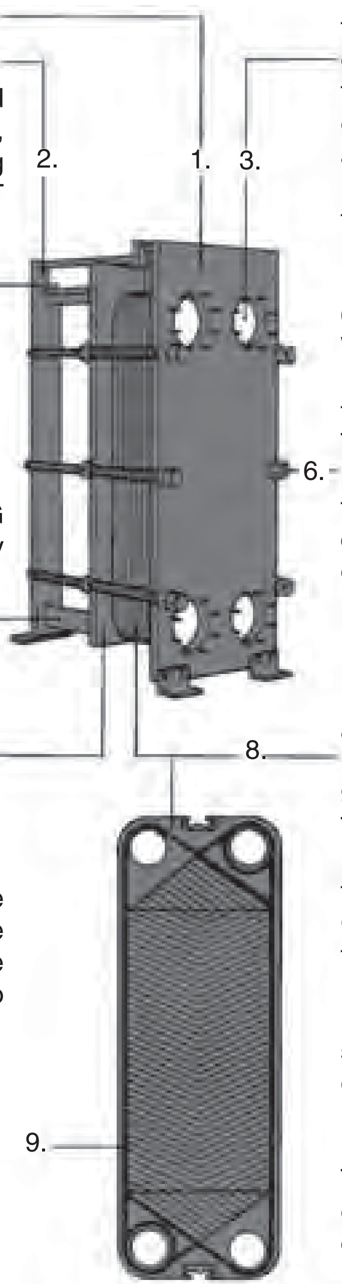
DIAGONAL FLOW UNITS

4B

Function

THE MAIN COMPONENTS OF THE PLATE HEAT EXCHANGER AND THEIR FUNCTIONS.

In ALFA LAVAL Plate Heat Exchangers, heat is transferred from one medium to another through thin metal plates which have been pressed into a special pattern.



1. FRAME PLATE

2. SUPPORT COLUMN
The two bars are suspended between the FRAME PLATE, to which in most cases the piping is connected, and a SUPPORT COLUMN.

4. CARRYING BAR

5. GUIDING BAR
The plates hang from a CARRYING BAR at the top and are kept in line by a GUIDING BAR at the bottom.

7. PRESSURE PLATE
The pressure plate is hung on the carrying bar and is moveable, as are the heat transfer plates. In some cases piping may be connected to the pressure plate.

3. CONNECTIONS
Holes matching the piping lead through the frame plate, permitting the media to enter into the heat exchanger. Threaded studs around the holes secure the pipes to the equipment. Depending on the application, metallic or rubber-type LININGS may protect the edges of the holes against corrosion.

6. TIGHTENING BOLTS
With the package of thin plates hanging between the frame plate and the pressure plate, a number of TIGHTENING BOLTS are used to press the thin plates together bringing them into metallic contact, and to compress the gaskets enough to seal off the narrow passages which have now been formed between the plates.

8. CHANNEL PLATES

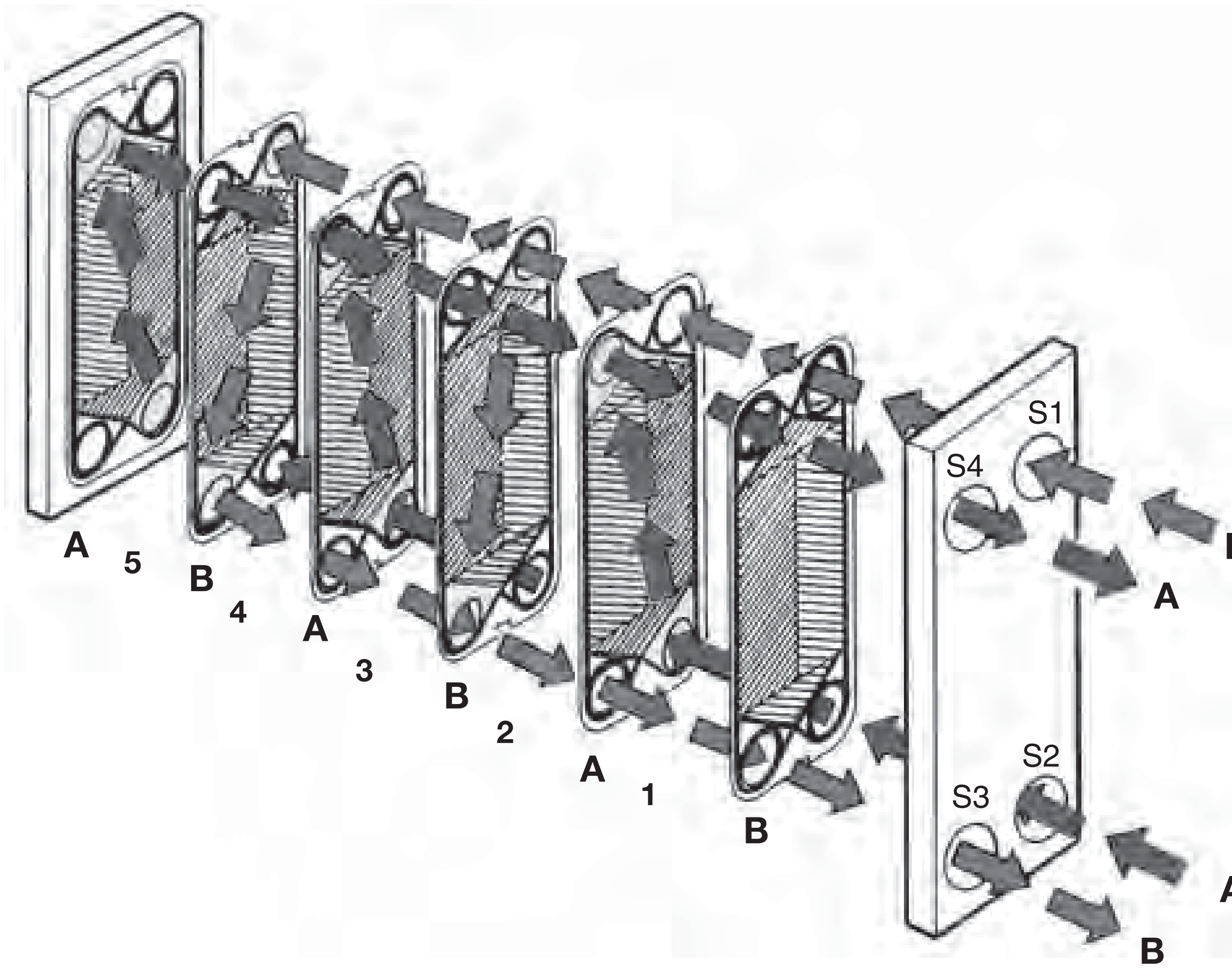
9. GASKET
These plates are called CHANNEL PLATES. A groove along the rim of the plate and around the ports hold a GASKET, usually made of a rubber-type material.

Heat is transferred through the surface which is contained by the gasket, except for some small areas near the corners.

The number of plates in your heat exchanger is determined by the size of the heat transfer surface required.

4B DIAGONAL FLOW UNITS

How it works



When a package of plates are pressed together, the holes at the corners form continuous tunnels or manifolds, leading the media (which participate in the heat transfer process) from the inlets into the plate pack, where they are distributed in the narrow passages between the plates.

Because of the gasket arrangement on the plates, and the placing of "A" and "B" plates alternately, the two liquids enter alternate passages, e.g. the warm liquid between even number passages, and cold liquid between odd number passages.

Thus the media are separated by a thin metal wall. In most cases the liquids flow in opposite directions.

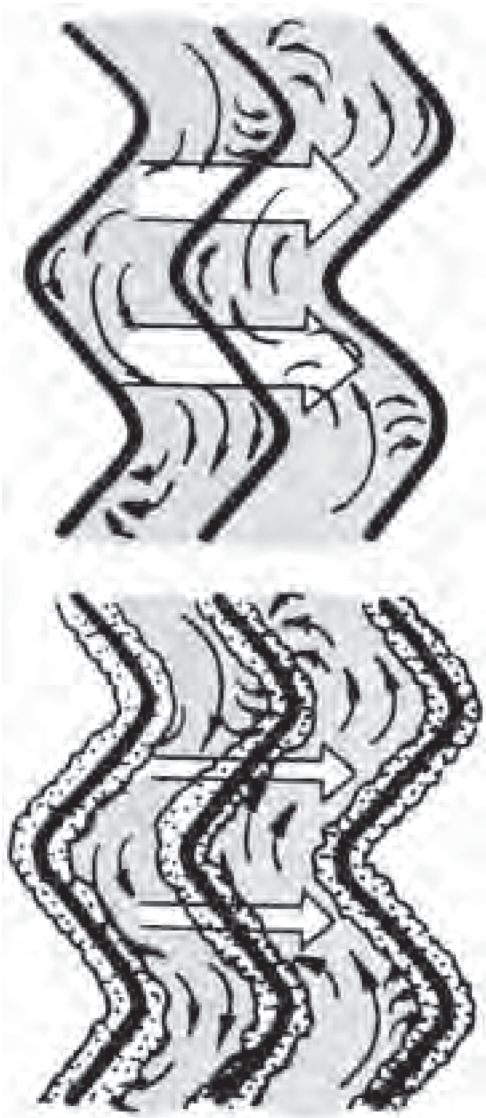
During the passage through the PHE, the warmer medium will give some of its heat energy to the thin wall, which instantly loses it again to the colder medium on the other side.

The warmer medium drops in temperature, while the colder one is heated up.

Finally, the media are led into similar hole-tunnels at the other end of the plates and discharged from the heat exchanger.

4B.3

Heat transfer



The purpose of the equipment is to transfer heat from one medium to another, and heat passes very easily through the thin wall separating the two media.

The novel pattern into which the plate material has been formed not only gives strength and rigidity, but greatly increases the rate of heat transfer from the warmer medium to the metal wall and from the wall to the other medium.

This high heat flow through the walls can be seriously reduced by the formation of deposits of various kinds on the wall surfaces.

The pattern of corrugation on Alfa Laval plates mentioned above induces highly turbulent flow. The turbulence gives strong resistance to the formation of deposits on the plate surface; however, it cannot always eliminate fouling.

The deposits may increase the total “wall thickness” substantially, and they consist of materials that have a much lower thermal conductivity than the metal plate. Consequently a layer of deposits can severely reduce the overall heat transfer rate.

The deposits will be considered in the chapter on MAINTENANCE and CLEANING. At this point we will only establish that this fouling is unwanted and can under certain circumstances, be harmful to the heat exchanger because corrosion may occur under the deposits.

Pressure drop

Pressure drops are wasted energy.

All pipe systems and equipment included in them offer resistance to media flowing through them.

Some pressure drop is unavoidable, but for a given PHE it should be kept as close as possible to the designed value.

The formation of deposits on the heat transfer surfaces instantly leads to a reduction of the free space between the plates. This means that more energy is needed to get the desired flow through the equipment.

It is clear that the fouling of the surfaces is undesirable.

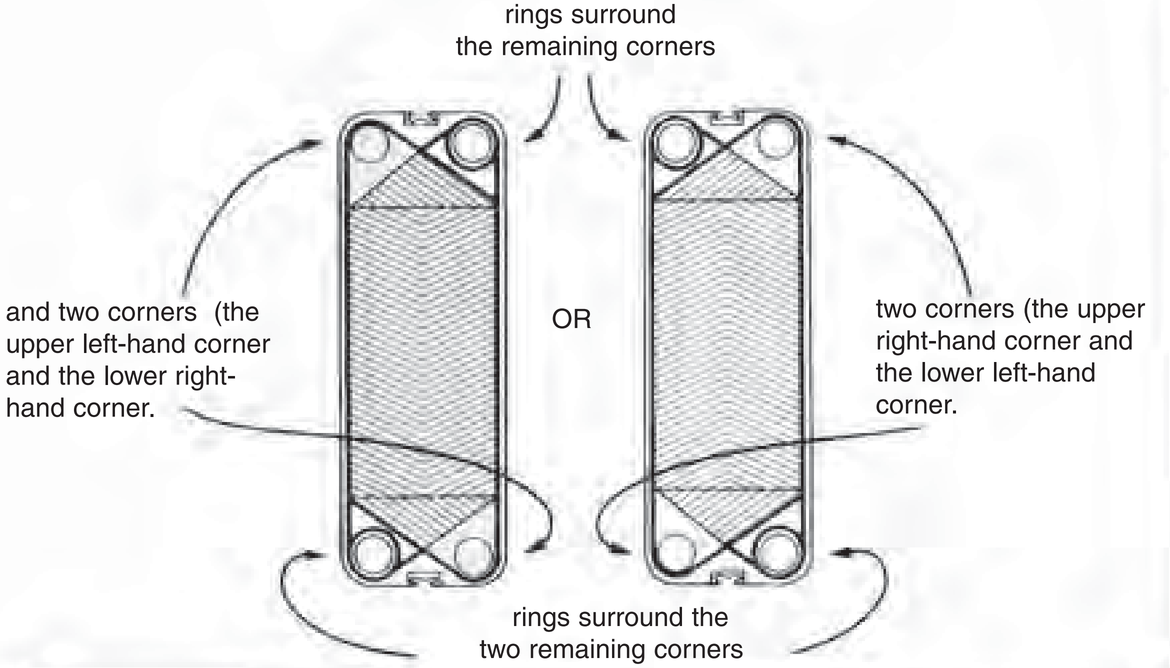
Larger particles and fibers may also be drawn into the heat exchanger and clog the passage ways if strainers or other means of protection have not been provided for.

A reduced ability by the heat exchanger to hold the desired temperatures, in combination with an increased pressure drop on any of the media, indicates that fouling or clogging is taking place.

For corrective action, see MAINTENANCE and CLEANING.

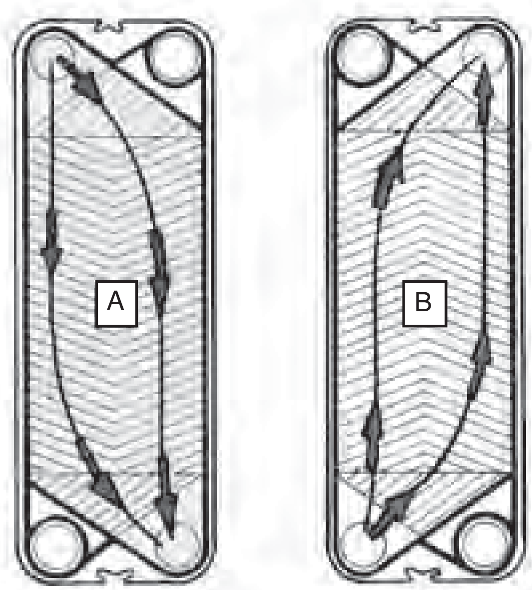
Plates

Studying the pictures, you will observe that on a plate hanging vertically, the gasket rests in a groove which includes the heat transfer area



Depending on which two corners are included with the heat transfer area, the plate is called an A- or a B-Plate.

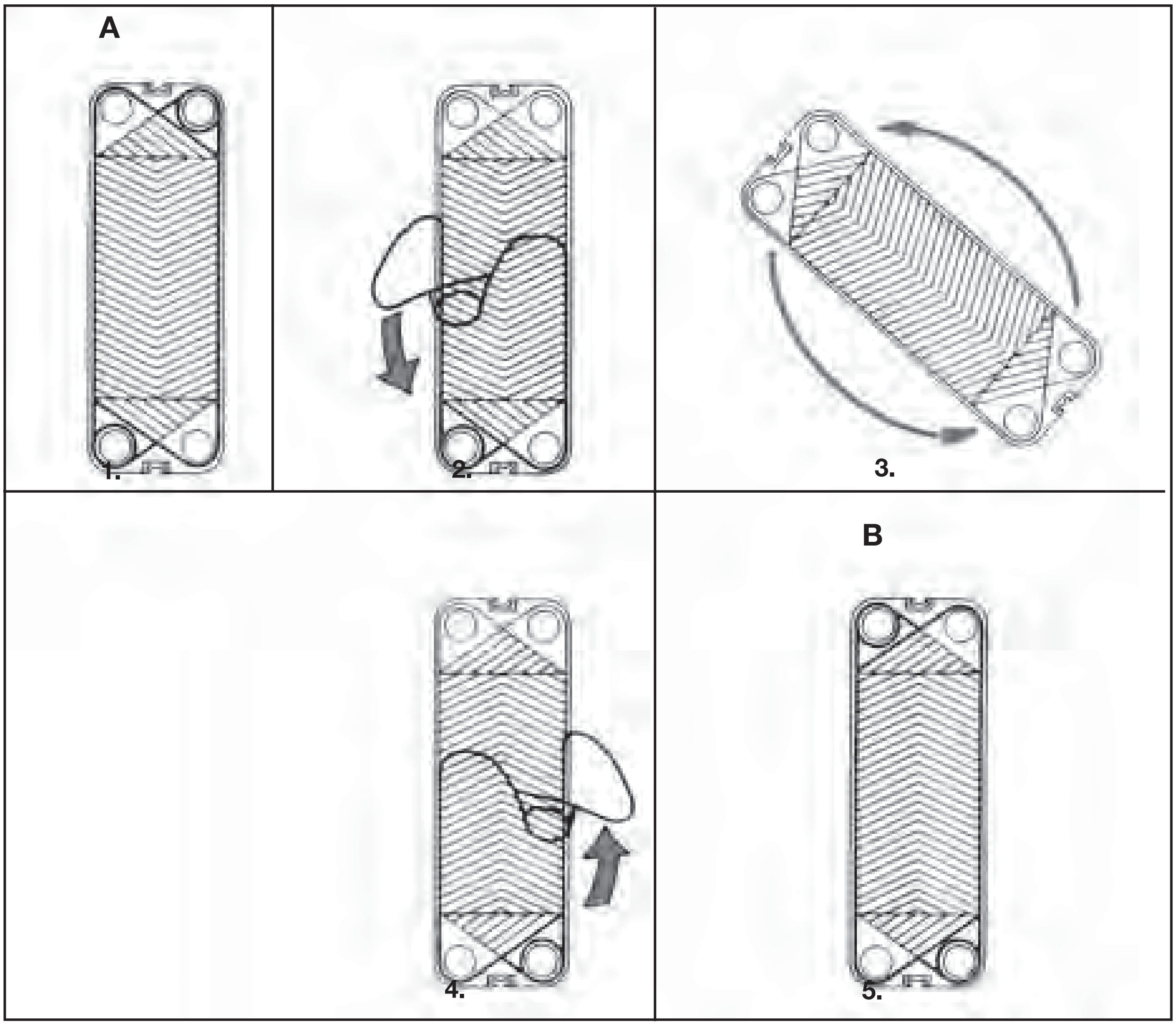
An A-plate is a plate hanging with the chevron pointing downwards.



A B-plate is a plate hanging with the chevron pointing upwards.

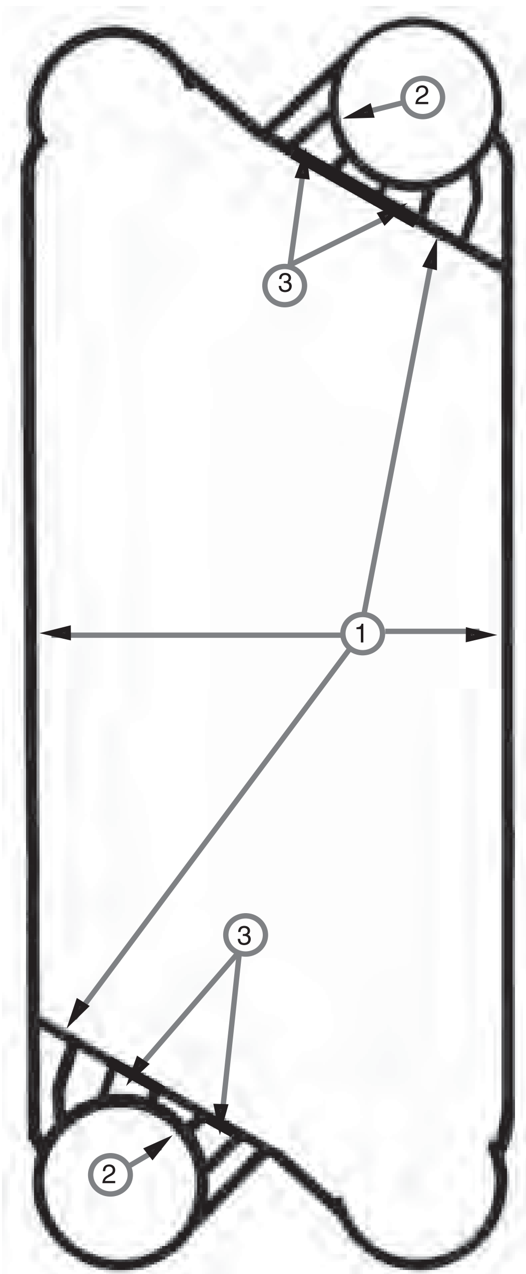
Plates

We can make a B-Plate from an A-plate or the opposite,
by changing the gasket and turning the plate upside down.



Gaskets

The GASKET is molded in one piece. The material is normally an elastomer, selected to suit the actual combination of temperature, chemical environment and possible other conditions that may be present.



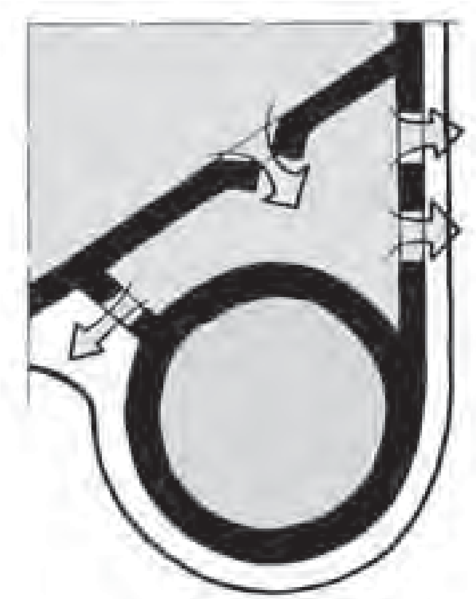
The one-piece gasket consists of:
1. One field gasket
2. Two ring gaskets
3. Links

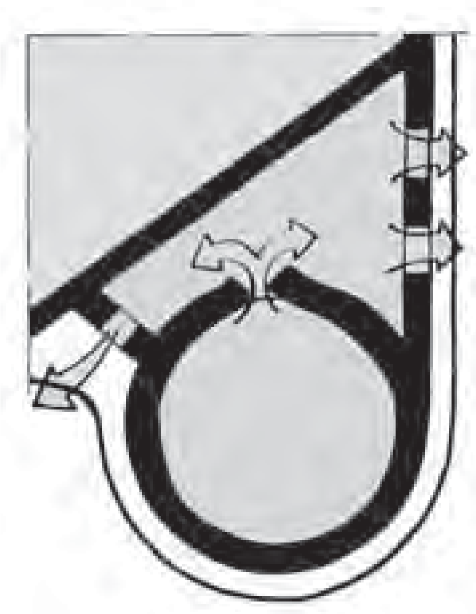
The field gasket is by far the larger part containing the whole heat transfer area and the two corners connected to it. The ring gaskets seal off the remaining two corners.

These three pieces are held together by a few short links, which have no sealing function at all. Their purpose is simply to tie the pieces together and to add some support in certain areas. On some plate heat exchangers, the gasket is held in place on the plate by means of a suitable cement or glue.

DIAGONAL FLOW UNITS

Gaskets



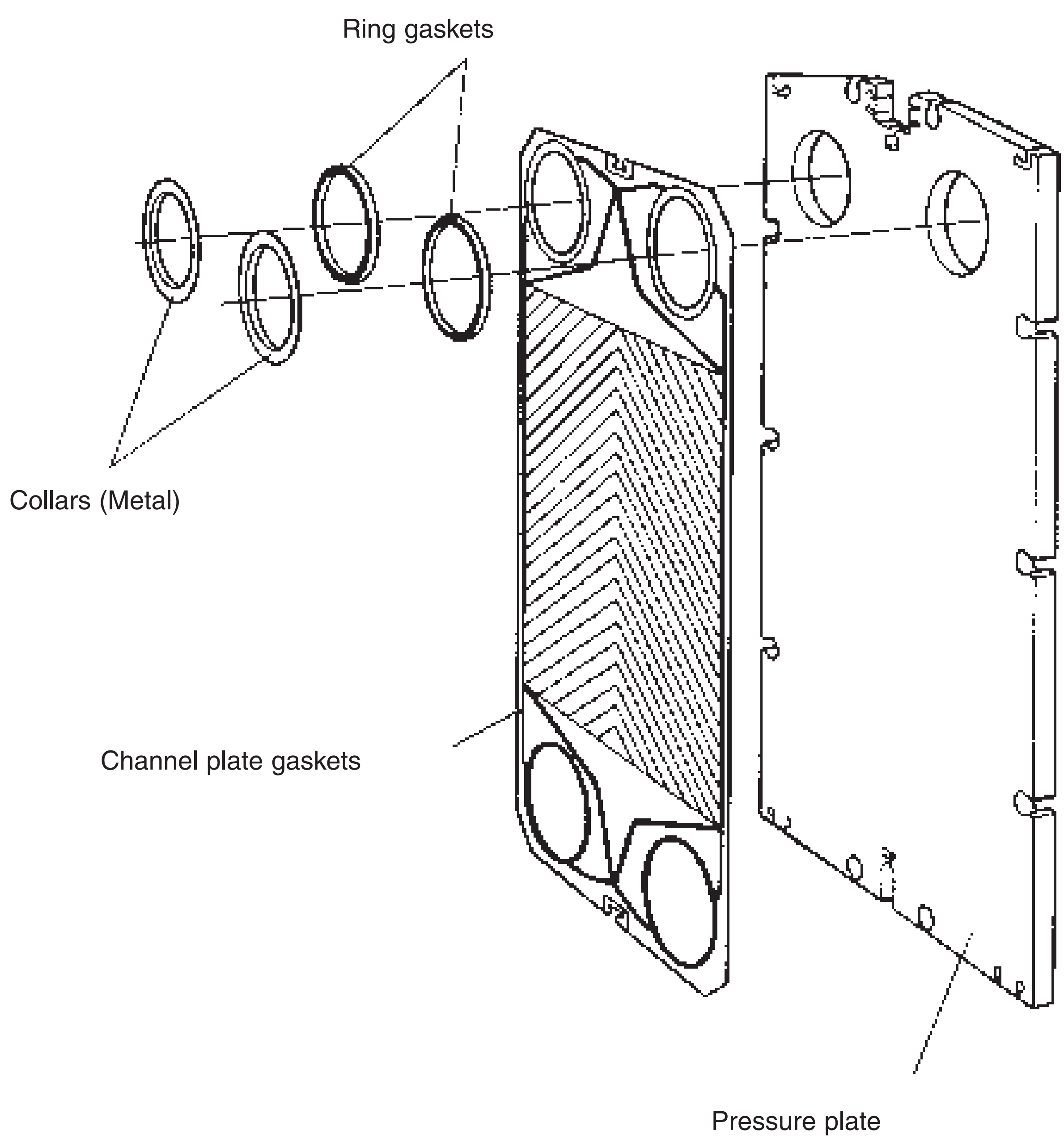


As already demonstrated, the two media are effectively kept apart by the ring and field gaskets. To prevent intermixing of the media in the corner areas where field and ring gaskets are very close to each other, the link pieces have a number of slots which open the area between the field and ring gaskets to atmosphere. Any leakage of media across either gasket will escape from the heat exchanger through these slots.

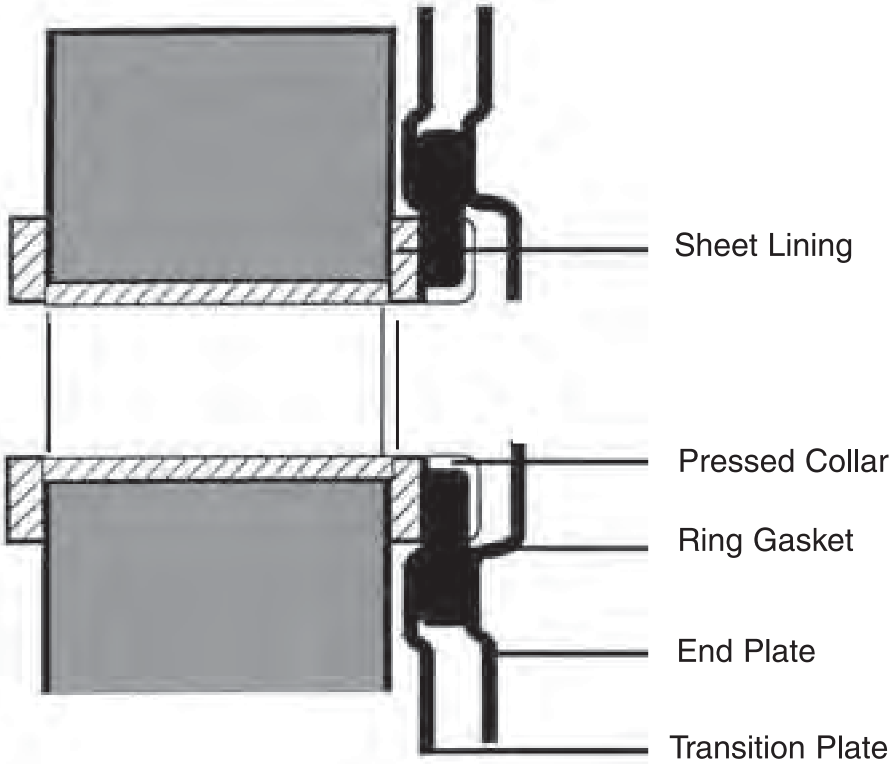
It is important that these openings are kept clear. If they are not, there is a risk that should a leak occur in that region of the plate, there might be a local pressure build-up, which could allow one medium to mix with the other.

Care should be taken not to cut or scratch the gaskets while handling plates.

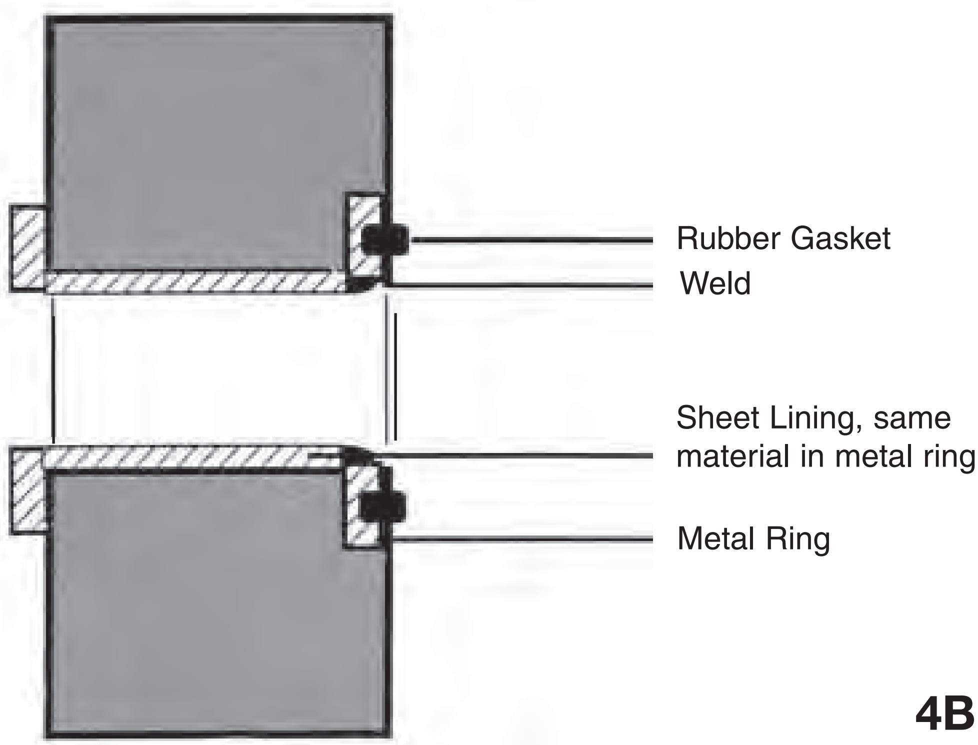
TRANSITION PLATE
M30, MX25, A20-B, AM20, AK20, T200, A15-B, M15, M10, M6

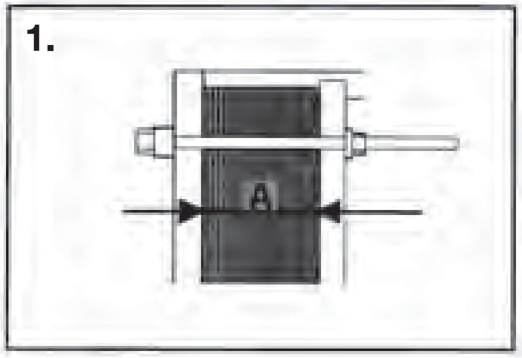


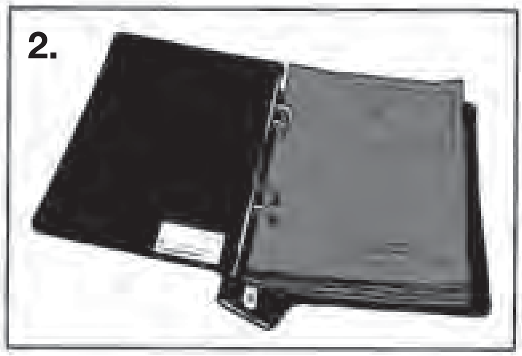
NON MACHINED PRESSURE PLATE

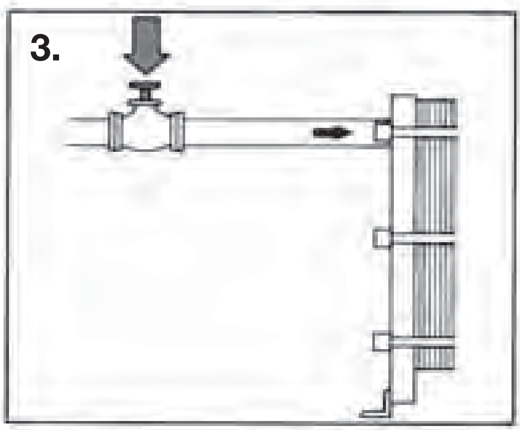


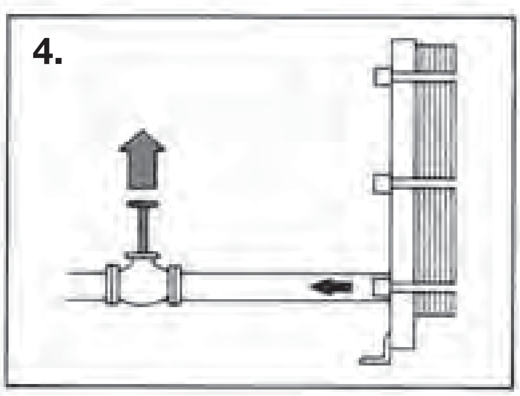
MACHINED PRESSURE PLATE (AX30, AM20 AND OBSOLETE FRAMES)











START UP

1. BEFORE STARTING UP FOR THE FIRST TIME OR AFTER A LONG TIME IN STORAGE: MAKE SURE THAT THE PLATE PACK IS COMPRESSED TO THE CORRECT MEASUREMENT A! Check with the Drawing or Nameplate, which is provided with each heat exchanger.

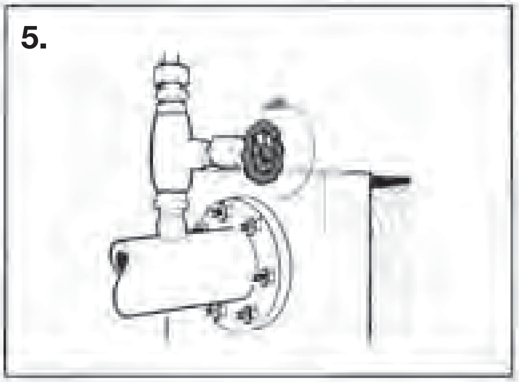
It is very important that the system to which the heat exchanger is connected, is protected against sudden and extreme variations of temperature and pressure. This is not only for the heat exchanger but also for the pipe system itself and every piece of equipment included in it.

This should be kept in mind whenever a maneuver is to be carried out, including starting up of the pumps in the system.

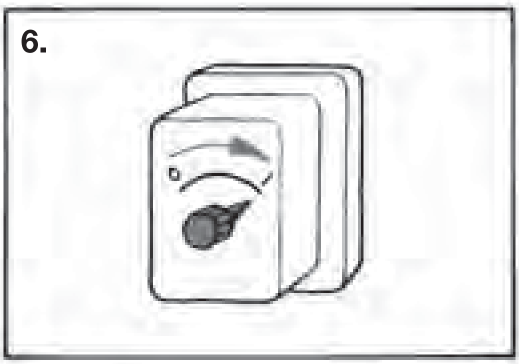
2. Before starting any pump, check whether instructions exist, telling you which pump should be started first.

3. Check that the valve between the pump and the equipment, controlling the flow rate of the system which you are about to start up is closed.

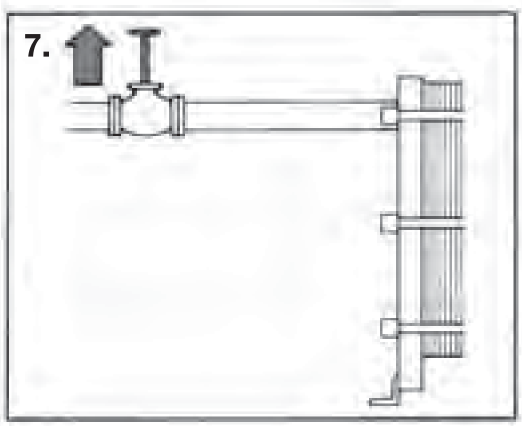
4. Check that the valve at the exit, if there is one, is fully open.



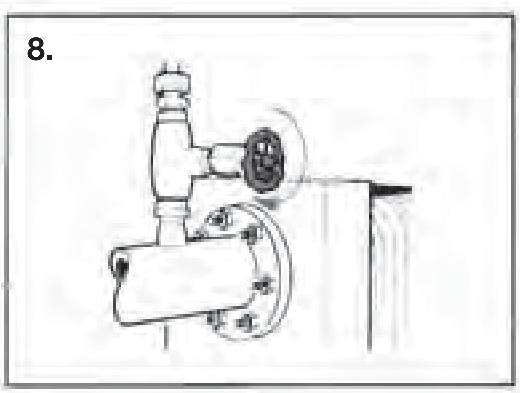
5. Open the vent.



6. Start the Pump.



7. Open the valve slowly.



8. When all air is out, close the vent.

9. Repeat the procedure for the other media.

UNIT IN OPERATION

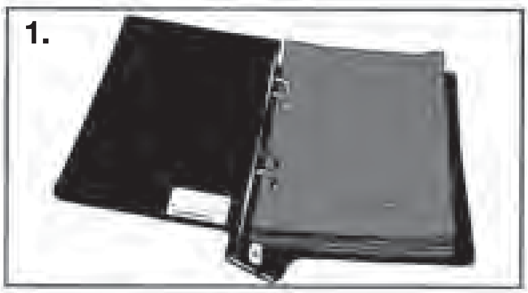
Any adjustment of the flowrates required to maintain correct temperatures or pressure drops should be made slowly, in order to prevent shocks to the system.

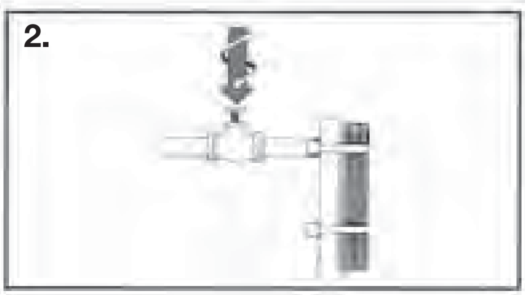
Problems in keeping up the performance of the heat exchanger may be caused by a change in some of the temperature conditions, the heat load or by fouling.

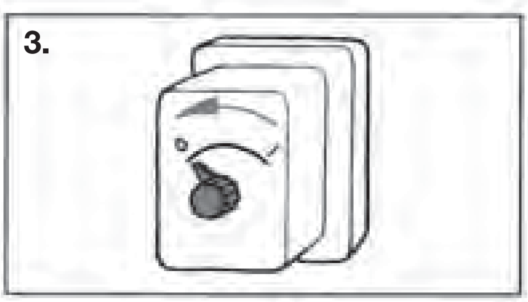
As long as the PHE is operating to satisfaction, it should be left without any interference.

SHUT-DOWN

If the heat exchanger is going to be shut down - or if for any reason the pumps are to be stopped - the following procedure should be followed:







1. First establish whether instructions exist that specify which side should be stopped first.
2. SLOWLY CLOSE THE VALVE controlling the flow rate of the pump you are about to stop.
3. When the valve is closed, stop the pump.
4. Repeat the procedure for the other side.
5. Poor quality cooling water may be hazardous to metallic materials. Typical examples are corrosion of stainless steels and nickel alloys.

   If for any reason the heat exchanger is shut down for a longer period (more than a number of days), it should be drained, and depending on the media processed, it is recommendable to rinse and dry it.

THE RISKS OF NOT COMPLYING WITH THE START-UP AND SHUT-DOWN PROCEDURES.

A liquid in motion in a pipe system represents a lot of energy, and it must be very carefully dealt with.

Particularly when the fluid is stopped it is imperative that this is done smoothly.

NOTE!
For this reason fast-closing valves should not be used unless the pipes of the system are very short.

Valves must be operated gradually. The longer the pipes and the higher the flow rate, the more important this becomes.

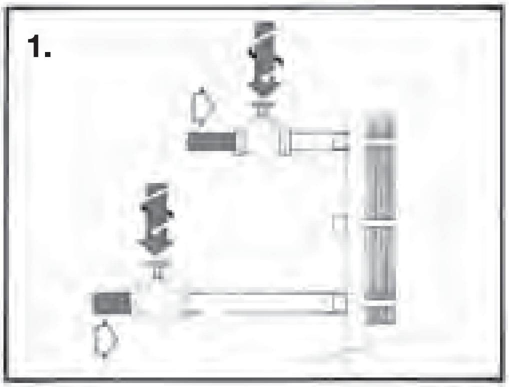
WATER HAMMER is the name given to a short duration pressure peak, traveling along the pipe as a wave at the speed of sound, and resulting from a sudden deceleration of the motion of the fluid in a closed system.

Thus, it is usually related to the shutting down of a system. However, when starting up a system with open valves and empty pipes, the fluid may burst into some obstacle, like a fine mesh strainer, a flow meter or a heat exchanger, causing a sudden reduction of the flow velocity - if not a complete halt, and so we may have the conditions of a Water Hammer.

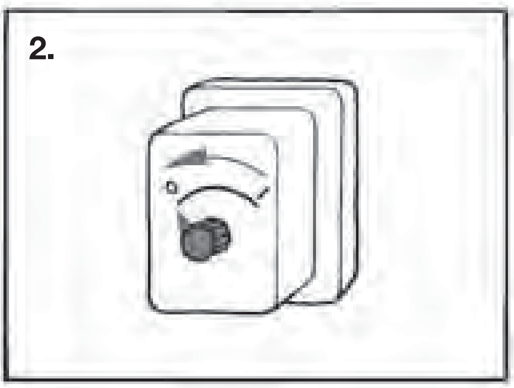
In the worst case, the pressure surge caused by such a sudden stop of the motion of a fluid, can be several times the normal pressure of the system.

Therefore it is very important for the protection of the whole installation that start-ups and close-downs are carried out with great care.

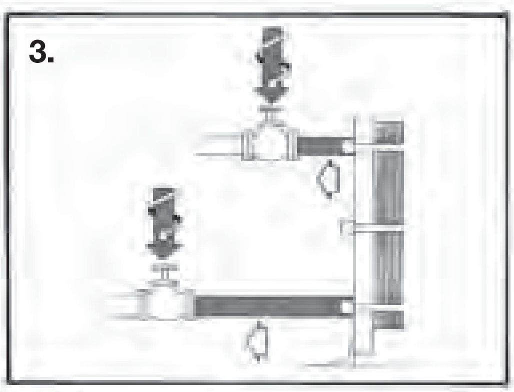
6 Opening



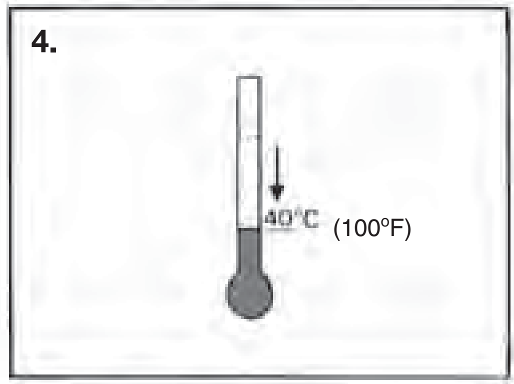
1. Slowly close the valves on the inlets. Shut off the inlet side, closing the highest pressure first.



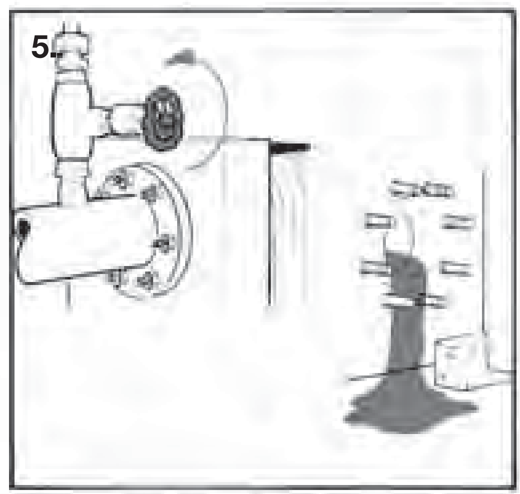
2. Switch off pumps.



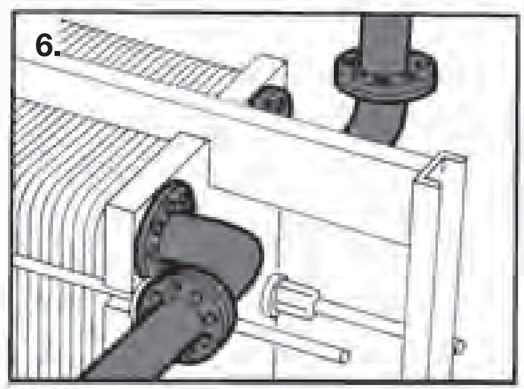
3. Close the valves on both outlets.



4. If the heat exchanger is hot, wait until it has cooled down to about 40°C (100°F).



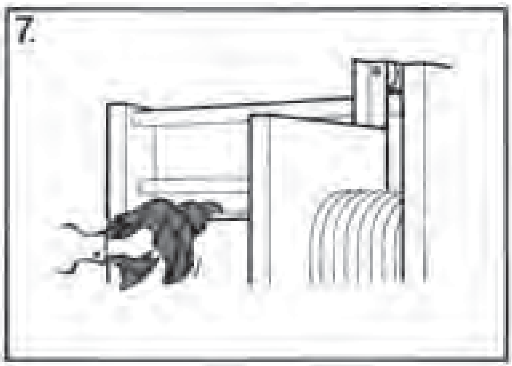
5. Drain



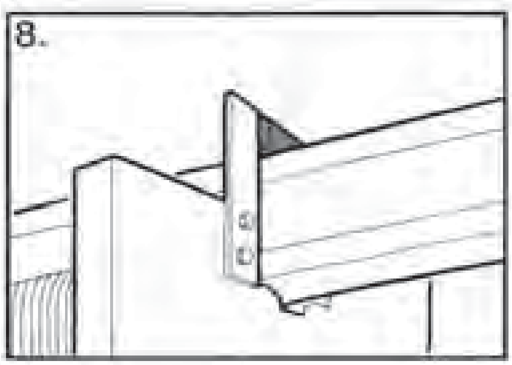
6. Dismantle any pipe bends connected to the pressure plate, so that it can be moved freely along the carrying bar.

6.1

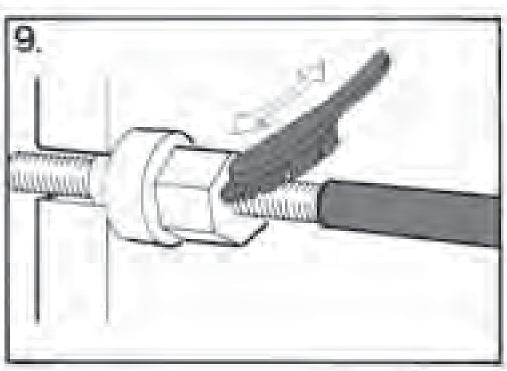
Opening



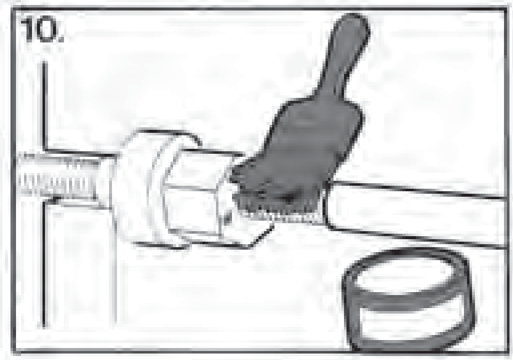
7. Inspect the sliding surfaces of the carrying bar and wipe clean



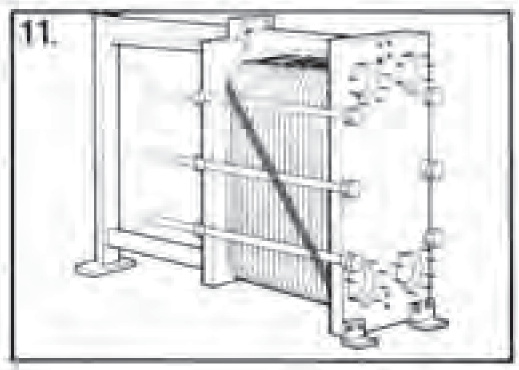
8. Inspect pressure plate roller.



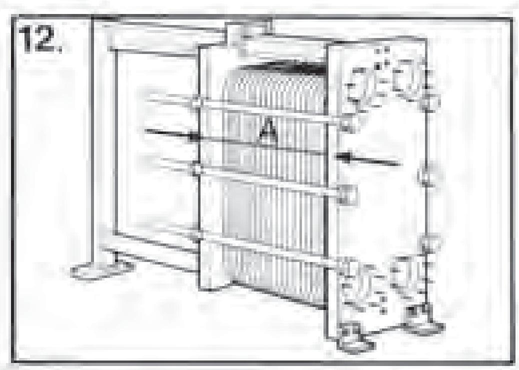
9. Pull back the plastic covers on the tightening bolts; brush the threads clean with a steel wire brush.



10. Lubricate the threads with a thin layer of grease, e.g LUBRIPLATE FGL-2 or equivalent.



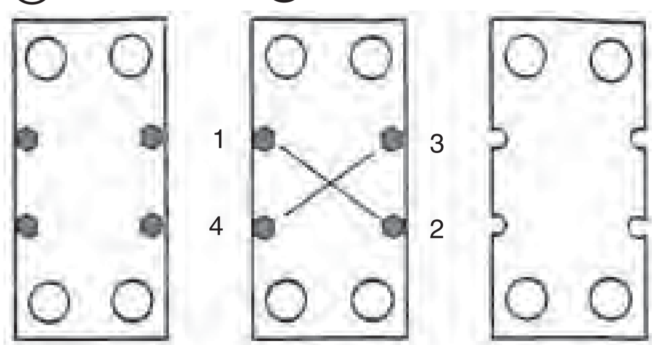
11. Mark the plate assembly on the outside by a diagonal line, or number the plates in sequence.



12. Measure and note the dimension A. Compare with code plate and PHE documentation for this same serial number.

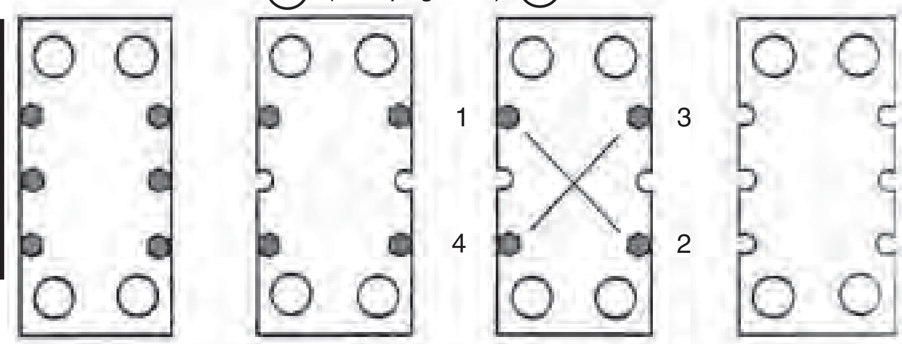
13 (See page 6.5) 14

	P2	A10B	TS6-M	AM10	M10B M10M
FG	X	X	X	X	
FM					X
FD			X		



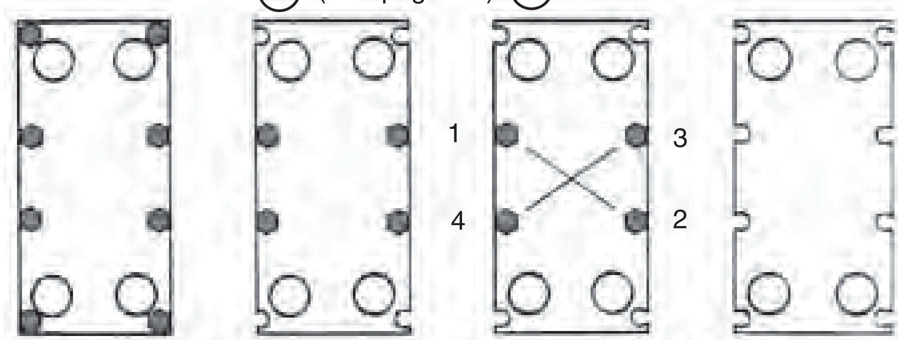
13 (See page 6.5) 14

	V8	P3	V13 V20	V28	M10B M10M	M10BW M10DW	M20-M
E		X					
FD			X				
FG			X	X	X	X	
FM							X
VG	X						



13 (See page 6.5) 14

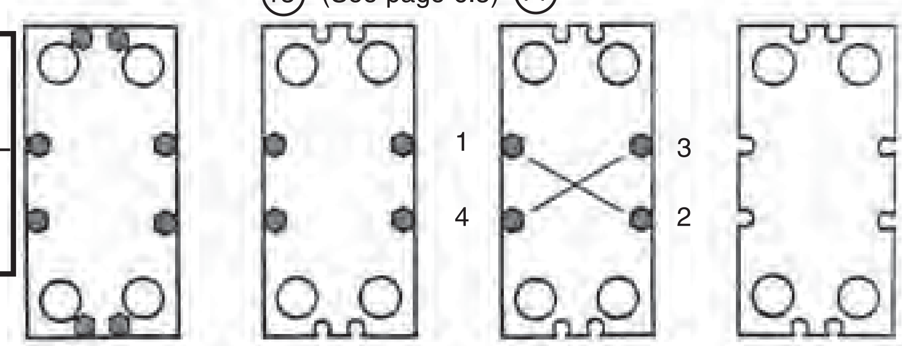
	M3	P2	P3	V28	V45
EH			X		
VG	X				
VLCH		X			
FG				X	X
FD				X	X



13 (See page 6.5) 14

	MX25B	A15BWA	15B	TS20-M	AM20 AM20B AM20W AM20S AM20DW	M6 M6M	M15M
FG		X	X	X	X	X	X
FD		X	X				X
FL			X				
FM	X			X			X
FS				X			

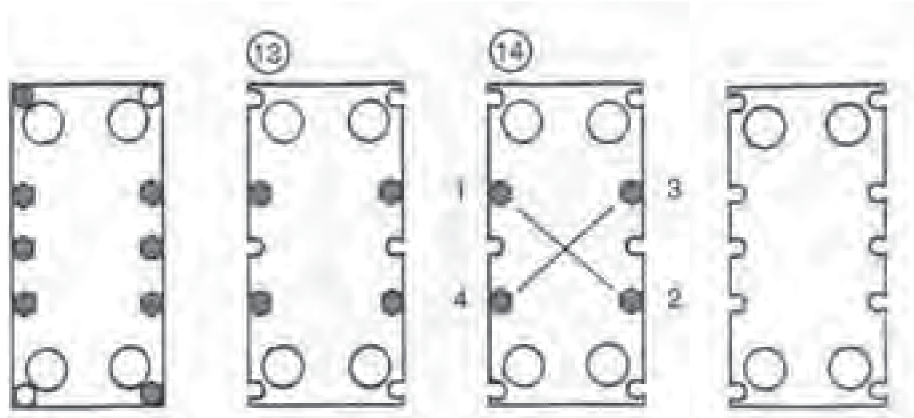
M6/M6-MFG & MX25-BFM ONLY HAS ONE BOLT TOP AND BOTTOM



Opening

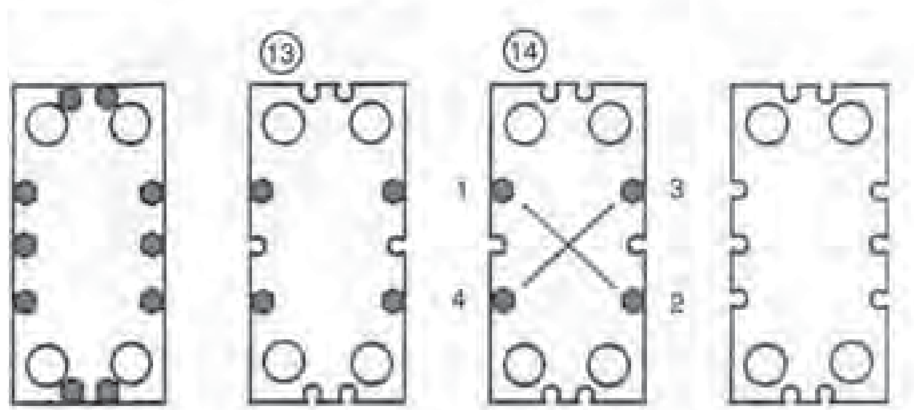
	M20-M			
FG				

M20-MFG ONLY HAS ONE BOLT TOP AND BOTTOM

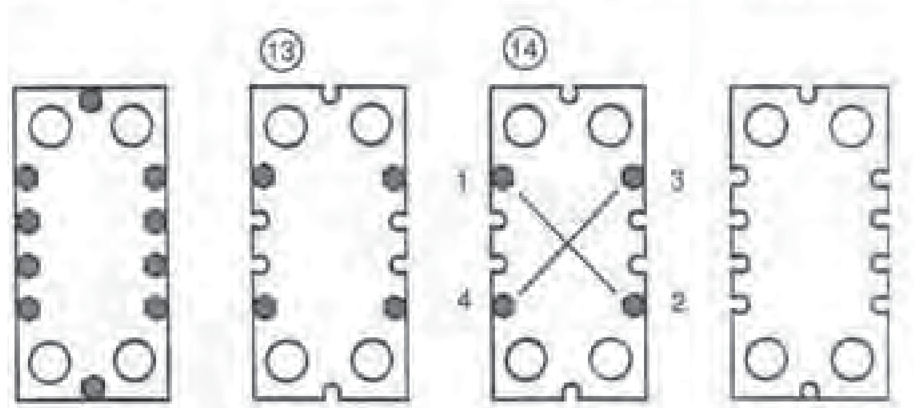


	M15B M15F	A20B	T200	M6 AK20 M6DW	M6M M30
FG		X	X		
FD				X	
FM					X
FS	X				

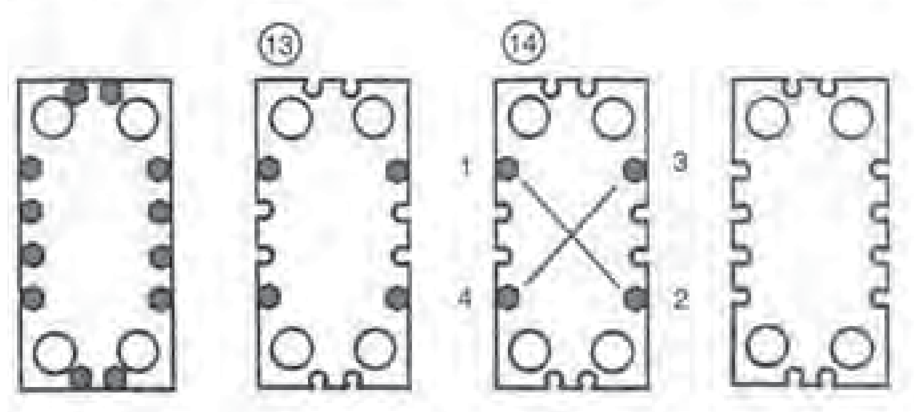
M6/M6-MFG ONLY HAS ONE BOLT TOP AND BOTTOM



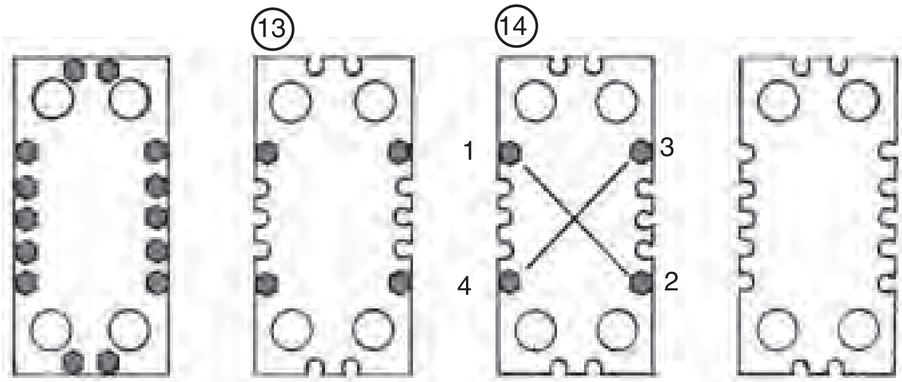
	M10B M10M	M10BW		
FD	X	X		



	A20B	AK20 T200	MX25B	V110
FD	X	X		
FL	X			
FG			X	X

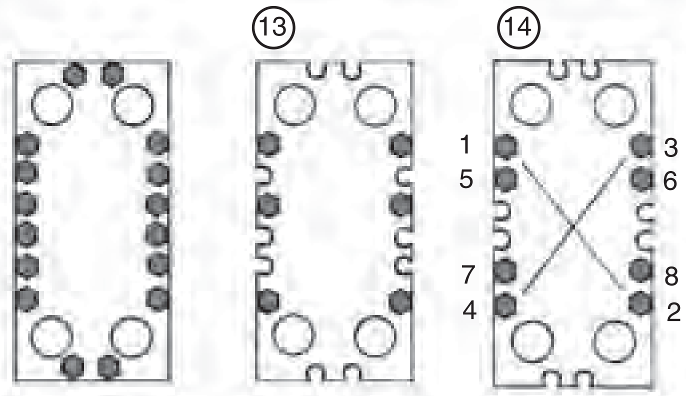


	AX30B AX30BW	V110		
FG	X			
FD		X		

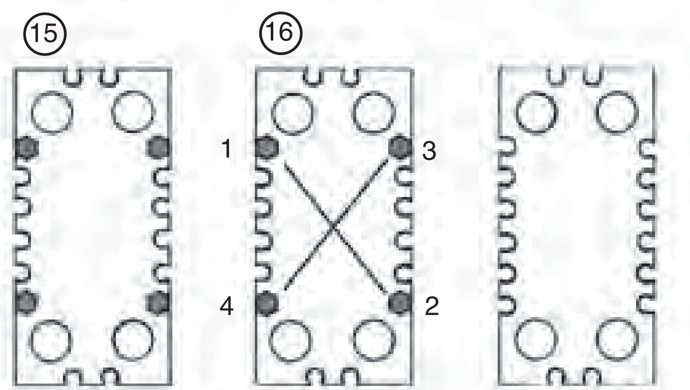


	AX30B AX30BW	A35 A45	AX35	M20M	M30	MX25B	V170 V280
FG			X		X		X
FD	X			X	X	X	X
HA		X					
FS						X	

NOTE: M30-FD, MA30-FG/FD, MX25-BFS, V280-FG/FD and V170-FD have a twenty bolt or larger pattern, use this picture only as a guide. Start sequence numbers 5 and 6 at the fourth bolt down on both sides.



ORDER	BOLT NO.	TO DIM.
1	1-2-3-4-5-6	1.05A
2	1-2-3-4	1.10A
3	1-2 OR 3-4	OPENING



(13) If bolts are fitted with bearing boxes loosen and remove them. If not fitted with bearing boxes, then follow the pictures above.

(14) Loosen the remaining bolts, alternately and diagonally, to bring length to 1.05A.

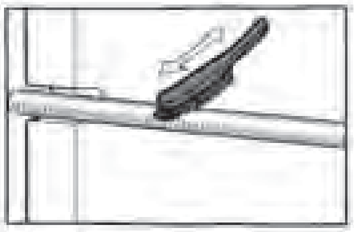
(15) Remove bolts 5 and 6 completely.

(16) Continue opening, alternately and diagonally.

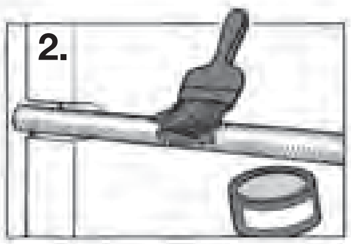
Note: Skewing of the Pressure Plate during opening must not exceed 10 mm (2 turns per bolts) across the width and 25 mm (5 turns per bolts) vertically.

Removal and insertion of plates

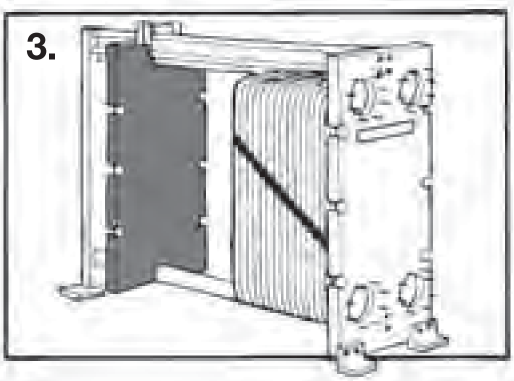
1.

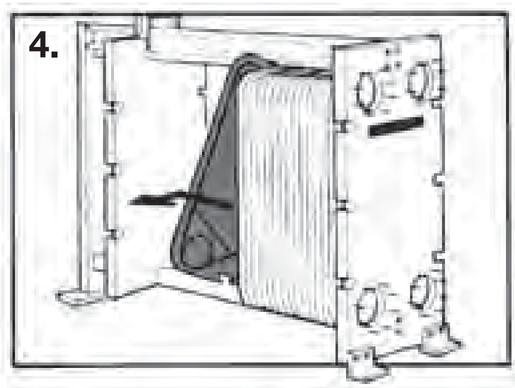


Brush the threads of the bolts clean, using a steel wire brush



Lubricate the threads with a thin layer of grease, e.g. LUBRIPLATE FGL-2 or equivalent.

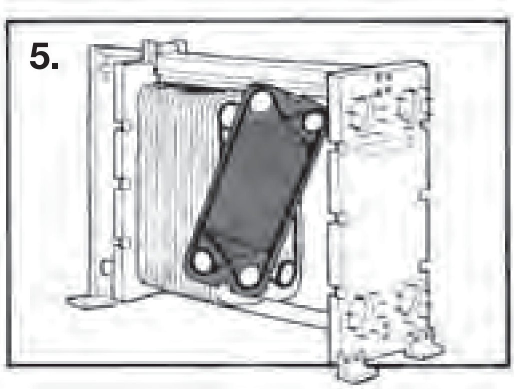




REMOVAL OF PLATES

3. Push the pressure plate against the support column.

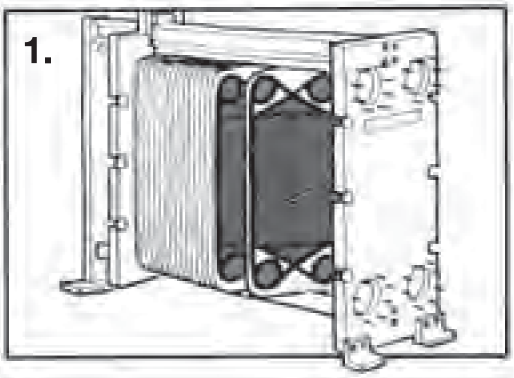
4. Remove the plates. Stack them neatly on a skid or pallet for easy transporting.



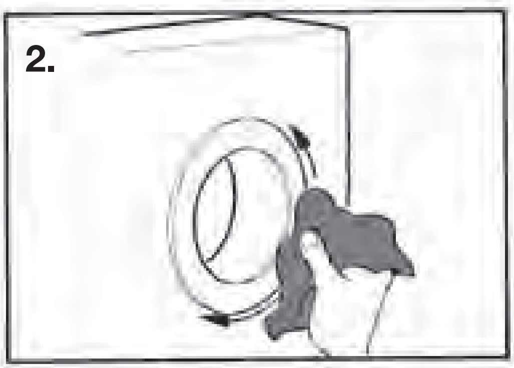
INSERTION OF PLATES

5. Hang the plates with their backs towards the pressure plate (the side without gasket).

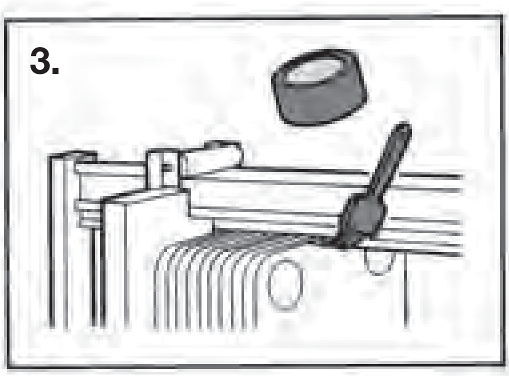
Closing



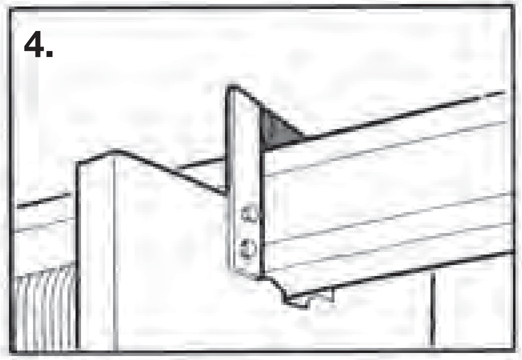
1. Check that all the sealing surfaces (i.e. surfaces in contact with the heat transfer medium) are clean.



2. Check that the ring gaskets or liners, when fitted in connections, are in position and are in good condition.

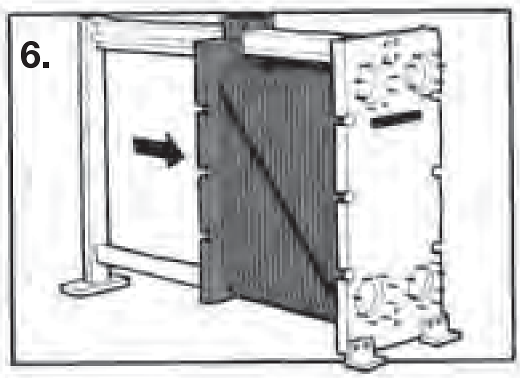


3. Clean and lubricate the sliding surfaces of the carrying bar.

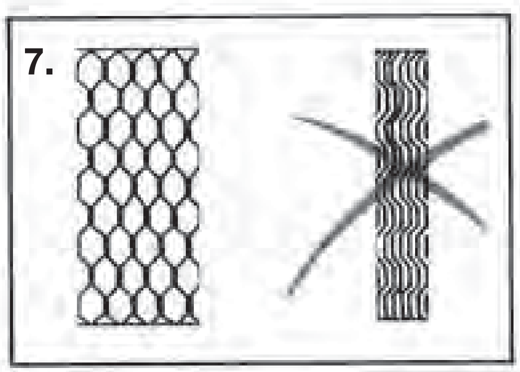


4. Inspect the pressure plate roller. Remove any debris from top surface of carrying bar.

5. Check against the drawing or flow sheet (provided with each heat exchanger) to make sure that the plates are hanging in the correct order.



6. Press the plate assembly together.



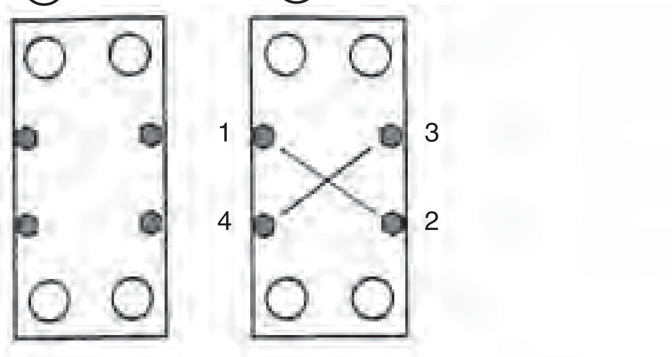
7. If the plates are correctly assembled, the edges form a “honeycomb” pattern.

   If the plate pack has been marked on the outside (fig. 6) check this.

Closing

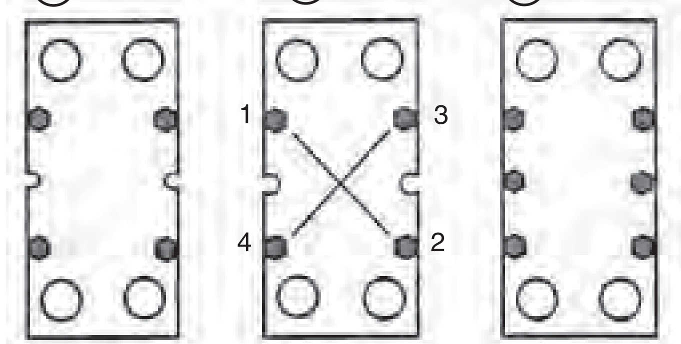
	P2	A10B	TS6-M	AM10	M10B M10M
FG	X	X	X	X	
FM					X
FD			X		

8 (See page 6.11) 11



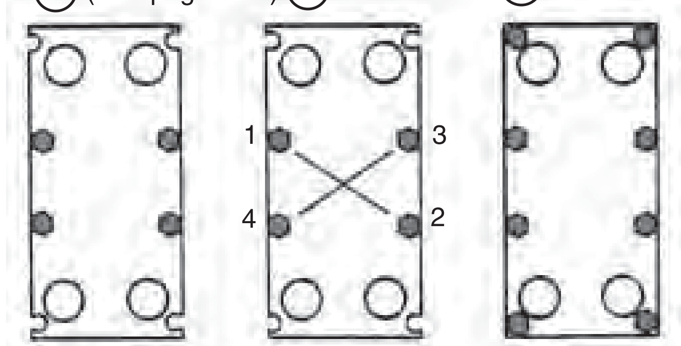
	V8	P3	V13 V20	V28	M10B M10M	M10BW M10DW	M20-M
E		X					
FD			X				
FG			X	X	X	X	
FM							X
VG	X						

8 (See page 6.11) 11 14 (See page 6.11)



	M3	P2	P3	V28	V45
EH			X		
VG	X				
VLCH		X			
FG					X
FD				X	X

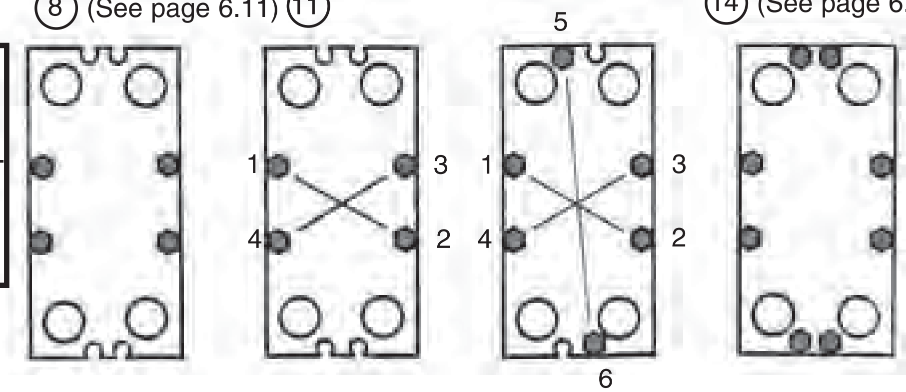
8 (See page 6.11) 11 14 (See page 6.11)



	MX25B	A15BW	A15B	TS20-M	AM20 AM20B AM20W AM20S AM20DW	M6 M6M	M15M
FG		X	X	X	X	X	X
FD		X	X				X
FL			X				
FM	X			X			X
FS				X			

M6/M6-MFG & MX25-BFM ONLY HAS ONE BOLT TOP AND BOTTOM

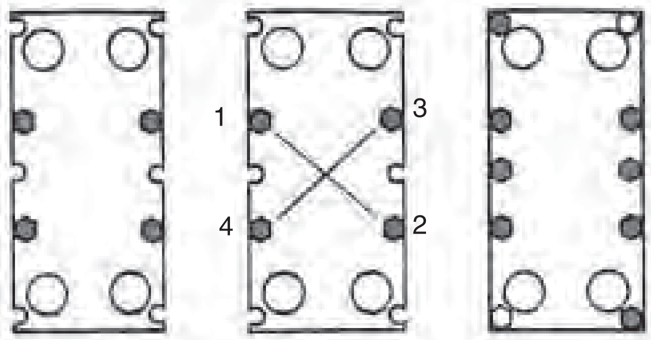
8 (See page 6.11) 11 14 (See page 6.11)



	M20-M			
FG				

M20-MFG ONLY HAS ONE BOLT TOP AND BOTTOM

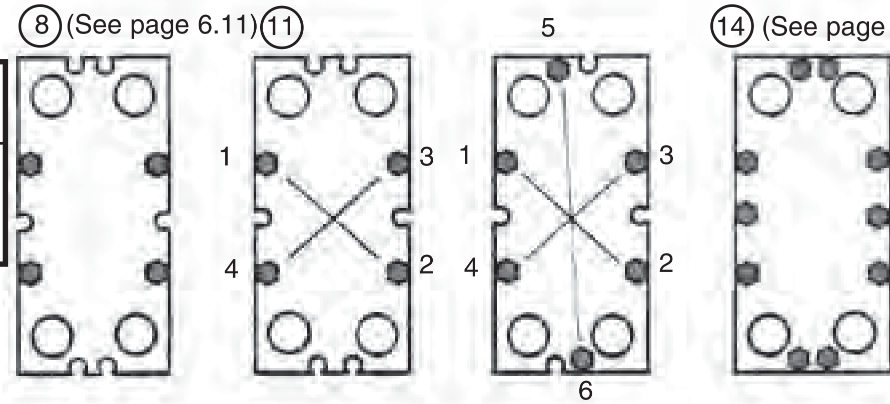
8 (See page 6.11) 11 14 (See page 6.11)



	M15B M15F	A20B	T200	M6 AK20 M6DW	M6M M30
FG		X	X		
FD				X	
FM					X
FS	X				

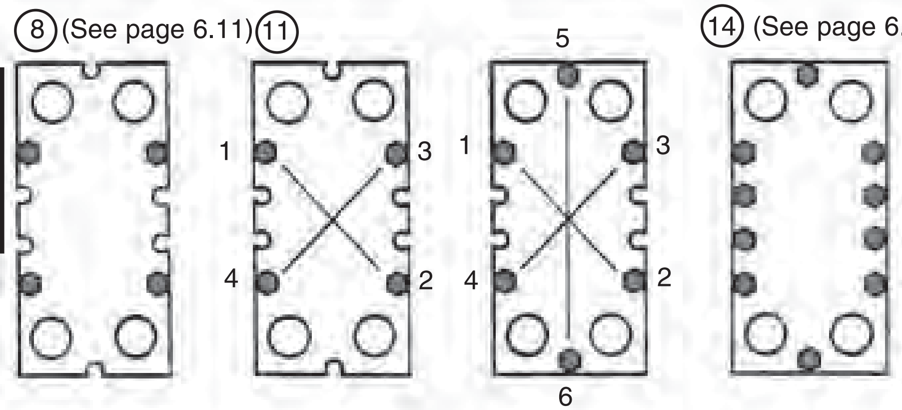
M6/M6-MFG ONLY HAS ONE BOLT TOP AND BOTTOM

8 (See page 6.11) 11 14 (See page 6.11)



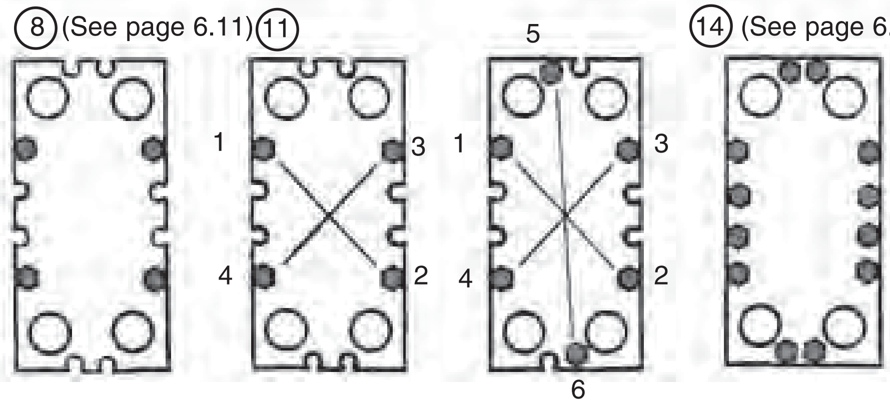
	M10B M10M	M10BW		
FD	X	X		

8 (See page 6.11) 11 14 (See page 6.11)

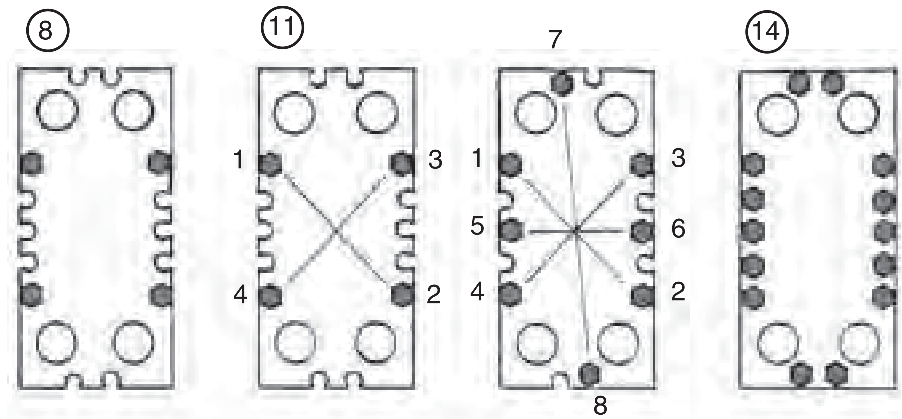


	A20B	AK20 T200	MX25B	V110
FD	X	X		
FL	X			
FG			X	X

8 (See page 6.11) 11 14 (See page 6.11)

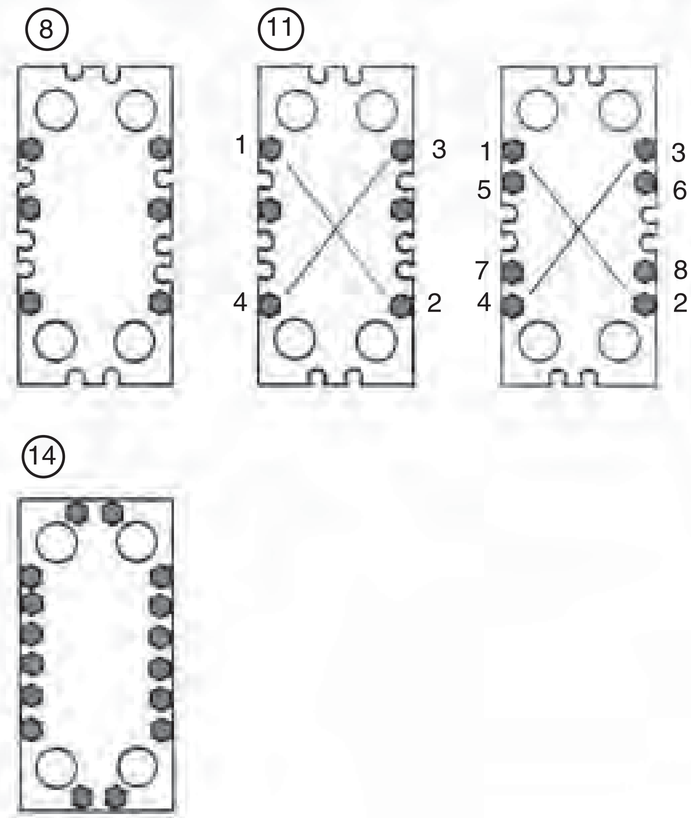


	AX30B AX30BW	V110		
FG	X			
FD		X		



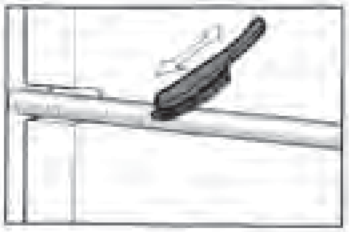
	AX30B AX30BW	A35 A45	AX35	M20M	M30	MX25B	V170 V280
FG			X		X		X
FD	X			X	X	X	X
HA		X					
FS						X	

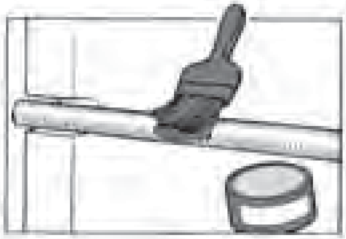
NOTE: M30-FD, MA30-FG/FD, MX25-BFS, V280-FG/FD and V170-FD have a twenty bolt or larger pattern, use this picture only as a guide. Start sequence numbers 5 and 6 at the fourth bolt down on both sides.



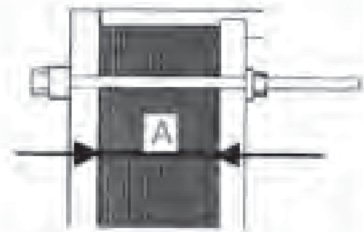
ORDER	BOLT NO.	TO DIM.
1	1-2-3-4-5-6	1.05A
2	1-2-3-4	1.10A
3	1-2 OR 3-4	OPENING

Note: See next page for closing instructions for all the models





Order	Bolt No.	To Dimension
1	1-2 or 3-4	1.10A
2	1-2-3-4-5-6-7-8	A



8. Place all the bolts that are fitted with bearing boxes in position. If not fitted with bearing boxes then follow the pictures for your specific model.

9. Brush the threads of the bolts clean, using a steel wire brush.

10. Lubricate the threads with a thin layer of grease, e.g. LUBRIPLATE FGL-2 or equivalent.

11. Tightening is carried out alternately and diagonally, as shown on the figure above.

12. Check the dimension A during tightening at the positions of the bolts that are being used. Skewing of the pressure plate during tightening must not exceed 10mm (2 turns per bolt) across the width and 25 mm (5 turns per bolt) vertically.

13. Nominal plate pack length A can be exceeded in exceptional cases, the tightening can be stopped at the following dimensions

Plate pack length/plat	Plate pack length
> 4 mm	A + 1%
> 3mm, < 4mm	A + 1.5%

14. Place the other bolts in position.
- Inspect the washers.
- When fully tightened, the bolts should all be equally tensioned.
- The difference between the plate pack lengths measured at adjacent bolts should not exceed:

  2mm when dimension A is < 1000mm

  4mm when dimension A is > 1000mm
- The plate pack length at all bolts must not differ by more than 1%
- If the unit does not seal fully, it can be tightened to the dimension A-1%.

IF DIMENSION A IS NOT REACHED WITH APPLICATION OF THE ABOVE STEPS:
- Check the number of plates and dimension A.
- Check that all the nuts and bearing boxes are running freely. If not, clean and lubricate or replace.
- Fit all the bolts, and tighten alternately.

Chlorine as growth inhibitor

Chlorine, commonly used as growth inhibitor in cooling water systems, reduces the corrosion resistance of stainless steels (including Hastelloy, Incoloy, Inconel and SMO).

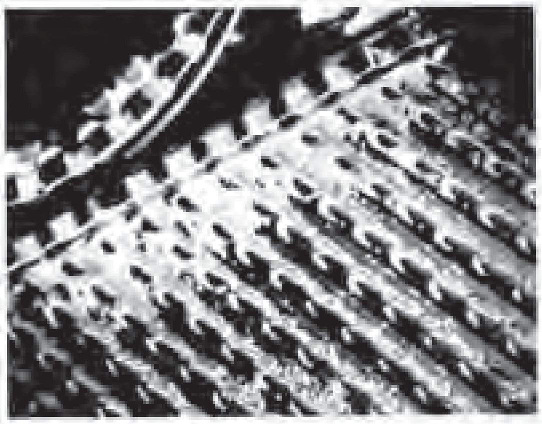
Chlorine weakens the protection layer of these steels making them more susceptible to corrosion attacks than they otherwise should be. It is a matter of time of exposure and concentration.

In every case where chlorination of non-titanium equipment cannot be avoided, ALFA LAVAL must be consulted.

Contact the following address:
ALFA LAVAL
Heat Transfer Center
5400 International Trade Drive
Richmond, VA 23231
Phone (804) 222-5300
Fax (804) 236-3276

NOTE! Titanium is not affected by chlorine.

Cleaning

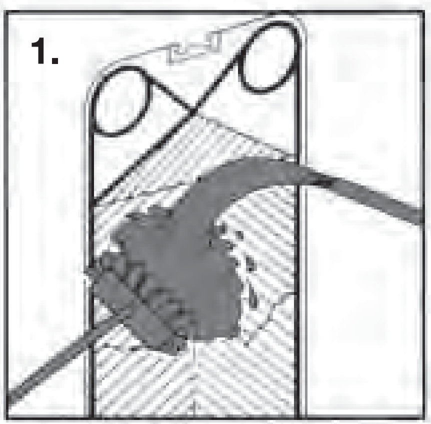


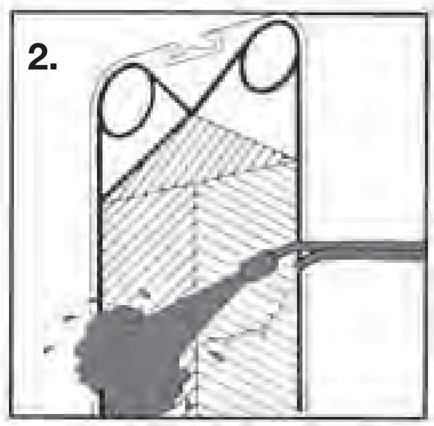
INCRUSTATION - SCALING

- Calcium carbonate
- Calcium sulphate
- Silicates

CLEANING

Mechanical cleaning after opening.





1. Soft brush and running water.
   NOTE! Avoid gasket damage.

2. High pressure hose.

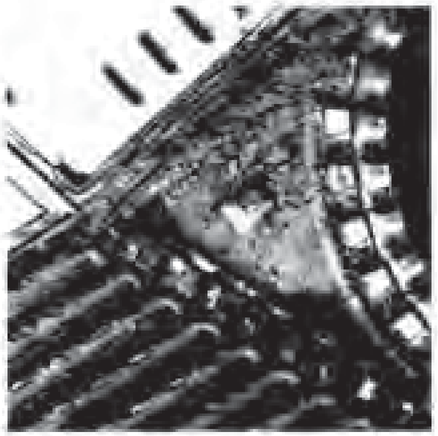
NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates

Concentration max 4% by wt%
Temperature max 140° F

Cleaning 7

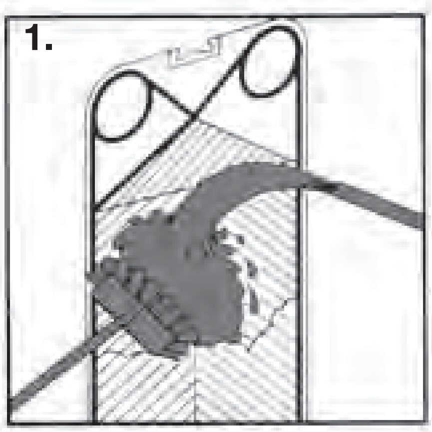


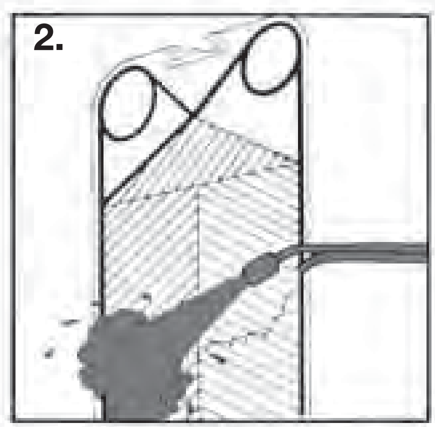
SEDIMENT

- Corrosion products
- Metal Oxides
- Silt
- Alumina
- Diatomic organisms and their excrement of various colors.

CLEANING

Mechanical cleaning after opening.





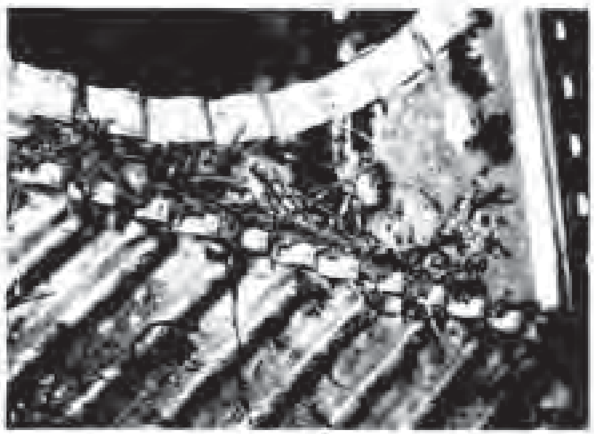
1. Soft brush and running water.
   NOTE! Avoid gasket damage.
2. High pressure hose.
3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates
4. The addition of surfactants can improve cleaning effect.

Concentration max 4% by wt%
Temperature max 140° F

NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

Cleaning

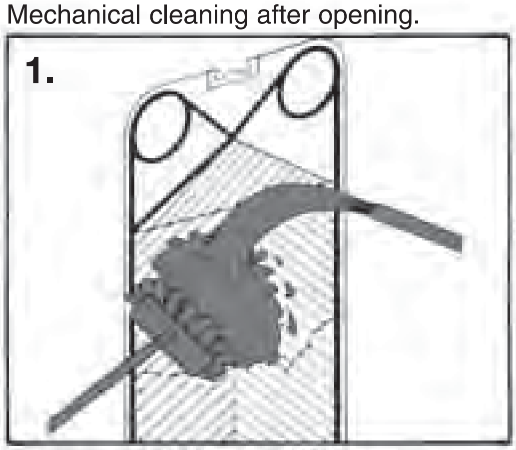


GROSS FOULING

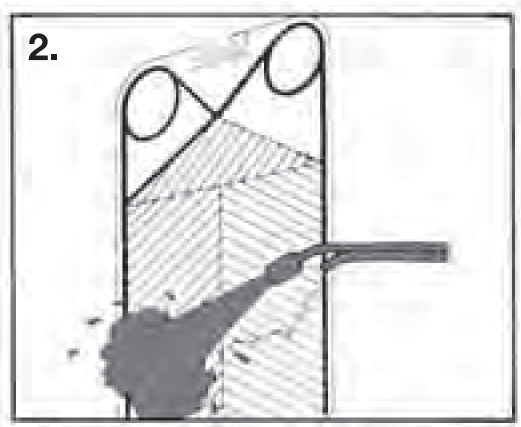
- Seaweeds
- Wood chips/fibers
- Mussels
- Barnacles

CLEANING: NOTE: BACKFLUSHING OF THE UNOPENED HEAT EXCHANGER CAN SOMETIMES BE SUFFICIENTLY EFFECTIVE.

Mechanical cleaning after opening.



1. Soft brush and running water.
   NOTE! Avoid gasket damage.



2. High pressure hose.

NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

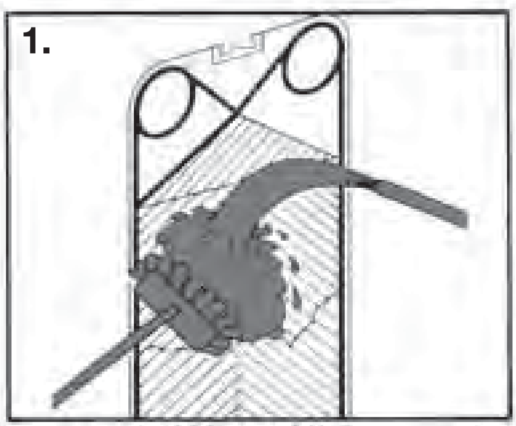
Cleaning

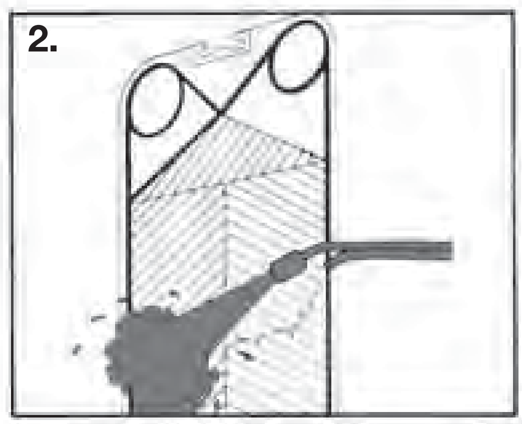
BIOLOGICAL GROWTH - SLIME

- Bacteria
- Nematodes
- Protozoa

CLEANING

Mechanical cleaning after opening.





1. Soft brush and running water.
   NOTE! Avoid gasket damage.

2. High pressure hose.

3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates

Concentration max 4% by wt%
Temperature max 140° F

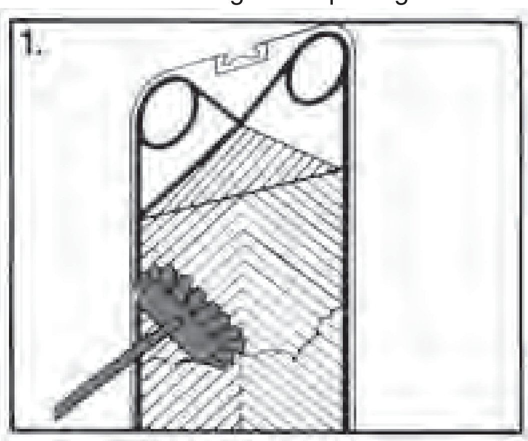
NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

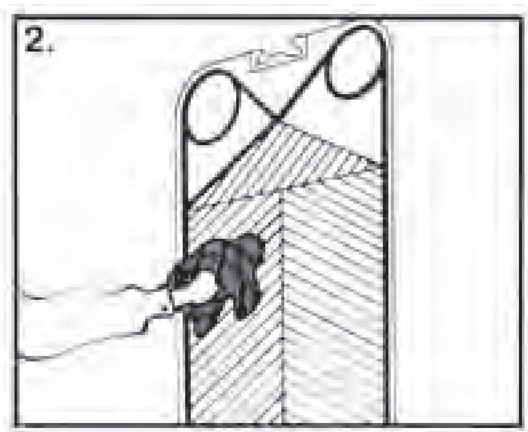
It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

- Oil residues
- Asphalt
- Fats

CLEANING

Mechanical cleaning after opening.





1. Hydrocarbon-based deposits may be removed by using a soft brush and a PARAFFINIC or NAPHTHA-BASED solvent (e.g. KEROSENE).

2. Dry with a cloth or rinse with water.

NOTE!
Gaskets in natural, butyl and EPDM rubber swell in these media.

Contact time should be limited to 0.5 hour.

THE FOLLOWING SOLVENTS SHOULD NOT BE USED

- Ketones (e.g. Acetone, Methyletylketone, Methylisobutylketone)
- Esters (e.g. Ethylacetate, Butylacetate)
- Halogenated hydrocarbons (e.g. Chlorothene, Carbon tetrachloride, Freons)
- Aromatics (e.g. Benzene, Toluene)

Regasketing

ALFA LAVAL has two types of glue for field repairs - GC11 and GC8 for repairs and exchange of gaskets in plates. A special glue is recommended for viton and silicone gaskets.

GC11

- A two-component, cold curing epoxy glue which gives a strong joint for higher temperatures.
- Future removal of gaskets usually requires heating or freezing of the joint.
- The shelf life is limited to approx. 1 year when stored at room temperature but can be prolonged when kept in a refrigerator.

GC8

- A single-component rubber-based solvent adhesive.
- Is normally used for repair work in an uncured condition.
- Can be used for operating temperatures below 200 F
- For operating temperatures above 200° F and oil coolers/heaters, the glued joints should be cured at 200° F for one hour.
- Future removal of the gasket can usually be carried out without heating of the cement joint.
- The storage life at room temperature is about two years. This period can be extended after checking the glue.

SEPARATE GLUING INSTRUCTIONS WILL BE DELIVERED TOGETHER WITH THE GLUE.

ALFA LAVAL RECONDITIONING SERVICE

In addition to supplying genuine gaskets for your plate heat exchangers, we are able to provide a “SPECIALIZED PLATE RECONDITIONING SERVICE” to quickly and efficiently meet your service requirements.

Our reconditioning service includes a liquid nitrogen debonding process with chemical cleaning, crack detection and regasketing using a special epoxy/phenolic resin adhesive.

This regasketing process requires special oven curing of the cement to ensure the strongest possible bond strength between plate and gasket, similar to the process used during manufacture. This is one reason why our service is guaranteed.

In most cases our reconditioning service has proved more economical and much faster when compared with on-site regasketing methods.

For further details, please contact your local ALFA LAVAL REPRESENTATIVE.
(See Section 1)

The Clip-on gasket -
a glue-free gasket system

The Clip-on gasket is attached to the plate by two gasket prongs which slip under the edge of the plate to hold the gasket securely in alignment in the gasket groove.

The prongs are situated at regular intervals around the periphery of the plate.

When the plate heat exchanger is then assembled and tightened, the gasket provides a tight seal around the plate.

The Clip-on gasket in the gasket groove.

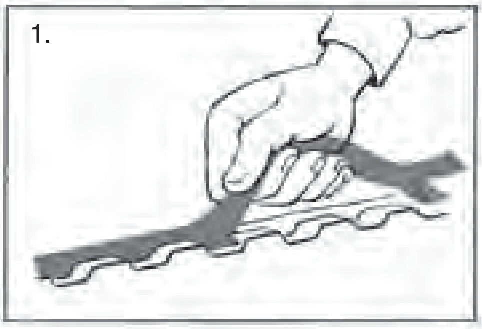
NOTE!

Before closing of the equipment: Check that the two gasket prongs are in correct position.

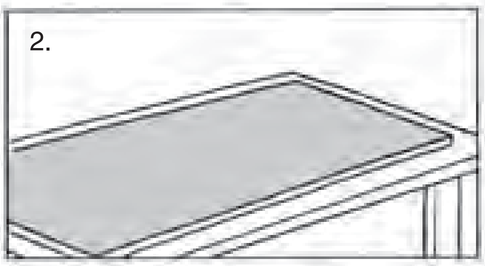
Regasketing of Snap-On Gaskets

THE PROCEDURES (2-7) ARE NOT NECESSARY FOR DOING A SMALL QUANTITY OF PLATES.
THESE PROCEDURES WILL INCREASE SPEED OF REGASKETING OF LARGE QUANTITIES OF PLATES.

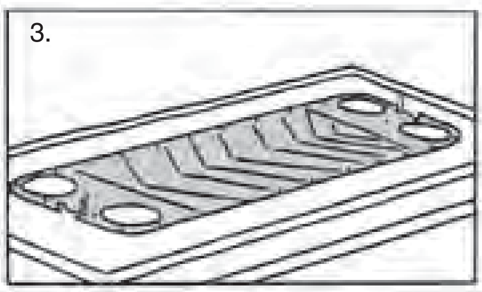
PREPARATORY PROCEDURES



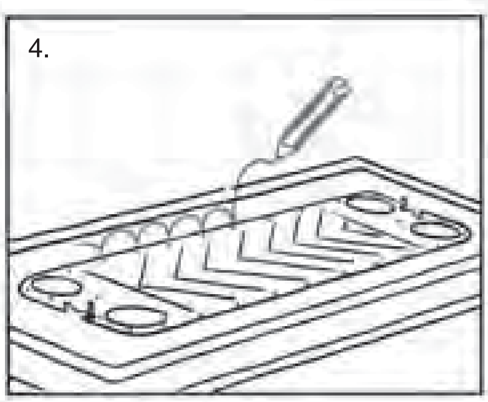
1. Pull the old gasket off the plate and clean the groove, if necessary.



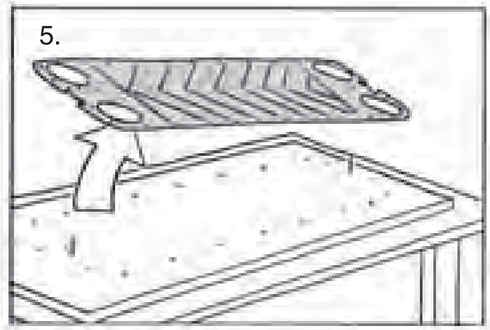
2. Place a flat sheet of plywood (somewhat larger than the PHE plate) on the table.



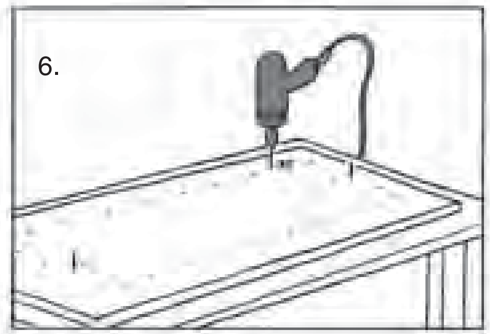
3. Place the PHE plate on the board with gasket groove upwards and fix firmly. Placing cylindrical pins in the plank at the carrying bar slots.



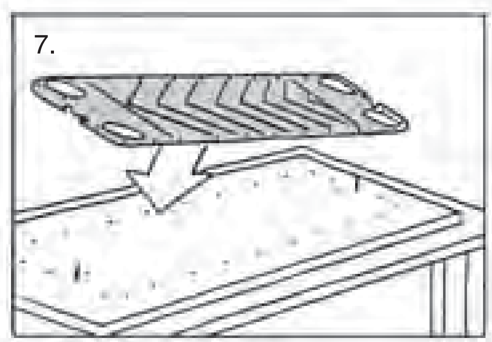
4. Make marks in the plank at all locations for gasket "snap-on".



5. Remove the plate.



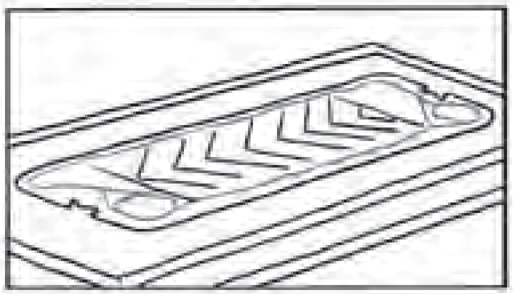
6. Drill holes approx. 7mm dia and 10 mm deep in the plank at the marked spots. The plank is now a practical tool for regasketing of larger numbers of plates.



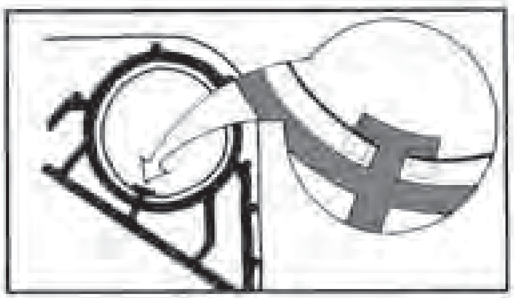
7. Replace PHE plate on the board in exactly the same location as at 3 above.

7 Regasketing of Snap-On Gaskets

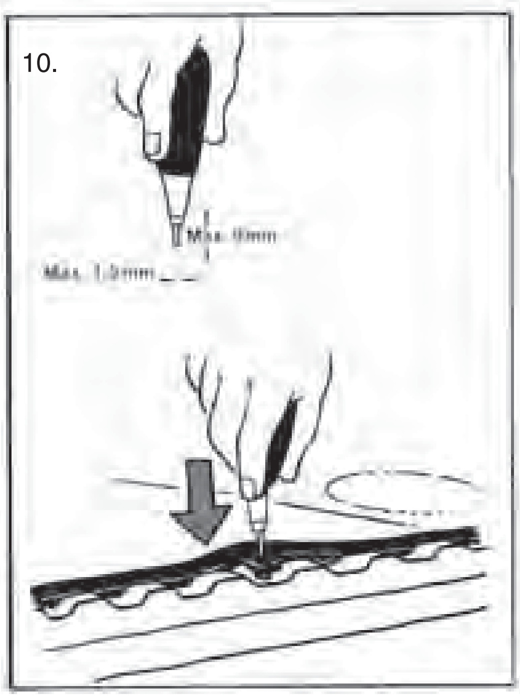
FASTENING OF THE “SNAP-ON” GASKET



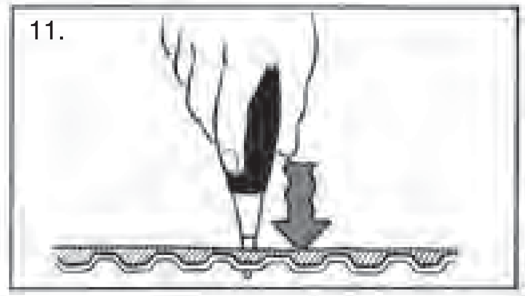
8. Place the gasket, with the “snap-on” projections downwards, in the gasket groove.



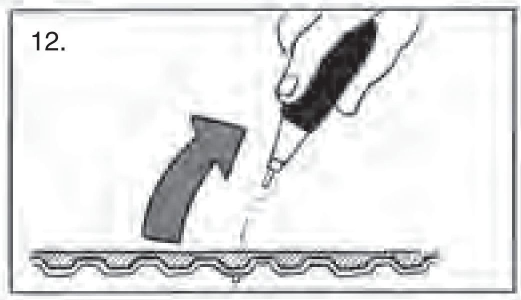
9. Place the ring gaskets in the groove and fix them with the T-flap.



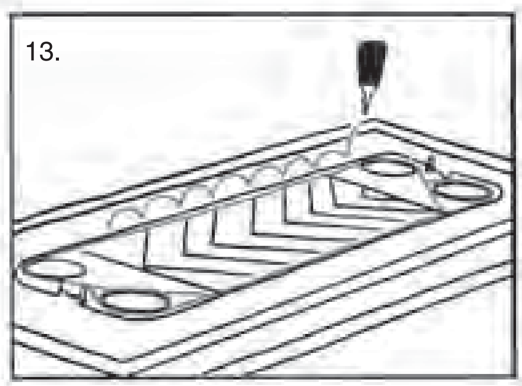
10. Insert the tool point into the recess in the projection.



11. Push the projection through the hole in the plate.



12. Remove the tool point, and the projection is now “snapped on”.

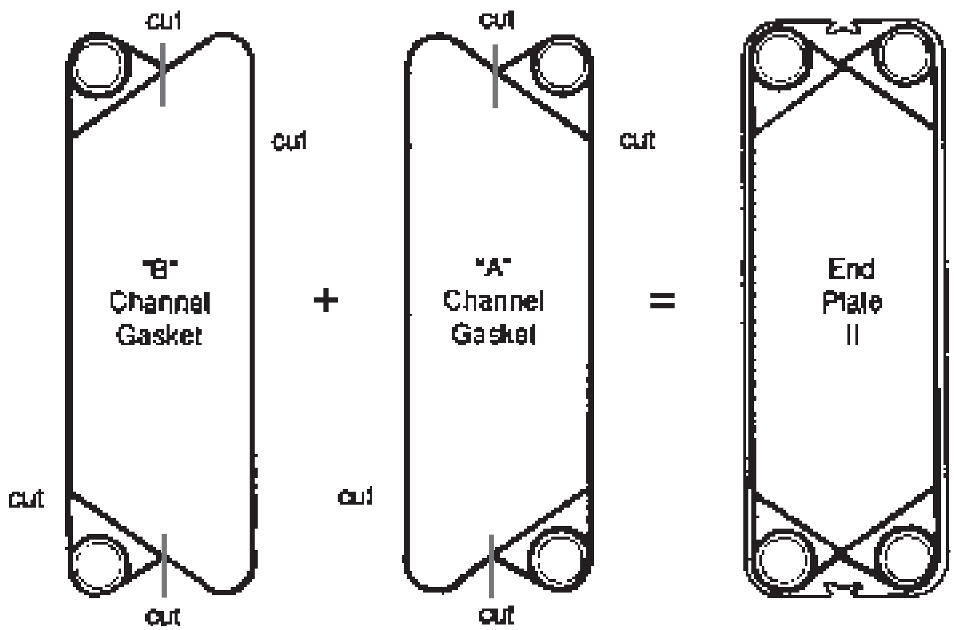


13. Repeat for all projections, and the gasket is “snapped on”.

NOTE!
BEFORE CLOSING OF THE EQUIPMENT: CHECK THAT THE T-FLAPS ARE IN CORRECT POSITION.

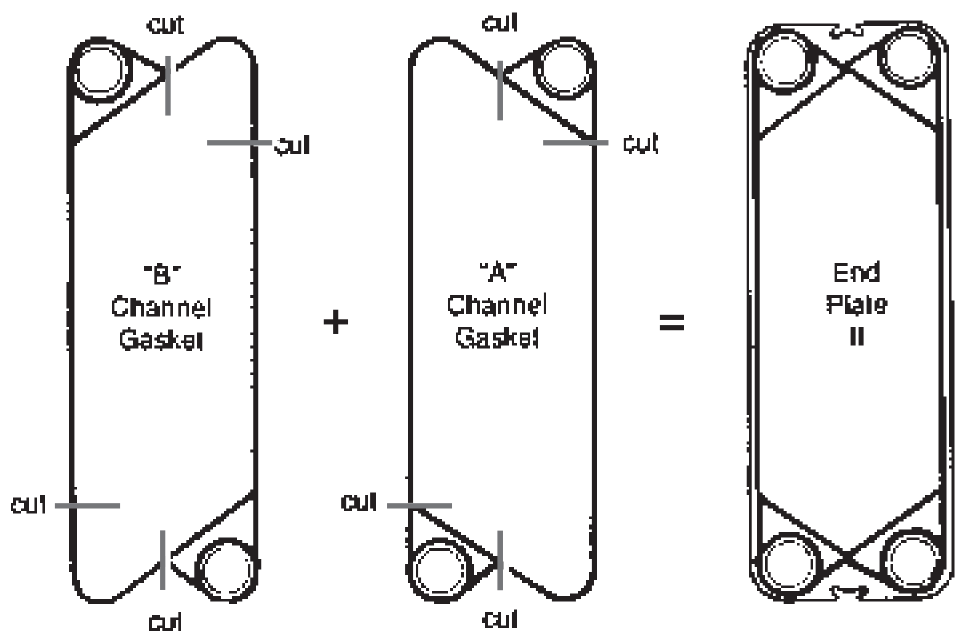
7.9

The End Plate II Gasket is formed by cutting (2) channel gaskets (as shown below) and gluing the gaskets to the first plate.



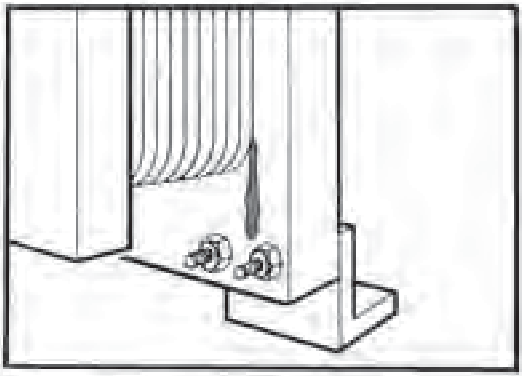
The (2) half channel gaskets should be glued to the end plate with GC-8 glue: or double sided tape (GC-1). The (4) port gasket areas are critical because these gaskets will be in contact with the process fluids.

The End Plate II Gasket is formed by cutting (2) channel gaskets (as shown below) and gluing the gaskets to the first plate.



The (4) parts of the channel gaskets should be glued to the end plate with GC-8 glue: or double sided tape (GC-1). The (4) port gasket areas are critical because these gaskets will be in contact with the process fluids.

Fault detection



SYMPTOM

LEAKAGE between plates and frame.

ACTION	CORRECTIONS

Mark with a felt tip or similar marker, mark the area where the leakage seems to be, and open the heat exchanger

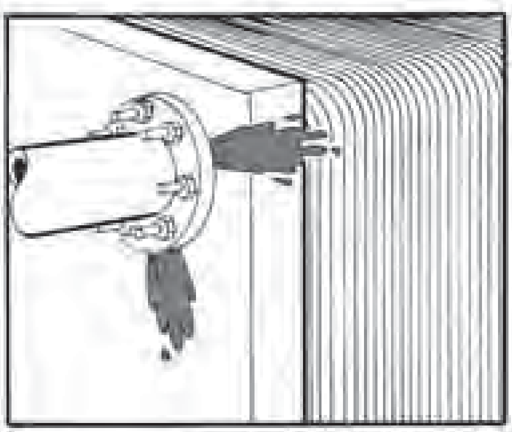
1. Investigate the gasket condition of the end plate and the connection if applicable, look for dislocation, foreign objects, scars and other damage to the gasket surfaces.
2. Check the surface of the pressure plate for unevenness, foreign objects sticking to it, etc. that might spoil the joint between the gasket and the adjacent surface.
3. Check the plate itself for cracks or holes.

CORRECTIONS

1. • Relocate gasket.
   • remove foreign matter.
   • replace connection lining if applicable.

   Remove anything disturbing the joint between gasket and pressure plate surface.

   A perforated end plate must be replaced.



SYMPTOM

LEAKAGE between flange and frame.

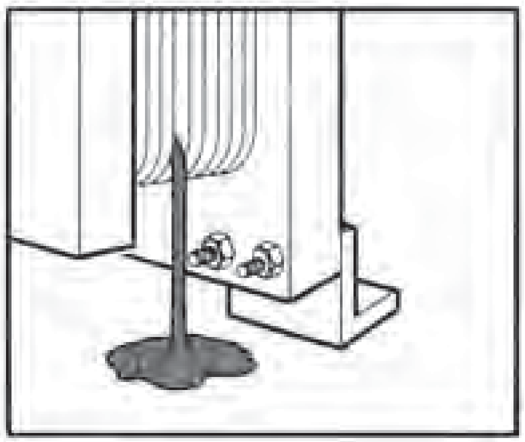
ACTION

1. Disconnect the flange, and look for misalignment between flange and connection, dislocated or damaged gasket, foreign objects on the surface of the gasket or the flange.

CORRECTIONS

1. • Rearrange the pipe in order to eliminate stress and to correct alignment.
   • relocate gasket
   • replace damaged gasket
   • replace connection lining if applicable
   • remove foreign matter from flange and gasket
   • reassemble, taking care to avoid misalignment

NOTE: On a Plate Heat Exchanger specially designed for high temperature duties, extreme and sudden temperature drops may sometimes cause a temporary leakage. A typical example is a sudden shutting-off of the hot medium flow. The heat exchanger will normally seal again, as soon as the temperatures of the equipment have stabilized.



SYMPTOM

LEAKAGE between plates to the outside.

ACTION

Mark the leakage area with a felt tip marker on the two plates next to the leakage, check and note the length of the plate pack between inside frame plate and inside pressure plate, and then open the heat exchanger.

1. Check for loose, dislocated or damaged gasket.
2. Check for plate damage in the area, and also check plate pack length against the drawing to see if possible plate or gasket damage could be caused by overtightening of the plate pack, or if the leakage itself may simply be caused by insufficient tightening.
3. Check hanger recess at both plate ends for deformations, which could cause misalignment between the plates.
4. Make sure that the plates are hanging correctly as A-B-A (see SECTION 4A or 4B).
5. Check for perforation of the plate (corrosion).

CORRECTIONS

1. • Relocate gasket.
   • Re-cement loose gasket, if applicable.
   • Replace damaged gasket.
2. A damaged plate must in most cases be taken out for repair or replacement. If it is a regular plate with 4 holes: take the damaged plate and the 4-hole plate just in front or just behind it out of the plate pack. The heat exchanger can now be reassembled and put back in service PROVIDED THE PLATE PACK IS TIGHTENED TO A NEW MEASUREMENT, WHICH IS EQUAL TO THE ONE ON THE DRAWING, REDUCED BY TWO TIMES THE SPACE REQUIRED PER PLATE. CONTACT ALFA LAVAL FOR ASSISTANCE IN THE RECALCULATION IF NECESSARY.
   The small reduction of the heat transfer area is normally of no importance, at least not for a short period of time.
   • Insufficient tightening must be corrected - see the drawing.
3. Damaged hanger recesses must be repaired if possible, or the plate replaced. For temporary arrangement with reduced number of plates - see paragraph 2 above.
4. Incorrect sequence of plates must be corrected (A-B-A-B-..). MAKE SURE THAT NO PLATE HAS BEEN DAMAGED, BEFORE REASSEMBLING THE PLATE PACK!
5. Perforated plates must be replaced. For temporary solution, see paragraph 2.

SYMPTOM

LEAKAGE between plates.

ACTION	CORRECTIONS
1. Check that the piping is connected to the heat exchanger at correct locations.	1. Relocate piping to correct connections.
2. Open the lower connection on one side, raise pressure on the other side and by looking into the open connection try to detect any liquid from the pressurized side leaking in, and if so - approximately how far into the plate pack the leakage is located. If no leakage is detected, the reason for the mixing of media must be sought elsewhere. (see paragraph 5).	
3. If a leakage was detected, note the position of the leakage along the plate pack and then open the plate heat exchanger.	
4. Before starting on the plates themselves, check that the corner areas between the ring and the field gaskets are clear, that the leakage slots are open. This ensures that any leakage is out of the plate heat exchanger and is to atmosphere. Therefore no pressure can build up to force the media across the gasket sealing off the other liquid.	4. All deposits or material which can block the free exit from the area must be removed. If the leak channels of the gasket have been destroyed, they must be reopened with a suitable tool, or the gasket replaced.
5. If it has not been possible to locate the leakage as described in par. 2 above, it will be necessary to check each single plate for possible perforations, using any of the following methods: • put a strong light behind the plate and watch for light coming through fine holes or cracks. • use a magnifying glass to check suspect area. • use a chemical penetrant, after having cleaned the plates well.	5. Plates with holes must be replaced. The PHE may be temporarily operated with a reduced number of plates. See “LEAKAGE between plates to the outside”.

SYMPTOM

PRESSURE DROP PROBLEMS,

Pressure drop has increased

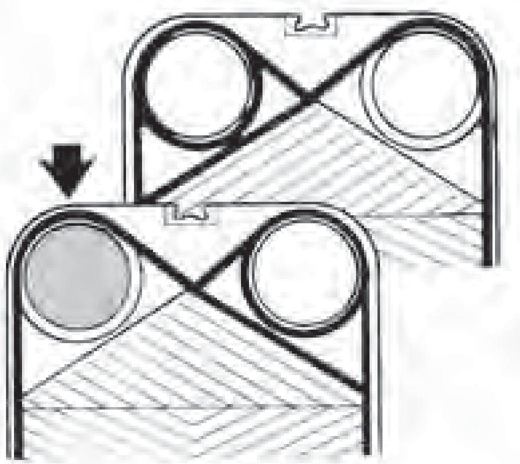
ACTION		CORRECTIONS	
	Check that all valves are open including non return valves.		
	Measure the pressure just before and just after the heat exchanger, and the flow rate. For viscous media a membrane manometer with a diameter of at least 30 millimeters should be used. Measure or estimate the flow rate if possible. A bucket and a watch showing seconds may be sufficient for small flow rates. For larger flow rates, some type of flowmeter is required. Compare the pressure drop observed with the one specified for the actual flow rate. (see plate print out)		
1.	If the pressure drop is higher than specified, the temperature program should also be checked:	1.	See next paragraph.
1.1	If the thermometer readings correspond to those specified, the heat transfer surface is probably clean enough, but the inlet to the heat exchanger may be clogged by some objects.	1.1	Open the PHE and take out whatever is clogging the passage, or use the back-flush system - if there is one - to rinse out the cloggings.
1.2	If the thermometer readings are NOT corresponding to those specified, heat transfer is obviously dropping below specifications, because of deposits on the heat transfer surface, which at the same time also increase the pressure drop, since the passage becomes narrower.	1.2	If a “cleaning-in-place” system is available, follow the instruction and use it to wash out the deposits. If not, open the PHE and clean the plates.
2.	If the pressure drop corresponds to the specifications, there is no need for any action.		
3.	If the pressure drop is lower than specified, the pump capacity is too small or the observation is wrong.	2.	See pump instruction manual.

SYMPTOM: HEAT TRANSFER PROBLEMS

The heat transfer capacity is dropping

ACTION	CORRECTIONS
Measure temperatures at inlet and outlets and also flow rates on both media, if possible. At least on one of the media, both temperatures and the flow rate must be measured. Check to see if the transferred amount of heat energy corresponds to the specifications. If great precision is important, it will be necessary to use laboratory thermometers with an accuracy of 0.2 degrees Fahrenheit, and also to use the best equipment available for flow measurements.	If the heat transfer capacity of the equipment has dropped below specified values, the heat transfer surface must be cleaned. Either use the “cleaning-in-place” arrangement if provided or open the heat exchanger for visual inspection and manual cleaning. NOTE: Contact the Alfa Laval Sales & Service Division for CIP recommendations (See Section 1).

9 Supplementary Parts



Example only

THE PARTITION PLATE - for special cases only.

If for instance, the thermal program requires that at least one of the media is to flow in more than one group through the plate package, there will be heat transfer plates with fewer than 4 holes.

To prevent the thin metal collapsing under the differential pressure, un-punched corners require extra support.

The extra support is provided by a partition plate - approximately the size of a channel plate - made of about 1/4" - 3/4" thick plate material with lined holes where a free passage is required.

The partition plate is suspended from the carrying bar. Where partition plates are required, in units with 8" ports or larger, there will be one at every turning point in a multi-grouped plate package.

9.1

Instruction Sheet
CA & PAX Expansion Tanks

402-002

SUPERSEDES: 402-002 dated May 1, 2001 EFFECTIVE: October 15, 2001

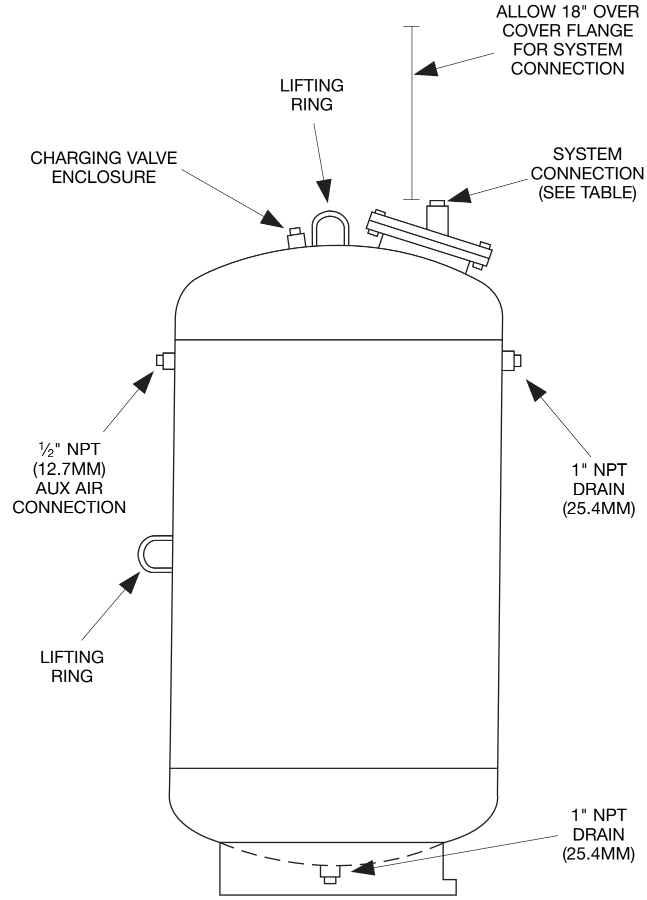
Plant ID No. 001-398

CA Tanks

1. Note location on the tank of the system connection, charging valve enclosure, and the drain plug. Note labels on the tank or refer to Diagram 1 – Location of Tank Fittings.
2. Carefully remove the plastic protective cover in the system connection coupling located at the center of the cover flange. Pause before completely removing to allow any trapped air to escape. There should not be much, if any, air pressure under the protective cover.

CAUTION: DO NOT REMOVE THE PIPE PLUGS LOCATED ON THE SIDE AND BOTTOM OF THE TANK (TANK DRAINS). THESE PLUGS SHOULD NEVER BE REMOVED UNLESS NECESSARY AND THEN ONLY AFTER THE AIR PRESSURE IN THE TANK HAS BEEN BLED OFF TO ZERO GAUGE PRESSURE. BEFORE BLEEDING OFF ANY OF THE AIR CHARGE, ALWAYS ISOLATE THE TANK FROM THE SYSTEM WITH A SHUT-OFF VALVE.

3. Before making any connections to the tank, check the tank air charge. Use an accurate automotive or similar type gauge on the air valve located on the top head of the tank. **The air charge pressure must be equal to the pre-charge pressure specified for the system. Refer to the label on the tank for the specified tank pre-charge pressure. In most cases the specified tank pre-charge pressure is equal to the system fill pressure at the tank location.** Use Diagram No. 3 – Air Charge Check Chart to correct the value read on the pressure gauge for the ambient temperature at the tank location.
4. The pipe connection to the system may now be made. The piping requirements for captive air tanks are different from those of plain steel expansion tanks. Note the Captive Air Tank Piping Diagrams. Piping and air elimination devices should be arranged so that air will not be trapped in the tank, above the tank or in the nozzle. Pitch the piping connection up away from the tank and use automatic air vents where necessary. Note the piping diagram.
5. Locate the CA tank connection as close as possible to the suction side of the pump. This ensures that the pressures realized from the pump head will be additive in the system. A combination shut-off and drain valve should be located in the connection piping to provide for tank isolation during the initial hydrostatic test.



SYSTEM CONNECTION	
CA140 TO CA2000	1½" NPT (38MM)
CA4000 & CA5000	2" NPT (51MM)
CA7500 & CA10000	3" NPT (76MM)

Diagram 1 – Location of Tank Fittings

PAX Tanks

1. Note location on the tank of the system connection, charging valve enclosure, coupling and the drain plug. Note labels on the tank or refer to Diagram 2 – Location of Tank Fittings.
2. Carefully remove the shipping pipe-cap on the system connection located in the center of the tank head. Pause before completely removing to allow any trapped air to escape. There should not be much, if any, air pressure under the protective cover.

CAUTION: DO NOT REMOVE THE PIPE PLUGS LOCATED ON THE SIDE AND BOTTOM OF THE TANK (TANK DRAINS). THESE PLUGS SHOULD NEVER BE REMOVED UNLESS NECESSARY AND THEN ONLY AFTER THE AIR PRESSURE IN THE TANK HAS BEEN BLED OFF TO ZERO GAUGE PRESSURE. BEFORE BLEEDING OFF ANY OF THE AIR CHARGE, ALWAYS ISOLATE THE TANK FROM THE SYSTEM WITH A SHUT-OFF VALVE.

3. Before making any connections to the tank, check the tank air charge. Use an accurate automotive or similar type gauge on the air valve located on the top head of the tank. **The air charge pressure must be equal to the pre-charge pressure specified for the system. Refer to the label on the tank for the specified tank pre-charge pressure. In most cases the specified tank pre-charge pressure is equal to the system fill pressure at the tank location.** Use Diagram No. 3 – Air Charge Check Chart to correct the value read on the pressure gauge for the ambient temperature at the tank location.
4. The pipe connection to the system may now be made. The piping requirements for captive air tanks are different from those of plain steel expansion tanks. Note the Captive Air Tank Piping Diagrams. Piping and air elimination devices should be arranged so that air will not be trapped in the tank, above the tank or in the nozzle. Pitch the piping connection up away from the tank and use automatic air vents where necessary. Note the piping diagram.
5. Locate the PAX tank connection as close as possible to the suction side of the pump. This ensures that the pressures realized from the pump head will be additive in the system. A combination shut-off and drain valve should be located in the connection piping to provide for tank isolation during the initial hydrostatic test.

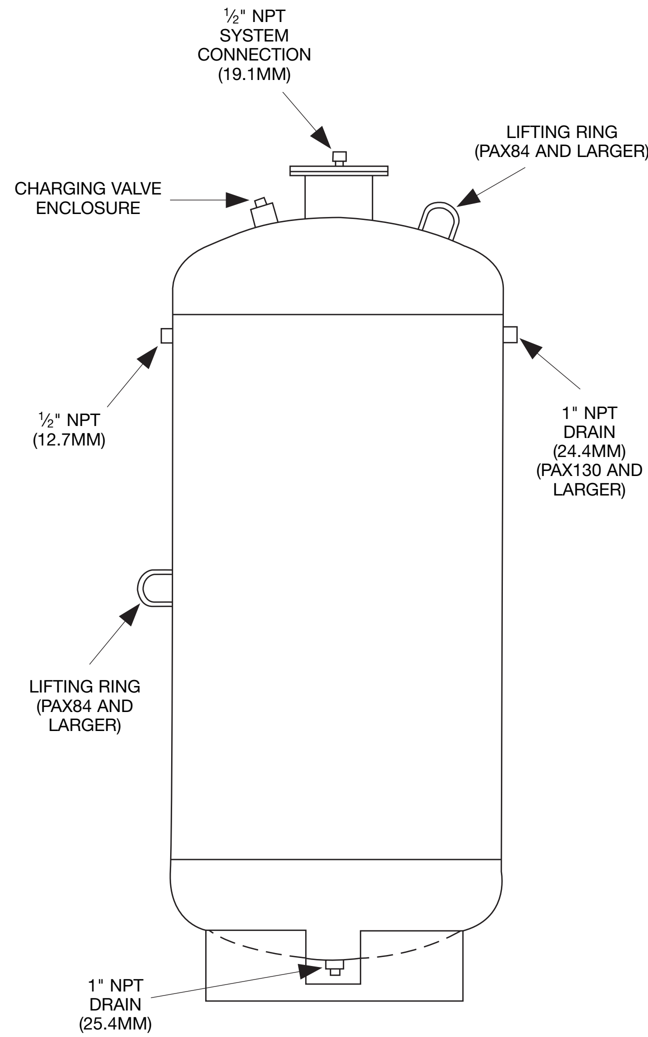


Diagram 2 – Location of Tank Fittings

Air Charge Check Chart

Specified Pre Charge Pressure P.S.I. (at 68°F)	Ambient Temperature (°F)								
	36	44	52	60	68	76	84	92	100
12	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.6
20	17.9	18.4	18.9	19.5	20.0	20.5	21.1	21.6	22.1
30	27.3	28.0	28.6	29.3	30.0	30.7	31.4	32.0	32.7
40	36.7	37.5	38.2	39.2	40.0	40.8	41.6	42.5	43.3
50	46.1	47.1	48.0	49.0	50.0	51.0	52.0	52.9	53.9
60	55.5	56.6	57.7	58.9	60.0	61.1	62.3	63.4	64.5
70	64.9	66.1	67.4	68.7	70.0	71.3	72.6	73.9	75.1

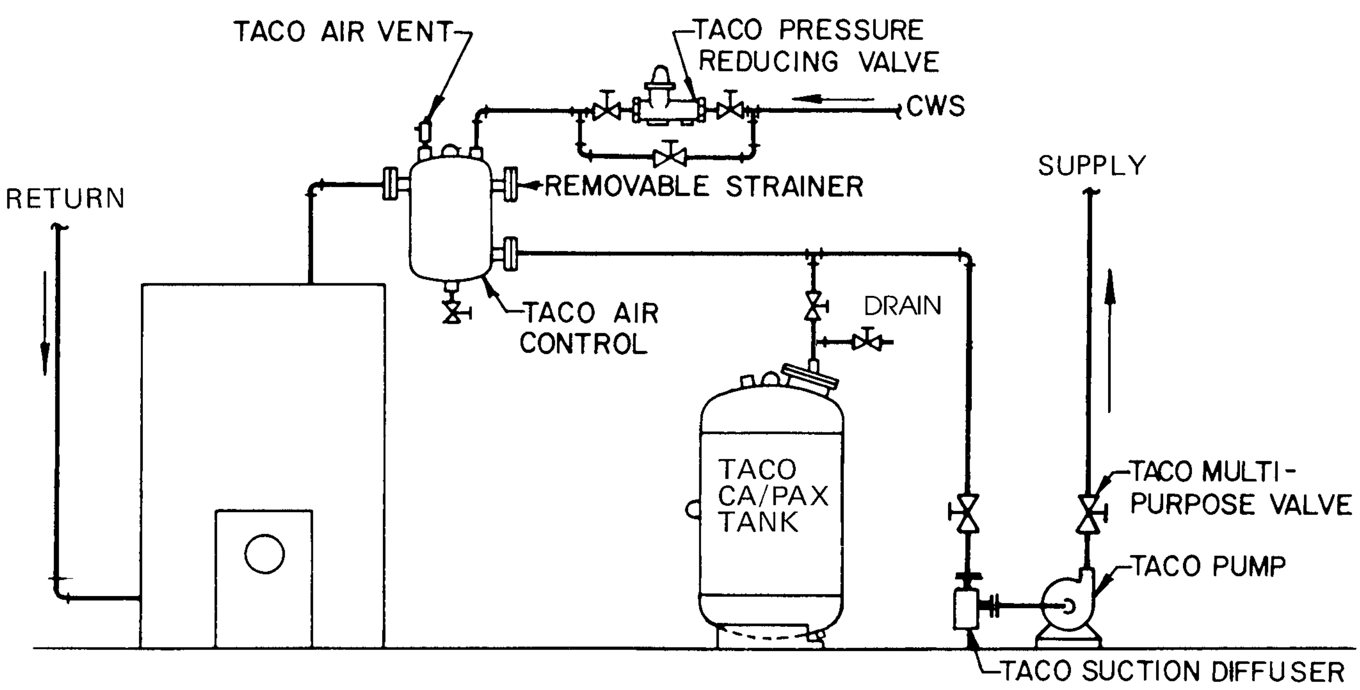
Diagram 3 – Air Charge Check Chart

How to Use the Chart

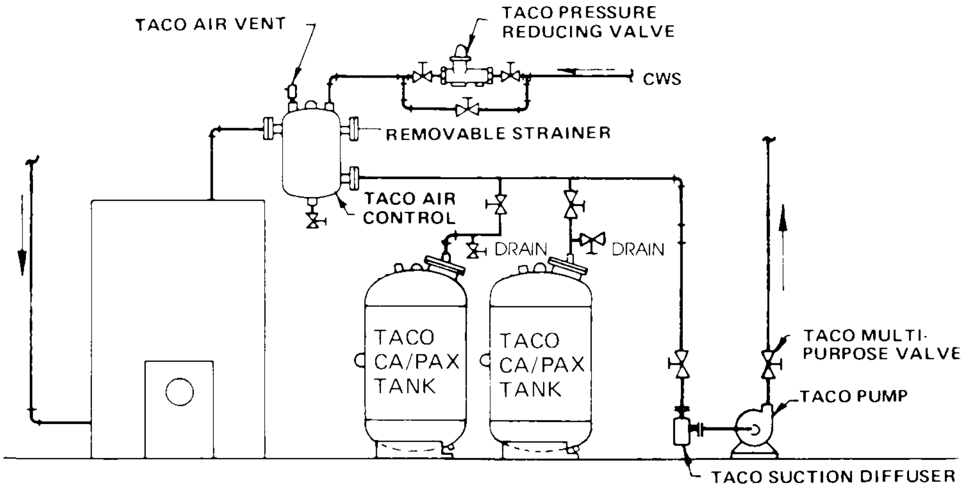
1. Determine ambient air temperature where the tank is being checked.
2. Locate the specified pre-charge pressure in the left hand column.
3. Follow across horizontally to the number under the ambient air temperature.
4. The number found under Step No. 3 is the temperature corrected air charge pressure in p.s.i. and should agree with the guage reading observed at the tank.
5. If the temperature corrected air charge pressure differs by more than 1 p.s.i. from the pre-charge pressure specified for the system, then correct it by bleeding pressure through the air charge valve or by adding pressure with an air compressor.

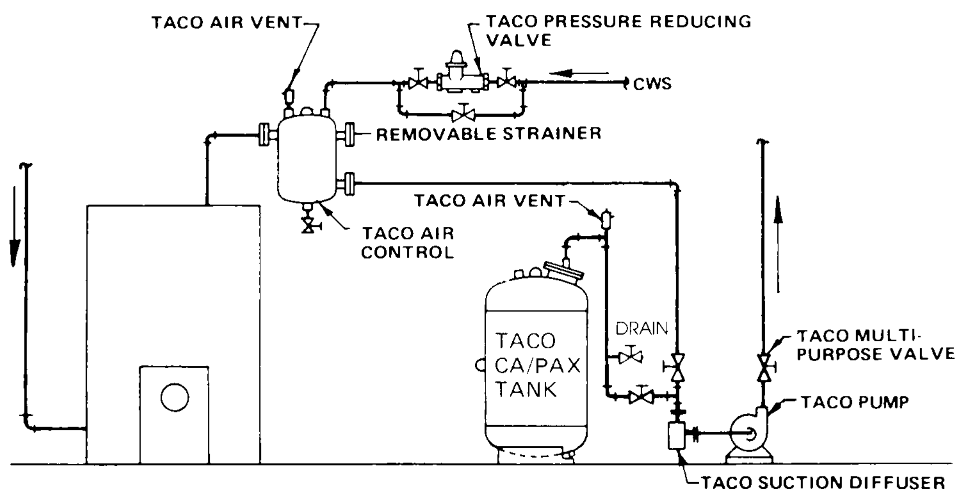
Captive Air Tank Piping Diagrams

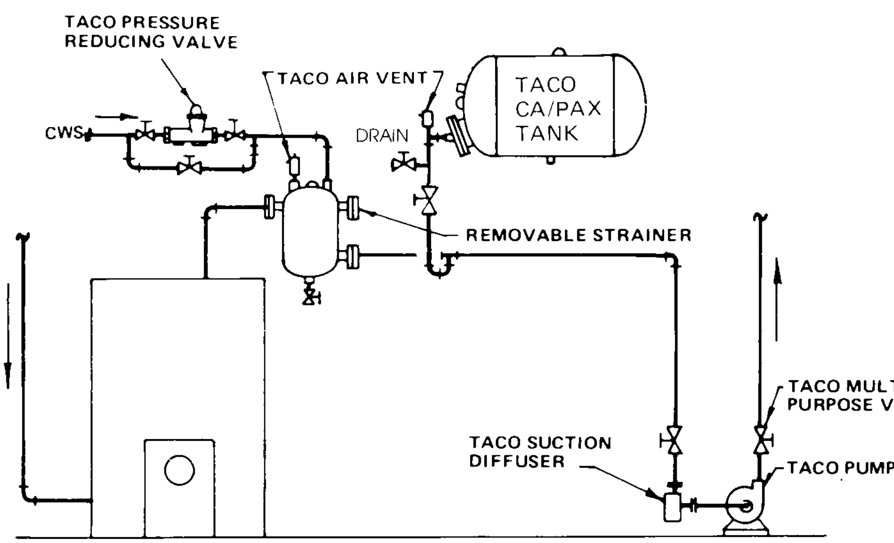
Recommended Location



Captive Air Tank Piping Diagrams – Alternate Locations







Do it Once. Do it Right.

TACO, INC., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401) 942-8000 FAX: (401) 942-2360.
TACO (Canada), Ltd., 6180 Ordan Drive, Mississauga, Ontario L5T 2B3. Telephone: 905/564-9422. FAX: 905/564-9436.

Visit our web site at: http://www.taco-hvac.com

<u>BRAY CONTROLS RESILIENT SEATED BUTTERFLY VALVES</u>

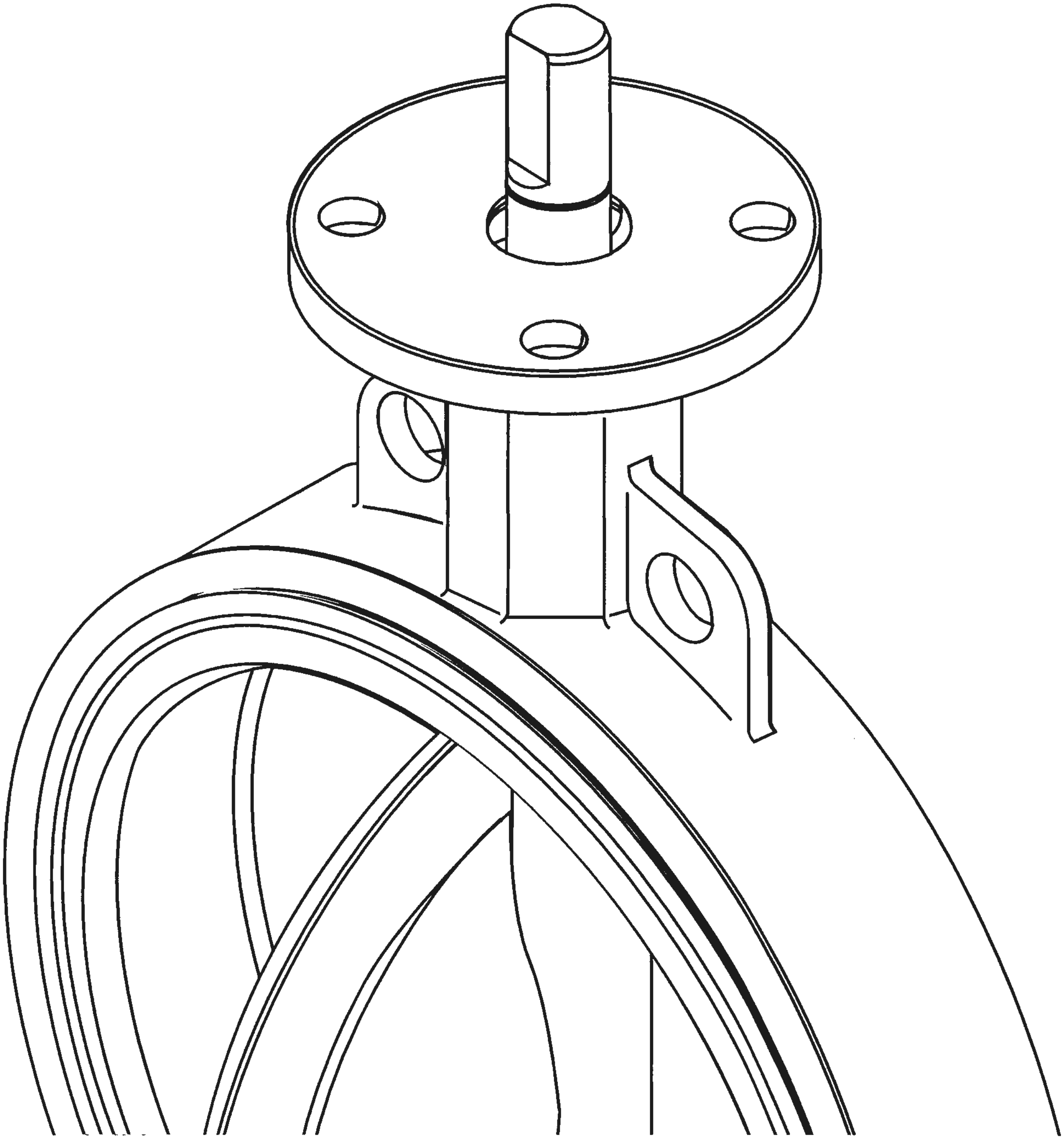
Operations & Maintenance Manual
December 2015

Bray CONTROLS

OPERATION AND MAINTENANCE MANUAL

RESILIENT SEATED BUTTERFLY VALVES

~~20/21, 22/23, 30/31, 3A/3AH~~, 31H, ~~31U, 32/33, 35/36, 36H~~



FOUNDED 1862

ABS

The High Performance Company

TABLE OF CONTENTS:

FOR INFORMATION ON THESE PRODUCTS AND OTHER BRAY PRODUCTS
PLEASE VISIT US AT OUR WEB PAGE - www.bray.com

Safety Instructions - Definition of Terms

READ AND FOLLOW THESE INSTRUCTIONS
SAVE THESE INSTRUCTIONS

⚠ WARNING	indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.
⚠ CAUTION	indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	used without the safety alert symbol indicates a potential situation which, if not avoided, may result in an undesirable result or state, including property damage.

Introduction

Historical Experience

Based on over twenty years experience in the butterfly industry, Bray can state without question the majority of all field problems for resilient seated butterfly valves are directly related to poor installation procedures. For this reason, it is very important all distributor salespeople educate their customers regarding proper installation of resilient seated butterfly valves.

Butterfly Valve Seat / Disc Function

Before reviewing the proper installation, maintenance, and repair procedures for resilient seated butterfly valves, let's discuss the seat-disc function of a butterfly valve. The seat in a resilient seated butterfly valve has molded o-rings on its flange face. **As a result, no gaskets are required as these o-rings serve the function of a gasket.** The flange face and molded o-rings of the seat extend beyond the body face-to-face to ensure sealing at the flange faces. The seat material, which extends past the face is compressed in installation and flows toward the center of the valve seat I.D.

In essence, the elastomer seat acts as a liquid, and the displaced elastomer moves toward the point of least resistance. The seat I.D. of all resilient seated butterfly valves is smaller than the disc O.D. This difference, the disc-seat interference, plus the increased interference due to the elastomer movement toward the seat center after installation, has been engineered so as to be the basis for pressure rating capability and the related seating/unseating torques. **Any change in this interference due to improper installation directly affects the pressure rating and seating/unseating torques.**

Finally, unlike many valve types, the resilient seated butterfly valve's disc actually extends beyond the face of the valve body at given angles of opening (say, 30° or more) when installed between flanges.

⚠ **CAUTION**

It is very important before installation to ensure the critical chord dimension of the disc at the full open position is less than the adjacent pipe flange I.D.

Shipment & Storage

A. The seat, disc, stem and bushing of the resilient seated butterfly valve should be coated with silicone lubricant unless specified otherwise as recommended by Bray Technical Bulletin 1028.

B. The disc should be positioned at 10° open. **Note**: See page 2 for special considerations for valves with spring return actuators.

C. Valves should be stored indoors with a preferred temperature range from 40° F (4°C) to 85° F (29°C).

D. When valves are stored for a long time, open and close the valves once every 3 months.

E. Ship and store valves so that no heavy loads are applied to the bodies.

Installation Considerations – Piping and Valve Orientation and Placement

Piping and Flanged Compatibilities

Piping

These valves have been engineered so that the critical disc chord dimension at the full open position will clear the adjacent inside diameter of most types of piping, including Schedule 40, lined pipe, heavy wall, etc.

Metal Flanges

Resilient seated butterfly valves have been designed to be suitable for all types of flanges (ASME, DIN, JIS and other international flange standards), whether flat-faced, raised face, slip-on, weld-neck, etc. Proper alignment of any butterfly valve between flanges is critical to good performance of the valve. The flange bolts must also be evenly tightened around the circumference of the valve, providing consistent flange compression of the molded o-ring in the seat face.

Since Bray does not recommend the use of gaskets between flanges on resilient seated butterfly valves, a uniform flange face is critical to proper valve sealing. Most weld-neck and slip-on flanges conforming to ASME specifications have an appropriate flange face. Types A and B butt-weld stub-end flanges also provide a suitable mating surface for the molded o-ring.

It should be noted that Type C butt-weld stub-end flanges have an "as formed" flange face. The varying surface of this flange face can create sealing problems between any resilient-seated butterfly valve and the flange face. For this reason, Type C flanges are not recommended for use with resilient-seating butterfly valves.

Non-Metallic Flanges

When non-metallic flanges, such as plastic or PVC, are used with resilient seated butterfly valves, care must be taken not to over-tighten the flange bolts. The inherent flexibility of these non-metallic flange materials allow them to be over-tightened relatively easily. Flexing caused by this over-tightening can actually reduce the compression of the valve between the flanges, causing leaks between the valve and the flange face. Proper alignment and firm, even, but not excessive tightening of flange bolts are especially important with non-metallic flanges. In some cases, non-metallic flanges of low quality will not mate tightly with butterfly valves regardless of the care taken during installation.

Valves with Spring Return Actuators

1. Fail Closed Assemblies

The resilient seated butterfly valve disc is shipped in the full closed position since no air pressure is present to compress the springs and open the disc. Installing the valve with the disc in the full closed position may create an increase in the valve seating torque, which may prevent the valve from opening.

Note: It is recommended that the actuator be removed and the disc be opened to approximately 10° before and during installation.

2. Fail Open Assemblies

The resilient seated butterfly valve disc is shipped in the full open position since no air pressure is present to compress the springs and close the valve disc. As a result, the disc edge is exposed to possible damage, which will cause premature valve failure.

CAUTION

Use caution when handling and installing the valve to prevent damage to the disc edge. It is recommended that the actuator be removed and the disc closed before and during installation.

3. Valve Location

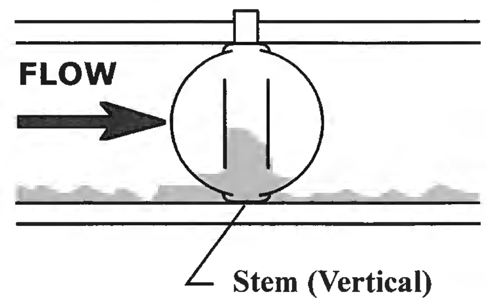
a. Resilient seated butterfly valves should be installed if possible a minimum of 6 pipe diameters from other line elements, i.e., elbows, pumps, valves, etc. of course, 6 pipe diameters are not always practical, but it is important to achieve as much distance as possible.

b. Where the resilient seated butterfly valve is connected to a check valve or pump, use an expansion joint between them to ensure the disc does not interfere with the adjacent equipment.

4. Valve Orientation

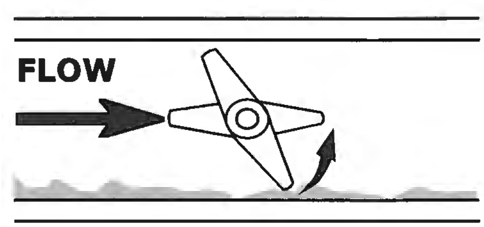
a. In general, Bray recommends the resilient seated valve be installed with the stem in the vertical position and the actuator mounted vertically directly above the valve; however, there are those applications as discussed below where the stem should be horizontal. Also, valves are not normally installed in an upside down position but can be installed in that manner when space restrictions make it necessary.

b. For slurries, sludge, mine tailing, pulp stock, dry cement, and any media with sediment or particles, Bray recommends the resilient seated valve be installed with the stem in the horizontal position with the lower disc edge opening in the down-stream direction.



INCORRECT INSTALLATION

Sludge builds up on disc



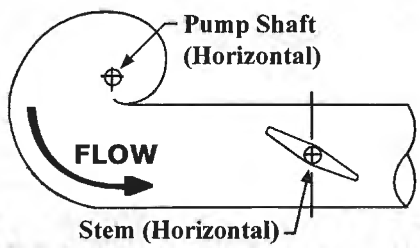
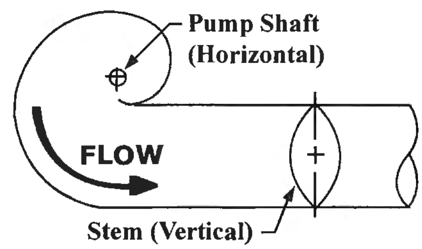
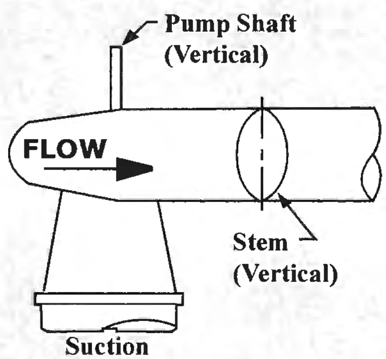
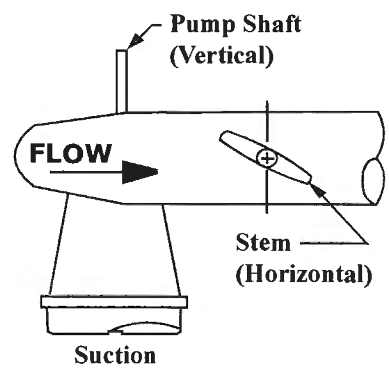
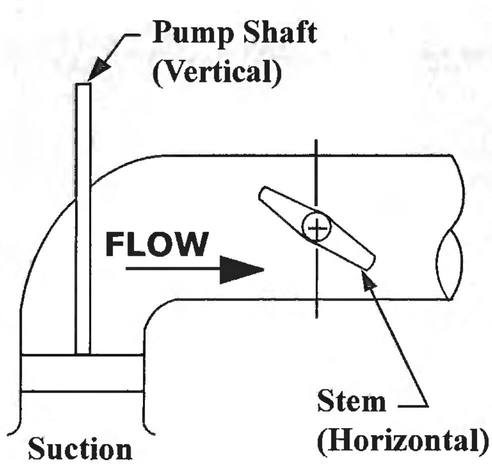
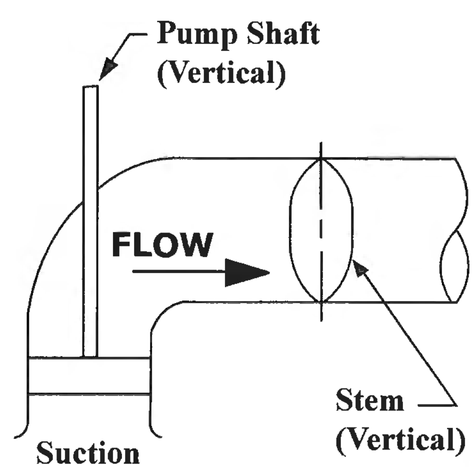
Stem (Horizontal)

CORRECT INSTALLATION

Sludge passes under disc

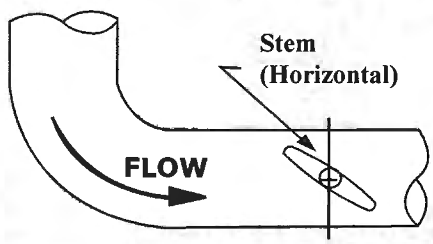
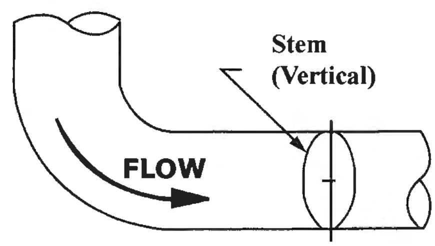
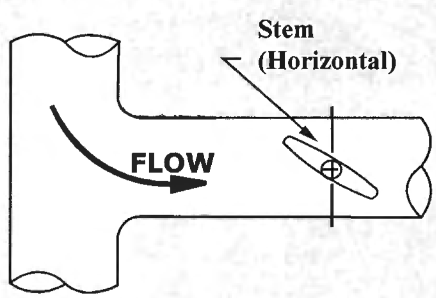
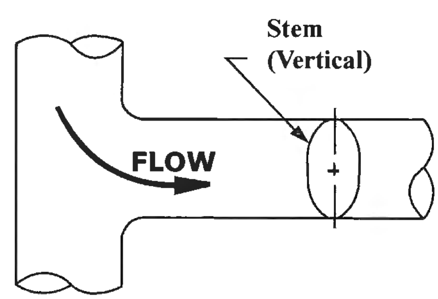
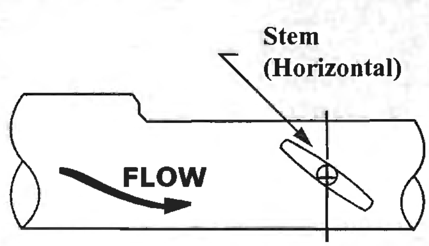
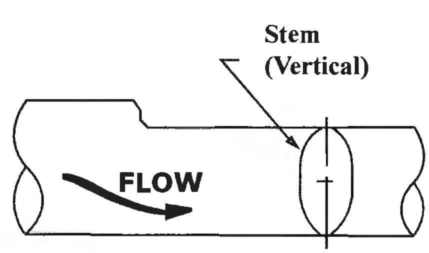
Valve Orientation (Continued)

c. Resilient seated butterfly valve located at the discharge of a pump should be oriented as follows:

	INCORRECT INSTALLATION	CORRECT INSTALLATION
i.) For centrifugal Pump – Pump shaft horizontal and stem vertical		
ii.) Centrifugal Pump – Pump shaft vertical & stem horizontal		
iii.) Axial Pump – Pump shaft vertical & stem vertical		

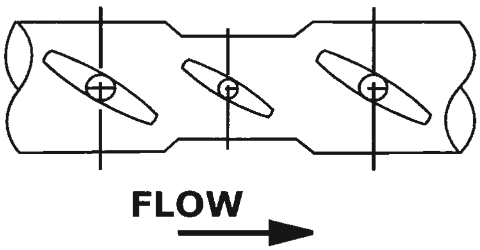
Valve Orientation (Continued)

d. Butterfly valves located downstream of a bend or pipe reducer should be oriented as follows:

	INCORRECT INSTALLATION	CORRECT INSTALLATION
i.) Bend		
ii.) Tee		
iii.) Pipe Reducer		

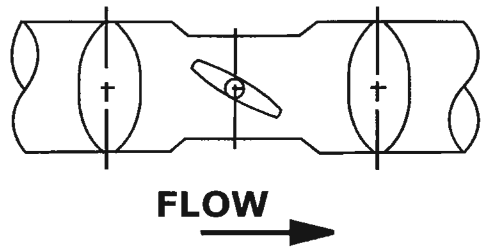
Valve Orientation (Continued)

e. Butterfly valves in combination for control/isolation applications should be installed as follows:



INCORRECT INSTALLATION

Combination with all valve stems in the same direction accelerates possible noise, vibration, & erosion problems.



CORRECT INSTALLATION

Combination with the stem of the control valve at right angle to those of other valves tends to cancel the drift of the fluid, and reduces noises, vibration, and erosion.

Installation Procedure

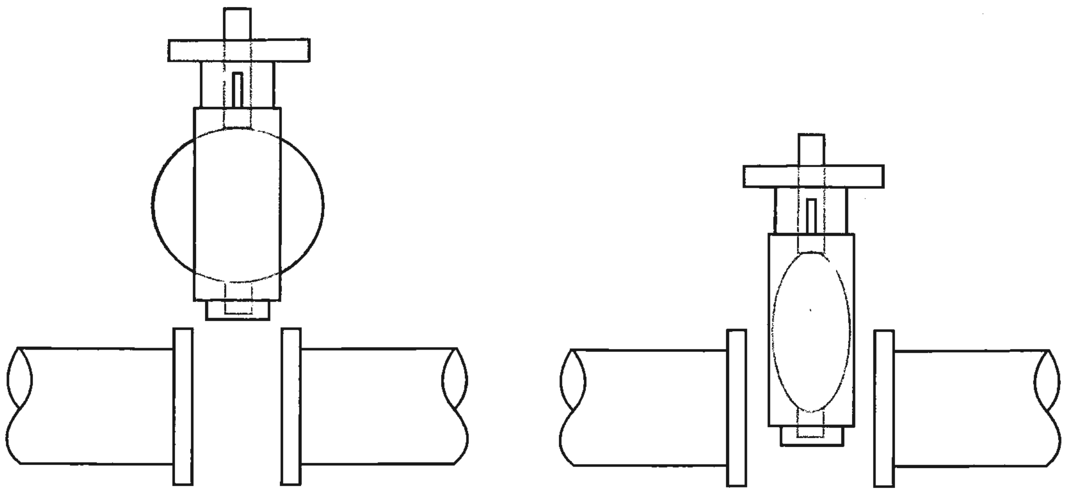
A. General Installation

1. Make sure the pipeline and pipe flange faces are clean. Any foreign material such as pipe scale, metal chips, welding slag, welding rods, etc., can obstruct disc movement or damage the disc or seat.
2. The Bray elastomer seat has molded o-rings on the face of the seat. **As a result, no gaskets are required as these o-rings serve the function of a gasket.**
3. Align the piping and then spread the pipe flanges a distance apart so as to permit the valve body to be easily dropped between the flanges without contacting the pipe flanges ***(see figure 1 page 6).***
4. Check to see that the valve disc has been positioned to a partially open position, with the disc edge about 1/2 inch to 3/8 inch inside the face of the seat, (approximately 10° open) ***(see figure 1 page 6)*** **Note: See page 2 for special consideration for valves with spring return actuators.**
5. Insert the valve between the flanges as shown in figure 1 of page 6, taking care not to damage the seat faces. Always pick the valve up by the locating holes or by using a nylon sling on the neck of the body.

WARNING

Never pick up the valve by the actuator or operator mounted on top of the valve.

Figure 1 – Insert Resilient Seated Butterfly Valve Between Flanges



INCORRECT INSTALLATION | **CORRECT INSTALLATION**

CAUTION

Pipe not spread, disc opened beyond valve body face; Results; Disc edge damaged when it hits pipe flange.

Pipe spread and aligned, disc rotated; Results; no undesirable beginning seating/ unseating torque, disc edge protected.

6. Place the valve between the flanges, center it, and then span the valve body with all flange bolts, but do not tighten the bolts. Carefully open the disc to the full open position, making sure the disc does not hit the adjacent pipe I.D. Now systematically remove jack bolts or other flange spreaders, and hand-tighten the flange bolts as shown in **Figure 2** below. Very slowly close the valve disc to ensure disc edge clearance from the adjacent pipe flange I.D. Now open the disc to full open and tighten all flange bolts per specification as shown in **Figure 2**. Finally, repeat a full close to full open rotation of the disc to ensure proper clearances ***(See figures 3 & 4 page 7)***.

Figure 2 – Flange Bolt Tightening Pattern

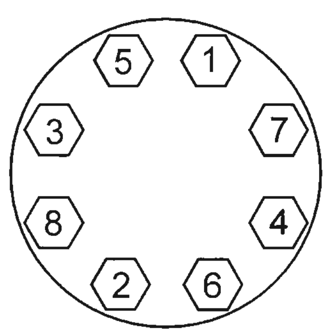
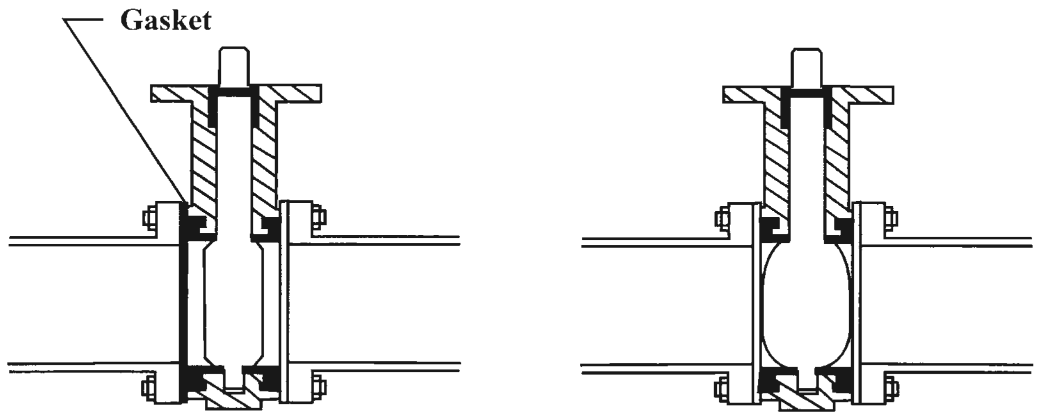


Figure 3 – Initial Centering & Flanging of Valve



<table>
<tr>
<td>

INCORRECT INSTALLATION

Disc in closed position; gaskets used; Results – Seat distorted and over-compressed causing high initial unseating torque problems.

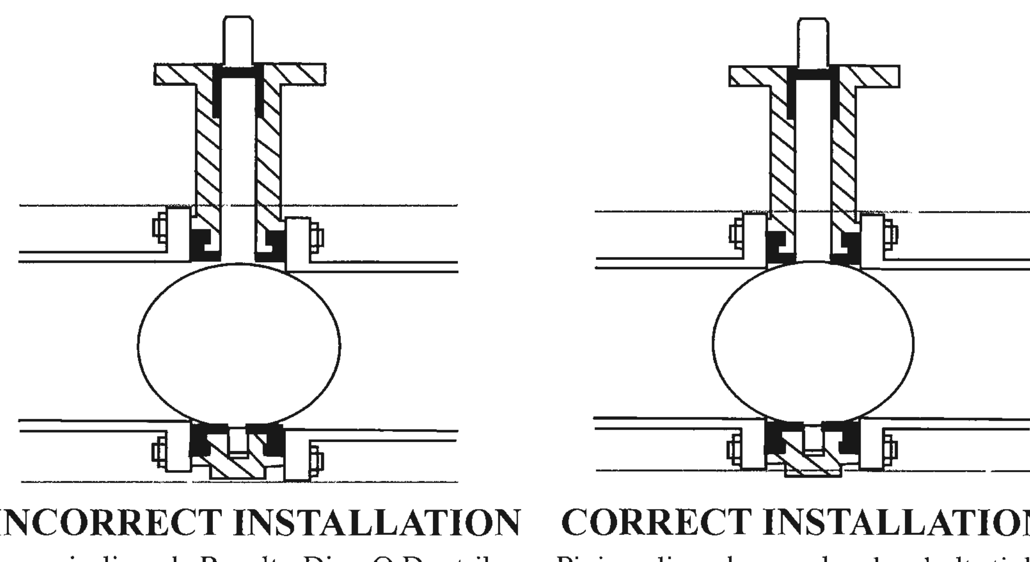
</td>
<td>

CORRECT INSTALLATION

Bolts snugged, not torqued tight, disc edge within body face-to-face but not fully closed, no flange gaskets; Results: No disc edge damage, proper sealing allowed.

</td>
</tr>
</table>

Figure 4 – Final Aligning & Tightening of Flange Bolts



<table>
<tr>
<td>

INCORRECT INSTALLATION

Piping misaligned; Results Disc O.D. strikes pipe I.D. causing disc edge damage, increased torque & leakage. Seat face o-rings will not seal properly with incorrectly aligned piping.

</td>
<td>

CORRECT INSTALLATION

Piping aligned properly when bolts tightened, disc in full open position; Results – disc clears adjacent pipe I.D., seat face seals properly, no excessive initial torque.

</td>
</tr>
</table>

When resilient seated butterfly valves are to be installed between ASME welding type flanges, care should be taken to abide by the following procedure to ensure no damage will occur to the seat:

1. Place the valve between the flanges with the flange bores and valve body aligned properly. The disc should be in the 10° open position.
2. Span the body with the bolts.
3. Take this assembly of flange-body-flange and align it properly to the pipe.
4. Tack weld the flanges to the pipe.
5. When tack welding is complete, remove the bolts and the valve from the pipe flanges and complete the welding of the flanges. Be sure to let the pipe and flanges cool before installing the valve.

CAUTION

Never complete the welding process (after tacking) with the valve between pipe flanges. This causes severe seat damage due to heat transfer.

Installation of Bray PTFE Seated Butterfly Valves in Plastic Flanges.

Bray recommends the following guidelines when PTFE Seated Valves are installed between plastic flanges:

1. The valve body should be coated with epoxy, not nylon. The extra thickness of the nylon coating slightly reduces the seat compression, and every advantage to maximize seat compression should be taken with plastic flanges.
2. The plastic flange can be either one piece construction, or two piece construction comprised of a stub end and a backup ring.
3. The plastic flange style can be butt-weld, socket or slip-on, but butt-weld and socket are preferred.
4. The plastic flange face must be flat. Concave and convex flange faces are not acceptable. This includes flange faces that were originally flat but later distorted into a concave shape by over tightening the flange bolts.
5. The plastic flange face surface may have grooves or serrations, provided the grooves do not exceed .100" (2.54 mm) in width or .020" (.508 mm) in depth. If the grooves are less than .100" (2.54 mm) in width, the groove depth must not exceed the width. However, fine conentric or "phonograph record" grooves are acceptable regardless of the groove depth.
6. Flange gaskets must not be used with PTFE seats, since they create an uncontrolled over compression that can buckle the PTFE and damage the seat. If a damaged face, a flange gasket can appear to cure the leak to atmosphere, while simultaneously damaging the PTFE seat and creating a second leak across the disc or up the stem hole. Leaks across the plastic flange must be cured without the use of gaskets, by proper selection and installation of the flange.
7. The bolts holding plastic flanges should be installed in strict conformance to the recommended practices of the plastic flange manufacturer. This usually involves aligning the flanges accurately, using lubricated bolts, and tightening the bolts in the proper sequence and to the specified torque. Uniform stress across the flange prevents leakage.

Maintenance and Repair

The many Bray features minimize wear and maintenance requirements. No routine lubrication is required. **All components – stem, disc, seat, bushing, stem seal, etc., are field replaceable, no adjustment is required**. If components require replacement, the valve may be removed from the line by placing the disc in the near closed position, then supporting the valve and removing the flange bolts.

WARNING No valve maintenance, including removal of manual or power actuators, should be performed until the piping system is completely depressurized.

Appendix E

Disassembly/Assembly Instructions

Series 31H Resilient Seated Butterfly Valves

Disassembly –

1. Remove the handle, gear operator, or power actuator from actuator mounting flange.
2. Remove the "Spirolox"® retaining ring and the two C-ring stem retainers from the stem hole.
3. Then remove the stem, bushing and seal.
4. Remove the disc from the seat, protecting the disc edge at all times.

Note: Valve is provided with the seat bonded to the body and therefore is not easily field replaceable. Please contact your local Bray representative for seat replacement.

Assembly –

1. Insert stem seal and bushing.
2. Push stem into the stem hole of the body until the bottom of the stem is flush with the inner top edge of the seat.
3. Install a light coating of silicone or grease on the I.D. of seat. Insert the disc into the seat by lining up the disc holes with the stem holes of the seat.

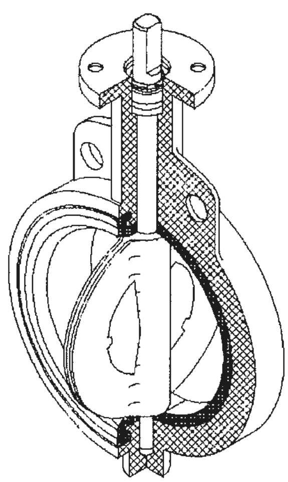
   Note: The broached double "D" flats in the disc must be toward the bottom of the valve body.

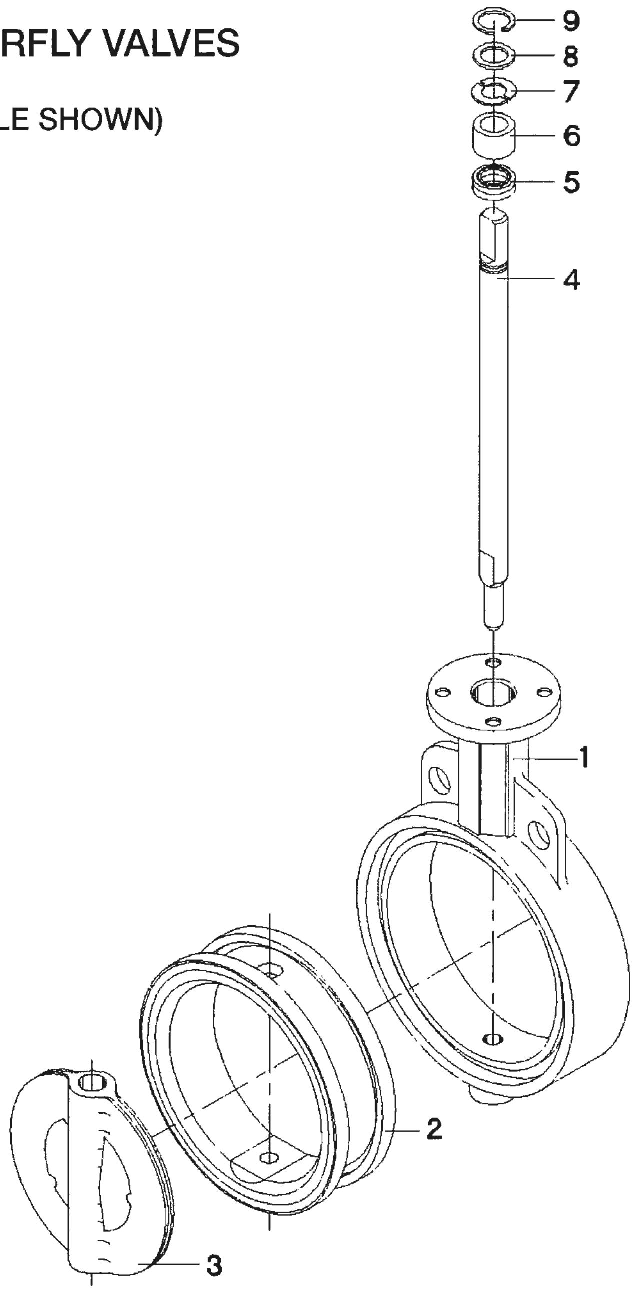
4. With a downward pressure and rotating the stem back and forth, push the stem until the stem touches the bottom of the body stem hole.
5. Make certain that when pushing the stem through the disc bottom, the broached flats of stem and disc are aligned.
6. Replace the stem bushing and two stem retainers, then replace the "Spirolox"® retaining ring back into position.
7. Replace handle, manual gear operator or power actuator on the actuator mounting flange.

SERIES 31H

RESILIENT SEATED BUTTERFLY VALVES

1. BODY (S30 WAFER STYLE SHOWN)
2. SEAT
3. DISC
4. STEM
5. STEM SEAL
6. STEM BUSHING
7. STEM RETAINER
8. THRUST WASHER
9. RETAINING RING





Bray CONTROLS
A Division of BRAY INTERNATIONAL, Inc.
13333 Westland East Blvd. Houston, Texas 77041
281/894-5454 FAX 281/894-9499 www.bray.com

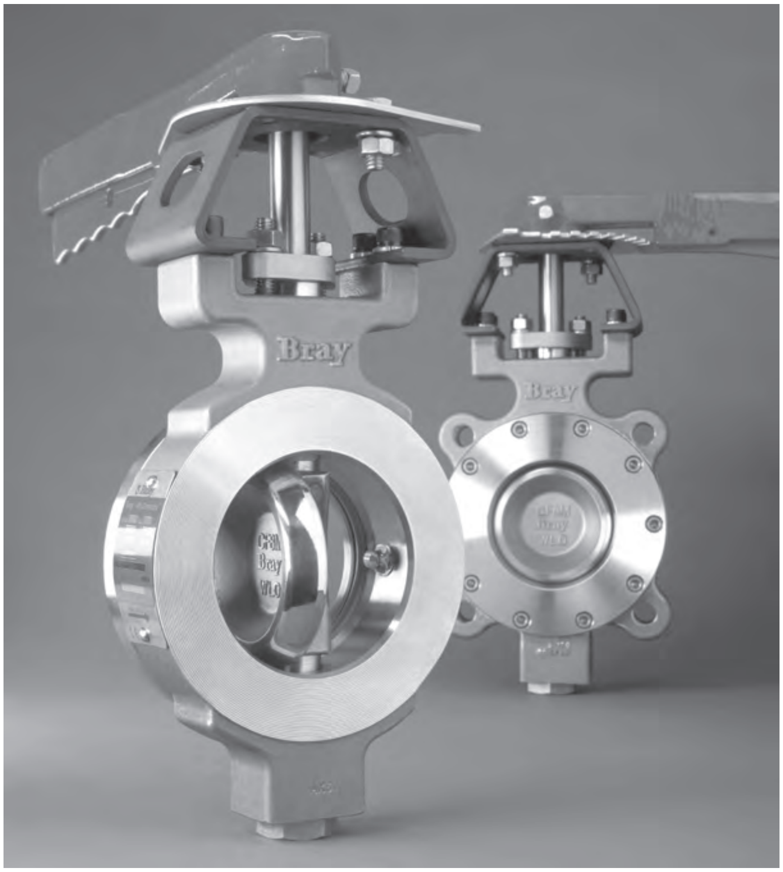
OM-RSBFV-001 08-2010

BRAY/McCANNALOK BUTTERFLY VALVES

Operations & Maintenance Manual
December 2015

Bray/McCannalok Butterfly Valves

Installation and Maintenance Instructions
ANSI Classes 150 and 300 - Sizes 2-1/2” through 24”
ANSI Classes 600 - Sizes 3” through 16”
Bidirectional Fire Safe ANSI Classes 150 and 300 - Sizes 2-1/2” through 24”



The Bray/McCannalok Series 40 high-performance butterfly valve combines the advantages of trunnion-type ball valves with the easy operation, light weight, and low cost of butterfly valves. One basic design is suitable for a wide range of services, including oxygen, chlorine, sour gas, vacuum, and steam applications.

Bubbletight shutoff is provided throughout a wide range of operating conditions.

Suitable for both modulating and on/off services, the Series 40 butterfly valve is easily automated with your choice of manual operators, electric and pneumatic actuators, positioners, and controls.

The Series 40 is available in a Fire Safe model qualified to API 607 4th Edition and BS 6755 part 2.

Additional information about Series 40 butterfly valves – including application data, engineering specifications, and actuator selection is available from your Bray distributor or sales representative.

Installation

Special instructions for Fire Safe valves appear on page 5.

1. The Series 40 valve is designed to be mounted between ANSI flanges. When the valve is open, the disc will extend into the pipe on both sides of the valve – further on the body side than the seat retainer side of the valve. Piping must be large enough to allow the disc to clear the pipe. The charts on page 2 show the minimum pipe ID allowable, and standard pipe IDs. In general, Class 150 valves will clear Schedule 40 pipe, and Class 300 valves will clear Schedule 80 pipe adequately. Class 600 will in general clear Schedule 80 sizes 3, 4, and 6; and Schedule 100 in sizes 8, 10, 12, 14, and 16.

2. If handle or actuator has been removed, do not rotate disc beyond full open or closed position – this could cause damage to sealing surfaces. (NOTE: Series 40 valves are equipped with stops to prevent over closure.) The valve is opened by turning counterclockwise, closed by turning clockwise. The double “D” flats or keyway at the top of the stem is parallel to the disc edge.

3. For maximum service life, install the valve with the seat retainer upstream. Positive shutoff will be obtained with the valve in either position; however, installation with the seat retainer upstream will give longer service life, especially in erosive services.

4. With the disc in closed position, carefully center valve between flanges. Guide holes (wafer pattern valve) or tapped holes (lugged valves) match ANSI Pipe flanges and assist in positive alignment.

5. Use standard torques when bolting valve into the line. The seat is sufficiently compressed by the seat retainer, and additional force from flange bolting is not required.

6. Gaskets should conform to the requirements of API Standard 601, Edition 3 for ASME/ANSI B16.5 class flanges. Spiral wound gaskets, such as Flexitallic CG or CGl series, conforming to ASME/ANSI B16.20 are acceptable.

MINIMUM INSIDE DIAMETER OF PIPE WITH THE RECOMMENDED CLEARANCE

Valve Size	Class 150	Class 300	Class 600
2.5	2.28	2.28	
3	2.86	2.86	2.75
4	3.72	3.72	3.56
5	4.80	4.80	
6	5.88	5.75	5.38
8	7.80	7.56	6.88
10	9.78	9.44	8.50
12	11.74	11.31	10.12
14	12.90	11.38	10.88
16	14.68	14.31	12.62
18	16.60	15.00	
20	18.50	16.50	
24	22.50	20.68	

NOMINAL INSIDE DIAMETER OF PIPE

Valve Size	Schedule 40	Schedule 80	Schedule 100
2.5	2.469	2.323	
3	3.068	2.900	
4	4.026	3.826	
5	5.047	4.813	
6	6.065	5.761	
8	7.981	7.625	7.439
10	10.020	9.564	9.314
12	11.938	11.376	11.064
14	13.124	12.500	12.126
16	15.000	14.314	13.938
18	16.876	16.126	
20	18.814	17.938	
24	22.626	21.564	

NOTES:

1. Minimum l.D. of pipe with recommended clearances (per API 609) have been calculated by adding the minimum I.D. with zero clearance to a minimum recommended diametric clearance for each pipe size.

2. These charts assume that the pipe is on the body side of the valve and that the pipe is perfectly centered. The seat retainer side of the valve will always have more clearance than the body side.

3. A minimum of 1/16” thick gasket is used between the pipe flange and valve body face.

4. When using a pipe whose l.D. is smaller than the recommended minimum inside diameter of pipe with adequate clearance, a chamfer of 45° should be provided on the end of the pipe so that it clears the disc.

Maintenance

1. Reasonable precautions should be taken before beginning work on the valve. Protective clothing, as required by the specific line fluid, should be worn.
2. Before removing handle or the actuator from the valve, or before removing seat retainer from a valve in dead end service, close the valve and depressurize the line. The eccentric design of the Series 40 may allow line pressure to open the valve if the handle/actuator is not in place while the valve is under pressure.
   DO NOT PRESSURIZE THE LINE WITHOUT A HANDLE OR ACTUATOR ON THE VALVE.
3. The Series 40 valve must be in the closed position to be removed from the line.
4. Begin all work on a valve that has been removed from the line by cleaning the valve, removing any grit or scale. When handling the valve, care should be taken not to scratch the disc edge or seats.
5. Replacement seats, seals and other parts are available from authorized distributors. Contact your distributor or sales representative for details of price and delivery.

Stem Seal Replacement

Refer to drawing on page 4 for parts identification

1. If required, remove handle assembly. Remove socket head cap screws (21) and lock washers (22). Remove mounting bracket (20). For actuated valves, unbolt mounting bracket from body and lift actuator assembly off stem. Note assembly positions before removal.
2. Remove gland retainer nuts (14) and lock washers (13). Remove gland retainer (11) anti-blowout retaining ring or split ring (10) (depending on size), and gland ring (7).
3. Hook out stem seals (8), taking care not to scratch stem or stuffing box bore. Do not remove thrust washer (9), unless further valve disassembly is required.
4. Examine stuffing box bore and stem, clean as necessary to remove any corrosion or foreign matter before installing new seals.
5. Install new seals in stuffing box one at a time, TFE (white) seals first, with the carbon fiber ring at the top. Stagger seal ring joints 180° apart when installing. Tamp each ring to bottom before installing next ring. Note: On the larger valves it will be necessary to compress each seal before adding the next.
6. Slide gland ring (7) over stem on top of seals (8). Install anti-blowout retaining ring or split ring (10) (depending on valve size). Slide gland retainer (11) over stem and onto gland studs (12). Place lockwashers (13) and hex nuts (14) on studs (12) and tighten finger tight. Tighten gland nuts (14) evenly and alternately to the proper torque value given in Table 2.
7. Remount actuator, or mounting bracket (20) with lock washers (22) and cap screws(21) and handle (27). Tighten handle set screw (28) to secure the handle to the valve stem.
8. Operate valve open and closed several times, to check for binding and to set the stem seals. Loosen gland nuts (14) and retighten to torque value given in Table 2.

TABLE 1

TOTAL NUMBER OF STEM SEALS

Valve Size	Class 150	Material CF / TFE	Class 300	Material CF / TFE	Class 600	Material CF / TFE
2.5	4	1 / 3	4	1 / 3		
3	4	1 / 3	4	1 / 3	12	2 / 10
4	4	1 / 3	4	1 / 3	12	2 / 10
5	4	1 / 3	4	1 / 3		
6	4	1 / 3	4	1 / 3	16	2 / 14
8	5	1 / 4	5	1 / 4	16	2 / 14
10	5	1 / 4	5	1 / 4	18	0 / 18
12	5	1 / 4	5	1 / 4	18	0 / 18
14	6	0 / 6	6	0 / 6	18	0 / 18
16	6	0 / 6	9	0 / 9	16	0 / 16
18	9	0 / 9	9	0 / 9		
20	9	0 / 9	9	0 / 9		
24	10	0 / 10	8	0 / 8		

CF=Carbon Fiber

Seat Replacement

1. With the disc in the closed position, remove the valve from the line.
2. Lay the valve down with the disc in the closed position and the seat retainer side facing up.
3. Remove the socket head cap screws (17), the seat retainer (16), and seat (15).
4. Carefully clean the seat area in the body and seat retainer. Remove foreign matter, dirt, etc. Check disc seating area for nicks or scratches.
5. Place the new seat (15) on disc (2), carefully centering it in the recess in the body.
6. Align the holes in the seat retainer (16) with matching holes in body and carefully place in position on top of seat (15). Be careful not to shift retainer to align holes so that seat is not shifted from correct position. Lightly grease cap screw (17) threads and tighten down evenly, alternating from top to bottom and side to side. Tighten to the torque value in Table 2.
7. Operate valve several times and examine seat for any damage before reinstalling the valve in the line.

TABLE 2

GLAND RETAINER NUT AND SEAT RETAINER SCREW TORQUE

Valve Size	Gland Nut			Seat Retainer Screws		
	150	300	600	150	300	600
2.5	60	60		100	100	
3	60	60	80	100	100	100
4	60	60	100	175	175	175
5	80	100		100	175	
6	80	120	140	100	175	300
8	80	140	200	175	175	300
10	110	190	200	175	300	300
12	130	220	200	300	300	300
14	130	200	240	300	300	500
16	150	220	240	300	300	750
18	150	220		300	300	
20	190	220		300	500	
24	190	240		500	500	

Disc and Stem Replacement

Refer to drawing on page 4 for parts identification.
NOTE: Stem and disc are supplied as a matched set with taper pins and are to be replaced as a set.

1. For handle-operated valves, loosen set screw (28) and remove handle assembly (27). Remove socket head cap screws (21) and lock washers (22). Remove mounting bracket (20). For actuated valves, unbolt mounting bracket from body and lift actuator assembly off stem. Note assembly positions before removal.
2. Remove gland retainer nuts (14) and lock washers (13). Remove gland retainer (11), anti-blowout retaining ring or split ring (10) (depending on valve size), and gland ring (7).
3. Hook out stem seals (8) taking care not to scratch stem or stuffing box bore.
4. Remove locating plug (19) and gasket (18).
5. Remove cap screws (17), seat retainer (16), and seat (15).
6. Turn disc to the full open position and drill out tack welds on large end of taper pins (4). Take care to support valve so that disc surfaces are not scratched. Drill sizes to remove tack welds as given in Table 3.
7. Place valve in flat position, with flat face of disc up. Support disc and body on wooden blocks to protect disc and body surfaces. Disc will rest in partially open position.
8. Knock out taper pins (4) using a rod or punch on small end of pin (opposite tack weld). It may be necessary to lift body and rotate disc slightly to do this. Make sure disc is resting on wood block since it will swing freely on stem with pins removed. When pins (4) are out, lay body down so disc and body are evenly supported on flat surface.
9. Using a brass bar or drift punch, knock stem (3) loose and pull from body. After long or severe service this may take considerable force. Be careful not to damage bearings, spacers or body.

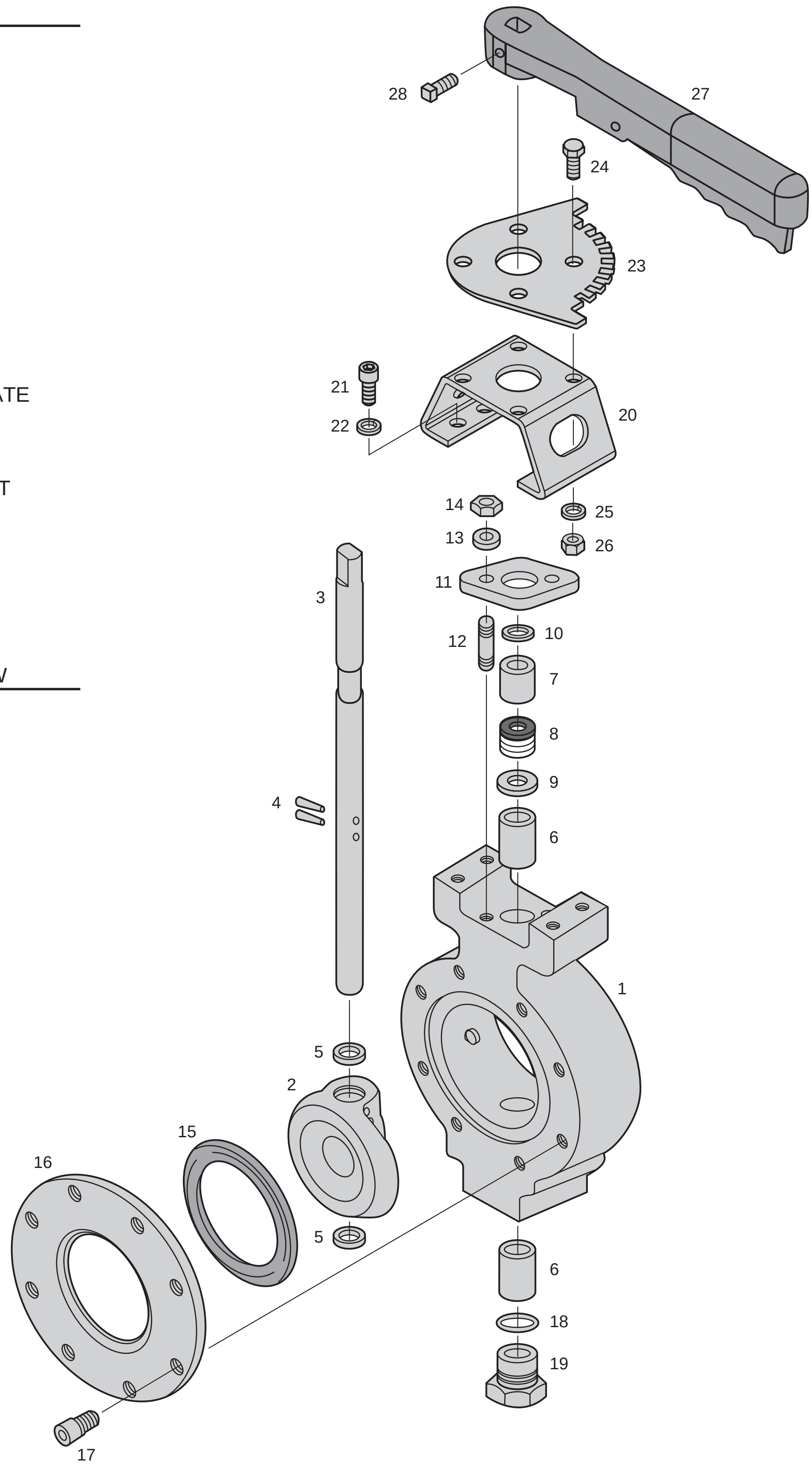
   NOTE: Disc spacers (5) are used at top and bottom of disc to properly position disc in body. Proper spacers were selected at initial assembly and rarely require replacement. The location of these spacers should be noted, and the spacers marked at disassembly so that they are reinstalled in the same positions, top and bottom.
10. Separate body from disc, and remove thrust washer (9) from packing bore.
11. Examine stem bearings (6) for excessive wear. If removed from body, note position and mark to reinstall in same location. Replacement is rarely needed, however, if bearing liner is worn through to the shell, or severe damage is evident they should be replaced.
12. Clean body thoroughly to remove all dirt, foreign matter, rust, etc.
13. Place the body (1) flat, seat retainer side up, and support it on wooden blocks sufficiently above the work surface as to facilitate insertion of the disc (2) in open position. Lower the disc into position, aligning the bores in body and disc.
14. Insert new stem (3) in body (1) with large end of the taper pin holes toward the top. Assemble disc spacers (5) as stem (3) is inserted, making sure that spacers are returned to original locations as marked.
15. Align taper pin holes in disc and stem, and install taper pins (4). Drive pins in tightly with rod or punch, and tack weld each pin (4) to disc (2) at large end of pin.
16. Install new gasket (18) on locating plug (19) and install plug in body.
17. Install new stem seals, following instructions in “Stem Seal Replacement” section.
18. Install new seat, following instructions in “Seat Replacement” section.
19. Remount handle assembly or actuator, and operate valve several times to verify proper operation. Examine disc and seat for any damage before reinstalling in line.

TABLE 3

DRILL SIZE TO REMOVE TACK WELD (In.)

Valve Size	Class					
	150		300		600	
2.5	.234	15/64	.234	15/64		
3	.234	15/64	.234	15/64	.250	1/4
4	.234	15/64	.234	15/64	.289	9/32
6	.234	15/64	.234	15/64	.341	11/32
8	.234	15/64	.234	15/64	.591	19/32
10	.234	15/64	.234	15/64	.706	45/64
12	.234	15/64	.234	15/64	.706	45/64
14	.591	19/32	.234	15/64	.706	45/64
16	.706	45/64	.706	45/64	1.032	1-1/32
18	.706	45/64	.706	45/64		
20	.706	45/64	.706	45/64		
24	.706	45/64	1.032	1-1/32		

No.	DESCRIPTION
1.	BODY
2.	DISC
3.	STEM
4.	TAPER PIN
5.	DISC SPACER
6.	BEARING ASS'Y
7.	GLAND RING
8.	STEM SEAL
9.	THRUST WASHER
10.	RETAINING RING
11.	GLAND RETAINER
12.	STUD
13.	LOCK WASHER
14.	HEX NUT
15.	SEAT ASSEMBLY
16.	SEAT RETAINER PLATE
17.	CAP SCREW
18.	O-RING GASKET
19.	LOCATING PLUG
20.	MOUNTING BRACKET
21.	CAP SCREW
22.	LOCK WASHER
23.	NOTCH PLATE
24.	BOLT
25.	LOCK WASHER
26.	HEX NUT
27.	HANDLE ASSEMBLY
28.	HANDLE SET SCREW



Special Instructions Fire Safe Butterfly Valve

Installation

1. The Fire Safe Series 40 valve will provide fire-safe shutoff with flow in either direction, meeting API 607 and British Standard 6755 part 2 criteria, as well as bubble-tight shutoff in either direction in normal service. However, installation with the seat retainer upstream provides maximum protection to the soft seat, and will increase seat life, especially in erosive services.
2. Installation bolting information and dimensional data given for the standard McCannalok valves is also applicable to the Fire Safe versions.

Stem Seal Replacement

The procedure for replacement on page 2 also applies to Fire Safe valves, with the following exceptions:

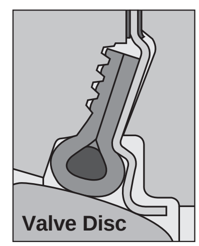
1. Graphite stem seals are used in the Fire Safe valves. The arrangement of the two types of stem seals when installed is: bottom seal carbon fiber braided ring; center seals – graphite rings; top seal carbon fiber braided ring.
2. Table 4 shows stem seal quantities for class 150 and 300 valves.

TABLE 4

	TOTAL NUMBER OF STEM SEALS					GLAND NUT TORQUE	
Valve Size	**Class 150**	**Material CF / G**	**Class 300**	**Material CF / G**	**Class 600**	**Class 150**	**Class 300**
2.5	4	2 / 2	4	2 / 2	NO FIRE SAFE VERSION	35	45
3	4	2 / 2	4	2 / 2		35	45
4	4	2 / 2	4	2 / 2		35	45
5	4	2 / 2	4	2 / 2		45	65
6	4	2 / 2	4	2 / 2		45	65
8	5	2 / 3	5	2 / 3		45	80
10	5	2 / 3	5	2 / 3		65	100
12	5	2 / 3	5	2 / 3		65	100
14	6	2 / 4	6	2 / 4		80	125
16	6	2 / 4	9	2 / 7		100	150
18	9	2 / 7	9	2 / 7		100	150
20	9	2 / 7	9	2 / 7		100	150
24	10	2 / 8	8	2 / 6		150	200

CF = Carbon Fiber
G = Formed Graphite

Seat Replacement



1. With the disc in the closed position, remove the valve from the line.
2. Lay the valve down with the disc in the closed position and the seat retainer side facing up.
3. Remove socket head cap screws, seat retainer, metal fire seat, gaskets, and soft seat.
4. Carefully remove graphite gaskets from metal seat. Do not bend or crimp metal seat. All traces of the old gaskets must be removed.
5. Clean seat retainer and body surfaces to remove any adhering gasket material, corrosion, or other foreign material. Examine disc seating surfaces for damage, and examine seating surface of metal seat for wear or damage. Replace if damaged.
6. Place new seat on disc, carefully centering in body recess.
7. Place new graphite gasket on the body. Position metal seat over the disc, lip facing out, on top of the polymer seat. Place another graphite gasket on top of the metal seat. Graphite gaskets can be first attached to the metal seat to simplify the assembly. Spray a suitable adhesive, like 3M Super 77 general purpose adhesive or similar, in 3 or 4 spots on both sides of the metal seat to hold the gaskets in position. Handle the gaskets carefully as they are very thin and are easily torn or scratched.
8. Align holes in seat retainer with holes in body and seat, and carefully place seat retainer in position, on top of seat. Be careful that seats do not shift when retainer is installed. Lightly grease cap screw threads and tighten down evenly in a criss-cross pattern to assure proper centering and uniform compression. Torque cap screws to the values given in Table 2 on page 3.
9. Lubricate the disc edge with molybdenum disulfphide spray or similar lubricant, if available. As a minimum, lubricate the disc edge with light machine oil or light grease. Operate valve several times and examine seat for damage before reinstalling in line.

Stem and Disc Replacement

The same procedures apply to Fire Safe valves as to the standard valves, with the addition of the special requirements for stem seal and seat replacement.

Field Adjustments – All Valves

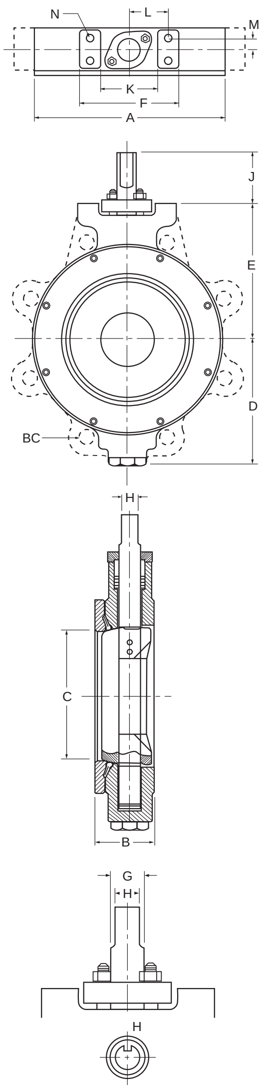
Stem Seal Leakage – Should leakage occur at the stem seals, it may be stopped by retightening the gland retainer nuts to the values specified in Tables 2 or 4. Do not overtighten gland nuts, as this may cause increased operating torque, and improper valve operation or closure. If the leakage cannot be stopped by this action, the stem seals require replacement.

Adjusting Valve Closure – Valves with gear actuators or electric/pneumatic actuators may require adjustment of the travel stops in the actuator to properly close valve for tight shut-off. The following procedure should be followed to set travel or limit stops. (It is recommended that the valve must be removed from line for this procedure and actuator mounting.)

1. Using a straight-edge and vernier or depth caliper, measure the distances from the face of the seat retainer to the disc (valve closed) face at the 3 o'clock and 9 o'clock positions (stem is at 12 o'clock position). The measurements must agree within 1/16" (0.062").
2. If they do not agree, disc must be rotated in the direction of the larger dimension. If the 3 o'clock dimension is larger, the disc is not fully closed, and must be rotated in the "close" direction more. If 9 o'clock dimension is larger, disc is over-closed, and must be opened slightly.
3. The valve disc is at the full open position when the disc is perpendicular to the body. Set the "open" actuator stop for this position. Do not allow the valve to over-open as this may damage the disc seating surfaces by hitting body or attached piping.
4. On gear operators, loosen and adjust the closing stop screw to permit proper disc positioning. Adjust and lock down when disc closure is within measured tolerance in paragraph 1. Open and close valve; recheck measurements before reinstalling in line.
5. For other power actuators, consult the manufacturer's instructions for setting travel stops, as these vary with actuator model and type.
6. If removing the valve from the line is not practical, as a crude remedy the disc can be placed into a position in the seat at which the leakage stops and travel stops are adjusted to this position.

Series 40 Butterfly Valves

Basic Dimensions - inches (mm)



ANSI 150 Series 40 / Series 41 WEIGHTS

Valve Size ins	Valve Size mm	A	B	C	D	E	F	G	H*	J	K	L	M	N	Lug Bolting Data BC	Lug Bolting Data No. Holes	Lug Bolting Data Threads UNC-2B	Series 40	Series 41
2 1/2	65	4.75	1.88	2.28	3.81	4.29	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	5.50	4	5/8-11	14	19
3	80	5.25	1.88	2.86	4.09	4.54	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	6.00	4	5/8-11	16	20
4	100	6.75	2.03	3.72	4.71	5.41	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	7.50	4	5/8-11	21	29
5	125	7.50	2.23	4.80	5.07	5.12	4.32	.75	.51	3.63	2.63	1.75	.50	3/8-16	8.50	8	3/4-10	26	42
6	150	8.62	2.23	5.88	5.57	5.62	4.32	.75	.51	3.63	2.63	1.75	.50	3/8-16	9.50	8	3/4-10	33	47
8	200	10.75	2.40	7.80	6.94	7.12	4.29	.87	.63	3.63	2.63	1.75	.50	3/8-16	11.75	8	3/4-10	46	70
10	250	13.06	2.75	9.78	8.56	8.47	5.50	1.18	.87	4.28	3.50	2.19	.56	3/8-16	14.25	12	7/8-9	80	110
12	300	15.50	3.08	11.74	10.18	9.97	5.50	1.18	.87	4.28	3.50	2.19	.56	1/2-13	17.00	12	7/8-9	123	167
14	350	17.50	3.73	12.90	11.95	14.00	7.75	1.38	.39x.39	2.50	5.00	3.13	.69	5/8-11	18.75	12	1-8	206	268
16	400	19.81	4.11	14.68	12.94	16.75	10.38	1.97	.47x.39	3.50	7.12	4.38	1.00	3/4-10	21.25	16	1-8	315	400
18	450	21.41	4.61	16.60	14.15	19.00	10.38	1.97	.47x.39	3.50	7.12	4.38	1.00	3/4-10	22.75	16	1 1/8-8	412	509
20	500	23.68	5.03	18.50	15.26	21.75	10.38	2.50	.62x.62	5.00	7.12	4.38	1.00	3/4-10	25.00	20	1 1/8-8	534	649
24	600	28.00	6.00	22.50	18.21	24.25	15.38	3.00	.75x.75	4.75	11.25	6.63	1.50	1-8	29.50	20	1 1/4-8	820	1010

ANSI 300 Series 42 / Series 43 WEIGHTS

Valve Size ins	Valve Size mm	A	B	C	D	E	F	G	H*	J	K	L	M	N	Lug Bolting Data BC	Lug Bolting Data No. Holes	Lug Bolting Data Threads UNC-2B	Series 42	Series 43
2 1/2	65	4.75	1.88	2.28	3.81	4.29	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	5.88	8	3/4-10	14	19
3	80	5.25	1.88	2.86	4.09	4.54	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	6.62	8	3/4-10	16	20
4	100	6.75	2.03	3.72	4.71	5.41	3.81	.63	.43	3.34	2.44	1.56	.38	5/16-18	7.88	8	3/4-10	21	29
5	125	8.25	2.23	4.80	5.13	5.62	4.32	.75	.51	3.63	2.50	1.75	.50	3/8-16	9.25	8	3/4-10	33	49
6	150	8.88	2.42	5.75	6.25	6.37	4.25	.87	.63	3.63	2.50	1.75	.50	3/8-16	10.62	12	3/4-10	40	62
8	200	10.94	2.82	7.56	7.55	7.72	5.50	1.18	.87	4.28	3.25	2.19	.56	3/8-16	13.00	12	7/8-9	69	107
10	250	13.26	3.28	9.44	9.36	9.10	5.50	1.38	.39x.39	4.28	3.38	2.19	.56	1/2-13	15.25	16	1-8	114	165
12	300	15.57	3.62	11.31	10.89	13.00	7.75	1.38	.39x.39	2.50	5.00	3.13	.69	5/8-11	17.75	16	1 1/8-8	181	250
14	350	17.90	4.66	11.38	12.50	17.25	10.38	1.97	.47x.39	3.50	7.12	4.38	1.00	3/4-10	20.25	20	1 1/8-8	331	459
16	400	19.94	5.35	14.31	13.88	20.00	10.38	2.50	.62x.62	5.00	7.12	4.38	1.00	3/4-10	22.50	20	1 1/4-8	457	641
18	450	22.00	5.98	15.00	15.43	20.25	15.38	2.50	.62x.62	4.75	11.25	6.63	1.50	1-8	24.75	24	1 1/4-8	605	869
20	500	24.10	6.34	16.50	16.80	21.50	15.38	3.00	.75x.75	4.75	11.25	6.63	1.50	1-8	27.00	24	1 1/4-8	780	1065
24	600	28.88	7.05	20.68	19.80	25.37	19.50	3.50	.88x.62	6.13	13.50	8.25	1.75	1 1/2-6	32.00	24	1 1/2-8	1270	1760

ANSI 600 Series 44 / Series 45 WEIGHTS

Valve Size ins	Valve Size mm	A	B	C	D	E	F	G	H*	J	K	L	M	N	Lug Bolting Data BC	Lug Bolting Data No. Holes	Lug Bolting Data Threads UNC-2B	Series 44	Series 45
3†	80	5.78	2.22	2.75	5.71	4.62	4.66	.75	.51	3.63	2.63	1.75	.50	3/8-16	6.62	8	3/4-10	24	31
4†	100	7.00	2.77	3.56	7.04	6.12	4.25	.87	.63	3.63	2.63	1.75	.50	3/8-16	8.50	8	7/8-9	41	58
6†	150	9.75	3.34	5.38	8.57	7.47	5.50	1.18	.87	4.28	3.25	2.19	.56	1/2-13	11.50	12	1-8	79	119
8†	200	11.80	4.23	6.88	10.80	11.75	7.75	1.38	.39x.39	2.50	5.00	3.13	.69	5/8-11	13.75	12	1 1/8-8	155	227
10†	250	14.09	4.82	8.50	14.62	16.00	10.38	1.97	.47x.39	3.50	7.12	4.38	1.00	3/4-10	17.00	16	1 1/4-8	280	400
12†	300	16.47	5.51	10.12	15.72	17.25	10.38	1.97	.47x.39	3.50	7.12	4.38	1.00	3/4-10	19.25	20	1 1/4-8	386	547
14†	350	18.03	6.09	10.88	17.48	19.00	15.38	2.50	.62x.62	4.75	11.25	6.63	1.50	1-8	20.75	20	1 3/8-8	549	750
16†	400	20.38	7.00	12.62	19.41	21.00	15.38	3.00	.75x.75	4.75	11.25	6.63	1.50	1-8	23.75	20	1 1/2-8	752	1100

Dimensions are in inches and weights in lbs.

†**Note:** For mounting of actuators and manual gear operators, dimensions are for reference only. Consult factory for exact dimensions. Bray reserves the right to change product dimensions without notice.

*Keyway is applicable on valve sizes 14"-42" Class 150, 10"-36" Class 300, and 8"-14" Class 600.

NOTICE:
Series 40 Butterfly Valves are designed and manufactured using good workmanship and materials, and they meet all applicable industry standards.

Bray Controls, is anxious to avoid injuries and property damage which would result from misapplication of the product. Proper valve selection is imperative. Examples of the misapplication or misuse of a valve include but are not limited to use in a service in which the pressure/temperature rating is exceeded or in a chemical service incompatible with the valve materials; use of undersized valve actuators; use of extremely fast valve actuation and/or continuous valve cycling on standard valves; making modifications of the product of any kind; failure to use caution in operating valves in high temperature, high pressure, or highly hazardous services; and the failure to maintain valves as recommended.

Patents applied for all over the world.
Bray® is a registered trademark of Bray International Inc.

A Division of BRAY INTERNATIONAL, Inc.
13333 Westland East Blvd. Houston, Texas 77041
281/894-5454 FAX 281/394-9499 www.bray.com

WATTS BRASS BALL VALVES

Operations & Maintenance Manual
December 2015

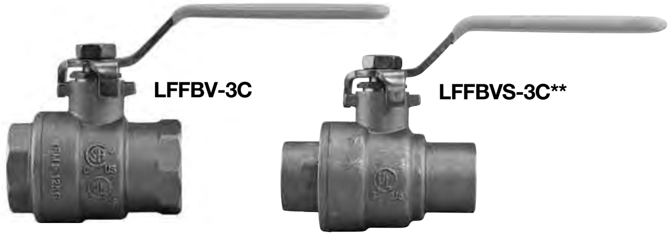
For Commercial and Industrial Applications

Job Name ____________________	Contractor ____________________
Job Location ____________________	Approval ____________________
Engineer ____________________	Contractor's P.O. No. ____________________
Approval ____________________	Representative ____________________

LEAD FREE*

Series LFFBV-3C, LFFBVS-3C

2-Piece, Full Port, Lead Free* Brass Ball Valves



Sizes: ¼" – 4" (8 – 100mm)

Series LFFBV-3C 2-piece, full port, Lead Free* brass ball valves are used in commercial and industrial applications for a full range of liquids and gases. They feature a bottom-loaded blowout proof stem, virgin PTFE seats, thrust washer, and adjustable stem packing gland, stem packing nut, chrome plated Lead Free* brass ball, brass adapter, and steel handle. The Series LFFBV-3C, LFFBVS-3C features Lead Free* construction to comply with Lead Free* installation requirements.

Features

- Lead Free* brass body and adapter
- Certified to NSF/ANSI standard 61/8
- CSA approved threaded valves only ¼" – 3" (15 – 80mm)
- UL/FM approved threaded valves ½" – 2" (15 – 50mm)
- UL Listed solder valves ½" – 2" (15 – 50mm)
- Fluorocarbon elastomer stem O-ring prevents stem leaks
- Adjustable stem packing gland
- PTFE stem packing seal, thrust washer, and seats
- Bottom loaded blowout proof stem
- Machined chrome plated Lead Free* brass ball
- Valves comply to MSS-SP-110 standard

Models

LFFBV-3C: ¼" – 4" (8 – 100mm) with threaded connections

LFFBVS-3C: ½" – 3" (15 – 80mm) with solder connections

Pressure – Temperature

Temperature Range: -40ºF to 400ºF (-40ºC to 204ºC)

Pressure Ratings

LFFBV-3C : ¼" – 2" (8 – 50mm)
600psi (41 bar) WOG, non-shock
150psi (10.3 bar) WSP

2½" – 4" (65 – 100mm)
400psi (27.5 bar) WOG, non-shock
125psi (8.6 bar) WSP

LFFBVS-3C : ½" – 2" (15 – 50mm)
600psi (41 bar) WOG, non-shock
150psi (10.3 bar) WSP

2½" – 3" (65 – 80mm)
400psi (27.5 bar) WOG, non-shock
125psi (8.6 bar) WSP

**This valve is designed to be soft soldered into lines without disassembly, using a low temperature solder to 420°F (216°C). Higher temperature solders may damage the seat material.

NOTE: Apply heat with the flame directed **AWAY** from the center of the valve body. Excessive heat can harm the seats. After soldering, the packing nut may have to be tightened.

Approvals

¼" – 4" (8 - 100mm) LFFBV-3C
Certified to NSF/ANSI standard 61/8*

½" – 3" (15 – 80mm) LFFBVS-3C
Certified to NSF/ANSI standard 61/8*
*Domestic cold water at 73ºF (23ºC)

½" – 2" (15 – 50mm) LFFBV-3C UL/FM approved

½" – 2" (15 – 50mm) LFFBVS-3C UL Listed

Gas Approvals (Threaded Valves Only)

½" – 2" (15 – 50mm) ASME B16.33, CSA

½ psig, 5psig, and 125psig (14, 34 and 862 kPa)
@ -40ºF to 125ºF (-40ºC to 52ºC)

2½" – 3" (65 – 80mm)

ASME B16.38, CSA

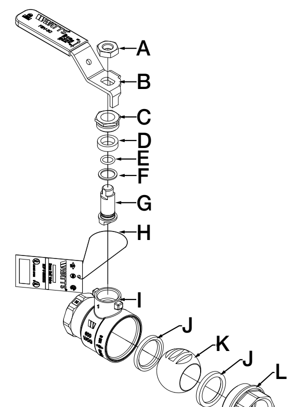
½ psig, 5psig, and 125psig (14, 34 and 862 kPa)
@ -40ºF to 125ºF (-40ºC to 52ºC)

Specifications

Approved valves shall be 2-piece full port design constructed using Lead Free* brass body and end adapter. Lead Free* ball valves shall comply with state codes and standards, where applicable, requiring reduced lead content. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded, blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks. Valve shall have chrome plated Lead Free* brass ball and adjustable packing gland. Threaded valves ½" – 3" shall be CSA approved to ½, 5, and 125psig (14, 34 and 862 kPa), UL/FM approved and certified to NSF/ANSI standard 61/8. Solder valves to be UL listed and certified to NSF/ANSI standard 61/8. Valve sizes ¼" – 2" shall be rated to 600psi (41 bar) WOG non-shock and 150psi (10.3 bar) WSP. Valve sizes 2½" – 4" threaded, shall be rated to 400psi (27.5 bar) WOG non-shock and 125psi (8.6 bar) WSP. Valve sizes 2½" – 3" solder shall be rated to 400psi (27.5 bar) WOG non-shock and 125psi (8.6 bar) WSP. Valve shall be a Watts Series LFFBV-3C (threaded) or LFFBVS-3C (solder).

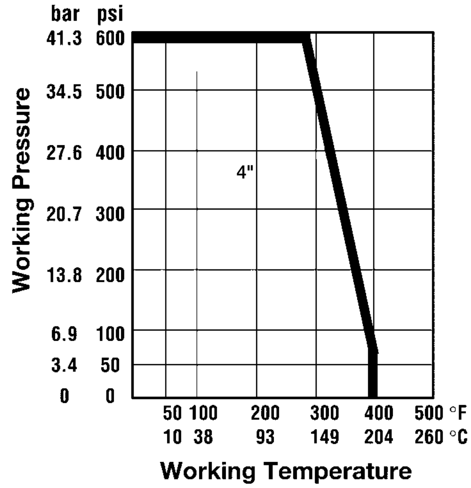
***The wetted surface of this product contacted by consumable water contains less than one quarter of one percent (0.25%) of lead by weight.**

Materials



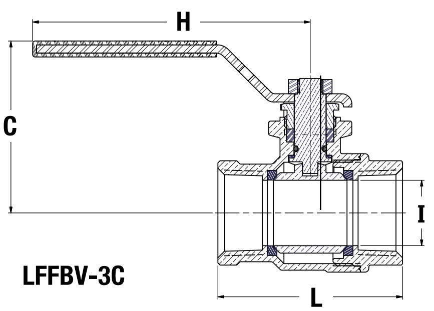
A. Handle Nut	Zinc plated carbon steel
B. Handle Assembly	Zinc plated carbon steel with vinyl insulator
C. Packing Nut	Lead Free* brass
D. Stem Packing	Virgin PTFE
E. O-ring	Fluorocarbon elastomer (FKM)
F. Thrust Washer	Virgin PTFE
G. Stem	Machined Lead Free* brass
H. Tag	Cardboard, Mylar coated both sides
I. Body	Forged Lead Free* brass
J. Seats	Virgin PTFE
K. Ball	Chrome plated Lead Free* brass
L. Adapter	Forged Lead Free* brass

Temperature – Pressure

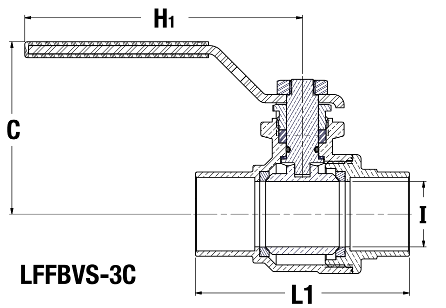


***See applicable note on reverse side for solder end valves with regards to pressure/ temperature rating.**

Dimensions – Weights



LFFBV-3C



LFFBVS-3C

SIZE (DN)		DIMENSIONS												WEIGHT	
		C		H		H1		I		L		L1			
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kg.
1/4	8	1 13/16	46	3 7/16	87	-	-	1/2	12.9	1 3/4	45	-	-	0.4	0.2
3/8	10	1 13/16	46	3 7/16	87	-	-	1/2	12.9	1 3/4	45	-	-	0.4	0.2
1/2	15	1 13/16	46	3 7/16	87	3 7/16	87	1/2	12.9	1 15/16	50	2 1/16	52	0.4	0.2
3/4	20	2 1/4	57	4	101	4	101	3/4	19.2	2 5/16	59	2 11/16	68	0.8	0.3
1	25	2 5/8	67	4 1/4	108	4 1/4	108	1	25.5	2 13/16	72	3 1/4	83	1.2	0.5
1 1/4	32	2 13/16	71	4 1/4	108	4 1/4	108	1 1/4	31.9	3 3/16	81	3 11/16	94	1.8	0.8
1 1/2	40	3 3/16	80	5 1/4	134	5 5/16	135	1 1/4	38.0	3 1/2	88	4 1/4	108	2.6	1.2
2	50	3 1/2	89	6	153	6	153	2	50.9	4 1/8	105	5 5/16	135	3.7	1.7
2 1/2	65	4 1/16	104	7 3/8	187	7 3/8	188	2 1/2	63.6	5 5/16	134	6 1/4	158	7.1	3.2
3	80	4 1/2	114	7 3/4	197	7 3/4	197	3	76.3	6 1/16	154	7 3/8	185	11.3	4.7
4	100	5 3/8	136	9 5/8	245	-	-	4	101.6	7 7/16	189	-	-	17.7	8.0

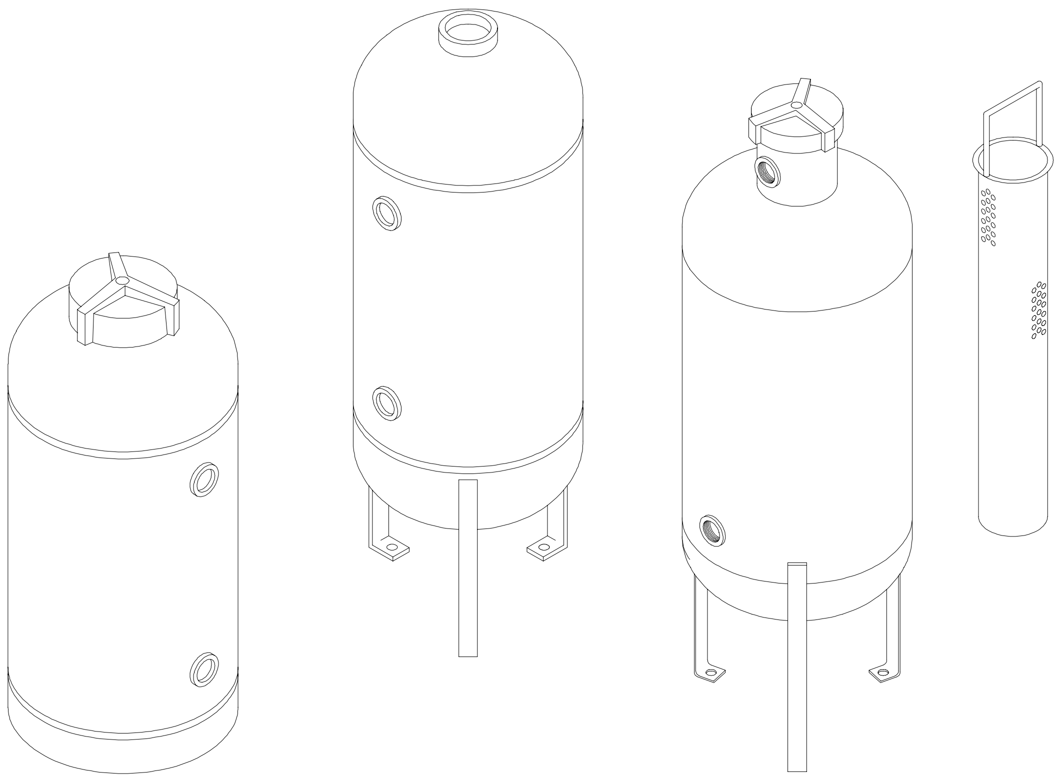
J.L. WINGERT CO. BYPASS, FILTER & BROMINE FEEDERS

Operations & Maintenance Manual
December 2015

J.L. WINGERT CO.

BYPASS, FILTER & BROMINE FEEDERS

OPERATION & MAINTENANCE MANUAL



PLEASE RECORD THE FOLLOWING DATA

(Information is located on the product label or packing slip)

Model Number: ____________________

Date Code: ____________________

Installation Date: ____________________

Installation Location / Application: ____________________

____

____

The above information will help when ordering replacement parts and accessories for your Wingert Feeder.

MANUFACTURING: *Mixers, Bypass Feeders, Filter Feeders, Bromine Feeders, Sample Coolers, Sludge Traps, Separators, Separator Systems, Tank Stands, Tank Package Systems, Glycol Feed Systems, Coupon Racks, Control Stations, NEMA Enclosures, Custom Packaged Systems and Specialty Welding*

P.O. Box 6207 • Garden Grove, CA 92846-6207 / 11800 Monarch St. • Garden Grove, CA 92841-2113 • Phone (714) 379-5519 • Fax (714) 379-5549
30998 Huntwood Ave. Unit 105 • Hayward, CA 94544-7033 • Phone (510) 487-5310 • Fax (510) 487-5137 ■ Southwest Region • Phone (602) 470-1015
On the Internet: http:// www.jlwingert.com • Email: customerservice@jlwingert.com

CONTENTS:	PAGE

1.0 INTRODUCTION

Wingert Feeders are designed to provide you with a rugged and dependable means of introducing chemicals into hot water, chilled water, or other liquid streams. Simplicity of design and ease of operation are inherent in every Wingert Feeder. Wingert Filter Feeders eliminate the need for a separate bypass feeder and filter. As rugged and dependable as our complete line of bypass feeders, the filter feeder offers ease of installation with precise filtering capabilities down to 25 micron.

2.0 WARRANTY

Wingert Bypass, Filter, & Bromine Feeders are guaranteed for one year from the date of shipment against manufacturing defects in material and workmanship which develop in the service for which they are designed. We will repair or replace defective material when returned to our factory with transportation prepaid: providing that the material is found to be defective upon inspection. We assume no liability for labor and/or other expenses in making repairs or adjustments. All replacements will be F.O.B. factory.

3.0 UNPACKING

Wingert Feeders are fully assembled and tested before shipping from the factory. Unpack and inspect feeder for physical damage. If feeder is damaged (and not noted with the freight carrier), contact the factory immediately for assistance. Verify that what you ordered is what you have received. Use the table on the following page along with the packing slip to identify the contents.

NOTE: You only have 3-5 days after receipt of goods to file a freight claim.

4.0 MODEL VERIFICATION

BYPASS FEEDERS

Rated for 200 PSI @ 200° F

MODEL NUMBER			
DB-	2	HD	/FBK

OPTIONS	
AR	Air release valve
PG	Pressure gauge
FBK	Filter bag kit
EK1	Epoxy coating inside only
EK2	Epoxy coating inside & outside
EK3	Epoxy coating outside only

FILL CLOSURE	
HD	Heavy duty 3 1/2", 1/4 turn fill port

CAPACITY	
2	2 gallon capacity
5	5 gallon capacity
12	12 gallon capacity
18	18 gallon capacity

STYLE	
---	Flat bottom (no drain, no legs)
DB	Dome bottom (drain port and legs)

FILTER FEEDERS

Rated for 200 PSI @ 200° F

MODEL NUMBER				
PF-	DB-	2	HD	/EK1

OPTIONS	
AR	Air release valve
PG	Pressure gauge
EK1	Epoxy coating inside only
EK2	Epoxy coating inside & outside
EK3	Epoxy coating outside only

FILL CLOSURE	
HD	Heavy duty 3 1/2", 1/4 turn fill port

CAPACITY	
2	2 gallon capacity
5	5 gallon capacity
12	12 gallon capacity

STYLE	
---	Flat bottom (no drain, no legs)
DB	Dome bottom (drain port and legs)

FILTER TYPE	
PF	Pleated filter
F	Filter
FHC	Filter, high capacity

4.0 MODEL VERIFICATION (CONTINUED)

HIGH PRESSURE BYPASS FEEDERS

Rated for 300 PSI @ 200° F

MODEL NUMBER			
HP-	2	LEG	/PG

OPTIONS	
AR	Air release valve
PG	Pressure gauge
EK1	Epoxy coating inside only
EK2	Epoxy coating inside & outside
EK3	Epoxy coating outside only

MOUNT	
LEG	Three floor mount legs

CAPACITY	
1	1 gallon capacity
2	2 gallon capacity
5	5 gallon capacity
12	12 gallon capacity

STYLE	
HP	High pressure (1" NPT fill)

BROMINE (FIBERGLASS) BYPASS FEEDERS

Rated for 150 PSI @ 120° F

MODEL NUMBER			
HP-	DB-	2	/ARPVC

OPTIONS	
ARPVC	PVC air release valve

CAPACITY	
2	2 gallon capacity
5	5 gallon capacity
12	12 gallon capacity
16	16 gallon capacity

STYLE	
---	Flat bottom (no legs, no drain)
DB	Dome bottom (drain port and legs)

MATERIAL	
FRP	Glass filled polyester resin (fiberglass)

5.0 LOCATION AND ENVIRONMENT

Wingert Feeders are designed for outdoor applications in direct exposure to the environment, however, exposure to extreme colds may cause contents to swell and vessel to burst. All feeders are coated with a water based enamel. Further protection may be added with a "-EK3" epoxy coating option.

6.0 INSTALLATION

These factors must be considered when installing your Wingert Feeder:

1) FLOWRATE
All Wingert Feeders are designed as bypass vessels and flow rate through feeder should not exceed:
1 GPM on 1 gallon feeders
2 GPM on 2 gallon feeders
5 GPM on 5 gallon feeders and larger

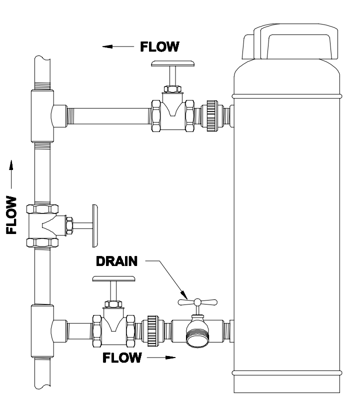
2) PRESSURE DIFFERENTIAL
Pressure differential should not exceed 5 PSI on filtered feeders.
On all others, pressure differential should not exceed 10 PSI.

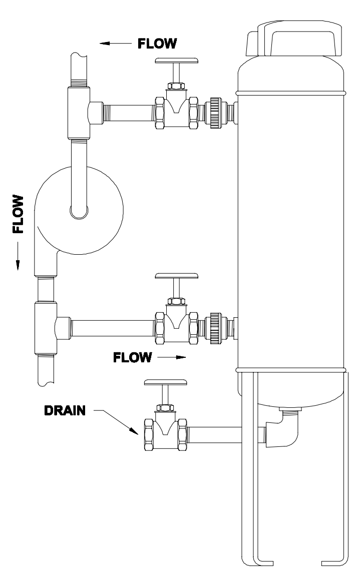
3) CREATING AND REGULATING FLOW AND PRESSURE DIFFERENTIAL
The key to any good installation is how you are going to create and control the flow rate and pressure differential. The most effective ways to do this is to plumb the bypass line across the recirculation pump, or to install a throttling valve in the main line. Controlling the flow is most effective when using a flow control valve set at a factory preset flow rate. You may also use globe, gate or needle valves to achieve proper flows.

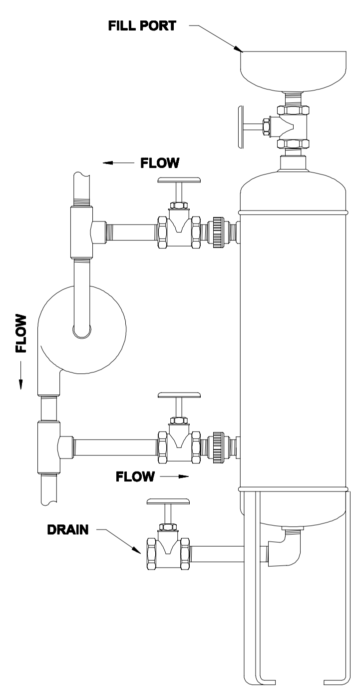
Use the following diagrams to decide which installation is best for your application.
Consult the factory for variations in standard installations.

6.1 INSTALLATION DIAGRAM - BYPASS FEEDERS, PLEATED FILTER FEEDERS, HIGH PRESSURE FEEDERS & BROMINE FEEDERS

Bypass Feeders, Pleated Filter Feeders, High Pressure Feeders & Bromine Feeders use the lower side port for inlet and the upper side port for outlet.

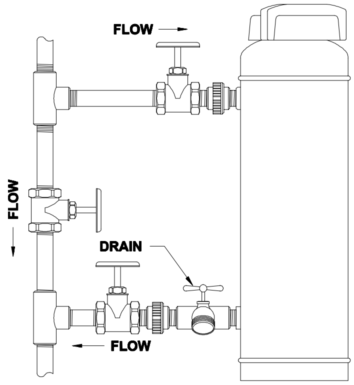


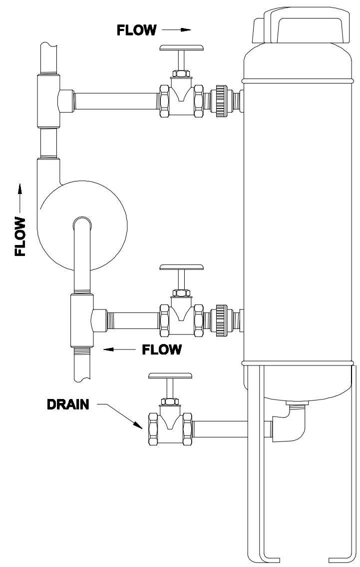




6.2 INSTALLATION

Filter Feeders use port for outlet.





7.0 APPLICATION INFORMATION & TROUBLESHOOTING

Follow the supplied guidelines closely. High volume and excess pressure are often contributing factors in shortening feeder life. A main contributing factor to decreasing the life of any feeder is trapped air. Once air is trapped in the feeder, the carbon steel will deteriorate rapidly. Removing excess trapped air is a necessity for any closed loop system.

TROUBLESHOOTING CHART

SYMPTOM	CAUSE	ACTION
Leaking at closure	**Improper seating of o-ring**	Remove cap, clean surface, and reseat cap and closure. If problem persists, replace o-ring.
Leaking at fittings	**Improper seal or cross-threading of fittings**	Remove leaking fitting and sealant, then inspect threading for damage. If threads seem to be intact, apply sealant (thread tape or pipe dope) and re-seat fitting. If problem persists, replace the fitting.
Filter damage	**High particle content or excess flow rate**	Check flow rate and control valves. Inspect filter chamber for solids contents. Adjust valves and replace filter. Large particle content is often a typical problem during start-up.
Interior corrosion	**Trapped air or chemical content**	If corrosion is apparent only near the fill port of vessel, typically there has been excessive trapped air. To remove trapped air, close isolation valves, and fill feeder to upmost point. Be sure to educate personnel of potential problems, and replace vessel if necessary. If corrosion is covering body interior, check with chemical supplier for compatibilty.
Leaking at seams	**Pinhole when being manufactured or excessive use**	Trapped gas when vessel is being produced may cause pin leaks when installed. Vessels that begin to leak after some time of service, may just be wearing thin. Typically there is no way to repair a vessel that is wearing thin, replace if needed.

8.0 ACCESSORY ITEMS

Wingert Feeders are offered with a complete line of accessory items. The chart below lists what the accessories are designed for, and their intended purposes.

BYPASS, FILTER & HIGH PRESSURE FEEDERS ACCESSORIES CHART

PART	DECRIPTION AND USE	DESIGNED FOR
3138	Valve package for flat bottom feeders. Includes inlet & outlet ball valves, unions, installation nipples, hose bibb and tee.	Flat bottom feeders
3139	Valve package for dome bottom feeders. Includes inlet & outlet ball valves, unions, installation nipples and drain valve.	Dome bottom feeders with 3 1/2" closure
3140 & 3140P	Valve package for high pressure feeders. Includes inlet & outlet ball valves, unions, installation nipples, drain valve, 1" fill valve and fill funnel. (3140P includes PE fill funnel)	High pressure feeders
3009, 3010 & 3080	Retrofit filter bag kit assembly for "HD" type feeders. Includes support tube, bag wire, bag and installation fittings. (3009 = 2 gallon, 3010 = 5 gallon & 3080 = 12 gallon)	"HD" style feeders
-AR	Air release, 1/4" NPT valve assembly	All feeders
-PG	Pressure gauge, 0-300 PSI assembly	All feeders
3061	3/4" NPT in-line PVC strainer with installation nipple	All feeders
3086	3/4" NPT sight flow indicator (125PSI, 100° F) with installation nipple	All feeders (PSI/TEMP limited)
3069 & 3069P	1" NPT fill funnel (3069 is carbon steel & 3069P is polyethylene)	"HP" style feeders

FIBERGLASS FEEDERS ACCESSORIES CHART

PART	DECRIPTION AND USE	WORKS WITH
3200	Valve package for flat bottom fiberglass feeders. Includes inlet & outlet ball valves, unions, installation nipples, drain valve and tee.	Flat bottom fiberglass feeders
3201	Valve package for dome bottom fiberglass feeders. Includes inlet & outlet ball valves, unions, installation nipples, drain valve with elbow and installation nipple.	Dome bottom fiberglass feeders
3202	PE fill funnel and isolation valve.	All fiberglass feeders
3203 & 3204	Rechargable PVC flow through dissolving chamber, 1" NPT fill port, 1/8" ports (3203 for 2 gallon models, 3204 for 5, 12 & 16 gallon models).	All fiberglass feeders
-ARPVC	PVC air release valve, installation tee and nipple	All fiberglass feeders

9.0 MAINTENANCE

When filling or inspecting a feeder, make sure that the vessel is not under pressure. Close isolation valves and open drain valve before opening fill port. Opening air release valve will release pressure ; beware that the contents may project through the valve.

Feeders generally need very little maintenance. When servicing or recharging the system, consult a water doctor for schedule. The most important factor in maintenance is to always purge trapped air when returning feeder to service. Filters should be maintained based on solids in system. Check frequently until schedule can be determined.

10.0 PARTS LISTING

CATEGORY	PART	DESCRIPTION
CLOSURE	**3071**	3 1/2" 1/4 turn cast closure with pressure plate and standard o-ring
	3072	212° F standard o-ring
	3073	400° F optional o-ring
FILTER BAG KITS	**3083**	Bag support wire assembly for 2 & 5 gallon filter bag kits
	3101	Bag support wire assembly for 12 gallon filter bag kits
	3084	Filter bag kit support tube assembly for 2 gallon models
	3085	Filter bag kit support tube assembly for 5 & 12 gallon models
FILTER FEEDERS	**3128**	Perforated basket assembly for 2 & 5 gallon models
	3129	Perforated basket assembly for 12 gallon models
	3131	Replacement 25 micron filter bag for 2 & 5 gallon models
	3132	Replacement 25 micron filter bag for 12 gallon models
HIGH CAPACITY FILTER FEEDERS	**3160**	Perforated basket assembly for all models
	3131	Replacement 25 micron filter bag for all models
PLEATED FILTER FEEDERS	**3186**	Hanger assembly for all models
	3187	Pleated 20 micron filter for all models
VALVE PACKAGE	**3141**	3/4" NPT brass ball valve and installation nipple
	3142	1" NPT brass ball valve and installation nipple
	3063	3/4" male NPT brass hose bibb
	3079	3/4" black iron union and installation nipple
FIBERGLASS FEEDERS	**3205**	2 1/2" CPVC closure with o-ring
	3206	4" CPVC closure with o-ring

Note: Other parts available upon request, please contact customer service for information and availability.

FEBCO SERIES 860 REDUCED PRESSURE ZONE ASSEMBLIES

Operations & Maintenance Manual
December 2015

INSTALLATION, OPERATION, MAINTENANCE

Maintenance Manual

Series 860 Reduced Pressure Zone Assemblies
Models 860, LF860, 860U & LF860U
$^1/_2$"- 2" (15 – 50mm)

Series 860

⚠ WARNING

THINK SAFETY FIRST

Read this Manual BEFORE using this equipment.

Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.

Keep this Manual for future reference.

NOTICE

If the unit is installed where a protective device is recommended may be a problem, the assembly should be protected and secured. On $^1/_2$" through 2" (15 – 50mm) units the handles of shutoff valves can be removed to discourage tampering. A protective enclosure can be installed over the unit to discourage vandals. If an enclosure is used, it should be installed so that adequate clearance is available for maintenance and testing. Consult local codes before installing any type of protective enclosure.

Table of Contents

Read and understand this manual prior to installing, operating or servicing this equipment.

FEBCO®

⚠ WARNING

IMPORTANT: You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product. **FAILURE TO COMPLY WITH PROPER INSTALLATION AND MAINTENANCE INSTRUCTIONS COULD RESULT IN PRODUCT FAILURE WHICH CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.** FEBCO is not responsible for damages resulting from improper installation and/or maintenance.

Local building or plumbing codes may require modifications to the information provided. You are required to consult the local building and plumbing codes prior to installation. If this information is not consistent with local building or plumbing codes, the local codes should be followed.

Need for Periodic Inspection/Maintenance: This product must be tested periodically in compliance with local codes, but at least once per year or more as service conditions warrant.

Replace internal components every 5 years.

Corrosive water conditions, and/or unauthorized adjustments or repair could render the product ineffective for the service intended. Regular checking and cleaning of the product's internal components helps assure maximum life and proper product function.

Feature and Operating Procedures

The FEBCO Series 860 Reduced Pressure Zone Backflow Preventer Assembly consists of two independently operating, spring loaded check valves with a pressure differential relief valve located between the two checks. The pressure drop across the first check valve is approximately 7.0 psid with no flow. The relief valve consists of a hydraulically balanced diaphragm with the high pressure side hydraulically connected to the upstream pressure zone. The relief valve remains closed during normal operation. The low pressure side of the diaphragm is spring loaded to force the relief valve to open when the pressure drop the first check and the diaphragm is reduced to approximately 3.0 psid. A complete assembly includes two shutoff valves and four test cocks.

General Service Procedures

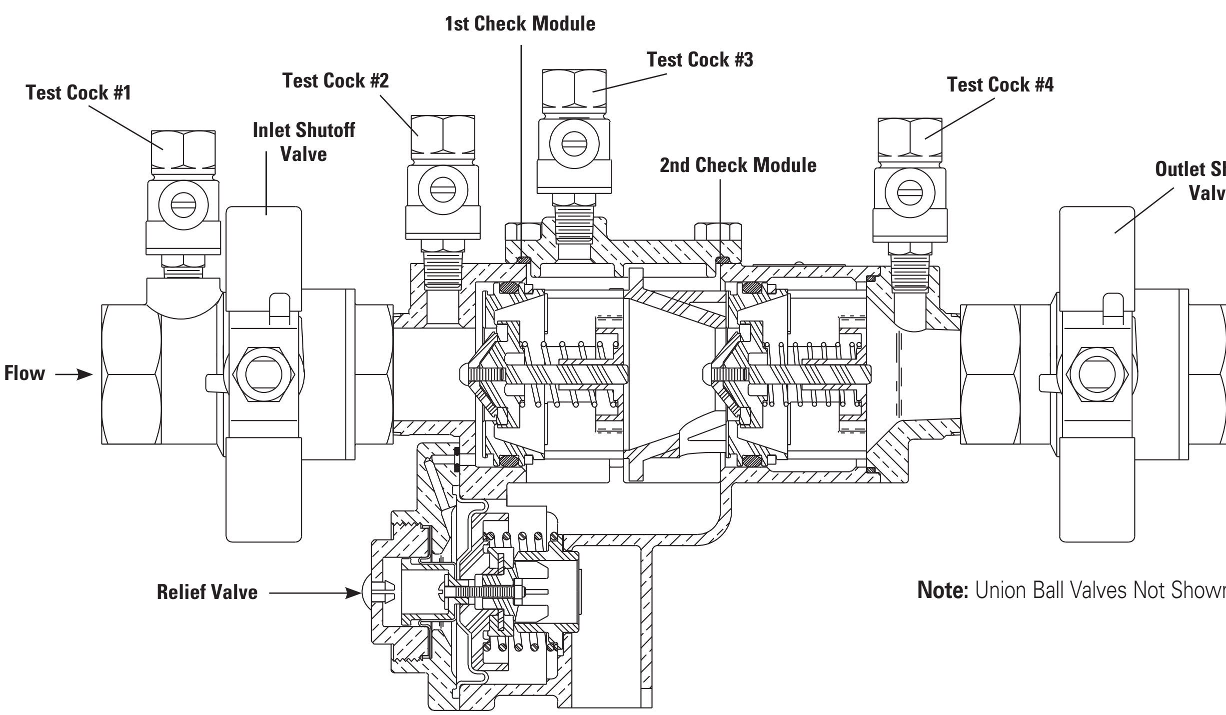
1. FEBCO backflow prevention assemblies can be serviced with standard tools and are designed for ease of maintenance. The assemblies are designed to be serviced in line, so the unit does not need to be removed from the line during servicing. **NO special tools are required.**

Suggested Tool Kit Series 860 ½"- 2"(15 - 50mm)

- 1 crescent wrench
- 1 medium standard screw driver
- Differential pressure test kit
- 1 medium Phillips screw driver
- Box/open end wrench

2. The most common cause of check fouling and relief valve discharge is dirt and debris in the seating areas. The line should be flushed clean of debris before installation of the assembly. To flush the line after installation of the assembly, slowly close the inlet shutoff valve, remove the cover and spring assemblies of both check valves and open the inlet shutoff valve to allow sufficient flow of water through the assembly to clear all sand, debris, etc. from the line. If debris in the water continues to cause fouling, a strainer may be installed upstream of the assembly (check local codes).
3. Rinse all parts with clean water before reassembly.
4. Carefully inspect diaphragms, seals, and seating surfaces for damage or debris. If the check valve seat disc has been severely cut at the seat ring diameter, the assembly has been subjected to extremely high and repeated back pressure. Either thermal water expansion or water hammer are the most likely causes. If back pressure persists, consider installation of a pressure relief valve downstream of the assembly.
5. Use caution to avoid damaging any guiding surfaces while handling parts. Do not force parts together. The O-ring seals used in FEBCO assemblies require only a small tightening force to ensure a positive seal.
6. Test unit after servicing in accordance with locally approved test methods to ensure proper operation (See page 9 for more details).
7. Refer to applicable exploded drawings and parts lists (pages 10-11) for visual aid information.
8. Apply a thin coating of the lubricant supplied in the repair kit to the O-rings and other seals as directed in this manual. Use of additional lubricants must be FDA approved food grade petroleum jelly.

Cut-A-Way Drawing



Note: Union Ball Valves Not Shown

Troubleshooting Guide

With Differential Pressure Gauge

SYMPTOM #1	READING	PROBLEM:
Check Differential Across #1 Check Valve	2 to 3 psid	Leak in #1 or #2 check valve
	6 to 8 psid and steady	Malfunctioning pressure relief valve
	2 to 7 psid and steady	Inlet pressure fluctuating

SYMPTOM #2	READING	PROBLEM:
Check Differential Across	2 to 3 psid	#1 check valve held open
#1 Check Valve	6 to 8 psid and steady	Malfunctioning pressure relief valve

Without Differential Pressure Gauge

SYMPTOM #1 AND #2	RESULT	PROBLEM:
A) Close Gate Valve #2	If discharge stops	Leak in #2 check valve
	If discharge does not stop	Go to "B"
B) Open #4 test cock to produce a flow greater than differential relief valve discharge	If discharge stops	Leak in #1 check valve
	If discharge does not stop	Malfunctioning pressure relief valve

SYMPTOM #1	CAUSE:	SOLUTION:
Continuous discharge from relief valve during NO FLOW conditions (Discharge stops with water flow) With this symptom, the pressure drop across the #1 check valve would be 2 to 3 psid. If a flow of water (more than discharge) is created through the valve, the pressure drop should increase to approximately 7psi	A. Debris fouling #1 check valve	Inspect and clean
	B. Outlet pressure higher than inlet pressure and debris fouling #2 check valve	Inspect and clean
	C. Spring stem not moving freely	Inspect for dirt or other foreign material
	D. Damaged seat or seat disc	Inspect and replace. If necessary, seat disc can be reversed in 1/2" through 2" sizes
	E. Leakage at check module O-ring	Inspect and replace seal or O-ring

SYMPTOM #2	CAUSE:	SOLUTION:
Intermittent discharge from relief valve during NO FLOW conditions. With the symptom, the pressure drop across the #1 check valve would be varying from about 2 to 7 psid	A. Inlet line pressure variations causing relief valve to discharge	Eliminate or reduce pressure variations by installing a soft seated, spring loaded check on upstream side of device
	B. Pressure surges (water hammer) causing relief valve to discharge as pressure wave passes through the zone	Eliminate or reduce pressure surges

Troubleshooting Guide (Continued)

SYMPTOM #3	CAUSE:	SOLUTION:
Continuous discharge from relief valve during FLOW and NO FLOW conditions With this symptom, the pressure drop across the #1 check valve would be 7 psid or more at all times	A. Seat disc dislodged from cavity in the main stem. (This can be caused by pressure surges during initial filling of system lines.)	Reposition disc in main stem cavity Repressurize system slowly
	B. Debris fouling the relief valve seat	Inspect and clean
	C. Debris blocking the relief valve sensing passage	Inspect and clean
	D. Dirt or scale jamming main stem	Inspect and clean, or replace
	E. Leakage at main stem	Inspect and clean, or replace

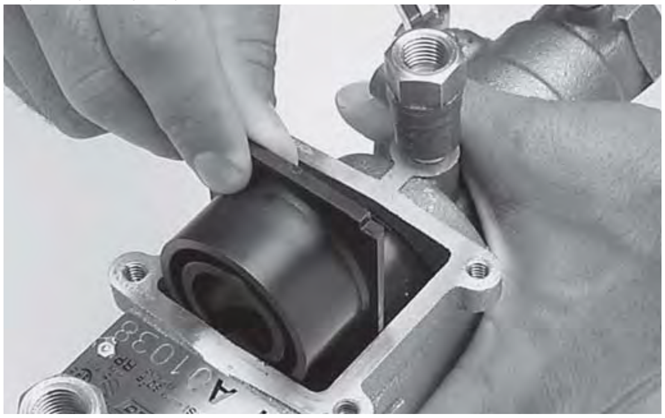
SYMPTOM #4	CAUSE:	SOLUTION:
Relief valve does not open above 2.0 psid during field testing	A. Outlet gate valve not closed completely	Inspect and clean
	B. Plugged low pressure hydraulic passage (from "ZONE" to inner diaphragm)	Inspect and clean
	C. Improper alignment of internal parts during reassembly (causing high resistance to movement)	Reassemble
	D. Jammed main stem due to debris Check for debris blocking gate valve	Clean

SYMPTOM #5	CAUSE:	SOLUTION:
First check pressure drop is low (less than 5 psid) during field testing	A. Debris fouling first check seat	Inspect and clean
	B. Debris fouling second seat with backpressure	Inspect and clean
	C. Inlet pressure variations causing inaccurate gauge reading	Eliminate pressure variations (see symptom #2A)
	D. Damaged seat or seat disc	Inspect and clean as required
	E. Worn guide, bushing or stem	Inspect and replace as required

SYMPTOM #6	CAUSE:	SOLUTION:
Second check fails to hold back pressure during field testing	A. Outlet gate valve not closed completely	Inspect and clean
	B. Debris fouling second check seat	Inspect and clean
	C. Damaged seat or seat disc	Inspect and replace if required
	D. Worn guide, bushing or stem	Inspect and replace if required

Check Module Disassembly

1. Slowly close inlet and outlet ball valves. Bleed residual pressure by opening #2, #3, and #4 test cocks. Allow the test cocks to remain open until the reassembling is completed. Test cock #1 should remain closed.
2. Remove the cover bolts (Item 21) using the appropriate size wrench.
3. Remove spacer (Item 8) by grasping the flanged end of the spacer and pulling straight up.

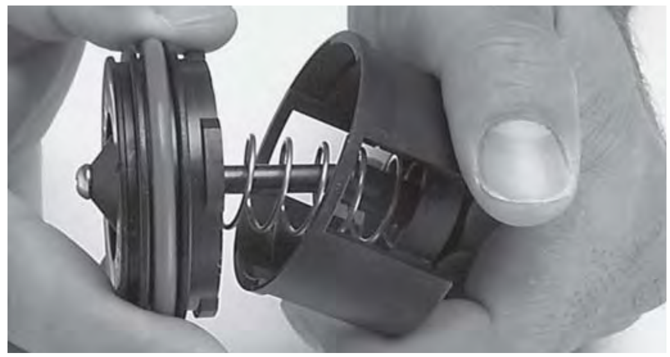


4. Remove the inlet check assembly by pulling it in the direction of flow out from the body bore until it is completely exposed then lift out of the body.
5. Remove the outlet check assembly by placing the tip of a medium size flat nose screw driver in the slot of the seat (Item 3) and prying the check assembly back until the red O-ring (Item 3.1) is exposed. Then, using your fingers, pull it out from the body bore until it is completely exposed then lift out of the body.

Check Module Seal Replacement

Both check assemblies are disassembled and reassembled in the same manner. To service the checks, you may replace the check modules with new ones by using check module assembly kits available from FEBCO. Or, you may also replace the rubber components in the check modules by using the replacement rubber parts kits available from FEBCO. For details on parts and kits, please see pages 10 - 12.

1. To disassemble, grasp the seat section (Item 3) in one hand and the guide section (Item 7) in the other hand and then rotate in a counter clock wise direction (approx. 1/8 turn) until the two parts disengage.



2. Remove retaining screw (Item 5.2) and disc retainer (Item 5.1) so the rubber disc is fully exposed. Carefully pry out the rubber disc from poppet. Be careful not to damage the poppet when removing the disc. Rinse poppet in clean water and replace the old rubber disc with new rubber disc. If the rubber disc is not damaged, it can be reversed and reinstalled when a new disc is not available. Rinse all other internal components with clean water. Replace disc retainer and secure with retaining screw (Item 5.2).

3. Reassemble check module in the reverse manner as indicated in above. When reassembling the check module, be sure to insert the poppet stem into the guide hole and keep fingers clear of the slots in the module.

Check Module Re-Assembly

Use reverse procedure for assembly with the following special instructions.

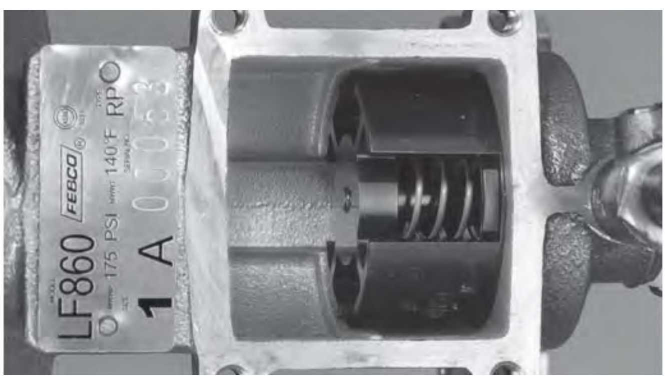
1. Inspect the check module O-ring (Item 3.1) for damage and replace if necessary. To ease assembly, apply a thin coating of supplied lubricant to the O-ring (Item 3.1) prior to installing in body.

⚠ CAUTION

Excess lubricant may cause foreign debris to collect on internal components which could foul the check assembly and result in a test failure.

2. The word **INLET** is inscribed on the end of each module. That end should face the inlet of the valve.

3. When installing the check modules On the Series 860 Reduced Pressure Assembly, make sure the check assembly with the heavy duty spring is inserted in the inlet bore of the body (1st check position). Ensure the orientation of the 1st check assembly is positioned so that one (1) of the four (4) flow path windows faces down towards the Relief Valve. The check assembly with the weaker spring must be installed in the outlet bore of the body (2nd check position).



4. When replacing spacer (Item 8) between the two check assemblies, be sure that the flanged end of the spacer is touching the back side of the inlet check assembly so that the cover will fit properly. Next, replace cover making sure #3 test cock is on the upstream side. Do not over tighten cover bolts (Approximately 35 inch•pounds is sufficient).
5. After reassembling, close test cock #2, #3 and #4 (test cock #1 should already be closed), slowly open inlet ball valve. Bleed air from the unit by opening and closing test cock #2, then #3 and finally #4.

NOTICE

During the bleeding process on the Series 860, the relief valve may discharge a high volume of water until all test cocks have been closed and pressure stabilized.

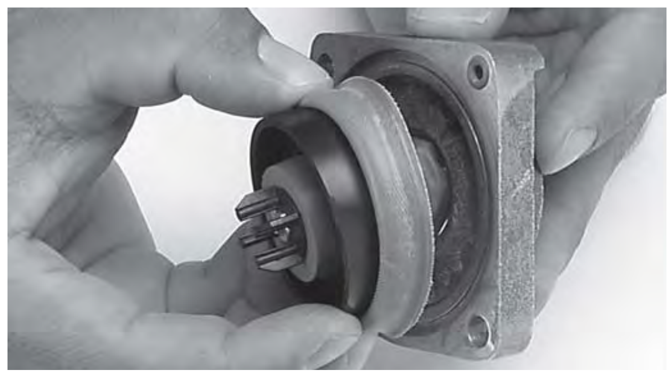
6. Check for external leaks and repair if necessary. Slowly open outlet ball valve.
7. Test assembly in accordance with the locally approved test methods.

Relief Valve Repair

NOTICE

Discharge from the relief valve assembly may not indicate a relief valve failure. The relief valve will discharge water when the mainline check valves become fouled with foreign debris. See Troubleshooting Guide for more information **BEFORE** disassembling the relief valve.

1. Slowly close inlet and outlet ball valves. Bleed off air from the unit by opening and closing test cock #2, then #3, and finally #4. Test cock #1 should remain closed.
2. Loosen brass cylinder in center of relief valve cover (Item 18) by unscrewing ¼ turn (counterclockwise). Remove the relief valve cover bolts (Item 21) and relief valve cover (Item 19).
3. The internal relief valve assembly module will be attached to the relief valve cover. Unscrew the brass cylinder and remove from cover. Grasp the outer diameter of the large outer diaphragm (Item 15) and pull away from the cover until the small outer diaphragm (Item 16) comes out through the relief valve cover hole and is completely separated from the relief valve cover. Discard old internal relief valve assembly module. Remove the plastic slip rings (Item 18.1) and discard. Slide out the seat ring (Item 12) and seat gasket ring (Item 12.1) from the relief valve body and discard.



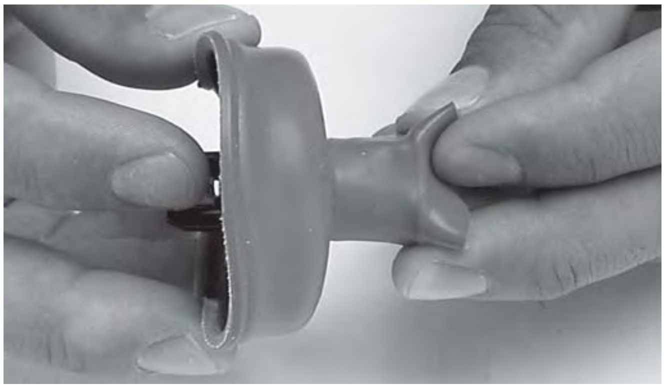
4. Apply a thin coating of supplied lubricant to both sides of the new seat gasket ring (Item 12.1), and slide it on the short end of the new seat ring (Item 12). Slide the short end of the new seat ring into the hole of the relief valve body. (The adhesion from the lubricant will hold the seat ring in place during the rest of the assembly process.)

NOTICE

If applying new diaphragms from a rubber kit, make sure that the smooth rubber side of each diaphragm, is facing outward. Before assembly.

Relief Valve Repair - continued

5. Before installing the new internal relief valve assembly module, apply a thin coating of supplied lubricant to both sides of one slip ring (Item 18.1) and insert it into the top of the relief valve cover. Install the new internal relief valve assembly module by grasping the outside of the outer diaphragm in one hand and the smaller diaphragm in the other hand. Then pull upward gently on the small outer diaphragm (Item 16) so that it forms the shape of a tulip. Hold the small diaphragm so that it maintains this “tulip” shape while sliding it through the relief valve cover hole and plastic diaphragm gasket.

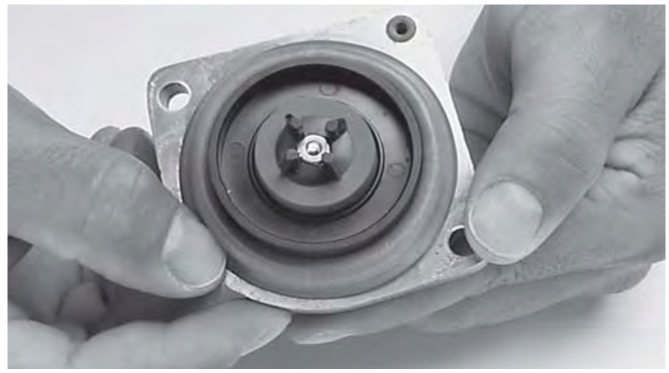


6. Apply a thin coating of supplied lubricant to both sides of the second slip ring (Item 18.1) and place it over the top of the small diaphragm making sure the outer diaphragm (Item 16) is not folded or creased under the slip ring. Push the slip ring down flat until the adhesion from the grease holds the small diaphragm in place. This should roll the diaphragm as shown. Thread the brass cylinder (Item 18) into the relief valve cover and hand tighten.

⚠ CAUTION

Do not twist the internal parts when the cylinder is tightened. The small diaphragm may become folded or creased if the internal assembly is restricted while tightening the cylinder.

7. Replace O-ring (Item 20) in relief valve cover. Make sure the round bead on the large diaphragm is properly seated in the counterbore of the relief valve cover. Position spring (Item 13) over the seat ring in the relief valve body and hold in place while inserting the guide end (Item 23) of the relief valve assembly module and relief valve cover. Position the assembly so the O-ring aligns with the sensing hole in the body and the guide slides into the seat ring. Replace relief valve cover bolts and tighten to approximately 35 inch•pounds. **Do not over tighten**. Tighten the brass cylinder (Item 18) in the relief valve cover to approximately 30 feet pounds of torque. **Do not over tighten**.



8. After reassembly, with all test cocks closed, slowly open inlet ball valve and bleed air from the unit by opening and closing test cock #2, then #3 and finally #4.

NOTICE

During the bleeding process, the relief valve may discharge a high volume of water until all test cocks have been closed and pressure has been stabilized.

9. Check for external leaks and repair if necessary. Slowly open outlet ball valve.
10. Test assembly in accordance with the locally approved test method.

Testing

All mechanical devices should be inspected on a regular basis to ensure they are working correctly. The assembly should be tested at time of initial installation, after servicing or maintenance, and at least annually thereafter. Acceptable test procedures are published by Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California (USC), The American Water Works Association (AWWA), The American Society of Sanitary Engineering (ASSE Series 5000) and the Canadian Standards Association (CAN/CSA B64•10). Please consult the regulatory authority in your area for more specific information.

Air Gap Drain Installation Instructions

1. Before installation check local codes. This type of drain may not be approved for use in some areas.

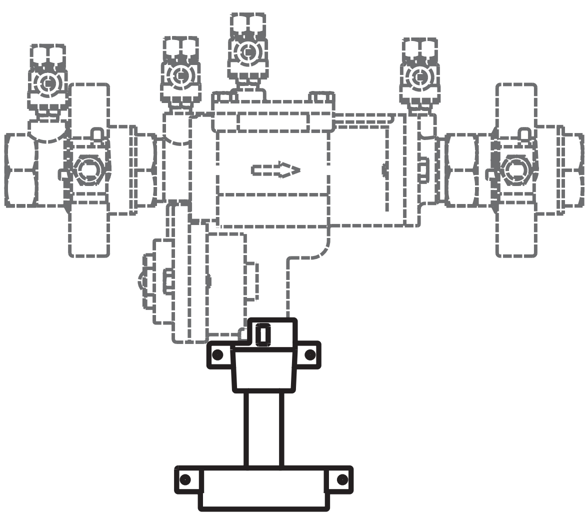
⚠ CAUTION

This drain is intended to catch moderate relief valve discharges due to line pressure fluctuations and minor check valve fouling. Under certain conditions relief valves can discharge water at rates greater than the air gap drain capacity.

2. If installed indoors, the assembly should be installed near a floor drain sized to adequately handle discharge. A Strainer before the backflow assembly is strongly suggested on indoor installation.
3. After installation of backflow assembly and piping, attach drain funnel to relief as shown, using self tapping screws provided in kit to join drain funnel halves together, making sure that the slots in the drain funnel are located over tabs on relief valve port.

NOTICE

Discharge of drain funnel is a slip fit design. Drain funnel was not designed to, nor is it able to support drainpipe weight.



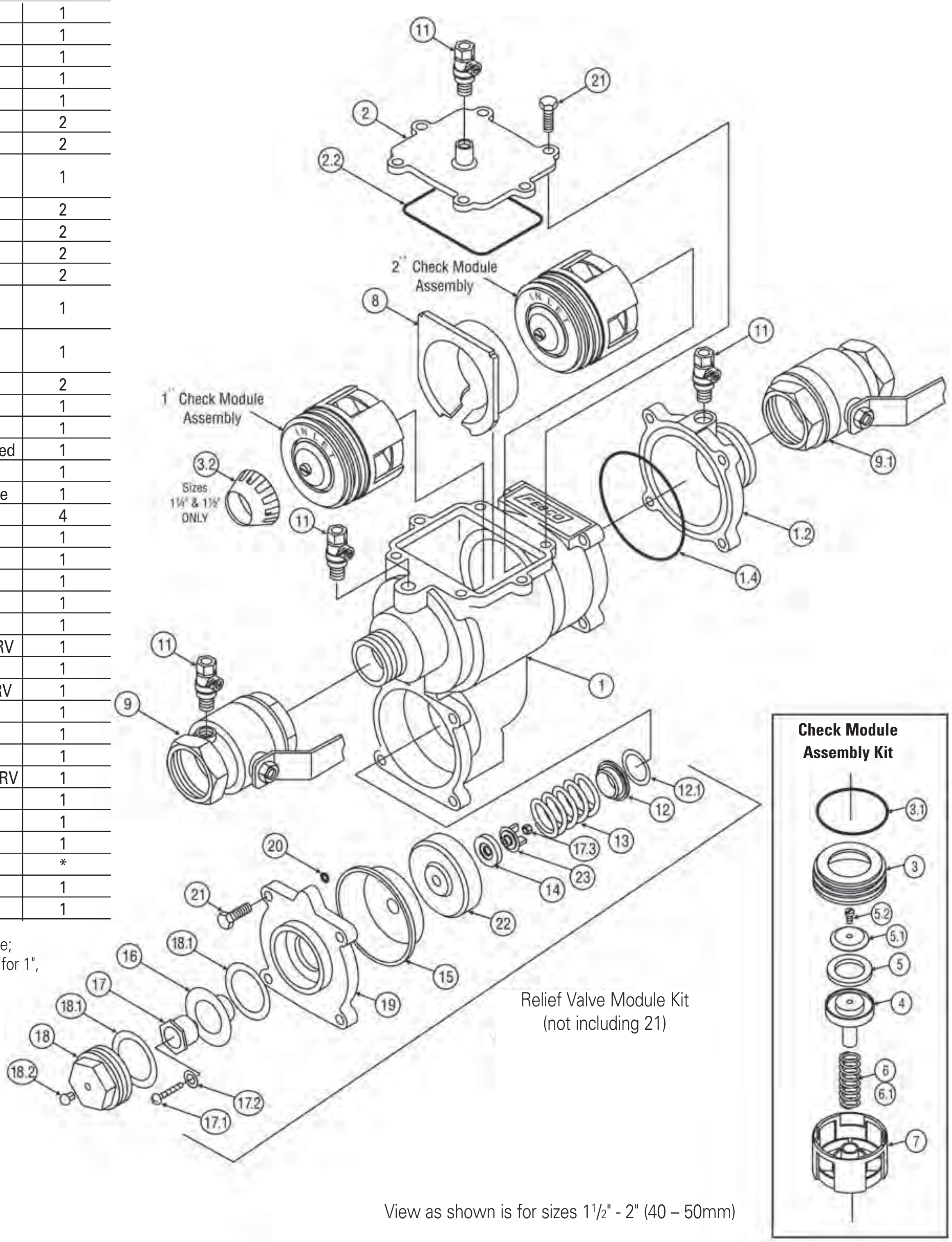
Air Gap Part Number

VALVE SIZE	PLASTIC PART NO.	METAL PART NO.
½"	905358	905532
¾"	905358	905532
1"	905358	905532
1¼"	905359	905533
1½"	905359	905533
2"	905359	905533

Exploded View

ITEM	DESCRIPTION	QUANTITY
1	Body	1
1.2	Tailpiece	1
1.4	O-Ring	1
2	Cover	1
2.2	O-Ring	1
3	Seat	2
3.1	O-Ring	2
3.2	Inlet Ring (1¼" & 1½")	1
4	Poppet	2
5	Seat Disc	2
5.1	Disc Retainer	2
5.2	Round HD Screw	2
6	Spring (1st Check Spring)	1
6.1	Spring (2nd Check Spring)	1
7	Guide	2
8	Retainer Spacer	1
9*	Ball Valve Tapped	1
	Union End BV Tapped	1
9.1*	Ball Valve	1
	Union End Ball Valve	1
11	Test Cock	4
12	Seat Ring - RV	1
12.1	Gasket Ring - RV	1
13	Spring - RV	1
14	Seat Disc - RV	1
15	Diaphragm - RV	1
16	Outer Diaphragm - RV	1
17	Small Piston - RV	1
17.1	Round HD Screw - RV	1
17.2	Washer - RV	1
17.3	Hex Nut - RV	1
18	Cylinder - RV	1
18.1	Slip Ring Cylinder - RV	1
18.2	Slide (Plug) - RV	1
19	Cover - RV	1
20	O-Ring - RV	1
21	Hex HD Capscrew	*
22	Large Piston - RV	1
23	Guide - RV	1

* Quantity varies with valve size; 6 each for ½" and ¾, 8 each for 1", 14 each 1¼", 1½", 2"



View as shown is for sizes 1½" - 2" (40 – 50mm)

Repair Kits

How to order parts and Repair Kits

1. Locate item number and kit number in this maintenance manual.
2. Verify the size of the valve the parts are to be used on.
3. Provide full model number located on I.D. plate.
4. Give kit number.
5. A serial number (located on the I.D. plate) will assist in ordering the proper kits.
6. Contact your local FEBCO Parts Distributor.

Complete Rubber Kit

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905355	ALL	1/2 & 3/4	15 & 20
905356	ALL	1	25
905357	ALL	1 1/4 - 2	32 - 50

Kit Includes: All rubber parts

Check Module Rubber Kit

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905342	ALL	1/2 & 3/4	15 & 20
905343	ALL	1	25
905344	ALL	1 1/4 - 2	32 - 50

Both checks. Kit Includes: Item 2.2 & 2 ea. of items 3.1 & 5

Relief Valve Rubber Kit

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905345	ALL	1/2 & 3/4	15 & 20
905345	ALL	1	25
905346	ALL	1 1/4 - 2	32 - 50

Kit Includes: Items 12, 12.1, 14 - 16, 18.1 (2 ea) & 20

Single Poppet Kit

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905339	ALL	1/2 & 3/4	15 & 20
905340	ALL	1	25
905341	ALL	1 1/4 - 2	32 - 50

Valve has two poppets. Kit Includes: Items 4 thru 5.2

#1 Check Module Kit (inlet)

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905348	ALL	1/2 & 3/4	15 & 20
905350	ALL	1	25
905352	ALL	1 1/4 - 2	32 - 50

Kit Includes: Items 3 - 7 for inlet check

#2 Check Module Kit (outlet)

LEAD FREE*

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905347	ALL	1/2 & 3/4	15 & 20
905349	ALL	1	25
905351	ALL	1 1/4 - 2	32 - 50

Kit Includes: Items 3 - 7 for outlet check

Full Relief Valve Module Kit

ORDERING CODE	STYLE	SIZE in.	SIZE mm
905353	ALL	1/2 & 3/4	15 & 20
905353	ALL	1	25
905354	ALL	1 1/4 - 2	32 - 50

Kit Includes: 1 ea of Items 12 - 17.3, 20, 22 & 23 & 2 ea. of 18.1

*The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.

NOTICE

The freeze protection backflow prevention assembly may be subject to damage if the internal water is allowed to freeze. The unit must be protected from freezing using a heated enclosure, insulation using heat tape, or other suitable means. The unit must always be accessible for testing and maintenance. If the system will be shut down during freezing weather, use the following procedures to drain internal passages.

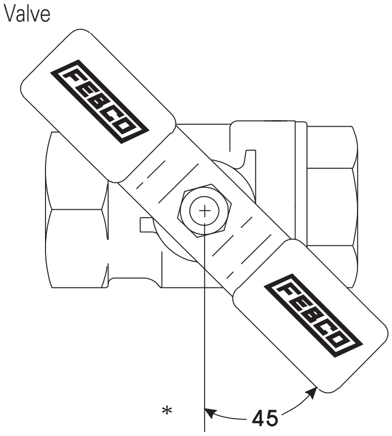
NOTICE

Ball Valve Shutoff Draining Procedure

If the assembly has been installed with ball valve shutoff valves, they must also be properly drained to prevent freeze damage. After draining procedure has been completed on the backflow prevention assembly, position all ball valve shutoffs and test cocks in a half open/half closed (45 degree) position. Open the ball valve approximately 45 degrees while draining the pipeline and assembly to allow water between the ball valve and valve body to drain. Leave the ball valve in this position for the winter to prevent freeze damage. The ball valve must be fully closed before the system is repressurized. **OPEN AND CLOSE BALL VALVES SLOWLY TO PREVENT DAMAGE TO THE SYSTEM CAUSED BY WATER HAMMER.**

Main Valve Draining Procedure ½"- 2" (15 - 50mm)

1. Close the main shutoff valve.
2. Open the inlet drain.
3. Open the inlet and outlet ball valves 45 degree (half open, half closed).
4. Open all testcocks.
5. Open the outlet drain.
6. Remove the cover and inlet check module until all water inside valve drains back out through inlet drain.
7. If you blowout the piping downstream of the backflow assembly using compressed air: Connect the air supply to the outlet drain and close the outlet ball valve. After clearing the system with air, partially open the outlet ball valve. Leave all drain valves, testcocks, and ball valves in half open/half closed position for the winter.
8. (RP UNITS ONLY) Loosen the relief valve cover to drain. Tighten when draining is complete.
9. *Reset Ball Valve



For additional information, visit our web site at: FEBCOonline.com

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.
For more information: www.watts.com/prop65

A Watts Water Technologies Company

USA: Tel: (800) 767-1234 • Fax: (800) 788-4491 • FEBCOonline.com
Canada: Tel: (905) 332-4090 • Fax: (905) 332-7068 • FEBCOonline.ca
Latin America: (52) 81-1001-8600 • Fax: (52) 81-8000-7091 • FEBCOonline.com

ZURN WILKINS MODEL 500XL REDUCING VALVE WITH INTEGRAL BYPASS

Operations & Maintenance Manual
December 2015

Model 500XL LEAD-FREE*

Pressure Reducing Valve with Integral By-pass

(1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2" & 3")

*This product contains a weighted average lead content less than 0.25% for wetted surfaces.

ZURN® WILKINS

❑ Installation ❑ Testing ❑ Maintenance Instructions

REPAIR KIT INSTRUCTIONS
HOW TO MAKE REPAIRS:

(Shut off service before starting disassembly)

1. Open faucet or hose bibb in dwelling to remove line pressure.
2. Loosen cap and remove counterclockwise.
3. Loosen plunger and remove counterclockwise; insert new seal ring.
4. Note distance that adjustment bolt protrudes from bell housing. Loosen locknut on adjustment bolt, then turn adjustment bolt out of bell housing to remove spring tension.
5. Unscrew bell housing counterclockwise and remove spring, spring disc and friction ring.
6. Remove stem unit from regulator. Inspect area in body where o-ring guides for pitting or scratches. Smooth bore with emery cloth if needed. This area must be smooth for the valve to function correctly.
7. Disassemble stem unit by holding stem securely while removing diaphragm bolt/nut. Discard old stem and diaphragm. Retain diaphragm disc and diaphragm bolt/nut for use on new stem.

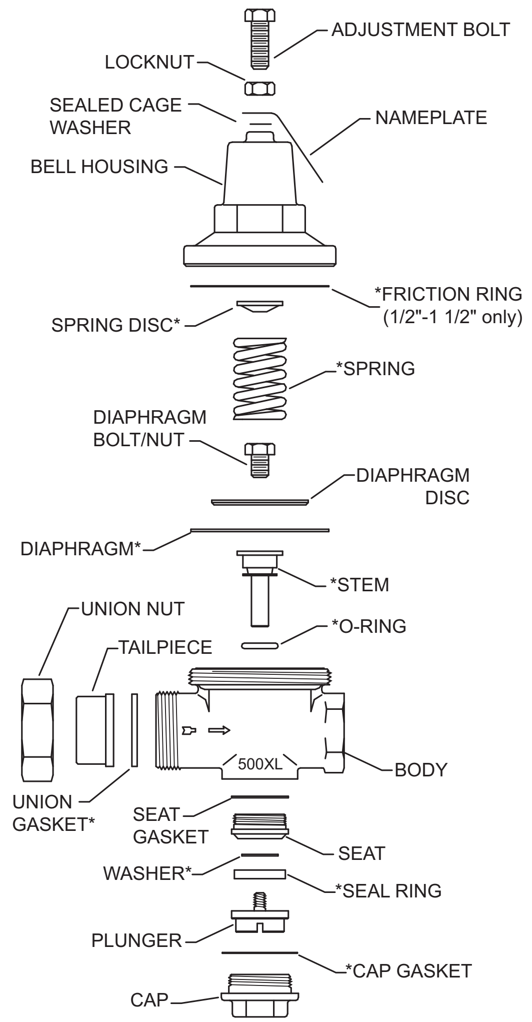
TO REASSEMBLE:

1. Open shut-off valve slowly and flush body and line of any debris.
2. Assemble new stem unit using new stem, o-ring, diaphragm, the old diaphragm disc and diaphragm bolt/nut. Tighten bolt/nut securely (CAUTION: Be sure the rounded edge of the diaphragm disc is next to the diaphragm).
3. Lubricate o-ring with grease supplied in repair kit and install stem unit in body. Install new spring, spring disc and friction ring.
4. Replace bell housing by tightening clockwise. Turn adjustment bolt clockwise until adjustment bolt touches spring disc.
5. Center washer on stem. Screw plunger into stem unit (CAUTION: Do not over tighten plunger; it is possible to break threaded end of plunger).
6. Install new cap gasket and replace cap by tightening clockwise.
7. Turn adjustment bolt into bell housing to old setting.
8. Enter dwelling and turn on several faucets.
9. Turn on water service. Let water run for several seconds then turn off faucets in dwelling.
10. Adjust the regulator to desired pressure by turning adjustment bolt clockwise (into bell housing) to raise pressure or counterclockwise (out of bell housing) to lower pressure. **It is recommended a pressure gauge be installed downstream of the regulator to ensure pressure is reduced below 75 psi.** NOTE: When reducing pressure, open a downstream faucet to relieve pressure.
11. Tighten locknut when desired pressure is achieved.

INSTALLATION INSTRUCTIONS

Install valve in line with arrow on valve body pointing in direction of flow. Before installing reducing valve, flush out line to remove loose dirt and scale which might damage seal ring and seat. All valves will be furnished with stock settings to reduce to approximately 50 psi. To readjust reduced pressure, loosen outer locknut and turn adjustment bolt clockwise (into bell housing) to raise reduced pressure, or counter-clockwise (out of bell housing) to lower reduced pressure.

NOTICE: Annual inspection and maintenance is required of all plumbing system components. To ensure proper performance and maximum life, this product must be subject to regular inspection, testing and cleaning.



*** INDICATES PARTS SUPPLIED IN REPAIR KITS**
(spring disc not included in sizes 1 1/2" - 3")

__Regulators in series:__ **Where the desired pressure reduction is more than a 4 to 1 ratio (i.e. 200psi to 50psi), multiple regulators in series should be installed.**

SEALED CAGE WARNING: Loosen lock washer at adjustment bolt slowly. Look for any trapped water pressure under the sealed cage washer. Relieve pressure before removing bell.

CAUTION: Anytime a reducing valve is adjusted, a pressure gauge must be used downstream to verify correct pressure setting. Do not bottom out adjustment bolt on bell housing. Valve may be installed in any position.

WARRANTY: ZURN WILKINS Valves are guaranteed against defects of material or workmanship when used for the services recommended. If in any recommended service, a defect develops due to material or workmanship, and the device is returned, freight prepaid, to ZURN WILKINS within 12 months from date of purchase, it will be repaired or replaced free of charge. ZURN WILKINS' liability shall be limited to our agreement to repair or replace the valve only.

__Proposition 65 Warning__ **This product contains chemicals known to the State of California to cause cancer or birth defects or other reproductive harm.**

Troubleshooting

Pipe lines in a water supply system must be of sufficient carrying capacity to maintain adequate pressure at the most remote or highest fixture. Under the maximum probable fixture use, minimum adequate pressure is generally 8 to 15 lbs. but may be more, depending on the equipment being supplied. Relatively high service pressures which can create high water velocities in pipe lines would allow use of smaller pipes to satisfy fixture use. However, high velocity tends to cause whistling and humming. Reduction of pressure by the use of a pressure reducing valve, in an attempt to eliminate such a condition, may reduce pipe line capacities below that which is adequate for maximum probable use. When high service pressures are in effect, either continuously or periodically, the application of a pressure reducing valve will be successful only when the installed pipe line is of adequate size to satisfy the system demand at the lower pressure. When actual water demands are unknown, the valve size should be no less then the existing pipe size.

PROBLEM / POSSIBLE CAUSE OR CAUSES

1. Pressure creeps or builds up in system above the setting of pressure reducing valve.

A. Thermal expansion of water as it is being heated.
B. Foreign matter on seating face of seal ring.
C. Cut, worn or chipped seal ring.
D. Cut or worn stem o-ring or worn o-ring groove.

SOLUTION
a. This is a natural consequence. It may happen each time that the heater runs. A pressure relief valve or expansion tank must be installed. This will not prevent pressure rise but should limit it to a safe level.
b. Flush the reducing valve by opening one or two fixture outlets wide. If this does not correct the problem, remove seal ring for cleaning.
c. Replace with new seal ring. Temporary repairs may be made by turning the seal ring over.
d. Replace with new stem o-ring and/or cartridge.

2. Pressure and fixture flow is unsteady.

A. Low water supply pressure in mains caused possibly by high area demand during certain periods of the day.
B. Heavy periodic demands by appliances in the house.

SOLUTION
a. This is a water department problem. It is due to the mains being inadequate for the demands made on them.
b. House service lines may at times be inadequate for the load. Size of some pipelines may need to be increased. Pressure setting of reducing valve may be too low.
c. Try increasing pressure before changing pipelines.

3. Small, inadequate flow from fixtures.

A. Pipelines to fixtures may be too small or house main supply may be inadequate for normal fixture demand.
B. Heavy periodic demands by appliances in the house.
C. Screen clogged with debris.

SOLUTION
a. It may be necessary to increase pipe sizes only in some sections of the system leading to the offending appliances or fixtures. Increasing the house service mains might be necessary if small supply is general at all fixtures.
b. Raise pressure gradually by readjusting valve until this point is determined.
c. Clean screen.

4. Valve appears to be noisy; hums, whistles or chatters.

A. Hum or whistle is usually caused by a high velocity of flow in pipelines causing vibration.
B. Chatter usually originates with worn seat washer or loosely installed seal ring.

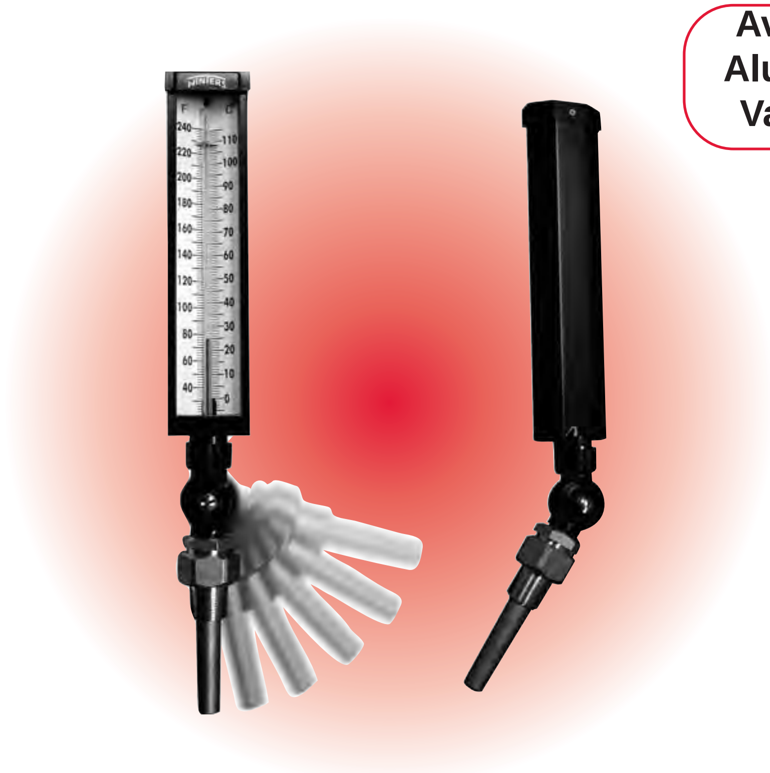
SOLUTION
a. Pipelines could be small or too light. Reducing valves could be too small. Pipes and valves being small would accentuate this condition.
b. Inspect seal ring. If a deep channel appears on seal ring face, replace or use the opposite side.
c. Frequently noise appears in a faucet or appliance and seems to originate from the reducing valve. There is a general tendency to use streamline piping of a relatively small size. Velocity is naturally high and noise of fast moving water is not unusual.

WINTERS INDUSTRIAL 9IT THERMOMETER

Operations & Maintenance Manual
December 2015

Industrial 9IT Thermometer

Available in Aluminum or Valox Case



Description

The Winters adjustable angle 9″ industrial thermometer is widely used by the construction industry in HVAC applications. Winters 9IT thermometer comes standard with 9″(228mm) Aluminum or Valox® case, a $3\frac{1}{2}$″ stem (or 6″ stem) and a $\frac{3}{4}$″ NPT brass separable socket (thermowell). An air duct stem with an aluminum duct flange is optional.

Highly visible black numerals on white coated aluminum. Dual scale (F&C) is standard and single scale is optional.

The instrument is fully adjustable to provide full 360 degree positioning on the vertical axis and 180 degree rotation on the horizontal axis. The thermometer can be "locked" into any position within this arc.

The thermometer stem features a tapered cast aluminum bulb chamber with graphite filling to allow for maximum heat conduction.

Specifications	
Case:	9″ (228mm) Aluminum or Valox® case, impact resistant
Lens:	Glass
Scales:	Aluminum painted white with black markings
Bulb Chamber:	Tapered cast aluminum with graphite fill
Connection:	$\frac{1}{4}$″ NPT with thermowell 1 $\frac{1}{4}$″ UNF swivel nut (no thermowell)
Liquid Filling:	Organic liquid filled tube
Adjustment:	Fully adjustable
Accuracy:	± 1% accuracy
Thermowell:	$\frac{3}{4}$″ brass separable socket Other thermowells available
Protection:	IP54

For an Industrial 9IT Thermowell, please refer to the Industrial 9IT Thermowell product page.

WINTERS 1953

Corporate Office: 121 Railside Road • Toronto • ON • M3A 1B2 • (416) 444-2345 • Fax: (416) 444-8979

U.S.A. Office: 600 Ensminger Road • Buffalo • NY • 14150 • (716) 874-8700 • Fax: (716) 874-8800

www.winters.com • 1-800-WINTERS (946-8377)

Industrial 9IT Thermometer

ALUMINUM CASE

How to order: Specify product code

PRODUCT CODES

STEM	3$^1/_2$″ (75mm)	6″ (150mm)
RANGES	CODE	CODE
-40 / 110^0 F & -40/40^0 C	T101A	T101-6A
0 / 120^0 F & -15/50^0 C	T102A	T102-6A
0 / 160^0 F & -15/70^0 C	T103A	T103-6A
30 / 180^0 F & 0/80^0 C	T104A	T104-6A
30 / 240^0 F & 0/115^0 C	T100A	T100-6A
30 / 300^0 F & 0/150^0 C	T105A	T105-6A
**170/270 F&P (retort)	T114A	*
**80/135 C/kg (retort)	T116A	*

VALOX® CASE

How to order: Specify product code

PRODUCT CODES

STEM	3$^1/_2$″ (75mm)	6″ (150mm)
RANGES	CODE	CODE
-40 / 110^0 F & -40/40^0 C	T101	T101-6
0 / 120^0 F & -15/50^0 C	T102	T102-6
0 / 160^0 F & -15/70^0 C	T103	T103-6
30 / 180^0 F & 0/80^0 C	T104	T104-6
30 / 240^0 F & 0/115^0 C	T100	T100-6
30 / 300^0 F & 0/150^0 C	T105	T105-6
**170/270 F&P (retort)	T114	*
**80/135 C/kg (retort)	T116	*

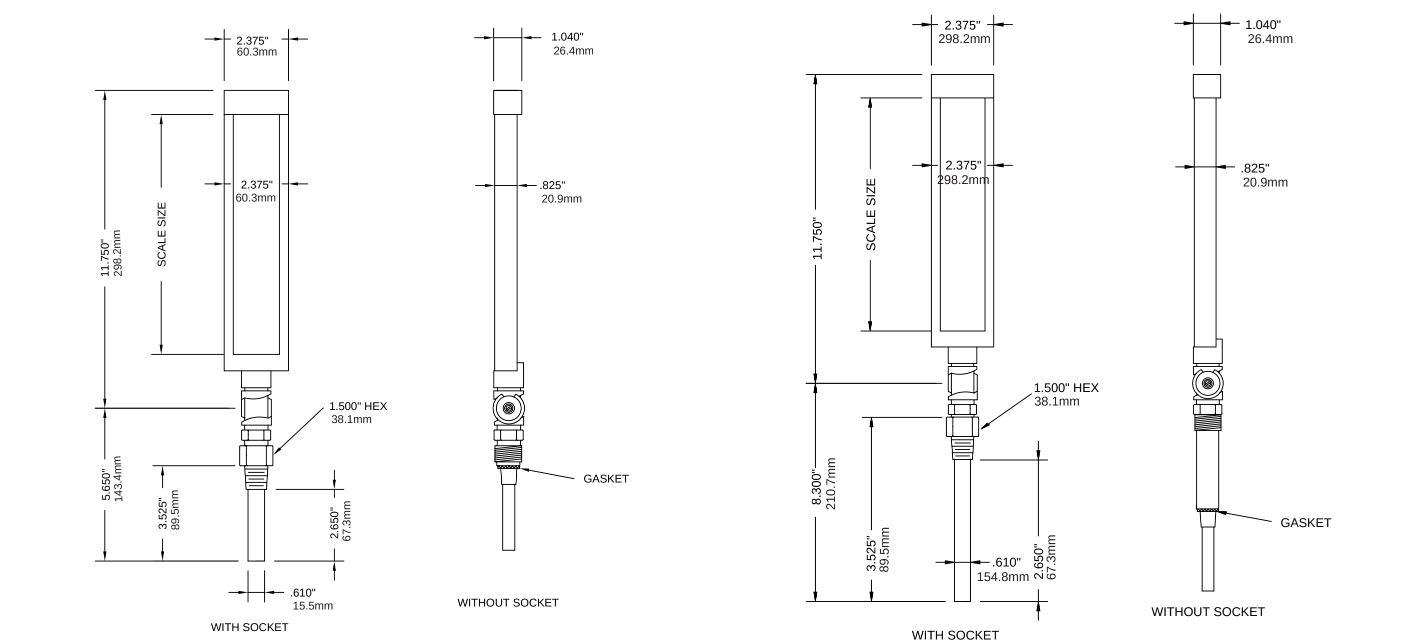
** Retort only available with 316 stainless steel stem and union. (Retort only available as a straight angle.)

Options:
- Mercury filling available upon request.
- Union connection available upon request.
- Duct flange available upon request.
- Other ranges and connection sizes available upon request.

® Valox is a registered trademark of General Electric Co.

3.5″ Stem

6″ Stem



Corporate Office: 121 Railside Road • Toronto • ON • M3A 1B2 • (416) 444-2345 • Fax: (416) 444-8979

U.S.A. Office: 600 Ensminger Road • Buffalo • NY • 14150 • (716) 874-8700 • Fax: (716) 874-8800

www.winters.com • 1-800-WINTERS (946-8377)

WINTERS PRESSURE GAUGE

Operations & Maintenance Manual
December 2015

WINTERS INSTRUMENTS

Head Office
121 Railside Rd.
Toronto, Ontario
M3A 1B2, Canada
www.winters.ca

Manufacturers of Temperature & Pressure Instruments

Tel: (416) 444-2345
Fax: (416) 444-8979
1- 800 - WINTERS
(946-8377)
sales@winters.ca

Pressure Gauge Installation, Operation & Maintenance

Table of Contents

Selecting a Pressure Gauge

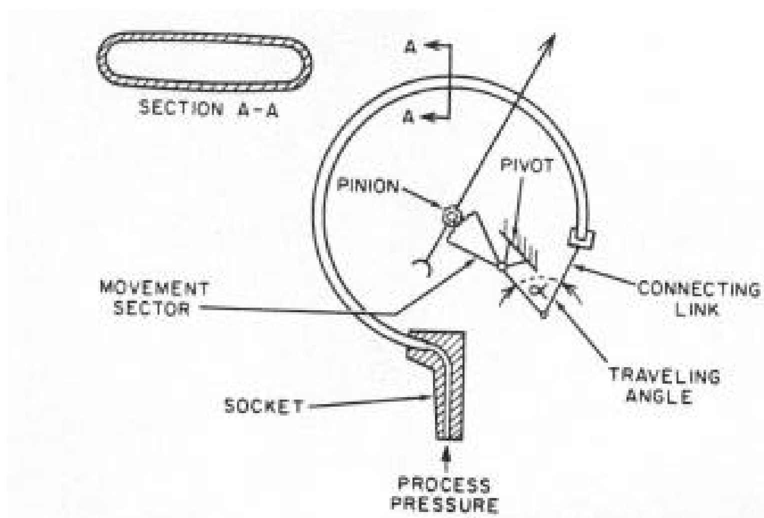
It is important to consider the various information outlined in this manual to ensure appropriate pressure gauge selection and usage. Improper application can lead to instrument failure and possible personal injury and/or property damage. The following information in this manual is meant to be a guide in the selection process. Please feel free to consult Winters Instruments for further assistance and clarification.

Types of Pressure Gauges

Winters offer a full range of pressure gauges suitable for virtually all types of applications. Some specific types of pressure gauges that will be covered in this manual are general-purpose Bourdon tube, capsule-type, duplex, and differential pressure gauges.

General-Purpose Bourdon Tube Gauge

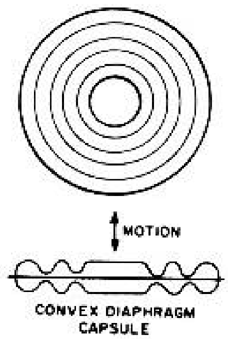
This common type of gauge utilizes a C-Bourdon tube, which usually has an arc of 250 degrees. The process pressure is connected to the fixed socket end of the tube, while the tip end is sealed. Because of the difference between inside and outside radii, the Bourdon tube tends to straighten when pressure is applied. The non-linear motion at the tip of the Bourdon tube is converted to linear rotational pointer response through the use of gears and pinion movement.



This type of pressure gauge is used in medium to high-pressure measurements with accuracies of 0.1 to 3% of full span. The pressure range capabilities starts from 15 psi (100 kPa) to 20,000 psi (137.8 Mpa).

Capsule-Type Gauge

Capsule-type are formed from welding two pre-formed plates together. Input process pressures cause the capsule to expand or contract which is then translated into a linear rotational pointer response through the use of gears and pinions.



Bellows gauges are typically used in low to intermediate and vacuum pressure ranges with 0.1 to 1% of full span accuracy. Winters Instruments capsule gauges have pressure ranges from 0-15" H2O (0-3.7 kPa) to 0-10 psi (0-68.9 kPa).

Duplex Gauge

A Duplex gauge indicates two related pressures in a process. There are two Bourdon tubes inside the gauge casing which results in two separate readings. The principal of the operation is as described in the General-Purpose Bourdon Tube Gauge section for Winters' Duplex Gauges.

Differential Gauges

The purpose of a differential gauge is similar to a duplex gauge, but this gauge will indicate the difference between two related pressures. Winters Instruments provide three different types of differential gauges; parallel Bourdon tube, magnet and piston, and opposing Bourdon tube designs.

Parallel Bourdon Tube Differential Gauge

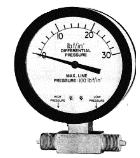
The placement of the Bourdon tubes is similar to that of the duplex gauges. The gears and pinions are calibrated to measure the difference between the flex of the two Bourdon tubes and this is translated to a single pointer. This type of differential gauge is used when the indicating scale is 2/3 of the process static pressure due to the limitations of the Bourdon tubes.

Piston Differential Gauge

The sensing element is a spring-biased diaphragm, which moves linearly in proportion to the difference between two basic pressures. A magnet on the **HI** pressure side of the piston assembly moves with the diaphragm and rotates a follower magnet located adjacent to the pressure cavity. The gauge pointer is located at the end of the rotary magnet shaft and rotates with the magnet to provide gauge readings proportional to the differential pressures. This type of instrument can indicate small values of differential pressure even when used in high-pressure processes.

Opposing Bourdon Tube Differential Gauge

The use of opposing Bourdon tubes allows for the use of standard gauge components, which helps reduce cost. The inherent limitation of the parallel Bourdon tube system is overcome. The relatively short deflection provided by the opposing Bourdon tubes is geared up through the use of a movement with a higher gear ratio than would be used in a parallel Bourdon tube differential gauge.



Pressure Range

Select a pressure gauge with a full-scale pressure range of approximately twice the normal operating pressure. For Bourdon tube gauges, the maximum operating pressure should not exceed 75% of the full-scale range. The exception to this rule is the opposing Bourdon tube differential gauge. Failure to select a gauge within these criteria may result in premature fatigue and failure of the Bourdon tube.

Temperatures

The normal ambient temperature ranges are –40C to 70C (-40F to 158F) for dry gauges and –25C to 65C (-13F to 149F) for glycerin filled gauges. The process temperature for dry gauges can be up to 400C (752F). In situations where the process temperature is extreme, utilizing a syphon or remote mounting the pressure gauge with a capillary and diaphragm seal are reasonable alternatives.

In general, a gauge is unduly hot if it cannot be grasped by hand without discomfort. It should be noted that gauges used on water might burst if exposed to frost. Please consult Winters for your specific requirements.

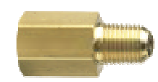
Materials

Winters provide a full range of casing and wetted parts to accommodate all types of applications. The most common wetted parts used are brass and 316 stainless steel. Brass wetted parts are suitable for use on the following types of media; air; oil, water and other non-corrosive fluids. For corrosive fluids, stainless steel should be specified. For special applications, other materials such as Monel can be used as well. Diaphragm seals may also be considered. Please consult Winters Instruments for assistance.

Vibrations

Vibrations and extreme ambient temperatures can affect the dial reading of the pressure gauges. These areas should be avoided as much as possible. Vibration effects can be minimized by the use of a dampening liquid such as glycerin or silicone. If vibration is extreme, then a flexible tube connected to an appropriate diaphragm seal should be considered.

Pulsations



If pressures are expected to pulsate violently, oscillate with high frequency or occur with sudden shock, a snubber should be considered. Winters snubbers incorporate sintered porous 316 stainless steel snubbing element with a large surface area to ensure long term effectiveness on most pressure media. Snubbers are available in the three viscosity classifications; heavy oil, water and air. Brass, stainless steel or Monel housing can be specified depending upon the media used.

Isolating Valves

It is recommended that isolating valves be fitted with the gauge. This enables the gauge to be removed at any time for checking, recalibration or replacing without interruption to the process. The valves should be opened or closed slowly to avoid sudden changes to pressure being applied to the gauge. It is recommended for systems that have an abrupt pressure surge at start-up to close the valves during initial start-up.

Installation

Location

Vibrations and extreme ambient temperatures can affect the dial reading of the pressure gauge. These areas should be avoided as much as possible. Vibration effects can be minimized by the use of a dampening liquid such as glycerin or silicone. If vibration is extreme, then a diaphragm seal connection should be considered.

Mounting

A suitable thread sealant is required for N.P.T. threads such as pipe dope or Teflon tape. **Never** use any part of the pressure gauge other than the wrench flats that is on the gauge socket. Always tighten with an open end or adjustable wrench on the wrench flats. Failure to do so will severely damage the pressure gauge. Please note the following special requirements for the piston differential gauge.

Piston Differential Gauge

Check instrument & identify **HI** and **LO** markings. **HI** identifies the high-pressure port; **LO** the low pressure port. If the instrument is installed backwards, it will neither operate nor be damaged. It is recommended that the instrument be located above the pressure source to allow for drainage of the unit.

Please ***note*** that since there is a magnetic movement, the piston differential gauge should **<u>never</u>** be mounted in direct contact with a steel surface. Failure to do so will cause a calibration shift. Mount the gauge so that the gauge body is at least 1" (25.4 mm) away from metal surface with non-magnetic spacers or an aluminum-mounting bracket.

Operation & Maintenance of Pressure Gauge

Storage

All pressure gauges should be placed in dry storage under ambient room temperatures. It is recommended to store the pressure gauges in their original packing boxes.

Inspection Frequency

Winters pressure gauges are rugged instruments featuring simplicity of design to provide dependable and efficient service. The frequency of inspection is dependent on the severity of service and how critical the accuracy of the indicating pressure is. The inspection frequency can range from monthly to annually basis.

Recalibration / Assembly & Disassembly Procedures

Positive Pressure Gauge

Inspect the pressure gauge for "zero reading" when there is no applied pressure. In many cases, the gauge pointer can simply be adjusted and then the gauge will work within specifications. However, if the gauge requires calibration, then follow the outlines procedures below.

1. Remove the ring and lens

2. Slowly pressurize the gauge to its full scale and slowly release the pressure back down to zero

3. Check the gauge at a minimum of four equal pressure intervals against a Certified Test Gauge

4. Adjust the movement accordingly by removing the pointer with a pointer extractor. Be careful not to bend the pointer shaft

5. Removing the dial plate by loosening the holding screws

6. When adjustments are complete, replace the dial plate and pointer

7. Re-check the gauge for accuracy

8. Check lens assembly gasket for any deformation, tears or cracks. If there are any visual defects, the gasket will need to be replaced

9. Re-assemble the lens assembly

Capsule-Type Pressure Gauge

The same inspection procedure applies as per the positive pressure gauge section above. The micrometer adjustable pointer is accessible by removing the white plastic knob on the lens and adjusting the screw. This is done without having to remove the lens. If calibration is required, please follow the outlined procedure below.

1. Remove lens by prying open the lens window with the notches provided on the sides of the case

2. Slowly pressurize the gauge to its full scale and slowly release the pressure back down to zero

3. Check the gauge at a minimum of four equal pressure intervals against a Certified Test Gauge

4. Adjust the movement accordingly by removing the pointer with a pointer extractor. Be careful not to bend the pointer shaft.

5. Remove the dial plate by loosening the holding screws

6. When adjustments are complete, replace the dial plate and pointer

7. Re-check the gauge for accuracy

8. Replace the lens window

Piston Pressure Gauge

Other than replacing broken lens, there is only one area where the gauge may need attention. Erratic pointer action may indicate that cleaning is required. Calibration is not required. However, if the range spring is damaged or a new dial is required, the gauge should be returned to the factory for parts and recalibration.

For cleaning:

1. Remove the low pressure end cap with 1” (25.4 mm) spanner wrench
2. Remove the range spring and the spacers at the bottom of the spring pocket. BE CAREFUL NOT TO LOSE STACKING SPACERS, IF ANY
3. Remove the four ¼-20 socket head screws and separate the body parts
4. Remove the diaphragm assembly
5. To replace the diaphragm, remove the screw at the top of the diaphragm disc to separate the assembly. DO NOT REMOVE THE SCREW IN THE MAGNET ASSEMBLY
6. Clean parts in a solvent solution after removing the “O”-ring seals since solvents will attack the seal material
7. Place diaphragm disc on magnet shaft with “O”-ring groove facing away from magnet. Place new diaphragm over shaft with the open end of the convolution facing the magnet. Place the second disc over diaphragm so that centre “O”-ring groove faces diaphragm “O”-ring
8. Replace the spring cup, and the #8-32 assembly screw. Tighten to finish assembly
9. Place the diaphragm assembly back into the diaphragm pocket with the magnet end of the assembly at the high pressure side
10. Reassemble both body parts with the four ¼-20 socket head screw
11. Insert the spacers and the range spring into the spring pocket of the end cap. While holding the instrument with the low pressure port down, insert the end cap back into the low pressure side of the body
12. Tighten the **LO** end cap and the instrument is now ready for service

No recalibration is required.

For replacing the lens:

To replace a broken lens, check to see if the lens is held on by a bezel or snap-ring. To remove a bezel, which is a pressed on cover, either twist off by hand or pry off with a screwdriver. To remove a snap-ring, pry out the ring with a small screwdriver. Remove all glass chips, insert new lens and re-insert the bezel or snap. With snap-rings, locate the ring joint at the bottom of the gauge.

For replacing the pointer:

Remove bezel or snap-ring as previously described and clean out glass chips. Remove old pointer with pointer extractor or two small screwdrivers opposite each other under pointer hub. Pry off evenly being careful not to bend the pointer shaft. Install new pointer on zero. <u>NOTE</u>: Gauges with a zero peg must have the pointer set at a reference pressure (preferable mid-scale) to offset the preload against the zero pegs. Re-install the lens, as described under lens replacement.

Spare Parts List

Spare parts are available for the following gauges.

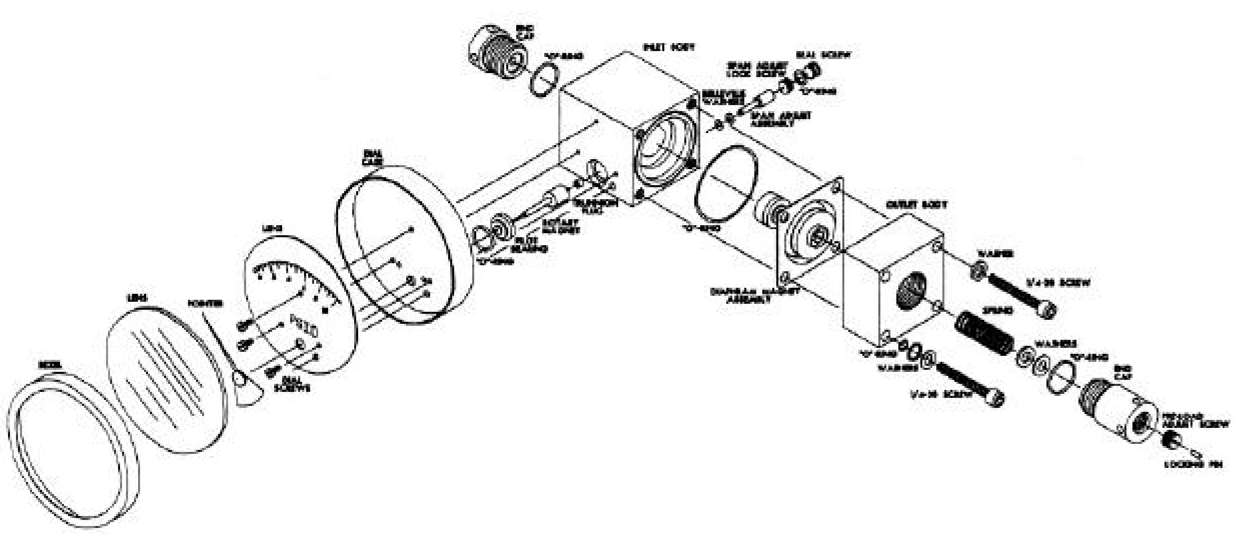
General-Purpose Bourdon Tube Gauge

100mm Safety Glass Lens.................................Part # SG-4

100mm Rubber Lens Gasket............................Part # RLG-4

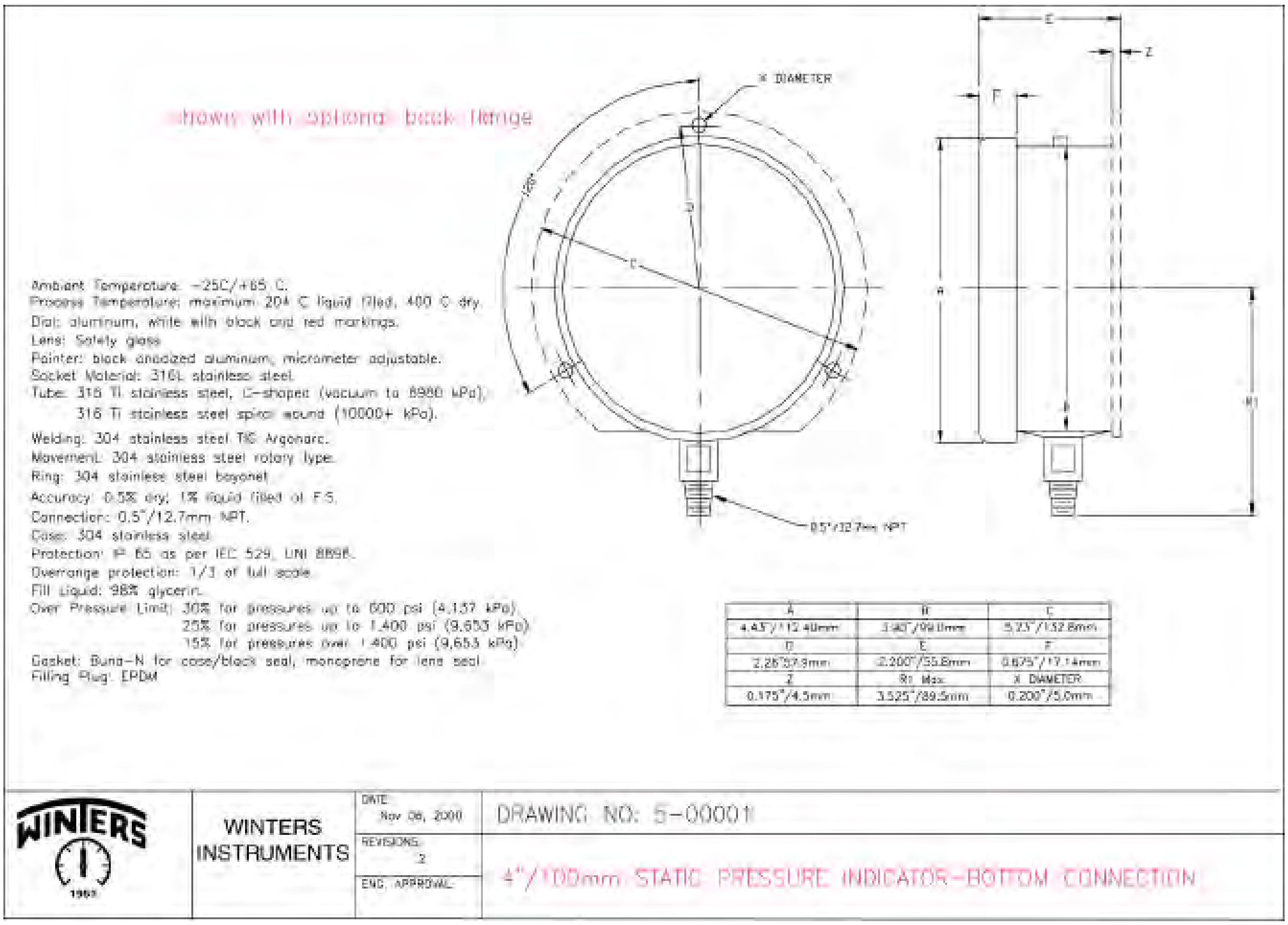
Piston Differential Gauge

<u>REPLACEMENT PARTS</u>



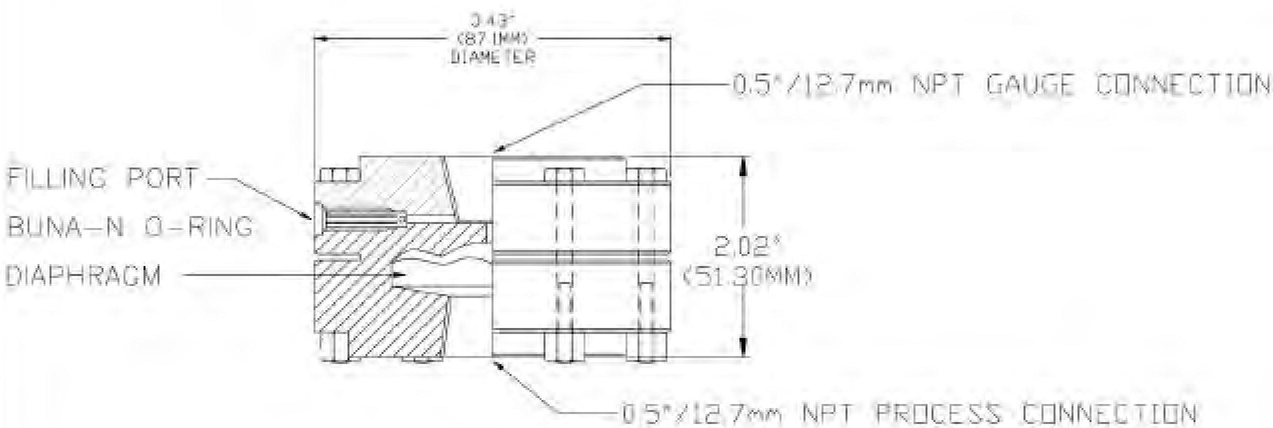
Technical Drawings

General-Purpose Bourdon Tube Gauge



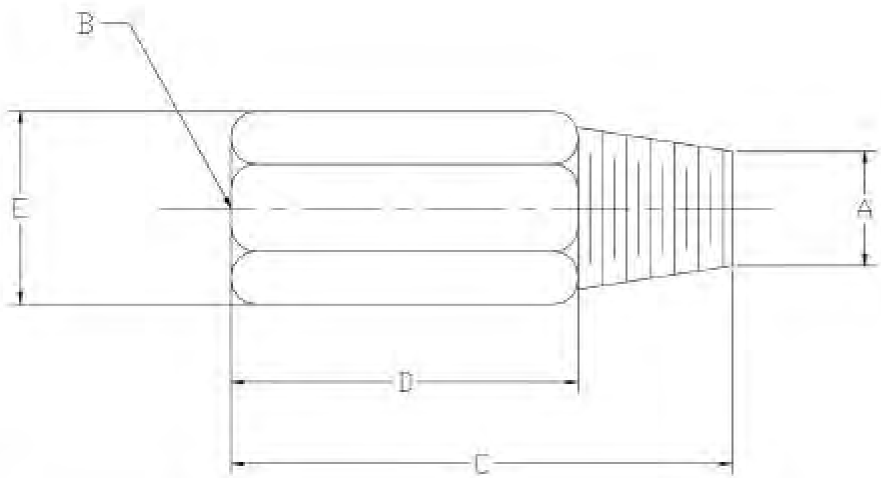
Diaphragm Seal

Process Temperature: minimum -45C, maximum +150C.
Upper Housing: AISI 316 stainless steel standard.
Lower Housing: AISI 316 stainless steel standard.
Diaphragm: AISI 316L stainless steel, welded standard.
Bolts and Nuts: AISI 304 stainless steel.
O-Ring: Buna-N



WINTERS 1953	WINTERS INSTRUMENTS	DATE: Nov 06, 2000	DRAWING NO: 5-00003
		REVISIONS: 2	STAINLESS STEEL DIAPHRAGM SEAL - D952S & D956S
		ENG. APPROVAL:	

Snubber



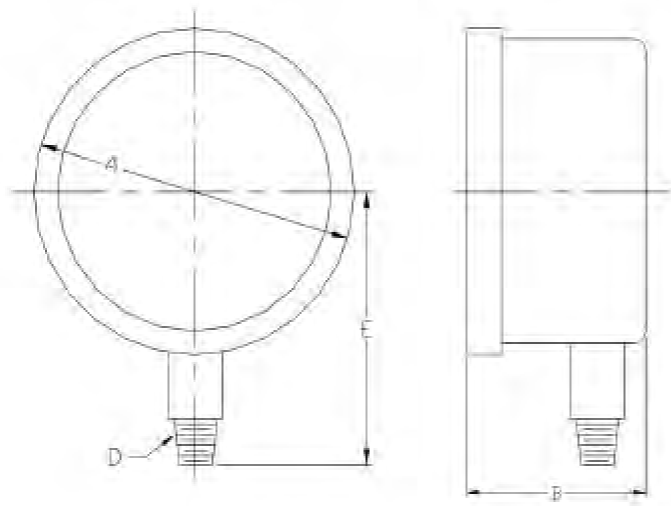
Operating Temperature: −195 C to 815 C.
Operating Pressure: maximum 20,000 psi (137,900 kPa).
Snubbing Element: sintered, porous type 316 stainless steel.
Retainer: 300 series stainless steel.
Burst Pressure: 60,000 psi (413,700 kPa).
Housing: 300 series stainless steel.

A.	B.	C.	D.	E.
0.5"/12.7mm NPT	0.5"/12.7mm NPTF	2.25"/57.15mm	1.25"/31.75mm	1.25"/19.05mm

1953	WINTERS INSTRUMENTS	DATE: 12/07/2000	DRAWING NO: BV.1230.5.4
		REVISIONS: 0 ENG. APPROVAL:	STAINLESS STEEL FILTER SNUBBER (Water)

Capsule-Type Gauge

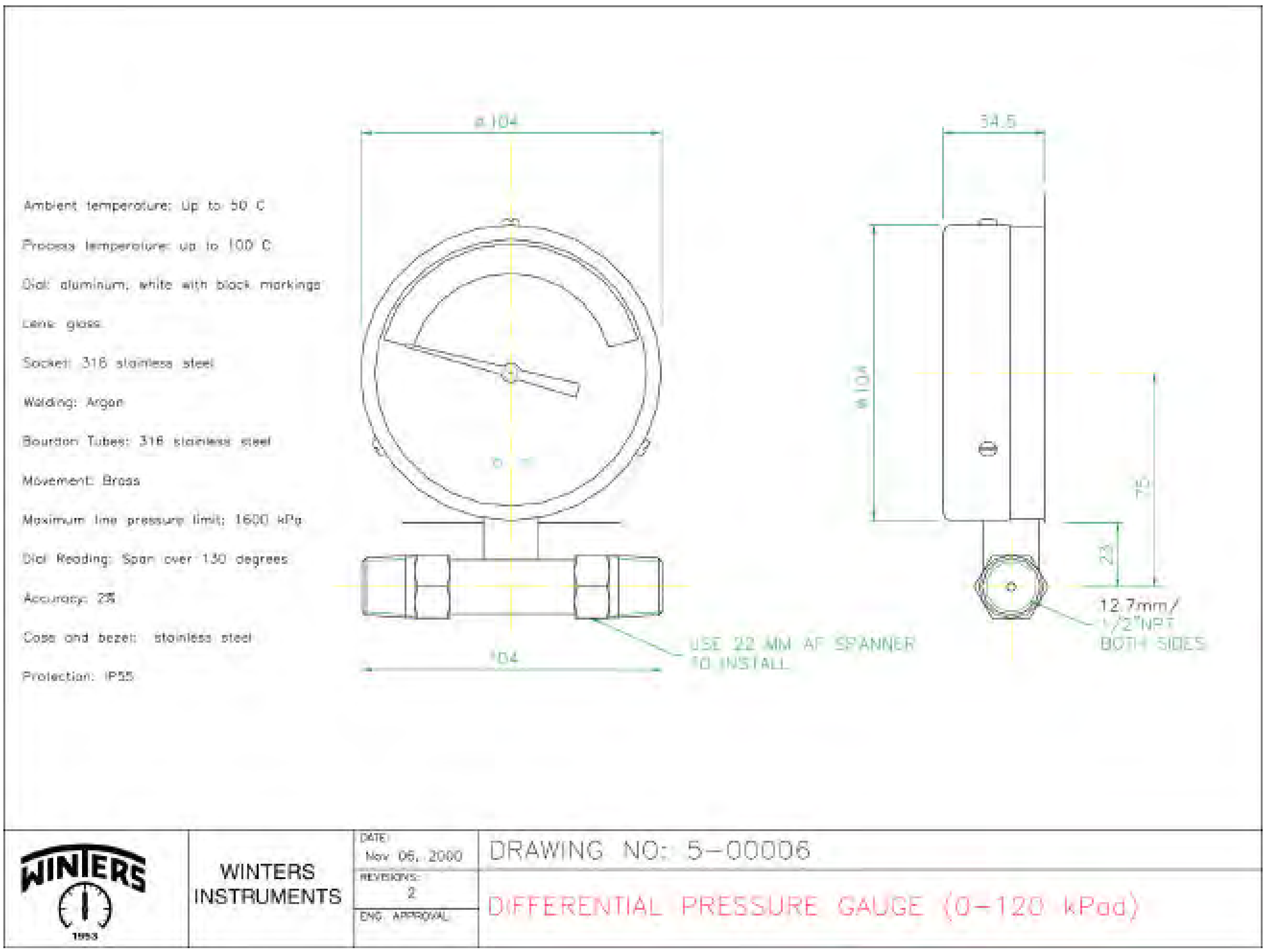
Socket: AISI 316 stainless steel.
Welding: 316 stainless steel.
Movement: AISI 316 stainless steel.
Accuracy: 1% accuracy (ANSI/ASME Grade 1A).
Connection: 0.5" / 12.7 mm NPT.
Case: 304 stainless steel.
Protection: IP32.
Operating Temperature: up to +212 F(+100 C).
Over range Protection: 30% of full scale value.
Capsule: AISI 316 stainless steel.



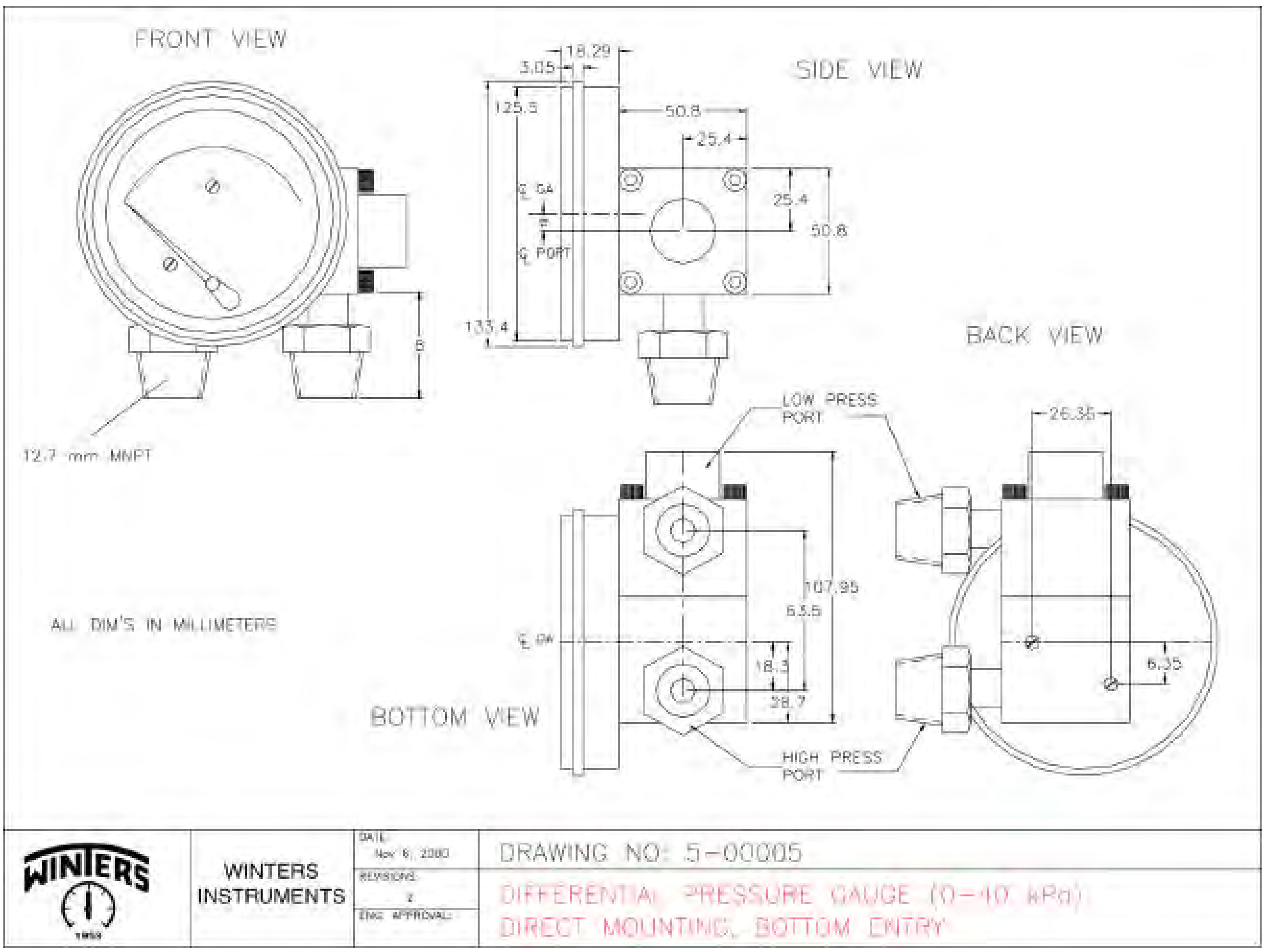
	A	B	D	E
4"/100mm	3.90"/99.06mm	1.93"/49.0mm	0.5"/12.7mm NPT	3.38"/86.0mm

WINTERS	WINTERS INSTRUMENTS	DATE: NOV 08, 2000	DRAWING NO: 5-00002
		REVISIONS: 2	STAINLESS STEEL LOW PRESSURE GAUGE, BOTTOM CONNECTION
		ENG. APPROVAL:	

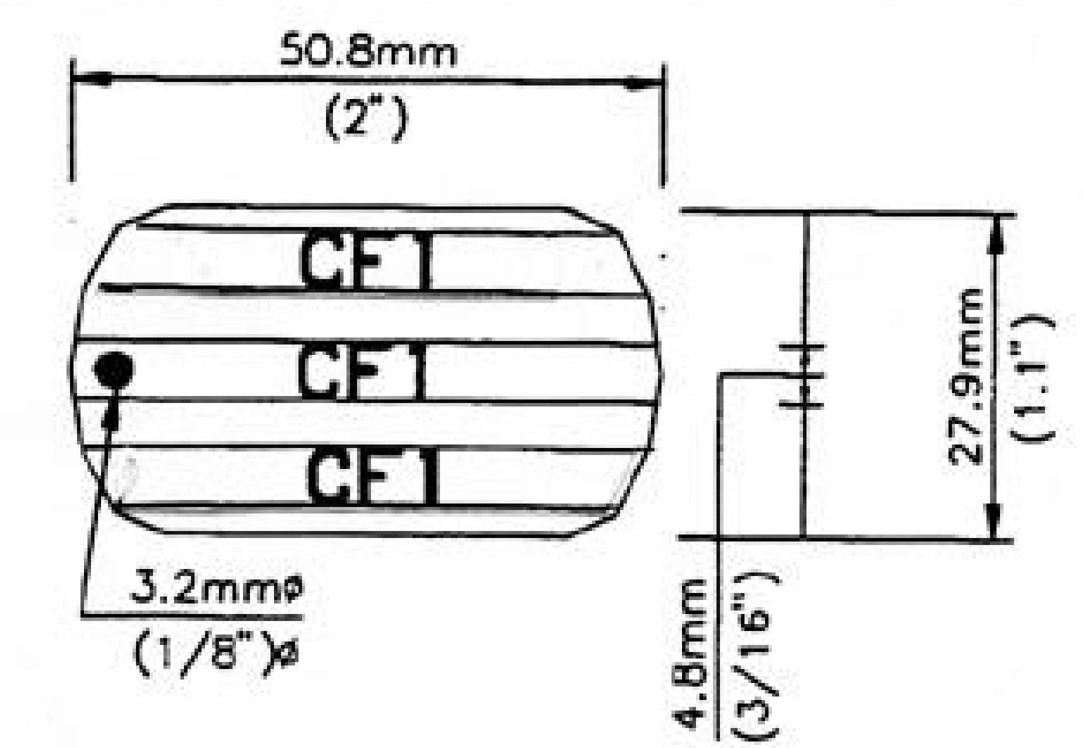
Opposing Bourdon Tube Differential Gauge



Piston Differential Gauge



Stainless Steel Tag

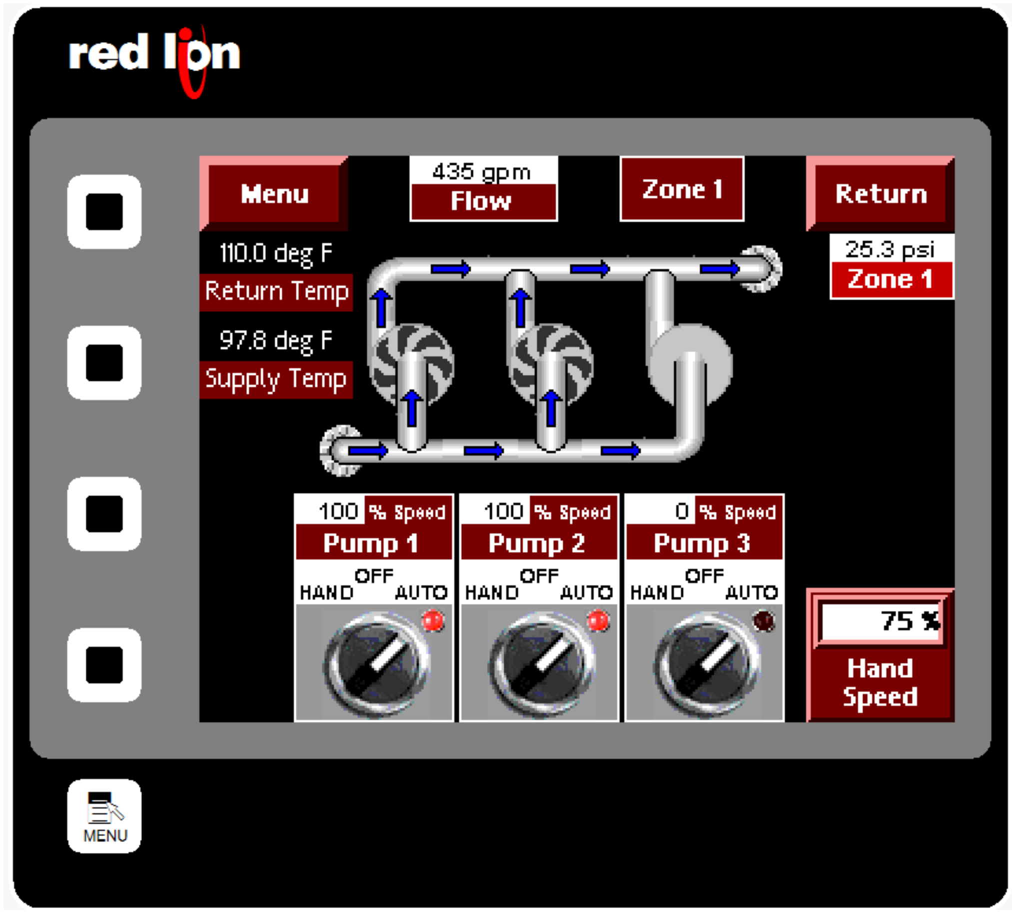


Index

TIGERFLOW TIGER'S EYE E-SERIES – MARK VI

Operations & Maintenance Manual
December 2015

User's Manual



TIGER'S EYE

E-Series – Mark VI

TIGERFLOW Systems, Inc.
4034 Mint Way
Dallas, Texas 75237
214-337-8780
www.tigerflow.com

Introduction

The E-Series - Mark VI is a variable speed pump controller, intended for closed-loop HVAC applications. The controller employs a user-friendly color touchscreen HMI (Human Machine Interface) to monitor conditions, and adjust the system settings.

The controller offers multiple zone differential pressure (DP) control, where the pumps will run at the speed required to satisfy the differential pressure of the zone farthest from set point.

In the following text, all the capabilities and options of this system will be discussed.

Pumps are staged ON and OFF based on the minimum number of pumps specified to run, zone DP and flow. The required minimum number of pumps will run constantly. If flow exceeds the capacity of the running pumps or if zone DP pressure is below pump start pressure, additional pumps are staged ON. Pump stages OFF as flow decreases and the zone DP is satisfied. However, the number of pumps running is never less than the minimum number of pumps required.

System Operation

MANUAL OPERATION:

In the **Main Screen** touch the pump HOA switch until it rotates to the HAND Position. The pump will start after a 2 second delay. Pump will run at the percent manual speed setting in the lower right corner of the main operating screen. To change this speed touch the hand speed % setting, enter the desired speed and touch the enter button. All Pumps running in Hand will immediately accelerate or decelerate to the selected speed.

CAUTION: Running pumps in hand position overrides all system safeties and alarm shutdown features.

NOTE: % speed is a percentage of 60 Hz. A pump running at 30 Hz is running at 50% speed. This percentage also relates the 0-10 V DC speed signal being transmitted to a drive. 75% speed equates to a 7.5 V DC speed reference signal to the drive. 100% speed equates to a 10.0 V DC speed reference signal to the drive.

Touch the OFF button above pump HOA or touch HOA switch to rotate it to OFF position and stop pump from touch screen interface. The pump may also be stopped through the VFD's keypad or disconnect.

All VFDs are provided with a means of manual operation from the drive. To operate the drive in manual mode, please consult the drive's operation manual and/or consult with your TIGERFLOW representative.

AUTOMATIC OPERATION:

WARNING: Do not run pumps in automatic prior to proper system setup. Failure to do so could damage drives, pumps / seals or over pressurize piping.

In order to set the pump(s) in AUTO operation, touch the HOA switch until the auto option is selected.

PUMP START:

The Mark VI sequences pumps (when pump HOA switches are in AUTO position) ON and OFF based on the number of pumps specified to run, active zone DP and flow. The VFD(s) must be in AUTO mode. The Lead pump starts when a pump is put in Auto and the on-time delay has expired. Additional pumps are brought online until the number of pumps running in auto equals the number of pumps specified to run.

If the differential pressure in the controlled zone falls below the start setpoint for the next available pump, it will start running and match the lead pump speed. Likewise, when the flow exceeds the flow capacity of the pumps running, an additional pump is added (if available).

Two means of pump run verification are provided; pump differential pressure (DP) and VFD run verification. For systems equipped with DP switches, the pump must produce 10 psi of boost before the pump fail time expires or the pump is considered failed and will be disabled until the fault gets reset. The pump failure energizes an alarm and attempts to start the next Auto available pump. A typical pump fail time setting is 30 seconds.

VFD run verification provides a much quicker means of detecting drive related pump failure. This feature is provided by monitoring the VFD running contact (N.O.). If a pump is commanded to run and the VFD running contact is does not close, the VFD is considered failed, an alarm is energized and the next pump available pump in auto mode will start. VFD run verification will detect numerous drive related problems including:

1. Drive in hand / manual mode.
2. Drive alarm condition.
3. Power disconnected from drive.

Pump and / or VFD failure detection is only active for pumps running in Auto mode. Touching the Alarm Reset button on the Mark VI touch screen resets all pump and VFD failure alarms.

PUMP SPEED CONTROL:

When starting automatically, the lead pump will ramp immediately to the minimum auto speed setting. Speed will automatically increase and decrease as necessary to satisfy the active zone differential pressure setpoint. However, pump speed will NEVER run at a lower speed than the minimum speed setting. All pumps running in auto run at the same speed.

The controller is capable of controlling multiple zones. Each zone has an independent differential pressure set point. The active zone is the zone differential pressure the PLC uses to control pump speed. This zone can be selected either manually or automatically. When the active zone is manually selected, the zone has exclusive control of pump speed. Automatic zone selection checks all zones for deviation from the respective setpoint every 30 seconds. The zone with the greatest deviation below setpoint becomes the active zone.

DEFAULT PUMP SPEED:

A default speed setting is provided in the even all zone DP transmitters fail. Zone DP is measured via a 2-10 V DC signal. This analog signal is monitored for out of range values. If the signal is less than 2 V DC or greater than 10 V DC a DP zone failure alarm is generated and all pumps will continue to run at the default speed setting.

PUMP STOP:

Pumps stop based on flow, system disable, alarm condition or pump alternation.

When the number of pumps running exceeds the minimum number of pumps specified to run, all extra pumps will stop when the flow rate is lower than the flow start setting and the DP pressure is greater or equal than the stop pressure setting for the off-time delay.

The system disable feature stops all pumps with a single customer furnished normally open contact. When contact closes all pumps shut down and the system is disabled until the contact opens.

ALTERNATION:

The lead pump may be alternated either manually or scheduled (daily, weekly or monthly). Manual alternation can be generated through a button on the HMI. The scheduled alternation occurs at a specific time and date. Daily alternation occurs at a user specified time every day. Weekly alternation occurs at a user specified day and time weekly. Monthly alternation occurs in the first week of a month, on the day and time specified by the user.

ALARMS:

Standard alarms include: pump failure, VFD failure, and Zone DP transmitter failure. Each alarm condition has a menu adjustable time delays.

POWER UP DELAY:

System has a user definable startup delay. When control power is lost, pumps will not start until delay time has elapsed after power is restored. Feature allows user to stage on equipment after a power outage.

System Setup

CONTROL SETUP:

IMPORTANT: Before powering up control panel verify incoming power meets system design requirements. These requirements can be found inside the control panel door in the lower left corner. Starting system with other than the design power could result in damage to controls and motors. This damage VOIDS the TIGERFLOW warranty.

Once proper power feed has been verified, turn ON control power and drive disconnects. After the HMI has powered up, the screen will show pumps and associated HOA switches.

SETTING PUMP START / STOP DIFFERENTIAL PRESSURES:

Set the pump's staging setpoints by touching the Pump Start/Stop button, located on the Menu screen. A password keypad appears. Screen now displays a table showing pump start/stop differential pressures and ON/OFF delay settings for lead and lag pumps. When the active zone differential pressure is equal to or less than a pump start differential pressure for the ON-delay time period then the pump starts. Likewise, when the differential pressure is greater or equal than pump stop differential pressure for the OFF-delay time and the number of pumps running is greater than the minimum required pumps then the pump stops.

If the system is equipped with a flow meter, the pumps will also stage on and off based on the current flow, the flow meter settings and the staging setpoints can be adjusted in the Flow Sequence screen, located in the Config System menu, to access this parameters log in with the user password.

After all pump start/stop settings have been made, touch Menu button to return to the menu screen.

FLOW METER SETUP:

Two types of flow meters can be used with the standard E-Series controller. Data Industrial 200 Series insertion flow meter with Model 310 pulse to analog signal converter is supported for most pipe sizes. Also, supported is any flow meter providing a 4-20 mA or 2-10 V DC signal factory calibrated for a specific maximum flow in a specific pipe size (i.e. Magmeters, Onicon insertion flow meters).

SETTING UP ALARMS:

Set alarm pressures by touching Alarm Settings button on the Menu screen. In this screen you can set the on-delay times for the VFD and pump failure.

A. Pump Failure Alarm is generated when a pump fails to produce 10 psi of boost for the pump failure ON-delay time period. Typical ON-delay time period is 30 seconds.
B. VFD Failure Alarm is generated when the drive running contact does not close within the ON-delay time period. Typical ON-delay time is 2 seconds.

If temperature sensors are used in this system, high temperature alarms can be set in this screen as well.

PUMP ALTERNATION:

Three types of pump alternation options are available:

A. Automatic
B. Manual
C. Timed

Automatic alternation alternates the lead pump after all pumps shutdown. If alternation is desired and all pumps never shutdown, do not use this options.

Manual alternation alternates the lead pump when an operator touches the manual alternation button. This option should also be selected if alternation is not desired.

Timed alternation alternates the lead pump at a specified time interval at a specific time of day. Options include daily, weekly and monthly alternation. Daily alternation occurs each day at the specified time (24 hour clock). Weekly alternation occurs on the day of the week (1=Monday, 2=Tuesday … 7=Sunday) and time (24 hour clock) specified. Monthly alternation occurs during the first week of the month at the time and day specified.

To setup pump alternation touch MENU button on main screen. Touch Config System button then touch the Pump Alternation button and select desire alternation mode. If Mthly/Wkly/Daily is selected, touch Setup button to set alternation day and time.

FACTORY DEFAULT SETTINGS:

To restore the controller to factory settings, access the Speed Control screen from the Config System menu, then touch the Speed Control 2 button. Set the second ΔP from setpoint to 0 and restart the PLC.

To restart the PLC, simply switch the Run/Stop switch located in the PLC, from run, to stop, and then back to run, or simply cycle power on the controller.

System Startup

Once the system pressure and alarm settings have been entered, the system is now ready for operation. Verify all drives are in Auto mode. Touch each pump HOA button until it rotates to the A or Auto position.

PUMP SPEED CONTROL:

Two user adjustable speed control parameters are provided to tune system response to the building demands. Settings are found from the main screen by touching MENU, CONFIG SYSTEM and SPEED CONTROL.

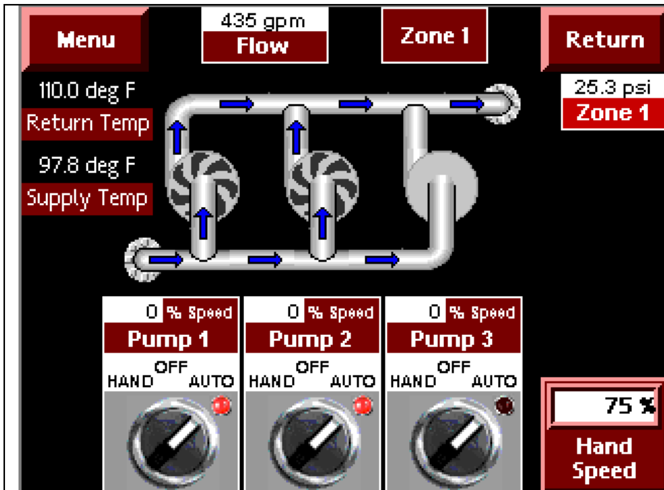
Minimum Auto Speed: The purpose of this setting to prevent pumps from running at non-productive speeds (no flow). It provides quicker flow responses, reduces pump cycling, it helps prevent motor/pump overheating and when set properly shuts down pumps during no flow conditions.

Set the minimum auto speed at the speed required to provide the desired boost at maximum suction conditions. Setting must be determined under low / no flow conditions.

CAUTION: Pump speed will NEVER be lower than the minimum auto speed setting. This setting is intended to be the speed required to produce the desired boost under no-flow conditions. Failure to take into account the maximum suction pressure conditions while making this setting will result in high pressure alarms.

System Response Time: This setting defines how often the controller makes speed adjustments. Increasing this setting makes system respond slower to pressure fluctuations. Decreasing the system response time makes it respond quicker.

HMI Operating Screens:



MAIN SCREEN:
Main operating screen shows differential pressure (DP) of Zone being controlled, flow, and pump run status. Pump status includes pump operating mode (hand, off, auto), ON / OFF.

If temperature sensors are used, the screen displays the current values.

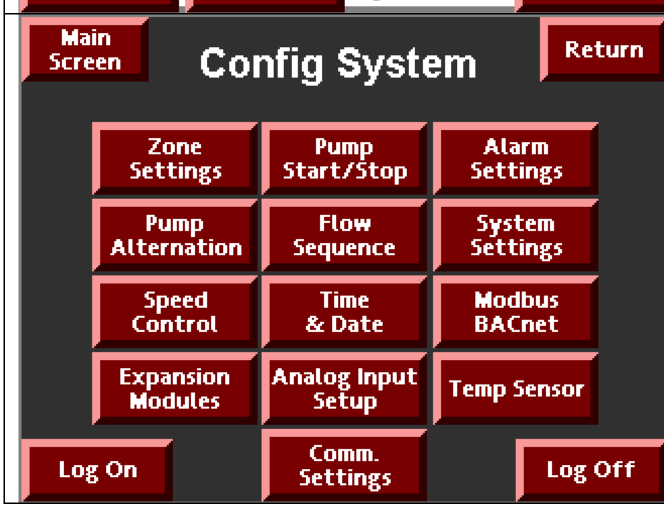
% SPD = Current speed signal to drives
Manual speed = % speed of pump in hand mode

Touch MENU to access menu screen

MENU SCREEN:
Menu screen provides direct access to all system settings and operational information. Touching a button will cause the screen to go to a sub-screen for the option selected.

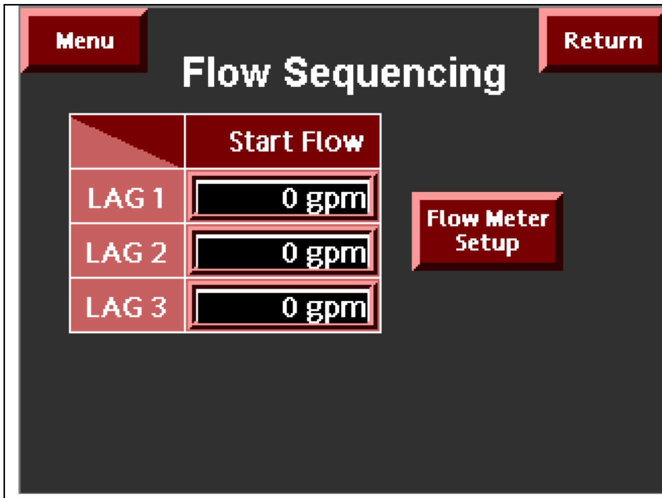
Log on to the system to access settings that are password protected

Touch Main Screen to return to the Main operating screen.



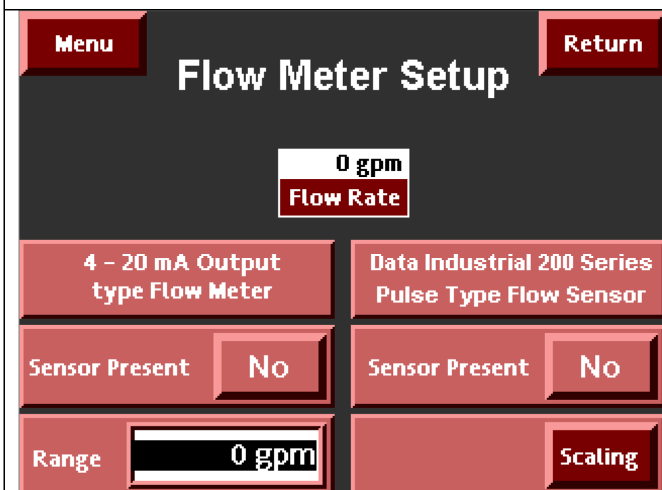
CONFIG SYSTEM SCREEN:
Screen is designed to provide quick access to all system settings during initial startup. Access requires at least a level 4 password and should only be accessed by the facility manager or authorized TIGERFLOW representative.

Settings exclusive to this screen include number of pumps, alternation, sensor ranges, and passwords.



FLOW SEQUENCING SCREEN:
Systems equipped with flow meters can stage lag pumps based on flow as well as pressure. Using this feature allows the system to maintain system pressure with less fluctuation in system pressure. Pumps stage ON when flow is > Lag start OR if system pressure is < Lag start pressure. Pumps stage OFF when flow is < start flow AND system pressure is > stop pressure.

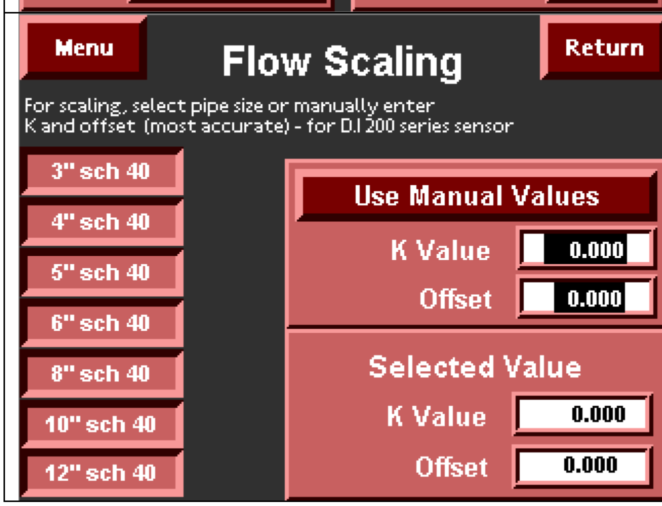
Setup Recommendations:
Lag1 start pressure should be set at lead pump design flow plus 1 gpm. Set Lag 2 start flow at Lead flow + Lag 1 flow + 1 gpm. Set Lag 3 start flow at Lead flow + Lag 1 flow + Lag 2 flow + 1 gpm.



FLOW METER SETUP SCREEN:
Standard flow meter options include 4-20 mA flow signals and Data Industrial pulse insertion meters. Option selected in this sample screen is for a Data Industrial flow meter.

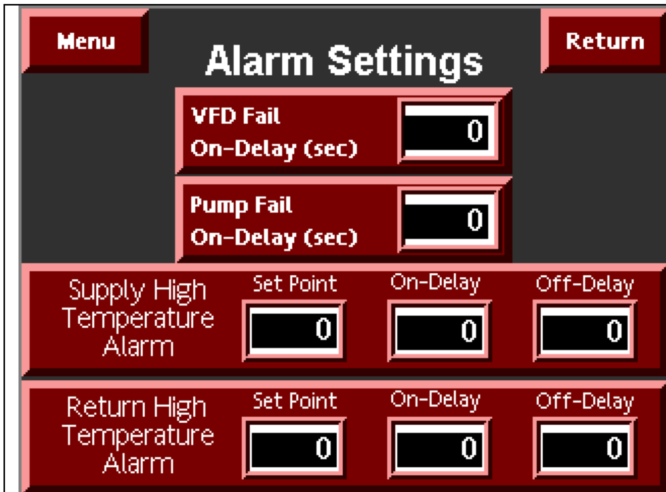
Touch Scaling button to complete Data Industrial setup.

If system is using a 4-20 mA flow signal, touch sensor present and enter max flow meter range.



FLOW SCALING SCREEN:
Select the pipe size in which the flow meter is installed. Both K Value and Offset is automatically entered. If correct pipe size and type is not shown, select Manual and enter K Value and Offset provided by Data Industrial or TIGERFLOW.

Touch Return to go back to Config System menu.

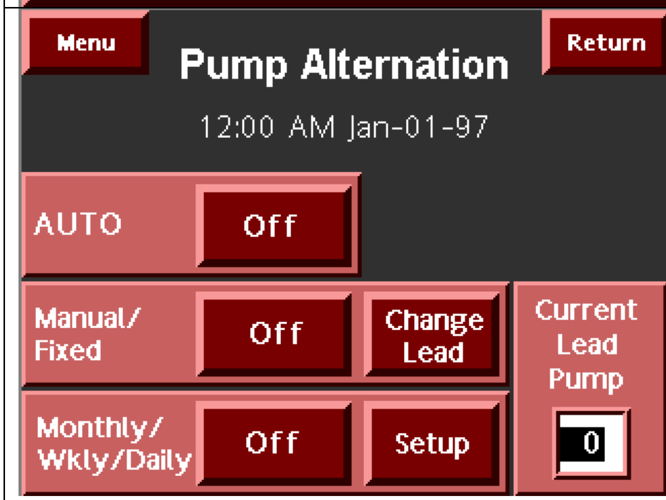


ALARM SETTINGS SCREEN:

VFD Fail ON-Delay is the time allowed for a drive to start when given a run command.

Pump Fail ON-Delay is the time allowed for the pump to break the DP switch installed across the pump suction and discharge.

High temperature setpoints can be set, and their respective on/off delays

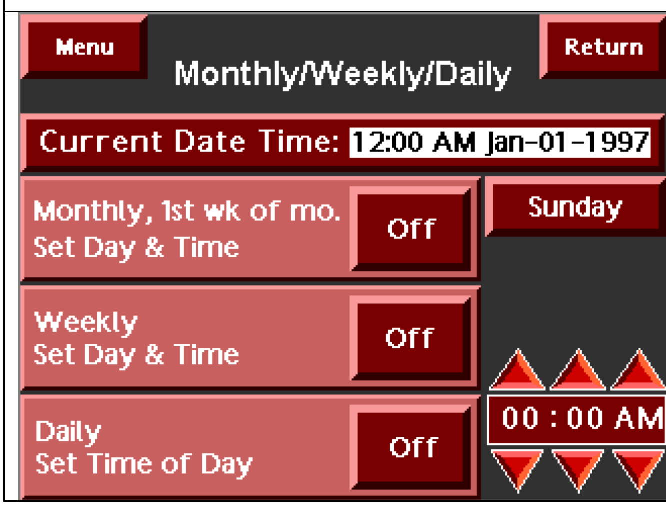


PUMP ALTERNATION SCREEN:

Provides the options of automatic, manual or timed alternation. Auto is the default mode. In this mode lead pumps alternate on lead pump shutdown.

Touch the OFF button to the right of MANUAL / FIXED, to select the manual alternation mode. In this mode touching the Change Lead button causes pumps to alternate

Touch the OFF button to the right of MONTHLY / WKLY / DAILY to select the timed alternation mode. Touch the Setup button to configure this option.

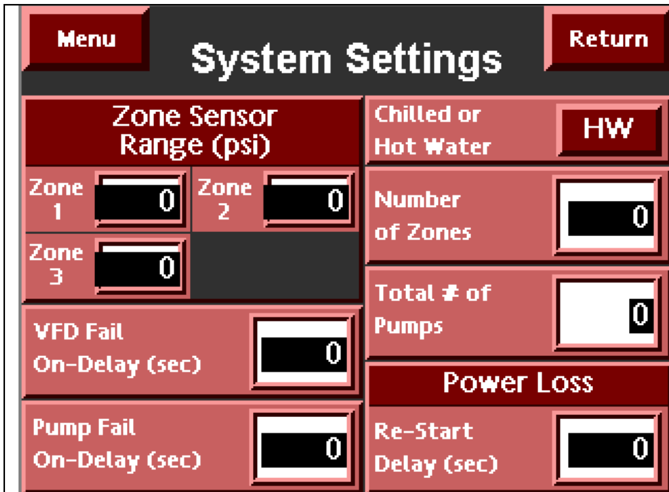


TIMED ALTERNATION SET UP SCREEN:

As shown (monthly option selected), pumps will alternate on the first Monday of each month at 12 pm. Selecting the weekly option will cause the pumps to alternate each Monday at 12 pm.

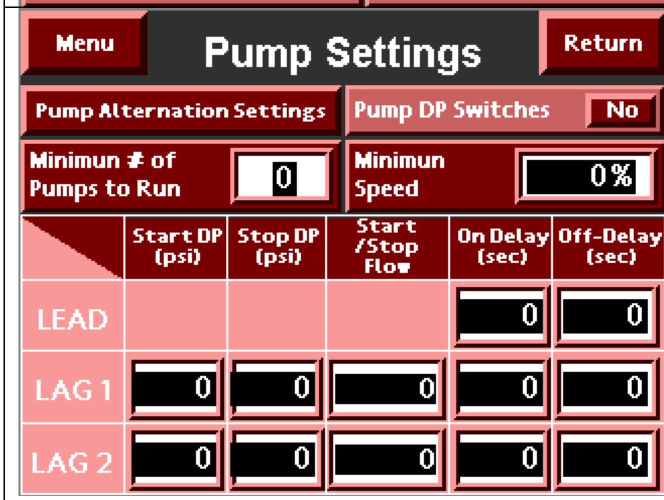
Adjust the day of the week by touching the current setting. A numeric keypad will appear. Enter a number between 1 and 7 (1=Monday, 7=Sunday).

Adjust the hour in like manor by touching the hour setting. Hour is based on the 24 hour clock.



SYSTEM SETTINGS SCREEN:
This screen is used to set the number of zones to be monitored, with their respective sensor ranges. The number of pumps in the skid, and the on-delay times for VFD and pump failure.

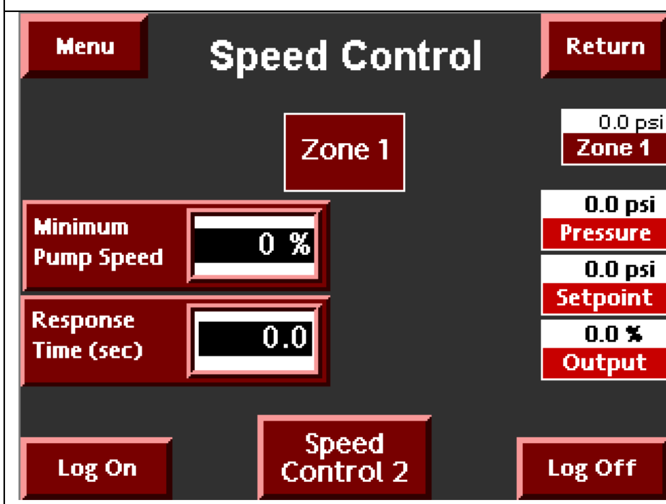
The Power Loss Restart delay will set the time that has to elapse before restoring normal operation after a power loss.



PUMP SETTINGS SCREEN:
Set minimum number of pumps to run in auto and minimum speed. Regardless of system load, no fewer than the minimum pumps will run at a speed greater than or equal to the minimum speed (Auto).

Set pump start and stop differential pressures DP, as well as, ON and OFF delay times.

Setting stop pressures for Lag pumps less than the lead pump stop pressure will help insure Lag pumps will not continue to run when not needed.



SPEED CONTROL SCREEN:
Provides access to customer accessible speed control variables.

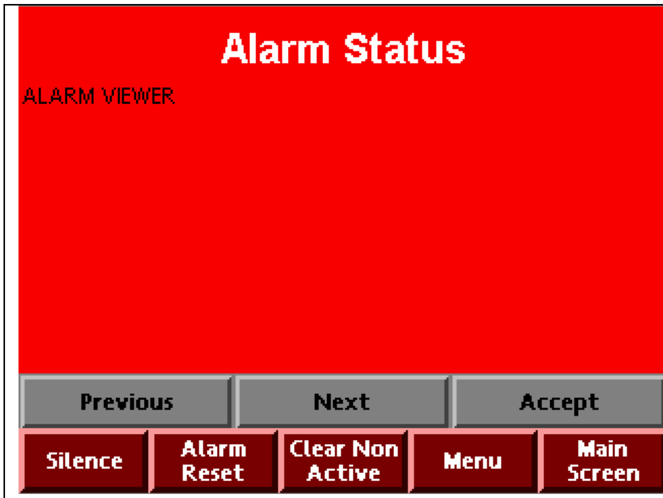
Minimum Pump Speed is the minimum speed a pump will run in automatic.

Response Time is the frequency in which speed changes are made.

Press. Is the current system pressure

SP is the current system pressure set point plus 1 psi.

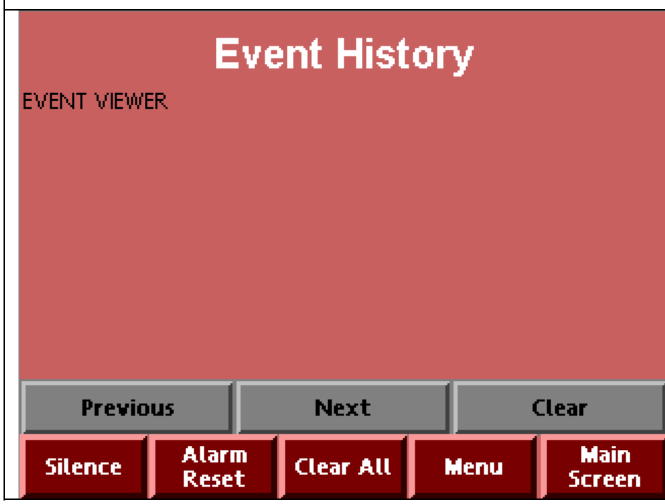
Output is the current % speed signal to drive. 50% speed is equivalent to 5.0 V DC. 75% speed is equivalent to 7.5 V DC.



ALARM / SYSTEM STATUS SCREEN:
Provides a list of all active system events. An event includes:

-Pump starts and stops
-Pump failure
-Alarm acknowledgement / silence
-Alarm reset
-Remote System failure
-System disable

Touch Silence button to acknowledge an alarm condition and silence horn. Touch Alarm Reset to reset alarm condition.



EVENT HISTORY SCREEN:
Provides a history of the last ten system events. An event includes:

Pump starts and stops
Pump failure
Alarms
Alarm acknowledgement / silence
Alarm reset
Econo Mode
System disable

Troubleshooting:

Code	Problem	Possible causes	Recommended Actions
TE-1	No display	**A.** Display screen saver is active.	Touch Screen and display should appear
		B. No 120 VAC control power	**1**. Verify control power disconnect is in ON position.
			2. Verify voltage between terminal 102 and 200 is 120 V. If not, verify there is power to the control panel. If power is present, turn control disconnect OFF and check control transformer fuses. If power is not present find some who can determine the cause of the outage.
			3. If power to panel is present and transformer fuses are not blown, replace control transformer.
		C. No DC control voltage	**1.** Measure DC voltage at the power supply (on most systems "+24V" and "0V" terminals). Voltage should be 24 V DC.
			2. If no DC power is present, check 1 amp glass fuse on AC side of power supply and replace if blown (factory provided a spare in the fuse holder for your convenience).
			3. If DC power is present at the power supply, check voltage between terminals 402 and 400. If no power is found, check 1 amp glass fuse on DC side of power supply. Replace if blown (factory provided a spare in the fuse holder for your convenience.). If fuse is good, check for loose connections at terminals 402 and 400. Check for loose power connection at HMI.

Code	Problem	Possible causes	Recommended Actions
TE-2	Touch screen not responding or not responding correctly to touch	**A.** Screen needs to be recalibrated	Contact your TIGERFLOW Representative.
		B. Screen is defective	Reset screen by cycling control power. NOTICE: Cycling control power will shutdown all pumps! If pump can not be shutdown, unplug and re-plug DC power plug on back of touch screen (HMI). If problem still exists, contact your TIGERFLOW Representative.
TE-3	PLC not found	**A.** Loose Serial Cable	1. Verify 9 pin serial plug is securely attached to COM1 on back side of HMI (touch screen).
			2. Verify round serial plug is securely plugged into ELC-PB14NNDR.
		B. PLC not running	1. Verify green power LED is illuminated on each ELC module. If not, check DC control voltage. **See TE-1.C**
			2. Verify ELC-PB14NNDR run/stop switch is in the RUN position. If it is not, slide it up to RUN Position.
			3. If problem still exists, contact your TIGERFLOW representative.
TE-4	Zone differential pressure reading does not match gauge(s).	**A.** Incorrect pressure transducer range	From main screen touch MENU, then CONFIG SYSTEM and SYSTEM SETTING. Verify maximum ranges shown for suction and system pressure transducers match the actual ranges of the installed transducers.
		B. Transducer problem	Check signal (2-10 V DC) by measuring the voltage between 203 and 400 (Zone 1 pressure) or between 204 and 400 (Zone 2 pressure). Voltage should be 2 V DC for 0 PSI and 10 V DC for max range, psi. Pressure is proportional to this signal, i.e., 6 V DC is 50% of max range, psi.
TE-5	Pressure transducer reading maximum value OR Transducer Failure Alarm	**A.** Pressure at or above transducer upper limit	1. Does pressure match gauge pressure? If not, measure pressure voltage signal (2-10 V DC)
			2. Check signal (2-10 V DC) by measuring the voltage between 203 and 400 (Zone 1 pressure) or between 204 and 400 (Zone 2 pressure). Voltage should be 10 V DC if pressure is reading full range. If reading is 24 V DC see **TE-3.B**.
		B. Loose termination	1. Check wire terminations at terminals 203, 204 and 400. Insert screw driver under resistor between 203 and 400. Gentle pull resistor away from terminal strip. If either leg of the resistor moves, re-insert the leg into the terminal and re-tighten terminal. Repeat this procedure for resistor between 204 and 400.
			2. Check transducer wire connection to terminal 402.
		C. Faulty pressure transducer	If recommended actions for TE-5. A and B do not correct the problem, replace the pressure transducer

Code	Problem	Possible causes	Recommended Actions
TE-6	Pump does not run when HMI display shows it running	**A.** Drive disconnect OFF	Check pump disconnect. Turn ON, if it is OFF.
		B. Drive in Alarm state.	Press RESET button or cycle drive power.
		C. Drive short circuit fuse(s) blown.	If this is the case, drive disconnect will be ON and drive will not be powered. Check fuses and replace if necessary.
		D. Drive does not have run permission.	1. Check terminations on run permissive cable(s): **Drive 1 = cable 231** **Drive 2 = cable 233** **Drive 3 = cable 235** **Drive 4 = cable 237**
			2. Jump drive run permissive
			3. If relay is energized, check AC volts to ground on relay terminals 11 and 14. Power should be present at all times on terminal 11, even when relay is not energized. Power should only be present on terminal 14 when either the relay is energized or the pump emergency override switch is ON.
		E. Drive does not have a speed reference.	1. Check terminations on dive speed reference cable(s): **Drive 1 = cable 251** **Drive 2 = cable 252** **Drive 3 = cable 253** **Drive 4 = cable 254**
			2. Change pump in question to hand and set hand speed to 50%. Speed reference voltage (0-10 V DC) between following terminals: **Drive 1 between terminals 251 and 400** **Drive 2 between terminals 252 and 400** **Drive 3 between terminals 253 and 400** **Drive 4 between terminals 254 and 400** Speed reference for the drive in question should be 5.0 Volts DC. If Voltage is not found verify: - PLC is in Run position and has power (Green LEDs illuminated) - There are no active alarms. If problem still exists, contact your TIGERFLOW Representative.
TE-7	Pump does not run. Controls are not calling for pump to run.	Alarm Condition	Touch MENU and SYSTEM STATUS. Check for alarm messages. Touch RESET to clear alarms. If alarm re-occurs, check alarm settings and see if alarm is valid. If alarm is valid, take actions to correct the condition. If alarm is not valid, contact your TIGERFLOW Representative.
		Pumps Turned OFF	Verify pump HOA switch is in HAND or AUTO position. Switch position is changed by touching the switch.

Code	Problem	Possible causes	Recommended Actions
		System pressure is higher than pump start pressure.	This is normal for a properly operating pump system. If pump needs to be running, increase pump start pressure by touching MENU and PUMP START/STOP.

WHITMAN CONTROLS CORP. DIFFERENTIAL PRESSURE SWITCH

Operations & Maintenance Manual
December 2015

WHITMAN CONTROLS CORPORATION

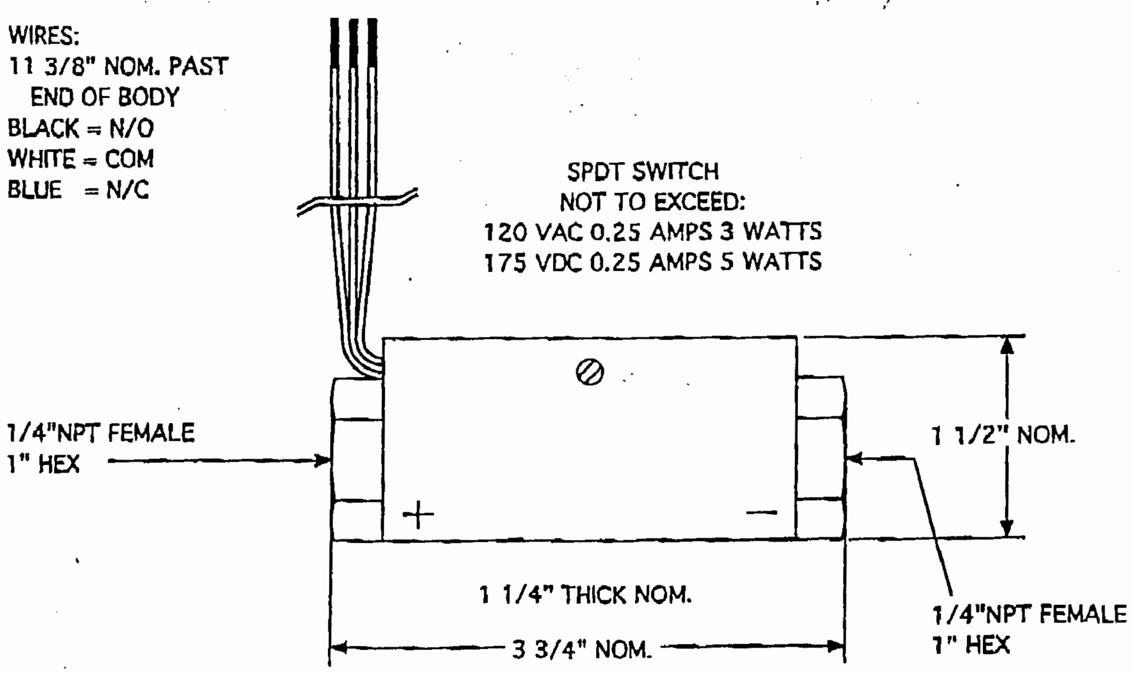
201 DOLPHIN ROAD • BRISTOL, CONNECTICUT 06010-8000
(860) 583-1847 • info@whitmancontrols.com • FAX (860) 583-5293

Model P845
Differential Pressure Switch

Set Point Adjustments
Wiring Instructions

Differential Pressure Set Point Adjustment - Model P845

Loosen setscrew located in switch body immediately above label. Push wires into body to **increase** differential pressure. Pull wires away from body, to **decrease** differential pressure. Then carefully tighten screw. Entire adjustable range may be covered by moving wires approximately 3/16 inch each side of mean.



Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

Bulletin No. G306A-G
Drawing No. LP0666
Released 02/13

MODEL G306A - GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH TFT QVGA DISPLAY AND TOUCHSCREEN

- *CONFIGURED USING CRIMSON® SOFTWARE (BUILD 424 OR NEWER)*
- *UP TO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 AND 1 RS-422/485 ON BOARD, 1 RS-232 AND 1 RS422/485 ON OPTIONAL COMMUNICATIONS CARD)*
- *10 BASE T/100 BASE-TX ETHERNET PORT TO NETWORK UNITS AND HOST WEB PAGES*
- *USB PORT TO DOWNLOAD THE UNIT'S CONFIGURATION FROM A PC OR FOR DATA TRANSFERS TO A PC*
- *UNIT'S CONFIGURATION IS STORED IN NON-VOLATILE MEMORY (8 MBYTE FLASH)*
- *COMPACTFLASH® SOCKET TO INCREASE MEMORY CAPACITY*
- *5.7-INCH TFT ACTIVE MATRIX 256 COLOR QVGA 320 X 240 PIXEL LCD W/LED BACKLIGHT*
- *5-BUTTON KEYPAD FOR ON-SCREEN MENUS*
- *THREE FRONT PANEL LED INDICATORS*
- *POWER UNIT FROM 24 VDC ±20% SUPPLY*
- *RESISTIVE ANALOG TOUCHSCREEN*

C UL US LISTED
43NH
PROCESS CONTROL EQUIPMENT

FOR USE IN HAZARDOUS LOCATIONS:
Class I, Division 2, Groups A, B, C, and D

GENERAL DESCRIPTION

The G306A Operator Interface Terminal combines unique capabilities normally expected from high-end units with a very affordable price. It is built around a high performance core with integrated functionality. This core allows the G306A to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306A is able to communicate with many different types of hardware using high-speed RS232/422/485 communications ports and Ethernet 10 Base T/100 Base-TX communications. In addition, the G306A features USB for fast downloads of configuration files and access to trending and data logging. A CompactFlash socket is provided so that Flash cards can be used to collect your trending and data logging information as well as to store larger configuration files.

In addition to accessing and controlling of external resources, the G306A allows a user to easily view and enter information. Users can enter data through the touchscreen and/or front panel 5-button keypad.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.

The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2

CAUTION: Risk Of Danger. Read complete instructions prior to installation and operation of the unit.	**CAUTION:** Risk of electric shock.

CONTENTS OF PACKAGE

- G306A Operator Interface.
- Panel gasket.
- Template for panel cutout.
- Hardware packet for mounting unit into panel.
- Terminal block for connecting power.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
G306A	Operator Interface for indoor applications, textured finish with embossed keys	G306A000
G3CF	CompactFlash Card [5]	G3CFxxxx
G3RS	RS232/485 Optional Communication Card	G3RS0000
G3CN	CANopen Optional Communication Card	G3CN0000
G3DN	DeviceNet option card for G3 operator interfaces with isolated high speed communications ports	G3DN0000
G3PBDP	Profibus DP Optional Communication Card	G3PBDP00
SFCRM2	Crimson 2.0 [2]	SFCRM200
CBL	RS-232 Programming Cable	CBLPROG0
	USB Cable	CBLUSB00
	Communications Cables [1]	CBLxxxxx
DR	DIN Rail Mountable Adapter Products [3]	DRxxxxxx
	Replacement Battery [4]	BNL20000
G3FILM	Protective Films	G3FILM06

[1] Contact your Red Lion distributor or visit our website for complete selection.
[2] Use this part number to purchase the Crimson® software on CD with a printed manual, USB cable, and RS-232 cable. Otherwise, download for free from www.redlion.net.
[3] Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details.
[4] Battery type is lithium coin type CR2025.
[5] Industrial grade two million write cycles.

SPECIFICATIONS

1. **POWER REQUIREMENTS**:
   Must use a Class 2 circuit according to National Electrical Code (NEC), NFPA-70 or Canadian Electrical Code (CEC), Part I, C22.1 or a Limited Power Supply (LPS) according to IEC 60950-1 or Limited-energy circuit according to IEC 61010-1.
   Power connection via removable three position terminal block.
   Supply Voltage: +24 VDC ±20%
   Typical Power[1]: 8 W
   Maximum Power[2]: 10 W
   Notes:
   1. *Typical power with +24 VDC, RS232/485 communications, Ethernet communications, CompactFlash card installed, and display at full brightness.*
   2. *Maximum power indicates the most power that can be drawn from the G306A. Refer to "Power Supply Requirements" under "Installing and Powering the G306A."*
   3. *The G306A's circuit common is not connected to the enclosure of the unit. See "Connecting to Earth Ground" in the section "Installing and Powering the G306A."*
   4. *Read "Power Supply Requirements" in the section "Installing and Powering the G306A" for additional power supply information.*
2. **BATTERY**: Lithium coin cell. Typical lifetime of 10 years.
3. **LCD DISPLAY**:

SIZE	5.7-inch
TYPE	TFT
COLORS	256
PIXELS	320 X 240
BRIGHTNESS	380 cd/m^2
BACKLIGHT*	50,000 HR TYP.

*Lifetime at room temperature. Refer to "Display" in "Software/Unit Operation"

4. **5-KEY KEYPAD**: for on-screen menus.
5. **TOUCHSCREEN**: Resistive analog
6. **MEMORY**:
   On Board User Memory: 8 Mbyte of non-volatile Flash memory.
   Memory Card: CompactFlash Type II slot for Type I and Type II CompactFlash cards.
7. **COMMUNICATIONS**:
   USB Port: Adheres to USB specification 1.1. Device only using Type B connection.

> WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

   Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.
   PGM Port: RS232 port via RJ12.
   COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12.
   DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC, V_{OL} = 0.5 V @ 25 mA max.
   Note: For additional information on the communications or signal common and connections to earth ground please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306A."
   Ethernet Port: 10 BASE-T / 100 BASE-TX
   RJ45 jack is wired as a NIC (Network Interface Card).
   Isolation from Ethernet network to G3 operator interface: 1500 Vrms

8. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50°C
   Storage Temperature Range: -20 to 70°C
   Operating and Storage Humidity: 80% maximum relative humidity (non-condensing) from 0 to 50°C.
   Vibration according to IEC 68-2-6: Operational 5 to 8 Hz, 0.8" (p-p), 8 to 500 Hz, in X, Y, Z direction, duration: 1 hour, 3 g.
   Shock according to IEC 68-2-27: Operational 40 g, 9 msec in 3 directions.
   Altitude: Up to 2000 meters.
9. **CERTIFICATIONS AND COMPLIANCES**:
   SAFETY
   UL Listed, File #E245515, UL61010-1, ANSI/ISA 12.12.01-2007, CAN/CSA 22.2 No. 61010.1, CSA 22.2 No. 213-M1987 and File #E179259, UL61010-1, CAN/CSA 22.2 No.61010-1
   LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
   Type 4X Indoor Enclosure rating (Face only), UL50
   IECEE CB Scheme Test Report #E179259-A1-CB-3
   Issued by Underwriters Laboratories Inc.
   IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
   IP66 Enclosure rating (Face only), IEC 529
   ELECTROMAGNETIC COMPATIBILITY
   Emissions and Immunity to EN 61326: 2006: Electrical Equipment for Measurement, Control and Laboratory use.

Immunity to Industrial Locations:

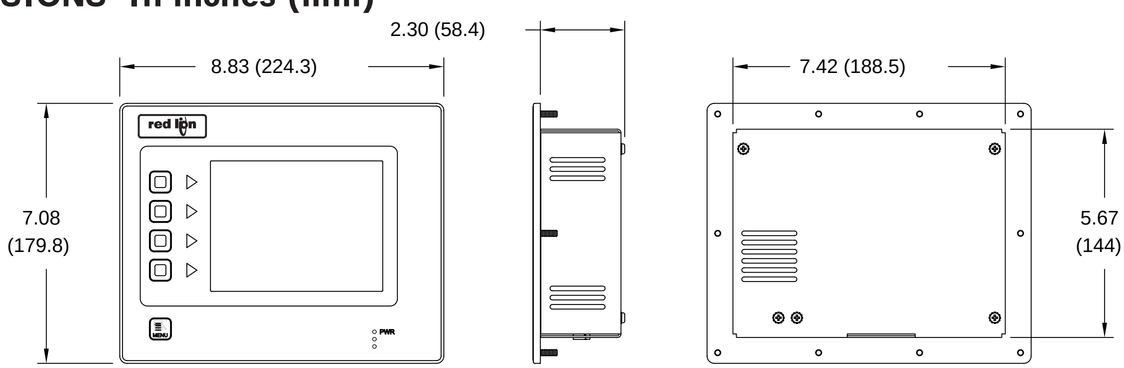
Electrostatic discharge	EN61000-4-2	Criterion A 4kV contact discharge 8kV air discharge
Electromagnetic RF fields	EN61000-4-3	Criterion A 10V/m (80 MHz to 1 GHz) 3 V/m (1.4 GHz to 2 GHz) 1 V/m (2 GHz to 2.7 GHz)
Fast transients (burst)	EN61000-4-4	Criterion A 2kV power 1kV I/O signal
Surge	EN61000-4-5	Criterion A 1kV L to L 2kV L to G power 1 kV signal
RF conducted interference	EN61000-4-6	Criterion A 3Vrms
Power frequency magnetic fields	EN61000-4-8	Criterion A 30A/m

Emissions:

Emissions	EN55011	Class A

   Note:
   1. *Criterion A: Normal operation within specified limits.*
10. **CONNECTIONS**: Compression cage-clamp terminal block.
    Wire Gage: 12-30 AWG copper wire
    Torque: 5-7 inch-pounds (56-79 N-cm)
11. **CONSTRUCTION**: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2.
12. **MOUNTING REQUIREMENTS**: Maximum panel thickness is 0.25" (6.3 mm). For NEMA 4X/IP66 sealing, a steel panel with a minimum thickness of 0.125" (3.17 mm) is recommended.
    Maximum Mounting Stud Torque: 17 inch-pounds (1.92 N-m)
13. **WEIGHT**: 3.0 lbs (1.36 Kg)

DIMENSIONS In inches (mm)

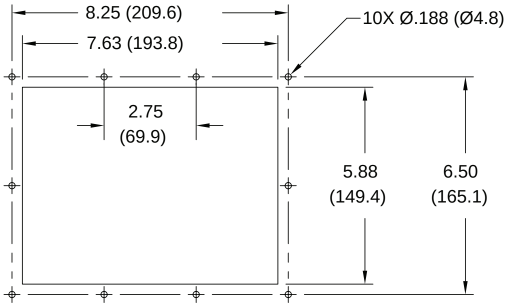


INSTALLING AND POWERING THE G306A

MOUNTING INSTRUCTIONS

This operator interface is designed for through-panel mounting. A panel cut-out diagram and a template are provided. Care should be taken to remove any loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4X/IP66 specification. Install the ten kep nuts provided and tighten evenly for uniform gasket compression.

Note: Tightening the kep nuts beyond a maximum of 17 inch-pounds (1.92 N-m) may cause damage to the front panel.



All tolerances ±0.010" (±0.25 mm).

ALL NONINCENDIVE CIRCUITS MUST BE WIRED USING DIVISION 2 WIRING METHODS AS SPECIFIED IN ARTICLE 501-4 (b), 502-4 (b), AND 503-3 (b) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WITHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.

CONNECTING TO EARTH GROUND

The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

Each G306A has a chassis ground terminal on the back of the unit. Your unit should be connected to earth ground (protective earth).

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your unit. But, other equipment connected to this unit may require isolation between signal common and earth ground. *To maintain isolation between signal common and earth ground care must be taken when connections are made to the unit.* For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common and earth ground.[1]

[1] USB's shield may be connected to earth ground at the host. USB's shield in turn may also be connected to signal common.

POWER SUPPLY REQUIREMENTS

The G306A requires a 24 VDC power supply. Your unit may draw considerably less than the maximum rated power depending upon the options being used. As additional features are used your unit will draw increasing amounts of power. Items that could cause increases in current are additional communications, optional communications card, CompactFlash card, and other features programmed through Crimson.

In any case, it is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply must be mounted close to the unit, with usually not more than 6 feet (1.8 m) of cable between the supply and the operator interface. Ideally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22-gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.
- A power supply with an NEC Class 2 or Limited Power Source (LPS) and SELV rating is to be used. This type of power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.

INSTALLING AN OPTION CARD

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

Each option card comes with a cable for communications and three screws for ataching the option card to the G306's rear cover. To install the option card, remove all power and I/O communications cables from the unit. Use the three screws provided to mount the option card to the rear cover of the G306 as shown in Figure 1.

Connect the cable from the option card to CN11 on the main board of the G306 as shown in Figure 2. Be sure both ends of the cable are firmly seated into their appropriate connector housing. Carefully replace the rear cover by reversing the instructions for removing the rear cover.

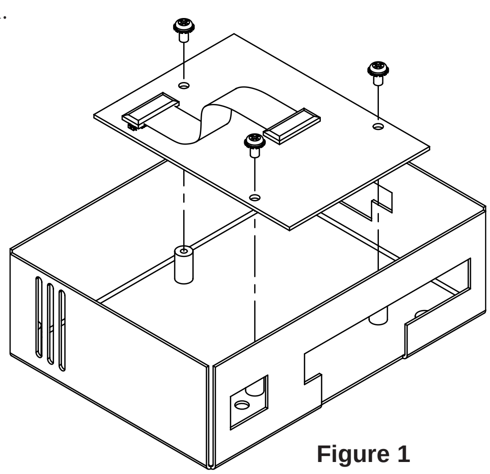


Figure 1

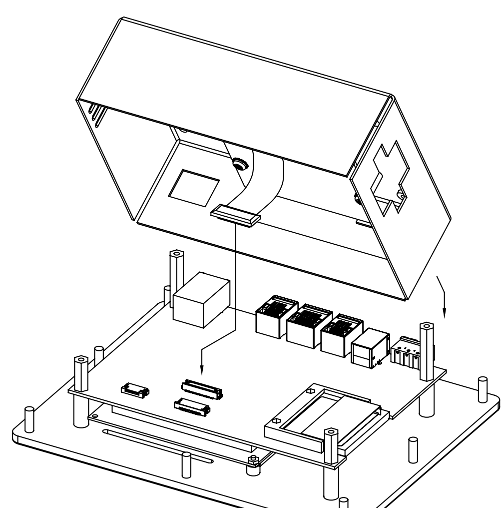


Figure 2

COMMUNICATING WITH THE G306A

CONFIGURING A G306A

The G306A is configured using Crimson® software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306A using the latest version of Crimson, you are assured that your unit has the most up to date feature set. Crimson® software can configure the G306A through the RS232 PGM port, USB port, or CompactFlash.

The USB port is connected using a standard USB cable with a Type B connector. The driver needed to use the USB port will be installed with Crimson.

The RS232 PGM port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If you choose to make your own cable, use the "G306A Port Pin Out Diagram" for wiring information.

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson literature for more information on the proper names and locations of the files.

USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD

WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson and is located in the folder C:\Program Files\Red Lion Controls\Crimson 2.0\Device\ after Crimson is installed. This may have already been accomplished if your G306A was configured using the USB port.

Once the driver is installed, connect the G306A to your PC with a USB cable, and follow "Mounting the CompactFlash" instructions in the Crimson 2 user manual.

CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "G306A Port Pin Outs" for wiring information.

ETHERNET COMMUNICATIONS

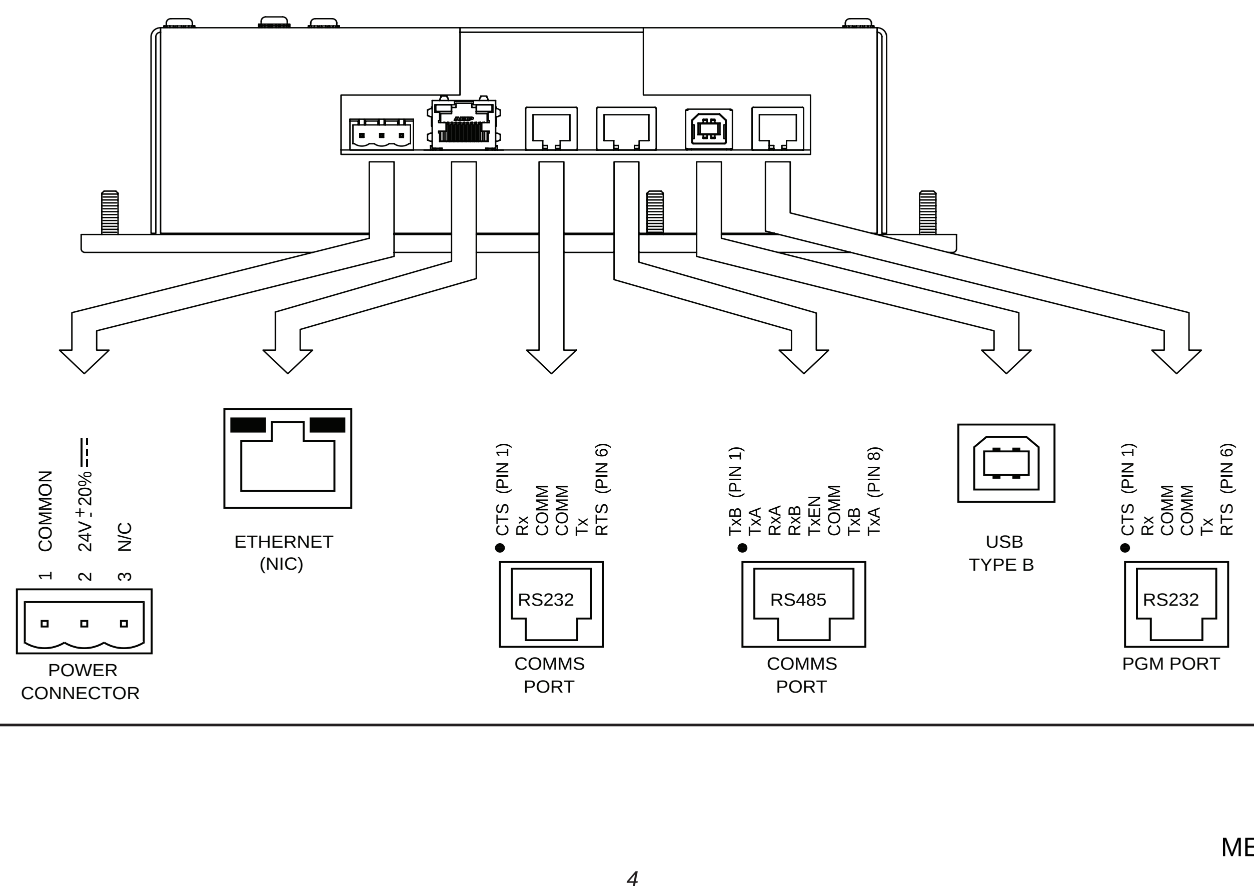
Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306A unit's RJ45 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straight-through cable, but when connecting to another NIC use a crossover cable.

The Ethernet connector contains two LEDs. A yellow LED in the upper right, and a bi-color green/amber LED in the upper left. The LEDs represent the following statuses:

LED COLOR	DESCRIPTION
YELLOW solid	Link established.
YELLOW flashing	Data being transferred.
GREEN	10 BASE-T Communications
AMBER	100 BASE-TX Communications

On the rear of each unit is a unique 12-digit MAC address and a block for marking the unit with an IP address. Refer to the Crimson manual and Red Lion's website for additional information on Ethernet communications.

G306A PORT PIN OUTS



RS232 PORTS

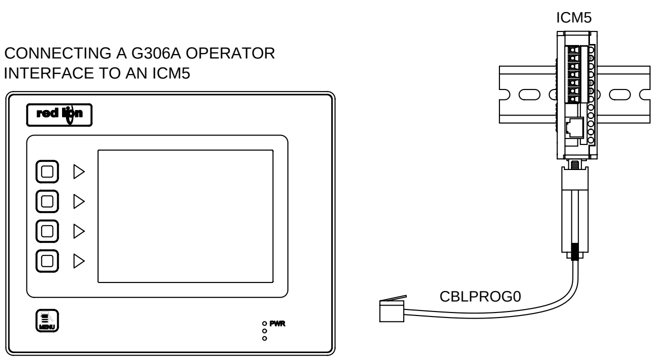
The G306A has two RS232 ports. There is the PGM port and the COMMS port. Although only one of these ports can be used for programming, both ports can be used for communications with a PLC.

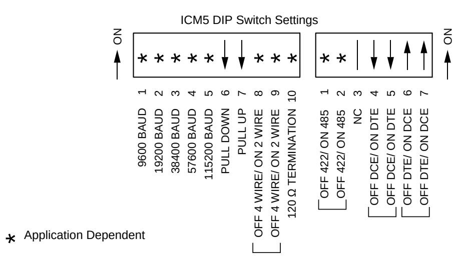
The RS232 ports can be used for either master or slave protocols with any G306A configuration.

Examples of RS232 communications could involve another Red Lion product or a PC. By using a cable with RJ12 ends on it, and a twist in the cable, RS232 communications with another G3 product or the Modular Controller can be established. Red Lion part numbers for cables with a twist in them are CBLPROG0 [1], CBLRLC01 [2], or CBLRC02 [3].

G3 RS232 to a PC

Connections			
G3: RJ12	Name	PC: DB9	Name
4	COMM	1	DCD
5	Tx	2	Rx
2	Rx	3	Tx
	N/C	4	DTR
3	COM	5	GND
	N/C	6	DSR
1	CTS	7	RTS
6	RTS	8	CTS
	N/C	9	RI





[1] CBLPROG0 can also be used to communicate with either a PC or an ICM5.
[2] DB9 adapter not included, 1 foot long.
[3] DB9 adapter not included, 10 feet long.

Examples of RS485 2-Wire Connections

G3 to Red Lion RJ11 (CBLRLC00) DLC, IAMS, ITMS, PAXCDC4C

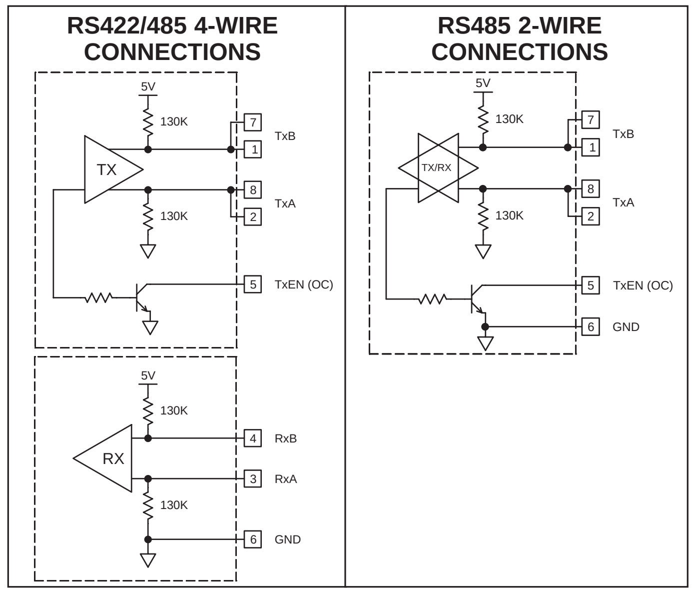
Connections			
G3: RJ45	Name	RLC: RJ11	Name
5	TxEN	2	TxEN
6	COM	3	COM
1	TxB	5	B-
2	TxA	4	A+

G3 to Modular Controller (CBLRLC05)

Connections			
G3	Name	Modular Controller	Name
1,4	TxB	1,4	TxB
4,1	RxB	4,1	RxB
2,3	TxA	2,3	TxA
3,2	RxA	3,2	RxA
5	TxEN	5	TxEN
6	COM	6	COM
7	TxB	7	TxB
8	TxA	8	TxA

RS422/485 COMMS PORT

The G306A has one RS422/485 port. This port can be configured to act as either RS422 or RS485.



Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to www.redlion.net for additional information.

DH485 COMMUNICATIONS

The G306A's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: **DO NOT** use a standard DH485 cable to connect this port to Allen Bradley equipment. A cable and wiring diagram are available from Red Lion.

G3 to AB SLC 500 (CBLAB003)

Connections			
RJ45: RLC	Name	RJ45: A-B	Name
1	TxB	1	A
2	TxA	2	B
3, 8	RxA	-	24V
4, 7	RxB	-	COMM
5	TxEN	5	TxEN
6	COMM	4	SHIELD
4, 7	TxB	-	COMM
3, 8	TxA	-	24V

MECH - 372

SOFTWARE/UNIT OPERATION

CRIMSON® SOFTWARE

Crimson® software is available as a free download from Red Lion's website or it can be purchased on a CD, see "Ordering Information" for part number. The latest version of the software is always available from the website, and updating your copy is free.

DISPLAY

This operator interface uses a liquid crystal display (LCD) for displaying text and graphics. The display utilizes aa LED backlight for lighting the display. The backlight can be dimmed for low light conditions.

The LED backlight has a limited lifetime. Backlight lifetime is based upon the amount of time the display is turned on at full intensity. Turning the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson® software when configuring your unit.

FRONT PANEL LEDS

There are three front panel LEDs. Shown below is the default status of the LEDs.

LED	INDICATION
RED (TOP, LABELED "PWR")	
FLASHING	Unit is in the boot loader, no valid configuration is loaded.[1]
STEADY	Unit is powered and running an application.
YELLOW (MIDDLE)	
OFF	No CompactFlash card is present.
STEADY	Valid CompactFlash card present.
FLASHING RAPIDLY	CompactFlash card being checked.
FLICKERING	Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive.[2]
FLASHING SLOWLY	Incorrectly formatted CompactFlash card present.
GREEN (BOTTOM)	
FLASHING	A tag is in an alarm state.
STEADY	Valid configuration is loaded and there are no alarms present.

[1] The operator interface is shipped without a configuration. After downloading a configuration, if the light remains in the flashing state continuously, try cycling power. If the LED still continues to flash, try downloading a configuration again.

[2] Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompactFlash" in the Crimson 2 User Manual.

TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input. The unit will only produce an audible tone (beep) when a touch on an active touchscreen cell is sensed. The touchscreen is fully functional as soon as the operator interface is initialized, and can be operated with gloved hands.

KEYPAD

The G306A keypad consists of five keys that can be used for on-screen menus.

TROUBLESHOOTING YOUR G306A

If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306A, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsupport@redlion.net
Web Site: http://www.redlion.net

BATTERY & TIME KEEPING

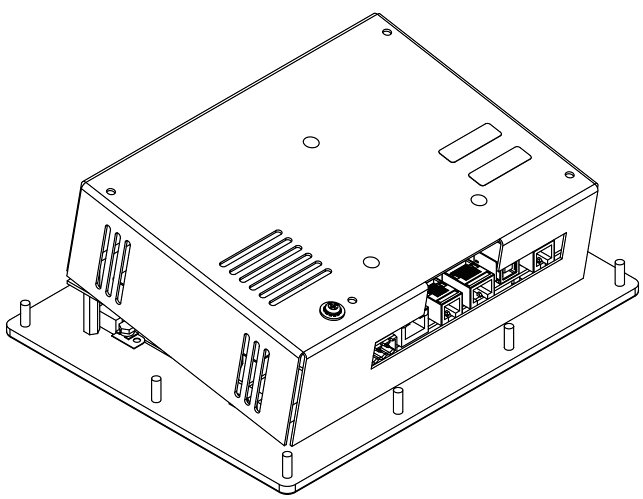
WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO BE NON-HAZARDOUS BEFORE SERVICING/ REPLACING THE UNIT AND BEFORE INSTALLING OR REMOVING I/O WIRING AND BATTERY.

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

A battery is used to keep time when the unit is without power. Typical accuracy of the G306A time keeping is less than one minute per month drift. The battery of a G306A unit does not affect the unit's memory, all configurations and data is stored in non-volatile memory.

CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover attached, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the operator interface at a static controlled clean workstation. Also, do not touch the surface areas of the circuit board. Dirt, oil, or other contaminants may adversely affect circuit operation.

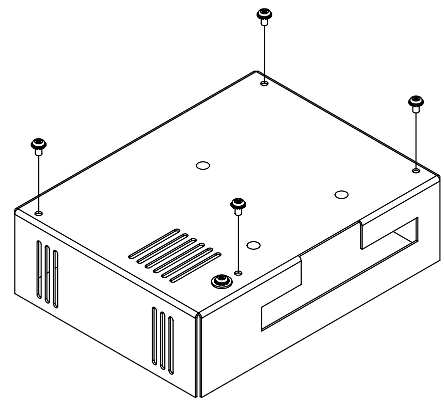
To change the battery of a G306A, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner.

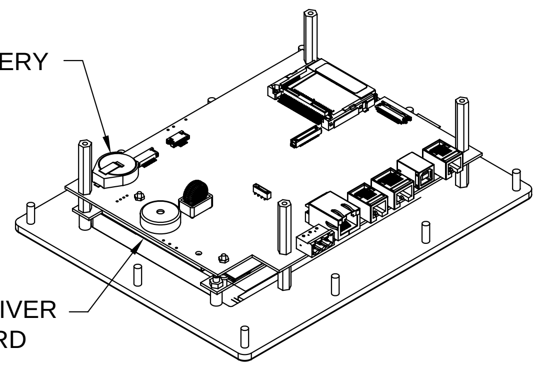


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

** Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also, the battery must not be disposed of in fire, or in a manner whereby it may be damaged and its contents come into contact with human skin.*

The battery used by the G306A is a lithium type CR2025.





OPTIONAL FEATURES AND ACCESSORIES

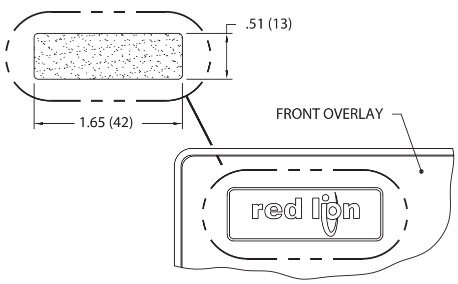
OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306A to communicate with many of the popular fieldbus protocols.

Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

CUSTOM LOGO

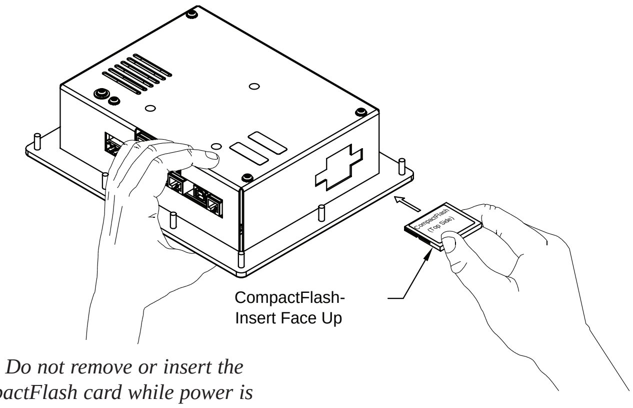
Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing.



COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes and formatted to a maximum of 2 Gbytes (See Note box below) with the G306A's CompactFlash socket. Cards are available at most computer and office supply retailers.

CompactFlash can be used for configuration transfers, larger configurations, data logging, and trending.



Note: Do not remove or insert the CompactFlash card while power is applied. Refer to "Front Panel LEDs."

Information stored on a CompactFlash card by a G306A can be read by a card reader attached to a PC. This information is stored in IBM (Windows®) PC compatible FAT16 file format.

NOTE

For reliable operation of this and other Red Lion products, one of the following brands of CompactFlash card must be used...

SimpleTech	SMART® Modular
SanDisk®	Silicon Systems

Not all of the above manufacturers offer CompactFlash cards recognized to UL standards, which may be required for your application.

Although RLC products limit use of CompactFlash card memory to 2 GB, cards with a larger capacity can be used. They MUST be formatted to 2 GB and use the FAT 16 file system. It is recommended to format the CF card using the format utility from within Crimson.

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

Red Lion Controls
Headquarters
20 Willow Springs Circle
York PA 17406
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839

Red Lion Controls
Europe
Softwareweg 9
NL - 3821 BN Amersfoort
Tel +31 (0) 334 723 225
Fax +31 (0) 334 893 793

Red Lion Controls
India
201-B, 2nd Floor, Park Centra
Opp 32 Mile Stone, Sector-30
Gurgaon-122002 Haryana, India
Tel +91 984 487 0503

Red Lion Controls
China
Unit 302, XinAn Plaza
Building 13, No.99 Tianzhou Road
ShangHai, P.R. China 200223
Tel +86 21 6113 3688
Fax +86 21 6113 3683

RESISTANT TEMPERATURE DEVICES

Operations & Maintenance Manual
December 2015

RESISTANCE TEMPERATURE DEVICES (RTD'S)

#1	SERIES
3	RTD (You may also use these pages to order integrated circuit sensors. Use X in symbol #2)

#2 ELEMENT TYPE [9, 10, 11, 15, 18, 19] [32] Platinum 0.00385 alpha (Ω/Ω/°C)

	Resistor Accuracy at 0°C\	Thermometer Class (Table 3, page 3-18)	Resistor Class (Table 1 & 2, page 3-18)
B	± 0.25° C (Competitor's Std)	B	≥ F 0.15
E	± 0.1° C (Standard)	A	≥ F 0.1
P	± 0.06° C *	AA	≥ 1/2 W 0.1
S	± 0.01° C (Best Accuracy *)	1/4 AA	≥ 1/10 W 0.1
X	Other, specify		

Note: Type E available for high temp. applications. See page 3-4.

* For best results, use a 4 wire RTD for high accuracy (types P & S).

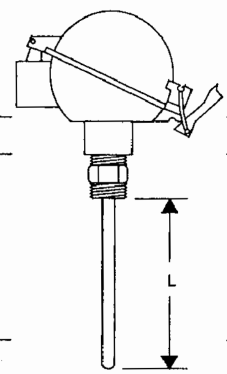
Add "S" here for TemplRsense i.e. SS (See Pg. 8-15)

#3 ELEMENT CONSTRUCTION [4] [3-11]

Note: See other letter selections on page 3-22 or use X and describe if not listed there.

S	Single	Standard construction
D	Dual	Standard construction
J	Single	Swaged construction
K	Dual	Swaged construction
X	Other, specify	

Note: Use swaged for high temperature, bendability, high vibration, or longer than 6'



#4 TUBE DIAMETER [5-30]

A	3/8" (.375")
B	1/4" (.250")
C	3/16" (.188")
D	1/8" (.125")
Q	Cuttable, See page 3-4 for details
X	Other, specify
Z	N/A

Note: To specify a special junction (i.e. gas air, tube skins, reduced tip...) use an "X" in #4 and describe. See page1-13 for a list of special junctions.

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION

#5 TUBE MATERIAL [11, 12]

K	316 Stainless Steel
L	316 LSS
M	I-600 (Use if symbol #7 >500°F)
C	Teflon Coated SS
X	Other, specify

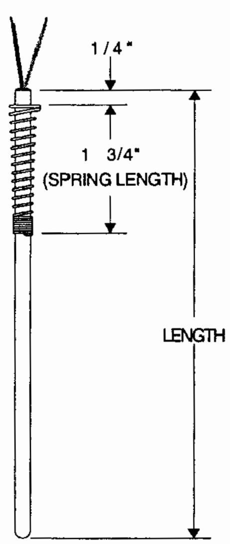
For fixed fittings and types S, C,B, D & N (symbol #8) this length normally equals the "A" dimension if a thermowell is used. (See Section 5)

#6	LENGTH (L) (See sketches on Pg. 3-1, 2, & 3 for lengths)
__"	Immersion length in inches

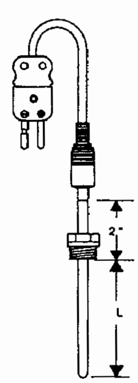
#7 MAX. TEMPERATURE AT WHICH TIP WILL BE EXPOSED [4, 8, 9,11, 12]

A	<100°C (212°F)	=2 PVC*
B	<200°C (392°F)	=3 Teflon*
C	<285°C (550°F)	=5 Kapton*
D	<482°C (900°F)	=1 Fiberglass*
E	<705°C (1300°F)	=4 HT Fiberglass*
F	>705°C (1300°F)	=7 Bare ends (heat shrink)*

*If no transition (Z) is in symbol 13, we recommend these corresponding selections for primary wire insulation in symbol 10.



Immersion for Symbol #8-E



Immersion for Symbol #8-G & D

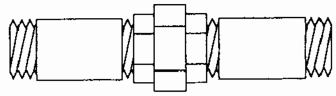
#8 STANDARD INDUSTRIAL FITTINGS [SECTION 6]

W	Fixed NPT ss fitting - double threaded
S	Spring-loaded NPT SS fitting - double threaded
C	Spring-loaded NPT SS fitting w/ oil ring - double threaded
D	Spring-loaded ss fitting - single threaded
B	Bayonet spring loaded assembly for thermowells & heads
E	Adjustable spring over .250", .188", .125" sheath
F	Reverse mounted steel plug fixed for attaching head
G	Fixed stainless steel to sheath
H	Compression fitting ss w/ ss ferrule
I	Compression fitting ss w/ teflon ferrule
J	Compression fitting ss w/ lava ferrule
K	Compression fitting ss w/ nylon ferrule
L	Compression fitting brass w/ brass ferrule
N	Nipple-Union-Nipple (NUN6G1) See page 2-3
X	Other, specify or if more than 1 is needed
Z	N/A (No fitting needed)

For materials other than SS, (ex: brass, carbon steel, etc.) Use X + material + letter designation

3	E	S	B	K	12"	B	W	MECH - 377

#9	PROCESS NPT [5-]
L	1/8"
M	1/4"
P	1/2" (Std w/ symbols W, S, & C above)
O	3/4"
X	Other, specify
Z	Note: To specify extensions such as nipples or unions, use X and see pg 3 for complete part #



#10	LEAD WIRE TYPE & LENGTH IN INCHES [SEE SECTION 7]		
1__"	Fiberglass braid	6__"	Bare wire
2__"	PVC	8	PVC coil cord - use when ordering symbol #8-B and symbol #14R
3__"	Teflon (Standard)		
4__"	Hi-temp glass braid	X__"	Other, specify
5__"	Kapton	Z	N/A

NOTE: All wire will be 24 awg in tubes > 1/8" OD. Smaller tubes will have a max. of 28 awg. If no transition or armor is specified, wire may be fragile. JMS standard wire for RTD's is Stranded Plated Copper.

#11	ARMOR OR HEAT SHRINK / JACKET [7-7]		
A	3/16" ID SS flex armor (Standard)	G	Heat shrink / sleeving
B	3/16" ID SS flex armor PVC coated white	H	Jacket to match primary insulation
C	3/16" ID SS flex armor PVC coated black	J	Aluminum mylar shielded and jacketed to match primary insulation
D	1/8" ID SS flex armor	Z	N/A
F	SS overbraid	X	Other, specify

#12	WIRE CONFIGURATION [17, 18]
T	2 Wire
Y	3 Wire
W	4 Wire
V	4 Wire (Compensating loop)

Note: Use a double symbol for 2 separate lead wires if dual elements. i.e. TT.

#13	TYPE OF TRANSITION [14]
H	Heat shrink
S	Size on size
T	3/8" OD
R	1/4" OD
X	Other,specify
Z	No transition

Note: For extra high humidity / moisture environments, put a "2" after your selection. [See page 3-14.]

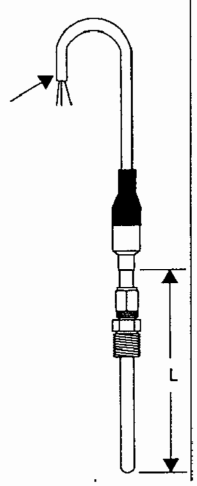
For high temperature at the transition area use an X + type of transition and maximum temperature.

#14	COLD END TERMINATION [SEE SECTION 6] Pick as many as applicable
A	Bare ends
B	Miniature plug (6A1B2)*
C	Standard plug (6A1C2)*
I	Explosion proof Nema 7 head (6I / 6B2)
K	Spade lugs (6SL)
L	Aluminum head w/ hinged cover (6LW / 6NTB)
M	Aluminum head w/ screw cover & chain (6M / 6G)
N	Cast iron head w/ screw cover (6N / 6G)
O	Open ceramic terminal block (6N)
Q	Black nylon Nema 4 head (6Q / 6C)
R	High dome head (6R)
V	Hermetic connector (6DC) - Male*
W	Microphone style connector (6DA) - Male*
X	Other, specify

* Use double symbol here for matching female connector. i.e. B/BB (male with matching female).

Note: For any other cold end termination, use appropriate part numbers from section 6 in place of symbol #14.

LEADWIRE



Immersion is overall length of tube for compression fittings

#15	OPTIONS USE ONLY IF APPLICABLE [INTRODUCTION]			
1	TAGGING	Stainless steel tag	5	CALIBRATION	Calibrate at specified point(s). Corrections data will be provi
2		Plastic tag			
3		Paper tag	6		Calibrate specified temperature Corrections data will be provic temperatures within the range **Note:** You must specify increr Ex. 0 to 300°F, 0.1° increme
4		Electroetch on probe **Note:** You must always specify information required on tag	7		CE Marking [PAGE XV]

#9	#10	#11	#12	#13	#14	#15	
P	3-36"	A	Y	T	A		MECH - 378

THREADED AND SOCKET WELD THERMOWELLS

#1	SERIES [See pages 20-24 for complete information on dimensions, velocity ratings, and pressure ratings)
5	Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5W)

#2	THREADED WELLS / EXTERNAL THREAD	SOCKET WELL WELDELET SIZE
1	1/2" NPT	N/A
2	3/4" NPT (standard)	3/4" (standard)
3	1" NPT	1"
X	Other, specify	

#3	SHANK STYLE [15]
A	Step shank (standard)
S	Straight shank
T	Tapered shank
B	Built up step shank (Recommended for over 22 1/2", see drawing on 5-2)
X	Other, specify

#4	THREADED OR SOCKET WELD WELLS
T	Threaded well design
S	Socket well design
V	Van stone
X	Other, specify

#5	BORE SIZE
2	.260" ID used for .250" OD sensors (standard)
3	.385" ID used for .375" OD sensors (straight or tapered only)
X	Other, specify

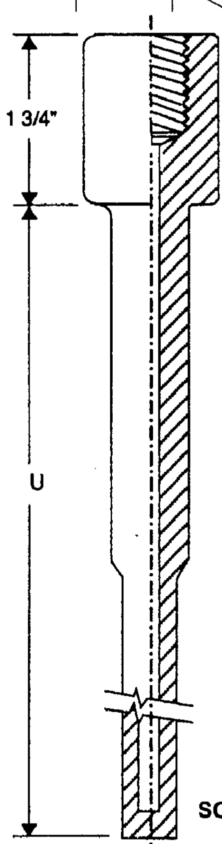
Note: Over 22 1/2" use "Built Up" design. See page 5-2 for drawing. Does not meet ASTM, ISA, ASTM, or IEC standards for thermowells.

#6	U (INSERTION) DEPTH [15]	STANDARD "T" DIMENSION	SENSOR LENGTH NO LAG	SENSOR LENGTH WITH LAG
B	2 1/2"	2	4	6
C	4 1/2"	3	6	9
D	6"	3	7 1/2	10 1/2
E	7 1/2"	3	9	12
F	10 1/2"	3	12	15
G	13 1/2"	3	15	18
H	16 1/2"	3	18	21
I	22 1/2"*	3	24	27
X	Other, specify			

#7	T (LAG) EXTENSION [15]
T	Standard lag
U	N/A (No lag)
X	Other, specify

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION

#8	WELL MATERIAL [31-34]
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel (standard)
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel
O	Hastelloy B
P	Molybdenum
Q	Hastelloy C
R	Tantalum
S	Titanium
X	Other, specify (i.e.: Teflon, PVC, Nickle, etc.)



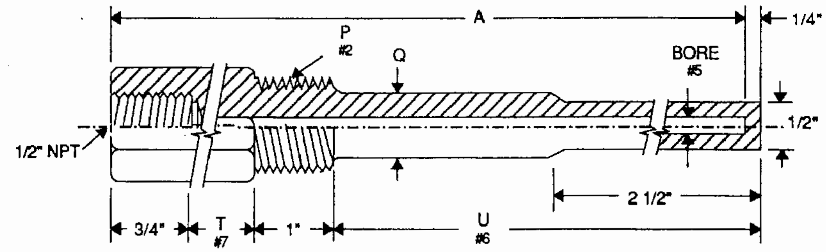
SOCKET WELL DESIGN

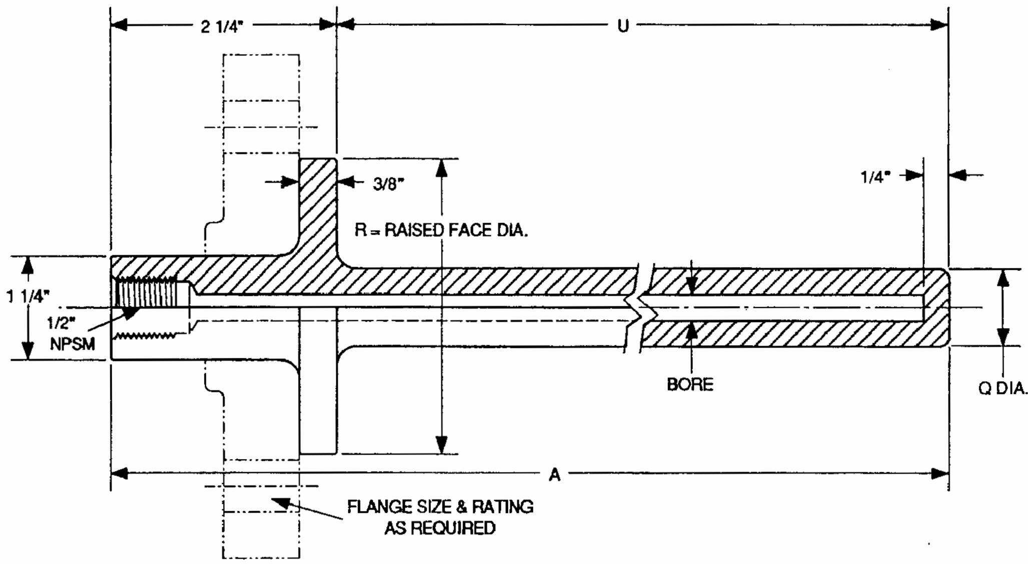
#9		TAGGING OPTIONS
1	TAGGING	Stainless steel tag
2		Plastic tag
3		Paper tag
4		Electroetch on probe **Note:** You must always specify information required on tag

5	2	A	T	2	E	T	H		

THREADED AND SOCKET WELD THERMOWELLS

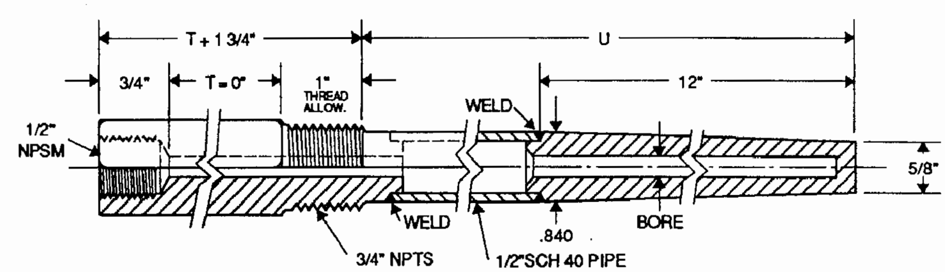
THREADED WELL WITH LAG EXTENSION





VAN STONE THERMOWELL

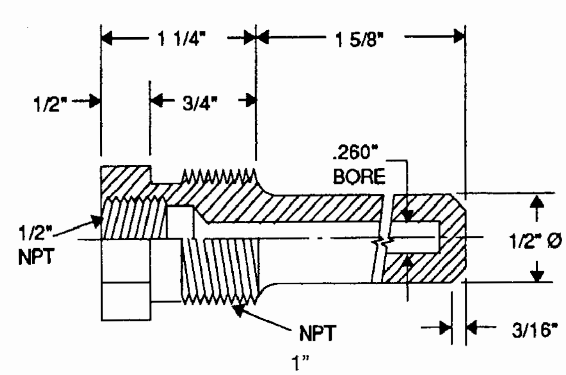
BUILT-UP THERMOWELL



LIMITED SPACE THERMOWELLS

#1	SERIES
5L	Limited Space Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5LW)

#2	WELL MATERIAL
H	304 Stainless steel
K	316 Stainless steel
M	Inconel 600
X	Other, specify



Note:
Immersion length of a spring-loaded sensor to fit this well is 2 1/2".

5L	M	MECH - 380

SECTION 5

ISOLATED TRANSMITTERS

These transmitters can be mounted in the JMS explosion proof head. See appropriate sensor section for complete assembly information. Input to output isolation eliminates ground loop errors and permits direct transmission of a signal to a receiver where common mode voltages up to 3700 volts RMS may exist.

JMS Southeast also carries non-standard transmitters. Options other than those listed are available. Contact JMS for information.

#1	SERIES [14, 15, 16, 17]
8	Transmitter

#2	TYPE OF TRANSMITTER	I / O ISOLATION	HART
H	Standard TempIR	1500 VAC	No
C	CAL 9400 (See pg. 8-5, 8-6)	1000 VAC	No
A	AI-1000 (See pg. 8-8, 8-9)	500 VAC	No
S	AI-1500 (See pg. 8-10, 8-11)	500 VAC	Yes
B	AI-2000 (See pg. 8-12)	850 VAC	No
I	TempIR with Hart Protocol	1500 VAC	Yes
E	Intrinsically safe TempIR	3750 VAC	No
D	TempIR / Hart / Intrinsically safe	3750 VAC	Yes
X	Other		

Note: H, I, & E are available in slim pack Din Rail mounting package. See page 8-17 for details. Use "R" in front of type to specify in symbol #2.

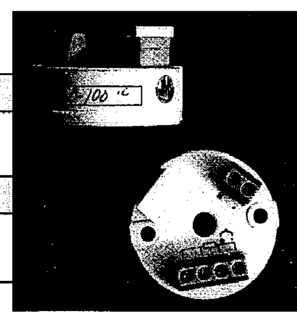
#3	INPUT
J	Iron/Constantan thermocouple
T	Copper/Constantan thermocouple
K	Chromel/Alumel thermocouple
E	Chromel/Constantan thermocouple
S	Platinum 10% Rhodium/Pure Platinum thermocouple
R	Platinum 13% Rhodium/Pure Platinum thermocouple
B	Platinum 6% Rhodium/Platinum 30% Rhodium thermocouple
N	Nicrosil/Nisil thermocouple
W	Tungsten/Tungsten 26% Rhenium thermocouple
3	3 wire, 100Ω, Platinum, a=.00385, RTD (3 - Wire Standard, If 2 or 4 Wire use X)
X	Other, specify
Z	N/A

#4	TEMPERATURE RANGE
-- to --°C	List desired temperature span
-- to -- °F	List desired temperature span
X	Other, specify
Z	N/A

#5	OUTPUT		
4	4 to 20 mA	P	Profibus
X	Other, specify	F	Fieldbus

#6	SOFTWARE
A	Yes - range at factory
Z	No - range at factory

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION



8H

***TOO NEW FOR THE CATALOG!!**

(Available NOW)

Profibus / Fieldbus Transmitters

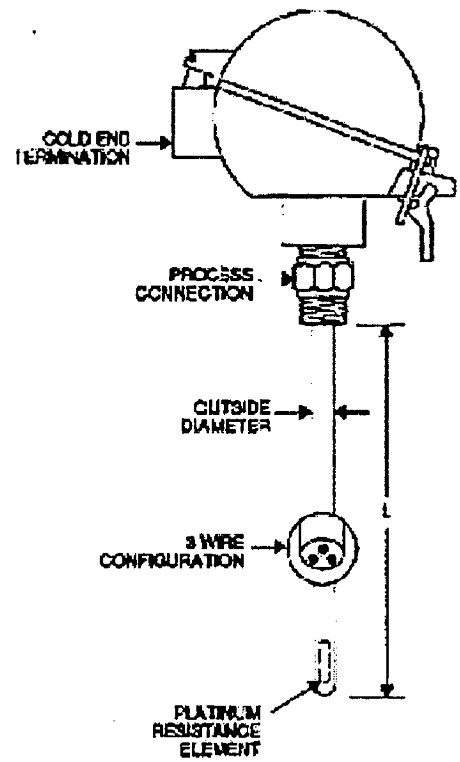
(No analog involved)

Call our Engineering Dept. for details NOW

8	H	J	50-150°F	4	Z

RTD's work on the principle that there is a positive correlation between the electrical resistance of a metal conductor and changes in temperature. The standard temperature range is from -200°F to 900°F. High temperature assemblies are available which can operate at up to 1475°F.

The advantages of using RTD's include accuracy, repeatability, and stability. Another advantage is that cold junction compensation is unnecessary. Copper wire is used for all connections. The signal level of an RTD is over ten times higher than that of a thermocouple which eliminates the need for high gain amplifiers. The signal is also less susceptible to noise than thermocouples. The accuracy of a 4 wire RTD is independent of the distance between the sensor and the readout instrument.



COMPONENTS OF RTD's

The Platinum Resistance Element

This is the actual temperature sensing portion of the RTD. Elements range in length from 1/8" to 3" (See Pg 3-8). There are many options. The standard resistance is 100 ohms at 0°C and the standard temperature coefficient is an alpha of 0.00385. A complete list of options is listed on page 3-22.

Outside diameter / Inside diameter

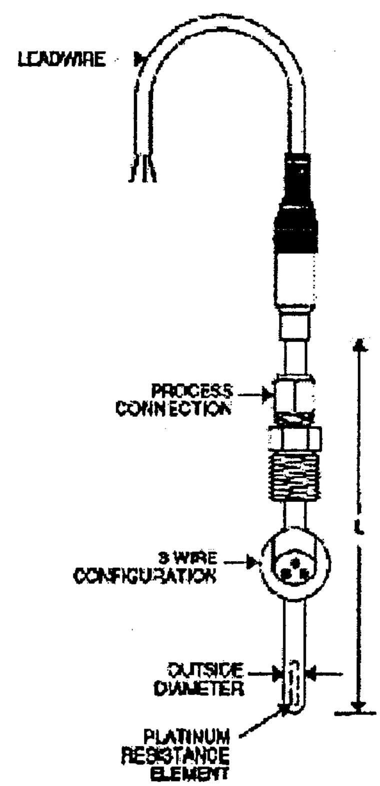
The most standard outside diameter is 1/4". However, outside diameters range from .063" to .500". A selection of tube diameters can be found on page 1.

Tubing Material

316 Stainless steel is commonly used for all assemblies up to 500°F. Above 500°F it is advisable to use Inconel 600. A list of some materials available is on page 1.

Process Connection

Process connection fittings include compression fittings and 1/2" N.P.T. x 1/2" N.P.T. welded or spring-loaded fittings. Various connection options are listed on page 1.



Wire Configuration and Insulation

RTD's are available in two, three, and four wire configurations. Three wire configuration is the most common. See page 3-17 for further information on selecting wire configuration for your application. Teflon and fiberglass are the standard wire insulation materials. Teflon is moisture resistant and has a maximum temperature rating of 400°F. Fiberglass is used for high temperature applications because it has a maximum temperature rating of 1000°F.

Cold End Termination

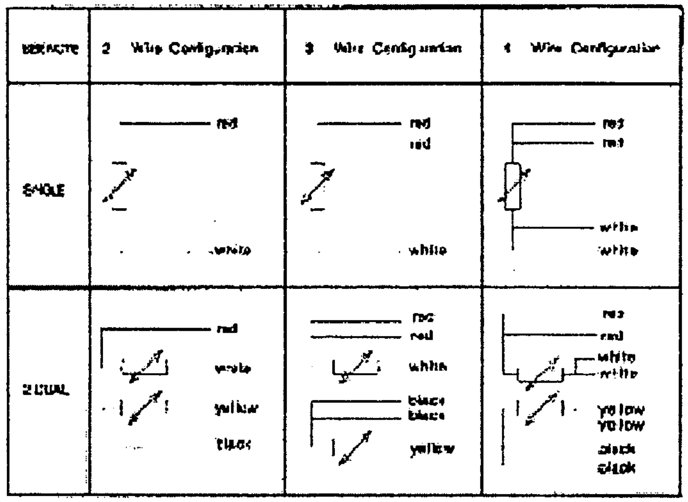
This may be in the form of bare wires, plugs, or terminal heads. The accessory section contains a wide variety of these options. Standard cold end terminations are listed on page 3-2.

A resistance temperature detector determines the temperature by measuring resistance. The sensing element is usually a small diameter wire manufactured so that its resistance will change in a known and consistent manner. To measure the resistance accurately and consistently, other extraneous resistances must be compensated for or minimized. A major cause of extraneous resistance is leadwire in series with the RTD. The readout is the sum of the bulb resistance and the leadwire resistances. The leadwire resistance can be compensated in most applications by a three wire RTD leadwire configuration.

In the three wire configuration, the power supply is taken to one side of the resistance temperature detector. This puts the other two leadwires in opposite arms of the wheatstone bridge so that they cancel each other out and have little effect on the bridge output voltage. In the 3 wire configuration, the resistance of the lead wire length is compensated for in the Wheatstone bridge. This design is recommended for most industrial applications.

An even more accurate wire configuration is the 4 wire design. In this design, leadwires #1 and #2 are on one side of the power supply while leadwires #3 and #4 are on the other side of the power supply. All four leadwire resistances in this case are negated and the bulb resistance stands as the resistance input alone. We strongly recommend this design. You must have a good 4 wire input device. Call us for recommendations.

Note:
For numbering sequence of connectors and terminal blocks see Section 6.



RTD Operation and Installation Instructions:

RTD's are installed by means of compression fittings, welded or spring-loaded NPT fittings, or bayonet fittings.

Follow these instructions for installation of an RTD with a 1/2" x 1/2" NPT fitting:

(1) Insert RTD into process hole or opening.

(2) Tighten probe into place by turning probe into threaded connection.

If cold-end termination of the RTD is wired into head and you have a spring loaded fitting, then the wires should be disconnected from the terminal block to prevent twisting and shorting.

ELECTRICAL:

Make sure the extension wire is clean so that a good electrical connection will result at the terminal block. We recommend the use of a lacquer, cement, or other moisture proof sealing to prevent oxidation and the loosening of terminals. Connect the positive extension wire to the positive RTD wire and the negative extension wire to the negative RTD wire. Wires are color coded for identification as follows:

Two Wire Configuration:
Connect the white wire to the positive connection terminal and connect the red wire to the negative connection terminal.

Three Wire Configuration:
The two red wires are common. Connect the white wire to the positive connection terminal and the two red wires to the negative connection terminals. The second red wire is the compensating lead wire.

Four Wire Configuration:
The two white wires are common and the two red wires are common. Connect the two red wires to the negative connection terminals and the two white wires to the positive connection terminals.

Characteristics

The temperature/resistance relationships and tolerances on this page are valid for the sensing resistor at its measuring points. For thermometers they are valid for the complete thermometer at its terminals.

In the case of two-wire connections the resistance values of the leads between the measuring point of the resistor and the terminals must be considered. They may be indicated on the thermometer and must be subtracted from measured values in ohms. In some cases it also may be advisable to consider the temperature coefficient of the leadwires and the temperature distribution along their length.

Temperature/resistance relationships

The temperature/resistance relationships used in this standard are as follows:

for the range of -200°C to 0°C:

$$R_t = R_o[1 + At + Bt^2 + c(t - 100°C)\, t^3]$$

for the range of 0°C to 850°C:

$$R_t = R_o(1 + At + Bt^2)$$

For the quality of platinum commonly used for industrial resistance thermometers, the values of the constants in these equations are:

$A = 3.9083 \times 10^{-3}\ °C^{-1}$ $C = 4.183 \times 10^{-12}\ °C^{-4}$

$B = 5.775 \times 10^{-7}\ °C^{-2}$ t = Modulus of temperature without sign

For resistance thermometers satisfying the above relationships, the temperature coefficient *is defined as:*

$$a = \frac{(R_{100} - R_0)}{100 \times R_0}$$ has the value $0.00385055°C^{-1}$

where

R_{100} is the resistance at 100°C;
R_0 is the resistance at 0°C.

These equations and coefficients are listed as the basis for the temperature / resistance tables in this book. The calibration of individual thermometers will yield different coefficients.

Values of temperatures in this book are based on the International Temperature Scale of 1990 (ITS 90).

Resistance values

Most resistors are constructed to have a nominal resistance of 100Ω. The resistance vs. temperature table is calculated for a resistance of 100.00 Ω at 0°C. For other nominal resistances R_{nom} such as 500 Ω or 1000Ω the table can be used by multiplying the table values with the factor $R_{nom}/100$.

General Requirements (Tolerances)

Sensing resistors

The tolerance values of wirewound resistors are classified in table 1 and the values of film resistors are classified in table 2.

Table 1: Tolerance classes for wound resistors

Tolerance class	Tolerance value (°C)	Temperature range of validity of tolerances
W 0.1	±(0.1°C + 0.0017 [t])	-50°C + 250°C
W 0.15	±(0.15°C + 0.002 [t])	-100°C to 450°C
W 0.3	±(0.3°C + 0.005 [t])	-196°C to 661°C
W 0.6	±(0.6°C + 0.01 [t])	-196°C to 661°C

Table 2: Tolerance classes for film resistors

Tolerance class	Tolerance value (°C)	Temperature range of validity of tolerances
F 0.1	±(0.1°C + 0.0017 [t])	-50°C + 250°C
F 0.15	±(0.15°C + 0.002 [t])	-50°C to 450°C
F 0.3	±(0.3°C + 0.005 [t])	-50°C to 661°C
F 0.6	±(0.6°C + 0.01 [t])	-50°C to 661°C

Table 3: Tolerance classes for thermometers (finished probes)

Tolerance * class	Tolerance values (°C)	
AA	±(0.1 °C + 0.0017 [t])	-50 to 250°C
A	±(0.13°C + 0.0017 [t])	-100 to 450°C
B	±(0.25°C + 0.0042 [t])	-196 to 600°C
C	±(0.6°C + 0.01 [t])	-196 to 600°C

* These tolerances meet or exceed ASTM / IEC thermometer class. They do not necessarily determine the working range of the thermometer.

DANFOSS VLT HVAC DRIVE

Operations & Maintenance Manual
December 2015

MAKING MODERN LIVING POSSIBLE

Instruction Manual

VLT® HVAC Drive

THE REAL DRIVE

MECH - 386

Safety

Safety

⚠WARNING

HIGH VOLTAGE!

Frequency converters contain high voltage when connected to AC mains input power. Installation, start up, and maintenance should be performed by qualified personnel only. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

High Voltage

Frequency converts are connected to hazardous mains voltages. Extreme care should be taken to protect against shock. Only trained personnel familiar with electronic equipment should install, start, or maintain this equipment.

⚠WARNING

UNINTENDED START!

When the frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to AC mains could result in death, serious injury, equipment, or property damage.

Unintended Start

When the frequency converter is connected to the AC mains, the motor may be started by means of an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate cautions to guard against an unintended start.

⚠WARNING

DISCHARGE TIME!

Frequency converters contain DC-link capacitors that can remain charged even when the frequency converter is not powered. To avoid electrical hazards, disconnect AC mains, any permanent magnet type motors, and any remote DC-link power supplies, including battery backups, UPS and DC-link connections to other frequency converters. Wait for the capacitors to fully discharge before performing any service or repair work. The amount of wait time is listed in the *Discharge Time* table. Failure to wait the specified time after power has been removed before doing service or repair could result in death or serious injury.

Voltage (V)	Minimum Waiting Time (Minutes)	
	4	15
200–240	1.1–3.7 kW 1 1/2–5 hp	5.5–45 kW 7 1/2 - 60 hp
380–480	1.1 - 7.5 kW 1 1/2 - 10 hp	11–90 kW 15–120 hp
525–600	1.1 - 7.5 kW 1 1/2 - 10 hp	11–90 kW 15–120 hp
525–690	n/a	11–90 kW 15–120 hp
High voltage may be present even when the warning LEDs are off!		

Discharge Time

Symbols

The following symbols are used in this manual.

⚠WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION

Indicates a situation that may result in equipment or property damage-only accidents.

NOTE!

Indicates highlighted information that should be observed in order to avoid mistakes or operate equipment at less than optimal performance.

Approvals

Table 1.2

Contents

1 Introduction

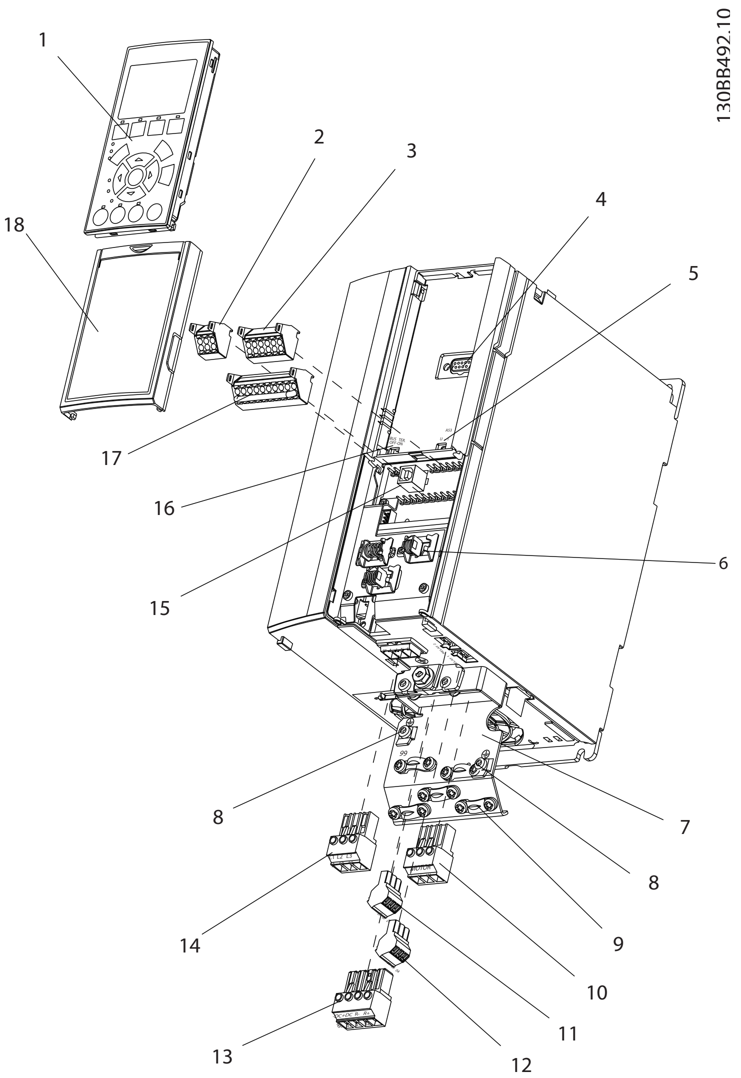


Figure 1.1 Exploded View A Size

1	LCP	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS-485 serial bus connector (+68, -69)	11	Relay 1 (01, 02, 03)
3	Analog I/O connector	12	Relay 2 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Line power input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable strain relief / PE ground	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24V power supply
9	Shielded cable grounding clamp and strain relief	18	Control cable coverplate

Table 1.1

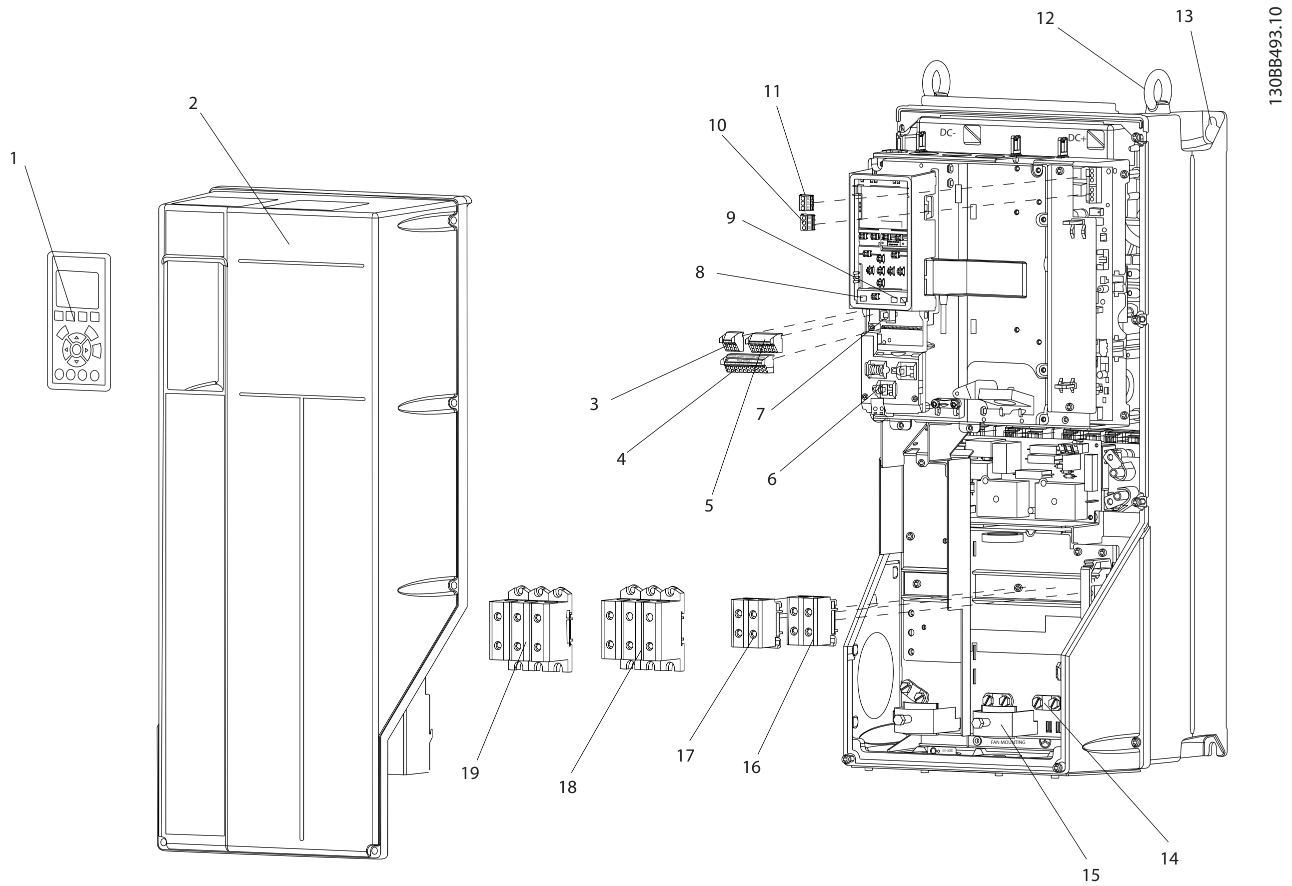


Figure 1.2 Exploded View B and C Sizes

1	LCP	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS-485 serial bus connector	13	Mounting slot
4	Digital I/O and 24V power supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable strain relief / PE ground
6	Cable strain relief / PE ground	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Serial bus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Line power input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)		

Table 1.2

1.1 Purpose of the Manual

This manual is intended to provide detailed information for the installation and start-up of the adjustable frequency drive. *2 Installation* details the requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring, and control terminal functions. *3 Start-up and Functional Testing* provides detailed procedures for start-up, basic operational programming, and functional testing. The remaining chapters provide supplementary details. These include user interface, detailed programming, application examples, start-up troubleshooting, and specifications.

1.2 Additional Resources

Other resources are available to understand advanced adjustable frequency drive functions and programming.

- The *VLT® Programming Guide, MG33MXYY* provides greater detail on working with parameters and many application examples.
- The *VLT® Design Guide, MG33BXYY* is intended to provide detailed capabilities and functionality to design motor control systems.
- Supplementary publications and manuals are available from Danfoss. See http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm for listings.
- Optional equipment is available that may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local Danfoss supplier or go to *http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm* for downloads or additional information.

1.3 Product Overview

A Adjustable frequency drive is an electronic motor controller that converts AC line power input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The Adjustable frequency drive can vary the speed of the motor in response to system feedback, such as changing temperature or pressure for controlling fan, compressor, or pump motors. The Adjustable frequency drive can also regulate the motor by responding to remote commands from external controllers.

In addition, the Adjustable frequency drive monitors the system and motor status, issues warnings or alarms for fault conditions, starts and stops the motor, optimizes energy efficiency, and offers many more control, monitoring, and efficiency functions. Operation and monitoring functions are available as status indications to an outside control system or serial communication network.

1.4 Internal Adjustable Frequency Drive Controller Functions

Figure 1.3 is a block diagram of the adjustable frequency drive's internal components. See *Table 1.3* for their functions.

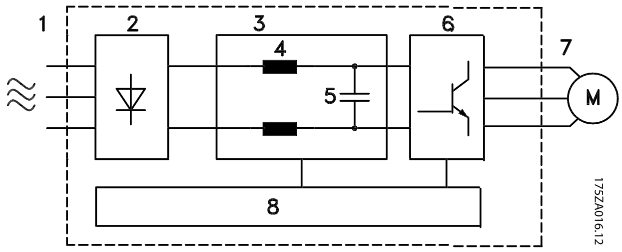


Figure 1.3 Adjustable Frequency Drive Block Diagram

Area	Title	Functions
1	Line power input	• Three-phase AC line power power supply to the adjustable frequency drive
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power
3	DC bus	• Intermediate DC bus circuit handles the DC current
4	DC reactors	• Filter the intermediate DC circuit voltage • Prove line transient protection • Reduce RMS current • Raise the power factor reflected back to the line • Reduce harmonics on the AC input
5	Capacitor bank	• Stores the DC power • Provides ride-through protection for short power losses
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor
7	Output to motor	• Regulated three-phase output power to the motor
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control • User interface and external commands are monitored and performed • Status output and control can be provided

Table 1.3 Adjustable Frequency Drive Internal Components

1.5 Frame Sizes and Power Ratings

References to frames sizes used in this manual are defined in *Table 1.4*.

	Frame Size (HP/kW)											
Volts	A2	A3	A4	A5	B1	B2	B3	B4	C1	C2	C3	C4
200–240	1.1–2.2	3.0–3.7	0.25–2.2	1.1–3.7	5.5–11	15	5.5–11	15–18.5	18.5–30	37–45	22–30	37–45
380–480	1.1–4.0	5.5–7.5	0.37–4.0	1.1–7.5	11–18.5	22–30	11–18.5	22–37	37–55	75–90	45–55	75–90
525–600	n/a	1.1–7.5	n/a	1.1–7.5	11–18.5	22–30	11–18.5	22–37	37–55	75–90	45–55	75–90
525–690	n/a	n/a	n/a	n/a	n/a	11–30	n/a	n/a	n/a	37–90	n/a	n/a

Table 1.4 Frames Sizes and Power Ratings

2 Installation

2.1 Installation Site Checklist

- The Adjustable frequency drive relies on the ambient air for cooling. Observe the limits on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the Adjustable frequency drive
- Keep the Adjustable frequency drive interior free from dust and dirt. Ensure that the components stay as clean as possible. In construction areas, provide a protective covering. Optional IP54 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
  - 1000 ft [300 m] for unshielded motor leads
  - 500 ft [150 m] for shielded cable.

2.2 Adjustable Frequency Drive and Motor Pre-installation Checklist

- Compare the model number of unit on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for the same voltage:

  Line power

  Adjustable frequency drive

  Motor
- Ensure that Adjustable frequency drive output current rating is equal to or greater than motor full load current for peak motor performance.

  Motor size and Adjustable frequency drive power must match for proper overload protection.

  If Adjustable frequency drive rating is less than motor, full motor output cannot be achieved.

2.3 Mechanical Installation

2.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional backplate (see *2.3.3 Mounting*)
- Top and bottom clearance for air cooling must be provided. Generally, 4–10 in [100–225 mm] is required. See *Figure 2.1* for clearance requirements
- Improper mounting can result in overheating and reduced performance.
- Derating for temperatures starting between 100°F (40°C) and 120°F (50°C) and elevation 3,300 ft (1,000 m) above sea level must be considered. See the equipment Design Guide for detailed information.

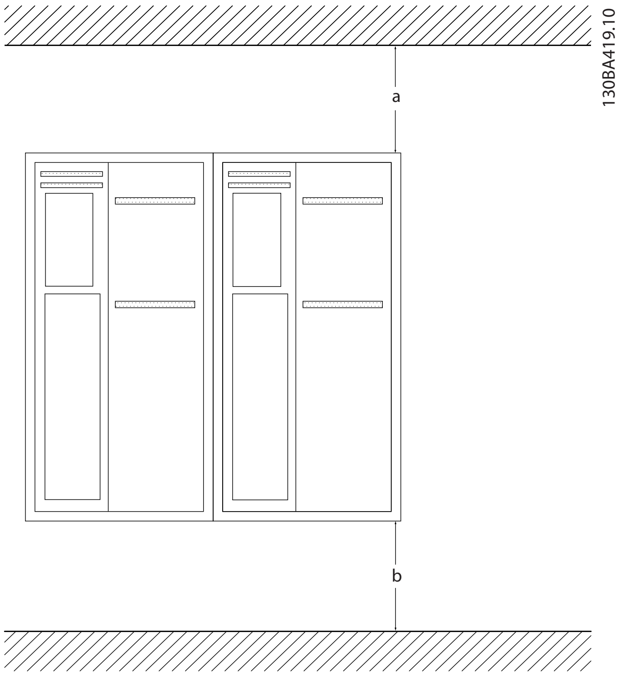


Figure 2.1 Top and Bottom Cooling Clearance

Enclosure	A2	A3	A4	A5	B1	B2
a/b (mm)	100	100	100	100	200	200
a/b (in)	4	4	4	4	8	8
Enclosure	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**
a/b (mm)	200	200	200	225	200	225
a/b (in)	8	8	8	9	8	9

Table 2.1 Minimum Airflow Clearance Requirements

2.3.2 Lifting

- Check the weight of the unit to determine a safe lifting method
- Ensure that the lifting device is suitable for the task
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit
- For lifting, use hoist rings on the unit, when provided

2.3.3 Mounting

- Mount the unit vertically
- The Adjustable frequency drive allows side by side installation.
- Ensure that the strength of the mounting location will support the unit weight
- Mount the unit to a solid flat surface or to the optional backplate to provide cooling airflow (see *Figure 2.2* and *Figure 2.3*).
- Improper mounting can result in overheating and reduced performance.
- Use the slotted mounting holes on the unit for wall mounting, when provided.

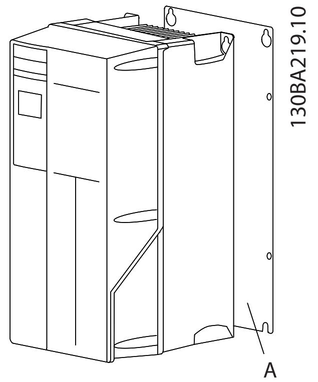


Figure 2.2 Proper Mounting with Backplate

Item A is a backplate properly installed for required airflow to cool the unit.

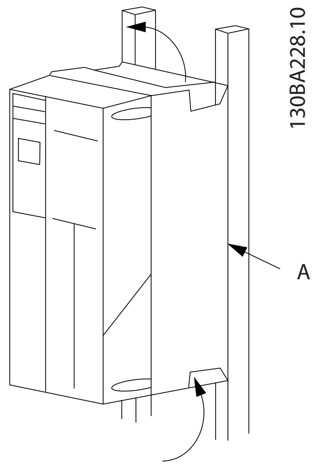


Figure 2.3 Proper Mounting with Railings

NOTE!

Backplate is needed when mounted on railings.

2.3.4 Tightening Torques

See *10.4 Connection Tightening Torques* for proper tightening specifications.

2.4 Electrical Installation

This section contains detailed instructions for wiring the Adjustable frequency drive. The following tasks are described.

- Wiring the motor to the Adjustable frequency drive output terminals
- Wiring the AC line power to the Adjustable frequency drive input terminals
- Connecting control and serial communication wiring
- After power has been applied, checking input and motor power; programming control terminals for their intended functions

Figure 2.4 shows a basic electrical connection.

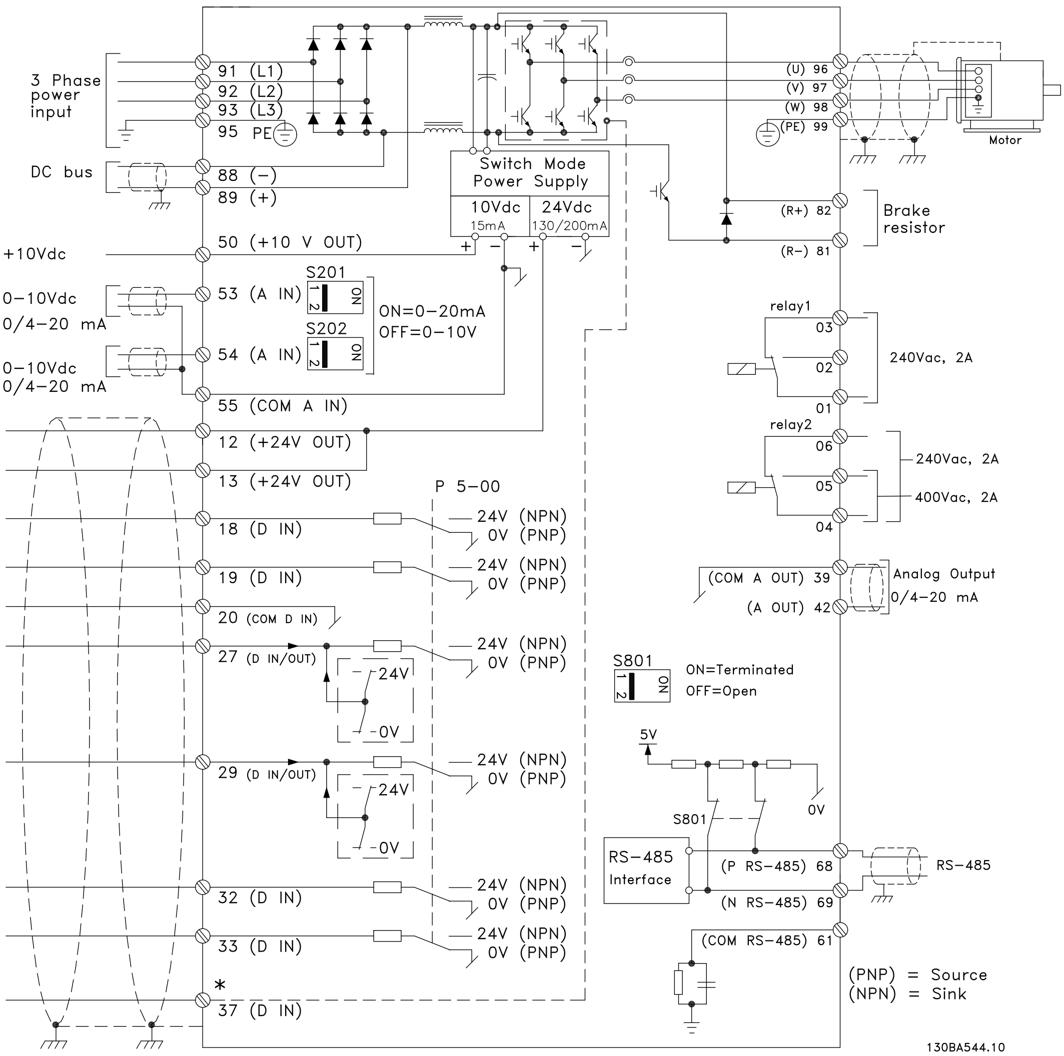


Figure 2.4 Basic Wiring Schematic Drawing.

* Terminal 37 is an option

2

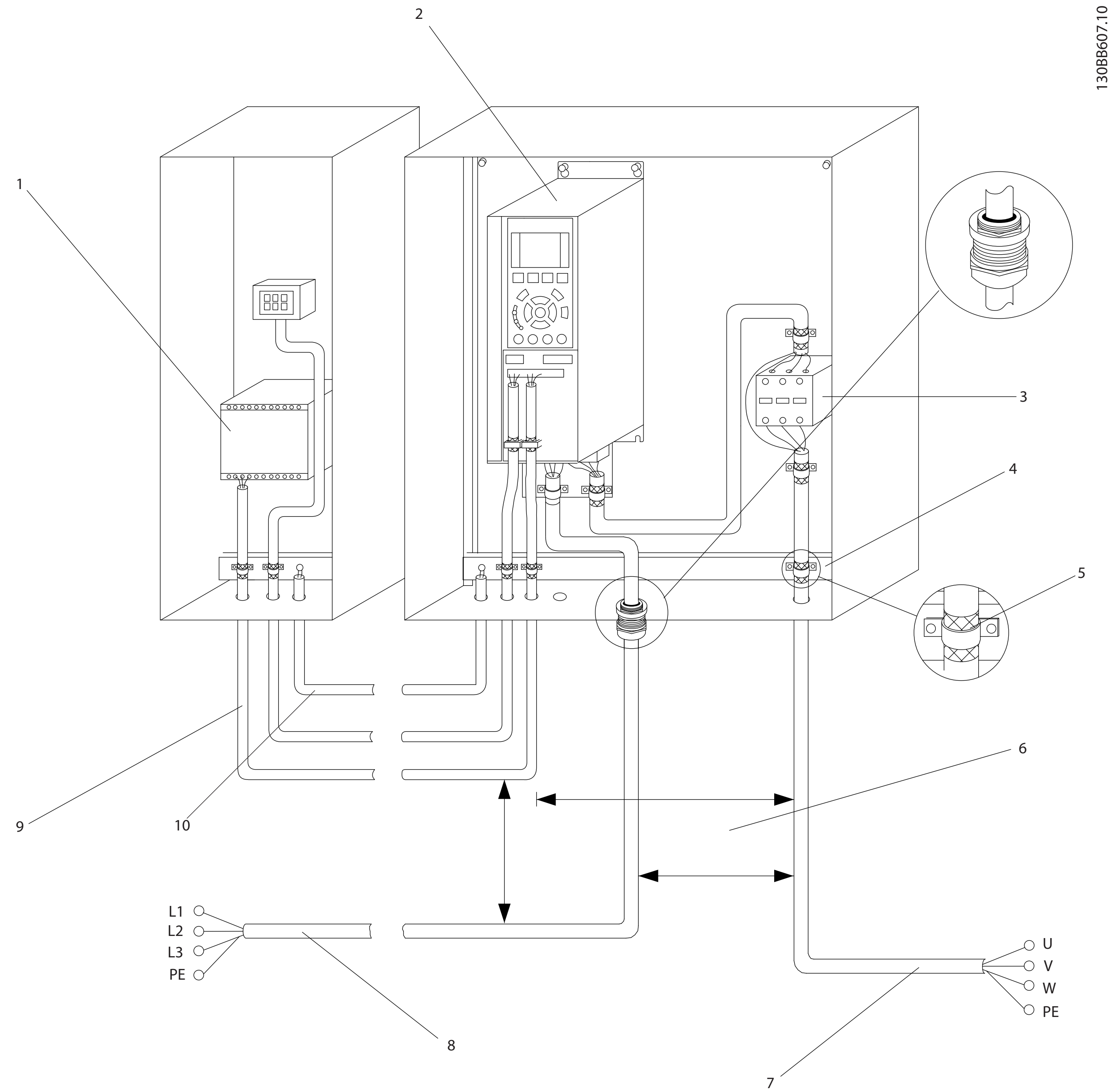


Figure 2.5 Typical Electrical Connection

1	PLC	6	Min. 8 in [200 mm] between control cables, motor and line power
2	Adjustable frequency drive	7	Motor, 3-phase and PE
3	Output contactor (Generally not recommended)	8	Line power, 3-phase and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalizing min. 0.025 in^2 (16mm^2)

Table 2.2

2.4.1 Requirements

⚠WARNING

EQUIPMENT HAZARD!

Rotating shafts and electrical equipment can be hazardous. All electrical work must conform to national and local electrical codes. It is strongly recommended that installation, startup, and maintenance be performed only by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

CAUTION

WIRING ISOLATION!

Run input power, motor wiring and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum Adjustable frequency drive and associated equipment performance.

For your safety, comply with the following requirements.

- Electronic controls equipment is connected to hazardous AC line voltage. Extreme care should be taken to protect against electrical hazards when applying power to the unit.
- Run motor cables from multiple adjustable frequency drives separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out.

Overload and Equipment Protection

- An electronically activated function within the Adjustable frequency drive provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See *8 Warnings and Alarms* for details on the trip function.
- Because the motor wiring carries high frequency current, it is important that wiring for line power, motor power, and control is run separately. Use metallic conduit or separated shielded wire. Failure to isolate power, motor, and control wiring could result in less than optimum equipment performance. See *Figure 2.6*.

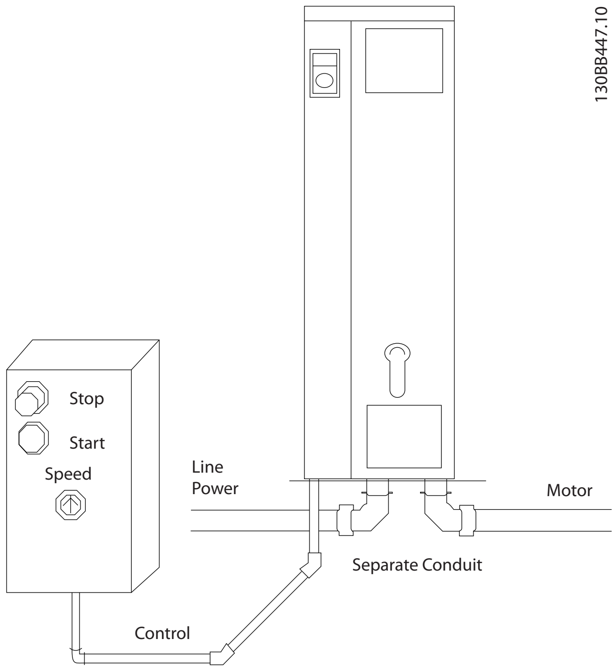


Figure 2.6 Proper Electrical Installation Using Conduit

- All adjustable frequency drives must be provided with short-circuit and overcurrent protection. Input fusing is required to provide this protection, see *Figure 2.7*. If not factory supplied, fuses must be provided by the installer as part of installation. See maximum fuse ratings in *10.3 Fuse Tables*.

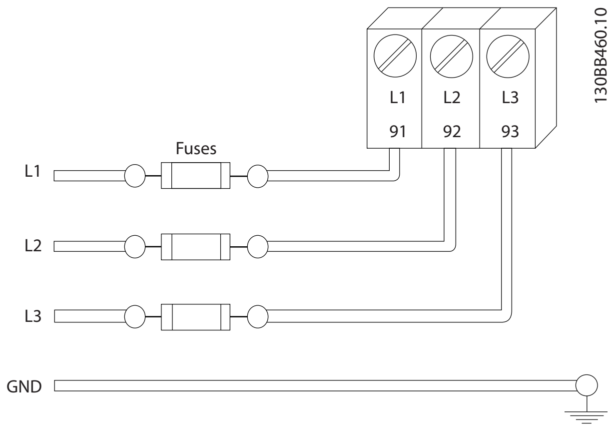


Figure 2.7 Adjustable frequency drive Fuses

2

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Danfoss recommends that all power connections be made with a minimum 170°F (75°C) rated copper wire.
- See *10.1 Power-dependent Specifications* for recommended wire sizes.

2.4.2 Grounding Requirements

WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground Adjustable frequency drive properly in accordance with national and local electrical codes as well as instructions contained within these instructions. Ground currents are higher than 3.5 mA. Failure to ground Adjustable frequency drive properly could result in death or serious injury.

NOTE!

It is the responsibility of the user or certified electrical installer to ensure correct grounding of the equipment in accordance with national and local electrical codes and standards.

- Follow all local and national electrical codes to ground electrical equipment properly.
- Proper protective grounding for equipment with ground currents higher than 3.5 mA must be established, see *Leakage Current (>3.5 mA)*
- A dedicatedground wire is required for input power, motor power and control wiring
- Use the clamps provided on the equipment for proper ground connections
- Do not ground one Adjustable frequency drive to another in a "daisy chain" fashion
- Keep the ground wire connections as short as possible
- Use of high-strand wire to reduce electrical noise is recommended
- Follow the motor manufacturer wiring requirements

2.4.2.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective grounding of equipment with a leakage current > 3.5 mA.

Adjustable frequency drive technology implies high frequency switching at high power. This will generate a leakage current in the ground connection. A fault current in the Adjustable frequency drive at the output power terminals might contain a DC component which can charge the filter capacitors and cause a transient ground current. The ground leakage current depends on various system configurations including RFI filtering, shielded motor cables, and Adjustable frequency drive power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5m A. Grounding must be reinforced in one of the following ways:

- Ground wire of at least 0.0155 in^2 [$10mm^2$]
- Two separate ground wires both complying with the dimensioning rules

See EN 60364-5-54 § 543.7 for further information.

Using RCDs

Where residual current devices (RCDs), also known as ground leakage circuit breakers (ELCBs), are used, comply with the following:

Use RCDs of type B only which are capable of detecting AC and DC currents

Use RCDs with an inrush delay to prevent faults due to transient ground currents

Dimension RCDs according to the system configuration and environmental considerations

2.4.2.2 Grounding Using Shielded Cable

Grounding clamps are provided for motor wiring (see *Figure 2.8*).

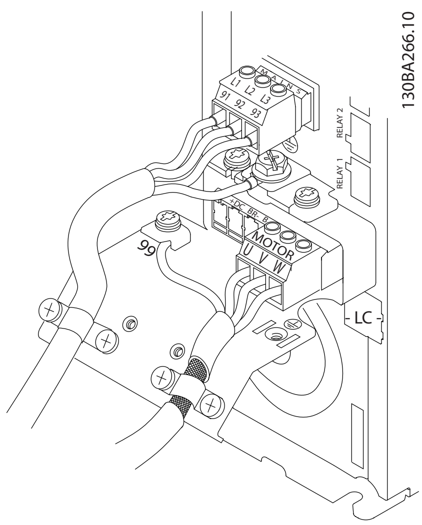


Figure 2.8 Grounding with Shielded Cable

2.4.3 Motor Connection

WARNING

INDUCED VOLTAGE!

Run output motor cables from multiple adjustable frequency drives separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

- For maximum wire sizes, see *10.1 Power-dependent Specifications*
- Comply with local and national electrical codes for cable sizes.
- Motor wiring knockouts or access panels are provided at the base of IP21 and higher (NEMA1/12) units
- Do not install power factor correction capacitors between the Adjustable frequency drive and the motor
- Do not wire a starting or pole-changing device between the Adjustable frequency drive and the motor
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
- Ground the cable in accordance with grounding instructions provided.
- Torque terminals in accordance with the information provided in *10.4.1 Connection Tightening Torques*
- Follow the motor manufacturer wiring requirements

The three following figures represent line power input, motor, and grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.

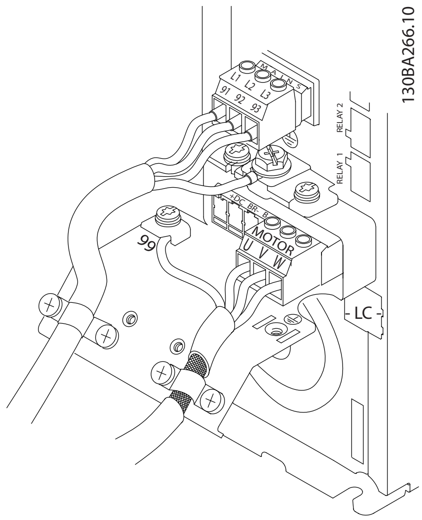


Figure 2.9 Motor, Line Power and Ground Wiring for A-Frame Sizes

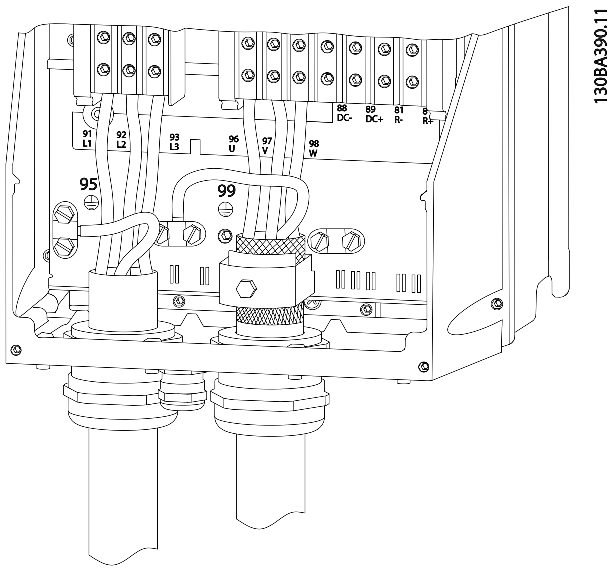


Figure 2.10 Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Shielded Cable

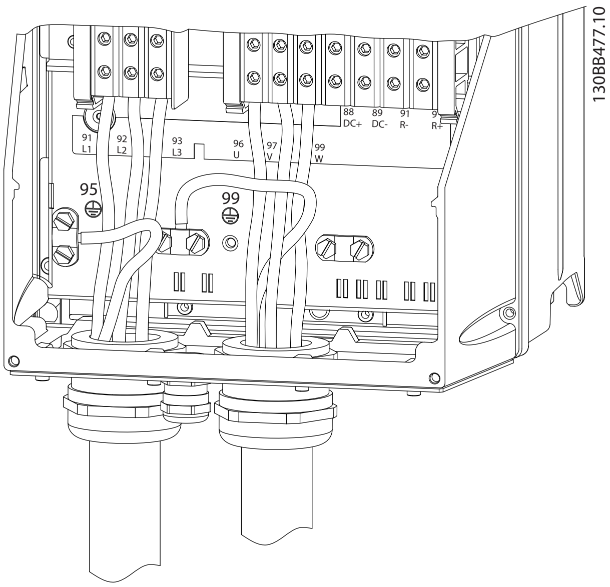


Figure 2.11 Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Conduit

2.4.4 AC Line Power Connection

- Size wiring based upon the input current of the Adjustable frequency drive. For maximum wire sizes, see *10.1 Power-dependent Specifications*.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Figure 2.12*).
- Depending on the configuration of the equipment, input power will be connected to the line power input terminals or the input disconnect.

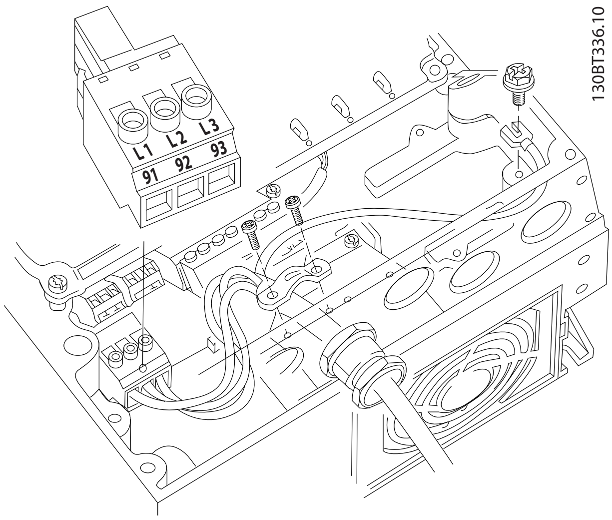


Figure 2.12 Connecting to AC Line Power

- Ground the cable in accordance with grounding instructions provided in *2.4.2 Grounding Requirements*
- All adjustable frequency drives may be used with an isolated input source as well as with ground reference power lines. When supplied from an isolated line power source (IT line or floating delta) or TT/TN-S power line with a grounded leg (grounded delta), set *14-50 RFI 1* to OFF. When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce ground capacity currents in accordance with IEC 61800-3.

2.4.5 Control Wiring

- Isolate control wiring from high power components in the adjustable frequency drive.
- If the adjustable frequency drive is connected to a thermistor, for PELV isolation, optional thermistor control wiring must be reinforced/ double insulated. A 24 V DC supply voltage is recommended.

2.4.5.1 Access

- Remove access coverplate with a screwdriver. See *Figure 2.13*.
- Or remove front cover by loosening attaching screws. See *Figure 2.14*.

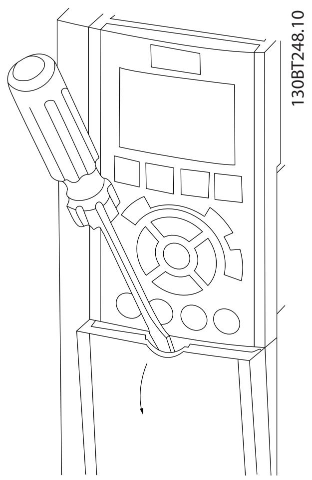


Figure 2.13 Control Wiring Access for A2, A3, B3, B4, C3 and C4 Enclosures

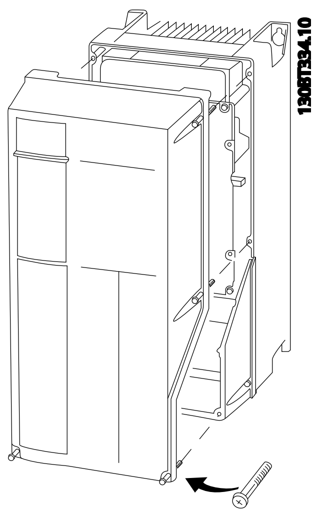


Figure 2.14 Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures

Please see *Table 2.3* before tightening the covers.

Frame	IP20	IP21	IP55	IP66
A4/A5	-	-	2	2
B1	-	*	2.2	2.2
B2	-	*	2.2	2.2
C1	-	*	2.2	2.2
C2	-	*	2.2	2.2
* No screws to tighten				
- Does not exist				

Table 2.3 Tightening Torques for Covers (Nm)

2.4.5.2 Control Terminal Types

shows the removable Adjustable frequency drive connectors. Terminal functions and default settings are summarized in *Table 2.4*.

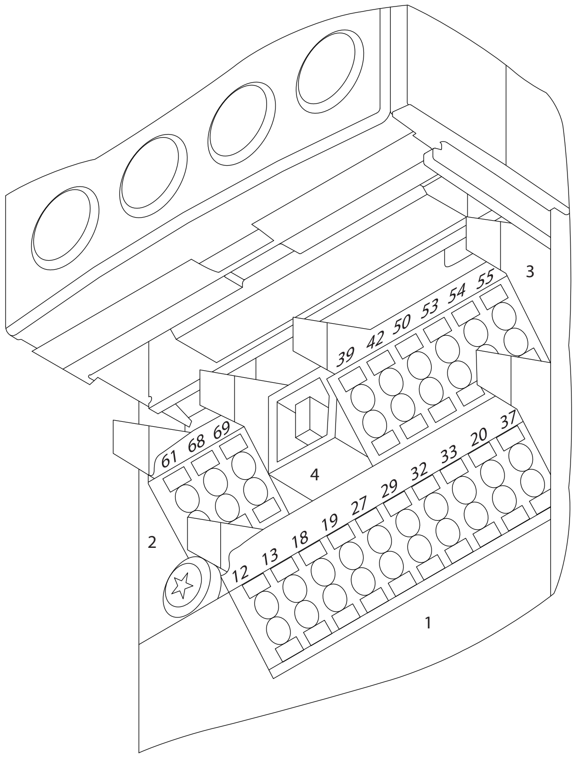


Figure 2.15 Control Terminal Locations

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24V DC terminal supply voltage, and a common for optional customer supplied 24V DC voltage
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10V DC supply voltage, and commons for the inputs and output
- **Connector 4** is a USB port available for use with the MCT 10 Set-up Software
- Also provided are two Form C relay outputs that are in various locations depending upon the Adjustable frequency drive configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See *10.2 General Technical Data* for terminal ratings details.

2

Terminal	Parameter	Default Setting	Description
Terminal Description			
Digital Inputs/Outputs			
12, 13	-	+24V DC	24V DC supply voltage. Maximum output current is 200mA total for all 24V loads. Useable for digital inputs and external transducers.
18	5-10	[8] Start	Digital inputs.
19	5-11	[0] No operation	
32	5-14	[0] No operation	
33	5-15	[0] No operation	
27	5-12	[2] Coast inverse	Selectable for either digital input or output. Default setting is input.
29	5-13	[14] JOG	
20	-		Common for digital inputs and 0V potential for 24V supply.
37	-	Safe Torque Off (STO)	(optional) Safe input. Used for STO
Analog Inputs/Outputs			
39	-		Common for analog output
42	6-50	Speed 0 - High Limit	Programmable analog output. The analog signal is 0–20mA or 4–20mA at a maximum of 500Ω
50	-	+10V DC	10V DC analog supply voltage. 15mA maximum commonly used for potentiometer or thermistor.
53	6-1	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	6-2	Feedback	
55	-		Common for analog input
Serial Communication			
61	-		Integrated RC filter for cable shield. ONLY for connecting the shield when experiencing EMC problems.
68 (+)	8-3		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3		
Relays			
01, 02, 03	5-40 [0]	[0] Alarm	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[0] Running	

Table 2.4 Terminal Description

2.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the Adjustable frequency drive for ease of installation, as shown in *Figure 2.16*.

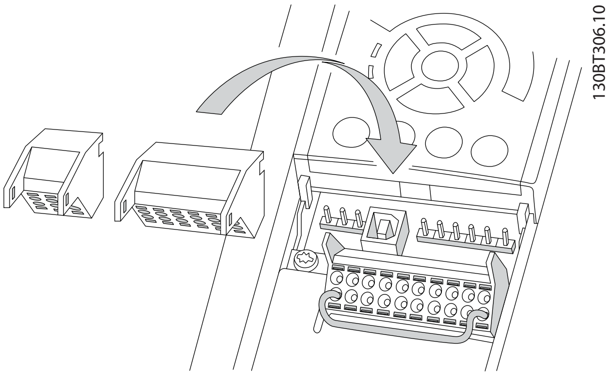


Figure 2.16 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Figure 2.17*.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *10.1 Power-dependent Specifications* for control terminal wiring sizes.

See *6 Application Set-Up Examples* for typical control wiring connections.

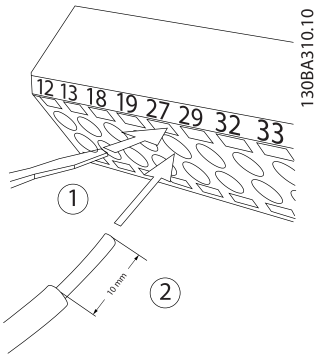


Figure 2.17 Connecting Control Wiring

2.4.5.4 Using Shielded Control Cables

Correct shielding

The preferred method in most cases is to secure control and serial communication cables with shielding clamps provided at both ends to ensure best possible high frequency cable contact.
If the ground potential between the adjustable frequency drive and the PLC is different, electric noise may occur that will disturb the entire system. Solve this problem by fitting an equalizing cable next to the control cable. Minimum cable cross-section: 0.025 in^2 (16 mm$^{2)}$.

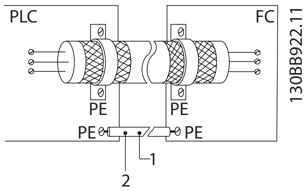


Figure 2.18

50/60 Hz ground loops

With very long control cables, ground loops may occur. To eliminate ground loops, connect one end of the shield-to-ground with a 100 nF capacitor (keeping leads short).

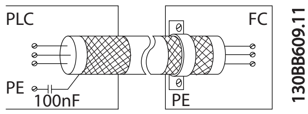


Figure 2.19

Avoid EMC noise on serial communication

This terminal is grounded via an internal RC link. Use twisted-pair cables to reduce interference between conductors. The recommended method is shown below:

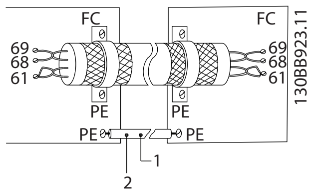


Figure 2.20

Alternatively, the connection to terminal 61 can be omitted:

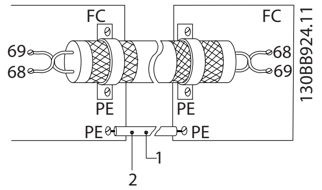


Figure 2.21

2.4.5.5 Control Terminal Functions

Adjustable frequency drive functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it will be supporting in the parameters associated with that terminal. See*Table 2.4* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and *5 About Adjustable Frequency Drive Programming* for details on programming.
- The default terminal programming is intended to initiate Adjustable frequency drive functioning in a typical operational mode.

2.4.5.6 Jumper Terminals 12 and 27

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the Adjustable frequency drive to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive an 24V DC external interlock command. In many applications, the user wires an external interlock device to terminal 27
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This provides an internal 24V signal on terminal 27
- No signal present prevents the unit from operating.
- When the status line at the bottom of the LCP reads AUTO REMOTE COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring

2.4.5.7 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (0 to 10V) or current (0/4–20mA) input signals
- Remove power to the Adjustable frequency drive before changing switch positions
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the LCP has been removed (see *Figure 2.22*). Note that some option cards available for the unit may cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.
- Terminal 53 default is for a speed reference signal in open-loop set in *16-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed-loop set in *16-63 Terminal 54 Switch Setting*

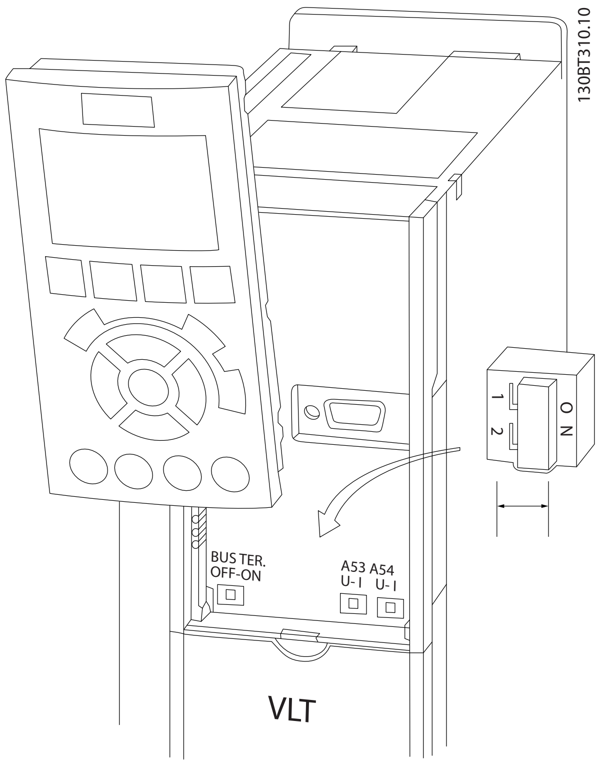


Figure 2.22 Location of Terminals 53 and 54 Switches

2.4.5.8 Terminal 37

Terminal 37 Safe Stop Function
The adjustable frequency drive is available with optional safe stop functionality via control terminal 37. Safe stop

disables the control voltage of the power semiconductors of the adjustable frequency drive output stage which in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the adjustable frequency drive issues an alarm, trips the unit, and coasts the motor to a stop. Manual restart is required. The safe stop function can be used for stopping the adjustable frequency drive in emergency stop situations. In the normal operating mode when safe stop is not required, use the adjustable frequency drive's regular stop function instead. When automatic restart is used – the requirements according to ISO 12100-2 paragraph 5.3.2.5 must be fulfilled.

Liability Conditions
It is the responsibility of the user to ensure personnel installing and operating the Safe Stop function:

- Read and understand the safety regulations concerning health and safety/accident prevention
- Understand the generic and safety guidelines given in this description and the extended description in the *Design Guide*
- Have a good knowledge of the generic and safety standards applicable to the specific application

User is defined as: integrator, operator, servicing, maintenance staff.

Standards
Use of safe stop on terminal 37 requires that the user satisfies all provisions for safety including relevant laws, regulations and guidelines. The optional safe stop function complies with the following standards.

EN 954-1: 1996 Category 3

IEC 60204-1: 2005 category 0 – uncontrolled stop

IEC 61508: 1998 SIL2

IEC 61800-5-2: 2007 – safe torque off (STO) function

IEC 62061: 2005 SIL CL2

ISO 13849-1: 2006 Category 3 PL d

ISO 14118: 2000 (EN 1037) – prevention of unexpected start-up

The information and instructions of the instruction manual are not sufficient for a proper and safe use of the safe stop functionality. The related information and instructions of the relevant *Design Guide* must be followed.

Protective Measures

- Safety engineering systems may only be installed and commissioned by qualified and skilled personnel
- The unit must be installed in an IP54 cabinet or in an equivalent environment
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D.4
- If any external forces influence the motor axis (e.g., suspended loads), additional measures (e.g., a safety holding brake) are required in order to eliminate hazards.

Safe Stop Installation and Set-up

⚠WARNING

SAFE STOP FUNCTION!

The safe stop function does NOT isolate AC line voltage to the adjustable frequency drive or auxiliary circuits. Perform work on electrical parts of the adjustable frequency drive or the motor only after isolating the AC line voltage supply and waiting the length of time specified under Safety in this manual. Failure to isolate the AC line voltage supply from the unit and waiting the time specified could result in death or serious injury.

- It is not recommended to stop the adjustable frequency drive by using the Safe Torque Off function. If a running adjustable frequency drive is stopped by using the function, the unit will trip and stop by coasting. If this is not acceptable, i.e., causes danger, the adjustable frequency drive and machinery must be stopped using the appropriate stopping mode before using this function. Depending on the application, a mechanical brake may be required.
- Concerning synchronous and permanent magnet motor adjustable frequency drives in case of a multiple IGBT power semiconductor failure: In spite of the activation of the Safe torque off function, the adjustable frequency drive system can produce an alignment torque which maximally rotates the motor shaft by 180/p degrees. p denotes the pole pair number.
- This function is suitable for performing mechanical work on the adjustable frequency drive system or affected area of a machine only. It does not provide electrical safety. This function should not be used as a control for starting and/or stopping the adjustable frequency drive.

The following requirements have to be meet to perform a safe installation of the adjustable frequency drive:

1. Remove the jumper wire between control terminals 37 and 12 or 13. Cutting or breaking the jumper is not sufficient to avoid short-circuiting. (See jumper on *Figure 2.23*.)
2. Connect an external Safety monitoring relay via a NO safety function (the instruction for the safety device must be followed) to terminal 37 (safe stop) and either terminal 12 or 13 (24V DC). The safety monitoring relay must comply with Category 3 (EN 954-1) / PL “d” (ISO 13849-1).

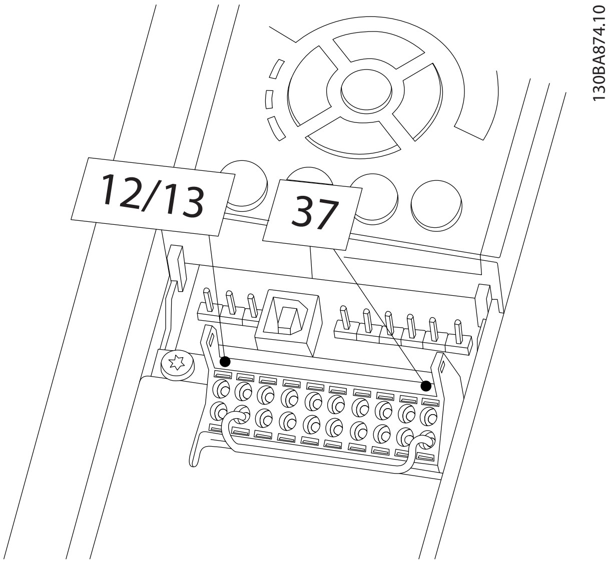


Figure 2.23 Jumper between Terminal 12/13 (24 V) and 37

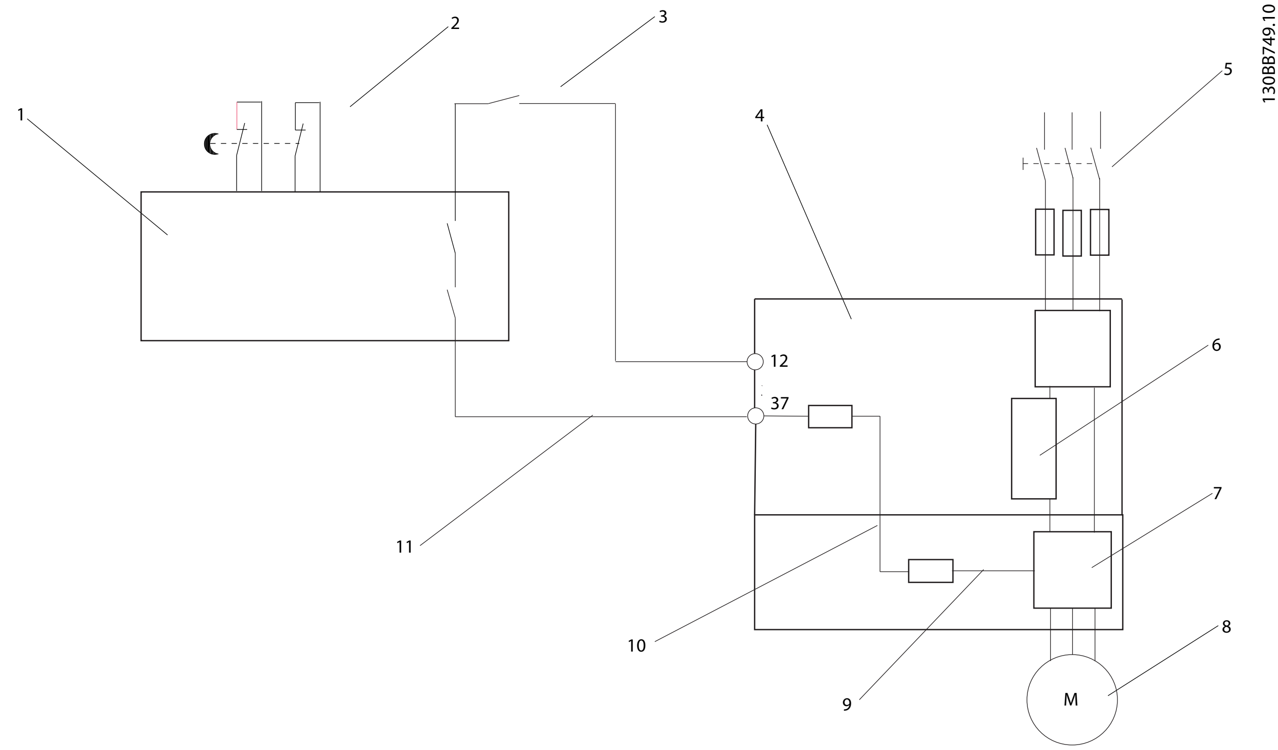


Figure 2.24 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Safety Cat. 3 (EN 954-1) / PL "d" (ISO 13849-1).

1	Safety device Cat. 3 (circuit interrupt device, possibly with release input)	7	Inverter
2	Door contact	8	Motor
3	Contactor (Coast)	9	5 V DC
4	Adjustable frequency drive	10	Safe channel
5	Line power	11	Short-circuit protected cable (if not inside installation cabinet)
6	Control board		

Table 2.5

Safe Stop Commissioning Test
After installation and before first operation, perform a commissioning test of the installation making use of safe stop. Also, perform the test after each modification of the installation.

2.4.5.9 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to be able to control an electro-mechanical brake:

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the Adjustable frequency drive is unable to 'support' the motor, for example due to the load being too heavy.
- Select *Mechanical brake control* [32] in parameter group 5-4* for applications with an electro-mechanical brake.
- The brake is released when the motor current exceeds the preset value in *2-20 Release Brake Current*.
- The brake is engaged when the output frequency is less than the frequency set in *2-21 Activate Brake Speed [RPM]*or *2-22 Activate Brake Speed [Hz]*, and only if the Adjustable frequency drive carries out a stop command.

If the Adjustable frequency drive is in alarm mode or in an overvoltage situation, the mechanical brake immediately cuts in.

In the vertical movement, the key point is that the load must be held, stopped, controlled (raised, lowered) in a perfectly safe mode during the entire operation. Because the Adjustable frequency drive is not a safety device, the crane/lift designer (OEM) must decide on the type and number of safety devices (e.g. speed switch, emergency brakes, etc.) to be used in order to be able to stop the load in case of emergency or malfunction of the system, according to relevant national crane/lifting regulations.

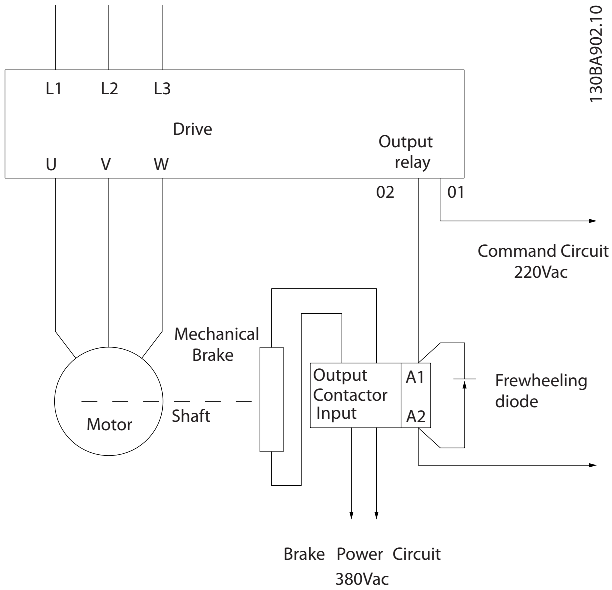


Figure 2.25 Connecting the Mechanical Brake to the Adjustable Frequency Drive

2.4.6 Serial Communication

RS-485 is a two-wire bus interface compatible with multi-drop network topology, i.e., nodes can be connected as a bus, or via drop cables from a common trunk line. A total of 32 nodes can be connected to one network segment. Repeaters divide network segments. Note that each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address across all segments. Terminate each segment at both ends using either the termination switch (S801) of the adjustable frequency drives or a biased termination resistor network. Always use shielded twisted pair (STP) cable for bus cabling, and always follow good common installation practice. Low-impedance ground connection of the shield at every node is important, including at high frequencies. Thus, connect a large surface of the shield to ground, for example with a cable clamp or a conductive cable connector. It may be necessary to apply potential-equalizing cables to maintain the same ground potential throughout the network. particularly in installations with long cables.

To prevent impedance mismatch, always use the same type of cable throughout the entire network. When connecting a motor to the adjustable frequency drive, always use shielded motor cable.

Cable: Shielded twisted pair (STP)
Impedance: 120 Ω
Cable length: Max. 4,000 ft [1,200 m] (including drop lines)
Max. 1,650 ft [500 m] station-to-station

Table 2.6

3 Start-up and Functional Testing

3.1 Pre-start

3.1.1 Safety Inspection

WARNING

HIGH VOLTAGE!

If input and output connections have been connected improperly, there is potential for high voltage on these terminals. If power leads for multiple motors are improperly run through the same conduit, there is a potential for leakage current to charge capacitors within the Adjustable frequency drive, even when disconnected from line power input. For initial start-up, make no assumptions about power components. Follow pre-start procedures. Failure to follow pre-start procedures could result in personal injury or damage to equipment.

1. Input power to the unit must be OFF and locked out. Do not rely on the Adjustable frequency drive disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground,
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
4. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
5. Check for proper grounding of the Adjustable frequency drive as well as the motor.
6. Inspect the Adjustable frequency drive for loose connections on terminals.
7. Record the following motor nameplate data: power, voltage, frequency, full load current, and nominal speed. These values are needed to program motor nameplate data later.
8. Confirm that the supply voltage matches voltage of Adjustable frequency drive and motor.

3

CAUTION

Before applying power to the unit, inspect the entire installation as detailed in *Table 3.1*. Check mark those items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the adjustable frequency drive or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the adjustable frequency drive. • Remove power factor correction caps on motor(s), if present.	
Cable routing	• Ensure that input power, motor wiring, and control wiring are separated or in three separate metallic conduits for high frequency noise isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Measure to make sure that the top and bottom clearance is adequate to ensure proper airflow for cooling.	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility.	
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits. • Humidity levels must be 5%–95% non-condensing.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position.	
(Grounding)	• The unit requires an ground wire(ground wire) from its chassis to the building ground. • Check for good ground connections(ground connections) that are tight and free of oxidation. • Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground.	
Input and output power wiring	• Check for loose connections. • Check that motor and line power are in separate conduits or separated shielded cables.	
Panel interior	• Inspect to ensure that the unit interior is free of dirt, metal chips, moisture, and corrosion.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 3.1 Start-up Check List

3.2 Applying Power to the Adjustable Frequency Drive

WARNING

HIGH VOLTAGE!

Adjustable frequency drives contain high voltage when connected to AC line power. Installation, startup and maintenance should be performed by qualified personnel only. Failure to perform installation, startup and maintenance by qualified personnel could result in death or serious injury.

WARNING

UNINTENDED START!

When Adjustable frequency drive is connected to AC line power, the motor may start at any time. The Adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the Adjustable frequency drive is connected to AC line power could result in death, serious injury, equipment, or property damage.

1. Confirm input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat procedure after voltage correction.
2. Ensure optional equipment wiring, if present, matches installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors closed or cover mounted.
4. Apply power to the unit. DO NOT start the Adjustable frequency drive at this time. For units with a disconnect switch, turn to the ON position to apply power to the Adjustable frequency drive.

NOTE!

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27. See *Figure 2.23* for details.

3.3 Basic Operational Programming

Adjustable Frequency require basic operational programming prior to running for best performance. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. Enter data in accordance with the following procedure. Parameter settings recommended are intended for startup and checkout purposes. Application settings may vary. See *4 User Interface* for detailed instructions on entering data through the LCP.

Enter data with power ON, but prior to operating the Adjustable frequency drive.

1. Press [Main Menu] twice on the LCP.
2. Use the navigation keys to scroll to parameter group 0-** *Operation/Display* and press [OK].

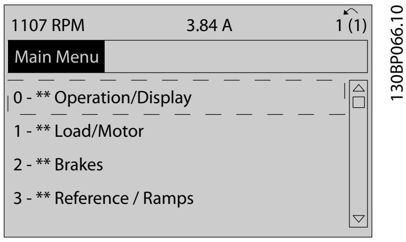


Figure 3.1

3. Use navigation keys to scroll to parameter group 0-0* *Basic Settings* and press [OK].

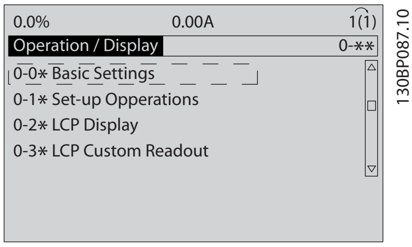


Figure 3.2

4. Use navigation keys to scroll to *0-03 Regional Settings* and press [OK].

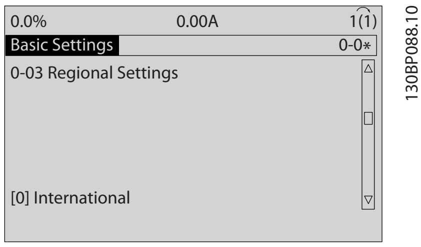


Figure 3.3

5. Use navigation keys to select *North America* or *International* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters. See *5.4 International/North American Default Parameter Settings* for a complete list.)
6. Press [Quick Menu] on the LCP.
7. Use the navigation keys to scroll to parameter group *Q2 Quick Set-up* and press [OK].

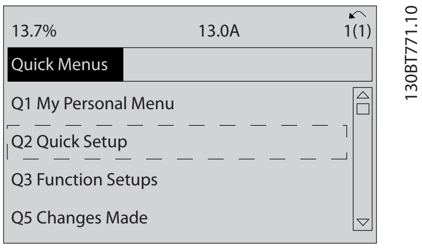


Figure 3.4

8. Select language and press [OK]. Then enter the motor data in parameters1-20/1-21 through 1-25 (induction motors only, for PM motors, skip these parameters for now). The information can be found on the motor nameplate. The entire quick menu is shown in *5.5.1 Quick Menu Structure*

   1-20 Motor Power [kW] or *1-21 Motor Power [HP]*

   1-22 Motor Voltage

   1-23 Motor Frequency

   1-24 Motor Current

   1-25 Motor Nominal Speed

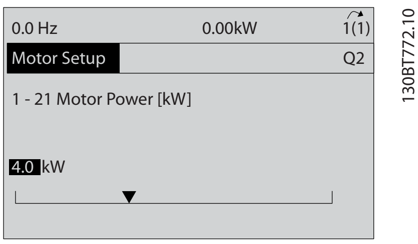


Figure 3.5

9. For best results, skip *1-28 Motor Rotation Check* at this time until basic programming is complete. This will be tested following basic set-up.
10. *3-41 Ramp 1 Ramp-up Time* is recommended as 60 seconds for fans or 10 seconds for pumps.
11. *3-42 Ramp 1 Ramp-down Time* is recommended as 60 seconds for fans or 10 seconds for pumps.
12. For *4-12 Motor Speed Low Limit [Hz]*, enter the application requirements. If these values are unknown at this time, the following values are recommended. These values will ensure initial Adjustable frequency drive operation. However, take any precautions necessary to prevent equipment damage. Make sure that the recommended values are safe to use for functional testing before starting the equipment.

    Fan = 20 Hz

    Pump = 20 Hz

    Compressor = 30 Hz
13. In *4-14 Motor Speed High Limit [Hz]*, enter the motor frequency from *1-23 Motor Frequency*.
14. Leave *3-11 Jog Speed [Hz]* (10 Hz) at the factory default (this is not used in initial programming).
15. A jumper wire should be in place between control terminals 12 and 27. If this is the case, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise select *No Operation*. For adjustable frequency drives with an optional Danfoss bypass, no jumper wire is required.
16. *5-40 Function Relay*, leave at factory default.

This concludes the quick set-up procedure. Press [Status] to return to the operational display.

3.4 PM Motor Set-up

This section is only relevant when using a PM motor.

Set up the basic motor parameters:

- *1-10 Motor Construction*
- *1-14 Damping Gain*
- *1-15 Low Speed Filter Time Const.*
- *1-16 High Speed Filter Time Const.*
- *1-17 Voltage filter time const.*
- *1-24 Motor Current*
- *1-25 Motor Nominal Speed*
- *1-26 Motor Cont. Rated Torque*
- *1-30 Stator Resistance (Rs)*
- *1-37 d-axis Inductance (Ld)*
- *1-39 Motor Poles*
- *1-40 Back EMF at 1000 RPM*
- *1-66 Min. Current at Low Speed*
- *4-13 Motor Speed High Limit [RPM]*
- *4-19 Max Output Frequency*

Note concerning advanced motor data:
Stator resistance and d-axis inductance values are often described differently in technical specifications. For programming resistance and d-axis inductance values in Danfoss adjustable frequency drives, always use line to common (starpoint) values. This is valid for both asynchronous and PM motors.

Par. 1-30	Stator Resistance (Line to common)	This parameter gives stator winding resistance (Rs) similar to asynchronous motor stator resistance. When line-line data (where stator resistance is measured between any two lines) are available, you need to divide it with 2.
Par. 1-37	d-axis Inductance (Line to common)	This parameter gives direct axis inductance of the PM motor. When line-line data are available, you need to divide it with 2.
Par. 1-40	Back EMF at 1000 RPM RMS (Line to Line Value)	This parameter gives back EMF across stator terminal of PM Motor at 1000 RPM mechanical speed specifically. It is defined between line to line and expressed in RMS Value. If the PM Motor specifications provide this value related to another motor speed, the voltage must be recalculated for 1000 RPM.

Table 3.2

Note concerning back EMF:
Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Technical specifications usually note this voltage as related to nominal motor speed or to 1000 RPM measured between two lines.

3.5 Automatic Motor Adaptation

Automatic motor adaptation (AMA) is a test procedure that measures the electrical characteristics of the motor to optimize compatibility between the Adjustable frequency drive and the motor.

- The Adjustable frequency drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters 1-20 to 1-25.
- It does not cause the motor to run or harm to the motor
- Some motors may be unable to run the complete version of the test. In that case, select *Enable reduced AMA*
- If an output filter is connected to the motor, select *Enable reduced AMA*
- If warnings or alarms occur, see *8 Warnings and Alarms*
- Run this procedure on a cold motor for best results

NOTE!
The AMA algorithm does not work when using PM motors.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group 1-** *Load and Motor*.
3. Press [OK].
4. Scroll to parameter group 1-2* *Motor Data*.
5. Press [OK].
6. Scroll to *1-29 Automatic Motor Adaptation (AMA)*.
7. Press [OK].
8. Select *Enable complete AMA*.
9. Press [OK].
10. Follow on-screen instructions.
11. The test will run automatically and indicate when it is complete.

3.6 Check Motor Rotation

Prior to running the Adjustable frequency drive, check the motor rotation. The motor will run briefly at 5Hz or the minimum frequency set in *4-12 Motor Speed Low Limit [Hz]*.

1. Press [Quick Menu].
2. Scroll to *Q2 Quick Set-up*.
3. Press [OK].
4. Scroll to *1-28 Motor Rotation Check*.
5. Press [OK].
6. Scroll to *Enable*.

The following text will appear: *Note! Motor may run in wrong direction*.

7. Press [OK].
8. Follow the on-screen instructions.

To change the direction of rotation, remove power to the Adjustable frequency drive and wait for power to discharge. Reverse the connection of any two of the three motor cables on the motor or Adjustable frequency drive side of the connection.

3.7 Local Control Test

⚠CAUTION

MOTOR START!
Ensure that the motor, system, and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any condition. Failure to ensure that the motor, system, and any attached equipment are ready for start could result in personal injury or equipment damage.

NOTE!
The [Hand On] key on the LCP provides a local start command to the adjustable frequency drive. The [Off] key provides the stop function.
When operating in local mode, [▲] and [▼] arrows on the LCP increase and decrease the speed output of the adjustable frequency drive. [◄] and [►] move the display cursor in the numeric display.

1. Press [Hand On].
2. Accelerate the adjustable frequency drive by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off].
5. Note any deceleration problems.

If acceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*.
- Check that motor data is entered correctly.
- Increase the ramp-up time in *3-41 Ramp 1 Ramp-up Time*.
- Increase current limit in *4-18 Current Limit*.
- Increase torque limit in *4-16 Torque Limit Motor Mode*.

If deceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*.
- Check that motor data is entered correctly.
- Increase the ramp-down time in *3-42 Ramp 1 Ramp-down Time*.
- Enable overvoltage control in *2-17 Over-voltage Control*.

NOTE!
The OVC algorithm does not work when using PM motors.

See *8.4 Warning and Alarm Definitions* for resetting the adjustable frequency drive after a trip.

NOTE!
***3.1 Pre-start* through *3.7 Local Control Test* in this chapter concludes the procedures for applying power to the adjustable frequency drive, basic programming, set-up, and functional testing.**

3.8 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. *6 Application Set-Up Examples* is intended to help with this task. Other aids to application set-up are listed in *1.2 Additional Resources*. The following procedure is recommended after application set-up by the user is completed.

⚠CAUTION

MOTOR START!
Ensure that the motor, system, and any attached equipment is ready for start. It is the responsibility of the user to ensure safe operation under any operational condition. Failure to ensure that the motor, system, and any attached equipment is ready for start could result in personal injury or equipment damage.

1. Press [Auto On].
2. Ensure that external control functions are properly wired to the Adjustable frequency drive and all programming completed.
3. Apply an external run command.
4. Adjust the speed reference throughout the speed range.
5. Remove the external run command.
6. Note any problems.

If warnings or alarms occur, see *8 Warnings and Alarms*.

3.9 Acoustic Noise or Vibration

If the motor or the equipment driven by the motor, e.g., a fan blade, is making noise or vibrations at certain frequencies, try the following:

- Speed Bypass, parameter group 4-6*
- Overmodulation, *14-03 Overmodulation* set to off
- Switching pattern and switching frequency parameter group 14-0*
- Resonance Dampening, *1-64 Resonance Dampening*

4 User Interface

4.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The LCP is the user interface to the adjustable frequency drive.

The LCP has several user functions.

- Start, stop, and control speed when in local control
- Display operational data, status, warnings and cautions
- Programming adjustable frequency drive functions
- Manually reset the adjustable frequency drive after a fault when auto-reset is inactive

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the Programming Guide for details on use of the NLCP.

NOTE!

The display contrast can be adjusted by pressing [STATUS] and the up/down key.

4.1.1 LCP Layout

The LCP is divided into four functional groups (see *Figure 4.1*).

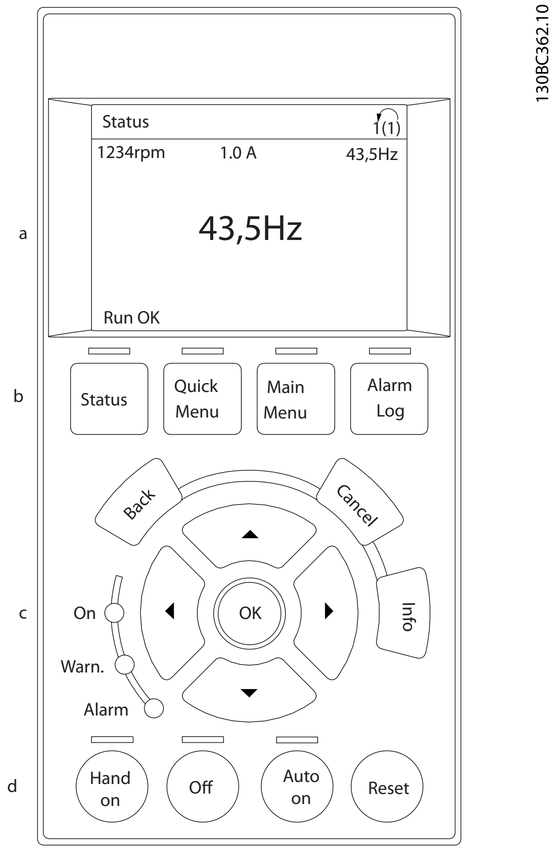


Figure 4.1 LCP

a. Display area.

b. Display menu keys for changing the display to show status options, programming, or error message history. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.

c. Operational mode keys and reset.

4

4.1.2 Setting LCP Display Values

The display area is activated when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V supply.

The information displayed on the LCP can be customized for user application.

- Each display readout has a parameter associated with it.
- Options are selected in the quick menu *Q3-13 Display Settings*.
- Display 2 has an alternate larger display option.
- The adjustable frequency drive status at the bottom line of the display is generated automatically and is not selectable.

Display	Parameter number	Default setting
1.1	0-20	Motor RPMs
1.2	0-21	Motor current
1.3	0-22	Motor power (kW)
2	0-23	Motor frequency
3	0-24	Reference in percent

Table 4.1

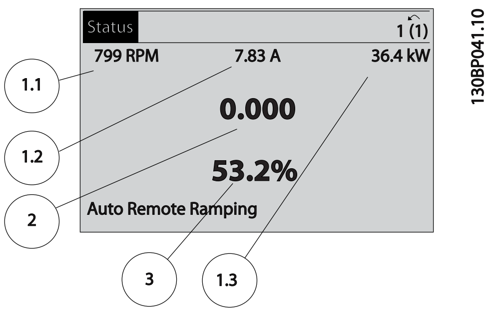


Figure 4.2

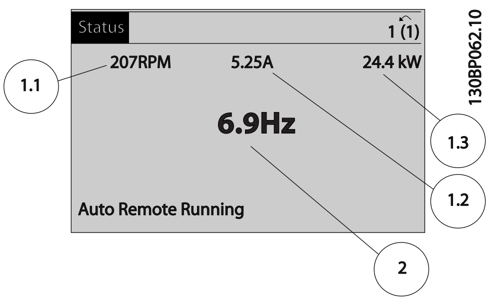


Figure 4.3

4.1.3 Display Menu Keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

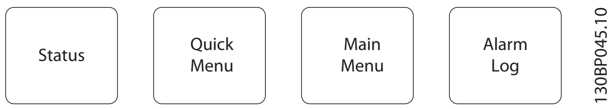


Figure 4.4

Key	Function
Status	Shows operational information. • In auto mode, press to toggle between status readout displays. • Press repeatedly to scroll through each status display. • Press [Status] plus [▲] or [▼] to adjust the display brightness. • The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.
Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions. • Press to access *Q2 Quick Setup* for sequenced instructions to program the basic frequency controller set up • Follow the sequence of parameters as presented for the function set-up
Main Menu	Allows access to all programming parameters. • Press twice to access top-level index • Press once to return to the last location accessed. • Press to enter a parameter number for direct access to that parameter.
Alarm Log	Displays a list of current warnings, the last 10 alarms, and the maintenance log. • For details about the adjustable frequency drive before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].

Table 4.2

4.1.4 Navigation Keys

are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. Three adjustable frequency drive status indicators are also located in this area.

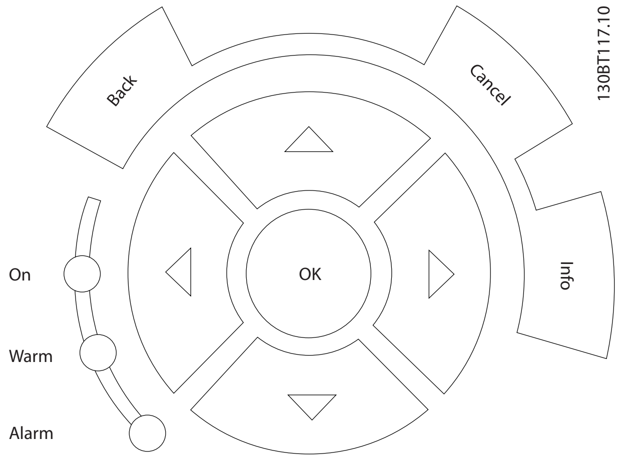


Figure 4.5

Key	Function
Back	Reverts to the previous step or list in the menu structure.
Cancel	Cancels the last change or command as long as the display mode has not changed.
Info	Press for a definition of the function being displayed.
Navigation Keys	Use the four navigation arrows to move between items in the menu.
OK	Use to access parameter groups or to enable a choice.

Table 4.3

Light	Indicator	Function
Green	ON	The ON light activates when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V supply.
Yellow	WARN	When warning conditions are met, the yellow WARN light comes on and text appears in the display area identifying the problem.
Red	ALARM	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 4.4

4.1.5 Operation Keys

Operation keys are found at the bottom of the LCP.

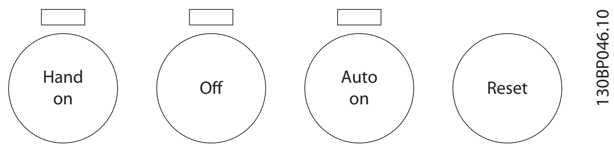


Figure 4.6

Key	Function
Hand On	Starts the adjustable frequency drive in local control. • Use the navigation keys to control adjustable frequency drive speed. • An external stop signal by control input or serial communication overrides the local hand on
Off	Stops the motor but does not remove power to the adjustable frequency drive.
Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication • Speed reference is from an external source
Reset	Resets the adjustable frequency drive manually after a fault has been cleared.

Table 4.5

4.2 Backup and Copying Parameter Settings

Programming data is stored internally in the adjustable frequency drive.

- The data can be uploaded into the LCP memory as a storage backup.
- Once stored in the LCP, the data can be downloaded back into the adjustable frequency drive.
- Data can also be downloaded into other adjustable frequency drives by connecting the LCP into those units and downloading the stored settings. (This is a quick way to program multiple units with the same settings.)
- Initialization of the adjustable frequency drive to restore factory default settings does not change data stored in the LCP memory.

4

⚠WARNING

UNINTENDED START!

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the adjustable frequency drive is connected to AC line power could result in death, serious injury, or equipment or property damage.

4.2.1 Uploading Data to the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to *0-50 LCP Copy*.
3. Press [OK].
4. Select *All to LCP*.
5. Press [OK]. A progress bar shows the uploading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

4.2.2 Downloading Data from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to *0-50 LCP Copy*.
3. Press [OK].
4. Select *All from LCP*.
5. Press [OK]. A progress bar shows the downloading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

4.3 Restoring Default Settings

CAUTION

Initialization restores the unit to factory default settings. Any programming, motor data, localization, and monitoring records will be lost. Uploading data to the LCP provides a backup before initialization.

Restoring the adjustable frequency drive parameter settings back to default values is done by initialization of the adjustable frequency drive. Initialization can be through *14-22 Operation Mode* or manually.

- Initialization using *14-22 Operation Mode* does not change adjustable frequency drive data such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions
- Using *14-22 Operation Mode* is generally recommended.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

4.3.1 Recommended Initialization

1. Press [Main Menu] twice to access parameters.
2. Scroll to *14-22 Operation Mode*.
3. Press [OK].
4. Scroll to *Initialization*.
5. Press [OK].
6. Remove power to the unit and wait for the display to turn off.
7. Apply power to the unit.

Default parameter settings are restored during start-up. This may take slightly longer than normal.

8. Alarm 80 is displayed.
9. Press [Reset] to return to operation mode.

4.3.2 Manual Initialization

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time and apply power to the unit.

Factory default parameter settings are restored during startup. This may take slightly longer than normal.

Manual initialization does not the following adjustable frequency drive information.

- *15-00 Operating Hours*
- *15-03 Power-ups*
- *15-04 Over Temps*
- *15-05 Over Volts*

5 About Adjustable Frequency Drive Programming

5.1 Introduction

The Adjustable frequency drive is programmed for its application functions using parameters. Parameter are accessed by pressing either [Quick Menu] or [Main Menu] on the LCP. (See *4 User Interface* for details on using the LCP function keys.) Parameters may also be accessed through a PC using the MCT 10 Set-up Software (see *5.6 Remote Programming with*).

The quick menu is intended for initial startup (*Q2-** Quick Set-up*) and detailed instructions for common Adjustable frequency drive applications (*Q3-** Function Set-up*). Step-by-step instructions are provided. These instructions enable the user to walk through the parameters used for programming applications in their proper sequence. Data entered in a parameter can change the options available in the parameters following that entry. The quick menu presents easy guidelines for getting most systems up and running.

The main menu accesses all parameters and allows for advanced Adjustable frequency drive applications.

5.2 Programming Example

Here is an example for programming the adjustable frequency drive for a common application in open-loop using the quick menu.

- This procedure programs the adjustable frequency drive to receive a 0–10 V DC analog control signal on input terminal 53
- The adjustable frequency drive will respond by providing 6-60 Hz output to the motor proportional to the input signal (0–10 V DC = 6–60 Hz)

Select the following parameters using the navigation keys to scroll to the titles and press [OK] after each action.

1. *3-15 Reference Resource 1*

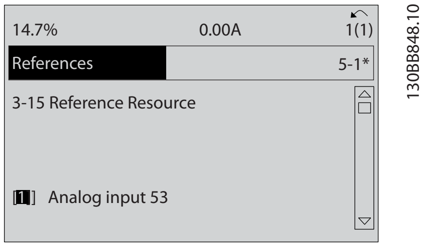


Figure 5.1

2. *3-02 Minimum Reference*. Set minimum internal adjustable frequency drive reference to 0 Hz. (This sets the minimum adjustable frequency drive speed at 0 Hz.)

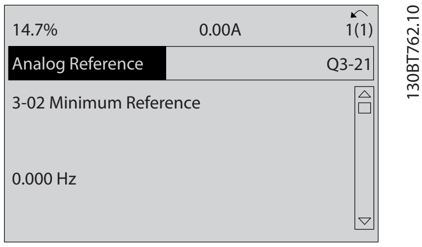


Figure 5.2

3. *3-03 Maximum Reference*. Set maximum internal adjustable frequency drive reference to 60 Hz. (This sets the maximum adjustable frequency drive speed at 60 Hz. Note that 50/60 Hz is a regional variation.)

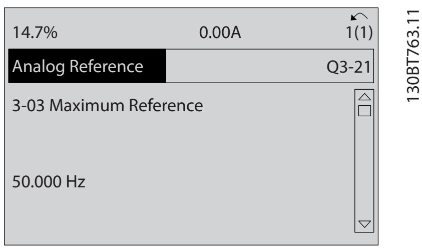


Figure 5.3

4. *6-10 Terminal 53 Low Voltage*. Set minimum external voltage reference on Terminal 53 at 0 V. (This sets the minimum input signal at 0 V.)

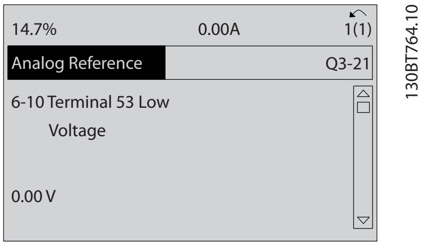


Figure 5.4

5. *6-11 Terminal 53 High Voltage*. Set maximum external voltage reference on Terminal 53 at 10 V. (This sets the maximum input signal at 10 V.)

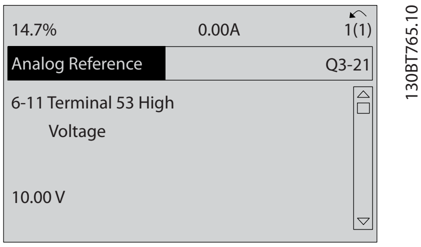


Figure 5.5

6. *6-14 Terminal 53 Low Ref./Feedb. Value*. Set minimum speed reference on Terminal 53 at 6Hz. (This tells the adjustable frequency drive that the minimum voltage received on Terminal 53 (0 V) equals 6 Hz output.)

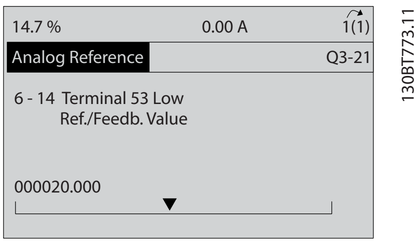


Figure 5.6

7. *6-15 Terminal 53 High Ref./Feedb. Value*. Set maximum speed reference on Terminal 53 at 60 Hz. (This tells the adjustable frequency drive that the maximum voltage received on Terminal 53 (10 V) equals 60 Hz output.)

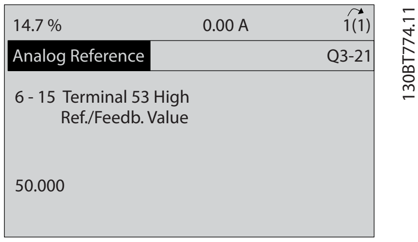


Figure 5.7

With an external device providing a 0–10 V control signal connected to adjustable frequency drive terminal 53, the system is now ready for operation. Note that the scroll bar on the right in the last figure of the display is at the bottom, indicating the procedure is complete.

Figure 5.8 shows the wiring connections used to enable this set-up.

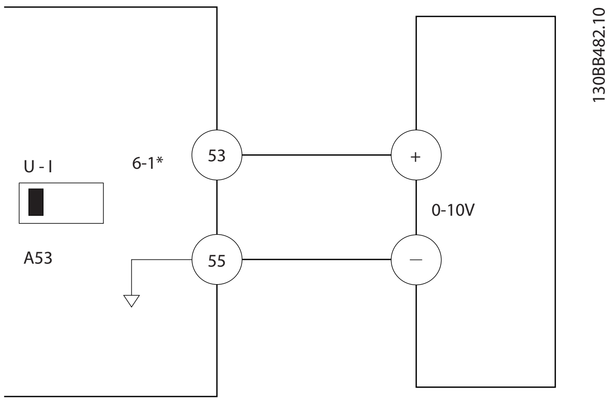


Figure 5.8 Wiring Example for External Device Providing 0–10 V Control Signal (adjustable frequency drive left, external device right)

5.3 Control Terminal Programming Examples

Control terminals can be programmed.

- Each terminal has specified functions it is capable of performing.
- Parameters associated with the terminal enable the function.
- For proper Adjustable frequency drive functioning, the control terminals must be
    - Wired properly
    - Programmed for the intended function
    - Receiving a signal

See *Table 2.4* for control terminal parameter number and default setting. (Default setting can change based on the selection in *0-03 Regional Settings*.)

The following example shows accessing Terminal 18 to see the default setting.

1. Press [Main Menu] twice, scroll to parameter group 5-** *Digital In/Out Parameter Data Set* and press [OK].

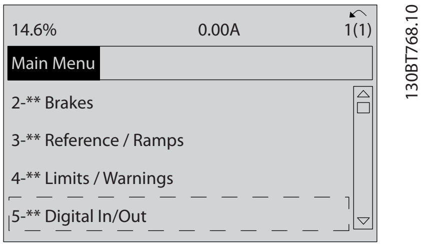


Figure 5.9

2. Scroll to parameter group 5-1* *Digital Inputs* and press [OK].

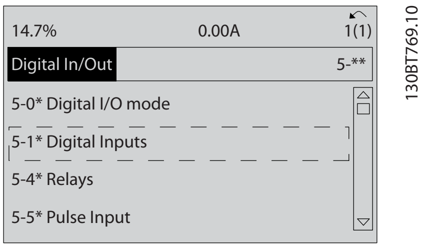


Figure 5.10

3. Scroll to *5-10 Terminal 18 Digital Input*. Press [OK] to access function choices. The default setting *Start* is shown.

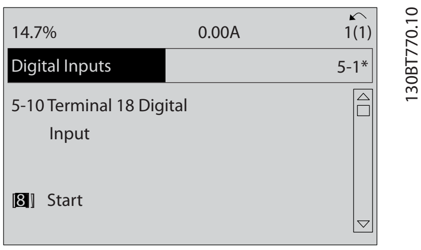


Figure 5.11

5.4 International/North American Default Parameter Settings

Setting *0-03 Regional Settings* to [0]*International* or [1] *North America* changes the default settings for some parameters. *Table 5.1* lists those parameters that are effected.

Parameter	International default parameter value	North American default parameter value
0-03 Regional Settings	International	North America
1-20 Motor Power [kW]	See Note 1	See Note 1
1-21 Motor Power [HP]	See Note 2	See Note 2
1-22 Motor Voltage	230 V/400 V/575 V	208 V/460 V/575 V
1-23 Motor Frequency	50 Hz	60 Hz
3-03 Maximum Reference	50 Hz	60 Hz
3-04 Reference Function	Sum	External/Preset
4-13 Motor Speed High Limit [RPM] See Note 3 and 5	1500 PM	1,800 RPM
4-14 Motor Speed High Limit [Hz] See Note 4	50 Hz	60 Hz
4-19 Max Output Frequency	132 Hz	120 Hz
4-53 Warning Speed High	1,500 RPM	1,800 RPM
5-12 Terminal 27 Digital Input	Coast inverse	External interlock
5-40 Function Relay	No operation	No alarm
6-15 Terminal 53 High Ref./Feedb. Value	50	60
6-50 Terminal 42 Output	No operation	Speed 4-20 mA
14-20 Reset Mode	Manual reset	Infinite auto reset

Table 5.1 International/North American Default Parameter Settings

Note 1: 1-20 Motor Power [kW] is only visible when 0-03 Regional Settings is set to [0] International.

Note 2: 1-21 Motor Power [HP] , is only visible when 0-03 Regional Settings is set to [1] North America.

Note 3: This parameter is only visible when 0-02 Motor Speed Unit is set to [0] RPM.

Note 4: This parameter is only visible when 0-02 Motor Speed Unit is set to [1] Hz.
Note 5: The default value depends on the number of motor poles. For a 4 poled motor the international default value is 1,500 RPM and for a 2 poled motor 3,000 RPM. The corresponding values for North America are 1,800 and 3,600 RPM respectively.

Changes made to default settings are stored and available for viewing in the quick menu along with any programming entered into parameters.

1. Press [Quick Menu].
2. Scroll to Q5 Changes Made and press [OK].

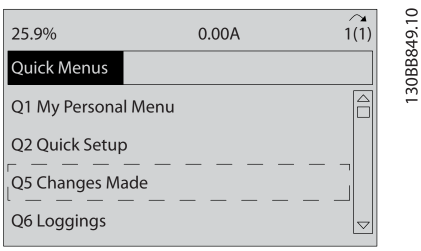


Figure 5.12

3. Select Q5-2 *Since Factory Setting* to view all programming changes or Q5-1 *Last 10 Changes* for the most recent.

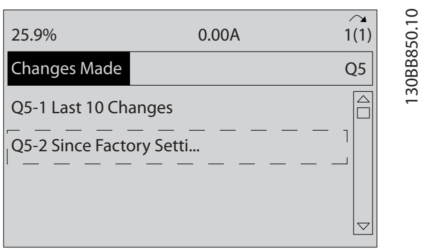


Figure 5.13

5.4.1 Parameter Data Check

1. Press [Quick Menu].
2. Scroll to Q5 Changes Made and press [OK].

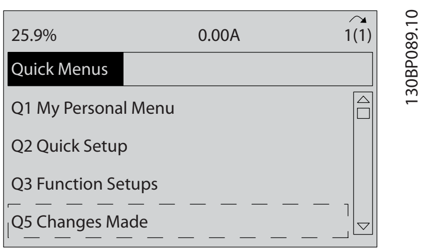


Figure 5.14

3. Select Q5-2 *Since Factory Setting* to view all programming changes or Q5-1 *Last 10 Changes* for the most recent.

5.5 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the Adjustable frequency drive with system details for the Adjustable frequency drive to operate properly. System details may include such things as input and output signal types, programming terminals, minimum and maximum signal ranges, custom displays, automatic restart, and other features.

- See the LCP display to view detailed parameter programming and setting options.
- Press [Info] in any menu location to view additional details for that function.
- Press and hold [Main Menu] to enter a parameter number for direct access to that parameter
- Details for common application set-ups are provided in *6 Application Set-Up Examples*

5.5.1 Quick Menu Structure

Q3-1 General Settings	0-24 Display Line 3 Large	1-00 Configuration Mode	**Q3-31 Single Zone Ext. Setpoint**	20-70 Closed-loop Type
Q3-10 Adv. Motor Settings	0-37 Display Text 1	20-12 Reference/Feedback Unit	1-00 Configuration Mode	20-71 PID Performance
1-90 Motor Thermal Protection	0-38 Display Text 2	20-13 Minimum Reference/Feedb.	20-12 Reference/Feedback Unit	20-72 PID Output Change
1-93 Thermistor Source	0-39 Display Text 3	20-14 Maximum Reference/Feedb.	20-13 Minimum Reference/Feedb.	20-73 Minimum Feedback Level
1-29 Automatic Motor Adaptation (AMA)	*Q3-2 Open-loop Settings*	6-22 Terminal 54 Low Current	20-14 Maximum Reference/Feedb.	20-74 Maximum Feedback Level
14-01 Switching Frequency	**Q3-20 Digital Reference**	6-24 Terminal 54 Low Ref./Feedb. Value	6-10 Terminal 53 Low Voltage	20-79 PID Autotuning
4-53 Warning Speed High	3-02 Minimum Reference	6-25 Terminal 54 High Ref./Feedb. Value	6-11 Terminal 53 High Voltage	**Q3-32 Multi Zone / Adv**
Q3-11 Analog Output	3-03 Maximum Reference	6-26 Terminal 54 Filter Time Constant	6-12 Terminal 53 Low Current	1-00 Configuration Mode
6-50 Terminal 42 Output	3-10 Preset Reference	6-27 Terminal 54 Live Zero	6-13 Terminal 53 High Current	3-15 Reference 1 Source
6-51 Terminal 42 Output Min Scale	5-13 Terminal 29 Digital Input	6-00 Live Zero Timeout Time	6-14 Terminal 53 Low Ref./Feedb. Value	3-16 Reference 2 Source
6-52 Terminal 42 Output Max Scale	5-14 Terminal 32 Digital Input	6-01 Live Zero Timeout Function	6-15 Terminal 53 High Ref./Feedb. Value	20-00 Feedback 1 Source
Q3-12 Clock Settings	5-15 Terminal 33 Digital Input	20-21 Setpoint 1	6-22 Terminal 54 Low Current	20-01 Feedback 1 Conversion
0-70 Date and Time	**Q3-21 Analog Reference**	20-81 PID Normal/ Inverse Control	6-24 Terminal 54 Low Ref./Feedb. Value	20-02 Feedback 1 Source Unit
0-71 Date Format	3-02 Minimum Reference	20-82 PID Start Speed [RPM]	6-25 Terminal 54 High Ref./Feedb. Value	20-03 Feedback 2 Source
0-72 Time Format	3-03 Maximum Reference	20-83 PID Start Speed [Hz]	6-26 Terminal 54 Filter Time Constant	20-04 Feedback 2 Conversion
0-74 DST/Summertime	6-10 Terminal 53 Low Voltage	20-93 PID Proportional Gain	6-27 Terminal 54 Live Zero	20-05 Feedback 2 Source Unit
0-76 DST/Summertime Start	6-11 Terminal 53 High Voltage	20-94 PID Integral Time	6-00 Live Zero Timeout Time	20-06 Feedback 3 Source
0-77 DST/Summertime End	6-12 Terminal 53 Low Current	20-70 Closed-loop Type	6-01 Live Zero Timeout Function	20-07 Feedback 3 Conversion
Q3-13 Display Settings	6-13 Terminal 53 High Current	20-71 PID Performance	20-81 PID Normal/ Inverse Control	20-08 Feedback 3 Source Unit
0-20 Display Line 1.1 Small	6-14 Terminal 53 Low Ref./Feedb. Value	20-72 PID Output Change	20-82 PID Start Speed [RPM]	20-12 Reference/Feedback Unit
0-21 Display Line 1.2 Small	6-15 Terminal 53 High Ref./Feedb. Value	20-73 Minimum Feedback Level	20-83 PID Start Speed [Hz]	20-13 Minimum Reference/Feedb.
0-22 Display Line 1.3 Small	*Q3-3 Closed-loop Settings*	20-74 Maximum Feedback Level	20-93 PID Proportional Gain	20-14 Maximum Reference/Feedb.
0-23 Display Line 2 Large	**Q3-30 Single Zone Int. Setpoint**	20-79 PID Autotuning	20-94 PID Integral Time	6-10 Terminal 53 Low Voltage

Table 5.2

5

6-11 Terminal 53 High Voltage	20-21 Setpoint 1	22-22 Low Speed Detection	22-21 Low Power Detection	22-87 Pressure at No-Flow Speed
6-12 Terminal 53 Low Current	20-22 Setpoint 2	22-23 No-Flow Function	22-22 Low Speed Detection	22-88 Pressure at Rated Speed
6-13 Terminal 53 High Current	20-81 PID Normal/ Inverse Control	*22-24 No-Flow Delay*	22-23 No-Flow Function	22-89 Flow at Design Point
6-14 Terminal 53 Low Ref./Feedb. Value	20-82 PID Start Speed [RPM]	22-40 Minimum Run Time	22-24 No-Flow Delay	22-90 Flow at Rated Speed
6-15 Terminal 53 High Ref./Feedb. Value	20-83 PID Start Speed [Hz]	22-41 Minimum Sleep Time	22-40 Minimum Run Time	1-03 Torque Characteristics
6-16 Terminal 53 Filter Time Constant	20-93 PID Proportional Gain	22-42 Wake-up Speed [RPM]	22-41 Minimum Sleep Time	1-73 Flying Start
6-17 Terminal 53 Live Zero	20-94 PID Integral Time	22-43 Wake-up Speed [Hz]	22-42 Wake-up Speed [RPM]	**Q3-42 Compressor Functions**
6-20 Terminal 54 Low Voltage	20-70 Closed-loop Type	22-44 Wake-up Ref./FB Difference	22-43 Wake-up Speed [Hz]	1-03 Torque Characteristics
6-21 Terminal 54 High Voltage	20-71 PID Performance	22-45 Setpoint Boost	22-44 Wake-up Ref./FB Difference	1-71 Start Delay
6-22 Terminal 54 Low Current	20-72 PID Output Change	22-46 Maximum Boost Time	22-45 Setpoint Boost	22-75 Short Cycle Protection
6-23 Terminal 54 High Current	20-73 Minimum Feedback Level	2-10 Brake Function	22-46 Maximum Boost Time	22-76 Interval between Starts
6-24 Terminal 54 Low Ref./Feedb. Value	20-74 Maximum Feedback Level	2-16 AC Brake Max. Current	22-26 Dry Pump Function	22-77 Minimum Run Time
6-25 Terminal 54 High Ref./Feedb. Value	20-79 PID Autotuning	2-17 Over-voltage Control	22-27 Dry Pump Delay	5-01 Terminal 27 Mode
6-26 Terminal 54 Filter Time Constant	***Q3-4 Application Settings***	1-73 Flying Start	22-80 Flow Compensation	5-02 Terminal 29 Mode
6-27 Terminal 54 Live Zero	**Q3-40 Fan Functions**	1-71 Start Delay	22-81 Square-linear Curve Approxi-mation	5-12 Terminal 27 Digital Input
6-00 Live Zero Timeout Time	22-60 Broken Belt Function	1-80 Function at Stop	22-82 Work Point Calculation	5-13 Terminal 29 Digital Input
6-01 Live Zero Timeout Function	22-61 Broken Belt Torque	2-00 DC Hold/Preheat Current	22-83 Speed at No-Flow [RPM]	5-40 Function Relay
4-56 Warning Feedback Low	22-62 Broken Belt Delay	4-10 Motor Speed Direction	22-84 Speed at No-Flow [Hz]	1-73 Flying Start
4-57 Warning Feedback High	4-64 Semi-Auto Bypass Set-up	**Q3-41 Pump Functions**	22-85 Speed at Design Point [RPM]	1-86 Trip Speed Low [RPM]
20-20 Feedback Function	1-03 Torque Characteristics	22-20 Low Power Auto Set-up	22-86 Speed at Design Point [Hz]	1-87 Trip Speed Low [Hz]

Table 5.3

5.5.2 Main menu structure

0-**	**Operation/Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups / Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1-**	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-03	Torque Characteristics
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage Filter Time Const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-39	Motor Poles
1-40	Back EMF at 1,000 RPM
1-5*	**Load Indep. Setting**
1-50	Motor Magnetization at Zero Speed
1-51	Min Speed Normal Magnetizing [RPM]
1-52	Min Speed Normal Magnetizing [Hz]
1-58	Flystart Test Pulses Current
1-59	Flystart Test Pulses Frequency
1-6*	**Load Depend. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Compressor Start Max Time to Trip
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
2-**	**Brakes**
2-0*	**DC Brake**
2-00	DC Hold/Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut-in Speed [RPM]
2-04	DC Brake Cut-in Speed [Hz]
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
3-**	**Reference / Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp-up Time
3-42	Ramp 1 Ramp-down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp-up Time
3-52	Ramp 2 Ramp-down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-82	Starting Ramp-up Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4-**	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low
4-53	Warning Speed High
4-54	Warning Reference Low
4-55	Warning Reference High
4-56	Warning Feedback Low
4-57	Warning Feedback High
4-58	Missing Motor Phase Function
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
5-**	**Digital In/Out**
5-0*	**Digital I/O mode**
5-00	Digital I/O Mode
5-01	Terminal 27 Mode
5-02	Terminal 29 Mode
5-1*	**Digital Inputs**
5-10	Terminal 18 Digital Input
5-11	Terminal 19 Digital Input
5-12	Terminal 27 Digital Input
5-13	Terminal 29 Digital Input
5-14	Terminal 32 Digital Input
5-15	Terminal 33 Digital Input
5-16	Terminal X30/2 Digital Input
5-17	Terminal X30/3 Digital Input
5-18	Terminal X30/4 Digital Input
5-19	Terminal 37 Safe Stop
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-02	Fire Mode Live Zero Timeout Function
6-1*	**Analog Input 53**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-17	Terminal 53 Live Zero
6-2*	**Analog Input 54**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-27	Terminal 54 Live Zero
6-3*	**Analog Input X30/11**
6-30	Terminal X30/11 Low Voltage
6-31	Terminal X30/11 High Voltage
6-34	Term. X30/11 Low Ref./Feedb. Value
6-35	Term. X30/11 High Ref./Feedb. Value
6-36	Term. X30/11 Filter Time Constant
6-37	Term. X30/11 Live Zero
6-4*	**Analog Input X30/12**
6-40	Terminal X30/12 Low Voltage
6-41	Terminal X30/12 High Voltage
6-44	Term. X30/12 Low Ref./Feedb. Value
6-45	Term. X30/12 High Ref./Feedb. Value
6-46	Term. X30/12 Filter Time Constant
6-47	Term. X30/12 Live Zero
6-5*	**Analog Output 42**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
6-52	Terminal 42 Output Max Scale
6-53	Terminal 42 Output Bus Control

5

6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter
6-6*	**Analog Output X30/8**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
6-62	Terminal X30/8 Max. Scale
6-63	Terminal X30/8 Output Bus Control
6-64	Terminal X30/8 Output Timeout Preset
8-**	**Comm. and Options**
8-0*	**General Settings**
8-01	Control Site
8-02	Control Source
8-03	Control Timeout Time
8-04	Control Timeout Function
8-05	End-of-Timeout Function
8-06	Reset Control Timeout
8-07	Diagnosis Trigger
8-08	Readout Filtering
8-09	Communication Charset
8-1*	**Control Settings**
8-10	Control Profile
8-13	Configurable Status Word STW
8-3*	**FC Port Settings**
8-30	Protocol
8-31	Address
8-32	Baud Rate
8-33	Parity / Stop Bits
8-34	Estimated cycle time
8-35	Minimum Response Delay
8-36	Maximum Response Delay
8-37	Maximum Inter-Char Delay
8-4*	**FC MC protocol set**
8-40	Telegram Selection
8-42	PCD write configuration
8-43	PCD read configuration
8-5*	**Digital/Bus**
8-50	Coasting Select
8-52	DC Brake Select
8-53	Start Select
8-54	Reversing Select
8-55	Set-up Select
8-56	Preset Reference Select
8-7*	**BACnet**
8-70	BACnet Device Instance
8-72	MS/TP Max Masters
8-73	MS/TP Max Info Frames
8-74	"I-Am" Service
8-75	Initialization Password
8-8*	**FC Port Diagnostics**
8-80	Bus Message Count
8-81	Bus Error Count
8-82	Slave Messages Rcvd
8-83	Slave Error Count
8-84	Slave Messages Sent
8-85	Slave Timeout Errors
8-89	Diagnostics Count
8-9*	**Bus Jog / Feedback**
8-90	Bus Jog 1 Speed
8-91	Bus Jog 2 Speed
8-94	Bus Feedback 1
8-95	Bus Feedback 2
8-96	Bus Feedback 3
9-**	**Profibus**
9-00	Setpoint
9-07	Actual Value
9-15	PCD Write Configuration
9-16	PCD Read Configuration
9-18	Node Address
9-22	Telegram Selection
9-23	Parameters for Signals
9-27	Parameter Edit
9-28	Process Control
9-44	Fault Message Counter
9-45	Fault Code
9-47	Fault Number
9-52	Fault Situation Counter
9-53	Profibus Warning Word
9-63	Actual Baud Rate
9-64	Device Identification
9-65	Profile Number
9-67	Control Word 1
9-68	Status Word 1
9-71	Profibus Save Data Values
9-72	ProfibusDriveReset
9-75	DO Identification
9-80	Defined Parameters (1)
9-81	Defined Parameters (2)
9-82	Defined Parameters (3)
9-83	Defined Parameters (4)
9-84	Defined Parameters (5)
9-90	Changed Parameters (1)
9-91	Changed Parameters (2)
9-92	Changed Parameters (3)
9-93	Changed Parameters (4)
9-94	Changed Parameters (5)
9-99	Profibus Revision Counter
10-**	**CAN Fieldbus**
10-0*	**Common Settings**
10-00	CAN Protocol
10-01	Baud Rate Select
10-02	MAC ID
10-05	Readout Transmit Error Counter
10-06	Readout Receive Error Counter
10-07	Readout Bus Off Counter
10-1*	**DeviceNet**
10-10	Process Data Type Selection
10-11	Process Data Config Write
10-12	Process Data Config Read
10-13	Warning Parameter
10-14	Net Reference
10-15	Net Control
10-2*	**COS Filters**
10-20	COS Filter 1
10-21	COS Filter 2
10-22	COS Filter 3
10-23	COS Filter 4
10-3*	**Parameter Access**
10-30	Array Index
10-31	Store Data Values
10-32	Devicenet Revision
10-33	Store Always
10-34	DeviceNet Product Code
10-39	Devicenet F Parameters
11-**	**LonWorks**
11-0*	**LonWorks ID**
11-00	Neuron ID
11-1*	**LON Functions**
11-10	Drive Profile
11-15	LON Warning Word
11-17	XIF Revision
11-18	LonWorks Revision
11-2*	**LON Param. Access**
11-21	Store Data Values
12-**	**Ethernet**
12-0*	**IP Settings**
12-00	IP Address Assignment
12-01	IP Address
12-02	Subnet Mask
12-03	Default Gateway
12-04	DHCP Server
12-05	Lease Expires
12-06	Name Servers
12-07	Domain Name
12-08	Host Name
12-09	Physical Address
12-1*	**Ethernet Link Parameters**
12-10	Link Status
12-11	Link Duration
12-12	Auto Negotiation
12-13	Link Speed
12-14	Link Duplex
12-2*	**Process Data**
12-20	Control Instance
12-21	Process Data Config Write
12-22	Process Data Config Read
12-27	Primary Master
12-28	Store Data Values
12-29	Store Always
12-3*	**EtherNet/IP**
12-30	Warning Parameter
12-31	Net Reference
12-32	Net Control
12-33	CIP Revision
12-34	CIP Product Code
12-35	EDS Parameter
12-37	COS Inhibit Timer
12-38	COS Filter
12-4*	**Modbus TCP**
12-40	Status Parameter
12-41	Slave Message Count
12-42	Slave Exception Message Count
12-8*	**Other Ethernet Services**
12-80	FTP Server
12-81	HTTP Server
12-82	SMTP Service
12-89	Transparent Socket Channel Port
12-9*	**Advanced Ethernet Services**
12-90	Cable Diagnostic
12-91	Auto Cross Over
12-92	IGMP Snooping
12-93	Cable Error Length
12-94	Broadcast Storm Protection
12-95	Broadcast Storm Filter
12-96	Port Config
12-98	Interface Counters
12-99	Media Counters
13-**	**Smart Logic**
13-0*	**SLC Settings**
13-00	SL Controller Mode
13-01	Start Event
13-02	Stop Event
13-03	Reset SLC
13-1*	**Comparators**
13-10	Comparator Operand
13-11	Comparator Operator
13-12	Comparator Value
13-2*	**Timers**
13-20	SL Controller Timer
13-4*	**Logic Rules**
13-40	Logic Rule Boolean 1
13-41	Logic Rule Operator 1
13-42	Logic Rule Boolean 2
13-43	Logic Rule Operator 2
13-44	Logic Rule Boolean 3
13-5*	**States**
13-51	SL Controller Event
13-52	SL Controller Action
14-**	**Special Functions**
14-0*	**Inverter Switching**
14-00	Switching Pattern
14-01	Switching Frequency
14-03	Overmodulation
14-04	PWM Random
14-1*	**Mains On/Off**
14-10	Line Failure
14-11	Mains Voltage at Mains Fault
14-12	Function at Mains Imbalance
14-2*	**Reset Functions**
14-20	Reset Mode
14-21	Automatic Restart Time
14-22	Operation Mode
14-23	Typecode Setting
14-25	Trip Delay at Torque Limit
14-26	Trip Delay at Inverter Fault
14-28	Production Settings
14-29	Service Code
14-3*	**Current Limit Ctrl.**
14-30	Current Lim Ctrl, Proportional Gain
14-31	Current Lim Ctrl, Integration Time
14-32	Current Lim Ctrl, Filter Time
14-4*	**Energy Optimizing**
14-40	VT Level
14-41	AEO Minimum Magnetization
14-42	Minimum AEO Frequency
14-43	Motor Cos Phi
14-5*	**Environment**
14-50	RFI Filter
14-51	DC Link Compensation
14-52	Fan Control
14-53	Fan Monitor
14-55	Output Filter
14-59	Actual Number of Inverter Units
14-6*	**Auto Derate**
14-60	Function at Over Temperature
14-61	Function at Inverter Overload
14-62	Inv. Overload Derate Current
15-**	**Drive Information**
15-0*	**Operating Data**
15-00	Operating Hours
15-01	Running Hours
15-02	kWh Counter
15-03	Power-ups
15-04	Over Temps
15-05	Over Volts
15-06	Reset kWh Counter
15-07	Reset Running Hours Counter
15-08	Number of Starts
15-1*	**Data Log Settings**
15-10	Logging Source
15-11	Logging Interval
15-12	Trigger Event
15-13	Logging Mode
15-14	Samples Before Trigger
15-2*	**Historic Log**
15-20	Historic Log: Event
15-21	Historic Log: Value
15-22	Historic Log: Time
15-23	Historic Log: Date and Time
15-3*	**Alarm Log**
15-30	Alarm Log: Error Code
15-31	Alarm Log: Value
15-32	Alarm Log: Time
15-33	Alarm Log: Date and Time
15-4*	**Drive Identification**
15-40	FC Type
15-41	Power Section
15-42	Voltage
15-43	Software Version
15-44	Ordered Typecode String
15-45	Actual Typecode String
15-46	Adj Freq Dr Ordering No.
15-47	Power Card Ordering No.
15-48	LCP ID Num.
15-49	SW ID Control Card
15-50	SW ID Power Card
15-51	Adj Freq Dr Serial No.
15-53	Power Card Serial Number
15-55	Vendor URL
15-56	Vendor Name
15-59	CSIV Filename
15-6*	**Option Ident**
15-60	Option Mounted
15-61	Option SW Version
15-62	Option Ordering No

15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-74 Option in Slot C0
15-75 Slot C0 Option SW Version
15-76 Option in Slot C1
15-77 Slot C1 Option SW Version
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference [%]
16-03 Status Word
16-05 Main Actual Value [%]
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor Current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-22 Torque [%]
16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Logging Buffer Full
16-43 Timed Actions Status
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
16-56 Feedback 3 [Unit]
16-58 PID Output [%]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Pulse Input #29 [Hz]
16-68 Pulse Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-8* Fieldbus & FC Port
16-80 Serial communication bus CTW 1
16-82 Serial communication bus REF 1
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-96 Maintenance Word
18- Info & Readouts**
18-0* Maintenance Log
18-00 Maintenance Log: Item
18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
18-03 Maintenance Log: Date and Time
18-1* Fire Mode Log
18-10 Fire Mode Log: Event
18-11 Fire Mode Log: Time
18-12 Fire Mode Log: Date and Time
18-3* Inputs & Outputs
18-30 Analog Input X42/1
18-31 Analog Input X42/3
18-32 Analog Input X42/5
18-33 Analog Out X42/7 [V]
18-34 Analog Out X42/9 [V]
18-35 Analog Out X42/11 [V]
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-5* Ref. & Feedb.
18-50 Sensorless Readout [unit]
20- Drive Closed-loop**
20-0* Feedback
20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
20-02 Feedback 1 Source Unit
20-03 Feedback 2 Source
20-04 Feedback 2 Conversion
20-05 Feedback 2 Source Unit
20-06 Feedback 3 Source
20-07 Feedback 3 Conversion
20-08 Feedback 3 Source Unit
20-12 Reference/Feedback Unit
20-13 Minimum Reference/Feedb.
20-14 Maximum Reference/Feedb.
20-2* Feedback/Setpoint
20-20 Feedback Function
20-21 Setpoint 1
20-22 Setpoint 2
20-23 Setpoint 3
20-3* Feedb. Adv. Conv.
20-30 Refrigerant
20-31 User-defined Refrigerant A1
20-32 User-defined Refrigerant A2
20-33 User-defined Refrigerant A3
20-34 Duct 1 Area [m2]
20-35 Duct 1 Area [in2]
20-36 Duct 2 Area [m2]
20-37 Duct 2 Area [in2]
20-38 Air Density Factor [%]
20-6* Sensorless
20-60 Sensorless Unit
20-69 Sensorless Information
20-7* PID Autotuning
20-70 Closed-loop Type
20-71 PID Performance
20-72 PID Output Change
20-73 Minimum Feedback Level
20-74 Maximum Feedback Level
20-79 PID Autotuning
20-8* PID Basic Settings
20-81 PID Normal/ Inverse Control
20-82 PID Start Speed [RPM]
20-83 PID Start Speed [Hz]
20-84 On Reference Bandwidth
20-9* PID Controller
20-91 PID Anti Windup
20-93 PID Proportional Gain
20-94 PID Integral Time
20-95 PID Differentiation Time
20-96 PID Diff. Gain Limit
21- Ext. Closed-Loop**
21-0* Ext. CL Autotuning
21-00 Closed-loop Type
21-01 PID Performance
21-02 PID Output Change
21-03 Minimum Feedback Level
21-04 Maximum Feedback Level
21-09 PID Autotuning
21-1* Ext. CL 1 Ref./Fb.
21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
21-12 Ext. 1 Maximum Reference
21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* Ext. CL 1 PID
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
21-23 Ext. 1 Differentation Time
21-24 Ext. 1 Dif. Gain Limit
21-3* Ext. CL 2 Ref./Fb.
21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
21-34 Ext. 2 Feedback Source
21-35 Ext. 2 Setpoint
21-37 Ext. 2 Reference [Unit]
21-38 Ext. 2 Feedback [Unit]
21-39 Ext. 2 Output [%]
21-4* Ext. CL 2 PID
21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
21-42 Ext. 2 Integral Time
21-43 Ext. 2 Differentation Time
21-44 Ext. 2 Dif. Gain Limit
21-5* Ext. CL 3 Ref./Fb.
21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
21-52 Ext. 3 Maximum Reference
21-53 Ext. 3 Reference Source
21-54 Ext. 3 Feedback Source
21-55 Ext. 3 Setpoint
21-57 Ext. 3 Reference [Unit]
21-58 Ext. 3 Feedback [Unit]
21-59 Ext. 3 Output [%]
21-6* Ext. CL 3 PID
21-60 Ext. 3 Normal/Inverse Control
21-61 Ext. 3 Proportional Gain
21-62 Ext. 3 Integral Time
21-63 Ext. 3 Differentation Time
21-64 Ext. 3 Dif. Gain Limit
22- Appl. Functions**
22-0* Miscellaneous
22-00 External Interlock Delay
22-01 Power Filter Time
22-2* No-Flow Detection
22-20 Low Power Auto Set-up
22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* No-Flow Power Tuning
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
22-35 Low Speed Power [HP]
22-36 High Speed [RPM]
22-37 High Speed [Hz]
22-38 High Speed Power [kW]
22-39 High Speed Power [HP]
22-4* Sleep Mode
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-42 Wake-up Speed [RPM]
22-43 Wake-up Speed [Hz]
22-44 Wake-up Ref./FB Difference
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-5* End of Curve
22-50 End of Curve Function
22-51 End of Curve Delay
22-6* Broken Belt Detection
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay
22-7* Short Cycle Protection
22-75 Short Cycle Protection
22-76 Interval between Starts
22-77 Minimum Run Time
22-78 Minimum Run Time Override
22-79 Minimum Run Time Override Value
22-8* Flow Compensation
22-80 Flow Compensation
22-81 Square-linear Curve Approximation
22-82 Work Point Calculation
22-83 Speed at No-Flow [RPM]
22-84 Speed at No-Flow [Hz]
22-85 Speed at Design Point [RPM]
22-86 Speed at Design Point [Hz]
22-87 Pressure at No-Flow Speed
22-88 Pressure at Rated Speed
22-89 Flow at Design Point
22-90 Flow at Rated Speed
23- Time-based Functions**
23-0* Timed Actions
23-00 ON Time
23-01 ON Action
23-02 OFF Time
23-03 OFF Action
23-04 Occurrence
23-0* Timed Actions Set.
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* Maintenance
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
23-14 Maintenance Date and Time
23-1* Maintenance Reset
23-15 Reset Maintenance Word
23-16 Maintenance Text
23-5* Energy Log
23-50 Energy Log Resolution

5

23-51 Period Start
23-53 Energy Log
23-54 Reset Energy Log
23-6* Trending
23-60 Trend Variable
23-61 Continuous Bin Data
23-62 Timed Bin Data
23-63 Timed Period Start
23-64 Timed Period Stop
23-65 Minimum Bin Value
23-66 Reset Continuous Bin Data
23-67 Reset Timed Bin Data
23-8* Payback Counter
23-80 Power Reference Factor
23-81 Energy Cost
23-82 Investment
23-83 Energy Savings
23-84 Cost Savings
24- Appl. Functions 2**
24-0* Fire Mode
24-00 Fire Mode Function
24-01 Fire Mode Configuration
24-02 Fire Mode Unit
24-03 Fire Mode Min Reference
24-04 Fire Mode Max Reference
24-05 Fire Mode Preset Reference
24-06 Fire Mode Reference Source
24-07 Fire Mode Feedback Source
24-09 Fire Mode Alarm Handling
24-1* Drive Bypass
24-10 Drive Bypass Function
24-11 Drive Bypass Delay Time
24-9* Multi-Motor Funct.
24-90 Missing Motor Function
24-91 Missing Motor Coefficient 1
24-92 Missing Motor Coefficient 2
24-93 Missing Motor Coefficient 3
24-94 Missing Motor Coefficient 4
24-95 Locked Rotor Function
24-96 Locked Rotor Coefficient 1
24-97 Locked Rotor Coefficient 2
24-98 Locked Rotor Coefficient 3
24-99 Locked Rotor Coefficient 4
25- Cascade Controller**
25-0* System Settings
25-00 Cascade Controller
25-02 Motor Start
25-04 Pump Cycling
25-05 Fixed Lead Pump
25-06 Number of Pumps
25-2* Bandwidth Settings
25-20 Staging Bandwidth
25-21 Override Bandwidth
25-22 Fixed Speed Bandwidth
25-23 SBW Staging Delay
25-24 SBW De-staging Delay
25-25 OBW Time
25-26 Destage At No-Flow
25-27 Stage Function
25-28 Stage Function Time
25-29 Destage Function
25-30 Destage Function Time
25-4* Staging Settings
25-40 Ramp-down Delay
25-41 Ramp-up Delay
25-42 Staging Threshold
25-43 De-staging Threshold
25-44 Staging Speed [RPM]
25-45 Staging Speed [Hz]
25-46 De-staging Speed [RPM]
25-47 De-staging Speed [Hz]
25-5* Alternation Settings
25-50 Lead Pump Alternation
25-51 Alternation Event
25-52 Alternation Time Interval
25-53 Alternation Timer Value
25-54 Alternation Predefined Time
25-55 Alternate if Load < 50%
25-56 Staging Mode at Alternation
25-58 Run Next Pump Delay
25-59 Run-on Line Delay
25-8* Status
25-80 Cascade Status
25-81 Pump Status
25-82 Lead Pump
25-83 Relay Status
25-84 Pump ON Time
25-85 Relay ON Time
25-86 Reset Relay Counters
25-9* Service
25-90 Pump Interlock
25-91 Manual Alternation
26- Analog I/O Option**
26-0* Analog I/O Mode
26-00 Terminal X42/1 Mode
26-01 Terminal X42/3 Mode
26-02 Terminal X42/5 Mode
26-1* Analog Input X42/1
26-10 Terminal X42/1 Low Voltage
26-11 Terminal X42/1 High Voltage
26-14 Term. X42/1 Low Ref./Feedb. Value
26-15 Term. X42/1 High Ref./Feedb. Value
26-16 Term. X42/1 Filter Time Constant
26-17 Term. X42/1 Live Zero
26-2* Analog Input X42/3
26-20 Terminal X42/3 Low Voltage
26-21 Terminal X42/3 High Voltage
26-24 Term. X42/3 Low Ref./Feedb. Value
26-25 Term. X42/3 High Ref./Feedb. Value
26-26 Term. X42/3 Filter Time Constant
26-27 Term. X42/3 Live Zero
26-3* Analog Input X42/5
26-30 Terminal X42/5 Low Voltage
26-31 Terminal X42/5 High Voltage
26-34 Term. X42/5 Low Ref./Feedb. Value
26-35 Term. X42/5 High Ref./Feedb. Value
26-36 Term. X42/5 Filter Time Constant
26-37 Term. X42/5 Live Zero
26-4* Analog Out X42/7
26-40 Terminal X42/7 Output
26-41 Terminal X42/7 Min. Scale
26-42 Terminal X42/7 Max. Scale
26-43 Terminal X42/7 Bus Control
26-44 Terminal X42/7 Timeout Preset
26-5* Analog Out X42/9
26-50 Terminal X42/9 Output
26-51 Terminal X42/9 Min. Scale
26-52 Terminal X42/9 Max. Scale
26-53 Terminal X42/9 Bus Control
26-54 Terminal X42/9 Timeout Preset
26-6* Analog Out X42/11
26-60 Terminal X42/11 Output
26-61 Terminal X42/11 Min. Scale
26-62 Terminal X42/11 Max. Scale
26-63 Terminal X42/11 Bus Control
26-64 Terminal X42/11 Timeout Preset
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
35- Sensor Input Option**
35-0* Temp. Input Mode
35-00 Term. X48/4 Temp. Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temp. Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temp. Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
35-47 Term. X48/2 Live Zero
99-* Devel support
99-00 DAC 1 selection
99-01 DAC 2 selection
99-02 DAC 3 selection
99-03 DAC 4 selection
99-04 DAC 1 scale
99-05 DAC 2 scale
99-06 DAC 3 scale
99-07 DAC 4 scale
99-08 Test param 1
99-09 Test param 2
99-10 DAC Option Slot
99-11 RFI 2
99-12 Fan
99-13 Idle time
99-14 Paramdb requests in queue
99-15 Secondary Timer at Inverter Fault
99-16 No. of Current Sensors
99-20 HS Temp. (PC1)
99-21 HS Temp. (PC2)
99-22 HS Temp. (PC3)
99-23 HS Temp. (PC4)
99-24 HS Temp. (PC5)
99-25 HS Temp. (PC6)
99-26 HS Temp. (PC7)
99-27 HS Temp. (PC8)
99-29 Platform Version
99-40 StartupWizardState
99-90 Options present
99-91 Motor Power Internal
99-92 Motor Voltage Internal
99-93 Motor Frequency Internal
99-94 Imbalance derate [%]
99-95 Temperature derate [%]
99-96 Overload derate [%]

5.6 Remote Programming with MCT 10 Set-up Software

Danfoss has a software program available for developing, storing, and transferring Adjustable frequency drive programming. The MCT 10 Set-up Software allows the user to connect a PC to the Adjustable frequency drive and perform live programming rather than using the LCP. Additionally, all Adjustable frequency drive programming can be done offline and simply downloaded to theAdjustable frequency drive. Or the entire Adjustable frequency drive profile can be loaded onto the PC for backup storage or analysis.

The USB connector or RS-485 terminal are available for connecting to the Adjustable frequency drive.

MCT 10 Set-up Software is available for free download at www.VLT-software.com. A CD is also available by requesting part number 130B1000. A user’s manual provides detailed instructions for operation.

6 Application Set-Up Examples

6.1 Introduction

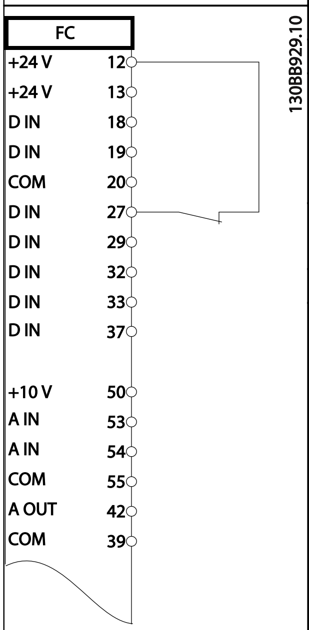
NOTE!

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the adjustable frequency drive to operate when using factory default programming values.

The examples in this section are intended as a quick reference for common applications.

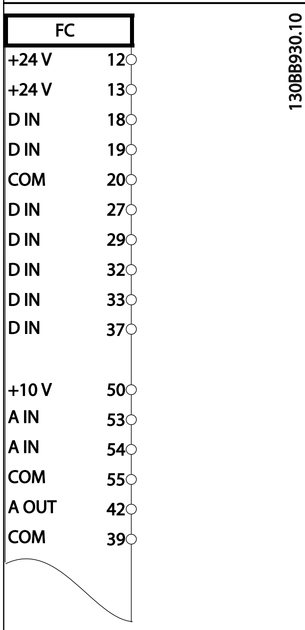
- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these are also shown.

6.2 Application Examples



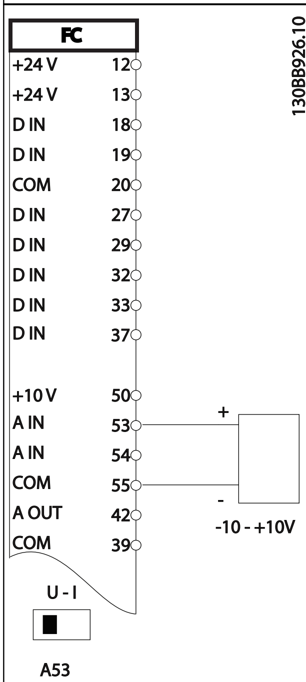
Parameters	
Function	Setting
1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
5-12 Terminal 27 Digital Input	[2]* Coast inverse
* = Default Value	
Notes/comments: Parameter group 1-2* must be set according to motor	

Table 6.1 AMA with T27 Connected



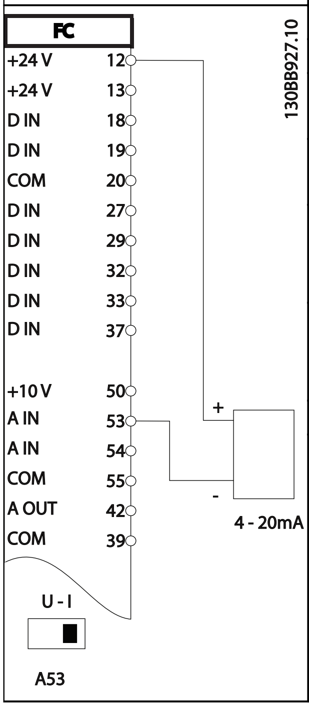
Parameters	
Function	Setting
1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
5-12 Terminal 27 Digital Input	[0] No operation
* = Default Value	
Notes/comments: Parameter group 1-2* must be set according to motor	

Table 6.2 AMA without T27 Connected



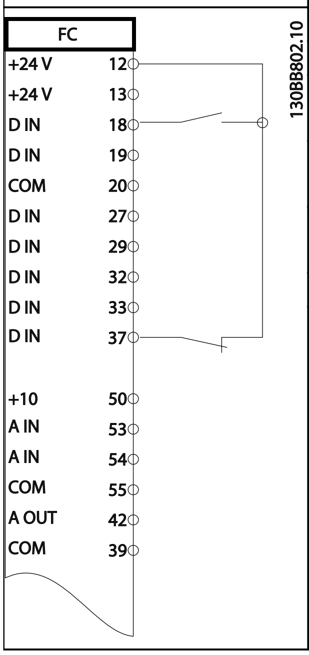
Parameters	
Function	Setting
6-10 Terminal 53 Low Voltage	0.07V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
* = Default Value	
Notes/comments:	

Table 6.3 Analog Speed Reference (Voltage)



Parameters	
Function	Setting
6-12 Terminal 53 Low Current	4mA*
6-13 Terminal 53 High Current	20mA*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
* = Default Value	
Notes/comments:	

Table 6.4 Analog Speed Reference (Current)



Parameters	
Function	Setting
5-10 Terminal 18 Digital Input	[8] Start*
5-12 Terminal 27 Digital Input	[0] No operation
5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
* = Default Value	
Notes/comments: If *5-12 Terminal 27 Digital Input* is set to [0] *No operation*, a jumper wire to terminal 27 is not needed.	

Table 6.5 Start/Stop Command with Safe Stop

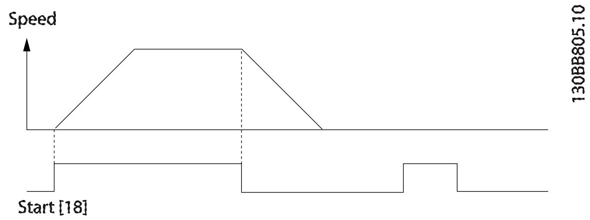
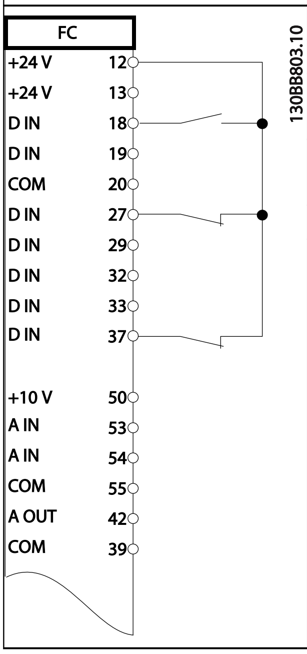


Figure 6.1



Parameters	
Function	Setting
5-10 Terminal 18 Digital Input	[9] Latched Start
5-12 Terminal 27 Digital Input	[6] Stop Inverse
* = Default Value	
Notes/comments: If *5-12 Terminal 27 Digital Input* is set to [0] *No operation*, a jumper wire to terminal 27 is not needed.	

Table 6.6 Pulse Start/Stop

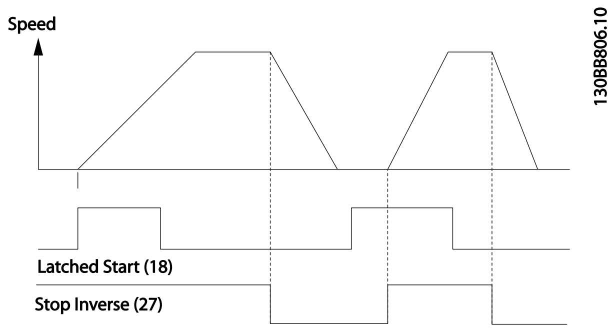
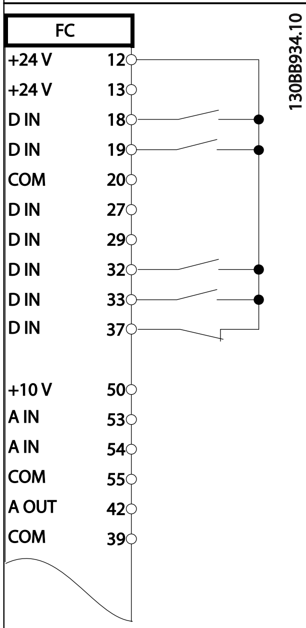
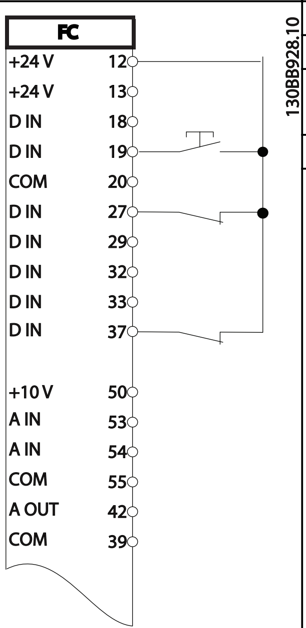


Figure 6.2



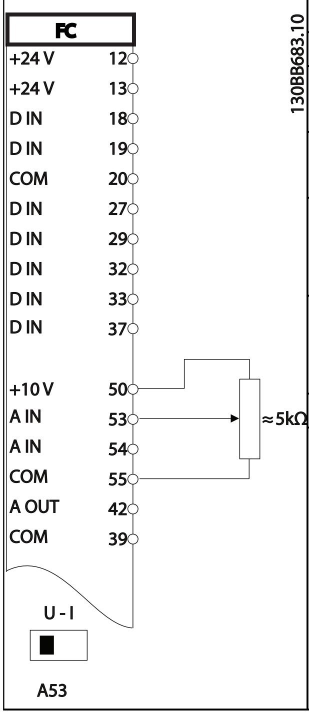
Parameters	
Function	Setting
5-10 Terminal 18 Digital Input	[8] Start
5-11 Terminal 19 Digital Input	[10] Reversing*
5-12 Terminal 27 Digital Input	[0] No operation
5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
3-10 Preset Reference	
Preset ref. 0	25%
Preset ref. 1	50%
Preset ref. 2	75%
Preset ref. 3	100%
* = Default Value	
Notes/comments:	

Table 6.7 Start/Stop with Reversing and Four Preset Speeds



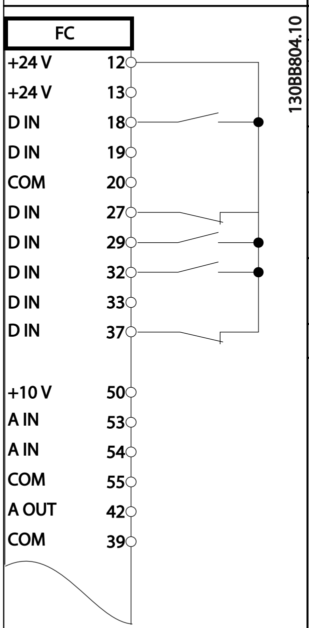
Parameters	
Function	Setting
5-11 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments:	

Table 6.8 External Alarm Reset



Parameters	
Function	Setting
6-10 Terminal 53 Low Voltage	0.07V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
* = Default Value	
Notes/comments:	

Table 6.9 Speed Reference (using a manual potentiometer)



Parameters	
Function	Setting
5-10 Terminal 18 Digital Input	[8] Start*
5-12 Terminal 27 Digital Input	[19] Freeze Reference
5-13 Terminal 29 Digital Input	[21] Speed Up
5-14 Terminal 32 Digital Input	[22] Slow
* = Default Value	
Notes/comments:	

Table 6.10 Speed Up/Down

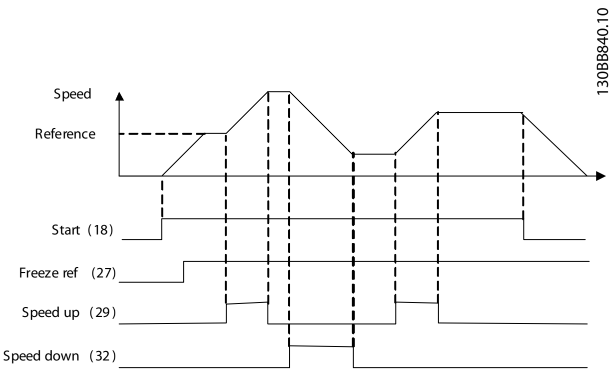
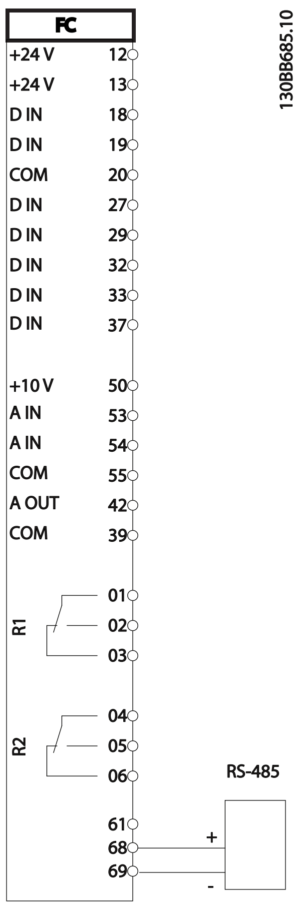


Figure 6.3

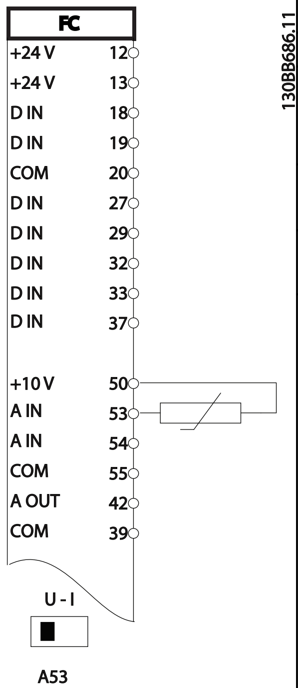


Parameters	
Function	Setting
8-30 Protocol	FC*
8-31 Address	1*
8-32 Baud Rate	9600*
* = Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.11 RS-485 Network Connection

CAUTION

Thermistors must use reinforced or double insulation to meet PELV insulation requirements.



Parameters	
Function	Setting
1-90 Motor Thermal Protection	[2] Thermistor trip
1-93 Thermistor Source	[1] Analog input 53
* = Default Value	
Notes/comments: If only a warning is desired, *1-90 Motor Thermal Protection* should be set to [1] *Thermistor warning*.	

Table 6.12 Motor Thermistor

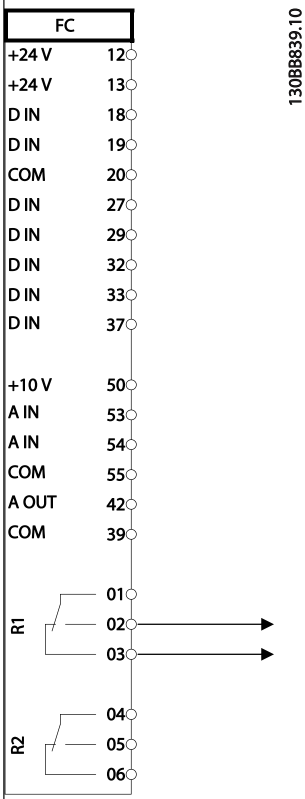
	Parameters	
	Function	**Setting**
	*4-30 Motor Feedback Loss Function*	[1] Warning
	4-31 Motor Feedback Speed Error	100 RPM
	4-32 Motor Feedback Loss Timeout	5 sec
	7-00 Speed PID Feedback Source	[2] MCB 102
	17-11 Resolution (PPR)	1024*
	13-00 SL Controller Mode	[1] On
	13-01 Start Event	[19] Warning
	13-02 Stop Event	[44] Reset key
	13-10 Comparator Operand	[21] Warning no.
	13-11 Comparator Operator	[1] ≈*
	13-12 Comparator Value	90
	13-51 SL Controller Event	[22] Comparator 0
	13-52 SL Controller Action	[32] Set digital out A low
	5-40 Function Relay	[80] SL digital output A
	* = Default Value	
	Notes/comments: If the limit in the feedback monitor is exceeded, Warning 90 will be issued. The SLC monitors Warning 90 and if Warning 90 becomes TRUE, then Relay 1 is triggered. External equipment may then indicate that service may be required. If the feedback error goes below the limit again within 5 sec., then the drive continues and the warning disappears. But Relay 1 will still be triggered until [Reset] on the LCP.	

Table 6.13 Using SLC to Set a Relay

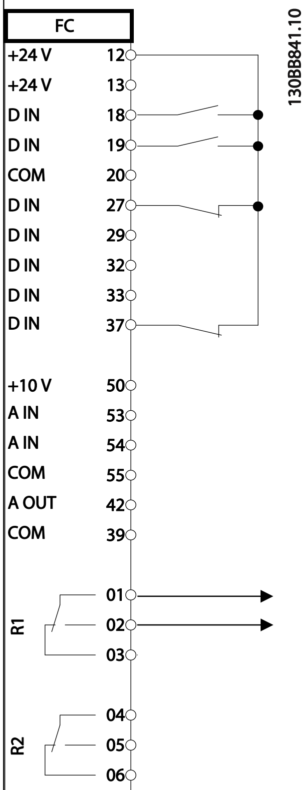
	Parameters	
	Function	**Setting**
	*5-40 Function Relay*	[32] Mech. brake ctrl.
	5-10 Terminal 18 Digital Input	[8] Start*
	5-11 Terminal 19 Digital Input	[11] Start reversing
	1-71 Start Delay	0.2
	1-72 Start Function	[5] VVC^{plus}/ FLUX Clockwise
	1-76 Start Current	Im,n
	2-20 Release Brake Current	App. dependent
	2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
	* = Default Value	
	Notes/comments:	

Table 6.14 Mechanical Brake Control

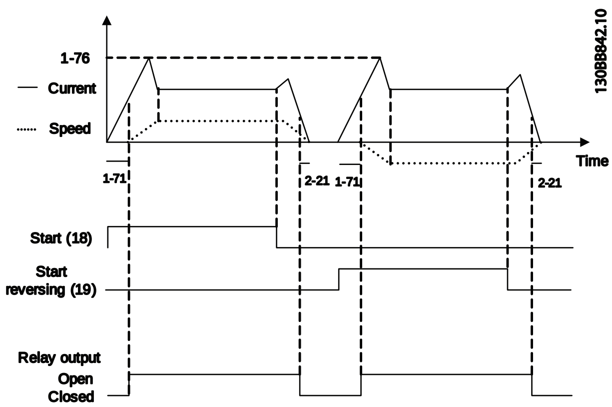


Figure 6.4

7 Status Messages

7.1 Status Display

When the Adjustable frequency drive is in status mode, status messages are generated automatically from within the Adjustable frequency drive and appear in the bottom line of the display (see *Figure 7.1*.)

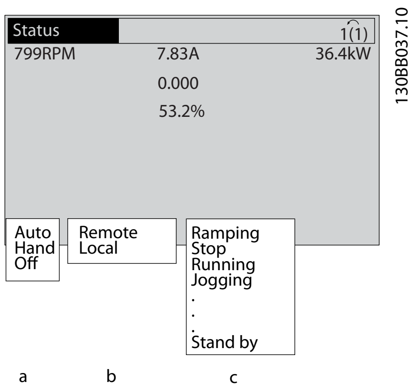


Figure 7.1 Status Display

a. The first word on the status line indicates where the stop/start command originates.

b. The second word on the status line indicates where the speed control originates.

c. The last part of the status line gives the present Adjustable frequency drive status. These show the operational mode the Adjustable frequency drive is in.

NOTE!

In auto/remote mode, the Adjustable frequency drive requires external commands to execute functions.

7.2 Status Message Definitions Table

The next three tables define the meaning of the status message display words.

	Operation Mode
Off	The Adjustable frequency drive does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The Adjustable frequency drive is controlled from the control terminals and/or the serial communication.
Hand On	The Adjustable frequency drive can be controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals can override local control.

Table 7.1

	Reference Site
Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The Adjustable frequency drive uses [Hand On] control or reference values from the LCP.

Table 7.2

	Operation Status
AC Brake	AC Brake was selected in *2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow-down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *2-12 Brake Power Limit (kW)* is reached.
Coast	• Coast inverse was selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is not connected. • Coast activated by serial communication

	Operation Status
Ctrl. Ramp-down	Control Ramp-down was selected in *14-10 Mains Failure*. • The AC line voltage is below the value set in *14-11 Mains Voltage at Mains Fault* at line power fault • The Adjustable frequency drive ramps down the motor using a controlled ramp-down
Current High	The Adjustable frequency drive output current is above the limit set in *4-51 Warning Current High*.
Current Low	The Adjustable frequency drive output current is below the limit set in *4-52 Warning Speed Low*
DC Hold	DC hold is selected in *1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *2-00 DC Hold/ Preheat Current*.
DC Stop	The motor is held with a DC current (*2-01 DC Brake Current*) for a specified time (*2-02 DC Braking Time*). • DC Brake is activated in *2-03 DC Brake Cut-in Speed [RPM]* and a Stop command is active. • DC Brake (inverse) is selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is not active. • The DC Brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *4-56 Warning Feedback Low*.
Freeze output	The remote reference is active which holds the present speed. • Freeze output was selected as a function for a digital input (Group 5-1*). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and slow. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but the motor will remain stopped until a run permissive signal is received.

	Operation Status
Freeze ref.	*Freeze Reference* was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal is active. The Adjustable frequency drive saves the actual reference. Changing the reference is now only possible via terminal functions speed up and slow.
Jog request	A jog command has been given, but the motor will be stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *3-19 Jog Speed [RPM]*. • *Jog* was selected as function for a digital input (parameter group 5-1*). The corresponding terminal (e.g., Terminal 29) is active. • The Jog function is activated via the serial communication. • The Jog function was selected as a reaction for a monitoring function (e.g., No signal). The monitoring function is active.
Motor check	In *1-80 Function at Stop*, *Motor Check* was selected. A stop command is active. To ensure that a motor is connected to the Adjustable frequency drive, a permanent test current is applied to the motor.
Over Voltage Control (OVC)	*Overvoltage* control was activated in *2-17 Over-voltage Control*. The connected motor is supplying the Adjustable frequency drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the Adjustable frequency drive from tripping.
PowerUnit Off	(For adjustable frequency drives with an external 24V power supply installed only.) Line power supply to the Adjustable frequency drive is removed, but the control card is supplied by the external 24V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4kHz. • If possible, protection mode ends after approximately 10sec. • Protection mode can be restricted in *14-26 Trip Delay at Inverter Fault*

	Operation Status
QStop	The motor is decelerating using *3-81 Quick Stop Ramp Time*. • *Quick stop inverse* was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp-up/down. The reference, a limit value or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *4-54 Warning Reference Low*.
Run on ref.	The Adjustable frequency drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The motor is driven by the Adjustable frequency drive.
Sleep Mode	The energy saving function is enabled. This means that at present the motor has stopped, but that it will restart automatically when required.
Speed high	Motor speed is above the value set in *4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *4-52 Warning Speed Low*.
Standby	In Auto On mode, the Adjustable frequency drive will start the motor with a start signal from a digital input or serial communication.
Start delay	In *1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor will start after the start delay time expires.
Start fwd/rev	Start forward and start reverse were selected as functions for two different digital inputs (parameter group 5-1*). The motor will start in forward or reverse depending on which corresponding terminal is activated.
Stop	The Adjustable frequency drive has received a stop command from the LCP, digital input or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the Adjustable frequency drive can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the Adjustable frequency drive. The Adjustable frequency drive can then be reset manually by pressing [Reset] or remotely by control terminals or serial communication.

Table 7.3

7

8 Warnings and Alarms

8.1 System Monitoring

The adjustable frequency drive monitors the condition of its input power, output, and motor factors as well as other system performance indicators. A warning or alarm may not necessarily indicate a problem internal to the adjustable frequency drive itself. In many cases, it indicates failure conditions from input voltage, motor load or temperature, external signals, or other areas monitored by the adjustable frequency drive's internal logic. Be sure to investigate those areas exterior to the adjustable frequency drive as indicated in the alarm or warning.

8.2 Warning and Alarm Types

Warnings
A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the Adjustable frequency drive issuing an alarm. A warning clears by itself when the abnormal condition is removed.

Alarms
Trip
An alarm is issued when the Adjustable frequency drive is tripped, that is, the Adjustable frequency drive suspends operation to prevent Adjustable frequency drive or system damage. The motor will coast to a stop. The Adjustable frequency drive logic will continue to operate and monitor the Adjustable frequency drive status. After the fault condition is remedied, the Adjustable frequency drive can be reset. It will then be ready to start operation again.

A trip can be reset in any of 4 ways:

- Press [RESET] on the LCP
- Digital reset input command
- Serial communication reset input command
- Auto reset

Trip lock
An alarm that causes the Adjustable frequency drive to trip-lock requires that input power be cycled. The motor will coast to a stop. The Adjustable frequency drive logic will continue to operate and monitor the Adjustable frequency drive status. Remove input power to the Adjustable frequency drive and correct the cause of the fault, then restore power. This action puts the Adjustable frequency drive into a trip condition as described above and may be reset in any of those four ways.

8.3 Warning and Alarm Displays

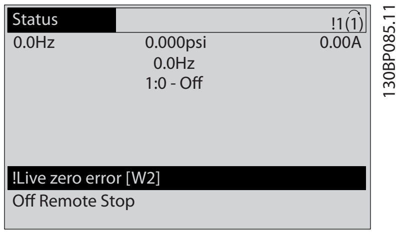


Figure 8.1

An alarm or trip lock alarm will flash on display along with the alarm number.

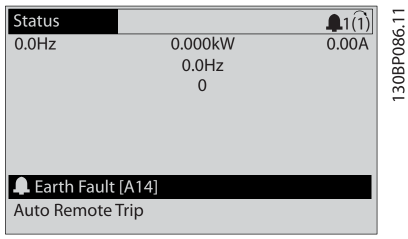


Figure 8.2

In addition to the text and alarm code on the adjustable frequency drive LCP, there are three status indicator lights.

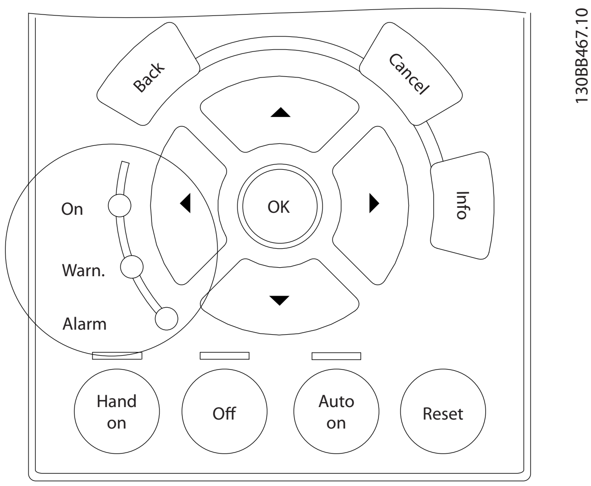


Figure 8.3

	Warn. LED	Alarm LED
Warning	ON	OFF
Alarm	OFF	ON (Flashing)
Trip Lock	ON	ON (Flashing)

Table 8.1

8.4 Warning and Alarm Definitions

Table 8.2 defines whether a warning is issued before an alarm, and whether the alarm trips the unit or trip locks the unit.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01 Live Zero Timeout Function
4	Mains phase loss	(X)	(X)	(X)	14-12 Function at Mains Imbalance
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC overvoltage	X	X		
8	DC undervoltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		1-90 Motor Thermal Protection
11	Motor thermistor over temperature	(X)	(X)		1-90 Motor Thermal Protection
12	Torque limit	X	X		
13	Overcurrent	X	X	X	
14	Ground fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short-circuit		X	X	
17	Control word timeout	(X)	(X)		8-04 Control Timeout Function
18	Start Failed				
23	Internal Fan Fault	X			
24	External Fan Fault	X			14-53 Fan Monitor
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13 Brake Power Monitoring
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15 Brake Check
29	Drive over temperature	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
31	Motor phase V missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
32	Motor phase W missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Out of frequency range	X	X		
36	Mains failure	X	X		
37	Phase Imbalance	X	X		
38	Internal fault		X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			5-00 Digital I/O Mode, 5-01 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			5-00 Digital I/O Mode, 5-02 Terminal 29 Mode
42	Overload of Digital Output On X30/6	(X)			5-32 Term X30/6 Digi Out (MCB 101)
42	Overload of Digital Output On X30/7	(X)			5-33 Term X30/7 Digi Out (MCB 101)
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit	X	(X)		1-86 Trip Speed Low [RPM]
50	AMA calibration failed		X		
51	AMA check Unom and Inom		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA Parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External Interlock	X			
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over Temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 Safe Stop	X	X[1)]		
72	Dangerous Failure			X[1)]	
73	Safe Stop Auto Restart				
76	Power Unit Setup	X			
77	Red. Pwr Mode				
79	Illegal PS config		X	X	
80	Drive Initialized to Default Value		X		
91	Analog input 54 wrong settings			X	
92	No-flow	X	X		22-2*
93	Dry Pump	X	X		22-2*
94	End of Curve	X	X		22-5*
95	Broken Belt	X	X		22-6*
96	Start Delayed	X			22-7*
97	Stop Delayed	X			22-7*
98	Clock Fault	X			0-7*
0.270 [201]	Fire M was Active				
202	Fire M Limits Exceeded				
203	Missing Motor				

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
204	Locked Rotor				
243	Brake IGBT	X	X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare parts			X	
251	New Type Code		X	X	

Table 8.2 Alarm/Warning Code List

(X) Dependent on parameter

1) Cannot be Auto reset via 14-20 Reset Mode

8

The warning/alarm information below defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

WARNING 1, 10 Volts low
The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

This condition can be caused by a short in a connected potentiometer or improper wiring of the potentiometer.

Troubleshooting
Remove the wiring from terminal 50. If the warning clears, the problem is with the customer wiring. If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error
This warning or alarm will only appear if programmed by the user in *6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. This condition can be caused by broken wiring or faulty device sending the signal.

Troubleshooting

Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. MCB 101 terminals 11 and 12 for signals, terminal 10 common. MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).

Check that the Adjustable frequency drive programming and switch settings match the analog signal type.

Perform Input Terminal Signal Test.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the line voltage imbalance is too high. This message also appears for a fault in the input rectifier on the adjustable frequency drive. Options are programmed at *14-12 Function at Mains Imbalance*.

Troubleshooting
Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5, DC link voltage high
The intermediate circuit voltage (DC) is higher than the high voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The intermediate circuit voltage (DC) is lower than the low voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.

Troubleshooting

Connect a brake resistor

Extend the ramp time

Change the ramp type

Activate the functions in *2-10 Brake Function*

Increase *14-26 Trip Delay at Inverter Fault*

WARNING/ALARM 8, DC undervoltage
If the intermediate circuit voltage (DC link) drops below the under voltage limit, the adjustable frequency drive checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the adjustable frequency drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

Make sure that the supply voltage matches the adjustable frequency drive voltage.

Perform input voltage test.

Perform soft charge circuit test.

WARNING/ALARM 9, Inverter overload

The adjustable frequency drive is about to cut out because of an overload (current too high for too long). The counter for electronic, thermal inverter protection gives a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive *cannot* be reset until the counter is below 90%.
The fault is that the adjustable frequency drive is overloaded by more than 100% for too long.

Troubleshooting

Compare the output current shown on the LCP with the adjustable frequency drive rated current.

Compare the output current shown on the LCP with measured motor current.

Display the Thermal Drive Load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter should increase. When running below the adjustable frequency drive continuous current rating, the counter should decrease.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the adjustable frequency drive gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor is overloaded by more than 100% for too long.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

Check that the motor current set in *1-24 Motor Current* is correct.

Ensure that Motor data in parameters 1-20 through 1-25 are set correctly.

If an external fan is in use, check in *1-91 Motor External Fan* that it is selected.

Running AMA in *1-29 Automatic Motor Adaptation (AMA)* tunes the adjustable frequency drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp

The thermistor might be disconnected. Select whether the Adjustable frequency drive gives a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *1-93 Thermistor Source* selects terminal 53 or 54.

When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50. Check *1-93 Thermistor Source* selects terminal 18 or 19.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this from a warning only condition to a warning followed by an alarm.

Troubleshooting

If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.

If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.

If torque limit occurs while running, possibly increase the torque limit. Be sure the system can operate safely at a higher torque.

Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Overcurrent

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the adjustable frequency drive trips and issues an alarm. This fault may be caused by shock loading or fast acceleration with high inertia loads. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

Remove power and check if the motor shaft can be turned.

Make sure that the motor size matches the adjustable frequency drive.

Check parameters 1-20 through 1-25 for correct motor data.

ALARM 14, Ground fault

There is current from the output phases to ground, either in the cable between the Adjustable frequency drive and the motor or in the motor itself.

Troubleshooting:

Remove power to the Adjustable frequency drive and repair the ground fault.

Check for ground faults in the motor by measuring the resistance to ground of the motor leads and the motor with a megohmmeter.

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact your Danfoss supplier:

15-40 FC Type

15-41 Power Section

15-42 Voltage

15-43 Software Version

15-45 Actual Typecode String

15-49 SW ID Control Card

15-50 SW ID Power Card

15-60 Option Mounted

15-61 Option SW Version (for each option slot)

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Remove power to the adjustable frequency drive and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the Adjustable frequency drive.
The warning will only be active when *8-04 Control Word Timeout Function* is NOT set to *OFF*.
If *8-04 Control Word Timeout Function* is set to *Stop* and *Trip*, a warning appears and the Adjustable frequency drive ramps down until it stops then displays an alarm.

Troubleshooting:

Check connections on the serial communication cable.

Increase *8-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify a proper installation based on EMC requirements.

ALARM 18, Start failed
The speed has not been able to exceed *AP-70 Compressor Start Max Speed [RPM]* during start within the allowed time. (set in *AP-72 Compressor Start Max Time to Trip*). This may be caused by a blocked motor.

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* ([0] Disabled).

For the D, E, and F Frame filters, the regulated voltage to the fans is monitored.

Troubleshooting

Check for proper fan operation.

Cycle power to the Adjustable frequency drive and make sure that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* ([0] Disabled).

Troubleshooting

Check for proper fan operation.

Cycle power to the Adjustable frequency drive and make sure that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The adjustable frequency drive is still operational but without the brake function. Remove power to the adjustable frequency drive and replace the brake resistor (see *2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 seconds of run time. The calculation is based on the intermediate circuit voltage and the brake resistance value set in *2-16 AC Brake Max. Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If *Trip* [2] is selected in *2-13 Brake Power Monitoring*, the Adjustable frequency drive will trip when the dissipated braking energy reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and if a short circuit occurs, the brake function is disabled and a warning is issued. The Adjustable frequency drive is still operational but, since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Remove power to the Adjustable frequency drive and remove the brake resistor.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working.
Check *2-15 Brake Check*.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault will not reset until the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the Adjustable frequency drive power size.

Troubleshooting
Check for the following conditions.

Ambient temperature too high.

Motor cable too long.

Incorrect airflow clearance above and below the Adjustable frequency drive

Blocked airflow around the Adjustable frequency drive.

Damaged heatsink fan.

Dirty heatsink.

ALARM 30, Motor phase U missing
Motor phase U between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase U.

ALARM 31, Motor phase V missing
Motor phase V between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase W.

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, communication fault
The serial communication bus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the adjustable frequency drive is lost and *14-10 Mains Failure* is NOT set to [0] *No Function*. Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in the table below is displayed.

Troubleshooting

Cycle power

Check that the option is properly installed

Check for loose or missing wiring

It may be necessary to contact your Danfoss supplier or service department. Note the code number for further troubleshooting directions.

No.	Text
0	Serial port cannot be initialized. Contact your Danfoss supplier or Danfoss Service Department.
256-258	Power EEPROM data is defective or too old
512-519	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your Danfoss supplier or the Danfoss Service Department.
1299	Option SW in slot A is too old
1300	Option SW in slot B is too old
1302	Option SW in slot C1 is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1318	Option SW in slot C1 is not supported (not allowed)
1379-2819	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware
5125	Option in slot C0: Hardware incompatible with control board hardware
5126	Option in slot C1: Hardware incompatible with control board hardware
5376-6231	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.

Table 8.3

ALARM 39, Heatsink sensor
No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

8

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 45, Earth fault 2
Ground fault on start-up.

Troubleshooting

Check for proper grounding and loose connections.

Check for proper wire size.

Check motor cables for short-circuits or leakage currents.

ALARM 46, Power card supply
The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24V, 5V, +/- 18V. When powered with 24V DC with the MCB 107 option, only the 24V and 5V supplies are monitored. When powered with three phase AC line voltage, all three supplies are monitored.

Troubleshooting

Check for a defective power card.

Check for a defective control card.

Check for a defective option card.

If a 24V DC power supply is used, verify proper supply power.

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card. The external 24 V DC backup power supply may be overloaded, otherwise contact your Danfoss supplier.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the adjustable frequency drive shows a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping), the adjustable frequency drive will trip.

ALARM 50, AMA calibration failed
Contact your Danfoss supplier or Danfoss Service Department.

ALARM 51, AMA check Unom and Inom
The settings for motor voltage, motor current, and motor power are wrong. Check the settings in parameters 1-20 to 1-25.

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings.

ALARM 53, AMA motor too big
The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA Parameter out of range
The parameter values of the motor are outside of the acceptable range. AMA will not run.

56 ALARM, AMA interrupted by user
The user has interrupted the AMA.

ALARM 57, AMA internal fault
Try to restart AMA again. Repeated restarts may overheat the motor.

ALARM 58, AMA internal fault
Contact your Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *4-18 Current Limit*. Ensure that Motor data in parameters 1-20 through 1-25 are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock
A digital input signal is indicating a fault condition external to the Adjustable frequency drive. An external interlock has commanded the Adjustable frequency drive to trip. Clear the external fault condition. To resume normal operation, apply 24V DC to the terminal programmed for external interlock. Reset the Adjustable frequency drive.

WARNING 62, Output frequency at maximum limit
The output frequency has reached the value set in *4-19 Max Output Frequency*. Check the application to determine the cause. Possibly increase the output frequency limit. Be sure the system can operate safely at a higher output frequency. The warning will clear when the output drops below the maximum limit.

WARNING/ALARM 65, Control card over temperature
The cutout temperature of the control card is 176° F [80°C].

8

Troubleshooting

- Check that the ambient operating temperature is within limits.
- Check for clogged filters.
- Check fan operation.
- Check the control card.

WARNING 66, Heatsink temperature low
The Adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.
Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the Adjustable frequency drive whenever the motor is stopped by setting *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe stop activated
Loss of the 24V DC signal on terminal 37 has caused the filter to trip. To resume normal operation, apply 24V DC to terminal 37 and reset the filter.

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

Check that the ambient operating temperature is within limits.

Check for clogged filters.

Check fan operation.

Check the power card.

ALARM 70, Illegal adjustable frequency drive configuration
The control card and power card are incompatible. Contact your supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 80, Drive initialized to default value
Parameter settings are initialized to default settings after a manual reset. Reset the unit to clear the alarm.

ALARM 92, No-Flow
A no-flow condition has been detected in the system. *22-23 No-Flow Function* is set for alarm. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

ALARM 93, Dry pump
A no-flow condition in the system with the Adjustable frequency drive operating at high speed may indicate a dry pump. *22-26 Dry Pump Function* is set for alarm. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

ALARM 94, End of curve
Feedback is lower than the setpoint. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *22-60 Broken Belt Function* is set for alarm. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

ALARM 96, Start delayed
Motor start has been delayed due to short-cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

WARNING 97, Stop delayed
Stopping the motor has been delayed due to short cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

WARNING 98, Clock fault
Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 200, Fire mode
This indicates the Adjustable frequency drive is operating in fire mode. The warning clears when fire mode is removed. See the fire mode data in the alarm log.

WARNING 201, Fire Mode was Active
This indicates the Adjustable frequency drive had entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode one or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 203, Missing motor
With a Adjustable frequency drive operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a Adjustable frequency drive operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

WARNING 250, New spare part
A component in the adjustable frequency drive has been replaced. Reset the adjustable frequency drive for normal operation.

WARNING 251, New type code
The power card or other components have been replaced and the type code changed. Reset to remove the warning and resume normal operation.

9 Basic Troubleshooting

9.1 Start-up and Operation

Symptom	Possible Cause	Test	Solution
Display dark / No function	Missing input power	See *Table 3.1*.	Check the input power source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes.	Follow the recommendations provided
	No power to the LCP	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminal 12/13 to 20-39 or 10 V supply for terminal 50 to 55.	Wire the terminals properly.
	Wrong LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM)		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective		Contact supplier.
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the adjustable frequency drive.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.

9

Symptom	Possible Cause	Test	Solution
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No line power with 24 V DC option card	If the display is functioning but no output, check that line power is applied to the adjustable frequency drive.	Apply line power to run the unit.
	LCP Stop	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor.
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check *5-12 Coast inv*. for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *No operation.*
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs.*	Deactivate reversing signal.
	Wrong motor phase connection		See in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *4-13 Motor Speed High Limit [RPM]*, *4-14 Motor Speed High Limit [Hz]* and *4-19 Max Output Frequency*	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in *6-* Analog I/O mode* and parameter group *3-1* References.* Reference limits in parameter group 3-0*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in parameter group *1-6* Analog I/O mode*. For closed-loop operation, check settings in parameter group *20-0* Feedback.*
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor data, 1-3* Adv motor data*, and *1-5* Load indep. setting.*
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times.	Check brake parameters. Check ramp time settings.	Check parameter group *2-0* DC brake* and *3-0* Reference limits.*

Symptom	Possible Cause	Test	Solution
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase for shorts.	Eliminate any shorts detected.
	Motor overload	Motor is overloaded for the application.	Perform start-up test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections.	Tighten loose connections.
Line power current imbalance greater than 3%	Problem with line power (See *Alarm 4 Line phase loss* description)	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check line power supply.
	Problem with the adjustable frequency drive	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the adjustable frequency drives	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Acoustic noise or vibration (e.g., a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g., in the motor/fan system	Bypass critical frequencies by using parameters in parameter group 4-6*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in *14-03 Overmodulation*.	
		Change switching pattern and frequency in parameter group 14-0*.	
		Increase Resonance Dampening in *1-64 Resonance Dampening*.	

Table 9.1

9

10 Specifications

10.1 Power-dependent Specifications

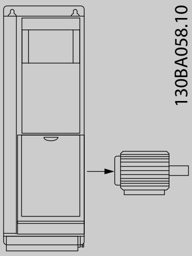
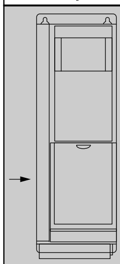
Line power supply 200–240V AC - Normal overload 110% for 1 minute						
Adjustable frequency drive		P1K1	P1K5	P2K2	P3K0	P3K7
Typical Shaft Output [kW]		1.1	1.5	2.2	3	3.7
IP20/Chassis (A2+A3 may be converted to IP21 using a conversion kit. (Please also see *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))		A2	A2	A2	A3	A3
IP55/Type 12		A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X		A4/A5	A4/A5	A4/A5	A5	A5
Typical Shaft Output [HP] at 208 V		1.5	2.0	2.9	4.0	4.9
Output current						
 130BA058.10	Continuous (3 x 200–240V) [A]	6.6	7.5	10.6	12.5	16.7
	Intermittent (3 x 200–240V) [A]	7.3	8.3	11.7	13.8	18.4
	Continuous kVA (208 V AC) [kVA]	2.38	2.70	3.82	4.50	6.00
Max. input current						
 130BA057.10	Continuous (3 x 200–240V) [A]	5.9	6.8	9.5	11.3	15.0
	Intermittent (3 x 200–240V) [A]	6.5	7.5	10.5	12.4	16.5
Additional specifications						
	Estimated power loss at rated max. load [W] [4]	63	82	116	155	185
	Max. cable size (line power, motor, brake) [mm^2 /AWG] [2]			4/10		
	Weight enclosure IP20 [lb][kg]	10.8/4.9	10.8/4.9	10.8/4.9	14.6/6.6	14.6/6.6
	Weight enclosure IP21 [lb][kg]	12.2/5.5	12.2/5.5	12.2/5.5	16.5/7.5	16.5/7.5
	Weight enclosure IP55 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	29.8/13.5	29.8/13.5
	Weight enclosure IPø66 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	29.8/13.5	29.8/13.5
	Efficiency [3]	0.96	0.96	0.96	0.96	0.96

Table 10.1 Line Power Supply 200–240V AC

10

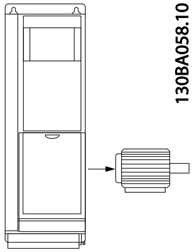
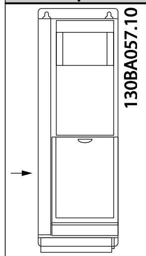
Line Power Supply 3x200–240V AC - Normal overload 110% for 1 minute										
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit. (Please see also items *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))		B3	B3	B3	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		B1	B1	B1	B2	C1	C1	C1	C2	C2
IP55/Type 12		B1	B1	B1	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		B1	B1	B1	B2	C1	C1	C1	C2	C2
Adjustable frequency drive		P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K
Typical Shaft Output [kW]		5.5	7.5	11	15	18.5	22	30	37	45
Typical Shaft Output [HP] at 208 V		7.5	10	15	20	25	30	40	50	60
Output current										
 130BA058.10	Continuous (3 x 200–240V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	115	143	170
	Intermittent (3 x 200–240V) [A]	26.6	33.9	50.8	65.3	82.3	96.8	127	157	187
	Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9	31.7	41.4	51.5	61.2
Max. input current										
 130BA057.10	Continuous (3 x 200–240V) [A]	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0
	Intermittent (3 x 200–240V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0
Additional Specifications										
	Estimated power loss at rated max. load [W] 4)	269	310	447	602	737	845	1140	1353	1636
	Max. cable size (line power, motor, brake) [mm² /AWG] 2)		10/7		35/2		50/1/0 (B4=35/2)		95/4/0	120/250 MCM
	With line power disconnect switch included:		16/6		35/2		35/2		70/3/0	185/ kcmil350
	Weight enclosure IP20 [lb][kg]	26.5/12	26.5/12	26.5/12	51.8/23.5	51.8/23.5	77.2/35	77.2/35	110.2/50	110.2/50
	Weight enclosure IP21 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP55 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP66 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Efficiency 3)	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97

Table 10.2 Line Power Supply 3x200–240V AC

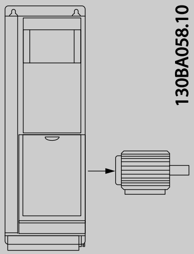
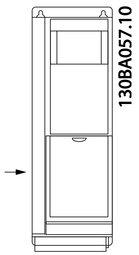
Line Power Supply 3 x 380–480V AC - Normal overload 110% for 1 minute								
Adjustable frequency drive		P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]		1.1	1.5	2.2	3	4	5.5	7.5
Typical Shaft Output [HP] at 460V		1.5	2.0	2.9	4.0	5.0	7.5	10
IP 20 / Chassis (A2+A3 may be converted to IP21 using a conversion kit. (Please see also items *Mechanical mounting* and *IP 21/Type 1 Enclosure kit* in the Design Guide.))		A2	A2	A2	A2	A2	A3	A3
IP 55 / Type 12		A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
IP 66 / NEMA 4X		A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current								
	Continuous (3 x 380–440V) [A]	3	4.1	5.6	7.2	10	13	16
	Intermittent (3 x 380–440V) [A]	3.3	4.5	6.2	7.9	11	14.3	17.6
	Continuous (3 x 441–480V) [A]	2.7	3.4	4.8	6.3	8.2	11	14.5
	Intermittent (3 x 441–480V) [A]	3.0	3.7	5.3	6.9	9.0	12.1	15.4
	Continuous kVA (400V AC) [kVA]	2.1	2.8	3.9	5.0	6.9	9.0	11.0
	Continuous kVA (460V AC) [kVA]	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Max. input current								
	Continuous (3 x 380–440V) [A]	2.7	3.7	5.0	6.5	9.0	11.7	14.4
	Intermittent (3 x 380–440V) [A]	3.0	4.1	5.5	7.2	9.9	12.9	15.8
	Continuous (3 x 441–480V) [A]	2.7	3.1	4.3	5.7	7.4	9.9	13.0
	Intermittent (3 x 441–480V) [A]	3.0	3.4	4.7	6.3	8.1	10.9	14.3
Additional specifications								
	Estimated power loss at rated max. load [W] 4)	58	62	88	116	124	187	255
	(line power, motor, brake) [[mm^2/AWG] 2)	4/10						
	Weight enclosure IP20 [lb][kg]	10.6/4.8	10.8/4.9	10.8/4.9	10.8/4.9	10.8/4.9	14.6/6.6	14.6/6.6
	Weight enclosure IPø21 [lb][kg]							
	Weight enclosure IPø55 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	31.3/14.2	31.3/14.2
	Weight enclosure IPø66 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	31.3/14.2	31.3/14.2
	Efficiency 3)	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 10.3 Line Power Supply 3 x 380–480V AC

10

10

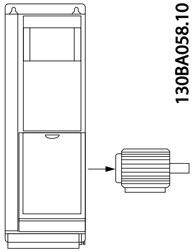
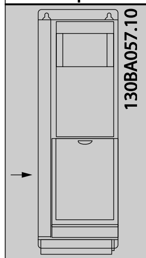
Line Power Supply 3 x 380–480V AC - Normal overload 110% for 1 minute											
Adjustable frequency drive		P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		11	15	18.5	22	30	37	45	55	75	90
Typical Shaft Output [HP] at 460V		15	20	25	30	40	50	60	75	100	125
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss)		B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current											
 130BA058.10	Continuous (3 x 380–439 V) [A]	24	32	37.5	44	61	73	90	106	147	177
	Intermittent (3 x 380–439 V) [A]	26.4	35.2	41.3	48.4	67.1	80.3	99	117	162	195
	Continuous (3 x 440–480V) [A]	21	27	34	40	52	65	80	105	130	160
	Intermittent (3 x 440–480V) [A]	23.1	29.7	37.4	44	61.6	71.5	88	116	143	176
	Continuous kVA (400V AC) [kVA]	16.6	22.2	26	30.5	42.3	50.6	62.4	73.4	102	123
	Continuous kVA 460V AC) [kVA]	16.7	21.5	27.1	31.9	41.4	51.8	63.7	83.7	104	128
Max. input current											
 130BA057.10	Continuous (3 x 380–439 V) [A]	22	29	34	40	55	66	82	96	133	161
	Intermittent (3 x 380–439 V) [A]	24.2	31.9	37.4	44	60.5	72.6	90.2	106	146	177
	Continuous (3 x 440–480V) [A]	19	25	31	36	47	59	73	95	118	145
	Intermittent (3 x 440–480V) [A]	20.9	27.5	34.1	39.6	51.7	64.9	80.3	105	130	160
Additional specifications											
	Estimated power lossat rated max. load [W] 4)	278	392	465	525	698	739	843	1083	1384	1474
	Max. cable size (line power, motor, brake) [mm²/ AWG] 2)		10/7			35/2		50/1/0 (B4=35/2)		95/ 4/0	120/ MCM250
	With line power disconnect switch included:			16/6			35/2	35/2		70/3/0	185/ kcmil350
	Weight enclosure IP20 [lb][kg]	26.5/12	26.5/12	26.5/12	51.8/23.5	51.8/23.5	51.8/23.5	77.2/35	77.2/35	110.2/50	110.2/50
	Weight enclosure IP21 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP55 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP66 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Efficiency 3)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99

Table 10.4 Line Power Supply 3 x 380–480V AC

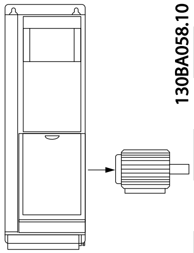
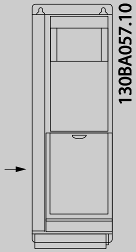
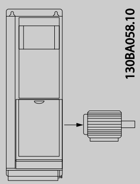
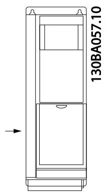
Line power supply 3 x 525–600V ACNormal overload 110% for 1 minute																			
Size:		P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		1.1	1.5	2.2	3	3.7	4	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
IP20/Chassis		A3	A3	A3	A3	A2	A3	A3	A3	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		A3	A3	A3	A3	A2	A3	A3	A3	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12		A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current																			
 130BA058.10	Continuous (3 x 525–550V) [A]	2.6	2.9	4.1	5.2	-	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
	Intermittent (3 x 525–550V) [A]	2.9	3.2	4.5	5.7	-	7.0	10.5	12.7	21	25	31	40	47	59	72	96	116	151
	Continuous (3 x 525–600V) [A]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	18	22	27	34	41	52	62	83	100	131
	Intermittent (3 x 525–600V) [A]	2.6	3.0	4.3	5.4	-	6.7	9.9	12.1	20	24	30	37	45	57	68	91	110	144
	Continuous kVA (525V AC) [kVA]	2.5	2.8	3.9	5.0	-	6.1	9.0	11.0	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
	Continuous kVA (575V AC) [kVA]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	17.9	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. input current																			
 130BA057.10	Continuous (3 x 525–600V) [A]	2.4	2.7	4.1	5.2	-	5.8	8.6	10.4	17.2	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
	Intermittent (3 x 525–600V) [A]	2.7	3.0	4.5	5.7	-	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
Additional specifications																			
	Estim. power loss at rated max. load [W] 4)	50	65	92	122	-	145	195	261	300	400	475	525	700	750	850	1100	1400	1500
	Max. cable size, IP21/55/66 (line power, motor, brake) [mm²]/[AWG] 2)	4/10								10/7			25/4		50/1/0			95/4/0	120/ MCM250
	Max. cable size, IP 20 (line power, motor, brake) [mm²]/[AWG] 2)	4/10								16/6			35/2		50/1/0			95/4/0	150/ MCM250 5)
	Line power disconnect switch included:	4/10								16/6					35/2			70/3/0	185/ kcmil350
	Weight IP20 [lb][kg]	14.3/ 6.5	14.3/ 6.5	14.3/ 6.5	14.3/ 6.5	-	14.3/6. 5	14.6/6 .6	14.6/ 6.6	26.5/1 2	26.5/12	26.5/1 2	51.8/23 .5	51.8/23. 5	51.8/ 23.5	77.2/35	77.2/3 5	110.2/50	110.2/50
	Weight IP21/55 [lb] [kg]	29.8/ 13.5	29.8/ 13.5	29.8/ 13.5	29.8/ 13.5	29.8/1 3.5	29.8/13 .5	31.3/1 4.2	31.3/ 14.2	50.7/2 3	50.7/23	50.7/2 3	59.5/27	59.5/27	59.5/ 27	99.2/45	99.2/4 5	143.3/65	143.3/65
	Efficiency 4)	0.97	0.97	0.97	0.97	-	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 10.5 5) With brake and load sharing 95/ 4/0

10.1.1 Line Power Supply 3 x 525–690V AC

		Normal overload 110% for 1 minute									
Size:		P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		11	15	18.5	22	30	37	45	55	75	90
Typical Shaft Output [HP] at 575V		10	16.4	20.1	24	33	40	50	60	75	100
IP21 / NEMA 1		B2	B2	B2	B2	B2	C2	C2	C2	C2	C2
IP55 / NEMA 12		B2	B2	B2	B2	B2	C2	C2	C2	C2	C2
Output current											
	Continuous (3 x 525–550 V) [A]	14	19	23	28	36	43	54	65	87	105
	Intermittent (3 x 525–550 V) [A]	15.4	20.9	25.3	30.8	39.6	47.3	59.4	71.5	95.7	115.5
	Continuous (3 x 551–690 V) [A]	13	18	22	27	34	41	52	62	83	100
	Intermittent (3 x 551–690V) [A]	14.3	19.8	24.2	29.7	37.4	45.1	57.2	68.2	91.3	110
	Continuous kVA (550V AC) [kVA]	13.3	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100
	Continuous kVA (575V AC) [kVA]	12.9	17.9	21.9	26.9	33.8	40.8	51.8	61.7	82.7	99.6
	Continuous kVA (690V AC) [kVA]	15.5	21.5	26.3	32.3	40.6	49	62.1	74.1	99.2	119.5
	Max. cable size (line power, motor, brake) [mm²]/[AWG] [2]			35 1/0					95 4/0		
Max. input current											
	Continuous (3 x 525–690 V) [A]	15	19.5	24	29	36	49	59	71	87	99
	Intermittent (3 x 525–690V) [A]	16.5	21.5	26.4	31.9	39.6	53.9	64.9	78.1	95.7	108.9
	Max. pre-fuses[1] [A]	63	63	63	63	80	100	125	160	160	160
	Environment:										
	Estimated power loss at rated max. load [W, hp] [4]	201, 0.27	285, 0.38	335, 0.45	375, 0.50	430, 0.58	592, 0.79	720, 0.97	880, 1.18	1200, 1.61	1440, 1.93
	Weight:										
	IP21 (lb [kg])	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]
	IP55 (lb [kg])	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]
	Efficiency [4]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

1) For type of fuse see
2) American Wire Gauge
3) Measured using 16 ft [5 m] shielded motor cables at rated load and rated frequency
4) The typical power loss is at normal load conditions and expected to be within +/- 15% (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the Adjustable frequency drive and vice versa.
If the switching frequency is raised from nominal, the power losses may rise significantly.
LCP and typical control card power consumptions are included. Further options and customer load may add up to 0.04 hp [30 Watts] to the losses. (Though typically only 0.005 hp [4 Watts] extra for a fully loaded control card or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/- 5%).
5) Motor and line cable: 300MCM/150mm²

Table 10.6 Line Power Supply 3 x 525–690V AC

10.2 General Technical Data

Line power supply (L1, L2, L3):

Supply voltage	200–240V ±10%, 380–480V ±10%, 525–690V ±10%

AC line voltage low / line drop-out:
During low AC line voltage or a line drop-out, the adjustable frequency drive continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the adjustable frequency lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the adjustable frequency lowest rated supply voltage.

Supply frequency	50/60Hz ±5%
Max. imbalance temporary between line phases	3.0% of rated supply voltage
True Power Factor ()	≥ 0.9 nominal at rated load
Displacement Power Factor (cos) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ enclosure type A	maximum twice/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ enclosure type B, C	maximum once/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ enclosure type D, E, F	maximum once/2 min.
Environment according to EN60664-1	overvoltage category III / pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 480/600V maximum.

Motor output (U, V, W):

Output voltage	0–100% of supply voltage
Output frequency	0–1000 Hz*
Switching on output	Unlimited
Ramp times	1–3600 sec.

** Dependent on power size.*

Torque characteristics:

Starting torque (Constant torque)	maximum 110% for 1 min.*
Starting torque	maximum 135% up to 0.5 sec.*
Overload torque (Constant torque)	maximum 110% for 1 min.*

**Percentage relates to the adjustable frequency drive's nominal torque.*

Cable lengths and cross-sections:

Max. motor cable length, shielded/armored	VLT® HVAC Drive: 492 ft [150 m]
Max. motor cable length, unshielded/unarmored	VLT® HVAC Drive: 984 ft [300 m]
Max. cross-section to motor, line power, load sharing and brake *	
Maximum cross-section to control terminals, rigid wire	0.0023 in^2 [1.5 mm^2]/16 AWG (2 x 0.00112^2 in [0.75 mm^2])
Maximum cross-section to control terminals, flexible cable	0.0016 in^2 [1 mm^2]/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.0008 in^2 [0.5 mm^2]/20 AWG
Minimum cross-section to control terminals	0.039 in2 [0.25 mm2]

** See 10.1 Power-dependent Specifications for more information!*

Digital inputs:

Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 [1)], 29 [1)], 32, 33,
Logic	PNP or NPN
Voltage level	0–24V DC
Voltage level, logic'0' PNP	< 5V DC
Voltage level, logic'1' PNP	> 10V DC
Voltage level, logic '0' NPN	> 19 V DC
Voltage level, logic '1' NPN	< 14V DC
Maximum voltage on input	28V DC

Input resistance, R_i	approx. 4kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as output.

Analog inputs:

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switches A53 and A54
Voltage mode	Switch A53/A54 = (U)
Voltage level	0 to + 10V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	± 20 V
Current mode	Switch A53/A54 = (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	200Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

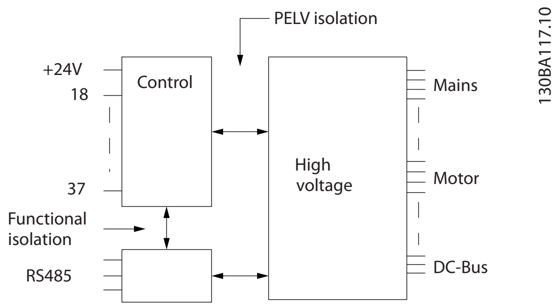


Figure 10.1

Pulse inputs:

Programmable pulse inputs	2
Terminal number pulse	29, 33
Max. frequency at terminal, 29, 33	110 kHz (push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see section on Digital input
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Max. error: 0.1% of full scale

Analog output:

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 - 20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8% of full scale
Resolution on analog output	8 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS-485 serial communication:

Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output:

Programmable digital/pulse outputs	2
Terminal number	27, 29 1)
Voltage level at digital/frequency output	0–24 V
Max. output current (sink or source)	40 mA
Max. load at frequency output	1 kΩ
Max. capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Max. error: 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output:

Terminal number	12, 13
Max. load	200mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs:

Programmable relay outputs	2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)1) on 1-3 (NC), 1-2 (NO) (Resistive load)	240V AC, 2A
Max. terminal load (AC-15)1) (Inductive load @ cosφ 0.4)	240V AC, 0.2A
Max. terminal load (DC-1)1) on 1-2 (NO), 1-3 (NC) (Resistive load)	60V DC, 1A
Max. terminal load (DC-13)1) (Inductive load)	24V DC, 0.1A
Relay 02 Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)1) on 4-5 (NO) (Resistive load)2)3)	400V AC, 2A
Max. terminal load (AC-15)1) on 4-5 (NO) (Inductive load @ cosφ 0.4)	240V AC, 0.2A
Max. terminal load (DC-1)1) on 4-5 (NO) (Resistive load)	80V DC, 2A
Max. terminal load (DC-13)1) on 4-5 (NO) (Inductive load)	24V DC, 0.1A
Max. terminal load (AC-1)1) on 4-6 (NC) (Resistive load)	240V AC, 2A
Max. terminal load (AC-15)1) on 4-6 (NC) (Inductive load @ cosφ 0.4)	240V AC, 0.2A
Max. terminal load (DC-1)1) on 4-6 (NC) (Resistive load)	50V DC, 2A
Max. terminal load (DC-13)1) on 4-6 (NC) (Inductive load)	24V DC, 0.1A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24V DC 10mA, 24V AC 2 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

1) IEC 60947 t 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
2) Overvoltage Category II
3) UL applications 300V AC 2A

Control card, 10 V DC output:

Terminal number	50
Output voltage	10.5 V ±0.5 V
Max. load	25 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

10

Control characteristics:	
Resolution of output frequency at 0–1000 Hz	+/- 0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open-loop)	1:100 of synchronous speed
Speed accuracy (open-loop)	30–4000 rpm: Maximum error of ±8 rpm

All control characteristics are based on a 4-pole asynchronous motor

Surroundings:	
Enclosure type A	IP 20/Chassis, IP 21kit/Type 1, IP55/Type12, IP 66/Type12
Enclosure type B1/B2	IP 21/Type 1, IP55/Type12, IP 66/12
Enclosure type B3/B4	IP20/Chassis
Enclosure type C1/C2	IP 21/Type 1, IP55/Type 12, IP66/12
Enclosure type C3/C4	IP20/Chassis
Enclosure type D1/D2/E1	IP21/Type 1, IP54/Type12
Enclosure type D3/D4/E2	IP00/Chassis
Enclosure type F1/F3	IP21, 54/Type1, 12
Enclosure type F2/F4	IP21, 54/Type1, 12
Enclosure kit available ≤ enclosure type D	IP21/NEMA 1/IP 4_X on top of enclosure
Vibration test all enclosure types	1.0g
Relative humidity	5–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	max. 131°F [55°C][1)]
- with full output power of typical EFF2 motors (up to 90% output current)	max. 122°F [50°C][1)]
- at full continuous FC output current	max. 113°F [45°C][1)]

[1)] *For more information on derating see the Design Guide, section on Special Conditions.*

Minimum ambient temperature during full-scale operation	32°F [0°C]
Minimum ambient temperature at reduced performance	14°F [- [-10°C]
Temperature during storage/transport	-13°–+149°/158°F [-25°–+65°/70°°C]
Maximum altitude above sea level without derating	3281 ft [1000 m]
Maximum altitude above sea level with derating	9843 ft [3000 m]

Derating for high altitude, see section on special conditions

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, Immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

See section on special conditions!

Control card performance:	
Scan interval	5 ms

Control Card, USB Serial Communication:	
USB standard	1.1 (Full speed)
USB plug	USB type B “device” plug

⚠CAUTION

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB connection is not galvanically isolated from protection ground. Use only isolated laptop/PC as connection to the USB connector on Adjustable frequency drive or an isolated USB cable/drive.

10

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the Adjustable frequency drive trips if the temperature reaches 203°F ± 9°F [95°C ± 5°C]. An overload temperature cannot be reset until the temperature of the heatsink is below 158°F ± 9°F [70°C ± 5°C] (Guideline - these temperatures may vary for different power sizes, enclosures, etc.). The Adjustable frequency drive has an auto derating function to avoid it's heatsink reaching 203°F [95°C].
- The Adjustable frequency drive is protected against short-circuits on motor terminals U, V, W.
- If a line phase is missing, the Adjustable frequency drive trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the Adjustable frequency drive trips if the intermediate circuit voltage is too low or too high.
- The Adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

10.3 Fuse Tables

10.3.1 Branch Circuit Protection Fuses

For compliance with IEC/EN 61800-5-1 electrical standards, the following fuses are recommended.

Adjustable frequency drive	Maximum fuse size	Voltage	Type
200–240 V - T2			
1K1-1K5	16A[1]	200–240	type gG
2K2	25A[1]	200–240	type gG
3K0	25A[1]	200–240	type gG
3K7	35A[1]	200–240	type gG
5K5	50A[1]	200–240	type gG
7K5	63A[1]	200–240	type gG
11K	63A[1]	200–240	type gG
15K	80A[1]	200–240	type gG
18K5	125A[1]	200–240	type gG
22K	125A[1]	200–240	type gG
30K	160A[1]	200–240	type gG
37K	200A[1]	200–240	type aR
45K	250A[1]	200–240	type aR
380–480 V - T4			
1K1-1K5	10A[1]	380–500	type gG
2K2-3K0	16A[1]	380–500	type gG
4K0-5K5	25A[1]	380–500	type gG
7K5	35A[1]	380–500	type gG
11K–15K	63A[1]	380–500	type gG
18K	63A[1]	380–500	type gG
22K	63A[1]	380–500	type gG
30K	80A[1]	380–500	type gG
37K	100A[1]	380–500	type gG
45K	125A[1]	380–500	type gG
55K	160A[1]	380–500	type gG
75K	250A[1]	380–500	type aR
90K	250A[1]	380–500	type aR
1) Max. fuses - see national/international regulations for selecting an applicable fuse size.			

Table 10.7 EN50178 fuses 200 V to 480 V

10.3.2 UL and cUL Branch Circuit Protection Fuses

For compliance with UL and cUL electrical standards, the following fuses or UL/cUL approved substitutions are required. Maximum fuse ratings are listed.

Adjustable frequency drive	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
200-240 V							
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
K25-K37	KTN-R05	JKS-05	JJN-05	5017906-005	KLN-R005	ATM-R05	A2K-05R
K55-1K1	KTN-R10	JKS-10	JJN-10	5017906-010	KLN-R10	ATM-R10	A2K-10R
1K5	KTN-R15	JKS-15	JJN-15	5017906-015	KLN-R15	ATM-R15	A2K-15R
2K2	KTN-R20	JKS-20	JJN-20	5012406-020	KLN-R20	ATM-R20	A2K-20R
3K0	KTN-R25	JKS-25	JJN-25	5012406-025	KLN-R25	ATM-R25	A2K-25R
3K7	KTN-R30	JKS-30	JJN-30	5012406-030	KLN-R30	ATM-R30	A2K-30R
5K5	KTN-R50	JKS-50	JJN-50	5012406-050	KLN-R50	-	A2K-50R
7K5	KTN-R50	JKS-60	JJN-60	5012406-050	KLN-R60	-	A2K-50R
11K	KTN-R60	JKS-60	JJN-60	5014006-063	KLN-R60	A2K-60R	A2K-60R
15K	KTN-R80	JKS-80	JJN-80	5014006-080	KLN-R80	A2K-80R	A2K-80R
18K5	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
22K	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
30K	FWX-150	-	-	2028220-150	L25S-150	A25X-150	A25X-150
37K	FWX-200	-	-	2028220-200	L25S-200	A25X-200	A25X-200
45K	FWX-250	-	-	2028220-250	L25S-250	A25X-250	A25X-250
380–480 V, 525–600 V							
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
K37-1K1	KTS-R6	JKS-6	JJS-6	5017906-006	KLS-R6	ATM-R6	A6K-6R
1K5-2K2	KTS-R10	JKS-10	JJS-10	5017906-010	KLS-R10	ATM-R10	A6K-10R
3K0	KTS-R15	JKS-15	JJS-15	5017906-016	KLS-R16	ATM-R16	A6K-16R
4K0	KTS-R20	JKS-20	JJS-20	5017906-020	KLS-R20	ATM-R20	A6K-20R
5K5	KTS-R25	JKS-25	JJS-25	5017906-025	KLS-R25	ATM-R25	A6K-25R
7K5	KTS-R30	JKS-30	JJS-30	5012406-032	KLS-R30	ATM-R30	A6K-30R
11K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
15K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
18K	KTS-R50	JKS-50	JJS-50	5014006-050	KLS-R50	-	A6K-50R
22K	KTS-R60	JKS-60	JJS-60	5014006-063	KLS-R60	-	A6K-60R
30K	KTS-R80	JKS-80	JJS-80	2028220-100	KLS-R80	-	A6K-80R
37K	KTS-R100	JKS-100	JJS-100	2028220-125	KLS-R100		A6K-100R
45K	KTS-R125	JKS-150	JJS-150	2028220-125	KLS-R125		A6K-125R
55K	KTS-R150	JKS-150	JJS-150	2028220-160	KLS-R150		A6K-150R
75K	FWH-220	-	-	2028220-200	L50S-225		A50-P225
90K	FWH-250	-	-	2028220-250	L50S-250		A50-P250

Table 10.8 UL fuses, 200–240 V and 380–600 V

10

10.3.3 Substitute Fuses for 240 V

Original fuse	Manufacturer	Substitute fuses
KTN	Bussmann	KTS
FWX	Bussmann	FWH
KLNR	LITTEL FUSE	KLSR
L50S	LITTEL FUSE	L50S
A2KR	FERRAZ SHAWMUT	A6KR
A25X	FERRAZ SHAWMUT	A50X

Table 10.9

10.4 Connection Tightening Torques

	Power (kW)				Torque (Nm)					
Enclo-sure	200–240V	380–480V	525–600V	525–690V	Line power	Motor	DC connection	Brake	Ground	Relay
A2	1.1 - 3.0	1.1 - 4.0	1.1 - 4.0		1.8	1.8	1.8	1.8	3	0.6
A3	3.7	5.5–7.5	5.5–7.5		1.8	1.8	1.8	1.8	3	0.6
A4	1.1–2.2	1.1–4.0			1.8	1.8	1.8	1.8	3	0.6
A5	1.1–3.7	1.1–7.5	1.1–7.5		1.8	1.8	1.8	1.8	3	0.6
B1	5.5–11	11–18.5	11–18.5	-	1.8	1.8	1.5	1.5	3	0.6
B2	- 15	22 30	22 30	11 30	4.5 4.5 2)	4.5 4.5 2)	3.7 3.7	3.7 3.7	3 3	0.6 0.6
B3	5.5–11	11–18.5	11–18.5	-	1.8	1.8	1.8	1.8	3	0.6
B4	15–18.5	22–37	22–37	-	4.5	4.5	4.5	4.5	3	0.6
C1	18.5–30	37–55	37–55	-	10	10	10	10	3	0.6
C2	37–45	75–90	75–90	30 90	14/24 1)	14/24 1)	14	14	3	0.6
C3	22–30	45–55	45–55	-	10	10	10	10	3	0.6
C4	37–45	75–90	75–90	-	14/24 1)	14/24 1)	14	14	3	0.6

Table 10.10 Tightening of Terminals

1) For different cable dimensions x/y, where x ≤ 0.147 in² [95 mm²] and y ≥ 0.147 in² [95 mm²].

2) Cable dimensions above 25 hp [18.5 kW] ≥ 0.0543 in² [35 mm²] and below 30 hp [22 kW] ≤ ≤ 0.0155 in² [10 mm²].

Index

www.danfoss.com/drives

Danfoss Drives
4401 N. Bell School Rd.
Loves Park IL 61111 USA
Phone: 1-800-432-6367
1-815-639-8600
Fax: 1-815-639-8000
www.danfossdrives.com

Danfoss Drives
8800 W. Bradley Rd.
Milwaukee, WI 53224 USA
Phone: 1-800-621-8806
1-414-355-8800
Fax: 1-414-355-6117
www.danfossdrives.com

130R0083 MG11AH22 *MG11AH22* Rev. 2012-03-23

BADGER METER SERIES 200 INSERTION STYLE FLOW SENSOR

Operations & Maintenance Manual
December 2015

Badger Meter

Series 200

Insertion Style Flow Sensors

IMPORTANT:
This manual contains important information.
READ AND KEEP FOR REFERENCE.

872020-EN (August 2012)
Rev. 8

Installation & Operation Manual

Contents

INTRODUCTION

Used in conjunction with any Badger Meter impeller flow monitor or transmitter, Badger Meter non-magnetic flow sensors provide an accurate rate of liquid flow as well as total accumulated flow. A number of sensor models are offered, which cover applications for a wide range of pipe sizes and pressure/temperature specifications.

The flow sensors generate a frequency which is proportional to flow rate. An internal preamplifier allows the pulse signal to travel up to 2000 feet without further amplification. Power to operate the sensor is provided by the flow monitor. The impeller bearing assembly, shaft and O-rings are replaceable in the field.

Badger Meter flow sensors feature a closed, six-bladed impeller design, using a proprietary, non-magnetic sensing technology. The forward-swept impeller shape provides higher, more constant torque than four-bladed impeller designs, and is less prone to fouling by water-borne debris. The forward-curved shape, coupled with the absence of magnetic drag, provides improved operation and repeatability, even at lower flow rates. As the liquid flow turns the impeller, a low impedance signal is transmitted with a frequency proportional to the flow rate.

Sensors of similar type are interchangeable, so there is no need for recalibration after servicing or replacement.

MECHANICAL INSTALLATION

General

Flow measurement accuracy for all flow measuring devices is highly dependent on proper location in the piping system. Irregular flow velocity profiles caused by valves, fittings, pipe bends, etc. can lead to inaccurate overall flow rate indications although local flow velocity measurement may be accurate. A sensor located where it can be affected by air bubbles, floating debris, or sediment may not achieve full accuracy and could be damaged. Badger Meter flow sensors are designed to operate reliably under adverse conditions, but the following recommendations should be followed to ensure maximum system accuracy:

1. Choose a location along the pipe where 10 pipe diameters upstream and 5 pipe diameters downstream of the sensor provide no flow disturbance. Pipe bends, valves, other fittings, pipe enlargements and reductions should not be present in this length of pipe.
2. The preferred location around the circumference of a horizontal pipe is on top. If trapped air or debris will interfere, then the sensor should be located further around the pipe from the top but not more than 45 degrees from top center. The sensor should never be located at the bottom of the pipe, as sediment may collect there. Locations off top center cause the impeller friction to increase, which may affect performance at low flow rates. Any circumferential location is correct for installation in vertical pipes.
3. An insertion depth of 1-1/2 inches for pipe sizes 2.5 inches and larger is required for accurate flow rate calibration. Detailed installation instructions for various sensor mounting configurations on the following pages include methods for ensuring correct insertion depth.
4. Alignment of the sensor to ensure that impeller rotation is parallel to flow is important. Alignment instructions are also included on the following pages.

INSTALLATION FOR 220BR, 220SS

Installation Procedure

The insertion depth and alignment of the sensor assembly are critical to the accuracy of the flow measurement. The flat end of the sensor tube assembly **MUST BE INSTALLED** 1-1/2 inches from the inside wall of the pipe. In order to allow for variations in wall thickness, lining, or coatings the depth adjustment is controlled by the position of the Hex Nuts on the three threaded studs of the hex mounting adapter. The hex mounting adapter is provided with a 2 inch male NPT connection.

There are two methods of mounting these sensors in a 2.5 inch or larger pipe. One is with a 2 inch NPT threaded pipe saddle. The other is with a welded-on fitting such as a Thredolet®, also tapped for a 2 inch NPT connection. In either case, cut a 2 inch hole through a depressurized pipe and then secure the saddle or weld-on fitting to the pipe. (For drilling into a pressurized pipe, see instructions for Series 225 and 226 sensors.) Install the 2 inch NPT adapter provided, using a thread sealant to prevent leakage. Tighten as necessary. Badger Meter insert style sensors are calibrated with the sensor inserted 1-1/2 inches into the pipe flow.

To determine the proper insertion depth, proceed as follows:

1. **Apply anti-seize thread lubricant , supplied with the sensor, to the threaded studs of the mounting adaptor.**
2. Insert the depth gauge into the mounting adapter and set it against the inside wall of the pipe as shown. Set the top of the upper adjusting nut to 3-3/4 inches as measured. Lock it in place with the bottom nut on the same stud. Repeat for the other adj. nuts.

Note: For Model 220PVS - set nuts 6.5 inches above inside wall of pipe.

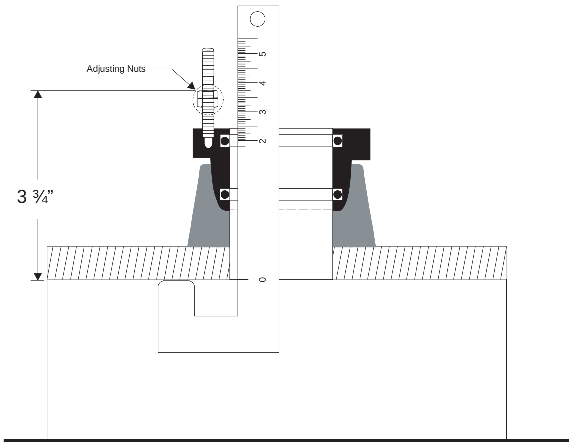


Figure 1: Installation for 220BR and 220SS

3. Clean O-rings and flow sensor sleeve, and lightly lubricate O-rings with silicone grease from the packet provided or some other acceptable lubricant. Take care not to get grease on the impeller or bearing.
4. Insert the flow sensor into the 2 inch NPT adapter so that the mounting holes in the positioning collar fit over the studs on the adapter. Lower the sensor onto the previously adjusted nuts. Install the lock nuts on top of the positioning collar and tighten. Now tighten the lower jam nuts firmly against the upper adjusting nuts to secure them for future removal of the sensor for inspection or service.

Alignment of Flow Sensor

1. Loosen positioning collar set screws with a 3/32 inch Allen wrench. Place the alignment rod through the sight holes in the flow sensor. Refer to Figure 2. Using the alignment rod as a guide, align the flow sensor so that the flow label arrow matches pipe flow direction and so that the alignment rod is exactly parallel to the pipe. This procedure aligns the impeller directly into the fluid flow.

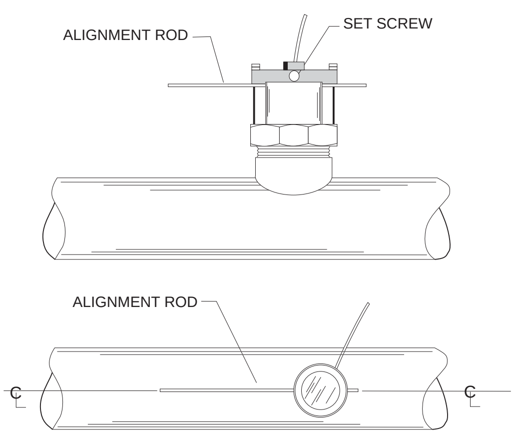


Figure 2: Alignment of Flow Sensor in 220BR and 220SS

2. As a backup to the flow arrow label, there is a small hole next to the larger sighting hole of the upstream side. With a 3/32 inch Allen wrench, tighten positioning collar set screws.
3. Double check that the sighting holes in the sleeve are parallel down the pipe and that the flow arrow label matches pipe liquid flow direction.
4. Cable routing: The positioning collar is threaded for connection of a standard 1/2 inch electrical conduit (flex cable) or a wire strain relief. Route cable as required. Be sure to leave enough flex in cable or conduit to allow future removal of sensor for service or cleaning if necessary.

HOT TAP INSTALLATION FOR 225BR, 226BR, AND 226SS

Badger Meter Series 200 hot tap style liquid flow sensors are designed for use in cases where pipelines will be in continuous service and depressurizing or draining the system for installation or service is not practical.

The Series 200 hot tap sensors are designed to be installed either in a depressurized pipe by hand or "Hot Tapped" into a pressurized pipeline. Both installation procedures are listed in this installation and operation manual. If there is the slightest possibility that the pipe could be full or pressurized, **FOLLOW THE INSTALLATION FOR PRESSURIZED PIPE.**

Refer to Figure 3 for location or identification of the various parts described in the following procedures.

The insertion depth and alignment of the sensor assembly are critical to the accuracy of the flow measurement. The flat end of the sensor tube assembly **MUST BE INSTALLED** 1-1/2 inches from the inside wall of the pipe. In order to allow for variations in wall thickness, lining or coatings the depth adjustment is controlled by the position of the hex nuts on the three threaded studs of the hex mounting adapter. The hex mounting adapter is provided with a 2 inch male NPT connection. Both gate and ball valve units are provided with 2 inch nipples for mounting onto saddles, weld-o-lets, etc.

Depth setting is accomplished by positioning the hex nuts 14-7/8 inches minus the thickness of the pipe, from the outside diameter of the pipe. For example, measure the wall thickness of the pipe from the coupon removed when the 1-7/8 inch hole was cut into the pipe. If the pipe was 1/8 inch thick, subtract 1/8 inch from 14-7/8 inch, or position the nuts 14-3/4 inch from the outside diameter of the pipe. This will allow the 16-3/8 inch sensor to protrude 1-1/2 inch into the pipe.

Apply anti-seize thread lubricant, supplied with the sensor, to the threaded studs of the mounting adaptor.

The alignment of the impeller with the flow in the pipe is accomplished by aligning the two "sight holes" at the top of the sensor tube assembly with the center line of the pipe. **Make sure the alignment is made to the pipe and not to a wall or surface near the sensor.** To adjust, loosen the two set screws in the positioning collar with a 3/32 inch Allen wrench provided in the Series 200 hot tap installation kit. Slip one end of the 1/4 inch x 18 inch steel rod (also supplied in the installation kit) through the holes in the sensor tube. Rotate the sensor tube until the rod is centered on the pipe. Ensure the flow label "Arrow" on the sensor matches the liquid flow direction. Tighten the positioning collar Allen screws to lock the sensor tube assembly in position. Note: As a backup to the flow direction arrow label on the tube assembly, there is a smaller hole located beside one of the sighting holes in the tube, to also indicate the upstream side of the tube assembly.

If the Pipe is Depressurized and Drained

1. Drill or cut a 1-7/8 inch hole in the pipe with a drill or hole saw. Note the pipe wall thickness for use in calculating sensor assembly depth. A location on the top of the pipe is best for overall performance and service life; however, any radial location on the top half of the pipe is acceptable. Allow a minimum of ten pipe diameters upstream and five downstream from the sensor of straight unobstructed pipe to allow full development of the flow profile.
2. Install either a service saddle or welded pipe fitting (2 inch female NPT) on the outside diameter of the pipe over the 1-7/8 inch hole.
3. Install the Badger Meter isolation valve and nipple onto the fitting using pipe thread sealant or Teflon® tape on all threads.
4. Install the Badger Meter hex mounting adapter onto the valve assembly. Use pipe thread sealant on the adapter. Tighten the hex adapter so that no stud is aligned with the center-line of the pipe. This could interfere with final sensor alignment. Measure depth and set the height of the nuts of the hex mounting adapter.
5. Open the bleed petcock valve on the hex adapter to relieve the pressure as the sensor tube is installed. Carefully hand insert the Badger Meter hot tap flow sensor tube into the hex mounting adapter. The sleeve should be inserted past the top two O-rings in the adapter (approx. 1 to 1-1/4 inches). **Take care not to push the tube in too far as the impeller could be damaged if it strikes the closed valve.**
6. Even if the sensor is installed with system drained, Badger Meter recommends that a HTT, hot tap insertion/removal tool be purchased for future service. This tools allows the sensor tube assembly to be removed from the pipe line without draining the entire loop where the sensor is mounted.
7. In a fully depressurized and drained pipe, the sensor tube assembly may be installed by hand. **Carefully and very slowly** open the isolation valve to relieve any pressure that may have built up. Fully open the isolation valve. Push the sensor tube into the pipe with a slight twisting motion. Guide the sensor collar holes over the three hex adapter studs until the collar rests on the nuts. Hex nuts should have been previously set to the correct height. Install the three lock nuts onto these studs at the top of the positioning collar and securely tighten.
8. Loosen the two set screws in the positioning collar with a 3/32 inch Allen wrench. Align the sensor sight holes along the pipe axis using the alignment rod provided in the installation kit supplied with the sensor. Ensure that the flow label arrow on the sensor matches the liquid flow direction inside the pipe. Tighten the positioning collar set screws. Note: As a backup to the flow label arrow, there is a small hole located beside one of the sighting holes to also indicate the upstream side of the sensor.

INSTALLATION INTO A PRESSURIZED PIPELINE USING MODEL HTT

For information on installing hot tap sensor with older 225H consult technical bulletin DID-001.

For pipe sizes 2½" and above; all Badger Meter sensors are inserted 1 1/2" from the inside wall of the pipe. The insertion depth is controlled by the position of the hex nuts on the three threaded rods. The formula below defines the distance between the top of the sensor hex mounting adaptor and the bottom of the positioning collar (the top of the hex nut). Reference Figure 3.

D = 16 3/8" - (H + Pipe Wall Thickness + 1.5 ")

Example: If sensor is installed in a 8 inch Sch 80 pipe with a pipe wall thickness of 1/2 inch and the "H" dimension is 10 inches then the calculation would be as below:

D = 16 3/8 - (10 inches + 0.5 inches + 1.5 inches)

D = 4 3/8"

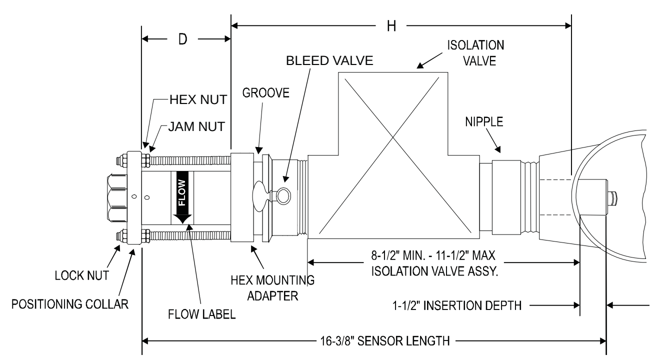


Figure 3:

1. Set one set of hex/jam nuts so that the distance between the top surface of the hex nut and the top surface of the hex mounting adaptor is equal to the "D" dimension calculated above. Then adjust the other two sets of hex/jam nuts 1-1/2 inches below the first jam nut to allow clearance for the tool top yoke.
2. Remove the tool split ring and clevis pin and slide tool bottom yoke into the groove on the sensor hex mounting adaptor and secure by replacing the clevis pin and split ring.
3. Mark sleeve 2-3/4 inches from impeller end of metal sleeve. This mark is a stopping point to insure that impeller/bearing is not damaged. Open the bleed petcock valve on the hex adapter to relieve the pressure resulting from the sensor tube insertion. Carefully hand insert the Badger Meter hot tap flow sensor sleeve assembly into the hex mounting adapter until the mark lines up with the top of the hex mounting adapter. At this point the sleeve will have been inserted past the top two "O"-rings in the adapter (approx. 1 1-1/4 inches). Take care not to push the sensor past the mark on the sleeve as the impeller could be damaged if it strikes the closed valve.
4. Fully extend tool by turning drive nut counterclockwise with a 15/16 inch socket or box wrench (not provided) until drive nut contacts tool and slide the positioning collar into the tool top yoke.
5. Rotate tool so the threaded rod with the adjusted hex/jam nuts is centered in the top yoke of hot tap tool.
6. Rotate sensor sleeve so positioning collar holes align with the threaded rods and flow direction label is in general direction making sure the positioning collar is located in the recessed area of the top yoke. Slide the top yoke of the tool over the positioning collar and secure by tightening the two thumbscrews on the top of the yoke.
7. Close the bleed petcock and slowly open the isolation valve. Slowly turn the 15/16 inch drive nut clockwise to insert the sensor tube assembly through the valve and into the pipeline. Carefully guide the three threaded studs of the hex mounting adapter through the holes of the sensor positioning collar. Carefully lower the sensor until the positioning collar contacts the hex nut preset for the correct depth adjustment. Install the three lock nuts onto the threaded rods, tightening only the lock nut on the threaded rod with the preset hex/jam nut; then, bring the two remaining lock nuts down until they just contact the positioning collar. Do not tighten at this time
8. Remove the Model HTT Insertion/Removal Tool, by loosening the two thumbscrews, removing the clevis pin and then sliding the insertion tool off the sensor. Then bring the two remaining sets of hex/jam nuts up to the underside of the positioning collar, and tighten.
9. Align the sensor by first loosening the two set screws in the side of positioning collar with a 3/32 inch Allen wrench. Then align the sensor sight holes along the pipe axis using the alignment rod provided in the sensor installation kit. Ensure that the flow label arrow on the sensor matches the liquid flow direction inside the pipe. Tighten the positioning collar set screws. Note: As a backup to the flow label arrow, there is a small hole located beside the sight hole on the upstream side of the sensor.

ELECTRICAL INSTALLATION "STANDARD" SENSORS

1. The metal collar on the top of the 220 sensors or an optional conduit cap on the Series 250 sensors will accept 1/2 inch threaded conduit fittings.
2. Route the cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be extended up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.
3. When connecting to a Badger Meter flow monitor/transmitter, locate the section of terminal strip on the monitor labeled **"SENSOR INPUT"** or **"SENSOR"**. Connect the red wire to **" IN"**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **"GND", "SIGNAL(-)"**, or "**COM**" terminal and the shield drain wire (if applicable) to **"SLD"**.
4. When interfacing with other equipment, consult manufacturer for input designations. The signal wave forms and power requirements are as shown in the specifications section. Refer to Technical Bulletin DTB-058 at www.badgermeter.com.

ELECTRICAL INSTALLATION "IR" SENSORS

The sensor leads are supplied with watertight caps over the ends. See Application Note DAB-031 and Technical Bulletin DID-003 at www.badgermeter.com.

1. DO **NOT** remove the plastic caps from the sensor leads until ready to splice.
2. Use a **twisted pair** cable suitable for direct burial to connect the sensor to the transmitter, monitor, or controller. Multi-pair telecommunication cable or direct burial cables may be used.
3. Make a water tight splice. Two part epoxy type waterproof kits are recommended. Be sure the epoxy seals the ends of the cable jacket.
4. Make sure the epoxy is hardened before inverting the splice or dropping it in standing water.

5. DO **NOT** make an underground splice unless absolutely necessary.
6. Route the cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be extended up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire with appropriate ratings. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.
7. When connecting to a Badger Meter flow monitor/ transmitter, locate the section of terminal strip on the monitor labeled **"SENSOR INPUT"** or **"SENSOR"**. Connect the red wire to **"IN"**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **"GND", "SIGNAL(-)"**, or "**COM**" terminal and the shield drain wire (if applicable) to **"SLD"**.
8. When interfacing with other equipment, the signal wave forms and power requirements are as shown in the specifications section. Refer to technical bulletin DTB-058 at www.badgermeter.com.

ELECTRICAL INSTALLATION "HIGH TEMPERATURE" SENSORS

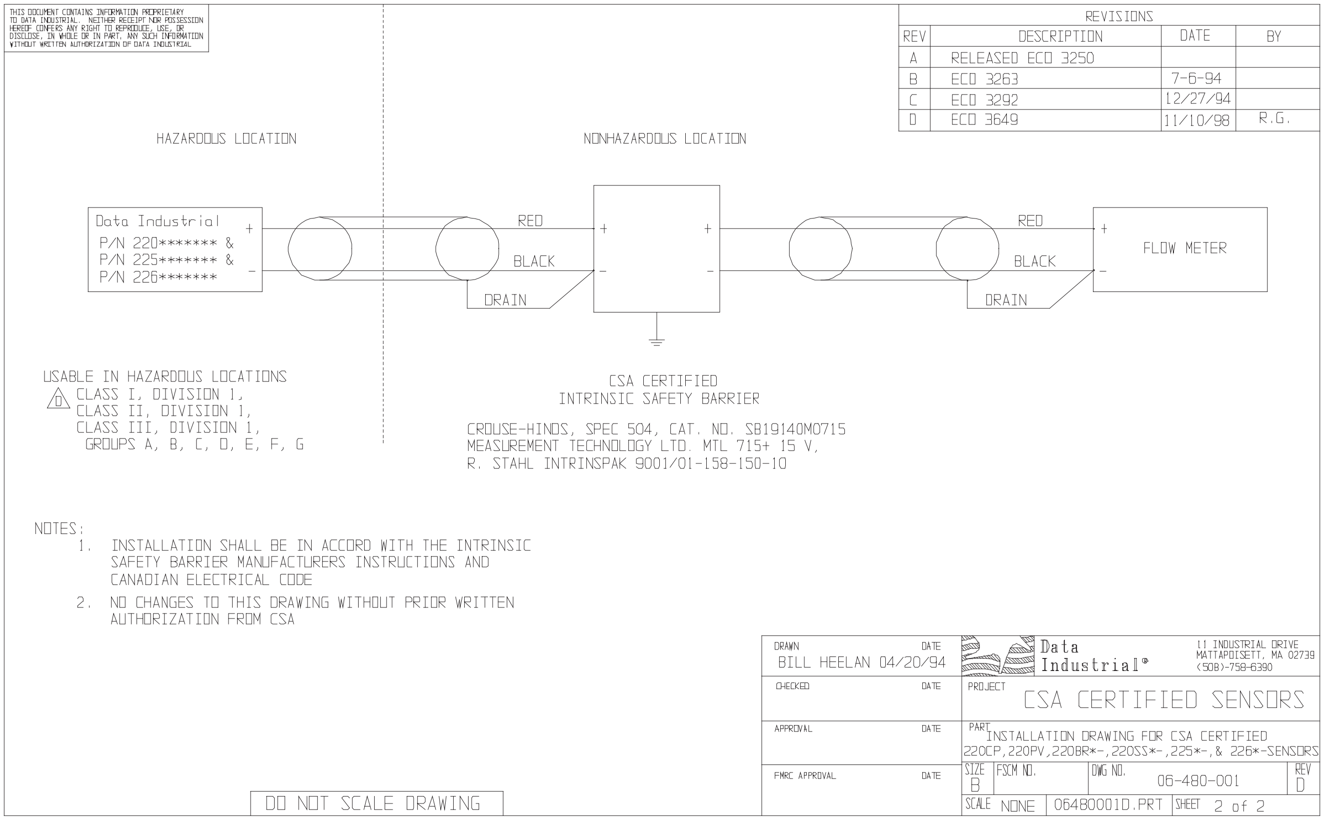
1. Route a cable from the sensor to a Badger Meter flow monitor/transmitter. The cable may be run up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.
2. Connect to cable inside sensor electronic housing on Series 220 sensors or attach to the sensor cable on the Series 225/226 and connect with standard wire nuts.
3. When connecting to a Badger Meter flow monitor or transmitter, locate the section of terminal strip on the monitor labeled **"SENSOR INPUT"** or **"SENSOR"**. Connect the red wire to **" IN"**, "**SIGNAL(+)**" or "**SIGNAL**" terminal and the black wire to **"GND", "SIGNAL(-)"**, or "**COM**" terminal and the shield drain wire (if applicable) to **"SLD"**.
4. When interfacing with other equipment, the signal wave forms and power requirements are as shown in the specifications section.

ELECTRICAL INSTALLATION

The Series 200 sensor is approved, as an entity, as intrinsically safe when installed in conformance with Badger Meter installation drawing 06-480-002 as specified on the blue label identifying an intrinsically safe sensor.

Entity approval implies that only the sensor is approved as intrinsically safe. Unless power supplies, equipment, and instruments connected to the sensor are each rated either explosion-proof or intrinsically safe, these devices cannot be installed in a hazardous area. The referenced installation drawing shows such apparatus located in a non-hazardous location. Proper interfacing between the hazardous and non-hazardous areas must be provided. It is of absolute importance that this interface be constructed and that all wiring be performed by qualified contractors. To ensure the intrinsic safety of the installation, the connection of the intrinsically safe sensor to instruments and or power supplies must take place using an approved intrinsically safe barrier located in a non-hazardous area. These barriers, listed below, are readily available from various suppliers.

Manufacturer:	Barrier:
Crouse-Hinds Spec 504	Cat No.SB19140M0715
Measurement Technology Ltd.	MTL 715+ 15 V
R Stahl Intrinspak	9001/1-158-150-10


THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO DATA INDUSTRIAL. NEITHER RECEIPT NOR POSSESSION HEREOF CONFERS ANY RIGHT TO REPRODUCE, USE, OR DISCLOSE, IN WHOLE OR IN PART, ANY SUCH INFORMATION WITHOUT WRITTEN AUTHORIZATION OF DATA INDUSTRIAL
REVISIONS
REV
DESCRIPTION
DATE
BY
A
RELEASED ECO 3250
B
ECO 3263
7-6-94
C
ECO 3292
12/27/94
D
ECO 3649
11/10/98
R.G.
HAZARDOUS LOCATION
NONHAZARDOUS LOCATION
Data Industrial
P/N 220******* &
P/N 225******* &
P/N 226*******
RED
BLACK
DRAIN
FLOW METER
USABLE IN HAZARDOUS LOCATIONS
CLASS I, DIVISION 1,
CLASS II, DIVISION 1,
CLASS III, DIVISION 1,
GROUPS A, B, C, D, E, F, G
CSA CERTIFIED
INTRINSIC SAFETY BARRIER
CROUSE-HINDS, SPEC 504, CAT. NO. SB19140M0715
MEASUREMENT TECHNOLOGY LTD. MTL 715+ 15 V,
R. STAHL INTRINSPAK 9001/01-158-150-10
NOTES:
1. INSTALLATION SHALL BE IN ACCORD WITH THE INTRINSIC SAFETY BARRIER MANUFACTURERS INSTRUCTIONS AND CANADIAN ELECTRICAL CODE
2. NO CHANGES TO THIS DRAWING WITHOUT PRIOR WRITTEN AUTHORIZATION FROM CSA
DRAWN
DATE
BILL HEELAN 04/20/94
Data Industrial®
11 INDUSTRIAL DRIVE
MATTAPOISETT, MA 02739
(508)-758-6390
CHECKED
DATE
PROJECT
CSA CERTIFIED SENSORS
APPROVAL
DATE
PART
INSTALLATION DRAWING FOR CSA CERTIFIED
220CP,220PV,220BR*-,220SS*-,225*-,& 226*-SENSORS
FMRC APPROVAL
DATE
SIZE
B
FSCM NO.
DWG NO.
06-480-001
REV
D
DO NOT SCALE DRAWING
SCALE
NONE
06480001D.PRT
SHEET
2 of 2

CALIBRATION

Badger Meter sensors use unique K and Offset numbers for calibration. These numbers are derived from calibration runs using NIST traceable instruments. Using both a K and an Offset number provides higher accuracy than using a K (pulse/gal) factor alone. K and Offset numbers for each tee configuration are listed in the following tables.

Calibration Tables

The table on pages 12 and 13 provides calibration and operation data for most scheduled pipe sizes from 3 inches through 18 inches. For tee-mounted sensors, see either Metal Tee (Manual Number 872021), or (Plastic Tee Manual Number 872022).

Description of Column Information for Pipe Sizes 3 inches through 36 inches

Column 1	Nominal Pipe Size
Column 2	Pipe O.D. as defined by ASA B36.10 and other standards
Column 3	Pipe I.D. as defined by ASA B36.10 and other standards
Columns 4 and 5	The K value and Offset that should be used in our frequency equation:
	$\text{Freq}= \frac{\text{Gpm}}{\text{K}} - \text{Offset}$
	This equation describes the frequency of the output signal of all Badger Meter flow sensors. By substituting the appropriate K and Offset values from the table, the sensor's output frequency can be calculated for each pipe size. This information is required when calibrating an output board or when using the raw sensor data as direct output to interface with a device that is not a Badger Meter product.
Column 6	This column indicates the suggested flow range of sensors in each pipe size. Badger Meter sensors will operate both above and below the indicated flow rates. However, good design practice dictates the use of this range for best performance. Sensors should be sized for flow rather than pipe size. To prevent disturbances to the flow profile, always conntect the sensor tee to the pipe nipples measuring at least ten pipe diameters in length on the downstream (delivery) side before making the transition in pipe size.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Pipe Size	Pipe O.D.	Pipe I.D.	K	Offset	Suggested Operating Range (GPM)
3 inch Sch 10S	3.500"	3.260"	5.009	.090	12-400
Std. Wt., Sch 40	3.5"	3.068"	4.362	.063	12-400
Extra Strong, Sch 80	3.5"	2.900"	3.858	.043	12-400
PVC Class 125	3.5"	3.284"	5.094	.093	12-400
PVC Class 160	3.5"	3.230"	4.902	.085	12-400
PVC Class 200	3.5"	3.166"	4.682	.076	12-400
4 inch Sch 10S	4.5"	4.260"	9.597	.241	20-600
Std. Wt., Sch 40	4.5"	4.026"	8.34	.229	20-600
Extra Strong, Sch 80	4.5"	3.826"	7.354	.188	20-600
PVC Class 125	4.5"	4.224"	9.396	.240	20-600
PVC Class 160	4.5"	4.154"	9.013	.240	20-600
PVC Class 200	4.5"	4.072"	8.578	.239	20-600
5 inch Sch 10S	5.563"	5.295"	16.305	.250	30-900
Std. Wt., Sch 40	5.50"	5.047"	14.674	.248	30-900
Extra Strong, Sch 80	5.50"	4.813"	13.165	.246	30-900
6 inch Sch 10S	6.625"	6.357"	24.089	.260	50-1,500
Std. Wt., Sch 40	6.5"	6.065"	21.574	.257	50-1,500
Extra Strong, Sch 80	6.5"	5.761"	19.457	.254	50-1,500
PVC Class 125	6.625"	6.217"	22.853	.258	50-1,500
PVC Class 160	6.625"	6.115"	21.968	.257	50-1,500
PVC Class 200	6.625"	5.993"	21.068	.256	50-1,500
8 inch Sch 10S	8.625"	8.329"	43.914	0.286	80-2,500
Sch 20	8.625"	8.125"	41.653	0.283	80-2,500
Sch 30	8.625"	8.071"	41.063	0.283	80-2,500
Std. Wt., Sch 40	8.625"	7.981"	40.086	0.281	80-2,500
Sch 60	8.625"	7.813"	38.288	0.279	80-2,500
Extra Strong, Sch 80	8.625"	7.625"	36.315	0.276	80-2,500
PVC Class 125	8.625"	8.095"	41.324	0.283	80-2,500
PVC Class 160	8.625"	7.961"	39.869	0.281	80-2,500
PVC Class 200	8.625"	7.805"	38.203	0.279	80-2,500
10 inch Sch 10S	10.75"	10.420"	70.195	0.321	125-4,000
Sch 20	10.75"	10.250"	67.668	0.318	125-4,000
Sch 30	10.75"	10.136"	66.069	0.316	125-4,000
Sch 40, Std.Wt.	10.75"	10.020"	64.532	0.314	125-4,000
Extra Strong, Sch 60	10.75"	9.750"	61.016	0.309	125-4,000
Sch 80	10.75"	9.564"	58.644	0.306	125-4,000
PVC Class 125	10.75"	10.088"	65.431	0.315	125-4,000
PVC Class 160	10.75"	9.924"	63.272	0.312	125-4,000
PVC Class 200	10.75"	9.728"	60.733	0.309	125-4,000
12 inch Sch 10S	12.75"	12.390"	104.636	0.367	175-5,000
Sch 20	12.75"	12.250"	102.553	0.364	175-5,000
Sch 30	12.75"	12.090"	99.347	0.36	175-5,000
Std. Wt., Sch 40S	12.75"	12.000"	97.576	0.358	175-5,000
Sch 40	12.75"	11.938"	96.369	0.356	175-5,000
Sch 60	12.75"	11.625"	90.441	0.348	175-5,000
Extra Strong	12.75"	11.750"	92.775	0.351	175-5,000
Sch 80	12.74"	11.376"	85.922	0.342	175-5,000
PVC Class 125	12.75"	11.966"	96.912	0.357	175-5,000
PVC Class 160	12.75"	11.770"	93.152	0.352	175-5,000
PVC Class 200	12.75"	11.538"	88.842	0.346	175-5,000

Calibration Table for Pipe Sizes 3 Inches Through 36 Inches

Continued on Next Page

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Pipe Size	Pipe O.D.	Pipe I.D.	K Value	Offset	Suggested Operating Range (GPM)
14 inch Sch 10S	14.00"	13.500"	122.307	0.391	200-6,000
Sch 20	14.00"	13.375"	120.216	0.388	200-6,000
Std. Wt., Sch 30	14.00"	13.250"	118.151	0.385	200-6,000
Sch 40	14.00"	13.124"	116.096	0.382	200-6,000
Sch 60	14.00"	12.814"	111.148	0.376	200-6,000
Extra Strong	14.00"	13.00"	114.098	0.33	200-6,000
Sch 80	14.00"	12.50"	106.299	0.369	200-6,000
16 inch Sch 10S	16.00"	15.500"	159.243	0.44	300-9,000
Sch 20	16.00"	15.375"	156.742	0.436	300-9,000
Std. Wt., Sch 30	16.00"	15.250"	154.267	0.433	300-9,000
Sch 60	16.00"	14.688"	143.456	0.419	300-9,000
Extra Strong, Sch 40	16.00"	15.000"	149.394	0.427	300-9,000
Sch 80	16.00"	14.314"	136.548	0.41	300-9,000
18 inch Sch 10S	18.00"	17.500"	202.739	0.498	350-10,000
Sch 20	18.00"	17.375"	199.828	0.494	350-10,000
Sch 30	18.00"	17.124"	194.061	0.486	350-10,000
Std. Wt.	18.00"	17.250"	196.943	0.49	350-10,000
Sch 40	18.00"	16.876"	188.464	0.479	350-10,000
Sch 60	18.00"	16.500"	180.171	0.469	350-10,000
Extra Strong	18.00"	17.000"	191.25	0.482	350-10,000
Sch 80	18.00"	16.126"	172.152	0.457	350-10,000
20 inch Std. Wt., Sch 20	20.00"	19.25"	246.179	0.555	400-12,000
Sch 40	20.00"	18.812"	234.836	0.540	400-12,000
Extra Strong, Sch 30	20.00"	19.000"	239.666	0.547	400-12,000
Sch 80	20.00"	17.938"	213.14	0.511	400-12,000
22 inch Std. Wt., Sch 20	22.00"	21.25"	301.975	0.621	500-15,000
Extra Strong, Sch 30	22.00"	21.00"	294.642	0.616	500-15,000
Sch 80	22.00"	19.75"	259.513	0.573	500-15,000
24 inch Std. Wt., Sch 20	24.00"	23.25"	364.331	0.666	600-18,000
Extra Strong	24.00"	23.00"	356.178	0.660	600-18,000
Sch 40	24.00"	22.624"	344.109	0.652	600-18,000
Sch 80	24.00"	21.562"	311.271	0.628	600-18,000
26 inch Sch 10	26.00"	25.376"	437.809	0.719	700-21,000
Std. Wt.	26.00"	25.25"	433.247	0.716	700-21,000
Sch 20, Extra Strong	26.00"	25.00"	424.274	0.709	700-21,000
28 inch Sch 10	28.00"	27.376"	513.698	0.774	900-23,000
Std. Wt.	28.00"	27.25"	508.723	0.770	900-23,000
Extra Strong, Sch 20	28.00"	27.00"	498.930	0.763	900-23,000
30 inch Sch 10	30.00"	29.376"	596.147	0.833	1,000-30,000
Std. Wt.	30.00"	29.25"	590.759	0.829	1,000-30,000
Sch 20, Extra Strong	30.00"	29.00"	580.146	0.822	1,000-30,000
32 inch Sch 10	32.00"	31.376"	685.156	0.897	1,200-35,000
Std. Wt.	32.00"	31.25"	679.355	0.893	1,200-35,000
Sch 20, Extra Strong	32.00"	31.00"	667.922	0.885	1,200-35,000
Sch 40	32.00"	30.624"	650.919	0.873	1,200-35,000
34 inch Sch 10	34.00"	33.312"	777.566	0.964	1,300-40,000
Std. Wt.	34.00"	33.25"	774.511	0.962	1,300-40,000
Extra Strong, Sch 20	34.00"	33.00"	762.258	0.953	1,300-40,000
Sch 40	34.00"	32.624"	744.022	0.940	1,300-40,000
36 inch Sch 10	36.00"	35.376"	882.855	1.040	1,500-45,000
Std. Wt.	36.00"	35.25"	876.227	1.035	1,500-45,000
Sch 20, Extra Strong	36.00"	35.00"	863.154	1.025	1,500-45,000
Sch 40	36.00"	34.50"	837.315	1.007	1,500-45,000

Calibration Table for Pipe Sizes 3 Inches Through 36 Inches

IMPELLER ASSEMBLY AND SHAFT REPLACEMENT

If you are replacing an existing Badger Meter sensor and have already calibrated your flow monitor/transmitter, no calibration changes are necessary. For installation of a new flow monitor or for relocation of a sensor in a new pipe size, please refer to the calibration instructions in flow monitor manual.

1. Depressurize pipe from which sensor is to be removed. If the sensor is one of the Series 225/IR225 or 226/IR226, consult the installation section on hot tap sensors.

NEVER disturb the securing lock nuts with pipe under pressure without hot tap insertion tool Model HTT installed.

2. Remove the three lock nuts that secure the positioning collar to the threaded rods of metal sensor.

NOTE: Before removing lock nuts, record the dimension from top of 2 inch NPT adapter to the bottom of the positioning collar. This dimension will be required later to reinstall.

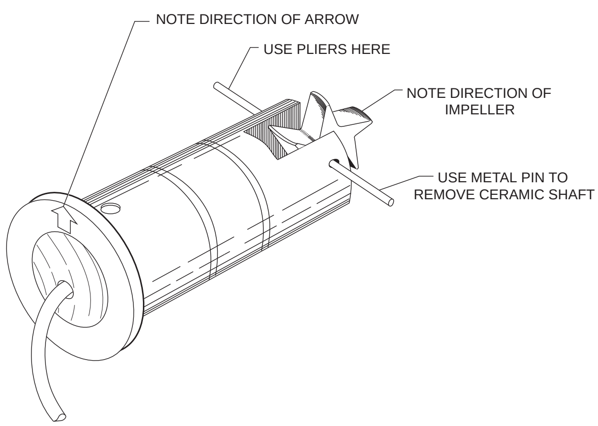


Figure 4: Impeller Assembly and Shaft Replacement

3. Remove the sensor from the hex adapter or the tee.
4. Note the impeller blade orientation relative to flow arrows and the alignment hole in metal sensors beside one of the sighting holes. In order to maintain proper calibration, the impeller will have to be reinstalled in the same manner with the impeller blades pointing toward the small alignment hole, and into the flow direction as indicated by the flow arrows.
5. To remove the old impeller blade assembly, push the old shaft out of the sleeve with the new shaft (or small diameter rod) just far enough to grab the end with a pair of pliers and pull the shaft completely out. The impeller assembly will now be free and will drop out.
6. Inspect the shaft and bearings for wear, and replace as necessary.
7. Refer to figure 4. To reinstall, position the impeller in the cavity oriented as in step 4 so that the impeller blades point into the flow direction and toward the small alignment hole located beside one of the sighting holes on metal sensors.
8. Carefully push the shaft through the sleeve and impeller taking care not to damage the bearings. Make sure that the shaft is inserted far enough so that it clears the sleeve on each side of the impeller housing.

NOTE: If shaft is not carefully installed, the bearing can be deformed preventing free rotation.

9. Inspect the O-rings for damage and replace as necessary. Clean the O-rings and the sleeve and relubricate with silicone grease from the packet provided or some other acceptable lubricant.
10. Install the sensor into the 2 inch NPT adapter or tee so that alignment hole is facing upstream and flow arrows point in the direction of the actual flow. Since the positioning collar was not loosened during this operation, the studs should all line up perfectly when the sighting holes are parallel to pipe. If this has been accidentally loosened, please refer to the installation instructions for the alignment of the flow sensor unit.
11. Install and tighten the nuts.
12. For metal sensors, double check that the distance from the top of the 2 inch NPT adapter to the bottom of the positioning collar equals the dimension as measured in step 2, and holes in sleeve sight exactly down the pipe, the arrows point in direction of flow and alignment holes located beside one sighting hole is pointing towards the source. If not, refer to *installation* section in this manual.
13. This completes the replacement procedure. The system may now be repressurized and tested.

TROUBLESHOOTING

1. If the voltage at the sensor input is less than 7 VDC in a no flow situation, disconnect the sensor from the barrier strip and measure the voltage at the sensor input terminals of the barrier strip again. It should be between 8 VDC and 20 VDC. If the voltage at the sensor input is still below 7 VDC or 3 VDC, the problem may be with the monitor (hardware or programming).

2. If you suspect that the sensor is bad, you can test the monitor circuitry by connecting a piece of wire to one of the sensor input terminals and tap the other side of the wire to the other sensor input terminal. Shorting across the sensor input terminals ON and OFF repeatedly allows the display to respond by trying to calculate a flow rate for the frequency of your shorting action. If the display does not show a change from 0.00, it indicates a problem with the monitor.
3. If the monitor tests ok and there are any splices in the cable, break the sensor cable at the splice closest to the sensor and retry the shorting test in step 2.
4. If the cable tests ok, drain the pipe line, verify the pressure is off, remove top lock nuts holding the sensor electronics. Spin the impeller by hand. If flows are noted on the display, and impeller spins freely then the flow rates may have been below our design minimums or the line was full of air. Try again. If the sensor fails to respond then replace sensor.

SPECIFICATIONS

Wetted Materials for all sensors

- See Technical Brief for material specifics

Sensor Sleeve and Hex Adapter for 220BR, 225BR, and 226BR

- Sleeve: admiralty brass, UNS C44300; hex adapter: valve bronze, UNS C83600

Sensor Sleeve and Hex Adapter for 220SS and 226SS

- Series 300 stainless steel

Temperature Ratings

- Standard version: 221ºF (105ºC) continuous service
- High temperature version: 285ºF (140.6ºC) continuous service; 305ºF (150ºC) peak temperature (limited duration)

Pressure Ratings

	At 100ºF	At 300ºF
220SS	400 psi	325 psi
220B	400 psi	325 psi
225B	300 psi	210 psi
226B	400 psi	250 psi
226SS	400 psi	300 psi

Recommended Design Flow Range

- 0.5 to 30 ft/sec
- Initial detection below 0.3 ft/sec

Accuracy

- ± 1.0% of full scale over recommended design flow range

Repeatability

- ± 0.3% of full scale over recommended design flow range

Linearity

- ± 0.2% of full scale over recommended design flow range

Transducer Excitation

- Quiescent current 600uA@8VDC to 35VDC max.
- Quiescent voltage (V_{high})

  Supply Voltage -(600uA*Supply impedance)
- ON State (V_{Low}) Max. 1.2VDC@40mA current limit (15ohm+0.7VDC)

Output Frequency

- 3.2 Hz to 200 Hz

Output Pulse Width

- 5 msec ±25%

Electrical Cable for Standard Sensor Electronics

- 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC wire provided for connection to display or analog transmitter unit. Rated to 105ºC. May be extended to a maximum of 2000 feet with similar cable and insulation appropriate for application.

Electrical Cable for IR Sensor Electronics

- 48 inches of U.L. Style 116666 copper solid AWG 18 wire with direct burial insulation. Rated to 105ºC.

This page intentionally left blank.

This page intentionally left blank.

www.badgermeter.com

The Americas | Badger Meter | 4545 West Brown Deer Rd | PO Box 245036 | Milwaukee, WI 53224-9536 | 800-876-3837 | 414-355-0400
México | Badger Meter de las Americas, S.A. de C.V. | Pedro Luis Ogazón N°32 | Esq. Angelina N°24 | Colonia Guadalupe Inn | CP 01050 | México, DF | México | +52-55-5662-0882
Europe, Middle East and Africa | Badger Meter Europa GmbH | Nurtinger Str 76 | 72639 Neuffen | Germany | +49-7025-9208-0
Czech Republic | Badger Meter Czech Republic s.r.o. | Maříkova 2082/26 | 621 00 Brno, Czech Republic | +420-5-41420411
Slovakia | Badger Meter Slovakia s.r.o. | Racianska 109/B | 831 02 Bratislava, Slovakia | +421-2-44 63 83 01
Asia Pacific | Badger Meter | 80 Marine Parade Rd | 21-04 Parkway Parade | Singapore 449269 | +65-63464836
China | Badger Meter | Rm 501, N° 11 Longyue Apartment | N° 180 Longjin Rd, Jiuting Songjiang District | Shanghai, China | 201615 | +86-21-5763 5412

<u>HART DELTABAR S DIFFERENTIAL PRESSURE MEASUREMENT</u>

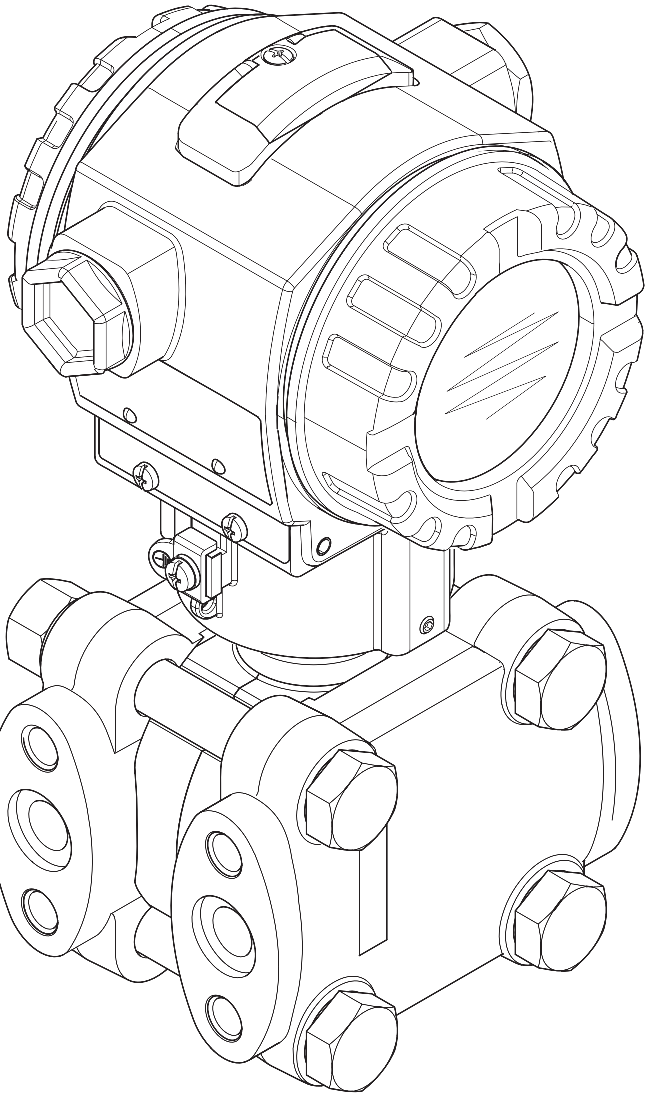
Operations & Maintenance Manual
December 2015

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Deltabar S FMD76/77/78, PMD70/75

Differential pressure measurement



BA270P/00/EN/05.10
71114104

valid from Software version:
02.10.zz

Endress+Hauser
People for Process Automation

Overview documentation

Device	Documentation	Content	Remarks
Deltabar S 4...20 mA HART	Technical Information TI382P	Technical data	– The documentation can be found on the supplied documentation CD. – The documentation is also available via the Internet. → See: www.endress.com
	Operating Instructions BA270P	– Identification – Installation – Wiring – Operation – Commissioning, Description of Quick Setup menus – Maintenance – Trouble-shooting and spare parts – Appendix: Illustration of menu	
	Operating Instructions BA274P	– Examples of configuration for pressure, level and flow measurement – Description of parameters – Trouble-shooting – Appendix: Illustration of menu	
	Brief Operating Instructions KA1018P	– Installation – Wiring – Operation on-site – Commissioning – Description of Quick Setup menus	– The documentation is supplied with the device. – The documentation can be found on the supplied documentation CD. – The documentation is also available via the Internet. → See: www.endress.com
	Leporello KA218P	– Wiring – Description of operating elements – Operation HistoROM®/M-DAT	– The documentation is supplied with the device. See cover of the terminal compartment. – The documentation can also be found on the supplied documentation CD.
	Functional Safety Manual SD189P	– Safety function with Deltabar S – Behaviour in operation and failure – Commissioning and iterative tests – Settings – Technical safety characteristic quantities – Management Summary	– The documentation can be found on the supplied documentation CD. It applies to the devices showing version "E" in feature 100 "Additional options 1" or in feature 110 "Additional options 2". → See also Technical Information TI382P, chapter "Ordering information".

Table of contents

1 Safety instructions

1.1 Designated use

The Deltabar S is a differential pressure transmitter for measuring differential pressure, flow and level.

The manufacturer accepts no liability for damages resulting from incorrect use or use other than that designated.

1.2 Installation, commissioning and operation

The device has been designed to operate safely in accordance with current technical, safety and EU standards. If installed incorrectly or used for applications for which it is not intended, however, it is possible that application-related dangers may arise, e.g. product overflow due to incorrect installation or calibration. For this reason, the instrument must be installed, connected, operated and maintained according to the instructions in this manual: personnel must be authorised and suitably qualified. The manual must have been read and understood, and the instructions followed. Modifications and repairs to the device are permissible only when they are expressly approved in the manual. Pay particular attention to the technical data on the nameplate.

1.3 Operational safety and process safety

Alternative monitoring measures must be taken to ensure operational safety and process safety durng configuration, testing and maintenance work on the device.

1.3.1 Hazardous areas (optional)

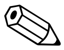
- Devices for use in hazardous areas are fitted with an additional nameplate (→ 🗎 6). If the device is to be installed in an explosion hazardous area, then the specifications in the certificate as well as all national and local regulations must be observed. The device is accompanied by separate "Ex documentation", which is an integral part of this Operating Instructions. The installation regulations, connection values and Safety Instructions listed in this Ex document must be observed. The documentation number of the related Safety Instructions is also indicated on the additional nameplate.
- Ensure that all personnel are suitably qualified.

1.3.2 Functional Safety SIL3 (optional)

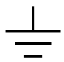
If using devices for applications with safety integrity, the Functional Safety Manual (SD190P) must be observed thoroughly.

1.4 Notes on safety conventions and icons

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

Symbol	Meaning
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument.
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.

	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its nameplate, it can be installed in an explosion hazardous area or a non-explosion hazardous area, according to the approval.
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. – Devices used in hazardous areas must possess an appropriate type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. – Devices used in hazardous areas must possess an appropriate type of protection. Lines used in hazardous areas must meet the necessary safety-related characteristic quantities.

	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied.
~	**Alternating voltage** A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied.
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system.
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment.
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice.

	**Safety instruction** For safety instructions refer to the manual for the appropriate instrument version.

2 Identification

2.1 Device designation

2.1.1 Nameplate

Note!

- The MWP (maximum working pressure) is specified on the nameplate. This value refers to a reference temperature of 20°C (68°F) or 100°F for ANSI flanges.
- The pressure values permitted at higher temperatures can be found in the following standards:
  - EN 1092-1: 2001 Tab. 18 [1)]
  - ASME B 16.5a – 1998 Tab. 2-2.2 F316
  - ASME B 16.5a – 1998 Tab. 2.3.8 N10276
  - JIS B 2220
- For PMD70 and PMD75, the MWP applies for the temperature ranges specified in the Technical Information TI382P in the "Ambient temperature range" and "Process temperature limits" sections.
- The test pressure corresponds to the over pressure limit (OPL) of the device = MWP x 1.5.
- The Pressure Equipment Directive (EC Directive 97/23/EC) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.

1) With regard to their stability-temperature property, the materials 1.4435 and 1.4404 are grouped together under 13EO in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.

Aluminium housing (T14/T15) and stainless steel housing (T14)

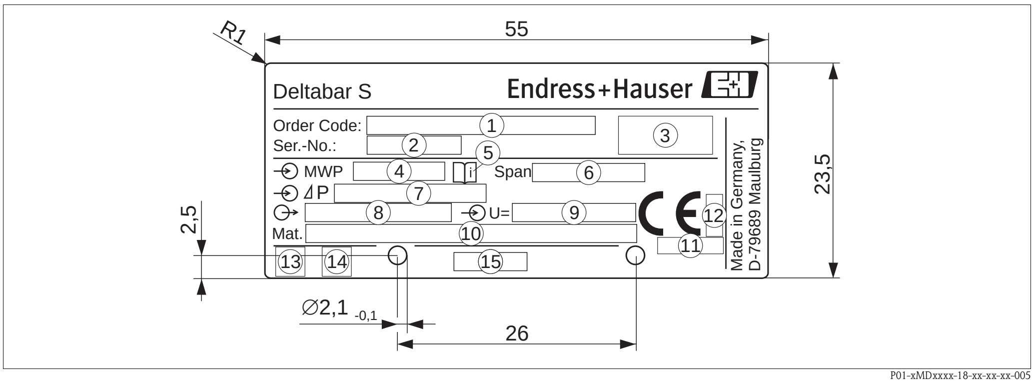
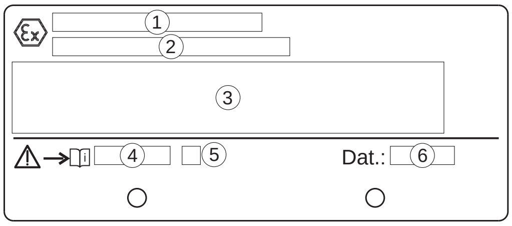


Fig. 1: Nameplate for Deltabar S

1 Order code
See the specifications on the order confirmation for the meanings of the individual letters and digits.
2 Serial number
3 Degree of protection
4 MWP (Maximum working pressure)
5 Symbol: Note: pay particular attention to the data in the "Technical Information"!
6 Minimum/maximum span
7 Nominal measuring range
8 Electronic version (output signal)
9 Supply voltage
10 Wetted materials
11 ID number of notified body with regard to Pressure Equipment Directive (optional)
12 ID number of notified body with regard to ATEX (optional)
13 GL-symbol for GL marine certificate (optional)
14 SIL-symbol for devices with SIL3/IEC 61508 Declaration of conformity (optional)
15 Layout identification of the nameplate

Devices for use in hazardous areas are fitted with an additional nameplate.

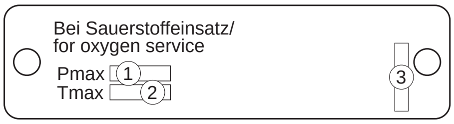


P01-xMD7xxxx-18-xx-xx-xx-002

Fig. 2: Additional nameplate for devices for hazardous areas

1 EC type examination certificate number
2 Type of protection e.g. II 1/2 G EEx ia IIC T4/T6
3 Electrical data
4 Safety Instructions number e.g. XA235P
5 Safety Instructions index e.g. A
6 Device manufacture data

Devices suitable for oxygen applications are fitted with an additional nameplate.

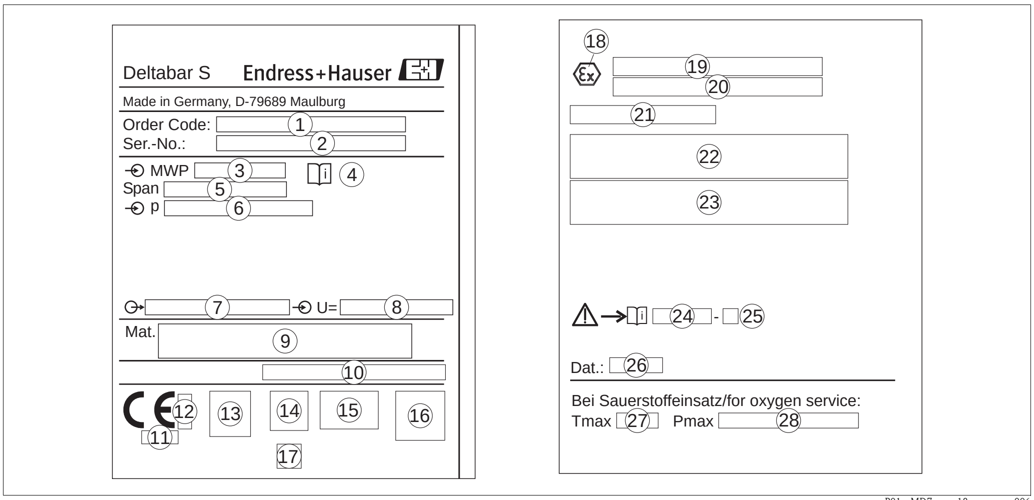


P01-xxxxxxxx-18-xx-xx-xx-000

Fig. 3: Additional nameplate for devices suitable for oxygen applications

1 Maximum pressure for oxygen applications
2 Maximum temperature for oxygen applications
3 Layout identification of the nameplate

Hygenic stainless steel housing (T17)



P01-xMD7xxxx-18-xx-xx-xx-006

Fig. 4: Nameplate for Deltabar S

1 Order code
See the specifications on the order confirmation for the meanings of the individual letters and digits.
2 Serial number
3 MWP (Maximum working pressure)
4 Symbol: Note: pay particular attention to the data in the "Technical Information"!
5 Minimum/Maximum span
6 Nominal measuring range
7 Electronic version (output signal)
8 Supply voltage
9 Wetted materials
10 Degree of protection

Optional:
11 ID number of notified body with regard to Pressure Equipment Directive
12 ID number of notified body with regard to ATEX
13 3A-symbol
14 CSA-symbol
15 FM-symbol
16 SIL-symbol for devices with SIL3/IEC 61508 Declaration of conformity
17 GL-symbol for GL marine certificate
18 Ex-symbol
19 EC type examination certificate
20 Type of protection e.g. II 1/2 G EEx ia IIC T4/T6
21 Approval number for WHG overspill protection
22 Temperature operating range for devices for use in hazardous areas
23 Electrical data for devices for use in hazardous areas
24 Safety Instructions number e.g. XA283P
25 Safety Instructions index e.g. A
26 Device manufacture data
27 Maximum temperature for devices suitable for oxygen applications
28 Maximum pressure for devices suitable for oxygen applications

2.1.2 Identifying the sensor type

See parameter "Sensor Meas.Type" in Operating Instruction BA274P. The Operating Instruction BA274P can be found on the supplied documentation CD.

2.2 Scope of delivery

The scope of delivery comprises:

- Deltabar S differential pressure transmitter
- For PMD70 and PMD75 with side flanges made of AISI 316L or C22.8: additional 2 vent valves, AISI 316L
- PMD75 with side flanges made of AISI 316L or C22.8 and side vent: additional 4 locking screws, AISI 316L
- For devices with the "HistoROM/M-DAT" option:
  CD-ROM with Endress+Hauser operating program and documentation
- Optional accessories

Documentation supplied:

- The Operating Instructions BA270P and BA274P, the Technical Information TI382P and the Safety Instructions, Functional Safety Manual and brochures can be found on the supplied documentation CD.
  See also → 2, "Overview documentation" chapter.
- Brief Operating Instructions KA1018P
- Leporello KA218
- Final inspection report
- Also Safety Instructions with ATEX, IECEx and NEPSI devices
- Optional: factory calibration form, test certificates

2.3 CE mark, declaration of conformity

The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.4 Registered trademarks

KALREZ, VITON, TEFLON
Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP
Registered trademark of Ladish & Co., Inc., Kenosha, USA

HART
Registered trademark of the HART Communication Foundation, Austin, USA.

3 Installation

3.1 Incoming acceptance and storage

3.1.1 Incoming acceptance

- Check the packaging and the contents for damage.
- Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Storage

The device must be stored in a dry, clean area and protected against damage from impact (EN 837-2).

Storage temperature range:
- –40 to +90°C (–40 to +194°F)
- On-site display: –40 to +85°C (–40 to +185°F)
- Separate housing: –40 to +60°C (–40 to +140°F)

3.2 Installation conditions

3.2.1 Dimensions

→ For dimensions, please refer to the Technical Information for Deltabar S TI382P, "Mechanical construction" section. → 2 "Overview documentation.

3.3 Installation instructions

Note!
- Due to the orientation of the Deltabar S, there may be a shift in the measured value, i.e. when the container is empty, the measured value does not display zero. You may correct this zero point shift either directly on the device using the "E"-key or by remote operation. → 34, "Function of the operating elements – on-site display not connected" or → 52, "Position adjustment".
- For FMD77 and FMD78, please refer to → 17, Section 3.3.4 "Installation instructions for devices with diaphragm seals (FMD78)".
- General recommendations for routing the impulse piping can be found in DIN 19210 "Methods for measurement of fluid flow; differential piping for flow measurement devices" or the corresponding national or international standards.
- Using a three-valve or five-valve manifold allows for easy commissioning, installation and maintenance without interrupting the process.
- When routing the impulse piping outdoors, ensure that sufficient anti-freeze protection is used, e.g. by using pipe heat tracing.
- Install the impulse piping with a monotonic gradient of at least 10%.
- To ensure optimal readability of the on-site display, it is possible to rotate the housing up to 380°. → 22, Section 3.3.9 "Rotating the housing".
- Endress+Hauser offers a mounting bracket for installing on pipes or walls. → 20, Section 3.3.7 "Wall and pipe-mounting (optional)".

3.3.1 Installation for flow measurement

Note!
For more information about flow measurement with the Deltabar S differential pressure transmitter
- Deltabar S with orifice plate (TI422P, Deltatop DO6x)
- Deltabar S with Pitot tube (TI425P, Deltatop DP6x)

Flow measurement in gases with PMD70/PMD75

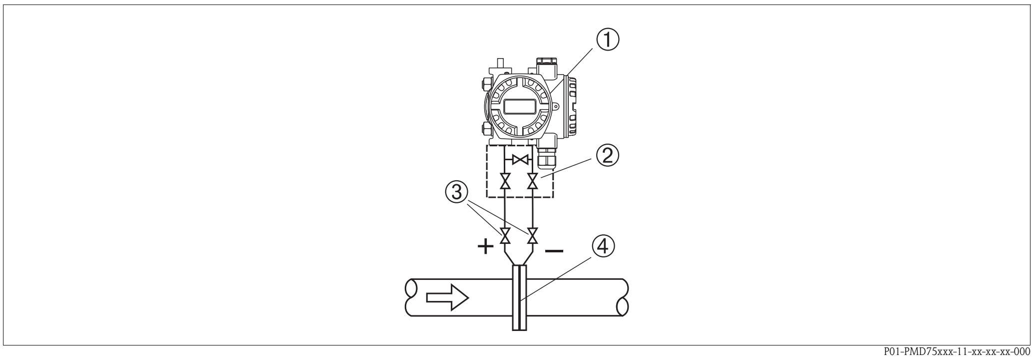


Fig. 5: Measuring layout for flow measurement in gases with PMD75

1 Deltabar S, here PMD75
2 Three-valve manifold
3 Shut-off valves
4 Orifice plate or pitot tube

- Mount the Deltabar S above the measuring point so that the condensate can run off into the process piping.

Flow measurement in steam with PMD70/PMD75

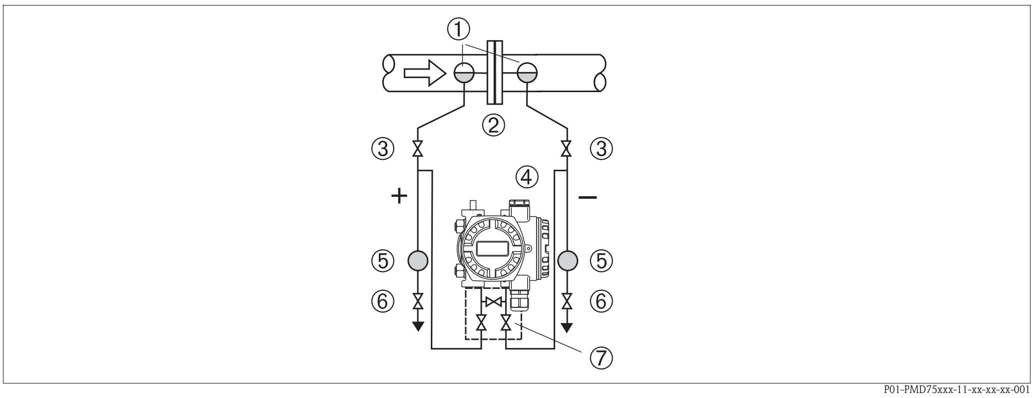


Fig. 6: Measuring layout for flow measurement in steam with PMD75

1 Condensate traps
2 Orifice plate or pitot tube
3 Shut-off valves
4 Deltabar S, here PMD75
5 Separator
6 Drain valves
7 Three-valve manifold

- Mount the Deltabar S below the measuring point.
- Mount the condensate traps at the same level as the tapping points and at the same distance to the Deltabar S.
- Prior to commissioning, fill the impulse piping to the height of the condensate traps.

Flow measurement in liquids with PMD70/PMD75

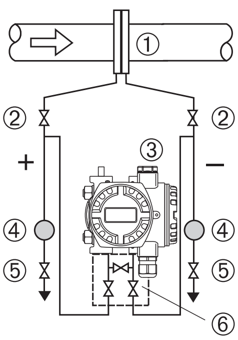


Fig. 7: Measuring layout for flow measurement in liquids with PMD75

1 Orifice plate or pitot tube
2 Shut-off valves
3 Deltabar S, here PMD75
4 Separator
5 Drain valves
6 Three-valve manifold

- Mount the Deltabar S below the measuring point so that the impulse piping is always filled with liquid and gas bubbles can run back into the process piping.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

3.3.2 Installation for level measurement

Level measurement in an open container with PMD70/PMD75

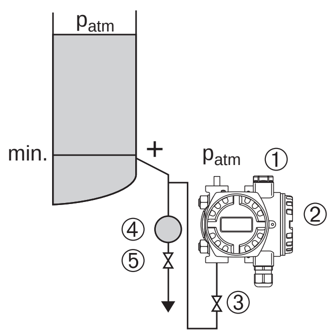
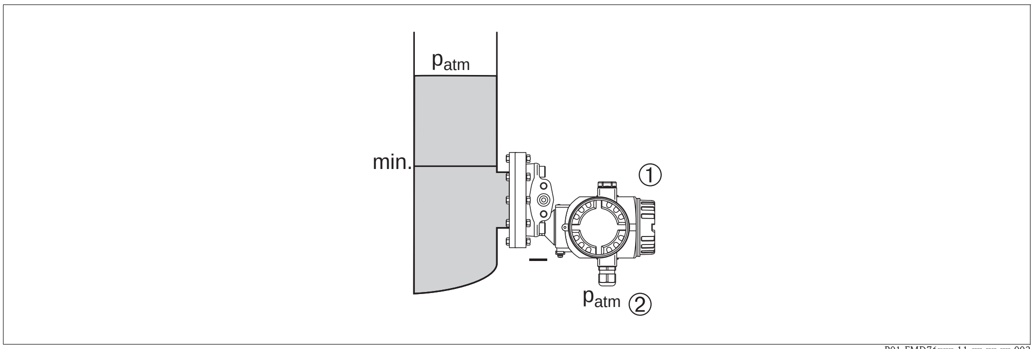


Fig. 8: Measuring layout for level measurement in open containers with PMD75

1 The negative side is open to atmospheric pressure
2 Deltabar S, here PMD75
3 Shut-off valve
4 Separator
5 Drain valve

- Mount the Deltabar S below the lower measuring connection so that the impulse piping is always filled with liquid.
- The negative side is open to atmospheric pressure.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

Level measurement in an open container with FMD76/FMD77



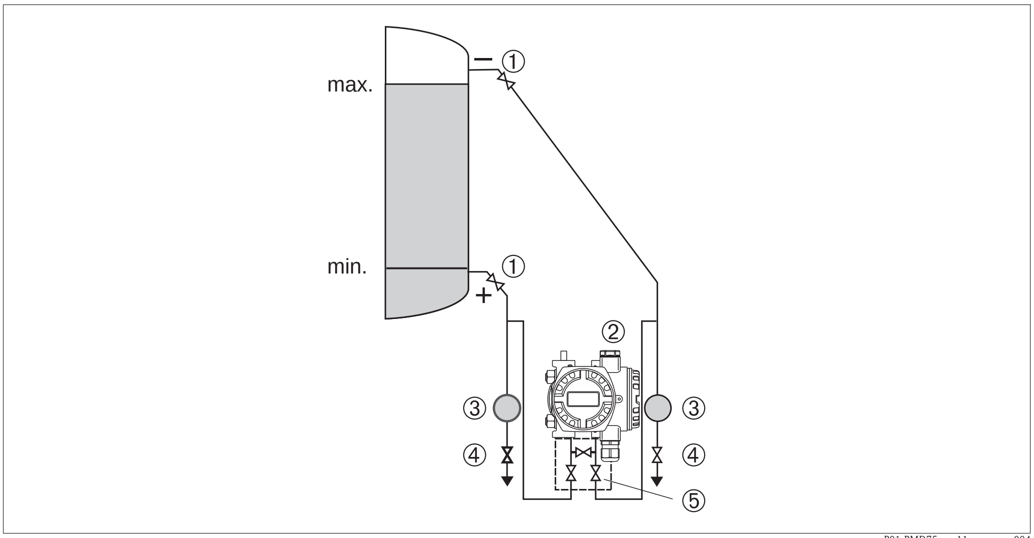
P01-FMD76xxx-11-xx-xx-xx-003

Fig. 9: Measuring layout for level measurement in open containers with FMD76

1 Deltabar S, here FMD76
2 The negative side is open to atmospheric pressure

- Mount the Deltabar S direct on the container. → 🗎 19, Section 3.3.5 "Seal for flange mounting".
- The negative side is open to atmospheric pressure.

Level measurement in a closed container with PMD70/PMD75



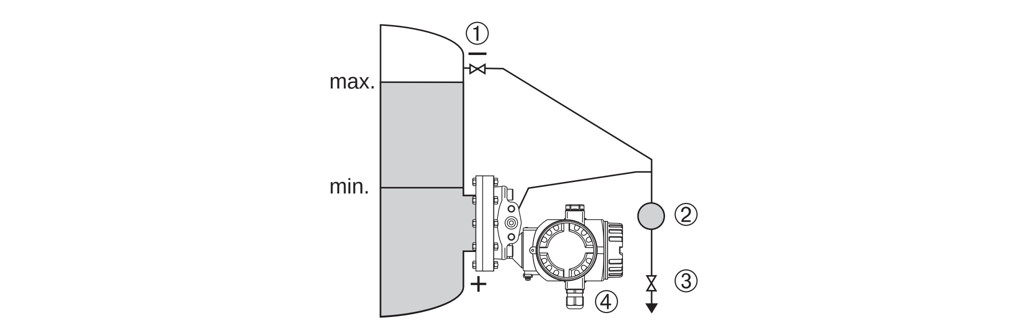
P01-PMD75xxx-11-xx-xx-xx-004

Fig. 10: Measuring layout for level measurement in a closed container with PMD75

1 Shut-off valves
2 Deltabar S, PMD75
3 Separator
4 Drain valves
5 Three-valve manifold

- Mount the Deltabar S below the lower measuring connection so that the impulse piping is always filled with liquid.
- Always connect the impulse piping of negative side above the maximum level.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

Level measurement in a closed container with FMD76/FMD77



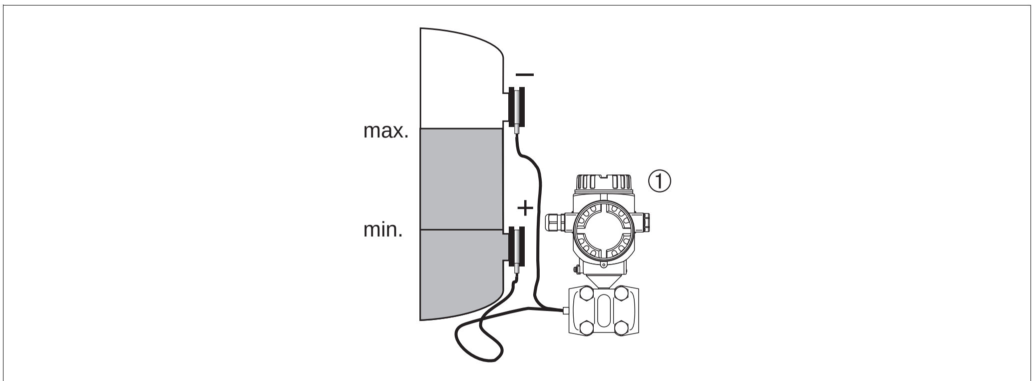
P01-FMD76xxx-11-xx-xx-xx-004

Fig. 11: Measuring layout for level measurement in a closed container with FMD76

1 Shut-off valve
2 Separator
3 Drain valve
4 Deltabar S, here FMD76

- Mount the Deltabar S direct on the container. → 19, Section 3.3.5 "Seal for flange mounting".
- Always connect the impulse piping of negative side above the maximum level.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

Level measurement in a closed container with FMD78



P01-FMD78xxx-11-xx-xx-xx-000

Fig. 12: Measuring layout for level measurement in a closed container with FMD78

1 Deltabar S, here FMD78

- Mount the Deltabar S below the lower diaphragm seal. → 17, Section 3.3.4 "Installation instructions for devices with diaphragm seals (FMD78)".
- The ambient temperature should be the same for both capillaries.

Note!
Level measurement is only ensured between the upper edge of the lower diaphragm seal and the lower edge of the upper diaphragm seal.

Level measurement in a closed container with superimposed steam with PMD 70/ PMD75

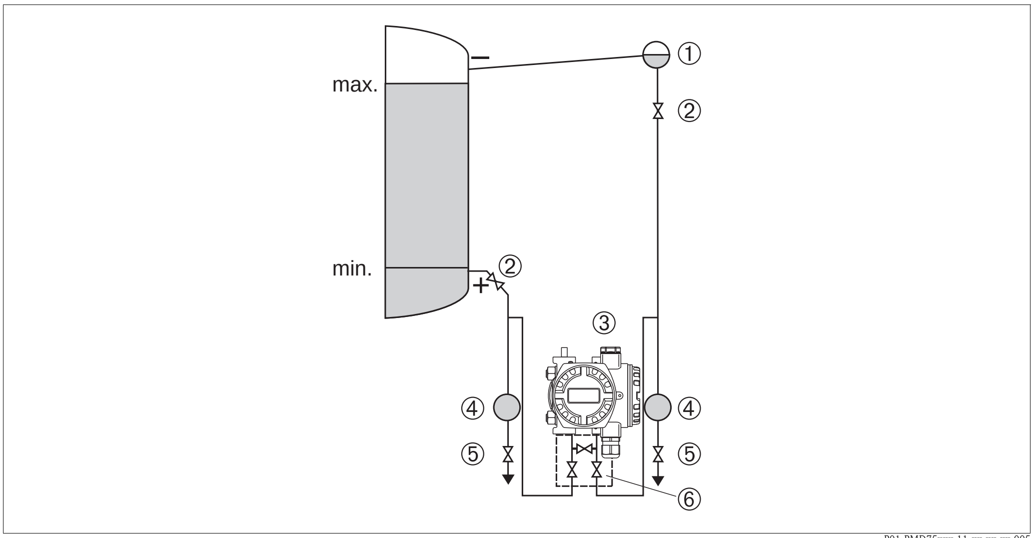


Fig. 13: Measuring layout for level measurement in a container with superimposed steam with PMD75

1 Condensate trap
2 Shut-off valves
3 Deltabar S, here PMD75
4 Separator
5 Drain valves
6 Three-valve manifold

- Mount the Deltabar S below the lower measuring connection so that the impulse piping is always filled with liquid.
- Always connect the impulse piping of negative side above the maximum level.
- A condensate trap ensures constant pressure on the negative side.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

Level measurement in a closed container with superimposed steam with FMD 76/ FMD77

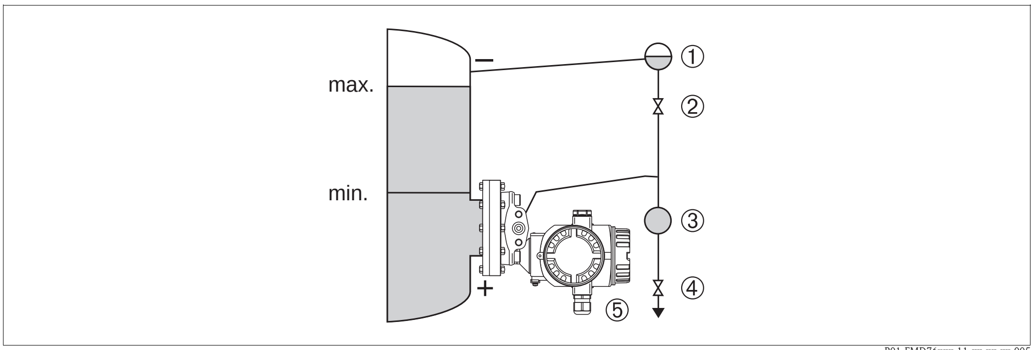


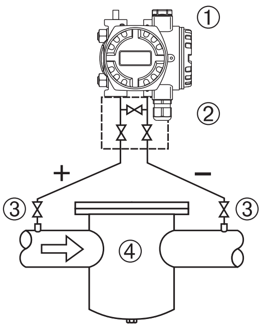
Fig. 14: Measuring layout for level measurement in a container with superimposed steam with FMD76

1 Condensate trap
2 Shut-off valve
3 Separator
4 Drain valve
5 Deltabar S, here FMD76

- Mount the Deltabar S direct on the container. → 🗎 19, Section 3.3.5 "Seal for flange mounting".
- Always connect the impulse piping of negative side above the maximum level.
- A condensate trap ensures constant pressure on the negative side.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

3.3.3 Installation for differential pressure measurement

Differential pressure measurement in gases and steam with PMD70/PMD75



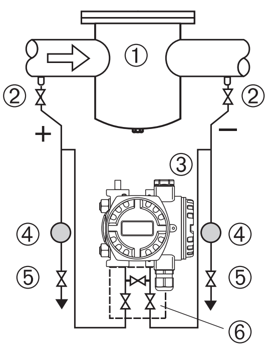
P01-PMD75xxx-11-xx-xx-xx-006

Fig. 15: Measuring layout for differential pressure measurement in gases and steam with PMD75

1 Deltabar S, here PMD75
2 Three-valve manifold
3 Shut-off valves
4 e.g. filter

- Mount the Deltabar S above the measuring point so that the condensate can run off into the process piping.

Differential pressure measurement in liquids with PMD70/PMD75



P01-PMD75xxx-11-xx-xx-xx-007

Fig. 16: Measuring layout for differential pressure measurement in liquids with PMD75

1 e.g. filter
2 Shut-off valves
3 Deltabar S, here PMD75
4 Separator
5 Drain valves
6 Three-valve manifold

- Mount the Deltabar S below the measuring point so that the impulse piping is always filled with liquid and gas bubbles can run back into the process piping.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

Differential pressure measurement in gases, steam and liquids with FMD78

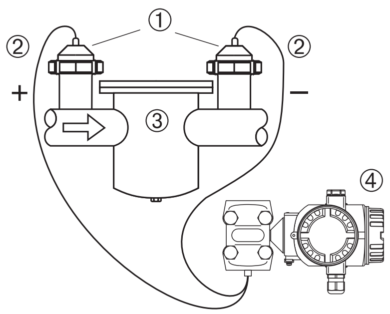


Fig. 17: Measuring layout for differential pressure measurement in gases, steam and liquids with FMD78

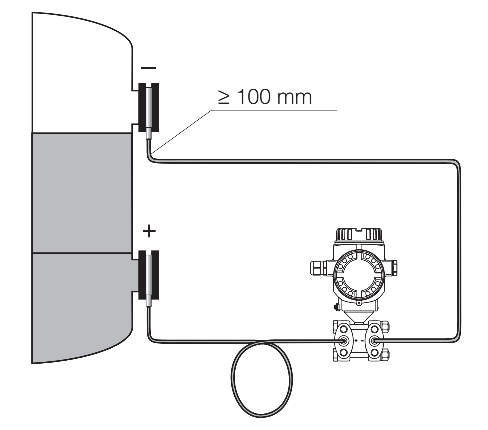
1 Diaphragm seal
2 Capillary
3 e.g. filter
4 Deltabar S, here FMD78

- Mount the diaphragm seal with capillaries at the top or on the side on the piping.
- For vacuum applications: mount the Deltabar S below the measuring point. → 17, Section 3.3.4 "Installation instructions for devices with diaphragm seals (FMD78)", "Vacuum application" part.
- The ambient temperature should be the same for both capillaries.

3.3.4 Installation instructions for devices with diaphragm seals (FMD78)

Note!
- The diaphragm seal, together with the pressure transmitter, forms a closed, calibrated system, which is filled through openings in the diaphragm seal and in the measurement system of the pressure transmitter. This openings are sealed and must not be opened.
- Do not clean or touch diaphragm seals with hard or pointed objects.
- Do not remove the protection of the process isolating diaphragm until shortly before installation.
- When using a mounting bracket, sufficient strain relief must be ensured for the capillaries in order to prevent the capillary bending down (bending radius ≥ 100 mm (3.94 in)).
- Please note that the hydrostatic pressure of the liquid columns in the capillaries can cause zero point shift. The zero point shift can be corrected. → 52, Section 6.3 "Position adjustment".
- Please note the application limits of the diaphragm seal filling oil as detailed in the Technical Information for Deltabar S TI382P, Section "Planning instructions for diaphragm seal systems". → → 2 "Overview documentation".

In order to obtain more precise measurement results and to avoid a defect in the device, mount the capillaries as follows:
- vibration-free (in order to avoid additional pressure fluctuations)
- not in the vicinity of heating or cooling lines
- insulate if the ambient temperature is below ore above the reference temperature
- with a bending radius of ≥100 mm (3.94 in).
- The ambient temperature and length of both capillaries should be the same when using two-sided diaphragm seal systems.
- Two diaphragm seals which are the same (e.g. with regard to diameter, material, etc.) should always be used for the negative and positive side (standard delivery).



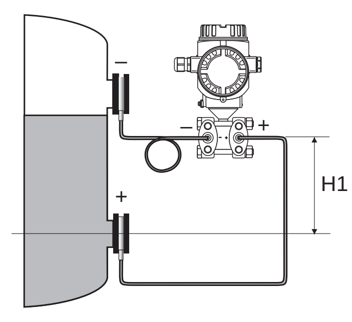
P01-FMD78xxx-11-xx-xx-xx-005

Fig. 18: Mounting Deltabar S, FMD78 with diaphragm seals and capillary, recommended mounting for vacuum applications: mount pressure transmitter below the lowest diaphragm seal!

Vacuum application (FMD78)

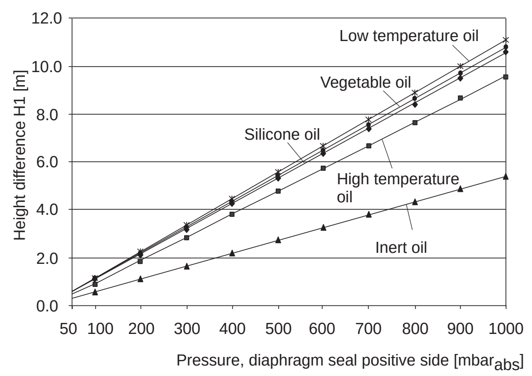
For applications under vacuum, Endress+Hauser recommends mounting the pressure transmitter underneath the lower diaphragm seal. A vacuum load of the diaphragm seal caused by the presence of filling oil in the capillaries is hereby prevented.

When the pressure transmitter is mounted above the lower diaphragm seal, the maximum height difference H1 in accordance with the illustration below on the left must not be exceeded. The maximum height difference is dependent on the density of the filling oil and the smallest ever pressure that is permitted to occur at the diaphragm seal on the positive side (empty container), see illustration below, on the right.



P01-FMD7xxxx-11-xx-xx-xx-001

Fig. 19: Installation above the lower diaphragm seal



P01-FMD7xxxx-05-xx-xx-xx-002

Fig. 20: Diagram of maximum installation height above the lower diaphragm seal for vacuum applications dependent on the pressure at the diaphragm seal on the positive side

3.3.5 Seal for flange mounting

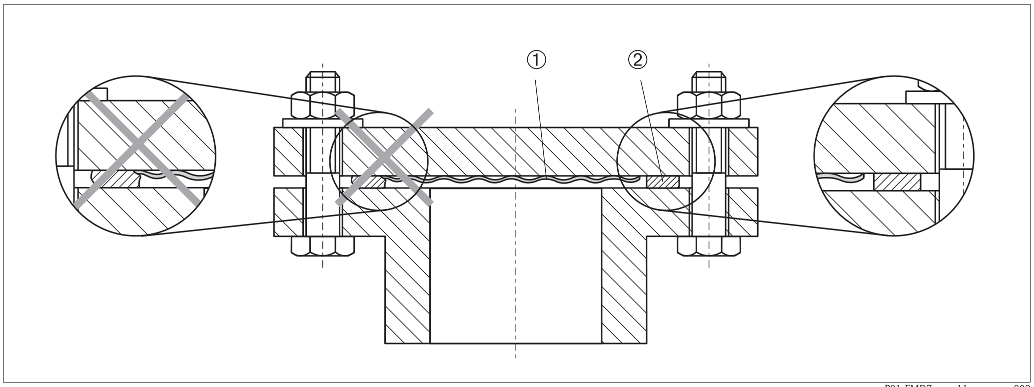


Fig. 21: Mounting the versions with flange or diaphragm seal

1 Process isolating diaphragm
2 Seal

Warning!
The seal is not allowed to press on the process isolating diaphragm as this could affect the measurement result.

3.3.6 Heat insulation – FMD77

The FMD77 must only be insulated up to a certain height. The maximum permitted insulation height is labelled on the devices and applies to an insulation material with a heat conductivity ≤ 0.04 W/(m x K) and to the maximum permitted ambient and process temperature (→ see table below). The data were determined under the most critical application "quiescent air".

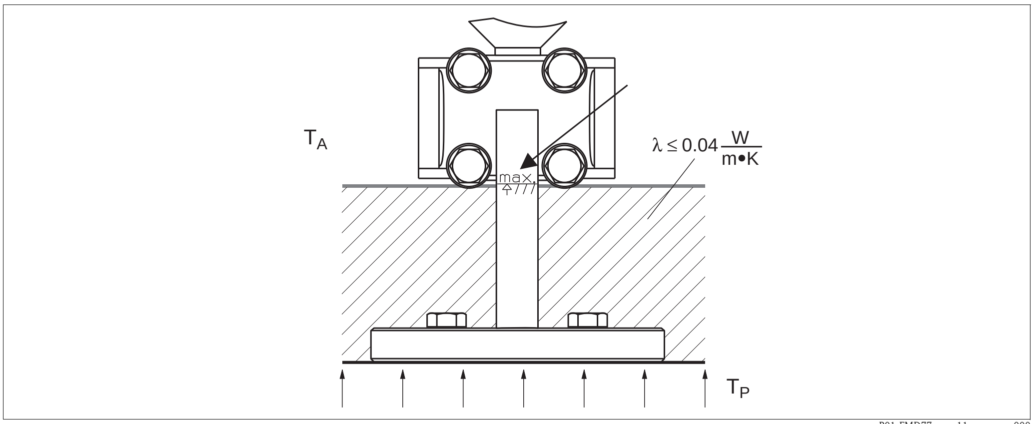


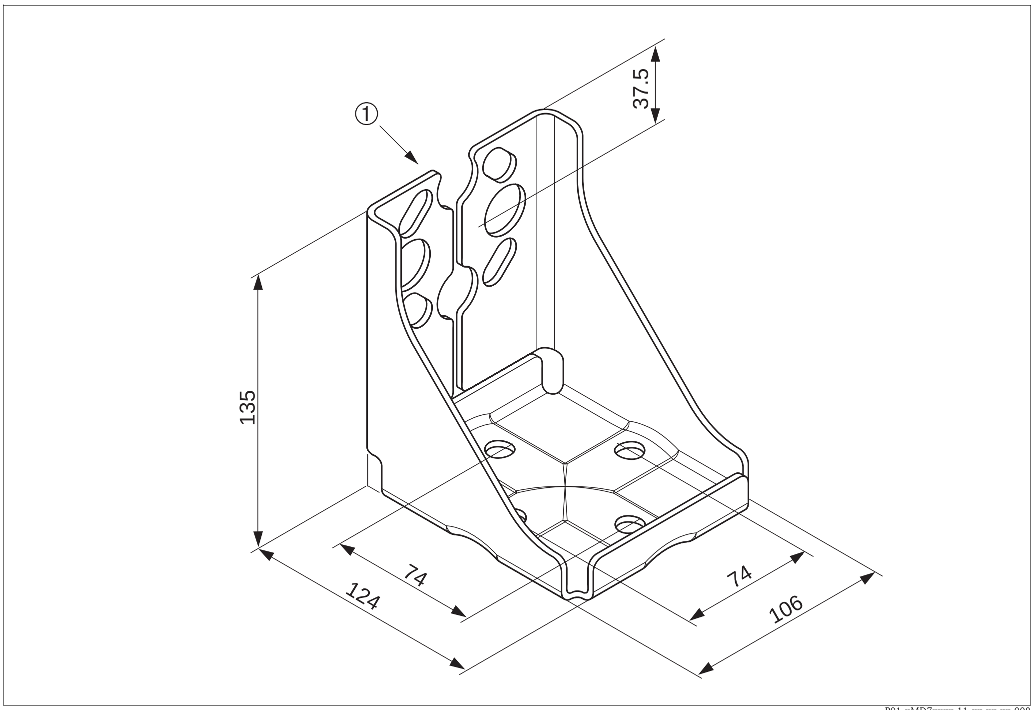
Fig. 22: Maximum permitted insulation height

	FMD77
Ambient temperature (T_A)	≤ 70°C (158°F)
Process temperature (T_P)	max. 400°C (752°F), depending on the diaphragm seal filling oil used (→ see Technical Information TI382P Deltabar S)

3.3.7 Wall and pipe-mounting (optional)

Endress+Hauser offers a mounting bracket for installing the device on pipes or walls. A bracket with mounting accessories for pipe mounting is included with the device.

Note!
When using a valve block, the block's dimensions must be taken into account.



P01-xMD7xxxx-11-xx-xx-xx-008

Fig. 23: Mounting bracket for wall and pipe mounting

1 Device mounting

Please note the following when mounting:
- Devices with capillary lines: mount capillaries with a bending radius of ≥ 100 mm (3.94 in).
- To prevent the mounting screws from scoring, lubricate them with a multi-purpose grease prior to mounting.
- In the case of pipe mounting, the nuts on the bracket must be tightened uniformly with a torque of at least 30 Nm (22.13 lbf ft).

3.3.8 Assembling and mounting the "separate housing" version

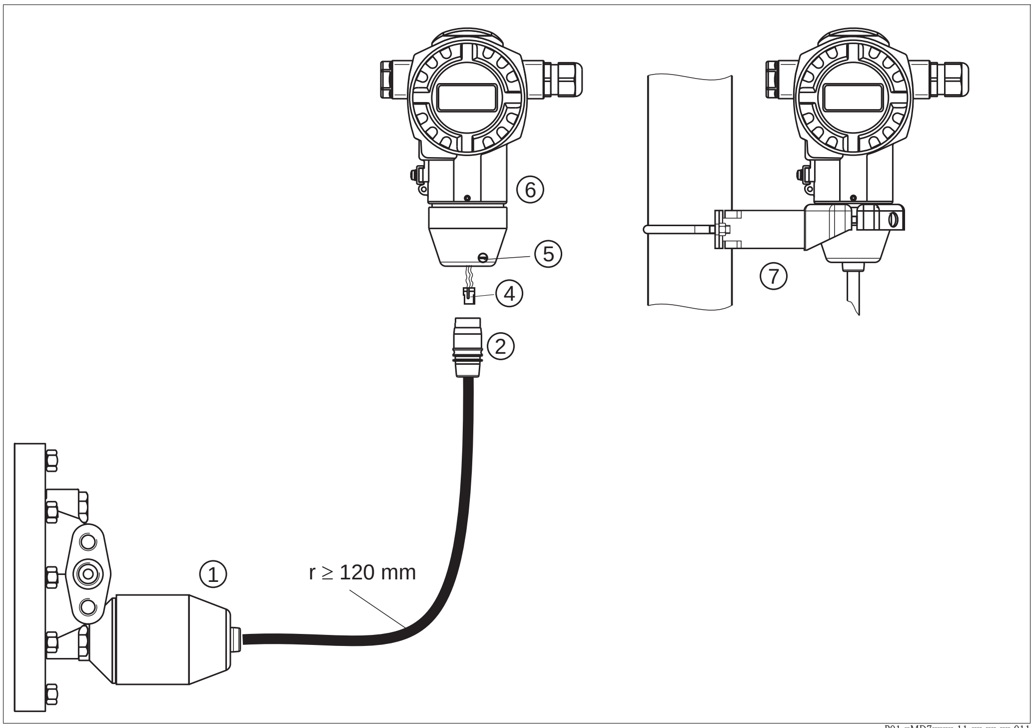


Fig. 24: "Separate housing" version

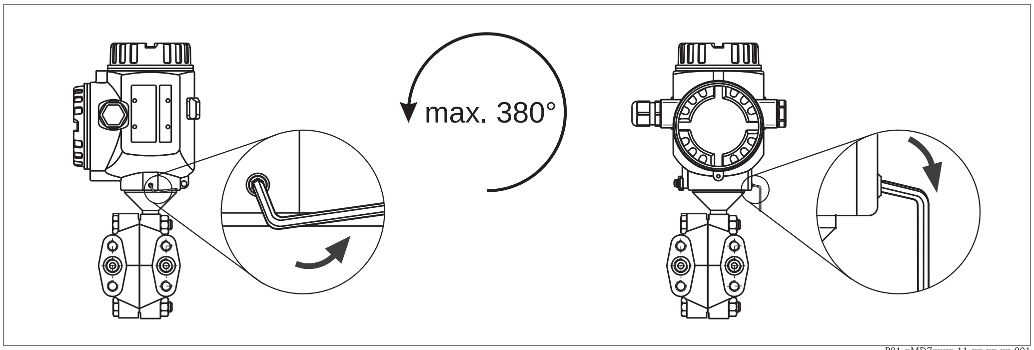
1 In the "separate housing" version, the sensor is supplied with process connection and cable fitted.
2 Cable with connection jack
4 Plug
5 Locking screw
6 Housing fitted with housing adapter, included
7 Mounting bracket suitable for wall and pipe mounting, included

Assembly and mounting

1. Connect plug (item 4) into the corresponding connection jack of the cable (item 2).
2. Plug the cable into the housing adapter (item 6).
3. Tighten the locking screw (item 5).
4. Mount the housing on a wall or pipe using the mounting bracket (item 7). When mounting on a pipe, tighten the nuts on the bracket uniformly with a torque of at least 5 Nm (3.69 lbs ft). Mount the cable with a bending radius (r) ≥ 120 mm (4.72 in).

3.3.9 Rotating the housing

The housing can be rotated up to 380° by loosening the Allen screw.

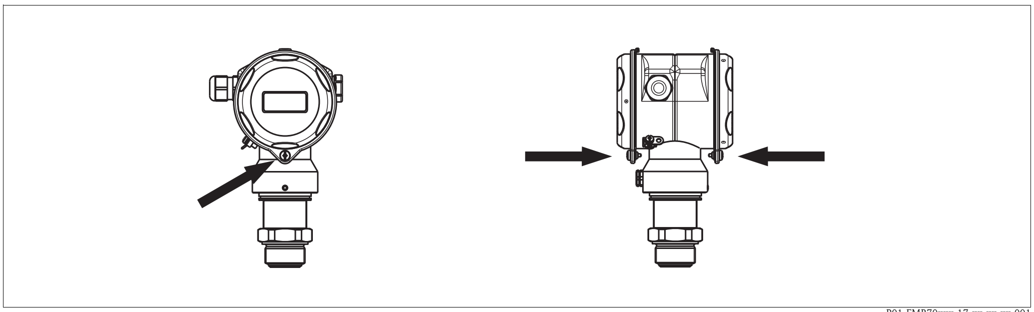


P01-xMD7xxxx-11-xx-xx-001

Fig. 25: Aligning the housing

– T14 and T15 housing: Loosen setscrew with a 2 mm (0.08 in) Allen key.
Hygenic T17 housing: Loosen setscrew with a 3 mm (0.12 in) Allen key.
– Rotate housing (max. up to 380°).
– Retighten setscrew.

3.3.10 Close cover on a hygenic stainless steel housing (T17)



P01-FMB70xxx-17-xx-xx-xx-001

Fig. 26: Close cover

The covers for the terminal and electronics compartment are hooked into the casing and closed with a screw. These screws should be finger-tightened (2 Nm (1.48 lbf ft)) to the stop to ensure that the covers sit tightly.

3.4 Post-installation check

After installing the device, carry out the following checks:

- Are all screws firmly tightened?
- Are the housing covers screwed down tight?
- Are all locking screws and vent valves firmly tightened?

4 Wiring

4.1 Connecting the device

Note!

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings.
- Devices with integrated overvoltage protection must be earthed.
- Protective circuits against reverse polarity, HF influences and overvoltage peaks are installed.

- The supply voltage must match the supply voltage on the nameplate. (→ 🗎 6, Section 2.1.1 "Nameplate".)
- Switch off the supply voltage before connecting the device.
- Remove housing cover of the terminal compartment.
- Guide cable through the gland. Preferably use twisted, screened two-wire cable.
- Connect device in accordance with the following diagram.
- Screw down housing cover.
- Switch on supply voltage.

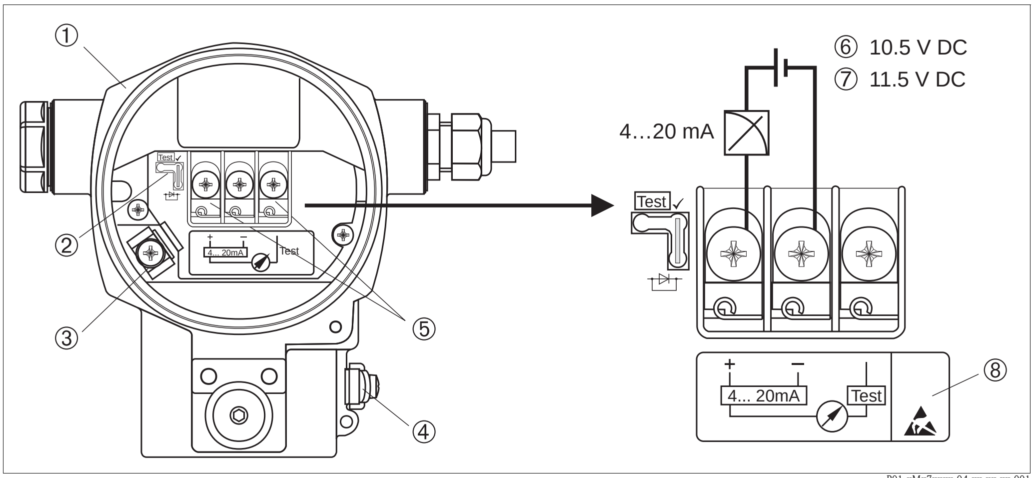
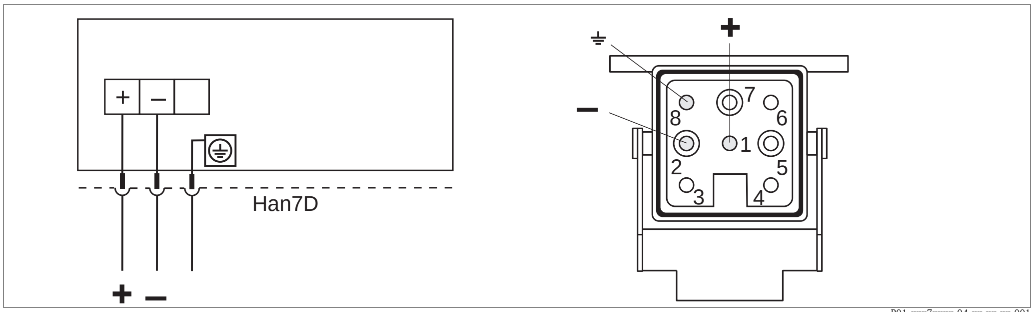


Fig. 27: Electrical connection 4...20 mA HART
→ Observe also sSection 4.2.1 "Supply voltage", → 🗎 25,.

1 *Housing*
2 *Jumper for 4...20 mA test signal.*
→ 🗎 25, Section 4.2.1 "Taking 4...20 mA test signal" part.
3 *Internal earth terminal*
4 *External earth terminal*
5 *4...20 mA test signal between plus and test terminal*
6 *minimum supply voltage = 10.5 V DC, jumper is inserted in accordance with the illustration.*
7 *minimum supply voltage = 11.5 V DC, jumper is inserted in "Test" position.*
8 *Devices with integrated overvoltage protection are labelled OVP (overvoltage protection) here.*

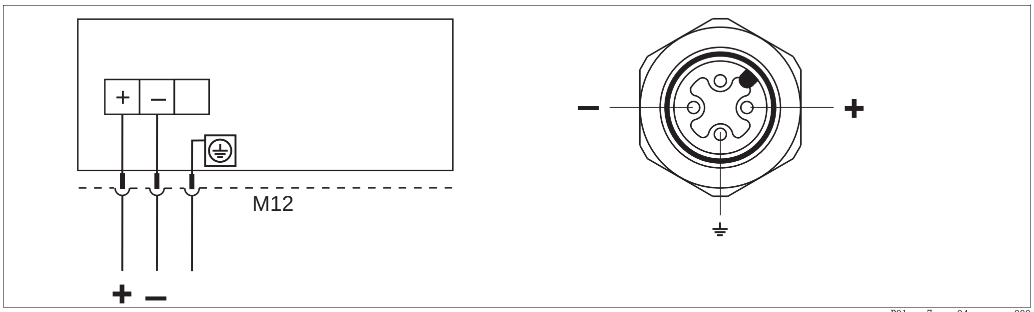
4.1.1 Connecting devices with Harting plug Han7D



P01-xxx7xxxx-04-xx-xx-xx-001

Fig. 28: Left: electrical connection for devices with Harting plug Han7D
Right: view of the plug connector at the device

4.1.2 Connecting devices with M12 plug



P01-xxx7xxxx-04-xx-xx-xx-000

Fig. 29: Left: electrical connection for devices with M12 plug
Right: view of the plug at the device

4.2 Connecting the measuring unit

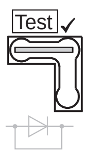
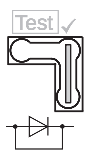
4.2.1 Supply voltage

Note!
- All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.
- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings.

Electronic version	Jumper for 4...20 mA test signal in "Test" position (Delivery status)	Jumper for 4...20 mA test signal in "Non-Test" position
4...20 mA HART, for non-hazardous areas	11.5...45 V DC	10.5...45 V DC

Taking 4...20 mA test signal

A 4...20 mA signal may be measured via the positive and test terminal without interrupting the measurement. The minimum supply voltage of the device can be reduced by simply changing the position of the jumper. As a result, operation is also possible with lower voltage sources. To keep the measured error below 0.1%, the current measuring device should display an internal resistance of < 0.7 Ω. Observe the position of the jumper in accordance with the following table.

Jumper position for test signal	Description
	– Taking 4...20 mA test signal via plus and test terminal: possible. (Thus, the output current can be measured without interruption via the diode.) – Delivery status – minimum supply voltage: 11.5 V DC
	– Taking 4...20 mA test signal via plus and test terminal: not possible. – minimum supply voltage: 10.5 V DC

4.2.2 Cable specification

- Endress+Hauser recommends using twisted, screened two-wire cables.
- Terminals for wire cross-sections 0.5...2.5 mm^2 (20 to 14 AWG)
- Cable external diameter: 5...9 mm (0.2 to 0.35 in)

4.2.3 Load

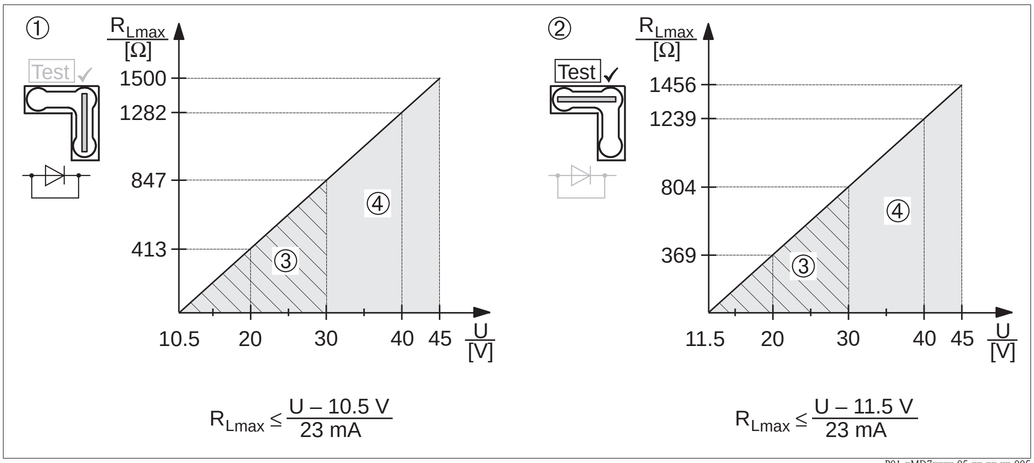


Fig. 30: Load diagram, observe the position of the jumper and the explosion protection (→ 🗎 25, Section 4.2.1 "Taking 4...20 mA test signal".)

1 Jumper for 4...20 mA test signal inserted in "Non-Test" position
2 Jumper for 4...20 mA test signal inserted in "Test" position
3 Supply voltage 10.5 (11.5)...30 V DC for 1/2 G, 1GD, 1/2 GD, FM IS, CSA IS, IECEx ia, NEPSI Ex ia
4 Supply voltage 10.5 (11.5)...45 V DC for device for non-hazardous areas, 1/2 D, 1/3 D, 2 G EEx d, 3 G EEx nA, FM XP, FM DIP, FM NI, CSA XP, CSA Dust Ex, NEPSI Ex d
R_{Lmax} Maximum load resistance
U Supply voltage

Note!
When operating via a handheld terminal or via PC with an operating program, a minimum communication resistance of 250 Ω must exist within the loop.

4.2.4 Screening/potential matching

- You achieve optimum screening against disturbances if the screening is connected on both sides (in the cabinet and on the device). If you have to reckon with potential equalisation currents in the plant, only earth screening on one side, preferably at the transmitter.
- When using in hazardous areas, you must observe the applicable regulations.
  Separate Ex documentation with additional technical data and instructions is included with all Ex systems as standard.

4.2.5 Connecting HART handheld terminal

With a HART handheld terminal you can set and check the transmitter and avail of additional functions all along the 4...20 mA line.

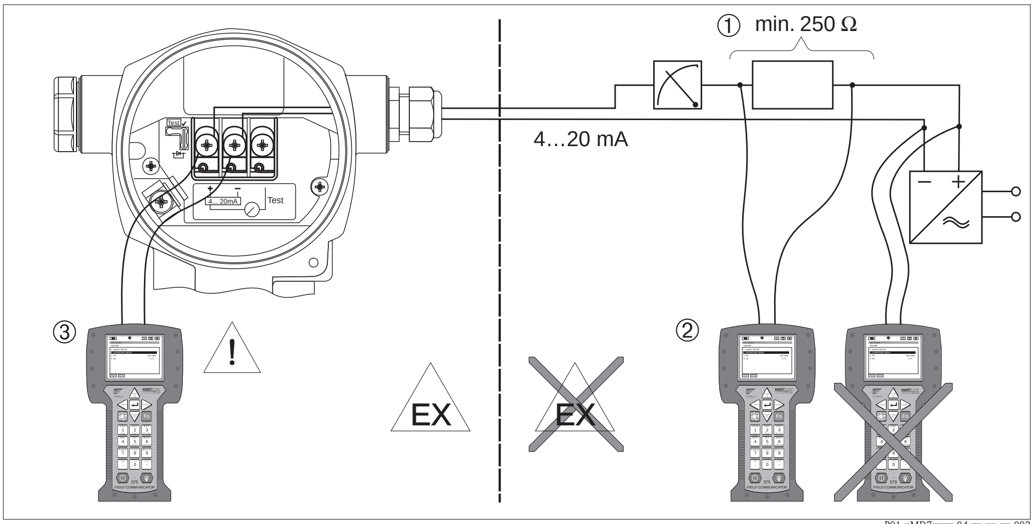
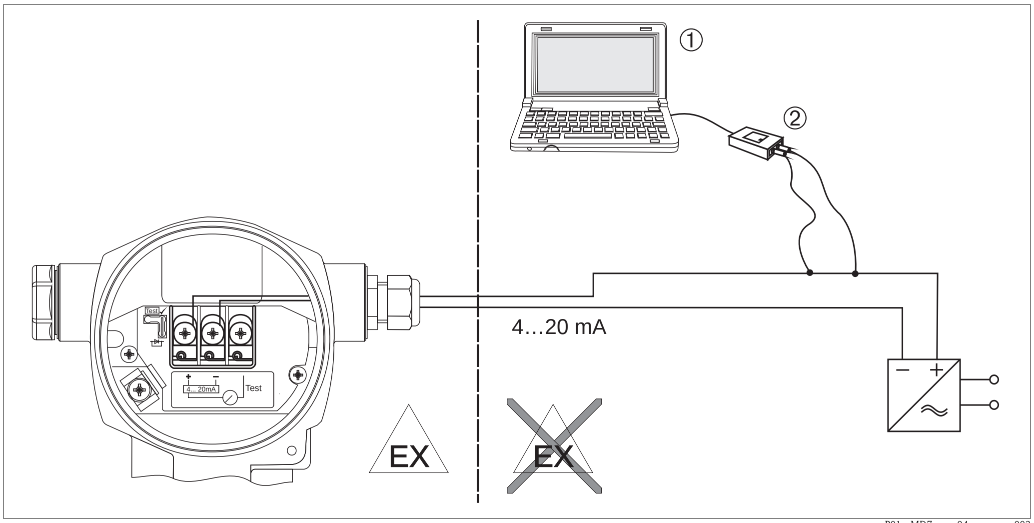


Fig. 31: Connecting an HART handheld terminal, e.g. Field Communicator 375

1 Necessary communication resistor ≥ 250 Ω
2 HART handheld terminal
3 HART handheld terminal, directly connected to the device even in the Ex i-area

Warning!
- In the case of Ex d type of protection, do not connect the handheld terminal in the hazardous area.
- Do not replace the battery of the handheld terminal in the hazardous area.
- For devices with FM or CSA certificates, establish electrical connection as per Installation or Control Drawing (ZD) supplied.

4.2.6 Connecting Commubox FXA195 for operation via FieldCare



P01-xMD7xxxx-04-xx-xx-xx-003

Fig. 32: Connecting PC with operating program FieldCare via Commubox FXA195

1 Computer with operating program FieldCare
2 Commubox FXA195

Connecting Commubox FXA195

The Commubox FXA195 connects intrinsically safe transmitters to a computer's USB port using the HART protocol. This allows remote operation of the measuring transmitter using Endress+Hauser operating program FieldCare. The Commubox is supplied with power through the USB port. The Commubox is also suitable for connection to intrinsically safe circuits. → See Technical Information TI237F for further information

4.2.7 Connecting Commubox FXA291/ToF Adapter FXA291 for operation via FieldCare

Connecting Commubox FXA291

The Commubox FXA291 connects Endress+Hauser field instruments with CDI interface (= Endress+Hauser Common Data Interface) to the USB interface of a personal computer or a notebook. For details refer to TI405C/07/en.

✎ Note!
For the following Endress+Hauser instruments you need the "ToF Adapter FXA291" as an additional accessory:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70

Connecting ToF Adapter FXA291

The ToF Adapter FXA291 connects the Commubox FXA291 via the USB interface of a personal computer or a notebook to the following Endress+Hauser instruments:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70

For details refer to KA271F/00/a2.

4.3 Potential matching

Ex applications: Connect all devices to the local potential matching.
Observe the applicable regulations.

4.4 Overvoltage protection (optional)

Devices showing version "M" in feature 100 "Additional options 1" or feature 110 "Additional options 2" in the order code are equipped with overvoltage protection (see also Technical Information TI382P "Ordering information".

- Overvoltage protection:
  - Nominal functioning DC voltage: 600 V
  - Nominal discharge current: 10 kA
- Surge current check î = 20 kA as per DIN EN 60079-14: 8/20 μs satisfied
- Arrester AC current check I = 10 A satisfied

Warning!
Devices with integrated overvoltage protection must be earthed.

4.5 Post-connection check

Perform the following checks after completing electrical installation of the device:

- Does the supply voltage match the specifications on the nameplate?
- Is the device connected as per section 4.1?
- Are all screws firmly tightened?
- Are the housing covers screwed down tight?

As soon as voltage is applied to the device, the green LED on the electronic insert lights up for a few seconds or the connected on-site display lights up.

5 Operation

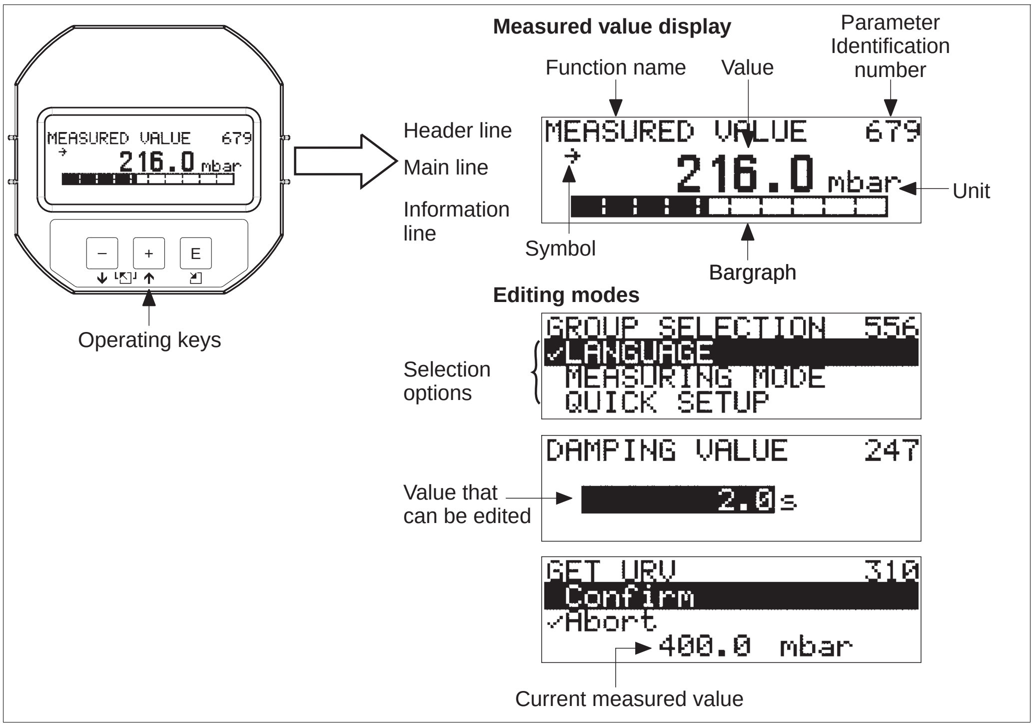
Feature 20 "Output; operation" in the order code provides you with information on the operating options available to you.

Versions in the order code		Operation
A	4...20 mA HART; external operation, LCD	Via on-site display and 3 keys on the exterior of the device
B	4...20 mA HART; internal operation, LCD	Via on-site display and 3 keys on the inside of the device
C	4...20 mA; internal operation	Without on-site display, 3 keys on the inside of the device

5.1 On-site display (optional)

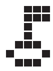
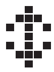
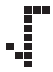
A 4-line liquid crystal display (LCD) is used for display and operation. The on-site display shows measured values, dialog texts, fault messages and notice messages.
The display of the device can be turned in 90° steps.
Depending on the installation position of the device, this makes it easy to operate the device and read the measured values.

Functions:
- 8-digit measured value display including sign and decimal point, bargraph for current display
- simple and complete menu guidance thanks to separation of the parameters into several levels and groups
- each parameter is given a 3-digit ID number for easy navigation
- option for configuring the display according to individual requirements and desires, such as language, alternating display, contrast setting, display of other measured values such as sensor temperature
- comprehensive diagnostic functions (fault and warning message, peak-hold indicators, etc.)
- rapid and safe commissioning with the Quick Setup menus



P01-xMx7xxxx-07-xx-xx-xx-001

The following table illustrates the symbols that can appear on the on-site display. Four symbols can occur at one time.

Symbol	Meaning
	**Alarm symbol** – Symbol flashing: warning, device continues measuring. – Symbol permanently lit: error, device does not continue measuring. *Note:* The alarm symbol may overlie the tendency symbol.
	**Lock symbol** The operation of the device is locked. Unlock device, → Section 5.8.
	**Communication symbol** Data transfer via communication *Note:* The alarm symbol may overlie the communication symbol.
	**Square root symbol** Active measuring mode "Flow measurement" The root flow signal is used for the current output.
	**Tendency symbol (increasing)** The measured value is increasing.
	**Tendency symbol (decreasing)** The measured value is decreasing.
	**Tendency symbol (constant)** The measured value has remained constant over the past few minutes.

5.2 Operating elements

5.2.1 Position of operating elements

With regard to aluminium housings (T14/T15) and stainless steel housing (T14), the operating keys are located either outside the device under the protection cap or inside on the electronic insert. In hygenic stainless housings (T17), the operating keys are always located inside on the electronic insert.

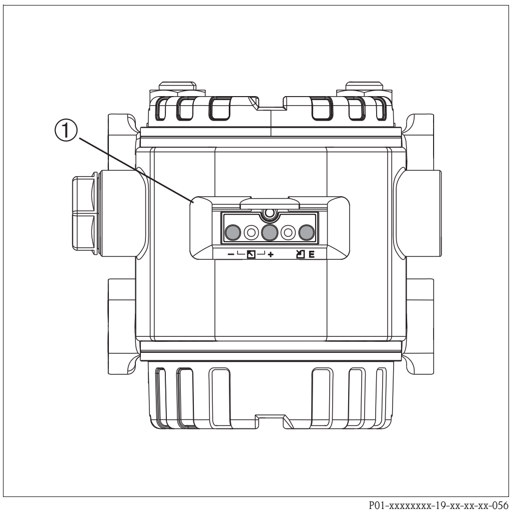


Fig. 33: Operating keys, external

1 *Operating keys on the exterior of the device under the protective flap*

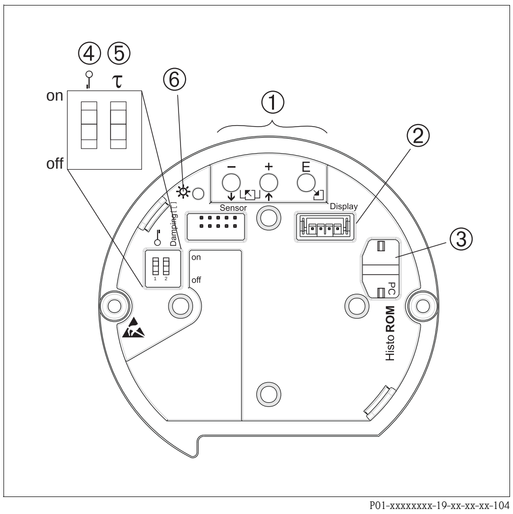
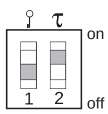


Fig. 34: Operating keys, internal

1 *Operating keys*
2 *Slot for optional display*
3 *Slot for optional HistoROM®/M-DAT*
4 *DIP-switch for locking/unlocking measured-value-relevant parameters*
5 *DIP-switch for damping on/off*
6 *Green LED to indicate value being accepted*

5.2.2 Function of the operating elements – on-site display not connected

Press and hold the key or the key combination for at least 3 seconds to execute the corresponding function. Press the key combination for at least 6 seconds for a reset.

Operating key(s)	Meaning
–	Adopt lower range value. A reference pressure is present at the device. → 36, Section 5.3.1 "Pressure measuring mode", → 37, Section 5.3.2 "Level measuring mode" or → 39, Section 5.3.3 "Flow measuring mode".
+	Adopt upper range value. A reference pressure is present at the device. → 36, Section 5.3.1 "Pressure measuring mode", → 37, Section 5.3.2 "Level measuring mode" or → 39, Section 5.3.3 "Flow measuring mode".
E	Position adjustment
+ and – and E	Reset all parameters. The reset via operating keys corresponds to the software reset code 7864.
+ and E	Copy the configuration data from the optional HistoROM®/M-DAT module to the device.
– and E	Copy the configuration data from the device to the optional HistoROM®/M-DAT module.
 P01-xxxxxxxx-19-xx-xx-xx-057	– DIP-switch 1: for locking/unlocking measured-value-relevant parameters Factory setting: off (unlocked) – DIP-switch 2: damping on/off, Factory setting: on (damping on)

5.2.3 Function of the operating elements – on-site display connected

Operating key(s)	Meaning
+	– Navigate upwards in the picklist – Edit the numerical values and characters within a function
–	– Navigate downwards in the picklist – Edit the numerical values and characters within a function
E	– Confirm entry – Jump to the next item
+ and E	Contrast setting of on-site display: darker
– and E	Contrast setting of on-site display: brighter
+ and –	ESC functions: – Exit edit mode without saving the changed value. – You are in a menu within a function group. The first time you press the keys simultaneously, you go back a parameter within the function group. Each time you press the keys simultaneously after that, you go up a level in the menu. – You are in a menu at a selection level. Each time you press the keys simultaneously, you go up a level in the menu. *Note:* The terms function group, level and selection level are explained in section 5.4.1, page 40.

5.3 On-site operation – on-site display not connected

Note!
To operate the device with a HistoROM®/M-DAT module → 🗎 42, Section 5.5 "HistoROM®/M-DAT (optional)".

5.3.1 Pressure measuring mode

If no on-site display is connected, the following functions are possible by means of the three keys on the electronic insert or on the exterior of the device:

- Position adjustment (zero point correction)
- Setting lower range value and upper range value
- Device reset, → 🗎 34, Section 5.2.2 "Function of the operating elements – on-site display not connected", Table.

Note!

- The operation must be unlocked. → 🗎 47, Section 5.8 "Locking/unlocking operation".
- The device is configured for the Pressure measuring mode as standard. You can switch measuring modes by means of the MEASURING MODE parameter. → 🗎 50, Section 6.2 "Selecting language and measuring mode".
- The pressure applied must be within the nominal pressure limits of the sensor. See information on the nameplate.

Carry out position adjustment.[1]	
Pressure is present at device.	
↓	
Press "E"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
Applied pressure for position adjustment has been accepted.	Applied pressure for position adjustment has not been accepted. Observe the input limits.

Setting lower range value.	
Desired pressure for lower range value is present at device.	
↓	
Press "–"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
Applied pressure for lower range value has been accepted.	Applied pressure for lower range value has not been accepted. Observe the input limits.

Setting upper range value.	
Desired pressure for upper range value is present at device.	
↓	
Press "+"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
Applied pressure for upper range value has been accepted.	Applied pressure for upper range value has not been accepted. Observe the input limits.

1) Observe "Warning" on page 50 in Chapter 6 "Commissioning".

5.3.2 Level measuring mode

If no on-site display is connected, the following functions are possible by means of the three keys on the electronic insert or on the exterior of the device:

- Position adjustment (zero point correction)
- Set the lower and upper pressure value and assign to the lower and upper level value
- Device reset, → 🗎 34, Section 4.2.2 "Function of the operating elements – on-site display not connected", Table.

Note!

- The "-" and "+"- keys only have a function in the following cases:
  - LEVEL SELECTION "Level Easy Pressure", CALIBRATION MODE "Wet"
  - LEVEL SELECTION "Level Standard", LEVEL MODE "Linear", CALIBRATION MODE "Wet"

  The keys have no function in other settings.
- The device is configured for the Pressure measuring mode as standard. You can switch measuring modes by means of the MEASURING MODE parameter. → 🗎 50, Section 6.2 "Selecting language and measuring mode".
  The following parameters are set to the following values in the factory:
  - LEVEL SELECTION: Level Easy Pressure
  - CALIBRATION MODE: Wet
  - OUTPUT UNIT or LIN. MEASURAND: %
  - EMPTY CALIB.: 0.0
  - FULL CALIB.: 100.0.
  - SET LRV: 0.0 (corresponds to 4 mA value)
  - SET URV: 100.0 (corresponds to 20 mA value)

  These parameters can only be modified by means of the on-site display or remote operation such as the FieldCare.
- The operation must be unlocked. → 🗎 47, Section 5.8 "Locking/unlocking operation".
- The pressure applied must be within the nominal pressure limits of the sensor. See information on the nameplate.
- → 🗎 56, Section 6.5 "Level measurement". For parameter description see Operating Instructions BA274P.
- LEVEL SELECTION, CALIBRATION MODE, LEVEL MODE, EMPTY CALIB., FULL CALIB, SET LRV and SET URV are parameter names used for on-site display or remote operation such as FieldCare for instance.

Carry out position adjustment.[1]	
Pressure is present at device.	
↓	
Press "E"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
Applied pressure for position adjustment has been accepted.	Applied pressure for position adjustment has not been accepted. Observe the input limits.

Setting lower pressure value.	
Desired pressure for lower pressure value (EMPTY PRESSURE[2]) is present at device.	
↓	
Press "–"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
The pressure present was saved as the lower pressure value (EMPTY PRESSURE[1]) and assigned to the lower level value (EMPTY CALIB.[1]).	The pressure present was not saved as the lower pressure value. Observe the input limits.

Setting upper pressure value.	
Desired pressure for upper pressure value (FULL PRESSURE[1]) is present at device.	
↓	
Press "+"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
The pressure present was saved as the upper pressure value (FULL PRESSURE[1]) and assigned to the upper level value (FULL CALIB.[1]).	The pressure present was not saved as the upper pressure value. Observe the input limits.

1) Observe "Warning" on page 50 in Chapter 6 "Commissioning".

2) Parameter name used for the on-site display or remote operation such as the FieldCare.

5.3.3 Flow measuring mode

If no on-site display is connected, the following functions are possible by means of the three keys on the electronic insert or on the exterior of the device:

- Position adjustment (zero point correction)
- Set the maximum pressure value and assign it to the maximum flow value
- Device reset, → 🗎 34, Section 5.2.2 "Function of the operating elements – on-site display not connected", Table.

Note!

- The operation must be unlocked. → 🗎 47, Section 5.8 "Locking/unlocking operation".
- The device is configured for the Pressure measuring mode as standard. You can switch measuring modes by means of the MEASURING MODE parameter. → 🗎 50, Section 6.2 "Selecting language and measuring mode".
- The "–"- key does not have any function.
- The pressure applied must be within the nominal pressure limits of the sensor. See information on the nameplate.
- → 🗎 55, Section 6.4.3 "Quick Setup menu for the Flow measuring mode" and Operating Instructions BA274P, parameter descriptions MAX. PRESS. FLOW, MAX. FLOW, SET LRV – Flow and LINEAR/SQROOT.

Carry out position adjustment.[1]	
Pressure is present at device.	
↓	
Press "E"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
Applied pressure for position adjustment has been accepted.	Applied pressure for position adjustment has not been accepted. Observe the input limits.

Setting maximum pressure value.	
Desired pressure for the maximum pressure value (MAX. FLOW[2]) is present at device.	
↓	
Press "+"-key for 3 s.	
↓	
Does the LED on the electronic insert light up briefly?	
Yes	No
↓	↓
The pressure present was saved as the maximum pressure value (MAX. PRESS FLOW[1]) and assigned to the maximum flow value (MAX. FLOW.[1]).	The pressure present was not saved as the maximum pressure value. Observe the input limits.

1) Observe "Warning" on page 50 in Chapter 6 "Commissioning".

2) Parameter name used for the on-site display or remote operation such as the FieldCare.

5.4 On-site operation – on-site display connected

If the on-site display is connected, the three operating keys are used to navigate through the operating menu, → 📄 35, Section 5.2.3 "Function of the operating elements – on-site display connected".

5.4.1 General structure of the operating menu

The menu is split into four levels. The three upper levels are used to navigate while you use the bottom level to enter numerical values, select options and save settings. The entire menu is illustrated in section 10.1 "Menu for on-site display, FieldCare and HART handheld terminal". The structure of the OPERATING MENU depends on the measuring mode selected, e.g. if the "Pressure" measuring mode is selected, only the functions necessary for this mode are displayed.

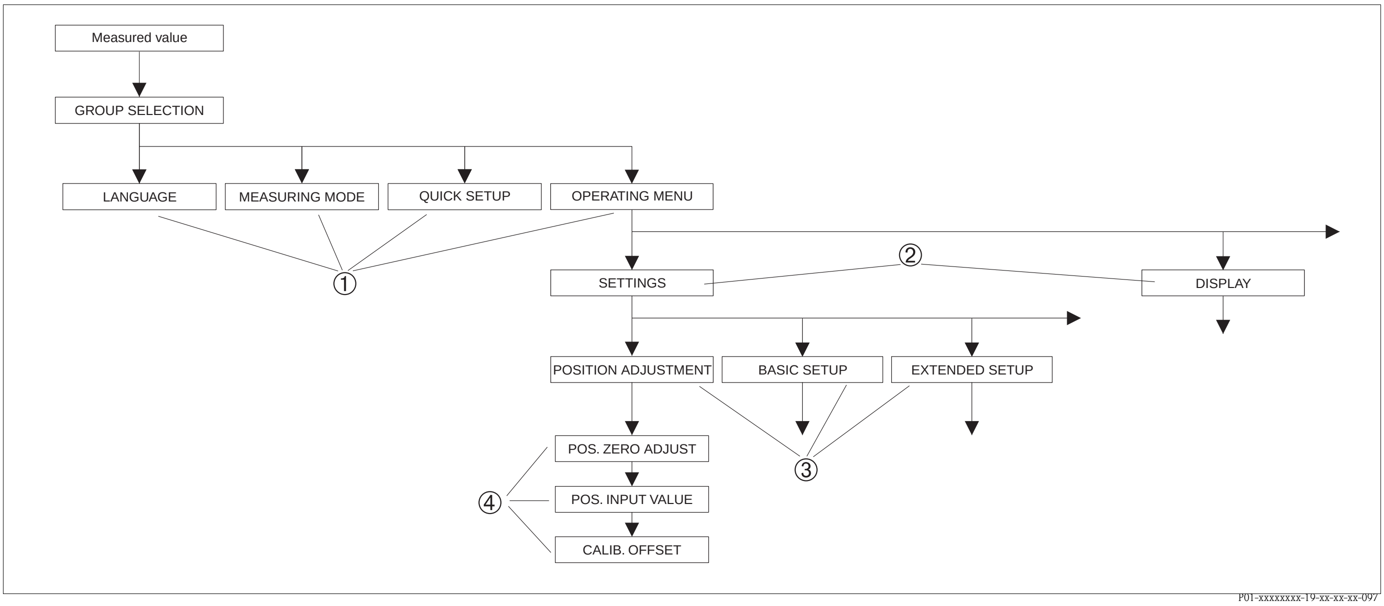


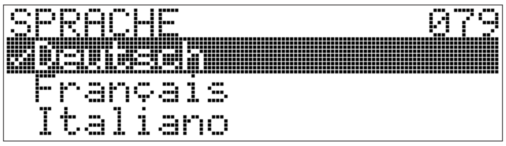
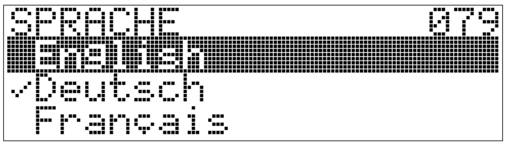
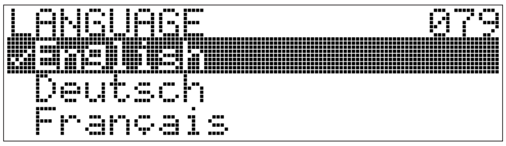
Fig. 35: Structure of the operating menu

1 1. Selection level
2 2. Selection level
3 Function groups
4 Parameter

Note!
The LANGUAGE and MEASURING MODE parameters are only displayed via the on-site display on the 1st selection level. In the digital communication, the LANGUAGE parameter is displayed in the DISPLAY group and the MEASURING MODE parameter is displayed in the QUICK SETUP menus or in the BASIC SETUP function group. → See also Section 10.1 "Operating menu for on-site display, FieldCare and HART handheld terminal".

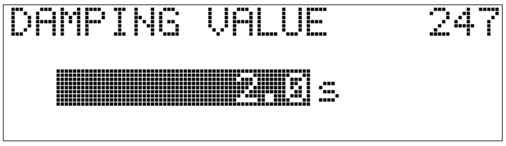
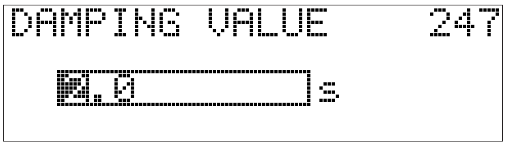
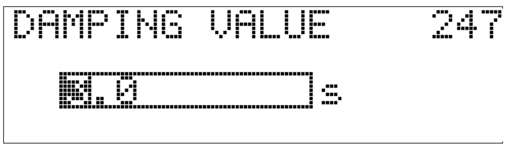
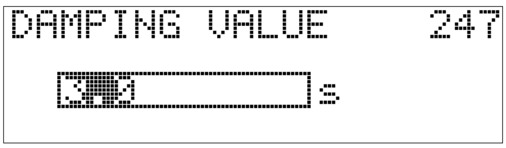
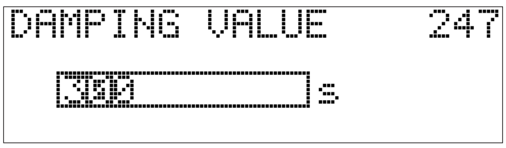
5.4.2 Selecting an option

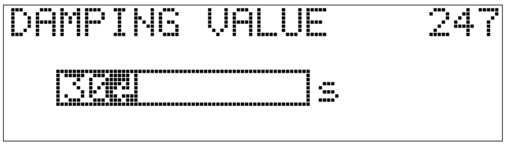
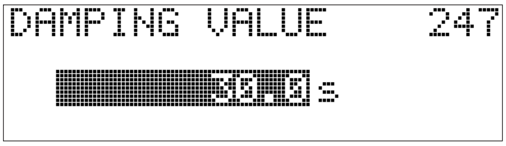
Example: select "English" as the language of the menu.

On-site display	Operation
 P01-xxxxxxxx-19-xx-xx-xx-017	German is selected as the language. A ✓in front of the menu text indicates the active option.
 P01-xxxxxxxx-19-xx-xx-xx-033	Select English with "+" or "–".
 P01-xxxxxxxx-19-xx-xx-xx-034	1. Confirm your choice with "E". A ✓ in front of the menu text indicates the active option. (English is now selected as the menu language.) 2. Jump to the next item with "E".

5.4.3 Editing a value

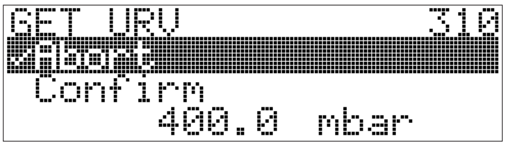
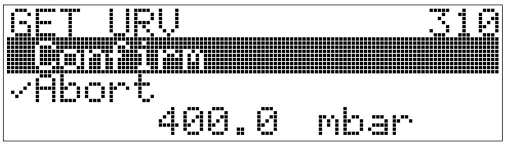
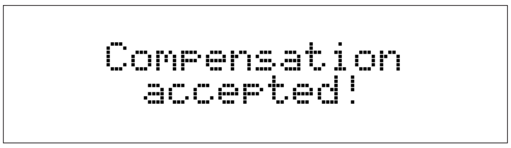
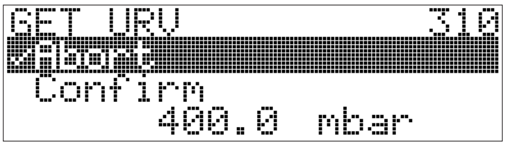
Example: adjusting DAMPING VALUE function from 2.0 s to 30.0 s. → 🗎 35, Section 5.2.3 "Function of the operating elements – on-site display connected".

On-site display	Operation
 P01-xxxxxxxx-19-xx-xx-xx-023	The on-site display shows the parameter to be changed. The value highlighted in black can be changed. The "s" unit is fixed and cannot be changed.
 P01-xxxxxxxx-19-xx-xx-xx-027	1. Press "+" or "–" to get to the editing mode. 2. The first digit is highlighted in black.
 P01-xxxxxxxx-19-xx-xx-xx-028	1. Use "+" to change "2" to "3". 2. Confirm "3" with "E". The cursor jumps to the next position (highlighted in black).
 P01-xxxxxxxx-19-xx-xx-xx-029	The decimal point is highlighted in black, i.e. you can now edit it.
 P01-xxxxxxxx-19-xx-xx-xx-030	1. Keep pressing "+" or "–" until "0" is displayed. 2. Confirm "0" with "E". The cursor jumps to the next position. ↵ is displayed and is highlighted in black. → See next graphic.

On-site display	Operation
 P01-xxxxxxxx-19-xx-xx-xx-031	Use "E" to save the new value and exit the editing mode. → See next graphic.
 P01-xxxxxxxx-19-xx-xx-xx-032	The new value for the damping is now 30.0 s. – Jump to the next parameter with "E". – You can get back to the editing mode with "+" or "–".

5.4.4 Taking pressure applied at device as value

Example: configuring upper range value – assign 20 mA to the pressure value 400 mbar.

On-site display	Operation
 P01-xxxxxxxx-19-xx-xx-xx-035	The bottom line on the on-site display displays the pressure present, here 400 mbar.
 P01-xxxxxxxx-19-xx-xx-xx-036	Use "+" or "–" to switch to the "Confirm" option. The active selection is highlighted in black.
 P01-xxxxxxxx-19-xx-xx-xx-037	Use "E" to assign the value (400 mbar) to the GET URV parameter. The device confirms the calibration and jumps back to the parameter, here GET URV (see next graphic).
 P01-xxxxxxxx-19-xx-xx-xx-035	Switch to the next parameter with "E".

5.5 HistoROM®/M-DAT (optional)

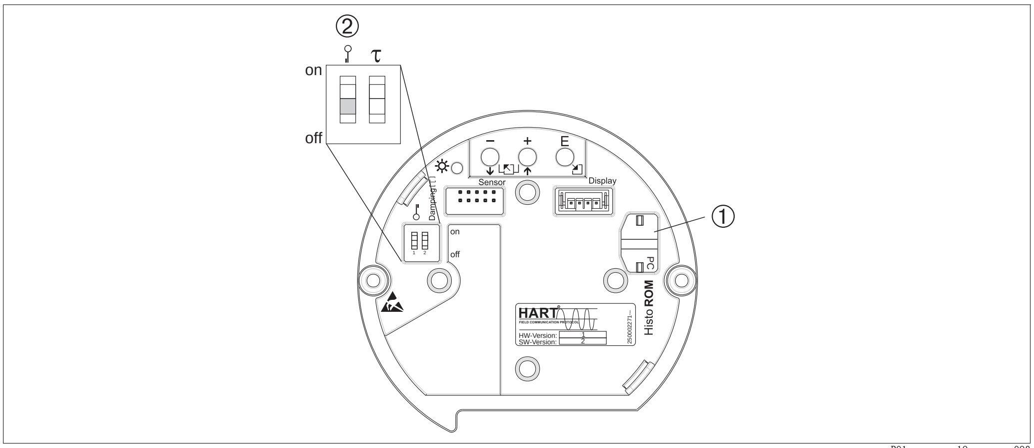
HistoROM®/M-DAT is a memory module, which is attached to the electronic insert and fulfils the following functions:

- Back-up copy of configuration data
- Copying configuration data of a transmitter into another transmitter
- Cyclic recording of pressure and sensor-temperature measured values
- Recording diverse events, such as alarms, configuration changes, counters for measuring range undershooting and exceeding for pressure and temperature, exceeding and undershooting the user limits for pressure and temperature, etc.

Warning!
Detach HistoROM®/M-DAT from the electronic insert or attach it to the insert in a deenergised state only.

Note!
- The HistoROM®/M-DAT module may be retrofitted at any time (Order No.: 52027785).
- The HistoROM data and the data in the device are analysed once a HistoROM®/M-DAT is attached to the electronic insert and power is reestablished to the device. During the analysis, the messages "W702, HistoROM data not consistent" and "W706, Configuration in HistoROM and device not identical" can occur. For measures, → 67, Section 8.1 "Messages."

5.5.1 Copying configuration data



P01-xxxxxxxx-19-xx-xx-xx-098

Abb. 36: Electronic insert with optional HistoROM®/M-DAT memory module

1 optional HistoROM®/M-DAT
2 To copy configuration data from the HistoROM®/M-DAT module to a device or from a device to a HistoROM®/ M-DAT,, the operation must be unlocked DIP-switch 1, Position "off" ,parameter INSERT PIN NO. = 100). Observe page 47, section 5.9 "Locking/unlocking operation".

On-site operation – on-site display not connected

Copying configuration data from a device to a HistoROM®/M-DAT module:

Note!
The operation must be unlocked.

1. Disconnect device from supply voltage.
2. Attach the HistoROM®/M-DAT module to the electronic insert.
3. Reestablish supply voltage to the device.
4. Press "E" and "–"-keys (for at least 3 seconds) until the LED on the electronic insert lights up.
5. Wait approx. 20 seconds. Configuration data are loaded from the device to the HistoROM®/ M-DAT. The device is not restarted.
6. Disconnect device from the supply voltage again.
7. Detach memory module.
8. Reestablish supply voltage to the device.

Copying configuration data from a HistoROM®/M-DAT to a device:

Note!
The operation must be unlocked.

1. Disconnect device from supply voltage.
2. Attach the HistoROM®/M-DAT module to the electronic insert. Configuration data from another device are stored in the HistoROM®/M-DAT.
3. Reestablish supply voltage to the device.
4. Press "E" und "+"-keys (for at least 3 seconds) until the LED on the electronic insert lights up.
5. Wait approx. 20 seconds. All parameters except DEVICE SERIAL No, DEVICE DESIGN., CUST. TAG NUMBER, LONG TAG NUMBER, DESCRIPTION, BUS ADDRESS and the parameters in the POSITION ADJUSTMENT and PROCESS CONNECTION group are loaded into the device by HistoROM®/M-DAT. The device is restarted.
6. Before removing the HistoROM®/M-DAT again from the electronic insert, disconnect the device from supply voltage.

On-site operation via on-site display (optional) or remote operation

Copying configuration data from a device to a HistoROM®/M-DAT:

Note!
The operation must be unlocked.

1. Disconnect device from supply voltage.
2. Attach the HistoROM®/M-DAT module to the electronic insert.
3. Reestablish supply voltage to the device.
4. The DOWNLOAD SELECT. parameter setting has no influence on an upload from the device into HistoROM.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → OPERATION)
5. Using the HistoROM CONTROL parameter select the option "Device → HistoROM" as the data transfer direction.
   (Menu path: GROUPSELECTION → OPERATING MENU → OPERATION)
6. Wait approx. 20 seconds. Configuration data are loaded from the device to the HistoROM®/M-DAT. The device is not restarted.
7. Disconnect device from the supply voltage again.
8. Detach memory module.
9. Reestablish supply voltage to the device.

Copying configuration data from a HistoROM®/M-DAT to a device:

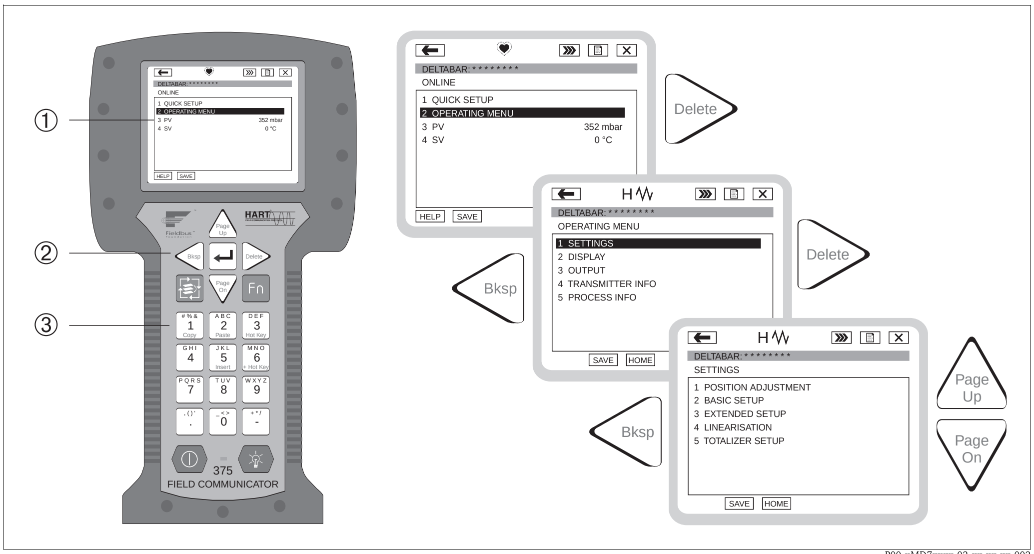
Note!
The operation must be unlocked.

1. Disconnect device from supply voltage.
2. Attach the HistoROM®/M-DAT module to the electronic insert. Configuration data from another device are stored in the HistoROM®/M-DAT.
3. Reestablish supply voltage to the device.
4. Use the DOWNLOAD SELECT parameter to select which parameters are to be overwritten (Menu path: (GROUPS SELECTION →) OPERATING MENU → OPERATION).

   The following parameters are overwritten according to the selection:
   – **Configuration copy (factory setting):**
     all parameters except DEVICE SERIAL No., DEVICE DESIGN, CUST. TAG NUMBER, LONG TAG NUMBER, DESCRIPTION, BUS ADDRESS and the parameters in the POSITION ADJUSTMENT, PROCESS CONNECTION, CURR. TRIM (SERVICE /SYSTEM 2), SENSOR TRIM and SENSOR DATA group.
   – **Device replacement:**
     all parameters except DEVICE SERIAL No., DEVICE DESIGN and the parameters in the POSITION ADJUSTMENT, PROCESS CONNECTION, CURR. TRIM (SERVICE/SYSTEM 2), SENSOR TRIM and SENSOR DATA group.
   – **Electronics replace**:
     all parameters except the parameters in the CURR. TRIM (SERVICE/SYSTEM 2), POSITION ADJUSTMENT and SENSOR DATA group.
   Factory setting: Configuration copy
5. Using the HistoROM CONTROL parameter select the option "HistoROM → Device" as the data transfer direction.
   (Menu path: GROUP SELECTION → OPERATING MENU → OPERATION)
6. Wait approx. 20 seconds. Configuration data are loaded from the device to the HistoROM®/ M-DAT. The device is restarted.
7. Before removing the HistoROM®/M-DAT again from the electronic insert, disconnect the device from supply voltage.

5.6 Operation via HART handheld terminal

Use the HART handheld terminal to set all parameters all the way along the 4...20 mA cable via menu operation.



P00-xMD7xxxx-02-xx-xx-xx-002

Fig. 37: HART handheld terminal, here e.g. Field Communicator 375 and menu guidance

1 LC display with menu text
2 Keys for menu selection
3 Keys for parameter entry

Note!
- → 27, Section 4.2.5 "Connecting HART handheld terminal".
- For further information, please refer to the Operating Instructions for the handheld terminal. The Operating Instructions are supplied with the handheld terminal.

5.7 FieldCare

FieldCare is an FDT-based system asset management tool from Endress+Hauser. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard. The following operating systems are supported: WinNT4.0, Win2000 and Windows XP.

FieldCare supports the following functions:
- Configuration of transmitters in online operation
- Loading and saving device data (upload/download)
- HistoROM®/M-DAT analysis
- Documentation of the measuring point

Connection options:
- HART via Commubox FXA195 and the USB interface of a computer
- HART via Fieldgate FXA520

Note!
- → 28, Section 4.2.6 "Connecting Commubox FXA195 for operation via FieldCare".
- Further information on the FieldCare can be found on the Internet (http://www.endress.com, Download → Search for: FieldCare).

5.8 Locking/unlocking operation

Once you have entered all the parameters, you can lock your entries against unauthorised and undesired access.

You have the following possibilities for locking/unlocking the operation:
- Via a DIP-switch on the electronic insert, locally on the display.
- Via the on-site display (optional)
- Via digital communication.

The -symbol on the on-site display indicates that operation is locked. Parameters which refer to how the display appears, e.g. LANGUAGE and DISPLAY CONTRAST can still be altered.

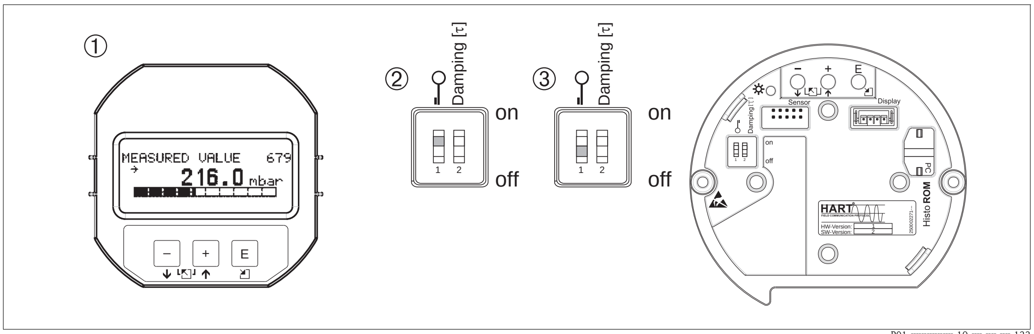
Note!
- If operation is locked by means of the DIP-switch, you can only unlock operation again by means of the DIP-switch. If operation is locked by means of the on-site display or remote operation e.g. FieldCare, you can only unlock operation again by means of the on-site display or remote operation.

The table provides an overview of the locking functions:

Locking via	View/read parameter	Modify/write via[1]		Unlocking via		
		On-site display	Remote operation	DIP-switch	On-site display	Remote operation
DIP-switch	Yes	No	No	Yes	No	No
On-site display	Yes	No	No	No	Yes	Yes
Remote operation	Yes	No	No	No	Yes	Yes

1) Parameters which refer to how the display appears, e.g. LANGUAGE and DISPLAY CONTRAST can still be altered.

5.8.1 Locking/unlocking operation locally via DIP-switch



P01-xxxxxxxx-19-xx-xx-xx-133

Fig. 38: DIP-switch position "Hardware locking" on the electronic insert

1 If necessary, remove on-site display (optional)
2 DIP-switch is at "on": operation is locked.
3 DIP-switch is at "off": operation is unlocked (operation possible)

5.8.2 Locking/unlocking operation via on-site display or remote operation

	Description
Locking operation	1. Select INSERT PIN NO. parameter, Menu path: OPERATING MENU → OPERATION → INSERT PIN NO. 2. To lock operation, enter a number for this parameter between 0...9999 that is ≠100.
Unlocking operation	1. Select INSERT PIN NO. parameter. 2. To unlock operation, enter "100" for the parameter.

5.9 Factory setting (reset)

By entering a certain code, you can completely, or partially, reset the entries for the parameters to the factory settings. (→ For factory settings refer to the Operating Instructions BA274P "Cerabar S/ Deltabar S/Deltapilot S, Description of device functions". → 🗎 2, "Overview documentation".)
Enter the code by means of the ENTER RESET CODE parameter (Menu path: (GROUP SELECTION →) OPERATING MENU → OPERATING).
There are various reset codes for the device. The following table illustrates which parameters are reset by the particular reset codes. Operation must be unlocked to reset parameters (→ 🗎 48, Section 5.9).

✎ Note!
Any customer-specific configuration carried out by the factory is not affected by a reset (customer-specific configuration remains). If, after a reset, you wish the parameters to be reset to the factory settings, please contact Endress+Hauser Service.

Reset code	Description and effect
1846	**Display reset** – This reset resets all parameters which have to do with how the display appears (DISPLAY group). – Any simulation which may be running is ended. – The device is restarted.
62	**PowerUp reset (warm start)** – This reset resets all the parameters in the RAM. Data are read back anew from the EEPROM (processor is initialised again). – Any simulation which may be running is ended. – The device is restarted.
2710	**Measuring mode level reset** – Depending on the settings for the LEVEL MODE, LIN MEASURAND, LINdMEASURAND or COMB. MEASURAND parameters, the parameters needed for this measuring task will be reset. – Any simulation which may be running is ended. – The device is restarted. Example LEVEL MODE = linear and LIN. MEASURAND = Height ▪ HEIGHT UNIT = m ▪ CALIBRATION MODE = wet ▪ EMPTY CALIB. = 0 ▪ FULL CALIB. = Sensor end value converted to mH_2O, e.g. 5.99 mH_2O for a 500 mbar (7,5 psi) sensor

333	**User reset**
	– Affects the following parameters:
	  – Function group POSITION ADJUSTMENT
	  – Function group BASIC SETUP, except for the customer-specific units
	  – Function group EXTENDED SETUP
	  – Function group TOTALIZER SETUP
	  – Group OUTPUT
	  – Function group HART DATA: BUS ADDRESS and PREAMBLE NUMBER
	– Any simulation which may be running is ended.
	– The device is restarted.

Reset code	Description and effect
7864	**Total reset** – Affects the following parameters: – Function group POSITION ADJUSTMENT – Function group BASIC SETUP – Function group EXTENDED SETUP – Function group LINEARISATION (an existing linearisation table is erased) – Function group TOTALIZER SETUP – Group OUTPUT – Function group PEAK HOLD INDICATOR – Function group HART DATA – All configurable messages ("Error" type) are set to factory setting. → 🗎 67, Section 8.1 "Messages" and page → 🗎 75, Section 8.2 "Response of outputs to errors". – Function group USER LIMITS – Function group SYSTEM 2 – Any simulation which may be running is ended. – The device is restarted.
8888	**HistoROM reset** The measured value memory and event memory are cleared. During the reset, the HistoROM must be attached to the electronic insert.

6 Commissioning

Warning!
- If a pressure smaller than the minimum permitted pressure is present at the device, the messages "E120 Sensor low pressure" and "E727 Sensor pressure error - overrange" are output in succession.
- If a pressure greater than the maximum permitted pressure is present at the device, the messages "E115 Sensor overpressure" and "E727 Sensor pressure error - overrange" are output in succession.
- Messages E727, E115 and E120 are "Error"-type messages and can be configured as a "Warning" or an "Alarm". These messages are configured as "Warning" messages at the factory. This setting prevents the current output from assuming the set alarm current value for applications (e.g. cascade measurement) where the user is consciously aware of the fact that the sensor range can be exceeded
- We recommend setting messages E727, E115 and E120 to "Alarm" in the following instances:
  - The sensor range does not have to be exceeded for the measuring application.
  - Position adjustment has to be carried out that has to correct a large measured error as a result of the orientation of the device (e.g. devices with a diaphragm seal).

Note!
The device is configured for the Pressure measuring mode as standard. The measuring range and the unit in which the measured value is transmitted correspond to the specifications on the nameplate.

6.1 Function check

Carry out a post-installation and a post-connection check as per the checklist before commissioning the device.

- "Post-installation check" checklist → see Section 3.4
- "Post-connection check" checklist → see Section 4.5

6.2 Selecting language and measuring mode

6.2.1 On-site operation

The LANGUAGE and MEASURING MODE parameters are located on the top menu level. → See also → 40, Section 5.4.1 "General structure of the operating menu".

The following languages are available:
- Deutsch
- English
- Français
- Italiano
- Español
- Nederlands
- Chinese (CHS)
- Japanese (JPN)

The following measuring modes are available:
- Pressure
- Level
- Flow

6.2.2 Digital communication

The MEASURING MODE parameter is displayed in the digital communication in the QUICK SETUP menus and in the BASIC SETUP function group (OPERATING MENU → SETTINGS → BASIC SETUP).

The following measuring modes are available:
- Pressure
- Level
- Flow

The LANGUAGE parameter is arranged in the DISPLAY group (OPERATING MENU → DISPLAY).
- Use the LANGUAGE parameter to select the menu language for the on-site display.
- Select the menu language for FieldCare by means of the "Language Button" in the configuration window. Select the menu language for the FieldCare frame via the "Extra" menu → "Options" → "Display" → "Language".

The following languages are available:
- Deutsch
- English
- Français
- Italiano
- Español
- Nederlands
- Chinese (CHS)
- Japanese (JPN)

6.3 Position adjustment

Due to the orientation of the device, there may be a shift in the measured value, i.e. when the container is empty or partly filled, the measured value parameter does not display zero. There are three options to choose from when performing position adjustment.
(Menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → POSITION ADJUSTMENT)

Parameter name	Description
POS. ZERO ADJUST (685) Entry	Position adjustment – the pressure difference between zero (set point) and the measured pressure need not be known. **Example:** – MEASURED VALUE = 2.2 mbar (0,032 psi) – Correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option. This means that you are assigning the value 0.0 to the pressure present. – MEASURED VALUE (after pos. zero adjust) = 0.0 mbar – The current value is also corrected. The CALIB. OFFSET parameter displays the resulting pressure difference (offset) by which the MEASURED VALUE was corrected. **Factory setting:** 0.0
POS. INPUT VALUE (563) Entry	Position adjustment – the pressure difference between zero (set point) and the measured pressure need not be known. To correct the pressure difference, you need a reference measurement value (e. g. from a reference device). **Example:** – MEASURED VALUE = 0.5 mbar (0,0073 psi) – For the POS. INPUT VALUE parameter, specify the desired set point for the MEASURED VALUE, e.g. 2.0 mbar (0,029 psi). (MEASURED VALUE$_{new}$ = POS. INPUT VALUE) – MEASURED VALUE (after entry for POS. INPUT VALUE) = 2.0 mbar (0,029 psi) – The CALIB. OFFSET parameter displays the resulting pressure difference (offset) by which the MEASURED VALUE was corrected. CALIB. OFFSET = MEASURED VALUE$_{old}$ – POS. INPUT VALUE, here: CALIB. OFFSET = 0.5 mbar (0,0073 psi) – 2.0 mbar (0,029 psi) = – 1.5 mbar (0,022 psi)) – The current value is also corrected. **Factory setting:** 0.0
CALIB. OFFSET (319) Entry	Position adjustment – the pressure difference between zero (set point) and the measured pressure is known. **Example:** – MEASURED VALUE = 2.2 mbar (0,032 psi) – Via the CALIB. OFFSET parameter, enter the value by which the MEASURED VALUE should be corrected. To correct the MEASURED VALUE to 0.0 mbar, you must enter the value 2.2 here. (MEASURED VALUE $_{new}$ = MEASURED VALUE$_{old}$ – CALIB. OFFSET) – MEASURED VALUE (after entry for calib. offset) = 0.0 mbar – The current value is also corrected. **Factory setting:** 0.0

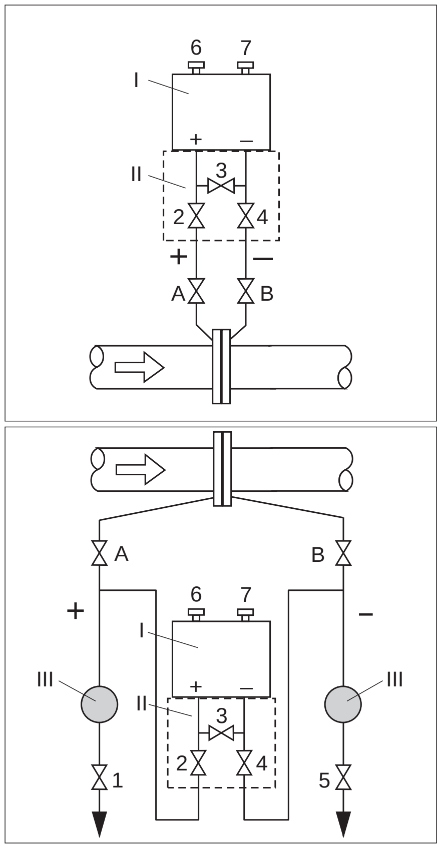
6.4 Flow measurement

6.4.1 Preparatory steps

Note!

- The Deltabar S PMD70 or PMD75 is usually used for flow measurement.
- Before calibrating the Deltabar S, the impulse piping must be cleaned and filled with fluid. → See the following table.

	Valves	Meaning	Preferred installation
1	Close 3.		
2	Fill measuring system with fluid.		
	Open A, B, 2, 4.	Fluid flows in.	
3	Clean impulse piping if necessary[1]: – by blowing out with compressed air in the case of gases – by rinsing out in the case of liquids.		
	Close 2 and 4.	Block off device.	
	Open 1 and 5.[1]	Blow out/rinse out impulse piping.	
	Close 1 and 5.[1]	Close valves after cleaning.	
4	Vent device.		
	Open 2 and 4.	Introduce fluid.	
	Close 4.	Close negative side.	
	Open 3.	Balance positive and negative side.	
	Open 6 and 7 briefly, then close them again.	Fill device completely with fluid and remove air.	
5	Carry out pos. zero adjustment if the following conditions are met. If the conditions are not met, then do not carry out the pos. zero adjustment until after step 6. → 55, Section 6.4.3 and → 52, Section 6.3. Conditions: – The process cannot be blocked off. – The tapping points (A and B) are at the same geodetic height.		
6	Set measuring point in operation.		
	Close 3.	Shut off positive side from negative side.	
	Open 4.	Connect negative side.	
	Now – 1[1], 3, 5[1], 6 and 7 are closed. – 2 and 4 are open. – A and B open (if present).		
7	Carry out pos. zero adjustment if the flow can be blocked off. In this case, step 5 is not applicable. → 55, Section 6.4.3 and → 52, Section 6.3		
8	Carry out calibration. → 54, Section 6.4.2.		



P01-xMD7xxxx-11-xx-xx-xx-002

Fig. 39: Above: preferred installation for gases
Below: preferred installation for liquids

I Deltabar S, PMD70 or PMD75
II Three-valve manifold
Separator
1, 5 Drain valves
2, 4 Inlet valves
3 Equalising valve
6, 7 Vent valves on Deltabar S
A, B Shut-off valves

1) for arrangement with 5 valves

6.4.2 Information on flow measurement

In the "Flow" measuring mode, the device determines a volume or mass flow value from the differential pressure measured. The differential pressure is generated by means of primary elements such as pitot tubes or orifice plates and depends on the volume or mass flow. Four flow measuring modes are available: volume flow, norm volume flow (European norm conditions), standard volume flow (American standard conditions) and mass flow.

In addition, the Deltabar S software is equipped with two totalizers as standard. The totalizers add up the volume or the mass flow. The counting function and the unit can be set separately for both totalizers. The first totalizer (totalizer 1) can be reset to zero at any time while the second (totalizer 2) totalises the flow from commissioning onwards and cannot be reset.

Note!

- There is a Quick Setup menu for each of the measuring modes Pressure, Level and Flow which guides you through the most important basic functions. With the setting in the MEASURING MODE parameter, you specify which Quick Setup menu should be displayed. → See also → 50, Section 6.2 "Selecting language and measuring mode".
- For a detailed description of the parameters see the Operating Instructions BA274P "Cerabar S/ Deltabar S/Deltapilot S, Description of device functions"
  - Table 6, POSITION ADJUSTMENT
  - Table 12, BASIC SETUP
  - Table 17, EXTENDED SETUP
  - Table 20, TOTALIZER SETUP.

  → See also → 2, section "Overview documentation".
- For flow measurement, select the "Flow" option by means of the MEASURING MODE parameter. The operating menu is structured appropriately. → Section 10.1.

6.4.3 Quick Setup menu for the Flow measuring mode

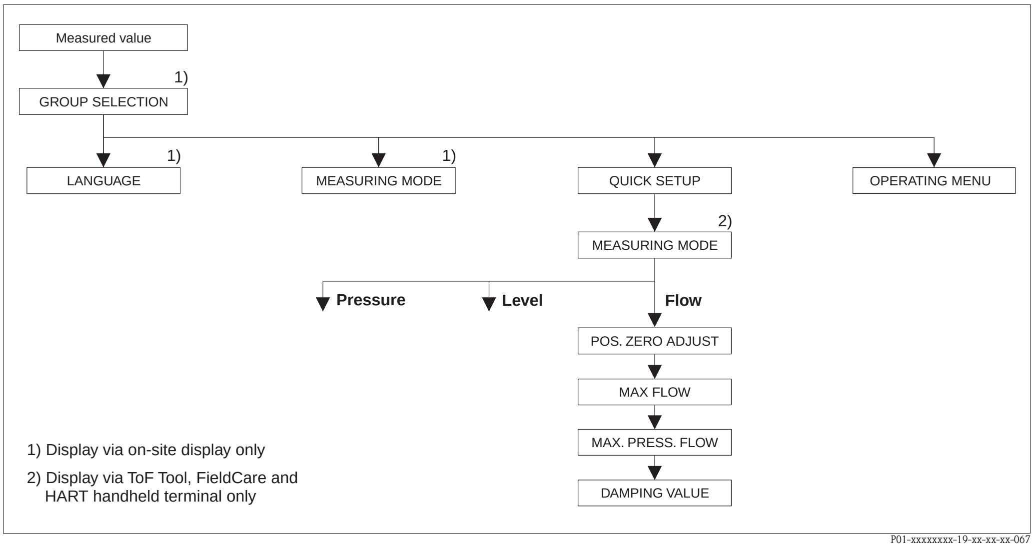


Fig. 40: Quick Setup menu for the Flow measuring mode

On-site operation	Digital communication
Measured value display On-site display: Switch from the measured value display to GROUP SELECTION with E.	**Measured value display** Select QUICK SETUP menu.
GROUP SELECTION Select MEASURING MODE.	**MEASURING MODE** Select "Flow" option.
MEASURING MODE Select "Flow" option.	
GROUP SELECTION Select QUICK SETUP menu.	
POS. ZERO ADJUST Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.	**POS. ZERO ADJUST** Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.
MAX. FLOW Enter maximum flow of primary device. (→ See also layout sheet of primary device).	**MAX. FLOW** Enter maximum flow of primary device. (→ See also layout sheet of primary device).
MAX. PRESS FLOW Enter maximum pressure of primary device. (→ See also layout sheet of primary device).	**MAX. PRESS FLOW** Enter maximum pressure of primary device. (→ See also layout sheet of primary device).
DAMPING TIME Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.	**DAMPING TIME** Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.

Note!
For on-site operation, → 35, Section 5.2.3 "Function of the operating elements – on-site display connected" and → 40, Section 5.4 "On-site operation – on-site display connected".

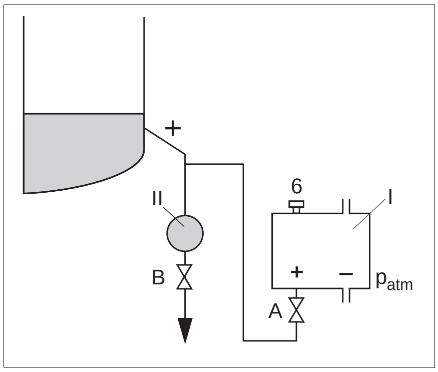
6.5 Level measurement

6.5.1 Preparatory steps

Open container

Note!

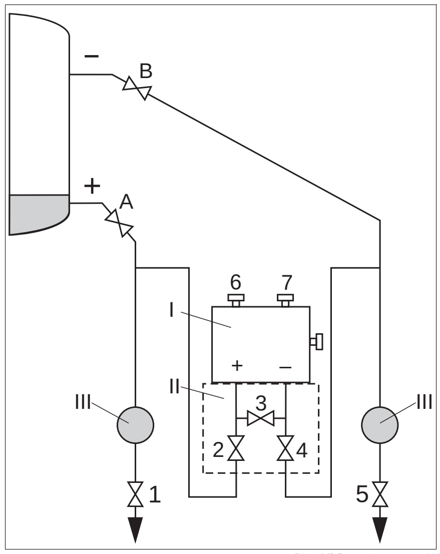
- The Deltabar S PMD70, PMD75, FMD76 and FMD77 are suitable for level measurement in an open container.
- FMD76 and FMD77: the device is ready for calibration immediately after opening a shut-off valve (may or may not be present).
- PMD70 and PMD75: before calibrating the device, the impulse piping must be cleaned and filled with fluid. → See the following table.

	Valves	Meaning	Installation
1	Fill container to a level above the lower tap.		 P01-xMD7xxxx-11-xx-xx-xx-003
2	Fill measuring system with fluid.		
	Open A.	Open shut-off valve.	
3	Vent device.		
	Open 6 briefly, then close it again.	Fill device completely with fluid and remove air.	
4	Set measuring point in operation.		
	Now – B and 6 are closed. – A is open.		
5	Carry out calibration. → 59, Section 6.5.2.		*Fig. 41: Open container* *I Deltabar S, PMD70 or PMD75* *II Separator* *6 Vent valves on Deltabar S* *A Shut-off valve* *B Drain valve*

Closed container

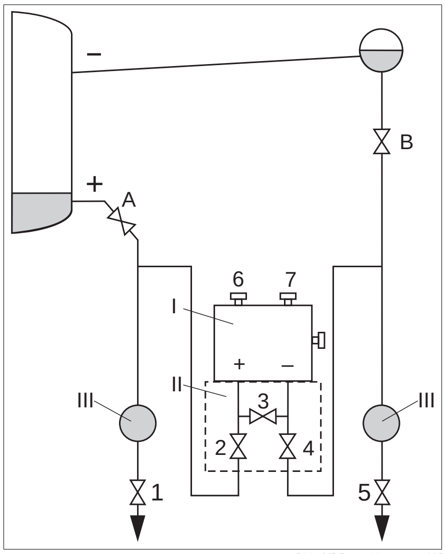
Note!

- All Deltabar S versions are suitable for level measurement in closed containers.
- FMD76 and FMD77: the device is ready for calibration immediately after opening the shut-off valves (may or may not be present).
- FMD78: the device is ready for calibration immediately.
- PMD70 and PMD75: before calibrating the device, the impulse piping must be cleaned and filled with fluid. → See the following table.

	Valves	Meaning	Installation
1	Fill container to a level above the lower tap.		 P01-xMD7xxxx-11-xx-xx-xx-004 *Fig. 42: Closed container* *I Deltabar S, PMD70 and PMD75* *II Three-valve manifold* *III Separator* *1, 2 Drain valves* *2, 4 Inlet valves* *3 Equalising valve* *6, 7 Vent valve on Deltabar S* *A, B Shut-off valve*
2	Fill measuring system with fluid.		
	Close 3.	Shut off positive side from negative side.	
	Open A and B.	Open shut-off valves.	
3	Vent positive side (empty negative side if necessary).		
	Open 2 and 4.	Introduce fluid on positive side.	
	Open 6 and 7 briefly, then close them again.	Fill positive side completely with fluid and remove air.	
4	Set measuring point in operation.		
	Now – 3, 6 and 7 are closed. – 2, 4, A and B are open.		
5	Carry out calibration. → 59, Section 6.5.2.		

Closed container with superimposed steam

Note!
- All Deltabar S versions are suitable for level measurement in containers with superimposed steam.
- FMD76 and FMD77: the device is ready for calibration immediately after opening the shut-off valves (may or may not be present).
- FMD78: the device is ready for calibration immediately.
- PMD70 and PMD75: before calibrating the device, the impulse piping must be cleaned and filled with fluid. → See the following table.

	Valves	Meaning	Installation
1	Fill container to a level above the lower tap.		
2	Fill measuring system with fluid.		
	Open A and B.	Open shut-off valves.	
	Fill the negative impulse piping to the level of the condensate trap.		
3	Vent device.		
	Open 2 and 4.	Introduce fluid.	
	Close 4.	Close negative side.	
	Open 3.	Balance positive and negative side.	
	Open 6 and 7 briefly, then close them again.	Fill device completely with fluid and remove air.	
4	Set measuring point in operation.		
	Close 3.	Shut off positive side from negative side.	
	Open 4.	Connect negative side.	
	Now – 3, 6 and 7 are closed. – 2, 4, A and B are open.		
5	Carry out calibration. → 59, Section 6.5.2.		

P01-xMD7xxxx-11-xx-xx-xx-005

Fig. 43: Closed container with superimposed steam

I Deltabar S, PMD70 and PMD75
II Three-valve manifold
III Separator
1, 5 Drain valves
2, 4 Inlet valves
3 Equalising valve
6, 7 Vent valves on Deltabar S
A, B Shut-off valves

6.5.2 Information on level measurement

✎ Note!

- The Flow, Level and Pressure operating modes each have a quick setup menu which guides you through the most important basic functions. → 🗎 61 for the "Level" quick setup menu.
- Furthermore, the three level modes "Level Easy Pressure", "Level Easy Height" and "Level Standard" are available to you for level measurement. You can select from the "Linear", "Pressure linearized" and "Height linearized" level types for the "Level Standard" level mode. The table in the "Overview of level measurement" section below provides an overview of the various measuring tasks.
  - In the "Level Easy Pressure" and "Level Easy Height" level modes, the values entered are not tested as extensively as in the "Level Standard" level mode. The values entered for EMPTY CALIB./FULL CALIB., EMPTY PRESSURE/FULL PRESSURE, EMPTY HEIGHT/FULL HEIGHT and SET LRV/SET URV must have a minimum interval of 1% for the "Level Easy Pressure" and "Level Easy Height" level modes. The value will be rejected with a warning message if the values are too close together. Further limit values are not checked; i.e. the values entered must be appropriate for the sensor and the measuring task so that the measuring device can measure correctly.
  - The "Level Easy Pressure" and "Level Easy Height" level modes encompass fewer parameters than the "Level Standard" mode and are used for quick and easy configuration of a level application.
  - Customer-specific units of fill level, volume and mass or a linearization table may only be entered in the "Level Standard" level mode.
  - Where the device is intended for use as a subsystem in a safety function (SIL), a "Device configuration with enhanced parameter security" (SAFETY CONFIRM.) is only possible for the "Level" operating mode in the "Level Easy Pressure" level mode. All parameters previously entered are checked after a password is entered. Once the "Level Easy Height" or "Level Standard" has been selected, the configuration will first have to be reset to the ex-works setting using the RESET parameter (menu path: (GROUP SELECTION →) OPERATING MENU → OPERATION) using the reset code "7864". → For further information see the Deltabar S (SD189P) Functional Safety Manual.
- See the Operating Instructions BA274P "Cerabar S/Deltabar S/Deltapilot S, Description of device functions". See also → 🗎 2, "Overview documentation" section.

6.5.3 Overview of level measurement

Measuring task	LEVEL SELECTION/ LEVEL MODE	Measured variable options	Description	Comment	Measured value display
The measured variable is in direct proportion to the measured pressure. Calibration is performed by entering two pressure-level value pairs.	LEVEL SELECTION: Level Easy Pressure	Via OUTPUT UNIT parameter: %, level, volume or mass units.	– Calibration with reference pressure – wet calibration, see Operating Instructions BA274P. – Calibration without reference pressure – dry calibration, see Operating Instructions BA274P.	– Incorrect entries are possible – SIL mode possible – Customised units are not possible	The measured value display and the LEVEL BEFORE LIN parameter show the measured value.
The measured variable is in direct proportion to the measured pressure. Calibration is performed by entering the density and two height-level value pairs.	LEVEL SELECTION: Level Easy Height	Via OUTPUT UNIT parameter: %, level, volume or mass units.	– Calibration with reference pressure – wet calibration, see Operating Instructions BA274P. – Calibration without reference pressure – dry calibration, see Operating Instructions BA274P.	– Incorrect entries are possible – SIL mode not possible – Customised units are not possible	The measured value display and the LEVEL BEFORE LIN parameter show the measured value.
The measured variable is in direct proportion to the measured pressure.	LEVEL SELECTION: Level standard/ LEVEL MODE: Linear	Via LIN. MEASURAND parameter: – % (level) – Level – Volume – Mass	– Calibration with reference pressure – wet calibration, see Operating Instructions BA274P. – Calibration without reference pressure – dry calibration, see Operating Instructions BA274P.	– Incorrect entries are rejected by the device – SIL mode not possible – Customised level, volume and mass units are possible	The measured value display and the LEVEL BEFORE LIN parameter show the measured value.
The measured variable is not in direct proportion to the measured pressure as, for example, with containers with a conical outlet. A linearisation table must be entered for the calibration.	LEVEL SELECTION: Level standard/ LEVEL MODE: Pressure linearized	Via LINd. MEASURAND parameter: – Pressure + % – Pressure + volume – Pressure + mass	– Calibration with reference pressure: semiautomatic entry of linearisation table, see Operating Instructions BA274P. – Calibration without reference pressure: manual entry of linearisation table, see Operating Instructions BA274P.	– Incorrect entries are rejected by the device – SIL mode not possible – Customised level, volume and mass units are possible	The measured value display and the TANK CONTENT parameter show the measured value.
– Two measured variables are required or – The container shape is given by value pairs, such as height and volume. The 1st measured variable %-height or height must be in direct proportion to the measured pressure. The 2nd measured variable volume, mass or % need not to be in direct proportion to the measured pressure. A linearisation table must be entered for the 2nd measured variable. The 2nd measured variable is assigned to the 1st measured variable by means of this table.	LEVEL SELECTION: Level standard/ LEVEL MODE: Height linearized	Via COMB. MEASURAND parameter: – Height + volume – Height + mass – Height + % – %-Height + volume – %-Height + mass – %-Height + %	– Calibration with reference pressure: wet calibration and semiautomatic entry of linearisation table, see Operating Instructions BA274P. – Calibration without reference pressure: dry calibration and manual entry of linearisation table, see Operating Instructions BA274P.	– Incorrect entries are rejected by the device – SIL mode not possible – Customised level, volume and mass units are possible	The measured value display and the TANK CONTENT parameter show the 2nd measured value (volume, mass or %). The LEVEL BEFORE LIN parameter displays the 1st measured value (%-height or height).

6.5.4 Quick Setup menu for Level measuring mode

Note!

- Some parameters are only displayed if other parameters are appropriately configured. For example, the EMPTY CALIB. parameter is only displayed in the following cases:
  – LEVEL SELECTION "Level Easy Pressure" and CALIBRATION MODE "Wet"
  – LEVEL SELECTION "Level Standard", LEVEL MODE "Linear" and CALIBRATION MODE "WET"
  You can find the LEVEL MODE parameter in the BASIC SETTINGS function group (menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → BASIC SETTINGS).
- The following parameters are set to the following values in the factory:
  – LEVEL SELETION: Level Easy Pressure
  – CALIBRATION MODE: Wet
  – OUTPUT UNIT or LIN. MEASURAND: %
  – EMPTY CALIB.: 0.0
  – FULL CALIB.: 100.0
  – SET LRV (BASIC SETTINGS group): 0.0 (corresponds to 4 mA value)
  – SET URV (BASIC SETTINGS group): 100.0 (corresponds to 20 mA value).
- The quick setup is suitable for simple and quick commissioning. If you wish to make more complex settings, e.g. change the unit from "%" to "m", you will have to calibrate using the BASIC SETTINGS group. → See Operating Instructions BA274P or → 2, "Overview documentation" section.

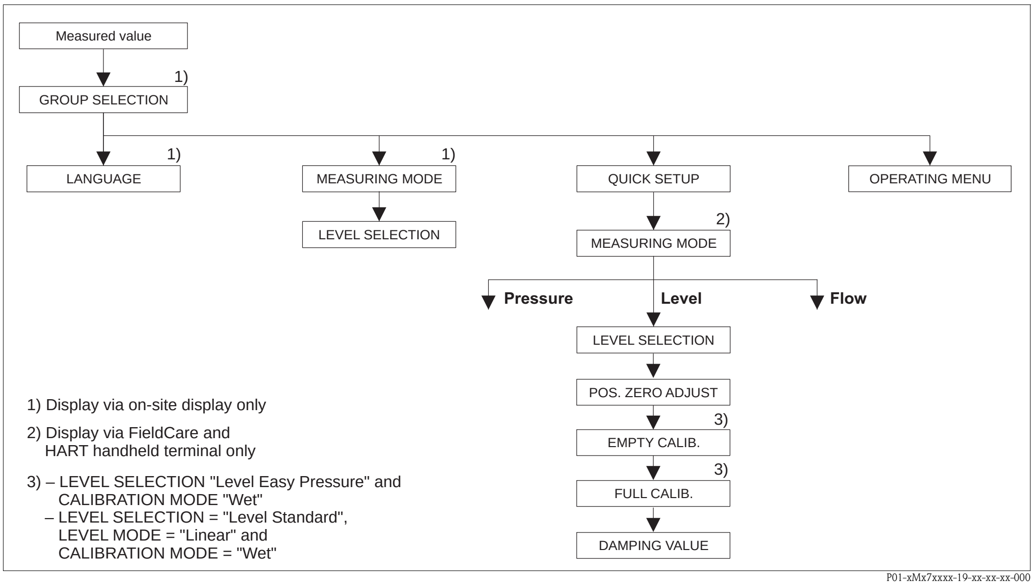


Abb. 44: Quick Setup menu for the Level measuring mode

On-site operation
Measured value display On-site display: Switch from the measured value display to GROUP SELECTION with E.
GROUP SELECTION Select MEASURING MODE.
MEASURING MODE Select "Level" option.
LEVEL SELECTION Select level mode. For an overview → 60.
GROUP SELECTION Select QUICK SETUP menu.

Digital communication
Measured value display Select QUICK SETUP menu.
MEASURING MODE Select "Level" option.
LEVEL SELECTION Select level mode. For an overview → 60.

On-site operation
POS. ZERO ADJUST Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.
EMPTY CALIB. [1] Enter level for the lower calibration point. For this parameter, enter a level value which is assigned to the pressure present at the device.
FULL CALIB. [1] Enter level for the upper calibration point. For this parameter, enter a level value which is assigned to the pressure present at the device.
DAMPING TIME Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.

Digital communication
POS. ZERO ADJUST Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.
EMPTY CALIB. [1] Enter level for the lower calibration point. For this parameter, enter a level value which is assigned to the pressure present at the device.
FULL CALIB. [1] Enter level for the upper calibration point. For this parameter, enter a level value which is assigned to the pressure present at the device.
DAMPING TIME Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.

1) – LEVEL SELECTION "Level Easy Pressure" and CALIBRATION MODE "Wet"
– LEVEL SELECTION "Level Standard", LEVEL MODE "Linear" and CALIBRATION MODE "Wet"

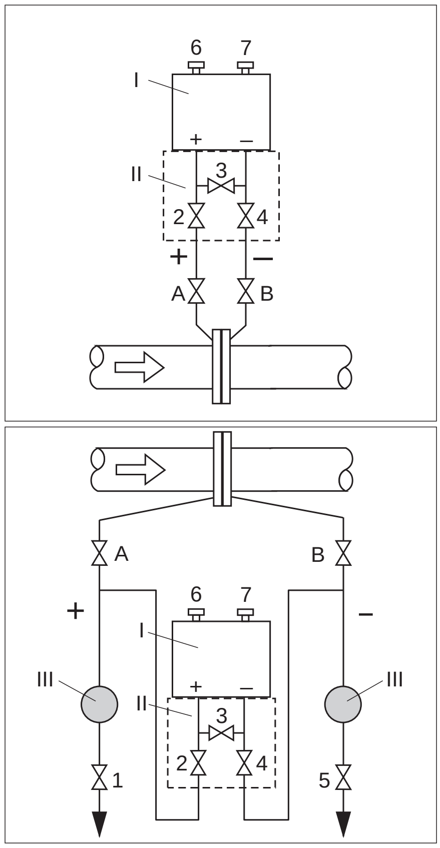
Note!
For on-site operation, → 35, Section 5.2.3 "Function of the operating elements – on-site display connected" and → 40, Section 5.4 "On-site operation – on-site display connected".

6.6 Differential pressure measurement

6.6.1 Preparatory steps

Note!
- The Deltabar S PMD70, PMD75 and FMD78 are usually used for differential pressure measurement.
- FMD78: the device is ready for calibration immediately.
- PMD70 and PMD75: before calibrating the device, the impulse piping must be cleaned and filled with fluid. → See the following table.

	Valves	Meaning	Preferred installation
1	Close 3.		
2	Fill measuring system with fluid.		
	Open A, B, 2, 4.	Fluid flows in.	
3	Clean impulse piping if necessary:[1] – by blowing out with compressed air in the case of gases – by rinsing out in the case of liquids.		
	Close 2 and 4.	Block off device.	
	Open 1 and 5.[1]	Blow out/rinse out impulse piping.	
	Close 1 and 5.[1]	Close valves after cleaning.	
4	Vent device.		
	Open 2 and 4.	Introduce fluid.	
	Close 4.	Close negative side.	
	Open 3.	Balance positive and negative side.	
	Open 6 and 7 briefly, then close them again.	Fill device completely with fluid and remove air.	
5	Set measuring point in operation.		
	Close 3.	Shut off positive side from negative side.	
	Open 4.	Connect negative side.	
	Now – 1[1], 3, 5[1], 6 and 7 are closed. – 2 and 4 are open. – A and B open (if present).		
6	Carry out calibration if necessary. → 64, Section 6.6.2.		



P01-xMD7xxxx-11-xx-xx-xx-002

Fig. 45: Above: preferred installation for gases
Below: preferred installation for liquids

I Deltabar S, PMD70 or PMD75
II Three-valve manifold
III Separator
1, 5 Drain valves
2, 4 Inlet valves
3 Equalising valve
6, 7 Vent valves on Deltabar S
A, B Shut-off valve

1) for arrangement with 5 valves

6.6.2 Information on differential pressure measurement

Note!

- There is a Quick Setup menu for each of the measuring modes Pressure, Level and Flow which guides you through the most important basic functions. With the setting in the MEASURING MODE parameter, you specify which Quick Setup menu should be displayed. → 🗎 50, Section 6.2 "Selecting language and measuring mode".
- For a detailed description of the parameters see the Operating Instructions BA274P "Cerabar S/ Deltabar S/Deltapilot S, Description of device functions"
  - Table 6, POSITION ADJUSTMENT
  - Table 7, BASIC SETUP
  - Table 15, EXTENDED SETUP

  → See also → 🗎 2, section "Overview documentation".
- For differential pressure measurement, select the "Pressure" option by means of the MEASURING MODE parameter. The operating menu is structured appropriately. → See also Section 10.1.

6.6.3 Quick Setup menu for Pressure measuring mode

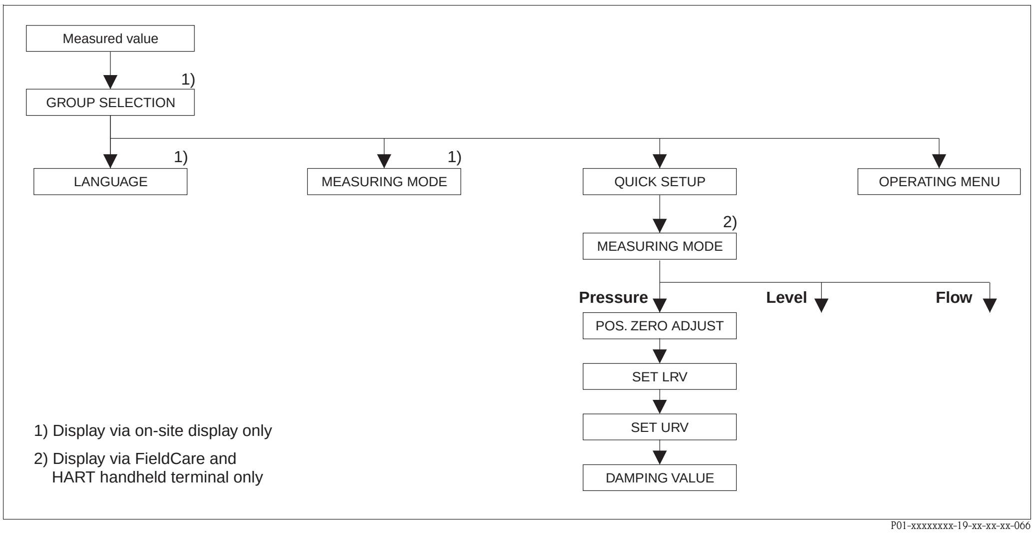


Fig. 46: Quick Setup menu for Pressure measuring mode

On-site operation
Measured value display On-site display: Switch from the measured value display to GROUP SELECTION with E.
GROUP SELECTION Select MEASURING MODE.
MEASURING MODE Select "Pressure" option.
GROUP SELECTION Select QUICK SETUP menu.
POS. ZERO ADJUST Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.
SET LRV Set the measuring range (enter 4 mA value). Specify a pressure value for the lower current value (4 mA value). A reference pressure does not have to be present at the device.

Digital communication
Measured value display Select QUICK SETUP menu.
MEASURING MODE Select "Pressure" option.
POS. ZERO ADJUST Due to orientation of the device, there may be a shift in the measured value. You correct the MEASURED VALUE via the POS. ZERO ADJUST parameter with the "Confirm" option, i. e. you assign the value 0.0 to the pressure present.
SET LRV Set the measuring range (enter 4 mA value). Specify a pressure value for the lower current value (4 mA value). A reference pressure does not have to be present at the device.

On-site operation	Digital communication
SET URV Set the measuring range (enter 20 mA value). The pressure for the upper current value (20 mA value) is present at device. With the "Confirm" option, you assign the upper current value to the pressure value present.	**SET URV** Set the measuring range (enter 20 mA value). The pressure for the upper current value (20 mA value) is present at device. With the "Confirm" option, you assign the upper current value to the pressure value present.
DAMPING TIME Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.	**DAMPING TIME** Enter damping time (time constant τ). The damping affects the speed at which all subsequent elements, such as the on-site display, measured value and current output react to a change in the pressure.

✎ Note!
For on-site operation, → 🗎 35, Section 5.2.3 "Function of the operating elements – on-site display connected" and → 🗎 40, Section 5.4 "On-site operation – on-site display connected".

7 Maintenance

Deltabar S requires no maintenance.

7.1 Exterior cleaning

Please note the following points when cleaning the device:

- The cleaning agents used should not attack the surface and the seals.
- Mechanical damage to the process isolating diaphragm, e.g. due to pointed objects, must be avoided.
- Observe degree of protection. See therefor nameplate if necessary (→ 6).

8 Trouble-shooting

8.1 Messages

The following table lists all the possible messages that can occur.
The device differentiates between the error types "Alarm", "Warning" and "Error". You may specify whether the instrument should react as if for an "Alarm" or "Warning" for "Error" messages.
→ See "Error type/NA 64" column and Section 8.2 "Response of outputs to errors".

In addition, the "Error type/NA 64" column classifies the messages in accordance with NAMUR Recommendation NA 64:
- Break down: indicated with "B"
- Maintenance need: indicated with "C" (check request)
- Function check: indicated with "I" (in service)

Error message display on the on-site display:
- The measured value display shows the message with the highest priority. → See "Priority" column.
- The ALARM STATUS parameter shows all the messages present in descending order of priority. You can scroll through all the messages present with the [-]-key or [+]-key.

Message display via digial communication:
- The ALARM STATUS parameter shows the message with the highest priority. → See "Priority" column.

Note!
- If the device detects a defect in the on-site display during initialization, special error messages are generated. → For the error messages, → 74, Section 8.1.1 "On-site display error messages".
- For support and further information, please contact Endress+Hauser Service.
- → See also Section 8.4 ff.

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
101 (A101)	Alarm B	B>Sensor electronic EEPROM error	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) This message normally only appears briefly. – Sensor defect.	– Wait a few minutes. – Restart the device. Perform reset (Code 62). – Block off electromagnetic effects or eliminate source of disturbance. – Replace sensor.	17
102 (W102)	Warning C	C>Checksum error in EEPROM: peakhold segment	– Main electronics defect. Correct measurement can continue as long as you do not need the peak hold indicator function.	– Replace main electronics.	53
106 (W106)	Warning C	C>Downloading - please wait	– Downloading.	– Wait for download to complete.	52
110 (A110)	Alarm B	B>Checksum error in EEPROM: configuration segment	– The supply voltage is disconnected when writing. – Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Main electronics defect.	– Reestablish supply voltage. Perform reset (Code 7864) if necessary. Carry out calibration again. – Block off electromagnetic effects or eliminate sources of disturbance. – Replace main electronics.	6
113 (A113)	Alarm B	B>ROM failure in transmitter electronic	– Main electronics defect.	– Replace main electronics.	1

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
115 (E115)	Error B factory setting: Warning	B>Sensor overpressure	– Overpressure present. – Sensor defect.	– Reduce pressure until message disappears. – Replace sensor.	29
116 (W116)	Warning C	C>Download error, repeat download	– The file is defect. – During the download, the data are not correctly transmitted to the processor, e.g. because of open cable connections, spikes (ripple) on the supply voltage or electromagnetic effects.	– Use another file. – Check cable connection PC – transmitter. – Block off electromagnetic effects or eliminate sources of disturbance. – Perform reset (Code 7864) and carry out calibration again. – Repeat download.	36
120 (E120)	Error B factory setting: Warning	B>Sensor low pressure	– Pressure too low. – Sensor defect.	– Increase pressure until message disappears. – Replace sensor.	30
121 (A121)	Alarm B	B>Checksum error in factory segment of EEPROM	– Main electronics defect.	– Replace main electronics.	5
122 (A122)	Alarm B	B>Sensor not connected	– Cable connection sensor –main electronics disconnected. – Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Main electronics defect. – Sensor defect.	– Check cable connection and repair if necessary. – Block off electromagnetic effects or eliminate source of disturbance. – Replace main electronics. – Replace sensor.	13
130 (A130)	Alarm B	B>EEPROM is defect.	– Main electronics defect.	– Replace main electronics.	10
131 (A131)	Alarm B	B>Checksum error in EEPROM: min/max segment	– Main electronics defect.	– Replace main electronics.	9
132 (A132)	Alarm B	B>Checksum error in totalizer EEPROM	– Main electronics defect.	– Replace main electronics.	7
133 (A133)	Alarm B	B>Checksum error in History EEPROM	– An error occurred when writing. – Main electronics defect.	– Perform reset (Code 7864) and carry out calibration again. – Replace electronics.	8
602 (W602)	Warning C	C>Linearisation curve not monotone	– The linearisation table is not monotonic increasing or decreasing.	– Add to linearisation table or perform linearisation again.	57
604 (W604)	Warning C	C>Linearisation table not valid. Less than 2 points or points too close	– The linearisation table consists of less than 2 points. – At least 2 points in the linearisation table are too close together. A minimum gap of 0.5 % of the distance between two points must be maintained. Spans for the "Pressure linearized" option: HYDR. PRESS MAX. – HYDR. PRESS MIN.; TANK CONTENT MAX. – TANK CONTENT MIN. Spans for the "Height linearized" option: LEVEL MAX – LEVEL MIN; TANK CONTENT MAX. – TANK CONTENT MIN.	– Add to linearisation table. If necessary, perform linearisation again. – Correct linearisation table and accept again.	58
613 (W613)	Warning I	I>Simulation is active	– Simulation is switched on, i.e. the device is not measuring at present.	– Switch off simulation.	60

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
620 (E620)	Error C Factory setting: Warning	C>Current output out of range	The current is outside the permitted range 3.8 to 20.5 mA. – The pressure applied is outside the set measuring range (but within the sensor range). – Loose connection at sensor cable	– Check pressure applied, reconfigure measuring range if necessary (→ See also Operating Instructions BA274P or these Operating Instructions → 🗎 2.) – Perform reset (Code 7864) and carry out calibration again. – Wait a short period of time and tighten the connection, or avoid loose connection.	49
700 (W700)	Warning C	C>Last configuration not stored	– An error occurred when writing or reading configuration data or the power supply was disconnected. – Main electronics defect.	– Perform reset (Code 7864) and carry out calibration again. – Replace main electronics.	54
701 (W701)	Warning C	C>Measuring chain config. exceeds sensor range	– The calibration carried out would result in the sensor nominal operating range being undershot or overshot.	– Carry out calibration again.	50
702 (W702)	Warning C	C>HistoROM data not consistent.	– Data were not written correctly to the HistoROM, e.g. if the HistoROM was detached during the writing process. – HistoROM does not have any data.	– Repeat upload. – Perform reset (Code 7864) and carry out calibration again. – Copy suitable data to the HistoROM. (→ See also → 🗎 43, Section 5.5.1 "Copying configuration data".)	55
703 (A703)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	22
704 (A704)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	12
705 (A705)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	21
706 (W706)	Warning C	C>Configuration in HistoROM and device not identical	– Configuration (parameters) in the HistoROM and in the device is not identical.	– Copy data from the device to the HistoROM. (→ See also → 🗎 43, Section 5.5.1 "Copying configuration data".) – Copy data from the HistoROM to the device. (→ See also → 🗎 43, Section 5.5.1 "Copying configuration data".) The message remains if the HistoROM and the device have different software versions. The message goes out if you copy the data from the device to the HistoROM. – Device reset codes such as 7864 do not have any effect on the HistoROM. That means that if you do a reset, the configurations in the HistoROM and in the device may not be the same.	59
707 (A707)	Alarm B	B>X-VAL. of lin. table out of edit limits.	– At least one X-VALUE in the linearisation table is either below the value for HYDR. PRESS MIN. or MIN. LEVEL or above the value for HYDR. PRESS. MAX. or LEVEL MAX.	– Carry out calibration again. (→ See also Operating Instructions BA274P or these Operating Instructions → 🗎 2.)	38

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
710 (W710)	Warning C	B>Set span too small. Not allowed.	– Values for calibration (e.g. lower range value and upper range value) are too close together. – The sensor was replaced and the customer-specific configuration does not suit the sensor. – Unsuitable download carried out.	– Adjust calibration to suit sensor. (→ See also Operating Instructions BA274P, parameter description MINIMUM SPAN or these Operating Instructions → 🗎 2.) – Adjust calibration to suit sensor. – Replace sensor with a suitable sensor. – Check configuration and perform download again.	51
711 (A711)	Alarm B	B>LRV or URV out of edit limits	– Lower range value and/or upper range value undershoot or overshoot the sensor range limits. – The sensor was replaced and the customer-specific configuration does not suit the sensor. – Unsuitable download carried out.	– Reconfigure lower range value and/ or upper range value to suit the sensor. Pay attention to position factor. – Reconfigure lower range value and/ or upper range value to suit the sensor. Pay attention to position factor. – Replace sensor with a suitable sensor. – Check configuration and perform download again.	37
713 (A713)	Alarm B	B>100% POINT level out of edit limits	– The sensor was replaced.	– Carry out calibration again.	39
715 (E715)	Error C Factory setting: Warning	C>Sensor over temperature	– The temperature measured in the sensor is greater than the upper nominal temperature of the sensor. (→ See also Operating Instructions BA274P, parameter description Tmax SENSOR or these Operating Instructions → 🗎 2.) – Unsuitable download carried out.	– Reduce process temperature/ ambient temperature. – Check configuration and perform download again.	32
716 (E716)	Error B Factory setting: Alarm	B>process isolating diaphragm broken	– Sensor defect. – PMD70, FMD76: Overpressure is present at minus or plus side of the device (on-sided overpressure)	– Replace sensor. – Reduce pressure.	24
717 (E717)	Error C Factory setting: Warning	C>Transmitter over temperature	– The temperature measured in the electronics is greater than the upper nominal temperature of the electronics (+88 °C (+190 °F)). – Unsuitable download carried out.	– Reduce ambient temperature. – Check configuration and perform download again.	34
718 (E718)	Error C Factory setting: Warning	C>Transmitter under temperature	– The temperature measured in the electronics is smaller than the lower nominal temperature of the electronics (–43 °C (-45 °F)). – Unsuitable download carried out.	– Increase ambient temperature. Insulate device if necessary. – Check configuration and perform download again.	35
719 (A719)	Alarm B	B>Y-VAL of lin. table out of edit limits	– At least on Y-VALUE in the linearisation table is below the MIN. TANK CONTANT or above the MAX. TANK CONTENT.	– Carry out calibration again. (→ See also Operating Instructions BA274P or these Operating Instruction → 🗎 2.)	40

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
720 (E720)	Error C Factory setting: Warning	C>Sensor under temperature	– The temperature measured in the sensor is smaller than the lower nominal temperature of the sensor. (→ See also Operating Instructions BA274P, parameter description Tmin SENSOR or Operating Instructions → 2.) – Unsuitable download carried out. – Loose connection at sensor cable	– Increase process temperature/ ambient temperature. – Check configuration and perform download again. – Wait a short period of time and tighten the connection, or avoid loose connection.	33
721 (A721)	Alarm B	B>ZERO POSITION level out of edit limits	– LEVEL MIN or LEVEL MAX has been changed.	– Perform reset (Code 2710) and carry out calibration again.	41
722 (A722)	Alarm B	B>EMPTY CALIB. or FULL CALIB. out of edit limits	– LEVEL MIN or LEVEL MAX has been changed.	– Perform reset (Code 2710) and carry out calibration again.	42
723 (A723)	Alarm B	B>MAX. FLOW out of edit limits	– FLOW-MEAS. TYPE has been changed.	– Carry out calibration again.	43
725 (A725)	Alarm B	B>Sensor connection error, cycle disturbance	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Sensor or main electronics defect.	– Block off electromagnetic effects or eliminate source of disturbance. – Replace sensor or main electronics.	25
726 (E726)	Error C Factory setting: Warning	C>Sensor temperature error - overrange	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Process temperature is outside permitted range. – Sensor defect.	– Block off electromagnetic effects or eliminate source of disturbance. – Check temperature present, reduce or increase if necessary. – If the process temperature is within the permitted range, replace sensor.	31
727 (E727)	Error C Factory setting: Warning	C>Sensor pressure error - overrange	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Pressure is outside permitted range. – Sensor defect.	– Block off electromagnetic effects or eliminate source of disturbance. – Check pressure present, reduce or increase if necessary. – If the pressure is within the permitted range, replace sensor.	28
728 (A728)	Alarm B	B>RAM error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	2
729 (A729)	Alarm B	B>RAM error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	3

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
730 (E730)	Error C Factory setting: Warning	C>LRV user limits exceeded	– Pressure measured value has undershot the value specified for the Pmin ALARM WINDOW parameter. – Loose connection at sensor cable	– Check system/pressure measured value. – Change value for Pmin ALARM WINDOW if necessary. (→ See also Operating Instructions BA274P, parameter description Pmin ALARM WINDOW or these Operating Instruction → 🗎 2.) – Wait a short period of time and tighten the connection, or avoid loose connection.	46
731 (E731)	Error C Factory setting: Warning	C>URV user limits exceeded	– Pressure measured value has overshot the value specified for the Pmax ALARM WINDOW parameter.	– Check system/pressure measured value. – Change value for Pmax ALARM WINDOW if necessary. (→ See also Operating Instructions BA274P, parameter description Pmax ALARM WINDOW or these Operating Instructions → 🗎 2.)	45
732 (E732)	Error C Factory setting: Warning	C>LRV Temp. User limits exceeded	– Temperature measured value has undershot the value specified for the Tmin ALARM WINDOW parameter. – Loose connection at sensor cable	– Check system/temperature measured value. – Change value for Tmin ALARM WINDOW if necessary. (→ See also Operating Instructions BA274P, parameter description Tmin ALARM WINDOW or these Operating Instructions → 🗎 2.) – Wait a short period of time and tighten the connection, or avoid loose connection.	48
733 (E733)	Error C Factory setting: Warning	C>URV Temp. User limits exceeded	– Temperature measured value has overshot the value specified for the Tmax ALARM WINDOW parameter.	– Check system/temperature measured value. – Change value for Tmax ALARM WINDOW if necessary. (→ See also Operating Instructions BA274P, parameter description Tmax ALARM WINDOW or these Operating Instructions → 🗎 2.)	47
736 (A736)	Alarm B	B>RAM error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	4
737 (A737)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	20
738 (A738)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	19
739 (A739)	Alarm B	B>Measurement error	– Fault in the main electronics. – Main electronics defect.	– Briefly disconnect device from the power supply. – Replace main electronics.	23

Code	Error type/ NA 64	Message/description	Cause	Measure	Priority
740 (E740)	Error C Factory setting: Warning	C>Calculation overflow, bad configuration	– Level measuring mode: the measured pressure has undershot the value for HYDR. PRESS. MIN. or overshot the value for HYDR. PRESS MAX. – Level measuring mode: The measured level did not reach the LEVEL MIN value or exceeded the LEVEL MAX value. – Flow measuring mode: the measured pressure has undershot the value for MAX. PRESS FLOW.	– Check configuration and carry out calibration again if necessary. – Select a device with a suitable measuring range. – Check configuration and carry out calibration again if necessary. (→ See also Operating Instructions BA274P, parameter description LEVEL MIN. these Operating Instructions → 🗎 2.) – Check configuration and carry out calibration again if necessary. – Select a device with a suitable measuring range.	27
741 (A741)	Alarm B	B>TANK HEIGHT out of edit limits	– LEVEL MIN or LEVEL MAX has been changed.	– Perform reset (Code 2710) and carry out calibration again.	44
742 (A742)	Alarm B	B>Sensor connection error (upload)	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) This message normally only appears briefly. – Cable connection sensor –main electronics disconnected. – Sensor defect.	– Wait a few minutes. – Perform reset (Code 7864) and carry out calibration again. – Check cable connection and repair if necessary. – Replace sensor.	18
743 (E743)	Alarm B	B>Electronic PCB error during initialisation	– This message normally only appears briefly. – Main electronics defect.	– Wait a few minutes. – Restart the device. Perform reset (Code 62). – Replace main electronics.	14
744 (A744)	Alarm B	B>Main electronic PCB error	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) – Main electronics defect.	– Restart the device. Perform reset (Code 62). – Block off electromagnetic effects or eliminate source of disturbance. – Replace main electronics.	11
745 (W745)	Warning C	C>Sensor data unknown	– Sensor does not suit the device (electronic sensor nameplate). Device continues measuring.	– Replace sensor with a suitable sensor.	56
746 (W746)	Warning C	C>Sensor connection error - initialising	– Electromagnetic effects are greater than specifications in the technical data. (→ See Section 9.) This message normally only appears briefly. – Overpressure or low pressure present.	– Wait a few minutes. – Restart the device. Perform reset (Code 7864). – Block off electromagnetic effects or eliminate source of disturbance. – Reduce or increase pressure.	26
747 (A747)	Alarm B	B>Sensor software not compatible to electronics	– Sensor does not suit the device (electronic sensor nameplate).	– Replace sensor with a suitable sensor.	16
748 (A748)	Alarm B	B>Memory failure in signal processor	– Electromagnetic effects are greater than specifications in the technical data. (→See Section 9.) – Main electronics defect.	– Block off electromagnetic effects or eliminate source of disturbance. – Replace main electronics.	15

8.1.1 On-site display error messages

If the device detects a defect in the on-site display during initialization, the following error messages can be displayed:

Message	Measure
Initialization, VU Electr. Defect A110	Exchange on-site display.
Initialization, VU Electr. Defect A114	
Initialization, VU Electr. Defect A281	
Initialization, VU Checksum Err. A110	
Initialization, VU Checksum Err. A112	
Initialization, VU Checksum Err. A171	

8.2 Response of outputs to errors

The device differentiates between the error types Alarm, Warning and Error.
→ See the following table and → 67, Section 8.1 "Messages".

Output	A (Alarm)	W (Warning)	E (Error: Alarm/Warning)
Current output	Assumes the value specified via the OUTPUT FAIL MODE[1], ALT. CURR. OUTPUT[1] and SET MAX. ALARM[1] parameter. → See also the following section "Configuring current output for an alarm".	Device continues measuring.	For this error, you can enter whether the device should react as in the event of an alarm or as in the event of a warning. See corresponding "Alarm" or "Warning" column. (→ See also Operating Instructions BA274P, parameter description SELECT ALARM TYPE or these Operating Instructions → 2.)
Bargraph (on-site display)	The bargraph adopts the value defined by the OUTPUT FAIL MODE [1] parameter.	The bargraph adopts the value which corresponds to the current value.	→ See this table, "Alarm" or "Warning" column, depending on selection.
On-site display	– The measured value and message are displayed alternately – Measured value display: ϟ -symbol is permanently displayed. Message display – 3-digit number such as A122 and description	– The measured value and message are displayed alternately – Measured value display: ϟ -symbol flashes. Message display: – 3-digit number such as W613 and description	– The measured value and message are displayed alternately – Measured value display: see corresponding "Alarm" or "Warning" column Message display: – 3-digit number such as E731 and description
Remote operation (digital communication)	In the case of an alarm, the ALARM STATUS[2] parameter displays a 3-digit number such as 122 for "Sensor not connected".	In the case of a warning, the ALARM STATUS[2] parameter displays a 3-digit number such as 613 for "Simulation is active".	In the case of an error, the ALARM STATUS[2] parameter displays a 3-digit number such as 731 for "URV user limits exceeded".

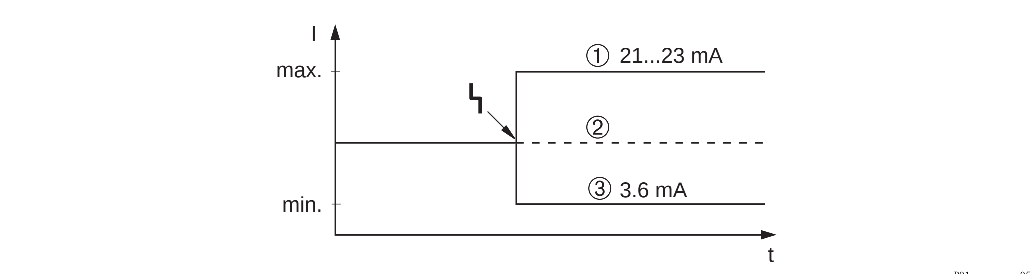
1) Menu path: (GROUP SELECTION →) OPERATING MENU → OUTPUT

2) Menu path: (GROUP SELECTION →) OPERATING MENU → MESSAGES

8.2.1 Configuring current output for an alarm

You can configure the current output for the event of an alarm by means of the OUTPUT FAIL MODE, ALT. CURR. OUTPUT and SET MAX. ALARM parameters. The parameters are displayed in the OUTPUT group (menu path: (GROUP SELECTION →) OPERATING MENU → OUTPUT).

In the event of an alarm, the current and the bargraph assume the value entered with the OUTPUT FAIL MODE parameter.



P01-xxxxxxxx-05

Fig. 47: Current output in the event of an alarm

Options:
1 Max. alarm (110%): can be set between 21...23 mA via the SET MAX. ALARM parameter
2 Hold meas. value: last measured value is kept
3 Min. alarm (–10%): 3.6 mA

Factory setting:
- OUTPUT FAIL MODE: Max. Alarm (110%)
- SET MAX. ALARM: 22 mA

Use the ALT. CURR. OUTPUT parameter to set the current output value for the error messages E 120 "Sensor low pressure" and E 115 "Sensor overpressure". You have the following options:
– Normal: the current output assumes the value set via the OUTPUT FAIL MODE and SET MAX. ALARM parameters.
– NAMUR
  – Lower sensor limit undershot (E 120 "Sensor low pressure"): 3.6 mA
  – Upper sensor limit overshot (E 115 "Sensor overpressure") overshot: current output assumes the value set via the SET MAX ALARM parameter.

Factory setting:
- ALT. CURR. OUTPUT: normal

8.3 Confirming messages

Depending on the settings for the ALARM DISPL. TIME and ACK. ALARM MODE parameters, the following measures should be taken to clear a message:

Settings [1]	**Measures**
– ALARM DISPL. TIME = 0 s – ACK. ALARM MODE = off	– Rectify cause of the message (see also Section 8.1).
– ALARM DISPL. TIME > 0 s – ACK. ALARM MODE = off	– Rectify cause of the message (see also Section 8.1). – Wait for the alarm display time to elapse.
– ALARM DISPL. TIME = 0 s – ACK. ALARM MODE = on	– Rectify cause of the message (see also Section 8.1). – Confirm message using ACK. ALARM parameter.
– ALARM DISPL. TIME > 0 s – ACK. ALARM MODE = on	– Rectify cause of the message (see also Section 8.1). – Confirm message using ACK. ALARM parameter. – Wait for the alarm display time to elapse. If a message appears and the alarm display time elapses before the message has been acknowledged, the message will be cleared once it has been acknowledged.

1) Menu path for ALARM DISPL. TIME and ACK. ALARM MODE: (GROUP SELECTION →) OPERATING MENU → DIAGNOSTICS → MESSAGES

If the on-site display displays a message, you can suppress it with the E-key.
If there are several messages, the on-site display shows the message which has the highest priority (see also Section 8.1). Once you have suppressed this message using the E-key, the message with the next highest priority is displayed. You can use the E-key to suppress each message, one after the other.
The ALARM STATUS parameter continues to display all the messages present.

8.4 Repair

The Endress+Hauser repairs concept provides for measuring devices to have a modular design and also the customer may carry out repairs (→ 79, Section 8.6 "Spare Parts").

Note!

- For certified devices, please consult Chapter "Repair of Ex-certified devices".
- For more information on service and spare parts contact the Endress+Hauser Service. (→ See www.endress.com/worldwide)

8.5 Repair of Ex-certified devices

Warning!

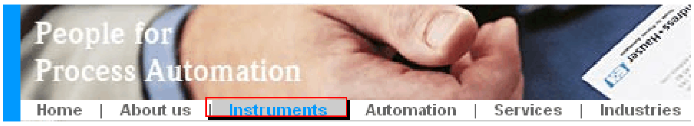
When repairing Ex-certified devices, please note the following:

- Only specialist personnel or Endress+Hauser may undertake repairs of certified devices.
- Relevant standards, national hazardous area regulations and Safety Instructions and Certificates must be observed.
- Only genuine Endress+Hauser spare parts may be used.
- When ordering spare parts, please check the device designation on the nameplate. Identical parts may only be used as replacements.
- Electronic inserts or sensors already in use in a standard instrument may not be used as spare parts for a certified device.
- Carry out repairs according to the instructions. After repairs, the device must fulfil the requirements of the specified individual tests.
- A certified device may only be converted into another certified variant by Endress+Hauser.
- All repairs and modifications must be documented.

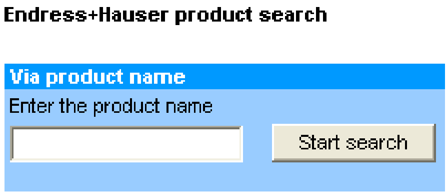
8.6 Spare Parts

An overview of the spare parts for your device is available in the internet at www.endress.com. To obtain information on the spare parts, proceed as follows:

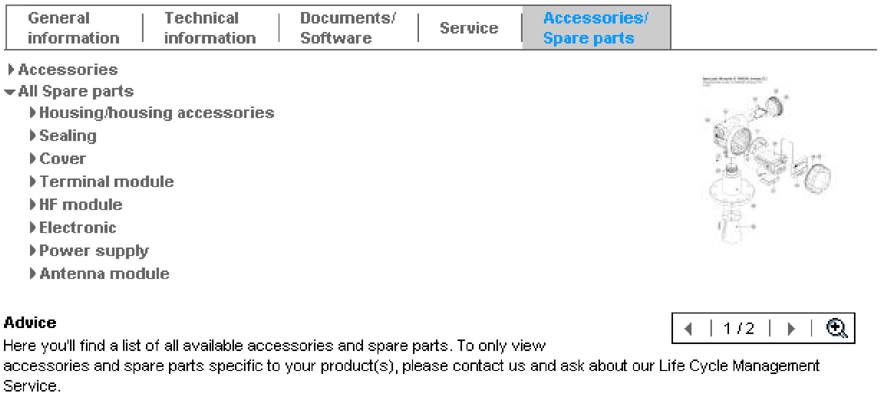
1. Go to "www.endress.com" and select your country.
2. Click "Instruments".



3. Enter the product name into the "product name" field.



4. Select the device.
5. Click the "Accessories/Spare parts" tab.



6. Select the required spare parts (You may also use the overview drawing on the right side of the screen.)

When ordering spare parts, always quote the serial number indicated on the nameplate. As far as necessary, the spare parts also include replacement instructions.

8.7 Returning the device

Before you send in a device for repairs or checking:

- Remove all signs of fluids, paying particular attention to seal grooves and gaps in which fluid can become lodged. This is especially important if the fluid is hazardous to health. Please refer also to the "Declaration of Hazardous Material and De-Contamination".

Please enclose the following when returning the device:

- Please fill out completely and sign the "Declaration of Hazardous Material and De-Contamination".
  It is only then possible for Endress+Hauser to inspect or repair the returned device.
- The chemical and physical properties of the fluid.
- A description of the application.
- A description of the error which occurred.
- Special instructions on handling, if necessary, e.g. safety data sheet as per EN 91/155/EEC.

8.8 Disposal

When disposing, separate and recycle the device components based on the materials.

8.9 Software history

Date	Software version	Changes software	Documentation		
			CD-ROM	**Operating Instructions**	**Description of Instrument Functions**
11.2003	01.00.zz	Original software. Compatible with: – ToF Tool Field Tool Package, version 1.04.00 or higher – Commuwin II version 2.08.-1, Update G or higher – HART Communicator DXR375 with Device Rev.: 10, DD Rev.: 1	—	BA270P/00/EN/10.03 52020515	—
06.2004	02.00.zz	– Number of parameters in the Quick Setup menus has been reduced. – On-site operation: LANGUAGE and MEASURING MODE parameters have been moved to the top level. – New SAFETY CONFIRM. group implemented for SIL. → See also SD189P Safety Manual Deltabar S. – MEASURING MODE "Level", LEVEL MODE "Linear": AREA UNIT and TANK SECTION parameters have been replaced with the TANK VOLUME and TANK HEIGHT parameters. – Function of the UNIT FLOW parameter has been split across four parameters. – Function of the SIMULATED VALUE parameter has been split across six parameters. – SENSOR TRIM and CURRENT TRIM groups have been removed. – Sensor adapt reset, code 1209 and sensor calibration reset, code 2509 have been removed. – Quick Setup menus are available via ToF Tool. Compatible with: – ToF Tool Field Tool Package version 2.00.00 or higher – Commuwin II version 2.08.-1, Update > G – HART Communicator DXR375 with Device Rev.: 20, DD Rev.: 1	—	BA270P/00/EN/05.04 52022793	BA274P/00/EN/05.04 52021469
06.2005	02.01.zz	– Operating keys also integrated on the optional on-site display. – Chinese and Japanese are available as the menu language on request. Compatible with: – ToF Tool Field Tool Package version 3.00.00 or higher – FieldCare version 2.01.00, DTM Library version 2.06.00, DTM: Deltabar S/MD7x/V02.00 V 1.4.98.74* – HART Communicator DXR375 with Device Rev.: 20, DD Rev.: 1* * Menu languages Chinese and Japanese not selectable	—	BA270P/00/EN/06.05 71000109	BA274P/00/EN/05.04 52021469
			—	BA270P/00/EN/11.05 71009586	BA274P/00/EN/05.04 52021469

Date	Software version	Changes software	Documentation		
			CD-ROM	**Operating Instructions**	**Description of Instrument Functions**
06.2006	02.10.zz	– New "Level Easy Pressure" and "Level Easy Height" level modes implemented. New LEVEL SELECTION parameter implemented. – OPERATION group with DOWNLOAD SELECT parameter extended. – SAFETY CONFIRM group extended for the "Level" operating mode in the "Level Easy Pressure" level selection. → See also SD189P Safety Manual Deltabar S. – Factory setting for the "Error" messages redefined. – Chinese and Japanese included as menu languages by default. Compatible with: – ToF Tool Field Tool Package version 4.0 – FieldCare version 2.02.00 – HART Communicator DXR375 with Device Rev.: 21, DD Rev.: 1	—	BA270P/00/en/07.06 71027244	BA274P/00/en/07.06 71027249
			—	BA270P/00/en/08.06 71027244	BA274P/00/en/07.06 71027249
			CD506P/00/A2/10.07 71033929	BA270P/00/en/10.07 71043294	BA274P/00/en/07.07 71061021
			CD506P/00/A2/12.07 71033929	BA270P/00/en/12.07 71043294	BA274P/00/en/07.07 71061021
			CD506P/00/A2/05.08 71071762	BA270P/00/en/05.08 71071730	BA274P/00/en/05.08 71071855
			CD506P/00/A2/08.08 71077542	BA270P/00/en/08.08 71077506	BA274P/00/en/05.08 71071855
			CD506P/00/A2/06.09 71095432	BA270P/00/EN/06.09 71095415	BA274P/00/EN/06.09 71095452
			CD506P/00/A2/05.10 71111787	BA270P/00/EN/05.10 71114104	BA274P/00/EN/05.10 71118244

9 Technical data

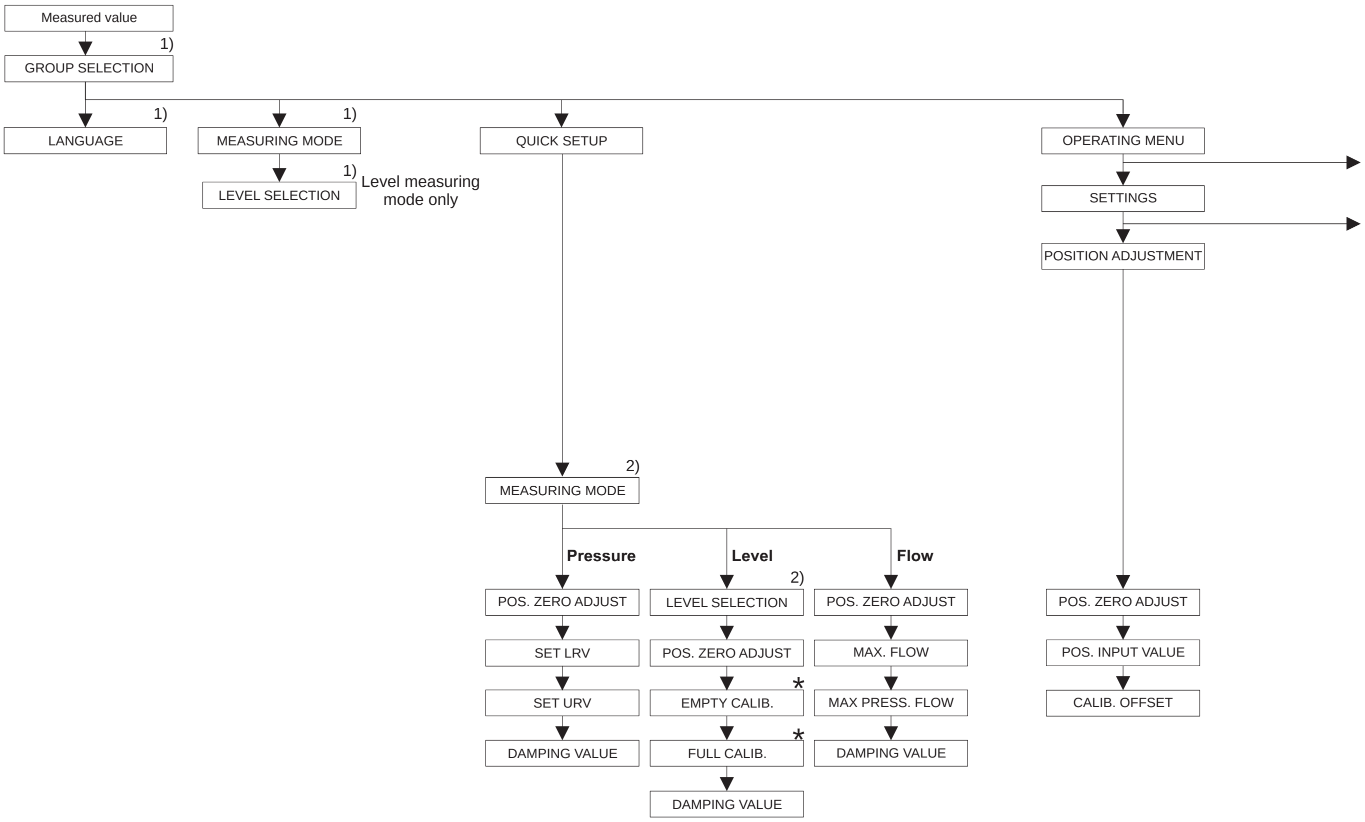
For technical data, please refer to the Technical Information TI382P for Deltabar S.
→ See also → 📄 2, section "Overview documentation".

10 Appendix

10.1 Operating menu for on-site display, FieldCare and HART handheld terminal

Note!

- The entire menu is depicted on the following pages.
- The menu has a different structure depending on the measuring mode selected. This means that some function groups are only displayed for one measuring mode, e.g. "LINEARISATION" function group for the Level measuring mode.
- In addition, there are also parameters that are only displayed if other parameters are appropriately configured. For example the Customer Unit P parameter is only displayed if the "User unit" option was selected for the PRESS. ENG. UNIT parameter. These parameters are indicated with a "*".
- For a description of the parameters, please refer to Operating Instructions BA274P "Description of device functions". The exact dependency of individual parameters on one another is explained here. See also → 📄 2, section "Overview documentation".

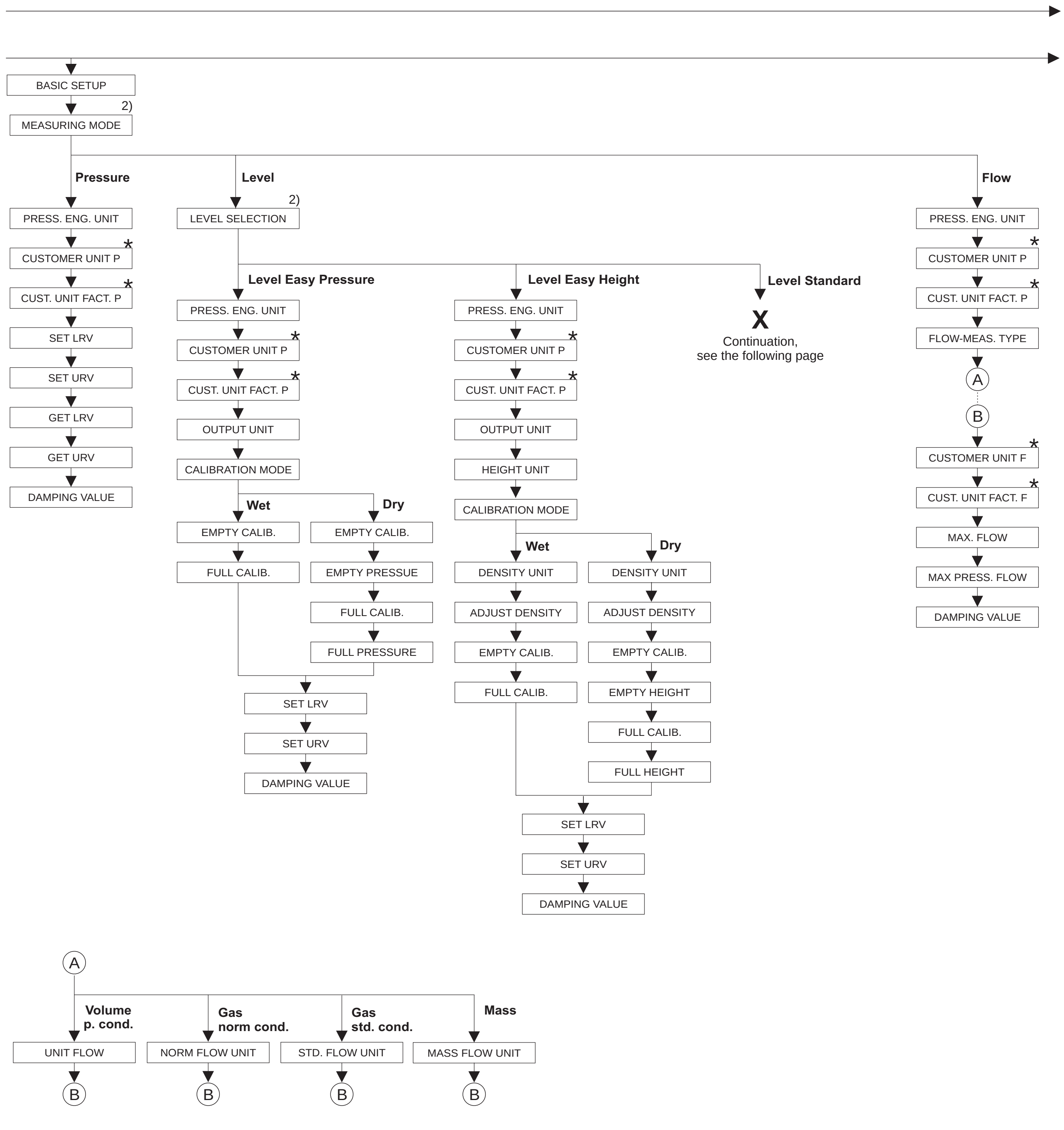


1) Display via on-site display only

2) Display via FieldCare and HART Handheld terminal only

* There are parameters that are only displayed if other parameters are appropriately configured.
For example the CUSTOMER UNIT P parameter is only displayed if the "User unit" option was selected for the PRESS. ENG. UNIT parameter.
These parameters are indicated with a "*".

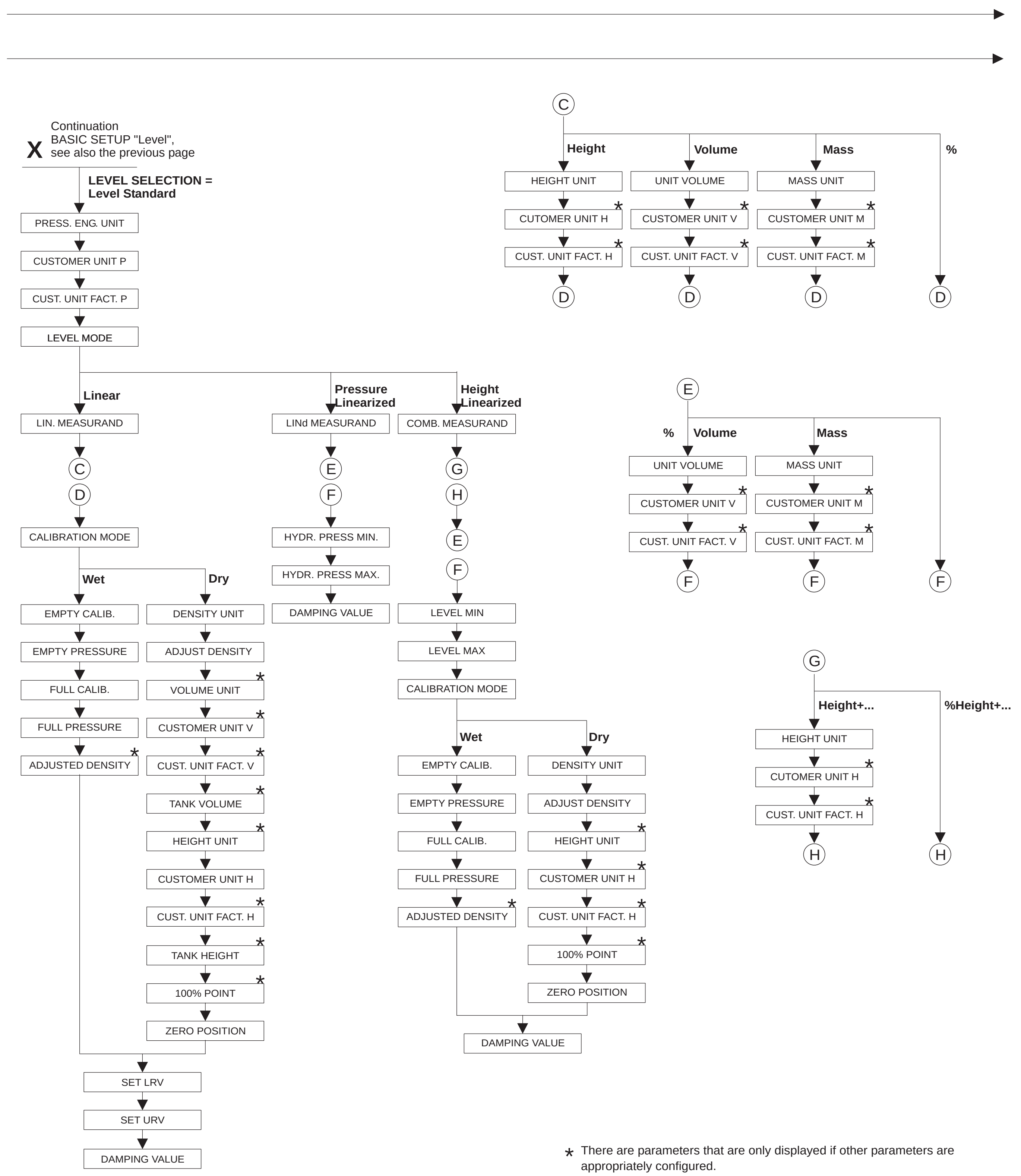
P01-xMD7xxxx-19-xx-xx-xx-003



2) Display via FieldCare and
HART Handheld terminal only

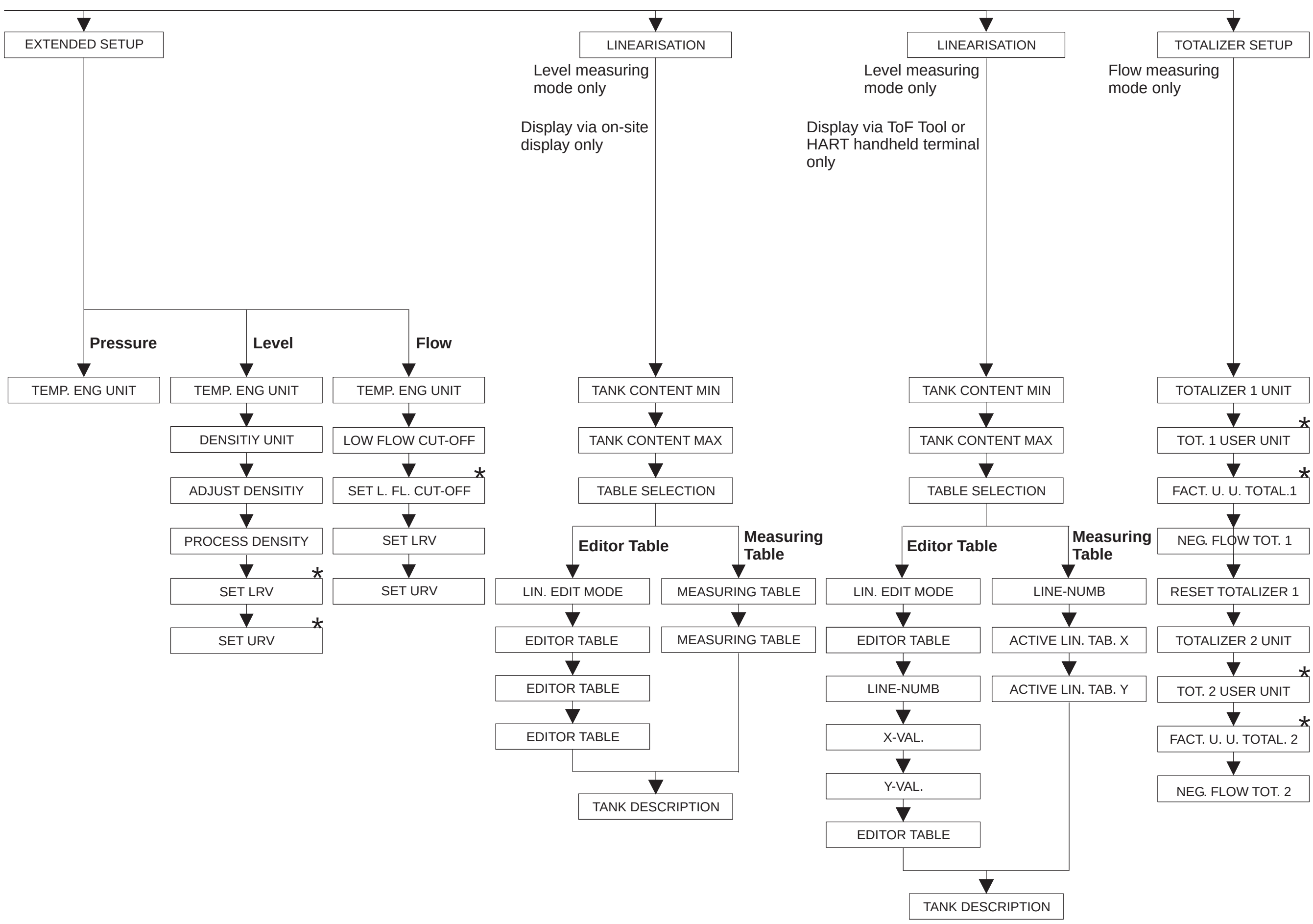
* There are parameters that are only displayed if other parameters are appropriately configured.
For example the CUSTOMER UNIT P parameter is only displayed if the "User unit" option was selected for the PRESS. ENG. UNIT parameter.
These parameters are indicated with a "*".

P01-xMD7xxxx-19-xx-xx-xx-004



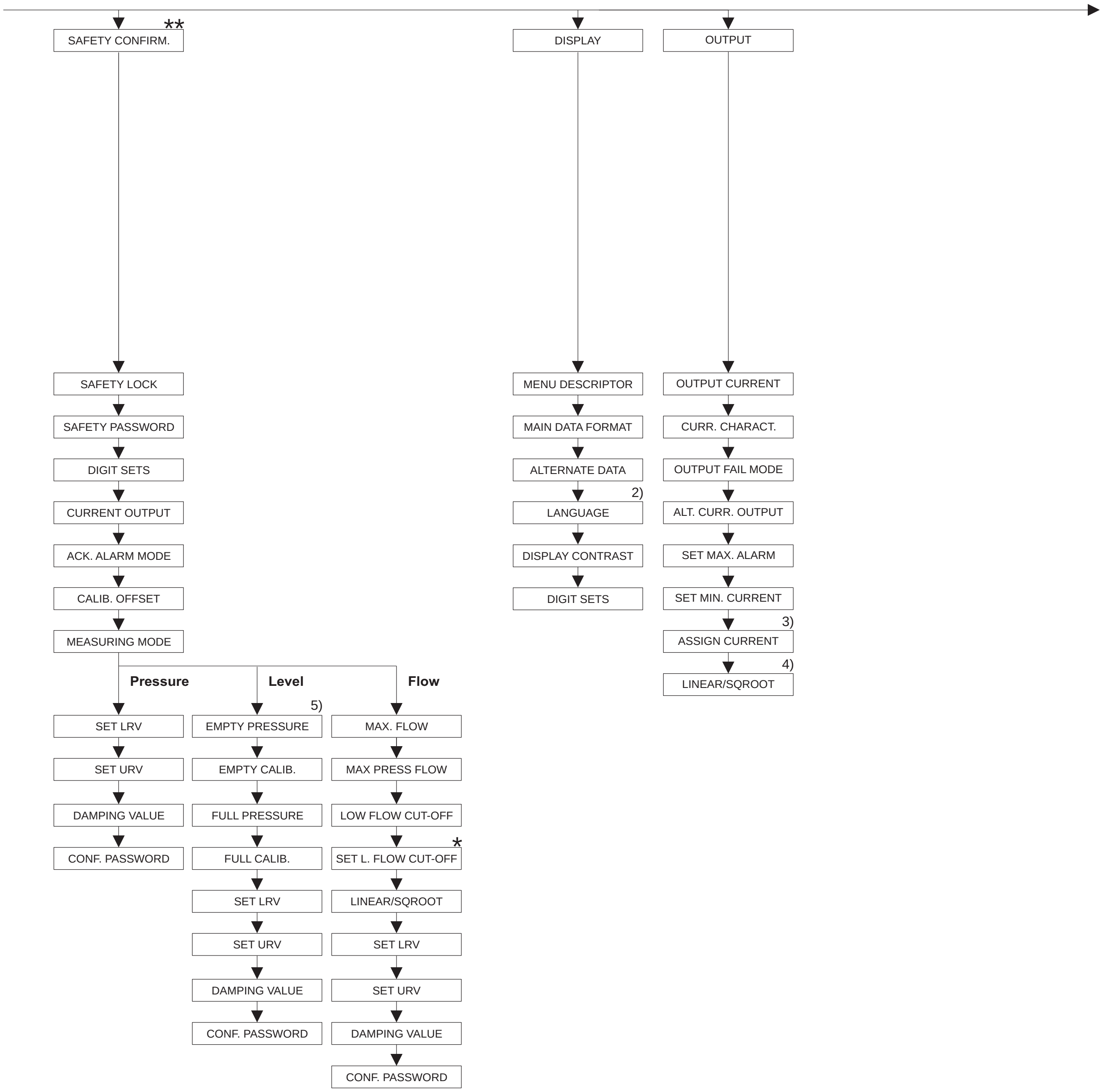
* There are parameters that are only displayed if other parameters are appropriately configured.
For example the CUST. UNIT FACT. H parameter is only displayed if the "User unit" option was selected for the HEIGHT UNIT parameter.
These parameters are indicated with a "*".

P01-xxxxxxxx-19-xx-xx-xx-140



* There are parameters that are only displayed if other parameters are appropriately configured.
For example the TOT. 1 USER UNIT parameter is only displayed if the "User unit" option was selected for the TOTALIZER 1 UNIT parameter.
These parameters are indicated with a "*".

P01-xMD7xxxx-19-xx-xx-xx-005



2) Display via
HART handheld terminal only

3) Level measuring mode only

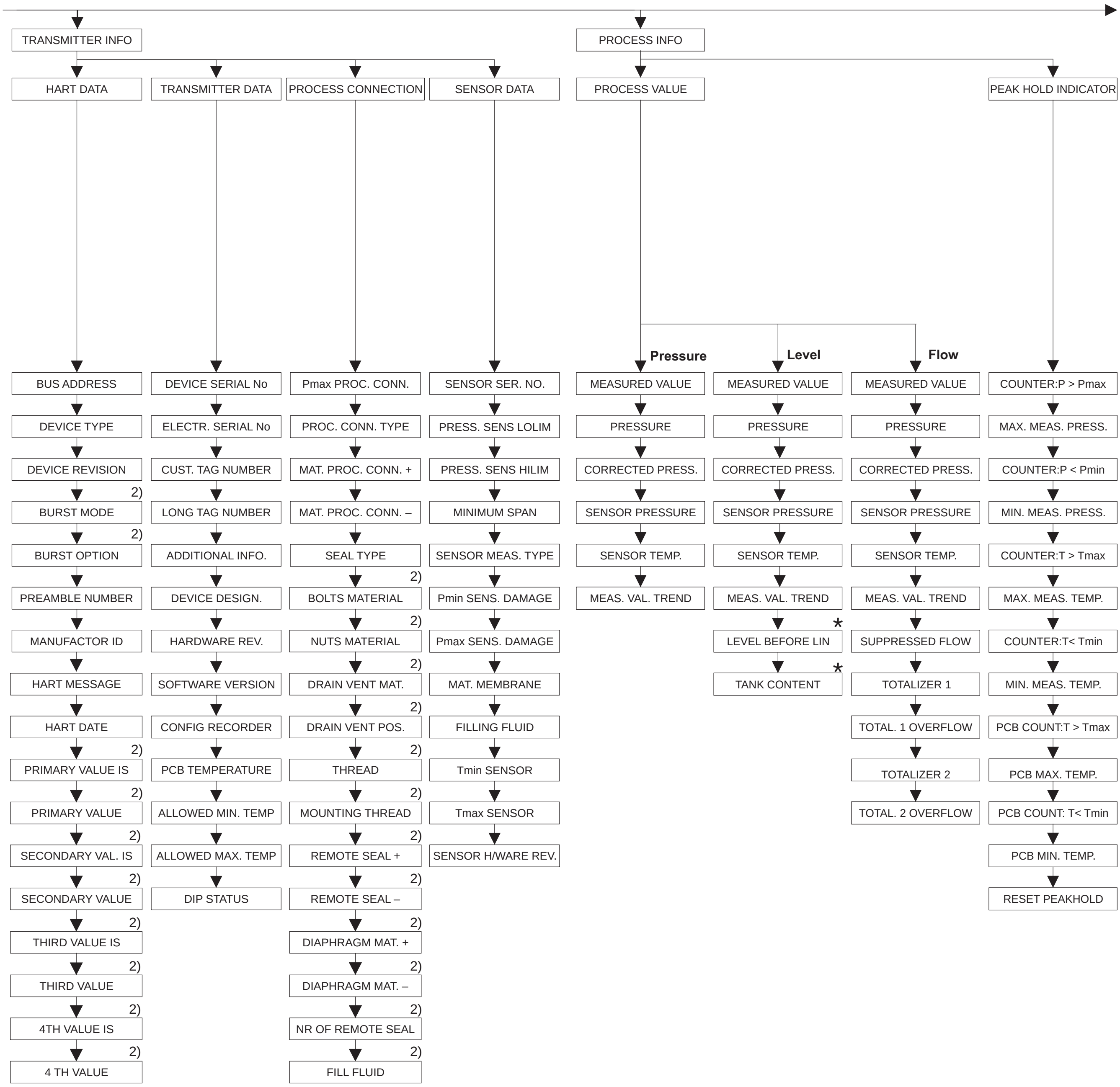
4) Flow measuring mode only

5) only LEVEL SELECTION = Level Easy Pressure

* There are parameters that are only displayed if other parameters are appropriately configured.
These parameters are indicated with a "*".

** See Safety Manual SD189P
for Deltabar S.

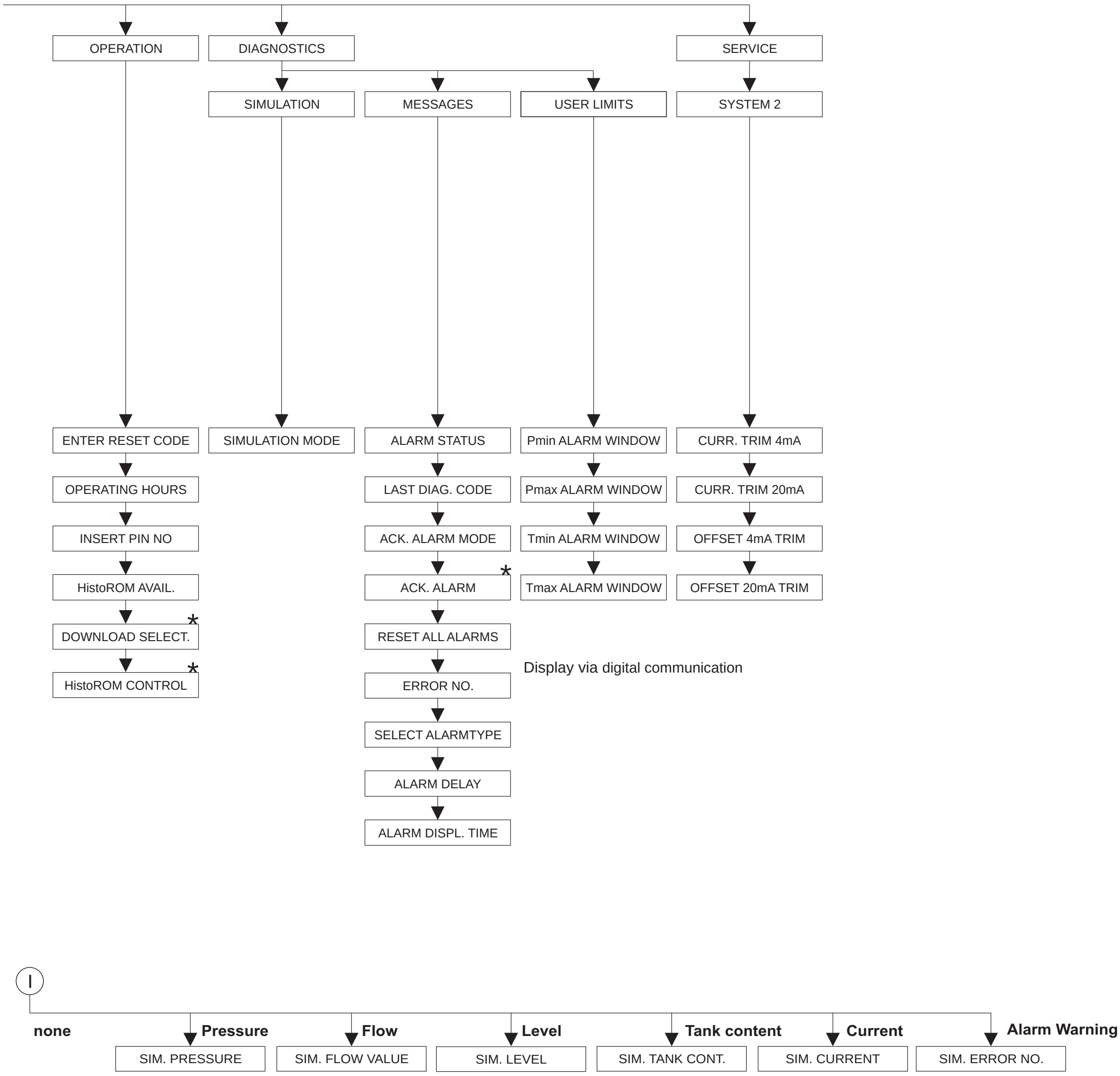
P01-xMD7xxxx-19-xx-xx-xx-006



2) Display via FieldCare
HART handheld terminal only

* There are parameters that are only displayed if other parameters are appropriately configured.
These parameters are indicated with a "*".

P01-xMD7xxxx-19-xx-xx-xx-007



* There are parameters that are only displayed if other parameters are appropriately configured.
These parameters are indicated with a "*".

P01-xxxxxxxx-19-xx-xx-xx-143

10.2 Patents

This product may be protected by at least one of the following patents. Further patents are pending.

- DE 203 11 320 U1
- US 6,631,644 A1 ≙ EP 1 299 701 B1
- US 5,670,063 A1 ≙ EP 0 516 579 B1
- US 5,539,611 A1
- US 5,050,034 A1 ≙ EP 0 445 382 B1
- US 5,097,712 A1 ≙ EP 0 420 105 B1
- US 5,050,035 A1 ≙ EP 0 414 871 B1
- US 5,005,421 A1 ≙ EP 0 351 701 B1
- EP 0 414 871 B1
- US 5,334,344 A1 ≙ EP 0 490 807 B1
- US 6,703,943 A1
- US 5,499,539 A1 ≙ EP 0 613 552 B1

Index

Endress+Hauser
People for Process Automation

Declaration of Hazardous Material and De-Contamination
Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.
Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp ____

Serial number
Seriennummer ________________________

☐ **Used as SIL device in a Safety Instrumented System /** *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* ________ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm²/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	flammable *entzündlich*	toxic *giftig*	corrosive *ätzend*	harmful/ irritant *gesundheits-schädlich/ reizend*	other * *sonstiges**	harmless *unbedenklich*
Process medium *Medium im Prozess*								
Medium for process cleaning *Medium zur Prozessreinigung*								
Returned part cleaned with *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* ____
____
____

Company data / *Angaben zum Absender*

Company / *Firma* ________________________________
____
Address / *Adresse*
____
____

Phone number of contact person / *Telefon-Nr. Ansprechpartner:*
____
Fax / E-Mail ____
Your order No. / *Ihre Auftragsnr.* ________________________

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."
"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

P/SF/Konta XIV

______________________ ______________________ ______________________
(place, date / *Ort, Datum)* Name, dept./*Abt.* (please print / *bitte Druckschrift*) Signature / *Unterschrift*

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA270P/00/EN/05.10
71114104
CCS/FM+SGML6.0

71114104

SPARE PARTS LIST

Operations & Maintenance Manual
December 2015

ARMSTRONG PUMP PARTS LIST

Operations & Maintenance Manual
December 2015

ARMSTRONG®

FILE NO.:	6040.60
DATE:	August 30, 2000
SUPERSEDES:	6040.60
DATE:	June 20, 2000

SERVICE WORK INSTRUCTIONS
SERIES 4030, 4280, 4360D & 4380 MECHANICAL SEAL KITS

Refer to appropriate Service Work Instructions (SWI) file for breakdown instructions for the pump being serviced. Mechanical seal replacement instructions are included in the pump SWI. The following instructions are included for convenience.

Caution: *Always disconnect power supply from motor before beginning service work.*

Seal Kit Installation Instructions

1. Remove Impeller and Mechanical Seal from pump or motor shaft. The mechanical seal spring usually comes free with the impeller. The mechanical seal rotating element must be pried loose with pry bars or screwdrivers. Once loosened, the seal may be pulled free of the shaft.

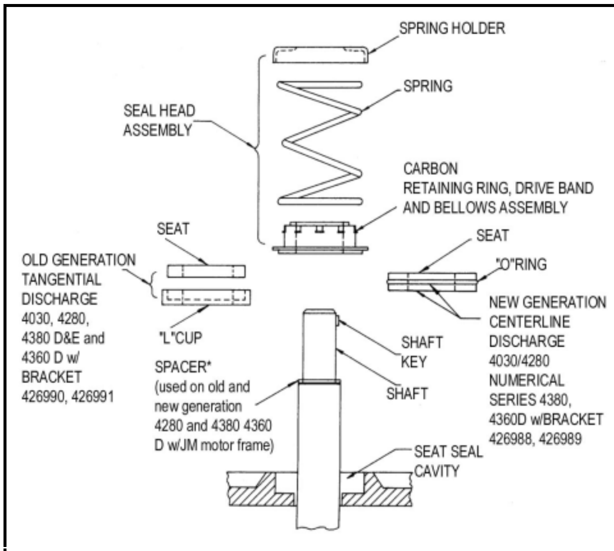
2. When removing impeller and seal from a motor shaft, take care to retrieve the spacer from between the impeller and shaft sleeve. Store for later use.

3. Remove Seal Seat from Adapter. The mechanical seal seat, “O” ring or “L” cup mounted, will be Ceramic or Ni-Resist material, and must be pried loose from the recess in the adapter. If the seat cannot be removed in this manner, separate the adapter from the bearing housing or motor. A screwdriver may then be used to push the seat out of the adapter from the rear.

4. Clean the shaft sleeve surface, ensuring all the former seal elastomeric residue has been removed. Inspect for damage and replace if necessary. (See separate instructions, File No. 6042.25, for removal of the motor shaft sleeve). Inspect the water slinger and replace if damaged.

5. *Ceramic is a suitable replacement for Ni-Resist and is the seal seat of choice. Ceramic is more delicate than Ni-Resist, however, and should be treated accordingly.*

6. Install a new seal seat in the adapter cavity, being sure the lapped (polished) side of the insert is facing up. Ensure that the cavity has been thoroughly cleaned. Lubricate the outside of the seat elastomer (“O” ring, or “L” cup) with a small amount liquid soap, silicon or glycerin lubricant and press down, straight and even, into the cavity. Do not press the seat in with bare fingers, use a clean cloth or the cardboard disc typically supplied with the seal. Contamination of the polished and lapped seat face could cause leakage.



*IMPORTANT: Spacer may come off when old seal kit is removed.
BE SURE IT IS ON WHEN INSTALLING NEW SEAL KIT.

CAUTION

Do not use oil, Vaseline or other petroleum based product for seal elastomer lubrication. Otherwise elastomer swelling may occur causing seal failure.

7. If the adapter was removed, replace now, taking care that the seal seat is carefully guided over the shaft.

8. Lubricate the inside of the seal rotating assembly (The ‘rubber’ bellows) with a small amount of liquid soap, silicon or glycerin lubricant and slide onto the shaft sleeve with a twisting motion, carbon face first, until the carbon face is pressed firmly against the seal seat.

9. Remove the spring retainer from the seal spring and place the seal spring over the seal rotating assembly. Re-install the shaft sleeve spacer and impeller key on the shaft and place the seal spring retainer onto the impeller hub register. Slide the impeller into place on the shaft. Take care and ensure that the seal spring is kept in place on the seal rotating assembly and fits well into the retainer on the impeller hub. Secure impeller and finish reassembling pump.

Seal Kit Part Number (See Note 1)	Seal Size	Used on:	Pump Construction	4030 Frame Size	4280/4380 Motor Frame Size	Seal Construction				
						Type	Elastomer	Trim	Seat Style (See Note 3)	Seat Material
816707-001	0.75	6 Series, 1000D	BF/AB				Buna	Brass	L-Cup	Ceramic
975000-991 (See Note 2)	1.25	4030/4280 Centerline Discharge, 4380 Numerical and 4360D w/Bracket 426988 or 426989	BF/AB/AI	S	56C, 143-215JM	21	**EPDM**	**St. Stl.**	**O-Ring**	**Ceramic**
810150-127						2	Viton			Ni-Resist
810150-137						2	Buna			
810150-128						21	EPDM			Tungsten
975000-993 (See Note 2)	1.625			M	254-326JM, 213-326JP	21	**EPDM**			**Ceramic**
810150-131						21	Viton			Ni-Resist
810150-138						2	Buna			
810150-132						21	EPDM			Tungsten
825458-001 (See Note 2)	1.25	4030/4280 Tangential Discharge, 4380 D & E and 4360D w/Bracket 426990 or 426991	BF/AB/AI	S	56C, 143-215JM	21	**Buna**	**St. Stl.**	**L-Cup**	**Ceramic**
825458-003						21	Viton			
810150-133			BF/AI/AB			2	Buna			Tungsten
811339-000 (See Note 2)	1.625		BF/AB	M	254-326JM, 213-326JP	2	**Buna**	**Brass**		**Ceramic**
811866-000 (See Note 2)			AI			2	Buna	Steel		
819299-000			BF/AB			2	Viton	Brass		
810150-139			BF/AI/AB			2	Buna	St. Stl.		Tungsten

Notes:

1. Seal Kit consists of rotating seal head, spring holder, stationary seal seat with O-ring or L-cup. Pump casing gasket and other minor hardware components possibly required to reassemble the pump are not included. Consult Service Parts Bulletins for more detail.
2. Standard seal used for the pump construction indicated. Other seals listed are optional.
3. O-ring and L-cup style seats are NOT interchangeable between tangential and centerline discharge pumps.

S.A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
Tel: (416) 755-2291
Fax: (416) 759-9101
Visit us at www.armstrongpumps.com

Armstrong Pumps Limited
Peartree Road, Stanway
Colchester, Essex
United Kingdom, C03 5JX
Tel: 01206-579491
Fax: 01206-760532

Armstrong Pumps Inc.
93 East Avenue
Buffalo, New York
U.S.A. 14120-6594
Tel: (716) 693-8813
Fax: (716) 693-8970

Armstrong Darling Inc.
2200 Place Transcanadienne
Montreal, Quebec
Canada, H9P 2X5
Tel: (514) 421-2424
Fax: (514) 421-2436

DRAINAGE CONTROL VALVE PARTS LIST

Operations & Maintenance Manual
December 2015

PENTAIR

Pentair Valves & Controls US LP
2821 S. Parker Road · Suite 265
Aurora, CO 80014
Phone: 303-632-4923
Fax: 303-632-4947

Template Rev 031913

ITEM	QTY	MODEL OR PART NUMBER & DESCRIPTION	UNIT PRICE	TOTAL
5	12"	**KEYSTONE AR2-805-ARA RESILIENT SEAT BUTTERFLY VALVE** --Cast Iron LUG-STYLE Body --316 Stainless Disc --316 Stainless Stem --EPDM Seat --ARRA Compliance **KEYSTONE 777-035 12 20 3X3XXXX3 ELECTRIC ACTUATOR** --120V-AC --NEMA-4 Enclosure --30% Duty Cycle --Heater --Dome Indicator --Direct Mount Switch assembly with 4 switches 2 motor control/ 2 potential free contacts for position feedback Beacon Indicator/ Handwheel Overide/Dual Travel Stops		
1	18"	**KEYSTONE AR2-072-ARA RESILIENT SEAT BUTTERFLY VALVE** --Cast Iron LUG-STYLE Body --316 Stainless Disc --18-8 Stainless Stem --EPDM Seat --ARRA Compliance **KEYSTONE 777-180 12 58 3X3XXXX3 ELECTRIC ACTUATOR** --120V-AC --NEMA-4 Enclosure --30% Duty Cycle --Heater --Dome Indicator --Direct Mount Switch assembly with 4 switches 2 motor control/ 2 potential free contacts for position feedback Beacon Indicator/ Handwheel Overide/Dual Travel Stops		

Keystone Butterfly Valves Figure AR1/AR2

General Purpose Valve

PENTAIR

VALVES & CONTROLS

Resilient seated butterfly valves
AR1 (wafer) (2" to 36"), 2" to 12", to 175 psi
AR2 (lug) (2" to 24"), 14" to 36", to 150 psi

Features and Benefits

- Triple function resilient seat helps provide bi-directional drop-tight shut-off, designed to totally isolate the valve body and stem from the line media.
- Molded-in O-ring seat design serves as flange seals, eliminating the need for gaskets between the flanges and the valve.
- Unique dovetail seat retention design allows for convenient and economical field replacement.
- Superior one-piece through shaft design provides high strength and positive disc control.
- Internal shaft seal is designed to prevent external media from entering valve and it also adjusts for pressure and shaft rotation.
- Heavy-duty, corrosion resistant top bushing delivers upper stem support, absorbs actuator side-loading and extends valve cycle life.
- Polished disc edge helps ensure optimal performance and maximum seat life.
- Stainless steel torque plug (2" to 12"), disc screws (14" to 20") and taper pins (24" to 36") provide positive leak-proof connections while allowing for quick and easy disassembly.
- One-piece body with extended neck allows clearance for flanges and insulation.
- Each valve is factory-tested to 110 percent of the manufacturer's pressure rating.

General Application

Ideally suited for many high performance applications, such as fire protection, water treatment, cooling systems, food and beverage and bulk product handling. Consult your sales representative for appropriate materials and specific services.

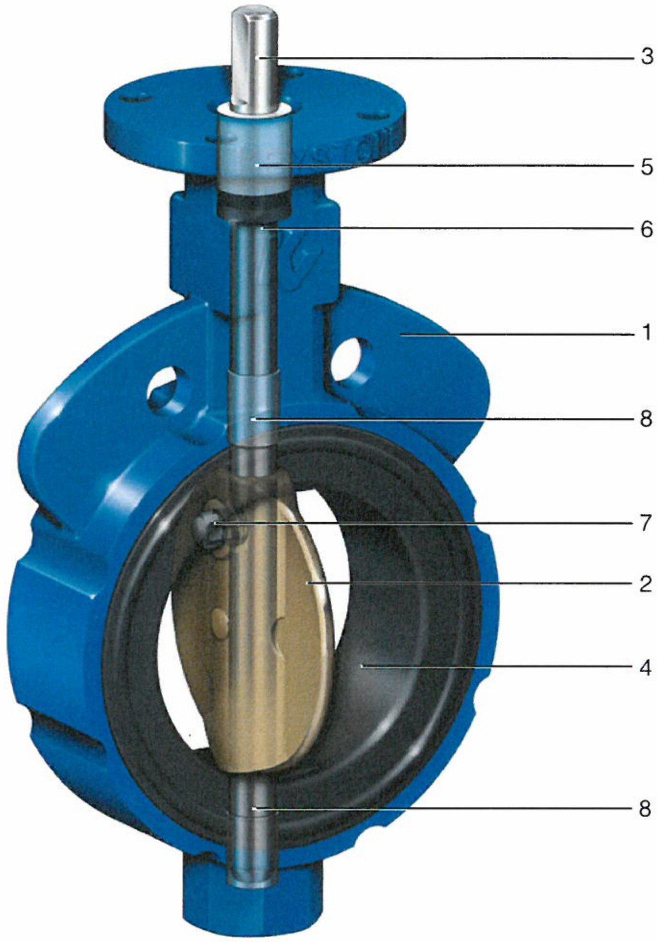
Technical Data

Size Range:
Figure AR1 (wafer style) 2" to 36"
Figure AR2 (lugged style) 2" to 24"

Flange Standard:
ANSI Class 125/150

(Consult your sales representative for additional drilling standards.)

Parts and Materials



Materials

Part	Standard Material	Material Specification	Optional Material
1 Body	Cast iron Ductile iron	ASTM A-126, Class B ASTM A-395 GR 60/40/18	Carbon steel Stainless steel
2 Disc	Ductile iron	ASTM A-536 GR 65/45/12	
	Aluminum bronze	ASTM B-148, UNS C95200 Grade A	
	316 Stainless steel	ASTM A-743, CF8M	
3 Stem	316 Stainless steel (2" to 12")	ASTM A-276 UNS S31600	
	18-8 Stainless steel (14" to 20")	ASTM A-276 UNS S30400	
	17-4 PH Stainless steel (24" to 36")	ASTM A-564 UNS S17400	Phosphate treated steel
	(2" to 20")	ASTM A-108 UNS G10450	
4 Seat	NBR food grade (0°F to 212°F)		Fluoroelastomer (FKM)
	EPDM food grade (-40°F to 250°F)		White NBR
5 Upper stem bushing	Polyester (2" to 20") Bronze (24" to 36")		
6 Stem packing	NBR		
7 Torque plug (2" to 12")	316 Stainless steel	ASTM A-276 UNS S31600 condition A	
Disc screws (14" to 20")	316 Stainless steel	ASTM F-593 Group 2 condition CW1	
Taper pins (24" to 36")	17-4 PH Stainless steel	ASTM A564 UNS S17400 H1075	
8 Bearings (2" to 12")	Sintered metal		

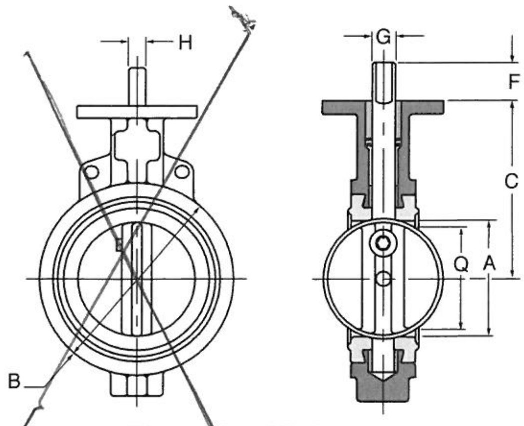


Figure AR1 Wafer

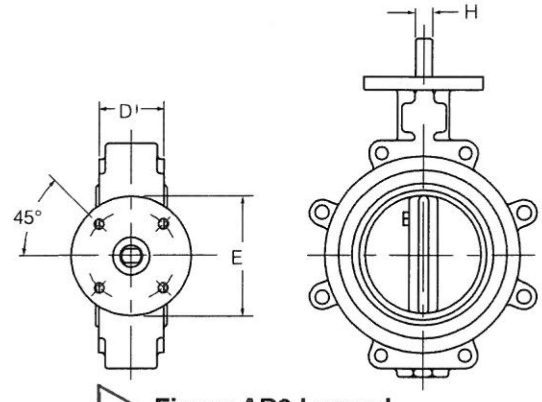


Figure AR2 Lugged

Figure AR1 – Dimensions (inches)

Size	A	B	C	D	E	F	G	H	Q	Key	Top Plate Drilling Bolt Circle	Top Plate Drilling No. Holes	Top Plate Drilling Hole Dia.	Weight (lbs)	Adapt. Code
2	2	4 1/8	5 1/2	1 5/8	4	1 1/4	9/16	3/8	1 3/8	N/A	3 1/4	4	7/16	6.3	BAB
2 1/2	2 1/2	4 5/8	6	1 3/4	4	1 1/4	9/16	3/8	2 1/16	N/A	3 1/4	4	7/16	8.5	BAB
3	3	5 1/8	6 1/4	1 3/4	4	1 1/4	9/16	3/8	2 9/16	N/A	3 1/4	4	7/16	10.0	BAB
4	4	6 3/8	7	2	4	1 1/4	5/8	7/16	3 5/8	N/A	3 1/4	4	7/16	14.0	BAC
5	5	7 3/8	7 1/2	2 1/8	4	1 1/4	3/4	1/2	4 3/4	N/A	3 1/4	4	7/16	18.0	BAD
6	5 3/4	8 1/2	8	2 1/8	4	1 1/4	3/4	1/2	5 1/2	N/A	3 1/4	4	7/16	22.0	BAD
8	7 3/4	10 11/16	9 1/2	2 1/2	6	1 1/4	7/8	5/8	7 1/2	N/A	5	4	9/16	38.0	CAE
10	9 3/4	13	10 3/4	2 1/2	6	2	1 1/8	N/A	9 19/32	1/4 x 1/4	5	4	9/16	51.0	CAF
12	11 3/4	14 13/16	12 1/4	3	6	2	1 1/8	N/A	11 9/16	1/4 x 1/4	5	4	9/16	71.0	CAF
14	13 1/4	16 3/4	12	3	6	3	1 3/8	N/A	13 1/8	5/16 x 5/16	5	4	9/16	114.0	CAG
16	15 1/4	19 1/4	12 61/64	4	6	3	1 5/8	N/A	15	3/8 x 3/8	5	4	9/16	193.0	CAH
18	17 1/4	21 1/2	14 1/2	4 1/4	8	4 1/4	1 7/8	N/A	16 7/8	1/2 x 3/8	6 1/2	4	13/16	222.0	DAJ
20	19 1/4	23 3/4	15 7/8	5	8	4 1/4	1 7/8	N/A	18 3/4	1/2 x 3/8	6 1/2	4	13/16	315.0	DAJ
24	23 1/4	28 1/4	19 1/2	5 15/16	8	4 1/4	1 7/8	N/A	22 5/8	1/2 x 3/8	6 1/2	4	13/16	506.0	DAJ
30	29 1/4	34 5/8	23	6 9/16	8	4 1/4	2 1/4	N/A	28 11/16	1/2 x 3/8	6 1/2	4	13/16	610.0	DAK
36	35 1/4	41 1/4	27 3/4	7 7/8	8	5 1/4	2 7/8	N/A	34 1/2	3/4 x 1/2	6 1/2	4	13/16	1,185.0	DAV

Figure AR2 – Dimensions (inches)

Size	A	B	C	D	E	F	G	H	Q	Key	Top Plate Drilling Circle	Top Plate Drilling Bolt Holes	Top Plate Drilling No. Dia.	Tapped Lug Data Hole Circle	Tapped Lug Data Bolt Holes	Tapped Lug Data No. Tap	Weight (lbs)	Adapt. Code
2	2	4 1/8	5 1/2	1 5/8	4	1 1/4	9/16	3/8	1 3/8	N/A	3 1/4	4	7/16	4 3/4	4	5/8 - 11 UNC	7.0	BAB
2 1/2	2 1/2	4 5/8	6	1 3/4	4	1 1/4	9/16	3/8	2 1/16	N/A	3 1/4	4	7/16	5 1/2	4	5/8 - 11 UNC	10.0	BAB
3	3	5 3/16	6 1/4	1 3/4	4	1 1/4	9/16	3/8	2 9/16	N/A	3 1/4	4	7/16	6	4	5/8 - 11 UNC	11.5	BAB
4	4	6 3/8	7	2	4	1 1/4	5/8	7/16	3 5/8	N/A	3 1/4	4	7/16	7 1/2	8	5/8 - 11 UNC	18.0	BAC
5	5	7 3/8	7 1/2	2 1/8	4	1 1/4	3/4	1/2	4 3/4	N/A	3 1/4	4	7/16	8 1/2	8	3/4 - 10 UNC	22.5	BAD
6	5 3/4	8 1/2	8	2 1/8	4	1 1/4	3/4	1/2	5 1/2	N/A	3 1/4	4	7/16	9 1/2	8	3/4 - 10 UNC	28.5	BAD
8	7 3/4	10 11/16	9 1/2	2 1/2	6	1 1/4	7/8	5/8	7 1/2	N/A	5	4	9/16	11 3/4	8	3/4 - 10 UNC	49.0	CAE
10	9 3/4	13	10 3/4	2 1/2	6	2	1 1/8	N/A	9 19/32	1/4 x 1/4	5	4	9/16	14 1/4	12	7/8 - 9 UNC	69.0	CAF
12	11 3/4	14 13/16	12 1/4	3	6	2	1 1/8	N/A	11 9/16	1/4 x 1/4	5	4	9/16	17	12	7/8 - 9 UNC	107.0	CAF
14	13 1/4	16 3/4	12	3	6	3	1 3/8	N/A	13 1/8	5/16 x 5/16	5	4	9/16	18 3/4	12	1 - 8 NC	143.0	CAG
16	15 1/4	19	12 61/64	4	6	3	1 5/8	N/A	15	3/8 x 3/8	5	4	9/16	21 1/4	16	1 - 8 NC	238.0	CAH
18	17 1/4	21 3/8	14 1/2	4 1/4	8	4 1/4	1 7/8	N/A	16 7/8	1/2 x 3/8	6 1/2	4	13/16	22 3/4	16	1 1/8 - 7 NC	261.0	DAJ
20	19 1/4	23 1/2	15 7/8	5	8	4 1/4	1 7/8	N/A	18 3/4	1/2 x 3/8	6 1/2	4	13/16	25	20	1 1/8 - 7 NC	366.0	DAJ
24	23 1/4	28 1/4	19 1/2	5 15/16	8	4 1/4	1 7/8	N/A	22 5/8	1/2 x 3/8	6 1/2	4	13/16	29 1/2	20	1 1/4 - 7 NC	576.0	DAJ

Notes:

1. "H" Dimension refers to flat on stem.
2. "Q" dimension is the minimum allowable pipe or flange inside diameter at the centered body face to protect the disc sealing edge against damage when opening the valve.

Valve Sizing

Rate of flow through a valve depends upon the pressure drop. The most common method of presenting this information is by C_V. The C_V is the valve coefficient of flow and represents the flow of water in gallons per minute (GPM) with a 1 psi pressure drop through the valve. The higher the C_V, the greater the flow and the better the control characteristics. Throttling characteristics are shown in the same manner with C_V's at the various disc openings. See Table 1 for tabulated C_V's for the Figure AR1/AR2 Butterfly Valve.

Table 1
C_V Chart (Water @ 70°F, Specific Gravity = 1.00)

Valve	Disc position (Degrees Open)							
Size	20	30	40	50	60	70	80	90
2"	1.3	5	14	26	40	52	59	60
2.5"	1.4	6	21	44	74	107	138	151
3"	1.5	8	29	67	115	175	234	262
4"	15	48	107	196	318	463	589	647
5"	32	99	206	362	579	832	1045	1141
6"	47	145	295	510	810	1160	1450	1580
8"	84	239	450	751	1190	1754	2385	2892
10"	133	360	652	1064	1683	2524	3596	4593
12"	192	509	899	1449	2288	3470	5085	6682
14"	340	770	1400	2200	3400	5600	7900	10000
16"	440	1000	1800	2800	4500	7400	10800	13000
18"	570	1300	2300	3600	5800	9600	15000	18000
20"	710	1600	2900	4600	7200	12000	18400	22000
24"	1000	2300	4000	6400	10000	16500	25900	30000
30"	1500	3600	6200	9900	16000	26000	42500	47000
36"	2600	5200	9100	15000	23000	38000	65000	70000

Torque Data

Torque is the rotary effort required to operate a valve. This turning force in a butterfly valve is determined by three factors – the friction of the disc and seat due to interference for sealing, bearing friction, and fluid dynamic torque.

Breakaway torque at 70°F

Breakaway torque is the total of the torques resulting from bearing friction and disc/seat interference friction at a given pressure differential. See Table 2 for torques to open and close the valve at pressures shown in wet services with minimum operating frequency of one per week (normal conditions).

Note: These values are valid for water and lubricating fluids only at 70°F. Since torques are greatly increased for dry and nonlubricating fluids and temperature variations, contact your Keystone representative for accurate values in Tathese applications.

Table 2
Seating and Unseating Torques

Valve	Category 2 (Normal Conditions)			
Size	50	100	150	175
2"	224	229	233	235
2.5"	277	284	291	264
3"	330	340	350	355
4"	500	519	539	549
5"	687	724	761	779
6"	953	1006	1059	1086
8"	1610	1720	1830	1885
10"	2521	2751	2963	3074
12"	3418	3737	4055	4214
14"	5147	5995	6842	–
16"	6808	8116	9424	–
18"	8810	10720	12630	–
20"	11172	13845	16517	–
24"	13372	16994	20616	–
30"	22074	29148	36222	–
36"	33224	45448	57672	–

PENTAIR

KEYSTONE F777/778 ELECTRIC ACTUATORS

The compact electric actuator for quarter turn (90°) valve operation providing a torque range from 35 to 4500 Nm

FEATURES

- Aluminium housing with ESPC coating
- Optimized mounting interface for direct mounting on top of Keystone valves
- Epicyclical gearing for smooth control and low noise level
- Top mounted position indicator (360 degree visibility)
- IP67 and NEMA 4X ingress protection
- Thermal overload protection
- Clutchless manual override by hand wheel (except smallest sizes)
- Easy accessible quick connect terminal strip
- Mechanical travel stops
- On/off and modulating duty
- Various options i.e. torque switches, additional voltage free contacts, local control module, etc.

GENERAL APPLICATION

The Keystone F777/778 is a compact economical actuator that can be used for various applications. It is particularly suitable for process applications like HVAC and water industry because of its torque span and low energy consumption.

TECHNICAL DATA

Material:	aluminium body and cover
Torque range:	35 to 4,500 Nm (300 to 40,000 lbin)
Ambient temperature range:	-30 to +65°C (-22 to +150°F)
IP rating:	IP67 / NEMA 4X
Voltage rating:	24 V DC / 24 V AC 50/60 Hz 110-120 V AC - 50/60 Hz (1-phase) 220-240 V AC - 50/60 Hz (1-phase) 400 V AC – 50/60 Hz (3-phase)
Electrical connection:	2x M20 or ½" NPT cable entry 8-point terminal strip
Certification:	CE, CSA, RoHs

The F777/778 electric actuator is available in three series with different torque values to cover the wide torque range. In addition there are various flange connections so it can be direct mounted to the Pentair butterfly valves, which reduces the requirement of brackets and creates a more compact valve package.

The available series are:
- F777 Keystone Imperial: Keystone shaft and flange - Imperial threading
- F777 Keystone Metric: Keystone shaft and flange – Metric threading
- F778 Keystone ISO: Keystone shaft / ISO flange – Metric threading

Note: when there is no difference between the F777 and F778 models, the models in the remainder of this document are referred to as F77x.

MODEL OVERVIEW

	Torque		Weight		
Model	(Nm)	(lbin)	(kg)	(lb)	Manual override
77x-003	35	310	2	5	Lever
77x-005	50	440	3	7	Lever
77x-008	90	800	11	25	Hand wheel
77x-013	150	1320	11	25	Hand wheel
77x-035	400	3540	20	45	Hand wheel
77x-044	500	4420	20	45	Hand wheel
77x-057	650	5750	20	45	Hand wheel
77x-088	1000	8850	32	72	Hand wheel
77x-130	1500	13280	32	72	Hand wheel
77x-180	2000	17700	71	158	Hand wheel
77x-220	2500	22130	71	158	Hand wheel
77x-265	3000	26560	72	160	Hand wheel
77x-310	3500	31000	72	160	Hand wheel
77x-400	4500	40000	106	236	Hand wheel

NOTES

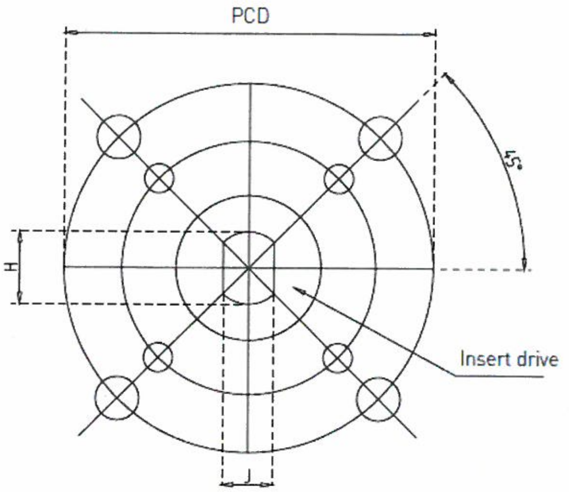
F777-014 is identical to F777-013 with larger bore
F777-036 is identical to F777-035 with larger bore
F777-045 is identical to F777-044 with larger bore
F777-058 is identical to F777-057 with larger bore
F777-089 is identical to F777-088 with larger bore
F777-181 is identical to F777-180 with larger bore
F778-058 is identical to F778-057 with larger flange
F778-089 is identical to F778-088 with larger flange
F778-131 is identical to F778-130 with larger flange

The F777/778 is available in various voltage ratings, which can be used in 50 and 60 Hz applications. Table 2 shows an overview of the available voltage ratings and appropriate stroking speed.

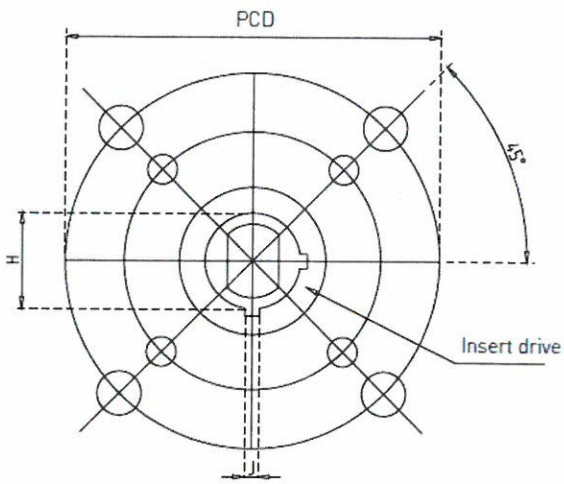
STROKE SPEED

	Torque		Stroke speed				
Model	(Nm)	(lbin)	24 V AC/DC (s/90°)	120 V AC - 60 Hz (s/90°)	240 V AC / 1 ph - 50 Hz (s/90°)	400 V AC / 3ph - 50 Hz (s/90°)	400 V AC / 3ph - 60 Hz (s/90°)
77x-003	35	310	15	12	12	12	12
77x-005	50	440	20	20	25	25	20
77x-008	90	800	15	12	18	18	12
77x-013	150	1320	22	20	25	25	20
77x-035	400	3540	15	18	18	18	18
77x-044	500	4420	20	25	25	25	25
77x-057	650	5750	28	30	30	30	30
77x-088	1000	8850	45	45	55	55	45
77x-130	1500	13280	45	45	55	55	45
77x-180	2000	17700	60	60	70	70	60
77x-220	2500	22130	60	60	70	70	60
77x-265	3000	26560	60	60	70	70	60
77x-310	3500	31000	60	60	70	70	60
77x-400	4500	40000	80	80	95	95	80

Speed indication can vary +/- 10%



MODELS 003 TO 014



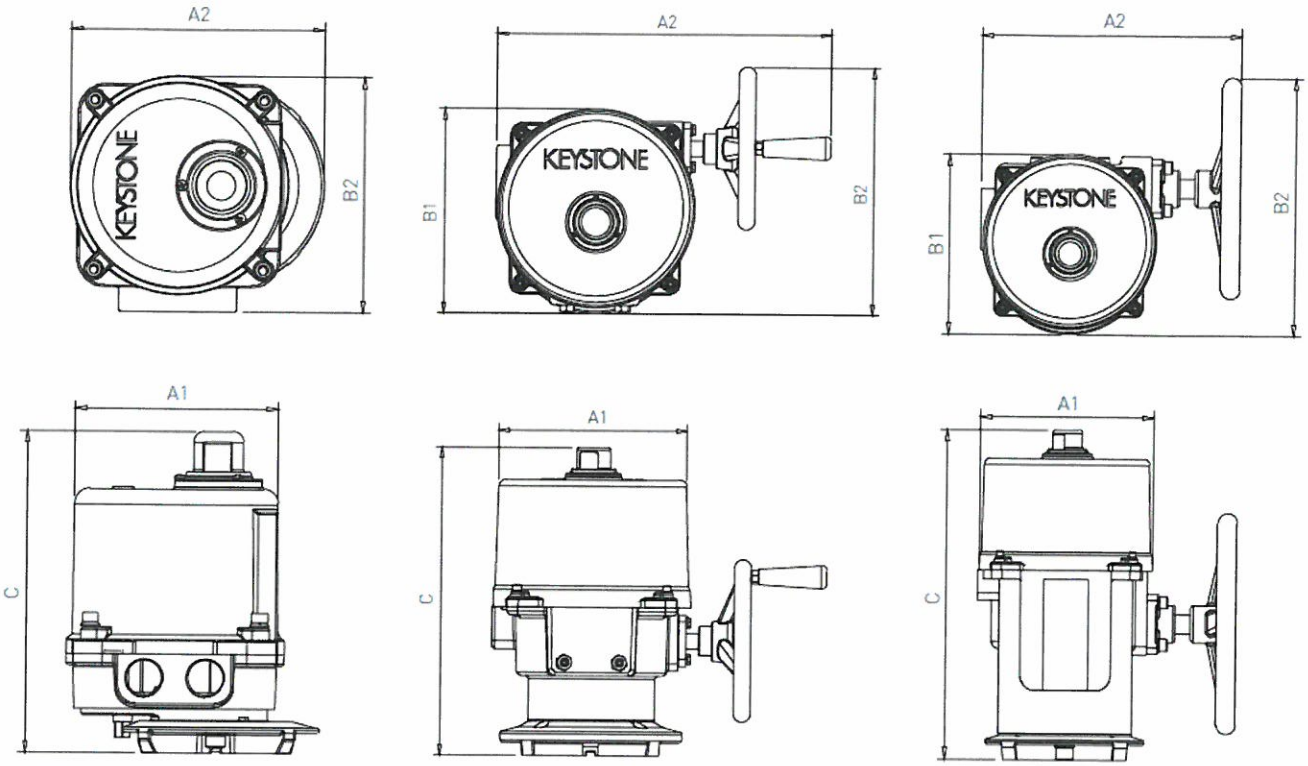
MODELS 035 TO 400

VALVE CONNECTION F778 KEYSTONE ISO

Model	Shaft connection (mm)					Mounting holes
	H	J	Key	Shaft depth	PCD	No x Size x Depth
778-003	16.0	11.0		30.0	F03	4x M5 x 10.0
					F05	4x M6 x 10.0
					F07	4x M8 x 12.0
778-005	16.0	11.0		30.0	F05	4x M6 x 10.0
					F07	4x M8 x 12.0
778-008	20.0	14.0		30.0	F07	4x M8 x 12.0
778-013	25.0	18.0		30.0	F07	4x M8 x 12.0
778-035	30.0	22.0		50.0	F07	4x M8 x 12.0
					F10	4x M10 x 15.0
					F12	4x M12 x 19.0
778-044	35.0		10.0 x 8.0	70.0	F07	4x M8 x 12.0
					F10	4x M10 x 15.0
					F12	4x M12 x 19.0
778-057	35.0		10.0 x 8.0	70.0	F10	4x M10 x 15.0
					F14	4x M16 x 24.0
778-058	35.0		10.0 x 8.0	70.0	F12	4x M12 x 19.0
					F16	4x M20 x 30.0
778-088	50.0		14.0 x 9.0	70.0	F10	4x M10 x 15.0
					F14	4x M16 x 24.0
778-089	50.0		14.0 x 9.0	70.0	F12	4x M12 x 19.0
					F16	4x M20 x 30.0
778-130	50.0		14.0 x 9.0	70.0	F10	4x M10 x 15.0
					F14	4x M16 x 24.0
778-131	50.0		14.0 x 9.0	70.0	F12	4x M12 x 19.0
					F16	4x M20 x 30.0
778-180	60.0		18.0 x 11.0	70.0	F16	4x M20 x 30.0
778-220	70.0		20.0 x 12.0	90.0	F16	4x M20 x 30.0
					F25	8x M16 x 24.0
778-265	70.0		20.0 x 12.0	90.0	F16	4x M20 x 30.0
					F25	8x M16 x 24.0
778-310	70.0		20.0 x 12.0	90.0	F16	4x M20 x 30.0
					F25	8x M16 x 24.0
778-400	70.0		20.0 x 12.0	100.0	F16	4x M20 x 30.0
					F25	8x M16 x 24.0

VALVE CONNECTION F777 KEYSTONE (IMPERIAL)

Model	Shaft connection (in)					Mounting holes
	H	J	Key	Shaft depth	PCD	No x Size x Depth
777-003	9/16	3/8		1.26	1.75	4x 1/4-20 UNC x 0.38
					3.25	4x 3/8-16 UNC x 0.56
777-005	9/16	3/8		1.26	3.25	4x 3/8-16 UNC x 0.56
777-008	3/4	1/2		1.26	3.25	4x 3/8-16 UNC x 0.56
777-013	3/4	1/2		1.26	3.25	4x 3/8-16 UNC x 0.56
777-014	7/8	5/8		2.00	3.25	4x 3/8-16 UNC x 0.56
					5.00	4x 1/2-13 UNC x 0.63
777-035	1 1/8		1/4 x 1/4	2.00	3.25	4x 3/8-16 UNC x 0.56
					5.00	4x 1/2-13 UNC x 0.63
777-036	1 3/8		5/16 x 5/16	2.00	3.25	4x 3/8-16 UNC x 0.56
					5.00	4x 1/2-13 UNC x 0.63
777-044	1 1/8		1/4 x 1/4	2.76	5.00	4x 1/2-13 UNC x 0.63
777-045	1 3/8		5/16 x 5/16	2.76	5.00	4x 1/2-13 UNC x 0.63
777-057	1 1/8		1/4 x 1/4	2.76	5.00	4x 1/2-13 UNC x 0.63
777-058	1 3/8		5/16 x 5/16	2.76	5.00	4x 1/2-13 UNC x 0.63
777-088	1 3/8		5/16 x 5/16	2.76	5.00	4x 1/2-13 UNC x 0.63
					6.50	4x 3/4-10 UNC x 1.00
777-089	1 5/8		3/8 x 3/8	2.76	5.00	4x 1/2-13 UNC x 0.63
					6.50	4x 3/4-10 UNC x 1.00
777-130	1 5/8		3/8 x 3/8	2.76	5.00	4x 1/2-13 UNC x 0.63
					6.50	4x 3/4-10 UNC x 1.00
777-131	1 7/8		1/2 x 3/8	2.76	5.00	4x 1/2-13 UNC x 0.63
					6.50	4x 3/4-10 UNC x 1.00
777-180	1 7/8		1/2 x 3/8	2.76	6.50	4x 3/4-10 UNC x 1.00
777-181	2 1/4		1/2 x 3/8	2.76	6.50	4x 3/4-10 UNC x 1.00
777-220	1 7/8		1/2 x 3/8	3.54	6.50	4x 3/4-10 UNC x 1.00
777-221	2 1/4		1/2 x 3/8	3.54	6.50	4x 3/4-10 UNC x 1.00
777-265	2 1/4		1/2 x 3/8	3.54	6.50	4x 3/4-10 UNC x 1.00
777-310	2 1/4		1/2 x 3/8	3.54	6.50	4x 3/4-10 UNC x 1.00
777-400	2 7/8		3/4 x 1/2	3.94	6.50	4x 3/4-10 UNC x 1.00
					10.00	8x 1/2-13 UNC x 1.00



DIMENSIONS F777/778

Model	Length A (mm)	Width B1 (mm)	Width B2 (mm)	Height C (mm)	Length A (in)	Width B1 (in)	Width B2 (in)	Height C (in)
77x-003	133		123	168	5.24		4.84	6.61
77x-005	126		123	213	4.96		4.84	8.39
77x-008	393	234	291	363	15.47	9.21	11.46	14.29
77x-013	393	234	291	363	15.47	9.21	11.46	14.29
77x-035	366	190	245	306	14.41	7.48	9.65	12.05
77x-044	366	190	245	306	14.41	7.48	9.65	12.05
77x-057	366	190	245	306	14.41	7.48	9.65	12.05
77x-088	347	234	343	440	13.66	9.21	13.50	17.32
77x-130	347	234	343	440	13.66	9.21	13.50	17.32
77x-180	451	276	402	554	17.76	10.87	15.83	21.81
77x-220	451	276	402	554	17.76	10.87	15.83	21.81
77x-265	451	276	402	554	17.76	10.87	15.83	21.81
77x-310	451	276	402	554	17.76	10.87	15.83	21.81
77x-400	458	276	496	581	18.03	10.87	19.53	22.87

NOTES

Following models use the same housing, but have different valve connection dimensions:

F778-014 dimensions are identical to F778-013

F778-036 dimensions are identical to F778-035

F778-045 dimensions are identical to F778-044

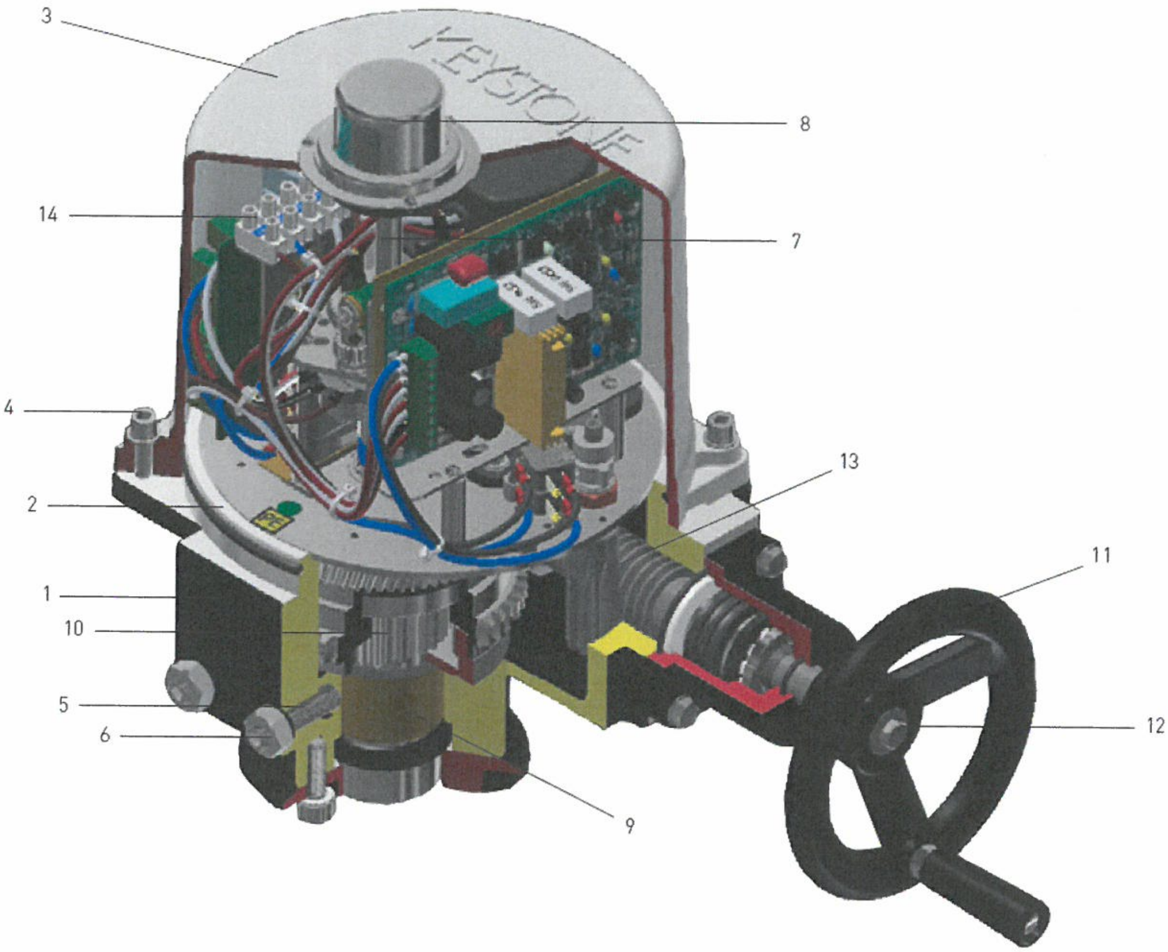
F778-058 dimensions are identical to F778-057

F778-089 dimensions are identical to F778-088

F778-131 dimensions are identical to F778-130

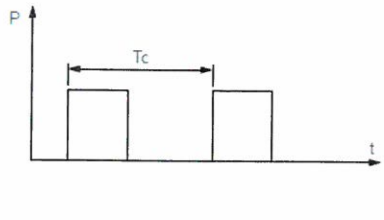
F778-181 dimensions are identical to F778-180

F778-221 dimensions are identical to F778-220

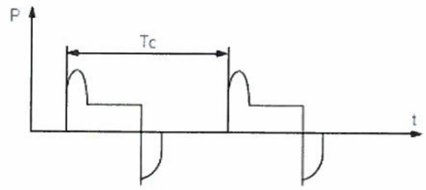


MATERIALS OF CONSTRUCTION

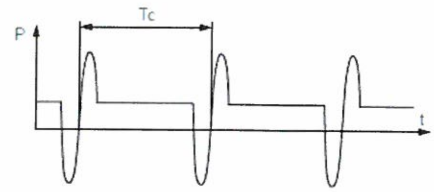
No.	Item	Material	Finish
1	Body	Aluminium alloy	ESPC
2	Body O-ring	NBR	Natural
3	Cover	Aluminium alloy	ESPC
4	Cover bolt	Stainless steel	Natural
5	Travel stop bolt	OM2-8-stainless steel	Natural/Zinc plated
6	Travel stop nut	Stainless steel	Natural
7	Position indicator shaft	S45C	Zinc plated
8	Position indicator	ABS765B	Natural
9	Output shaft	S45C/FCD60	Nickel plated/Phosphate coated
10	Gear	Alloy steel	Natural
11	Hand wheel	Up to F77x-057 Nylon	Natural
		From F77x-088: Aluminium	ESPC
12	Hand wheel bolt	Steel	Zinc plated
13	Torque shaft	S45C	Electrodeposition coating
14	Terminal strip	PA66	Natural



DUTY CYCLE S3



DUTY CYCLE S5



DUTY CYCLE S7

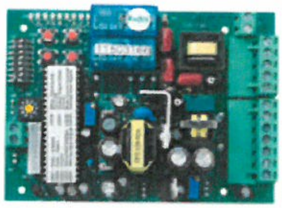
POWER REQUIREMENTS

Model	Motor power (W)	Duty cycle (IEC60034)	12V DC/AC			24V DC/AC		
			Run (A)	Start (A)	Lock (A)	Run (A)	Start (A)	Lock (A)
77x-003	10	S7-75%	1.9	2.0	2.8	1.1	1.1	1.6
77x-005	10	S7-75%	1.3	1.5	2.8	0.8	0.9	1.6
77x-008	40	S7-75%	3.4	5.2	16.5	2.2	4.5	14.5
77x-013	40	S7-75%	4.4	4.9	16.5	2.4	5.0	14.5
77x-035	80	S7-75%	16.1	16.1	33.0	8.5	9.2	30.0
77x-044	80	S7-75%	14.1	13.5	33.0	7.5	9.0	30.0
77x-057	80	S7-75%	12.3	12.5	33.0	7.0	8.5	30.0
77x-088	80	S7-75%				6.8	7.8	30.0
77x-130	80	S7-75%	25.0	26.0	59.0	8.1	8.0	30.0
77x-180	80	S5-50%				8.8	11.0	26.0
77x-220	80	S5-50%	28.0	60.0	59.0	11.8	11.0	26.0
77x-265	80							
77x-310	220							
77x-400	220							

Model	Motor power (W)	Duty cycle (IEC60034)	110V AC - 1 Ph			240V AC - 1 Ph		
			Run (A)	Start (A)	Lock (A)	Run (A)	Start (A)	Lock (A)
77x-003	10	S3-30%	0.6	0.6	0.7	0.3	0.4	0.4
77x-005	10	S3-30%	0.6	0.6	0.7	0.3	0.4	0.5
77x-008	40	S3-30%	1.0	1.8	1.6	0.5	0.8	0.9
77x-013	40	S3-30%	1.2	1.8	1.6	1.0	1.2	0.9
77x-035	80	S3-30%	1.9	3.8	3.6	1.1	2.0	2.2
77x-044	80	S3-30%	2.0	3.8	3.6	1.1	2.0	2.2
77x-057	80	S3-30%	2.1	3.8	3.6	1.1	2.0	2.2
77x-088	120	S3-30%	3.1	8.5	9.0	1.4	4.1	5.0
77x-130	120	S3-30%	3.3	9.0	9.0	1.6	4.4	5.0
77x-180	180	S3-30%	3.3	5.8	5.9	2.1	3.8	3.6
77x-220	180	S3-30%	4.0	6.5	5.9	2.3	4.0	3.6
77x-265	180	S3-30%	4.5	3.5	5.9	2.5	4.2	3.6
77x-310	220	S3-30%	4.0	8.0	7.5	2.4	4.4	4.8
77x-400	220	S3-30%	4.2	8.0	7.5	2.4	4.8	4.8

Model	Motor power (W)	Duty cycle (IEC60034)	220V AC - 3 Ph			380V AC - 3 Ph			440V AC - 3 Ph		
			Run (A)	Start (A)	Lock (A)	Run (A)	Start (A)	Lock (A)	Run (A)	Start (A)	Lock (A)
77x-003											
77x-005											
77x-008	40	S3-30%	0.8	1.4	1.5	0.4	0.7	0.7	0.4	0.9	0.6
77x-013	40	S3-30%	0.8	1.4	1.5	0.4	0.7	0.7	0.4	0.9	0.6
77x-035	80	S3-30%	1.0	1.8	2.3	0.7	1.3	1.5	0.6	1.4	1.4
77x-044	80	S3-30%	1.0	1.8	2.3	0.7	1.3	1.5	0.6	1.4	1.4
77x-057	80	S3-30%	1.0	1.8	2.3	0.7	1.3	1.5	0.6	1.4	1.4
77x-088	120	S3-30%	0.9	2.0	2.2	0.7	1.2	1.4	0.5	1.3	1.3
77x-130	120	S3-30%	1.0	2.4	2.6	0.7	1.5	1.5	0.6	1.2	1.2
77x-180	180	S3-30%	1.3	3.7	3.9	0.7	2.0	2.3	0.7	2.0	2.2
77x-220	180	S3-30%	1.3	3.4	3.9	0.7	2.0	2.4	0.7	2.0	2.2
77x-265	180	S3-30%	1.3	3.5	3.9	0.7	2.0	2.4	0.7	2.0	2.2
77x-310	220	S3-30%	1.5	4.8	5.4	0.9	2.5	2.5	0.8	2.6	2.4
77x-400	220	S3-30%	1.5	4.9	5.4	1.0	2.5	2.5	0.8	2.6	2.4

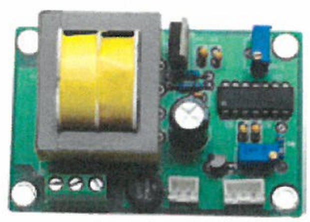
OPTIONS



Modulating controller
The F777/778 can be equipped with a modulating controller board and control a valve position from 0-100% based on an analog input signal. This input signal can be 4-20 mA, 1-5 V DC or 2-10 V DC. This option also includes a position feedback signal either 4-20 mA or 2-10 V DC.

Heater
The heater option increases the internal temperature and avoids internal condensation. It is not recommended using a heater above 35°C (95°F) ambient temperature, but with large temperature deviations between day/night or between summer/winter, the heater in combination with a thermostat is recommended for these applications.

Additional limit switches
The standard position feedback switches can be extended with 2 additional switches providing dry contacts for fully open and close position. Alternatively they can also be used for intermediate position indication.



Current position transmitter
For continuous monitoring of valve position, the current position transmitter can be used. It provides a feedback signal of 0-20 mA, 4-20 mA, 0-5 V DC, 1-5 V DC, 0-10 V DC, or 2-10 V DC.

Potentiometer
The alternative continuous position monitoring is using a potentiometer. The potentiometer is available as 1k or 5k ohm resistance value, and can be used on on/off actuators only.

Torque switches
In order to reduce the torque applied to the valve stem, configurable torque switches can be used. They are available for the model F777/778-008 onwards, and must be ordered with the actuator.

Local control module
For safety during maintenance the local control module has a Local/Remote selector switch and Open/Close buttons for local operation.

SELECTION GUIDE

Example										
	778	035	24	15	3	X1XXXTXS	1	M	00	M11	D30

Figure number

777 Keystone flange
778 ISO flange

Model/Size

003	**035**	**058**	**180**	**310**
005	**036**	**088**	**181**	**400**
008	**044**	**089**	**221**	
013	**045**	**130**	**220**	
014	**057**	**131**	**265**	

Voltage

01	12 V DC	**12**	120 V AC 1Ph
02	24 V DC	**24**	240 V AC 1Ph
03	24 V AC 1Ph	**40**	400 V AC 3Ph

Cycle speed

Check Table for cycle speed per model

Duty cycle

3 30% (standard 120-240 V AC))
5 50%
7 70%

Options (consult sales for possible combinations)

XXXXXXX	None (standard)	**XXX1XXX**	Potentiometer 1K ohm
MXXXXXX	Modulating controller	**XXX2XXX**	Potentiometer 5K ohm
X1XXXXX	Heater 24 V DC	**XXXXTXX**	Torque switches
X2XXXXX	Heater 48 V DC	**XXXXXLX**	Local control
X3XXXXX	Heater 120 V AC	**XXXXXXB**	Switch card with 2 additional limit switches (USA)
X4XXXXX	Heater 240 V AC		
XXTXXXX	4-20 mA Current position transmitter	**XXXXXXS**	2 additional limit switches

IP rating

1 IP67/Nema 4X

Flange threading

M Metric
U Imperial

Variant

00 Standard

Valve flange

F03	PCD 36 mm (ISO 5211)	**M05**	F03+F05 (ISO 5211)	**U1C**	PCD 1.75" (Keystone 45°)
F05	PCD 50 mm (ISO 5211)	**M06**	F03+F05+F07 (ISO 5211)	**U34**	PCD 3.25" (Keystone 45°)
F07	PCD 70 mm (ISO 5211)	**M07**	F05+F07 (ISO 5211)	**U50**	PCD 5.00" (Keystone 45°)
F10	PCD 102 mm (ISO 5211)	**M10**	F07+F10 (ISO 5211)	**U68**	PCD 6.50" (Keystone 45°)
F12	PCD 125 mm (ISO 5211)	**M11**	F07+F10+F12 (ISO 5211)		
F14	PCD 140 mm (ISO 5211)	**M12**	F10+F12 (ISO 5211)	**C34**	PCD 1.75+3.25" (Keystone 45°)
F16	PCD 165 mm (ISO 5211)	**M14**	F10+F14 (ISO 5211)	**C50**	PCD 3.25+5.00" (Keystone 45°)
		M16	F12+F16 (ISO 5211)	**C68**	PCD 5.00+6.50" (Keystone 45°)
		M25	F16+F25 (ISO 5211)	**CA0**	PCD 6.50+10.0" (Keystone 45°)

Shaft dimension

S11	Star11	**D12**	DD12 x 8	**M35**	35K10 x 8	**P06**	DD⅜" x ¼" (9.53 x 6.35 mm)	**U0D**	Dia 13/16"; K3/16 x 3/16 (20.6K4.78 mm)
S14	Star14	**D16**	DD16 x 11	**M40**	40K12.0	**P09**	DD9/16" x ⅜" (14.29 x 9.53 mm)	**U10**	Dia 1"; K¼ x 3/16" (25.4K6.35 mm)
S17	Star17	**D20**	DD20 x 14	**M44**	44K12.0	**P0A**	DD⅝" x 7/16" (15.88 x 11.1 mm)	**U11**	Dia 1⅛"; K¼ x ¼" (28.6K6.35 mm)
S22	Star22	**D25**	DD25 x 18	**M50**	50K14 x 9	**P0C**	DD¾" x ½" (19.05 x 12.7 mm)	**U16**	Dia 1⅜"; K5/16 x 5/16 (34.9K7.94 mm)
S27	Star27	**D30**	DD30 x 22	**M60**	60K18 x 11	**P0E**	DD⅞" x ⅝" (22.2 x 15.88 mm)	**U1A**	Dia 1⅝"; K⅜ x ⅜" (41.3K9.53 mm)
S36	Star36			**M70**	70K20 x 12			**U1E**	Dia 1⅞"; K½ x ⅜" (47.6K12.7 mm)
S46	Star46			**M75**	75K20 x 12			**U24**	Dia 2¼; K½ x ⅜" (57.2K12.7 mm)
S55	Star55			**M80**	80K22 x 14			**U26**	Dia 2⅜"; K⅝ (63.3 x K15.9 mm)
S75	Star75			**M90**	90K25			**U2C**	Dia 2¾"; K⅝" (69.9 x K15.9 mm)
				MA0	100K28			**U2E**	Dia 2⅞"; K¾" (73.0 x K19.1 mm)
								U38	Dia 3½"; K⅞" (88.9K22.23 mm)

PENTAIR VALVES & CONTROLS

www.pentair.com/valves

PENTAIR

KEYSTONE FIGURE 777/778 ELECTRIC ACTUATOR

INSTALLATION AND MAINTENANCE INSTRUCTIONS

Before installation or maintenance, these instructions must be fully read and understood

INTRODUCTION

The Keystone F77x electric actuator range is available in 3 mounting options:

- F777 – Keystone shaft and flange – Imperial threading
- F777M – Keystone shaft and flange - Metric threading
- F778 – Keystone shaft / ISO flange – Metric threading

The actuators offer a torque range of 35 to 4500 Nm. The product design is based on an epi-cyclic gearing, which provides a smooth running, dependable and robust drive system. All models have a visual position indicator and a manual override. The manual operation is continuously engaged, and requires no clutch mechanism. The models F77x-003 and F77x-005 have a manual override which requires a standard 8 mm wrench (not included). All other models are operated with a hand wheel.

The actuator is available in 12 V DC, 24 V DC, 24 V AC, 120 V AC single phase, 240 V AC single phase, and 400 V AC 3-phase versions. Please make sure that the correct voltage is ordered for your specific application.

Keystone F77x actuators are designed to be mounted to quarter turn valves either directly or using the correct mounting brackets/adapter kit.

The actuator drives the valve by means of a bored/double keyed female shaft output, or female double D conforming to the Keystone standard. A comprehensive range of adaptors is available for the various Keystone valves.

Adjustable travel stops are provided for each end of travel to ensure that the actuator will open and close the valve precisely.

RECEIVING/INSPECTION

Carefully inspect for any shipping damage. Damage to the shipping carton is usually a good indication for rough handling. Report all damage immediately to the freight carrier and your Pentair sales contact.

After unpacking the product and information packet, please take care to save the shipping carton and any packing material in case of product return or replacement. Verify that the item on the packing list or bill of lading is the same as your own documentation. If there is any discrepancy, please contact with the seller.

STORAGE

If the actuator cannot be installed immediately, store it in a dry place, it must be protected from excess moisture, dust, and weather influences, until you are ready to connect the wiring.
If the actuator has to be installed but cannot be wired immediately, please don't remove the plastic transit cable entry plugs. When the actuator is ready to be wired, it is mandatory to replace the plastic transit plugs with water-proof plugs with suitable IP protection.

LUBRICATION

The gear train is permanently lubricated, and doesn't require any further maintenance.

INSTALLATION SAFETY INSTRUCTIONS:

1. Please make sure that the valve is fixed and that the actuator is firmly mounted onto the valve, ether direct or by using a mounting kit.
2. Check for correct voltage prior to wiring.
3. Mount the wiring using the enclosed wiring diagrams.
4. Use sealant to seal conduit connections to prevent dust or water ingress.
5. The electric actuator should be installed at a maximum angle of 180 degrees. Do not install upside down or over 180 degrees.
6. Do not install this actuator in or near explosion hazardous areas.
7. Actuators should be placed at a clean and dry place for storage, and protected with carton. Large temperature changes and vibration should be avoided.
8. Electronic components can be damaged by static electricity. Please avoid static electricity by touching any PCB components with metal tools or bare hands.
9. Please make sure to connect the ground wire to the PE connection inside the electric actuator.

WARNING1

Always turn off the power before servicing or any maintenance purposes.

WARNING2

When using a 3-phase on/off actuator please use the manual override to turn the actuator to 45 degrees open position before applying any power. If the direction of operation is the opposite direction than intended, please change any 2 wires labelled U, V, or W.

WARNING3

When applying power to the actuator with the cover removed, there is a risk of electrical shock or even death. For safety reasons the cover should always be mounted when power is applied to the actuator.

INSTALLATION

1. Before mounting the actuator, please verify that the valve torque requirement is less than the output torque of the actuator.
2. Check if the actuator output shaft and flange fits to the valve stem, and use appropriate mounting kit or adaptor to connect if it does not match.
3. Determine that actuator position (open or closed), matches with the valve position. Use the manual override to change position if necessary.
4. Place actuator on top of the valve, and make sure it fits correctly. Tighten all screws and nuts.
5. Check with the manual operator that the valve and actuator operate correctly in both open and close direction.
6. Check if the power is switched off and remove actuator cover. Please be aware that while the cover is lifted a vacuum is created. For your comfort there is a special pocket for a flathead screwdriver to support the lifting.
7. Wire the actuator using the following wiring diagrams, or use the wiring diagram inside the cover.
8. For the 3-phase on/off actuator, please use the manual override to turn the actuator to 45 degrees open position before applying any power. If the direction of operation is the opposite direction than intended, please change any 2 wires labelled U, V, or W.
9. Mount the cover to the actuator and provide a control signal to the open command terminal.
10. Verify that the actuator opens the valve completely.
11. Switch power from open to close command terminal.
12. Verify that the actuator closes the valve completely.

Note1: The actuator is calibrated for 90 degree operation in the factory. If adjustments for the full open or close position are required, please check the routine for adjusting the travel stops.

Note2: For modulating applications, please check the configuration routine for the modulating module.

DUTY CYCLE

The duty cycle determines the starting frequency to which the actuator can be operated, and is defined with the formula:

Duty Cycle = Stroke Time / (Stroke time + Rest Time) × 100%

Based on this formula the rest time for an actuator with a 15 seconds stroke and 30% duty cycle is 35 seconds. This can be calculated by rewriting the formula into:

Rest Time = Stroke Time × (1- duty cycle) / duty cycle

Example based on stroke time of 15 seconds:
- 30% duty cycle: 15 × [(1 – 30%) / 30%] = 35. The rest time will be 35 seconds.
- 75% duty cycle: 15 × [(1 – 75%) / 75%] = 5. The rest time will be 5 seconds.

If the duty cycle is higher, the rest is shortened, and the starting frequency can be higher.

WIRING DIAGRAMS

Abbreviations used:

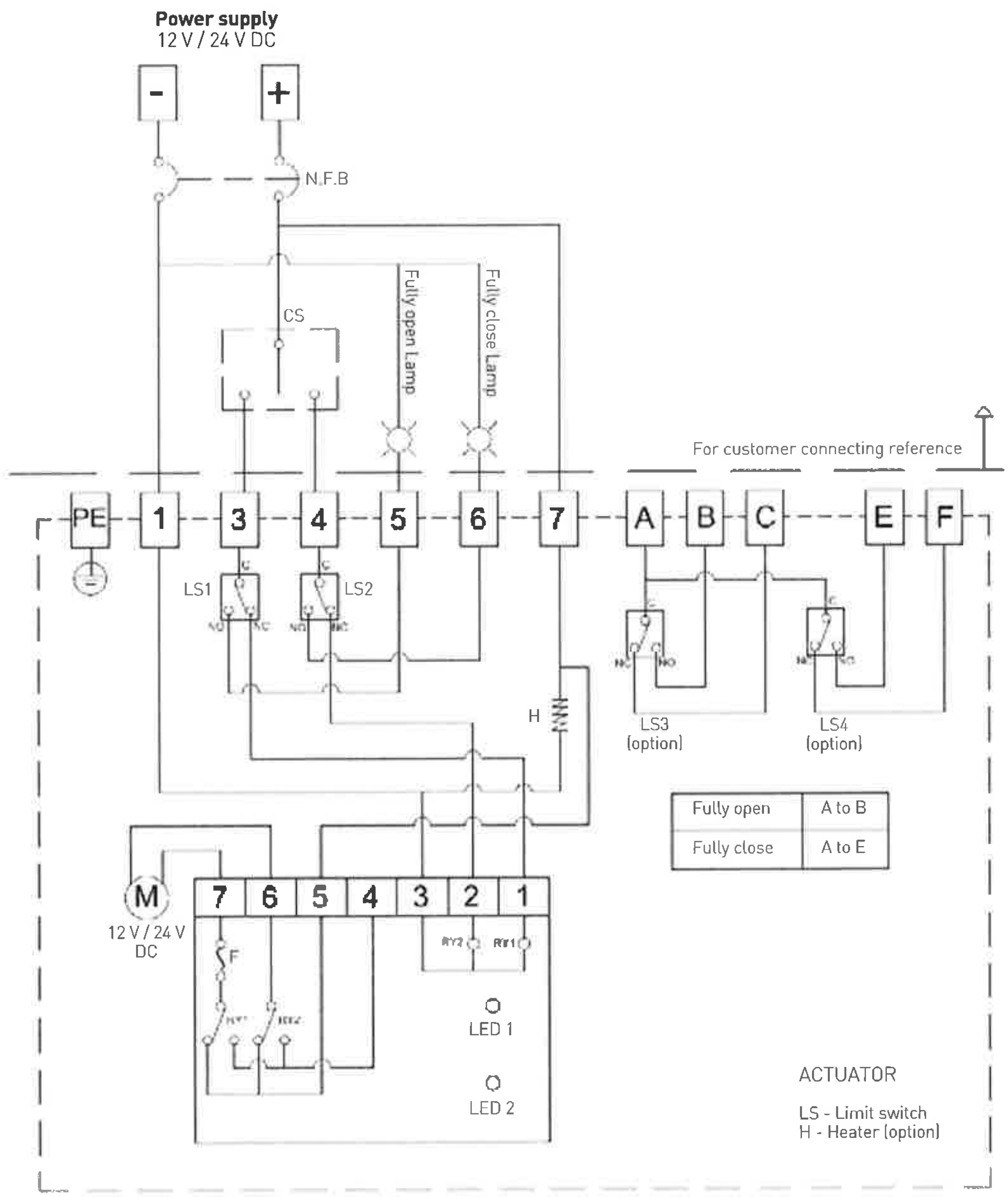
MC1 and MC2	Electromagnetic contactor
NFB	No fuse breaker
C.S.	Control switch
C	Capacitor
N	Neutral
L	Live Wire
PE	Protective Earth
O.L.	Over-load relay
H	Heater
LS	Limit switch
TS	Torque switch
Switch(1)	Local/Remote Control
Switch(2)	Open/Stop/Close select
LS1	Limit switch for open
LS2	Limit switch for close
LS3	Optional limit switch
LS4	Optional limit switch

WIRING DIAGRAM OVERVIEW

	Voltage					
Model	**12 V DC**	**24 V DC**	**12 V AC**	**24 V AC**	**120 V AC**	**240 V AC**
F77x-003	**Diagram 1**		**Diagram 3**		**Diagram 5**	
F77x-005						
F77x-008						
F77x-013						
F77x-014						
F77x-035						
F77x-036	**Diagram 2**		**Diagram 4**		**Diagram 6**	
F77x-044						
F77x-045						
F77x-057						
F77x-058						
F77x-088						
F77x-089						
F77x-130						
F77x-180						
F77x-181						
F77x-220						
F77x-221						
F77x-265						
F77x-310						
F77x-400						

WIRING DIAGRAM 1 ON/OFF ACTUATOR

12 V DC - F77x-003 to F77x-005
24 V DC - F77x-003 to F77x-005



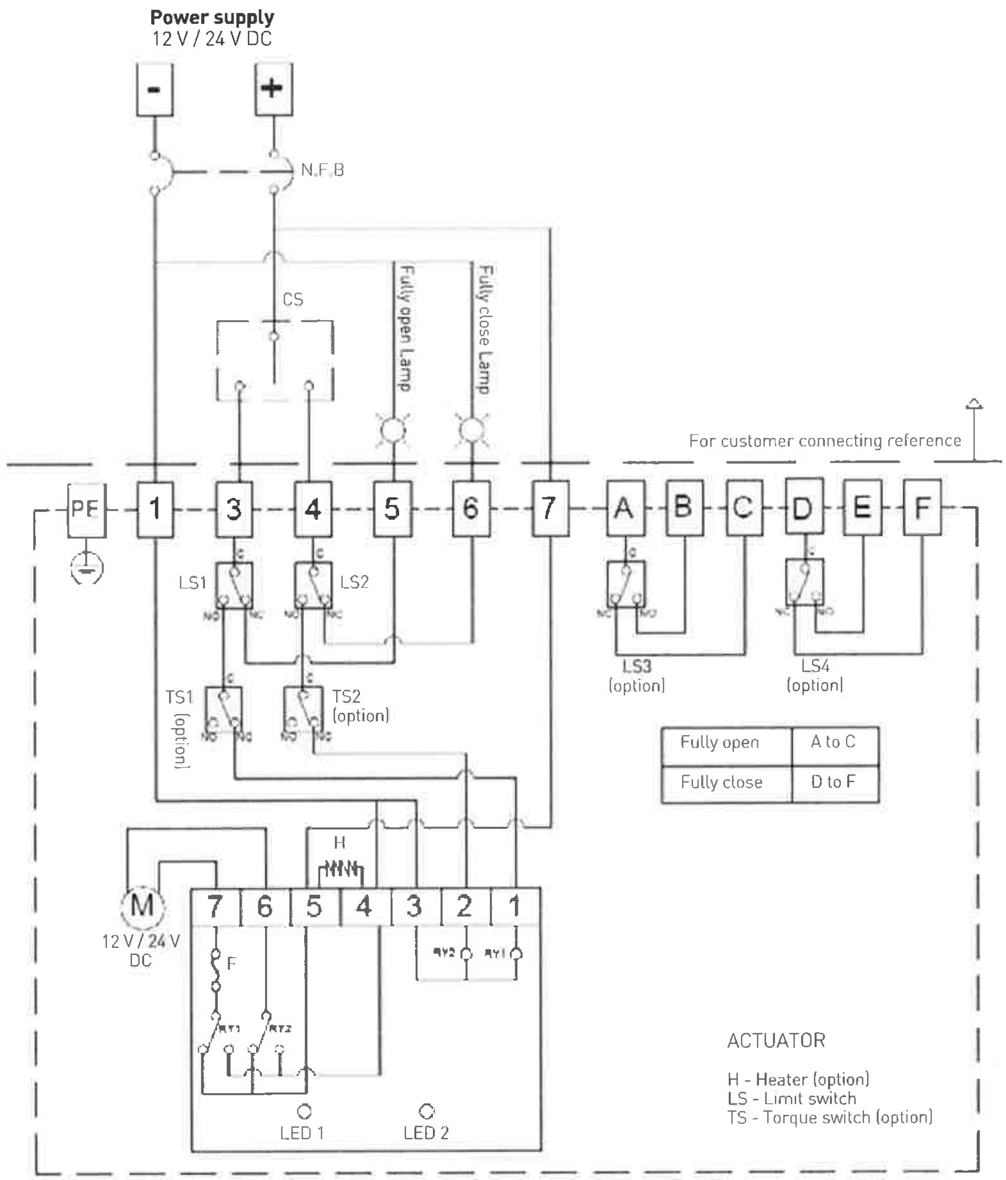
Fully open	A to B
Fully close	A to E

NOTES

1. "+" connects to #7; "-" connects to #1
2. "+" connects to #3 for "open"; "+" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 3A

WIRING DIAGRAM 2 ON/OFF ACTUATOR

12 V DC - F77x-008 to F77x-058
24 V DC - F77x-008 to F77x-310

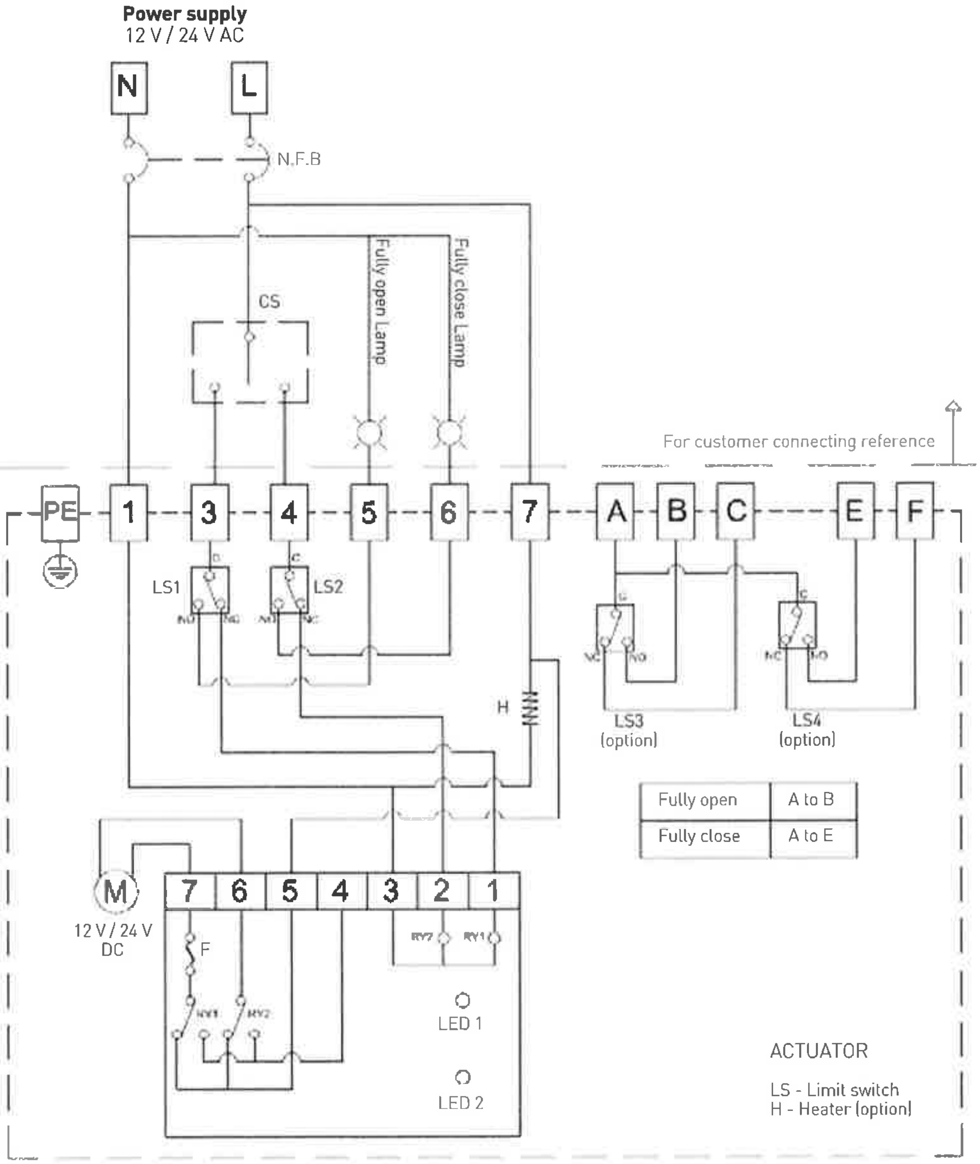


NOTES

1. "+" connects to #7; "-" connects to #1
2. "+" connects to #3 for "open"; "+" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 5A

WIRING DIAGRAM 3 ON/OFF ACTUATOR

12 V AC - F77x-003 to F77x-005
24 V AC - F77x-003 to F77x-005



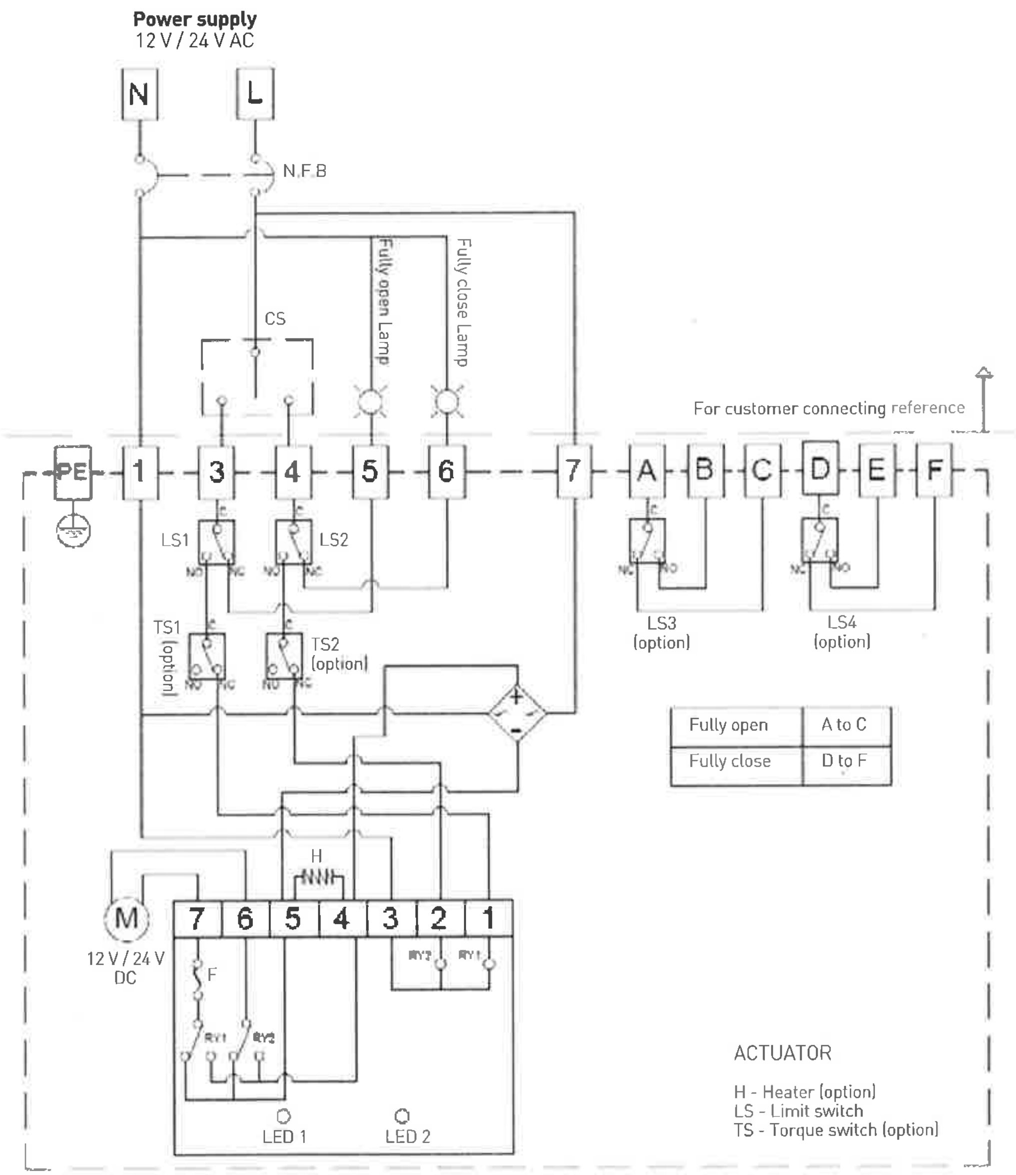
Fully open	A to B
Fully close	A to E

NOTES

1. "L" connects to #7; "N" connects to #1
2. "L" connects to #3 for "open"; "L" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 3A

WIRING DIAGRAM 4 ON/OFF ACTUATOR

12 V AC - F77x-008 to F77x-058
24 V AC - F77x-008 to F77x-310



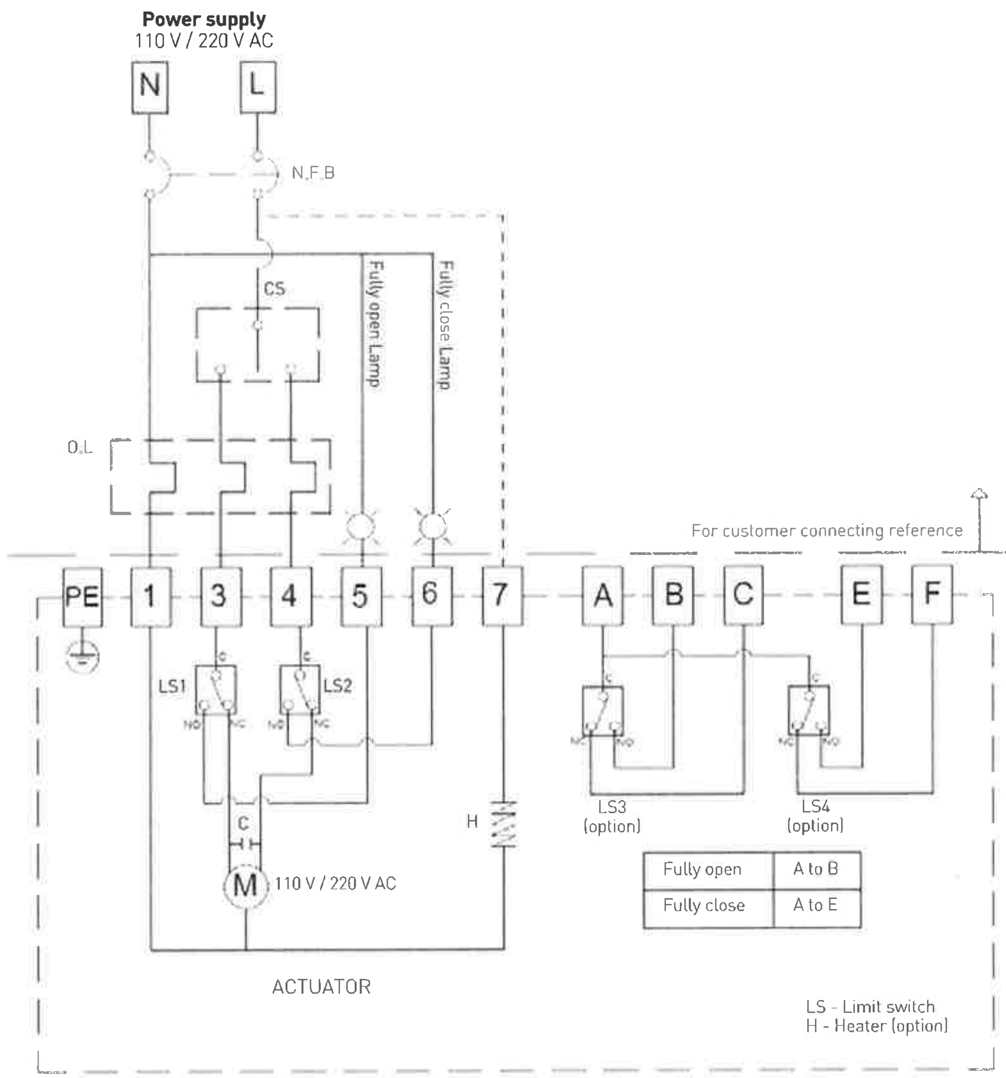
Fully open	A to C
Fully close	D to F

NOTES

1. "L" connects to #7; "N" connects to #1
2. "L" connects to #3 for "open"; "L" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 5A

WIRING DIAGRAM 5 ON/OFF ACTUATOR

120 V AC - F77x-003 to F77x-005
240 V AC - F77x-003 to F77x-005

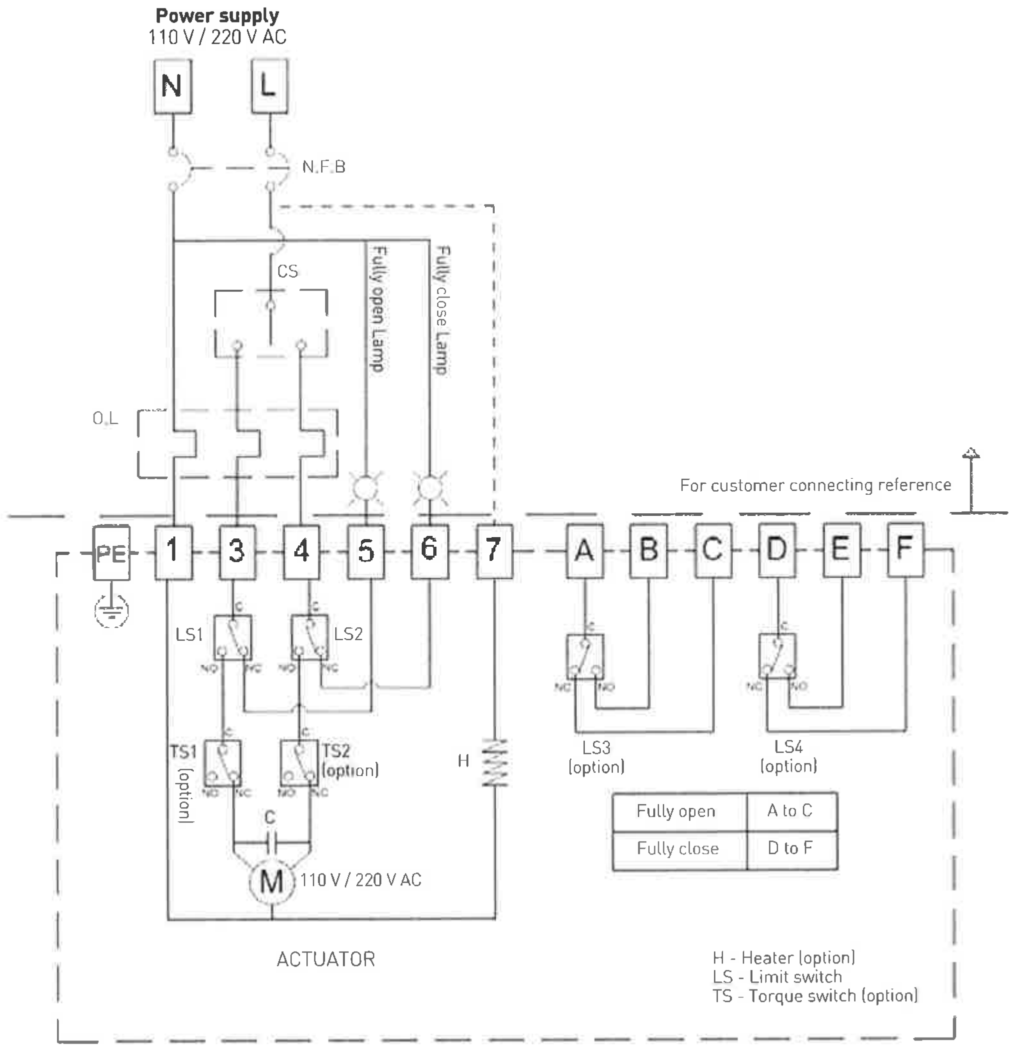


NOTES

1. "L" connects to #7; "N" connects to #1
2. "L" connects to #3 for "open"; "L" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 3A

WIRING DIAGRAM 6 ON/OFF ACTUATOR

120 V AC - F77x-008 to F77x-400
240 V AC - F77x-008 to F77x-400



Fully open	A to C
Fully close	D to F

NOTES

1. "L" connects to #7; "N" connects to #1
2. "L" connects to #3 for "open"; "L" connects to #4 for "close"
3. Max. current for LS3 and LS4 is 5A

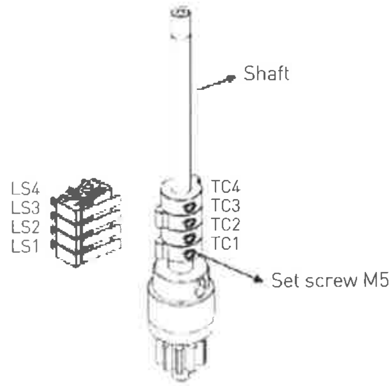
LIMIT SWITCH AND CAM SETTING

The cams and switches are set to control the open and closed position of the valve. The position is set to stop the travel of the actuator when the travel cams activate the limit switch. Standard is two limit switches (LS1 and LS2), LS1 for open, LS2 for closed. LS1 and LS2 limit the maximum range by disabling the electric motor.
LS3 and LS4 are optional, and they provide potential free contact to other equipment to confirm that the valve has reached the fully open or fully closed position.

The travel cams can be adjusted with a 2.5 mm Allen key. The cams are preset at the factory for 0 and 90 degree operation. When additional adjustments are needed, follow steps described below:

Note:
If LS3 and LS4 are fitted, please set them to trip prior to LS1 and LS2 in order to avoid incorrect position feedback.

Note:
For modulating units please refer to the specific product literature.



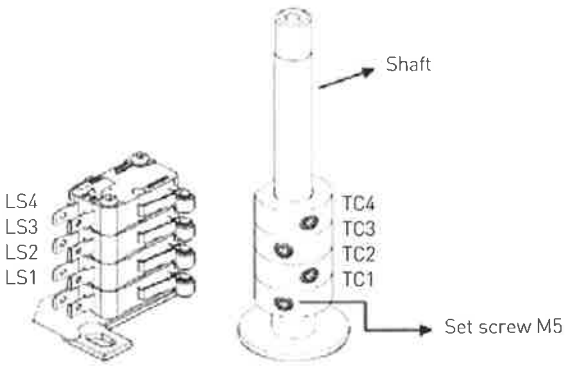
F77x-003 + F77x-005

To set the open position:

a. Turn power off.
b. Use manual override to turn valve to the fully open position.
c. Remove cover and loosen the M5 set screw on the TC1 with a 2.5 mm Allen Key.
d. Rotate cam(TC1) counter clockwise to contact with switch.
e. Slowly rotate cam(TC1) clockwise until a light click is heard.
f. Securely tighten the M5 set screw and apply power to check the travel position. If the position is not correct, please repeat steps a to f.
g. After the adjustment is completed, check again the M5 set screw is securely tightened.

To set the close position:

a. Turn power off.
b. Use manual override to turn valve to the fully-closed position.
c. Loosen the M5 set screw on the TC2 with a 2.5 mm Allen key.
d. Rotate cam(TC2) clockwise to contact with switch.
e. Slowly rotate cam(TC2) counter clockwise until a light click is heard.
f. Securely tighten the set screw and apply power to check the traveling position. If the position is not correct, please repeat steps a to f.
g. After the adjustment is completed, check again the M5 set screw is securely tightened.



F77x-008 to F77x-400

To set the open position:

a. Turn power off and loosen both mechanical stops.
b. Use manual override to turn valve to the fully open position.
c. Remove cover and loosen the M5 set screw on the TC1 with a 2.5mm Allen key.
d. Rotate cam (TC1) clockwise to contact with switch.
e. Slowly rotate cam (TC1) counter clockwise until a light click is heard.
f. Securely tighten the set screw and apply power to check the travel position. If the position is not correct, please repeat steps a to f.
g. After the adjustment is completed, check again the M5 set screw is securely tightened.

To set the close position:

a. Turn power off.
b. Use manual override to turn valve to the fully closed position.
c. Loosen the M5 set screw on the TC2 with a 2.5mm Allen key.
d. Rotate cam (TC2) counter clockwise to contact with switch.
e. Slowly rotate cam (TC2) clockwise until a light click is heard.
f. Securely tighten the set screw and apply power to check the travel position. If the position is not correct, please repeat steps a to f.
g. After the adjustment is completed, check again the M5 set screw is securely tightened.
h. Tighten both mechanical stops and follow travel stop instructions.

MECHANICAL TRAVEL STOPS

WARNING
Mechanical travels stops should only be used during manual operation. If the travel limit switch is set incorrectly and the motorised actuator action is limited by the mechanical travel stop, the actuator life will be significantly reduced and will fail prematurely.

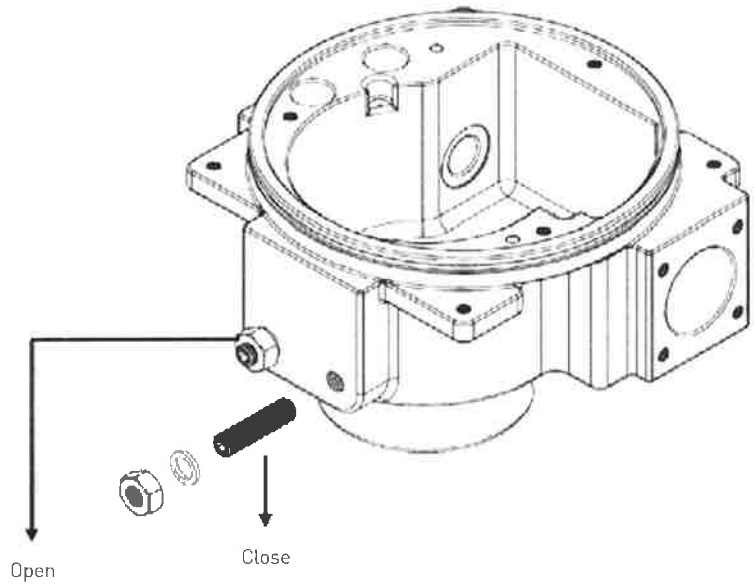
The mechanical stops are factory set, though in some cases adjustment may be required once the actuator is fitted to a valve and travel switches and cams have been adjusted.

Note:
For modulating units please refer to the specific product literature.

For on/off motorised end of travel adjustment please refer to "Limit switch and cam setting".

For manual operation of on/off units

a. Turn power off.
b. Loosen locknut and unwind it a few turns.
c. Use manual override to turn the actuator to desire limit position.
d. Tighten the mechanical stop screw until it reaches the shaft, and reverse one cycle.
e. Tighten locknut.
f. Check that the electrical limit switches are still engaged prior to reaching the mechanical travel stop.



BOILER MAINTENANCE

Operations & Maintenance Manual
December 2015

2 Maintenance

Maintenance and annual startup

***Table 2A**_Service and Maintenance Schedules*

Service technician **(see the following pages for instructions)**	
ANNUAL START-UP	**General:** • Address reported problems • Inspect interior; clean and vacuum if necessary; • Check for leaks (water, gas, flue, condensate) • Examine venting system • Check system water pressure/system piping/expansion tank • Check control settings • Check igniters • Check wiring and connections • Check flue gas passageways • Flame inspection (stable, uniform) • Inspect and clean the burners • Check manifold gas pressures • Perform start-up checkout and performance verification per the Startup Section in the Installation and Operation Manual. **If combustion or performance indicate need:** • Clean heat exchanger with a stiff bristle brush • Remove and clean burners using water. Dry before re-assembling. • Clean the blower wheel with a brush and vacuum. Do not let dirt from cleaning get pulled into the blower.

Owner maintenance **(see the User's Information Manual for instructions)**	
Daily	• Check appliance area • Check pressure/temperature gauge
Monthly	• Check vent piping • Check air piping • Check relief valve • Replace combustion air filter **Note:** More frequent replacement may be necessary in dirty environments. Do not use pleated filters.
Periodically	• Test low water cutoff (if used) • Reset button (low water cutoff)
Every 6 months	• Check appliance piping (gas and water) for leaks • Operate relief valve
End of season months	• Shut appliance down (unless boiler used for domestic hot water)

2 Maintenance

⚠ WARNING Follow the service and maintenance procedures given throughout this manual and in component literature shipped with the appliance. Failure to perform the service and maintenance could result in damage to the appliance or system. Failure to follow the directions in this manual and component literature could result in severe personal injury, death, or substantial property damage.

⚠ WARNING The appliance should be inspected annually only by a qualified service technician. In addition, the maintenance and care of the appliance designated in Table 2A and explained on the following pages must be performed to assure maximum appliance efficiency and reliability. Failure to service and maintain the appliance and system could result in equipment failure.

⚠ WARNING Electrical shock hazard – Turn off power to the appliance before any service operation on the appliance except as noted otherwise in this instruction manual. Failure to turn off electrical power could result in electrical shock, causing severe personal injury or death.

Address reported problems

1. Inspect any problems reported by the owner and correct before proceeding.

Inspect appliance area

1. Verify that appliance area is free of any combustible materials, gasoline and other flammable vapors and liquids.

Inspect appliance interior

1. Remove the outer access panels and inspect the interior of the appliance.

2. Vacuum any sediment from inside the appliance and components. Remove any obstructions.

Check all piping for leaks

⚠ WARNING Eliminate all system or appliance leaks. Continual fresh makeup water will reduce appliance life. Minerals can build up in sections, reducing heat transfer, overheating heat exchanger, and causing heat exchanger failure. Leaking water may also cause severe property damage.

1. Inspect all water and gas piping and verify to be leak free.

2. Look for signs of leaking lines and correct any problems found.

3. Check gas line using the procedure found in the *Gas Connections* of the Installation and Operation Manual.

Flue vent system and air piping

1. Check for gastight seal at every connection, seam of air piping, and vent piping periodically inspected by a qualified service agency.

⚠ WARNING Venting system must be sealed gastight to prevent flue gas spillage and carbon monoxide emissions, which will result in severe personal injury or death.

Combustion air filter

This appliance has a standard air filter located at the combustion air inlet at the rear of the appliance. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace. The filter size on the 500,000 - 750,000 Btu/hr models is 12" x 12" x 1" and 16" x 16" x 1" on the 990,000 - 2,070,000 Btu/hr models. You can find these commercially available at any home center or HVAC supply store. Do not use pleated filters.

Check water system

1. Verify all system components are correctly installed and operational.

2. Check the cold fill pressure for the system. Verify it is correct (must be a minimum of 12 PSI).

3. Watch the system pressure as the boiler heats up (during testing) to ensure pressure does not rise too high. Excessive pressure rise indicates expansion tank sizing or performance problem.

4. Inspect automatic air vents and air separators. Remove air vent caps and briefly press push valve to flush vent. Replace caps. Make sure vents do not leak. Replace any leaking vents.

Check expansion tank (if provided)

1. Expansion tanks provide space for water to move in and out as the heating system water expands due to temperature increase or contracts as the water cools. Tanks may be open, closed, diaphragm or bladder type. See the *Water Connections Section* of the Installation and Operation Manual for suggested best location of expansion tanks and air eliminators.

2 Maintenance *(continued)*

Check relief valve

1. Inspect the relief valve and lift the lever to verify flow. Before operating any relief valve, ensure that it is piped with its discharge in a safe area to avoid severe scald potential. Read the *Water Connections* Section of the Installation and Operation Manual before proceeding further.

⚠ WARNING Safety relief valves should be re-inspected AT LEAST ONCE EVERY THREE YEARS, by a licensed plumbing contractor or authorized inspection agency, to ensure that the product has not been affected by corrosive water conditions and to ensure that the valve and discharge line have not been altered or tampered with illegally. Certain naturally occurring conditions may corrode the valve or its components over time, rendering the valve inoperative. Such conditions are not detectable unless the valve and its components are physically removed and inspected. This inspection must only be conducted by a plumbing contractor or authorized inspection agency – not by the owner. Failure to re-inspect the boiler relief valve as directed could result in unsafe pressure buildup, which can result in severe personal injury, death, or substantial property damage.

⚠ WARNING Following installation, the valve lever must be operated AT LEAST ONCE A YEAR to ensure that waterways are clear. Certain naturally occurring mineral deposits may adhere to the valve, rendering it inoperative. When manually operating the lever, water will discharge and precautions must be taken to avoid contact with hot water and to avoid water damage. Before operating lever, check to see that a discharge line is connected to this valve directing the flow of hot water from the valve to a proper place of disposal. Otherwise severe personal injury may result. If no water flows, valve is inoperative. Shut down the appliance until a new relief valve has been installed.

2. After following the above warning directions, if the relief valve weeps or will not seat properly, replace the relief valve. Ensure that the reason for relief valve weeping is the valve and not over-pressurization of the system due to expansion tank waterlogging or undersizing.

Inspect/replace hot surface igniter

This unit uses a proven hot surface ignition module and a hot surface igniter. The hot surface ignition module is not repairable. Any modification or repairs will invalidate the warranty.

⚠ WARNING Do not attempt to repair a faulty hot surface igniter or ignition module. Any modification or repairs may create hazardous conditions that result in property damage, personal injury, fire, explosion and/or toxic gases.

A faulty hot surface igniter or ignition module must be replaced with an identical part. A specification igniter and ignition module for this specific unit is available from your local distributor. **Do not use general purpose field replacement ignition modules or igniters.**

Inspect/replace hot surface igniters

1. Turn off main electrical power to the appliance.
2. Turn off main manual gas shutoff to the appliance.
3. Remove lower front door to gain access to the hot surface igniter.
4. Locate the hot surface igniter. Disconnect the two power leads to the hot surface igniter.
5. Loosen and remove the two screws used to attach the igniter.
6. Remove the igniter from the combustion chamber door. Use care, do not hit or break the silicon carbide igniter. Do not contaminate the igniter by handling with oily or dirty hands.
7. Check the replacement igniter for cracks or damage before installing.
8. Ensure that the fiber gasket used to seal the base of the igniter to the combustion chamber door is reinstalled to seal the base of the replacement igniter.
9. Carefully insert the igniter into the opening of the combustion chamber door and re-attach the two screws removed in Step 5. Over-tightening may break the ceramic mounting flange.
10. Ensure that the igniter gasket is properly installed and seals the point of contact between the igniter and the combustion chamber door.
11. Reconnect the power leads to the igniter.
12. Replace the lower front door.
13. Turn on main gas supply and main power.
14. Test fire the appliance to ensure proper operation.

2 Maintenance

Check all wiring

1. Inspect all wiring, making sure wires are in good condition and securely attached.

Check control settings

1. Set the SMART SYSTEM control module display to Parameter Mode and check all settings. See Section 1 of this manual. Adjust settings if necessary. See Section 1 of this manual for adjustment procedures.
2. Check settings of external limit controls (if any) and adjust if necessary.

Perform start-up and checks

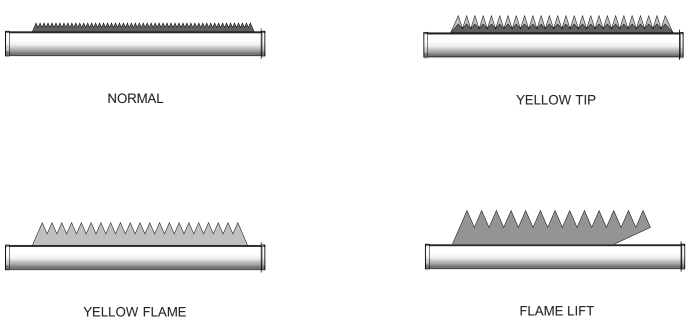
1. Start appliance and perform checks and tests specified in *Start-up Section* of the Installation and Operation Manual.
2. Verify cold fill pressure is correct and that operating pressure does not go too high.

Check burner flame

Visually check main burner flames at each start-up after long shutdown periods or at least every six months. The burner viewports are located on either end of the appliance.

⚠ WARNING The area around the burner viewport is hot and direct contact could result in burns.

***Figure 2-1**_Flame Pattern Illustration*



Normal Flame: A normal flame at 100% of burner input is blue, with slight yellow tips, a well defined flame and no flame lifting.

Yellow Tip: Yellow tipping can be caused by blockage or partial obstruction of air flow to the burner.

Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner or excessive gas input. This condition MUST be corrected immediately.

Lifting Flames: Lifting flames can be caused by over firing the burner, excessive primary air or high draft.

If improper flame is observed, examine the venting system, ensure proper gas supply and adequate supply of combustion and ventilation air.

Check flue gas passageways

Any sign of soot around the refractory, at the burners, or in the areas between the fins on the copper heat exchanger indicates a need for cleaning. The following cleaning procedure must only be performed by a qualified serviceman or installer. Proper service is required to maintain safe operation. Properly installed and adjusted units seldom need flue cleaning.

NOTICE All gaskets/sealants on disassembled components or jacket panels must be replaced with new gaskets/sealants on reassembly. Gasket and sealant kits are available from your distributor.

⚠ CAUTION When a Category IV vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

Inspect and clean burner

The burner should be removed for inspection and cleaned on an annual basis. An appliance installed in a dust or dirt contaminated environment may require cleaning of the burner on a 3 to 6 month schedule or more often, based on severity of the contamination. The fan assisted combustion process may force airborne dust and dirt contaminants, contained in the combustion air, into the burner. With sustained operation, non-combustible contaminants may reduce burner port area, reduce burner input or cause non-warrantable damage to the burners.

Use extreme care when operating an appliance for temporary heat during new construction. Airborne contaminants such as dust, dirt, concrete dust or drywall dust can be drawn into the burner with the combustion air and block the burner port area. An external combustion air filter is provided with the appliance. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The burner of an appliance used for temporary heat without a combustion air filter installed will probably require a thorough cleaning before the unit is placed into normal service.

2 Maintenance *(continued)*

Access to the burners will require the following steps:

1. Turn off main electrical power to the appliance.
2. Turn off main manual gas shutoff to the appliance.
3. Remove the upper and lower outer front access doors.
4. Disconnect the manifold(s) from the gas train using the union(s) just below each gas valve.
5. Disconnect the wiring to the hot surface igniter(s) and ground.
6. Disconnect burner pressure line at burner.
7. Remove the screws from the manifold mounting bracket(s) and remove the manifold(s).
8. Remove the screws from the burner mounting flanges and slide the burner(s) out toward the front of the unit. Use caution to prevent damage to the burners, refractory, hot surface igniter, and wiring.
9. Remove soot from the burners with a stiff bristle brush. Dirt may be removed from the burner ports by rinsing the burner thoroughly with water. Drain and dry burners before re-installing. Damaged burners must be replaced.
10. Reassemble in reverse order.

NOTICE When installed in a dusty and dirty location, the burners may require cleaning on a 3 to 6 month schedule or as needed, based on the severity of contamination. Contaminants can be drawn in with the combustion air. Non-combustible particulate matter such as dust, dirt, concrete dust, or drywall dust can bloc burner ports and cause non-warrantable failure. The standard inlet air filter will help eliminate dust and dirt from entering the unit.

NOTICE While burners are removed, check the heat exchanger surface for sooting. If present, the heat exchanger must be cleaned. Reference the *Heat Exchanger Cleaning* procedures in this manual.

Checking combustion air pressure

The combustion air fans are factory pre-set and should not require adjustment in most cases. Follow the steps in the *Checking / Adjusting Combustion Air Pressure* Section to adjust the fan if a continuous Low Air status code occurs.

NOTICE On the 399,999 - 750,000 Btu/hr models, the air shutter is adjusted to the side of the fan as depicted in FIG. 2-2. On the 990,000 - 2,070,000 Btu/hr models, the air shutter is adjusted by sliding the arm located on the front of the air box as depicted in FIG. 2-3.

Check for proper installation and draft in the venting system prior to any adjustments. Correct as needed.

***Figure 2-2**_Adjusting air shutter - 399,999 - 750,000 Btu/hr Models*

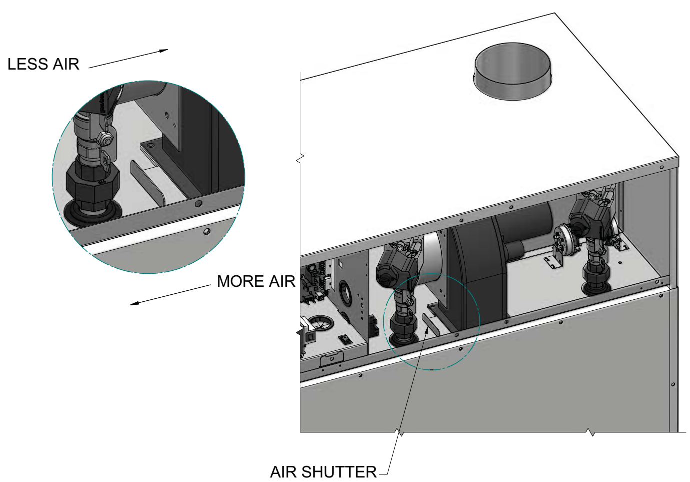
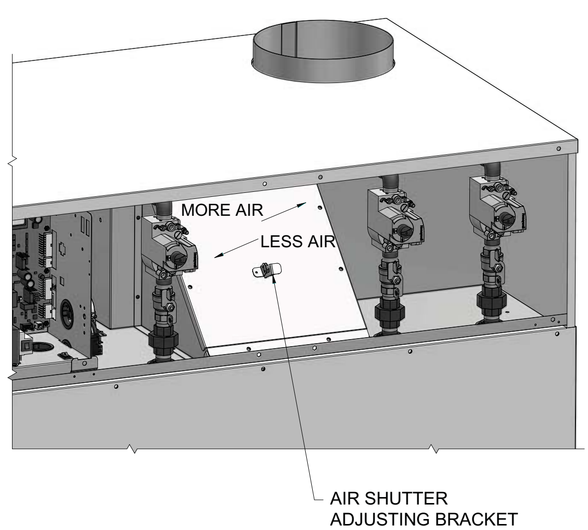


***Figure 2-3**_Adjusting air shutter - 990,000 - 2,070,000 Btu/hr Models*



2 Maintenance

Adjusting combustion air pressure

The following is a recommended method for setting the combustion air pressure. The following pressure settings are for installations up to 4000 feet altitude. Contact the factory for high altitude air pressure settings.

Upon removal of the upper front doors, locate the capped tee in the pressure tubing that connects between the inner top and the gas valves. Remove this cap and connect a hose from the tee to a manometer.

For 399,999 - 750,000 Btu/hr models (reference FIG. 2-2)

1. The combustion air chamber pressure for these models is typically 1.2 - 1.3 inches water column when the fan is at high speed.
2. If adjustment is necessary, slightly loosen the nuts connecting the fan to the inner top.
3. Adjust the air shutter located underneath the fan assembly to obtain the desired chamber pressure. Slide the shutter inward to decrease the chamber pressure or outward to increase the chamber pressure.

For 990,000 - 2,070,000 Btu/hr models (reference FIG. 2-3)

1. The combustion air chamber pressure for these models is typically 1.2 - 1.3 inches water column when the fan is at high speed.
2. If adjustment is necessary, slightly loosen the nut located on the air shutter arm.
3. Adjust the air shutter arm to obtain the desired chamber pressure. Slide the arm inward to decrease the chamber pressure or outward to increase the chamber pressure.

All models

4. Once the adjustment procedure is complete, tighten all connections, disconnect the manometer, and replace the cap at the tee.
5. Check all connections and test fire the unit.
6. Replace all panels.

Checking manifold gas pressure

The gas regulator on the combination gas valve is adjustable to supply the proper manifold pressure for normal operation. The gas valves are factory pre-set and should not need adjusting in most cases. Gas manifold pressures are listed in Table 2B.

Gas manifold pressures may be checked with the use of a manometer. Follow the steps in the *Checking Combustion Air Pressure Section* prior to checking the manifold pressures.

Checking manifold gas pressure

1. Turn the appliance power switch to the “OFF” position.
2. Remove the upper outer access panels.
3. Remove the 1/8" hex plug from the downstream side of the gas valve (see FIG. 2-4). Install a fitting in the tap and connect a hose from the tap to a manometer.
4. Connect a hose from the tee used to measure the combustion air pressure to the other side of the manometer.
5. Turn the appliance power switch to the “ON” position.
6. With the unit at high fire, check and record the manifold pressure of the valve. The manifold pressure will be the sum of the two pressure readings (reference Table 2B).
7. Repeat this process with each gas valve.

⚠ WARNING Overfire and underfire hazards! Possible fire, explosion, overheating, and component failure. Do not attempt to adjust firing rate of the appliance. The firing rate must be adjusted only by factory trained personnel.

If you must adjust the gas valve regulator pressure, follow the steps below:

1. Remove the cap covering the manifold pressure adjustment screw (see FIG. 2-4). **Note**: Once the cap is removed, the pressure shown on the manometer will change and the unit may turn off.
2. Make a slight adjustment to the manifold pressure adjustment screw. Turning the screw clockwise increases manifold pressure and counterclockwise decreases manifold pressure.
3. Replace the cap and check the manifold pressure. **Note**: Allow the unit to re-light if necessary.
4. Repeat the steps above to match the manifold pressures from Table 2B.
5. Once the adjustment procedure is complete, turn off the appliance, disconnect the manometer, replace and tighten all connections, and replace all panels.
6. Turn on the appliance and test fire the unit.
7. Repeat this process with each gas valve.

2 Maintenance *(continued)*

Figure 2-4*_Measuring manifold gas pressure*

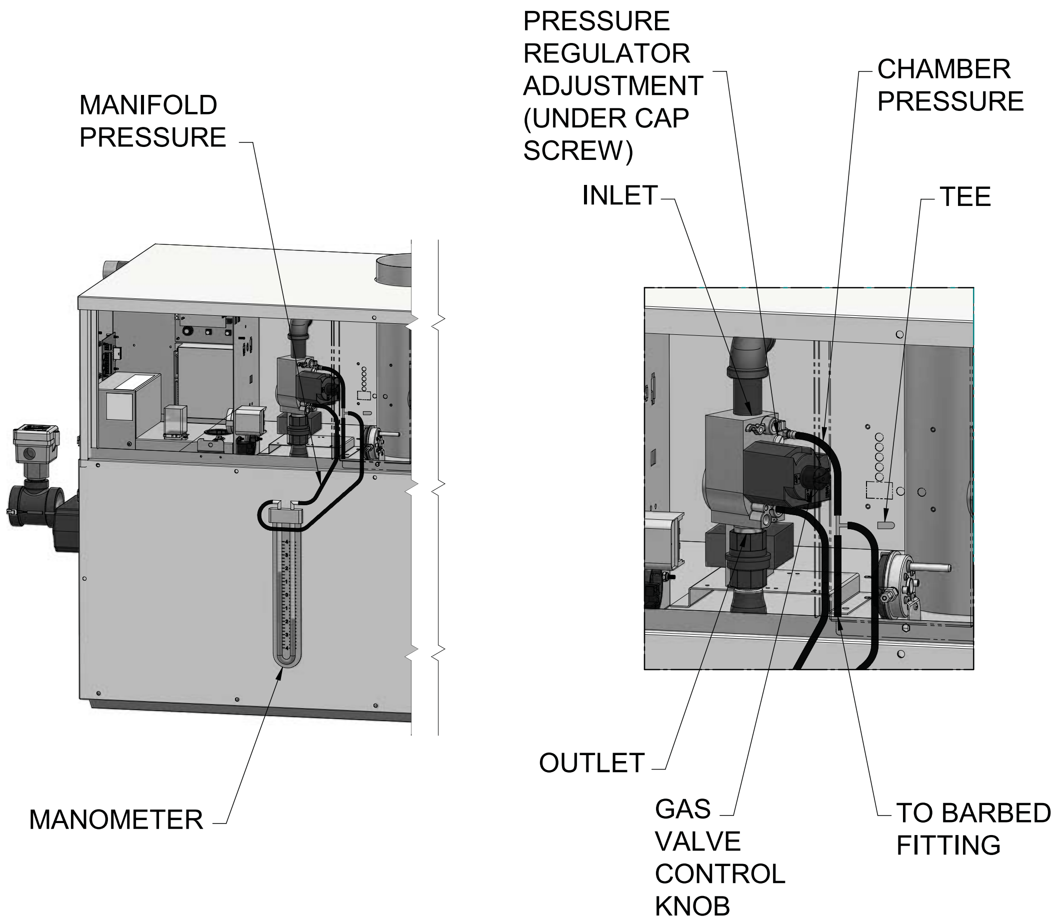


TABLE 2B Net Manifold Pressure Regulator Pressure Less Front Chamber Pressure		
MODEL	**Nat. Gas**	**LP**
402 - 752	1.8" w.c.	4.6" w.c.
992 - 2072	1.2" w.c.	4.6" w.c.

2 Maintenance

Inspect and clean the heat exchanger

1. Turn off the main electrical power to the appliance.
2. Turn off the main manual gas shutoff to the appliance.
3. Remove the lower outer fron access door.
4. Disconnect the manifold(s) from the gas train using the union(s) just below each gas valve.
5. Disconnect wiring to the hot surface igniter(s) and ground.
6. Disconnect burner pressure line at burner.
7. Remove the screws from the manifold mounting bracket(s) and remove the manifold(s).
8. Remove the screws from the burner mounting flanges and slide the burner(s) out toward the front of the unit. Use caution to prevent damage to the burners, refractory, hot surface igniter, and wiring.
9. Remove the inner jacket panel mounting screws and slide the panel assembly out toward the front of the appliance. Use caution to prevent damage to the refractory and hot surface igniter.
10. Check "V" baffles along the front and back edges of the heat exchanger (FIG. 2-5). Remove and clean if necessary.
11. Remove soot from the heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from the surfaces and inner chamber.
12. If additional cleaning is required, the heat exchanger can be removed by disconnecting all water piping to the heat exchanger, removing the screws holding the heat exchanger to the inner left side panel, and sliding the heat exchanger towards the front of the appliance. Once the heat exchanger is removed from the appliance, a garden hose can be used to wash the tubes to ensure that all soot is removed from the heat exchanger surfaces.

NOTICE Do not wet the refractory located on the inside of the combustion chamber.

13. Ensure that all burner ports are cleaned to remove any soot (reference this section).
14. Carefully reinstall the heat exchanger, "V" baffles, and frame runners if removed from the appliance.

NOTICE Make sure the frame runners seal securely where they contact the front and rear compartment refractory.

15. Carefully reinstall inner jacket panels, burners, manifolds, wires and hoses. Use new gasket material to ensure a proper air seal.
16. Reassemble all gas and water piping. Test for gas leaks.
17. Reassemble outer jacket panels.
18. Cycle the appliance and check for proper operation.

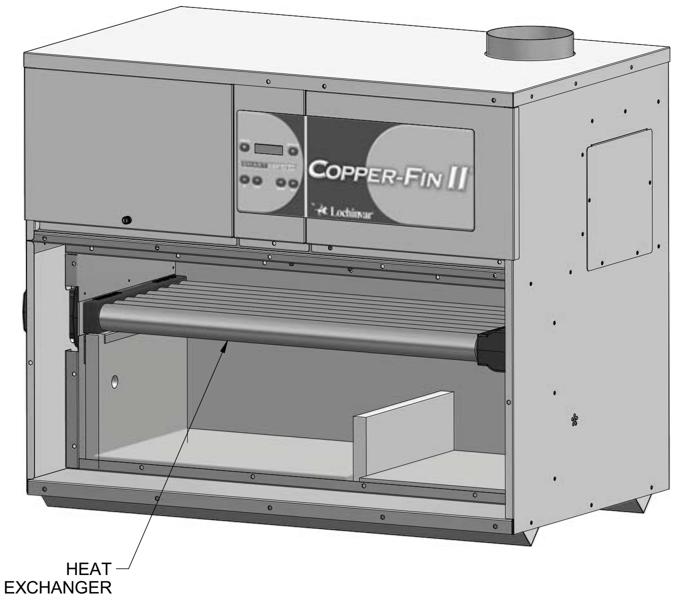


***Figure 2-5**_Location of the Heat Exchanger Inside Jacket*

Review with owner

1. Review the User's Information Manual with the owner.
2. Emphasize the need to perform the maintenance schedule specified in the User's Information Manual (and in this manual as well).
3. Remind the owner of the need to call a licensed contractor should the appliance or system exhibit any unusual behavior.
4. Remind the owner to follow the proper shutdown procedure and to schedule an annual start-up at the beginning of the next heating season.

Oiled bearing circulators

Inspect the pump every six (6) months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by the pump manufacturer.

BOILER & WATER HEATER PARTS LIST

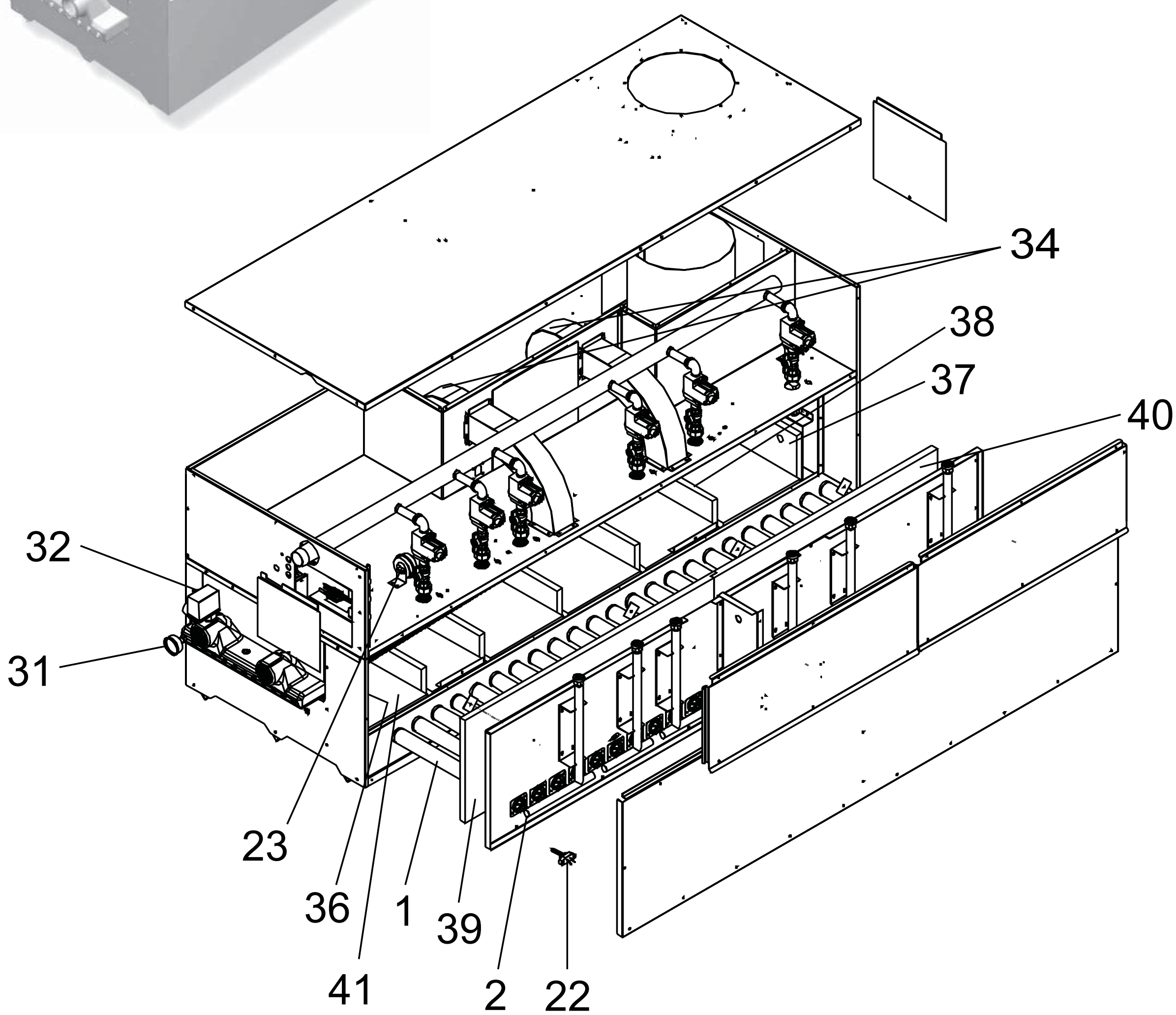
Operations & Maintenance Manual
December 2015

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

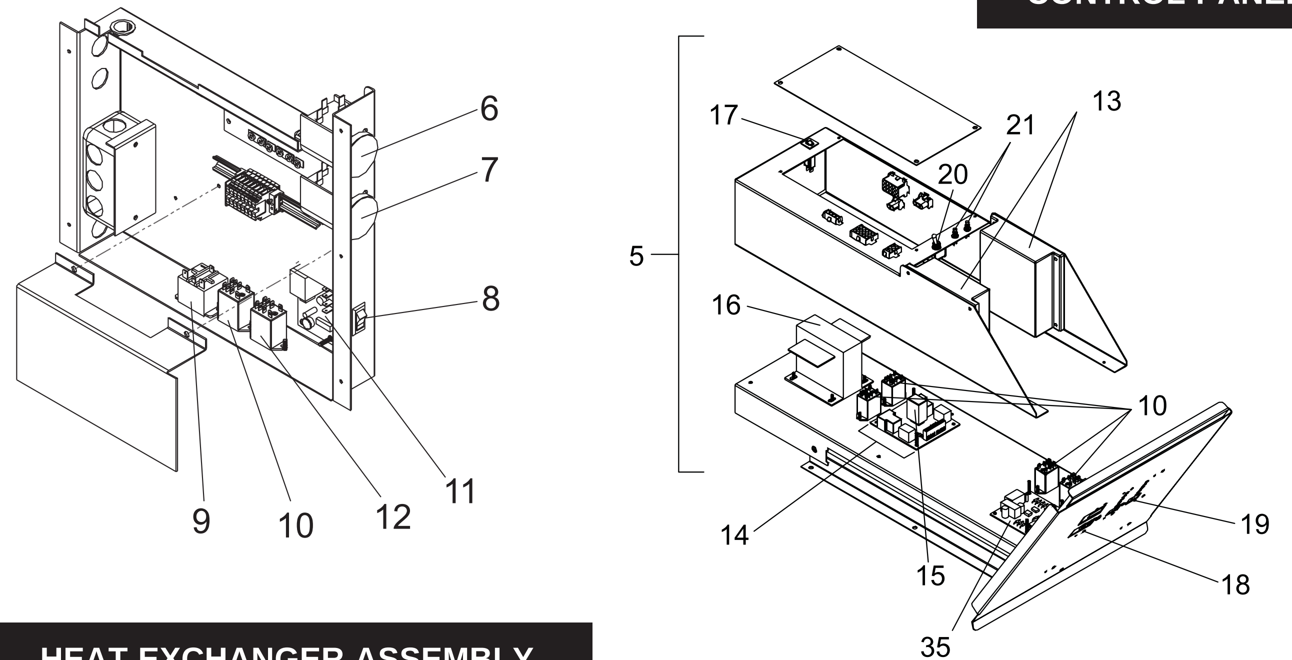
Replacement Parts List

PARTS & SERVICE DEPARTMENT
Nashville, Tennessee
615-889-8900 • Fax: 615-882-2918
parts_team@lochinvar.com
www.Lochinvar.com

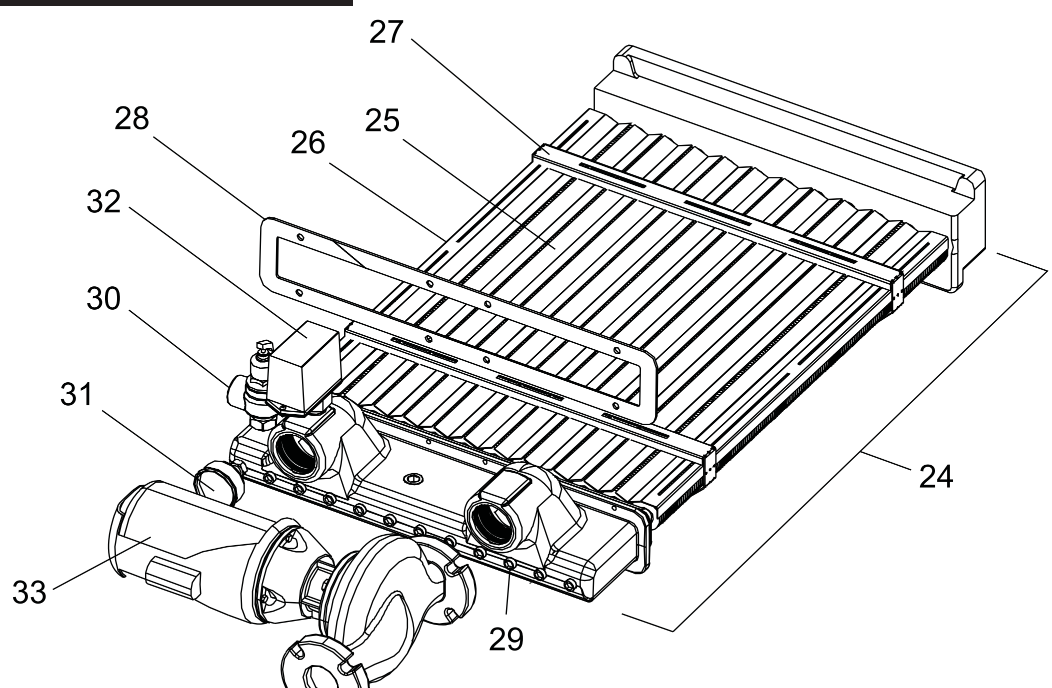
Copper-Fin II®
Boilers & Water Heaters
CH – CF 991-2071



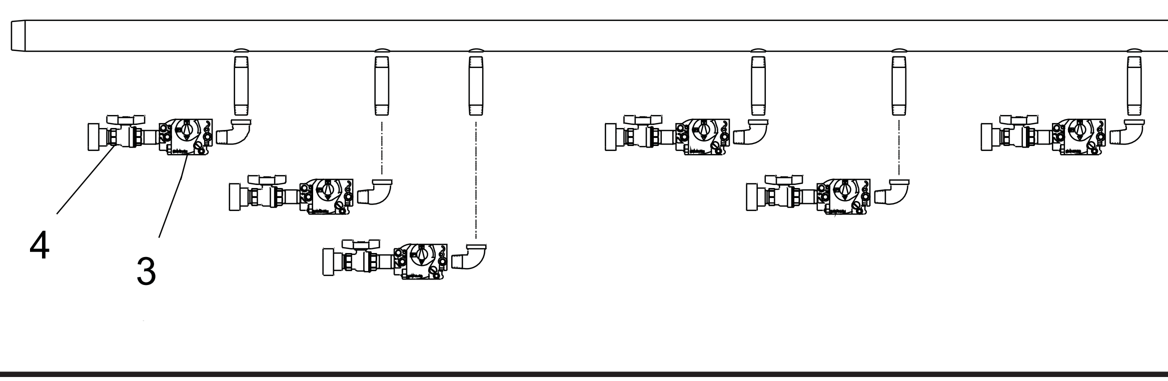
CONTROL PANEL



HEAT EXCHANGER ASSEMBLY



GAS TRAIN



BARNARD
People building for People.
P.O. Box 99 • Bozeman, MT 59771-0099 • (406) 586-1995 • FAX (406) 586-3530

Eisenhower/Johnson Memorial Tunnel
Fixed Fire Suppression System
Design Build Project, NO. C 0703-360

Mechanical Parts List

ITEM NO.	PART NO.	DESCRIPTION	MODEL NO.

Burners

ITEM NO.	PRIOR TO SERIAL #E05H00176040			BEGINNING SERIAL #E05H00176040		
	MODEL	BNR3422	BNR3423	MODEL	BNR3422	BNR3430
1	991	9 ea	2 ea	991	9 ea	2 ea
	1261	12 ea	2 ea	1261	12 ea	2 ea
	1441	14 ea	2 ea	1441	14 ea	2 ea
	1801	18 ea	2 ea	1801	18 ea	2 ea
	2071	21 ea	2 ea	2071	21 ea	2 ea

ITEM NO.	PART NO.	DESCRIPTION	MODEL NO.
		GAS TRAIN ASSEMBLIES	
2	ORF2421	ORIFICE, NAT	ALL
2	ORF2418	ORIFICE, LP	ALL
3	VAL2076	GAS VALVE, NAT	ALL
3	VAL2413	GAS VALVE, LP	ALL
4	VAL2421	BALL VALVE	ALL
		CONTRLS & GAUGES	
5	PAN3008	CONTROL PANEL	ALL
6	HLC2701	HIGH LIMIT, AUTO RESET (OPTIONAL)	ALL
7	HLC2702	HIGH LIMIT, MANUAL RESET	ALL
8	SWT2006	SWITCH, ON / OFF	ALL
9	RLY2708	RELAY, 24V PUMP	ALL
10	RLY2903	RELAY, 24V	ALL
11	RLY2714	RELAY, TIME DELAY	ALL
12	RLY2051	RELAY, 120VAC LOUVER/VENTER	ALL
13	RLY2402	IGNITION MODULE	ALL
14	RLY2049	RELAY BOARD	ALL
15	RLY2050	RELAY, 115VAC	ALL
16	TRF2701	TRANSFORMER, 150VA	ALL
17	MSC2447	CIRCUIT BREAKER, 7AMP	ALL
18	RLY2046	ELECTRONIC CONTROL (PRIOR TO SERIAL #A05H00173023)	991
18	RLY2083	ELECTRONIC CONTROL (BEGINNING SERIAL #A05H00173023)	991
18	RLY2046	ELECTRONIC CONTROL	1261-2071
19	RLY2044	DISPLAY BOARD	ALL
20	MSC2527	SWITCH, TOGGLE (OPTIONAL)	ALL
21	SWT2004	BUTTON, TEST / RESET	ALL
22	PLT3400	HOT SURFACE IGNITOR	ALL
23	PRS30012	PRESSURE SWITCH, NAT (PRIOR TO SERIAL #E05H00176040)	991-1261
23	PRS30030	PRESSURE SWITCH, NAT (BEGINNING SERIAL #E05H00176040)	991-1261
23	PRS30015	PRESSURE SWITCH, NAT (PRIOR TO SERIAL #E05H00176040)	1441-2071
23	PRS30029	PRESSURE SWITCH, NAT (BEGINNING SERIAL #E05H00176040)	1441-2071
23	PRS30008	PRESSURE SWITCH, LP (PRIOR TO SERIAL #E05H00176040)	991-2071
23	PRS30029	PRESSURE SWITCH, LP (BEGINNING SERIAL #E05H00176040)	991-2071
		HEAT EXCHANGERS	
24	HEX3000	HEAT EXCHANGER, HLW	CF991
24	HEX3001	HEAT EXCHANGER, HLW	CF1261
24	HEX3002	HEAT EXCHANGER, HLW	CF1441
24	HEX3003	HEAT EXCHANGER, HLW	CF1801
24	HEX3004	HEAT EXCHANGER, HLW	CF2071
24	HEX3420	HEAT EXCHANGER, H	CH991
24	HEX3421	HEAT EXCHANGER, H	CH1261
24	HEX3422	HEAT EXCHANGER, H	CH1441
24	HEX3423	HEAT EXCHANGER, H	CH1801
24	HEX3424	HEAT EXCHANGER, H	CH2071
25	JKE2004	V-BAFFLE (9 REQ)	991
25	JKE2005	V-BAFFLE (9 REQ)	1261
25	JKE2006	V-BAFFLE (9 REQ)	1441
25	JKE2007	V-BAFFLE (9 REQ)	1801
25	JKE2008	V-BAFFLE (9 REQ)	2071
26	JKE6159	FRAME RUNNER (2 REQ)	991
26	JKE6160	FRAME RUNNER (2 REQ)	1261
26	JKE6161	FRAME RUNNER (2 REQ)	1441
26	JKE6162	FRAME RUNNER (2 REQ)	1801
26	JKE6163	FRAME RUNNER (2 REQ)	2071
27	JKD6187	FRAME END	ALL
28	GKT2418	GASKET, HEAT SHIELD	ALL
29	TST2300	BULBWELL	ALL
30	RLV2001	RELIEF VALVE, PRESSURE ONLY	CH991-2071
30	RLV2017	RELIEF VALVE, TEMPERATURE & PRESSURE	CF991-2071
31	GTP2900	GAUGE, TEMPERATURE & PRESSURE	CH991-2071
31	GTP3000	GAUGE, TEMPERATURE	CF991-2071
32	WTR2041	FLOW SWITCH, OUTDOOR	ALL
32	WTR2040	FLOW SWITCH, INDOOR	ALL

PUMPS			
33	ARM3024PAB	PUMP	CF991-2071
MISCELLANEOUS			
34	FAN2009	FAN ASSEMBLY	991-1261
34	FAN2010	FAN ASSEMBLY	1441-2071
-	JKE6411	AIR SHUTTER	ALL
35	WTR2530	LOW WATER CUT-OFF, MANUAL RESET (OPTIONAL) PRIOR TO SERIAL #H08H00211349	ALL
35	WTR30000	LOW WATER CUT-OFF, MANUAL RESET (OPTIONAL) BEGINNING SERIAL #H08H00211349	ALL
35	WTR2528	LOW WATER CUT-OFF, AUTO RESET (OPTIONAL) PRIOR TO SERIAL #H08H00211349	ALL
35	WTR30001	LOW WATER CUT-OFF, AUTO RESET (OPTIONAL) BEGINNING SERIAL #H08H00211349	ALL
-	WTR2222	LOW WATER CUT-OFF PROBE (OPTIONAL)	ALL
-	WTR20000	LOW WATER CUT-OFF BOOT (OPTIONAL)	ALL
-	MSC3415	SIGHT GLASS AND GASKET KIT	ALL
-	GKT3408	GASKET, STRIP 45”	ALL
-	PRS2701	PRESSURE TAP, ALUMINUM	ALL
-	TUB2002	TUBING, AIR PRESSURE SWITCH (PRIOR TO SERIAL #E05H00176040)	ALL
-	TUB2004	TUBING, AIR PRESSURE SWITCH (BEGINNING SERIAL #E05H00176040)	ALL
-	MSC2155	TEE, AIR PRESSURE TUBE	ALL
-	MSC2156	TEE FITTING, AIR PRESSURE TUBE CAP	ALL
-	TST2313	TEMPERATURE SENSOR	ALL
-	MSC2461	TUBING, SILICONE, 1/8” CLEAR	ALL
-	MSC2406	TUBING, EPDM, 1/8” BLACK	ALL
-	MSC7119	BULBWELL CLIP	ALL
-	GKT2023	TRANSITION GASKET	ALL
-	FIL2000	FILTER, 16 X 16 X 1	ALL
LOCH-HEAT TILE			
36	FIB2204	HEAD SIDE PANEL, FRONT	ALL
37	FIB2205	HEAD SIDE PANEL, REAR	ALL
38	FIB2228	DIVIDER PANEL	ALL
39	FIB2202	INSULATION PAD, FRONT	991
39	FIB2210	INSULATION PAD, FRONT	1261
39	FIB2214	INSULATION PAD, FRONT LEFT	1441
39	FIB2220	INSULATION PAD, FRONT LEFT	1801
39	FIB2224	INSULATION PAD, FRONT LEFT	2071
40	FIB2215	INSULATION PAD, FRONT RIGHT	1441
40	FIB2221	INSULATION PAD, FRONT RIGHT	1801
40	FIB2225	INSULATION PAD, FRONT RIGHT	2071
-	FIB2472	BACK PANEL	991
-	FIB2456	BACK PANEL	1261
-	FIB2457	BACK PANEL, LEFT	1441
-	FIB2458	BACK PANEL, LEFT	1801
-	FIB2459	BACK PANEL, LEFT	2071
-	FIB2455	BACK PANEL, RIGHT	1441-2071
-	FIB2258	INSULATION PAD, BACK	991-1441
-	FIB2260	INSULATION PAD, BACK	1801-2071
-	FIB2257	INSULATION PAD, TOP	991-1441
-	FIB2259	INSULATION PAD, TOP	1801-2071
-	FIB2256	INSULATION PAD, RIGHT SIDE	ALL
LOCH-HEAT TILE BOTTOM PANELS			
41	FIB2206	BOTTOM PANEL POSITION 1*	991
41	FIB2207	BOTTOM PANEL POSITION 2*	991
41	FIB2208	BOTTOM PANEL POSITION 3*	991
41	FIB2211	BOTTOM PANEL POSITION 1*	1261
41	FIB2212	BOTTOM PANEL POSITION 2 & 3*	1261
41	FIB2207	BOTTOM PANEL POSITION 4*	1261
41	FIB2218	BOTTOM PANEL POSITION 1*	1441
41	FIB2207	BOTTOM PANEL POSITION 2 & 3*	1441
41	FIB2219	BOTTOM PANEL POSITION 4*	1441
41	FIB2222	BOTTOM PANEL POSITION 1*	1801
41	FIB2207	BOTTOM PANEL POSITION 2, 3, & 4*	1801
41	FIB2223	BOTTOM PANEL POSITION 5*	1801
41	FIB2226	BOTTOM PANEL POSITION 1*	2071
41	FIB2212	BOTTOM PANEL POSITION 2*	2071
41	FIB2207	BOTTOM PANEL POSITION 3, 4, & 5*	2071
41	FIB2227	BOTTOM PANEL POSITION 6*	2071

***Denotes placement order of combustion chamber bottom tile from left to right (front to rear heat exchanger head)**

PLEASE HAVE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS

4034 Mint Way
Dallas, Texas 75237
Ph: (214) 337-8780
Fax: (214) 333-2742
www.tigerflow.com
sales@tigerflow.com

INSTALLATION, OPERATION & INSTALLATION

DATE:	6/18/15
JOB#:	**510000315**
SUBMITTAL#:	15-48988-R2
QUOTE#:	15-48988-R5
JOB NAME:	EMJT Fixed Fire Suppression Denver, CO
CONTRACTOR:	Braconier Plumbing & Heating Company, Inc.
ENGINEER:	Barnard Inc.
REPRESENTATIVE:	Unit Process Company Everett, WA

(1) **TIGERFLOW** Series WHS-11000, Model DVMV-25GF-C-S6-VM-HVAC, engineered packaged duplex hot water heating system consisting of:

- (2) Lochinvar Model CHN1442, 1,440,000 BTU, **85% efficient boiler** with common gas line connection, circulating pump, communication cables - **(vent piping by others)**
- (2) Grundfos Series CR, Model CR64-2, cast iron, stainless fitted, mechanical seal, vertical-multistage pumps each coupled to a **25 hp, 3600 rpm, 480/3/60** odp **premium** efficient motor – **Class 250 rated**

  Condition Point: 320 gpm @ 200' tdh (each)
- (2) 3" Val-Matic wafer-style, non-slam check valves – **Class 125 rated**
- (2) 4" Val-Matic wafer-style, non-slam check valves – **Class 250 rated**
- (2) 4" x 4" Taco, Model SD040040-4A suction diffusers – **Class 250 rated**
- (2) 1" relief valve at each boiler set at – **Class 125 rated**
- (2) 4" Taco circuit setter balancing valve – **Class 125 rated**
- (2) 3" Taco circuit setter balancing valve – **Class 125 rated**
- (1) 4" Taco Model AC4, ASME Code, air separator less strainer – **Class 125 rated**
- (1) 5" Taco Model AC05-250, ASME Code, air separator less strainer – **Class 250 rated**
- **(3) ½" Valmatic VMC-22 auto air vent – Class 250 rated**
- **(1) Alfa Laval, Model AQ4MFD Plate and frame heat exchanger 304 plate – Class 250 rated**
- (3) ¾" Model 15A air vent

(2) Taco Model CA-1400-125P, 370 gallon, ASME expansion tank – **Class 250 rated**

(1) Taco Model CAX-42, 11 gallon, ASME expansion tank – **Class 125 rated**

(4) 3” Bray 31H isolation lug style butterfly valves – **Class 250 rated**

(4) 4” Bray 43 isolation lug style butterfly valves – **Class 250 rated**

(1) 6” Bray 43 isolation lug style butterfly valves – **Class 250 rated**

(2) 2” Ball valves for gas

(1) Chemical shot feeder

(1) 1” FEBCO Model 860 backflow preventer

(2) 1-1/2” Stainless steel water make-up lines with PRV and strainer – **Class 250 rated**

(1) 1” Black water make-up lines with PRV and strainer

(5) 9” Scale-type thermometer with well

(10) 2 ½” Diameter glycerin-filled gauges with gauge cocks

- (1) UL Listed, **NEMA 4**, **TIGER's EYE Mark VI, E-Series** Solid State, Power and Control Panel
- (·) UL/C-UL 508 Label
- (·) Micro Controller:
  - -Memory Non-Volatile - no battery backup required
  - -Multi Level Security Passwords
- (·) Touch screen operator interface **Red Lion Model R-6 with 6” color screen**
  - Functions Included:
  - -Best efficiency control (Combination Flow & Pid Pressure)
  - -End of curve protection
  - -Transmitter failure alarms
  - -Automatic system status
  - -H-O-A selector
  - -ETM's
  - -Individual transmitter status
  - -Flow readout in gpm
  - -Pump, motor, drive status
  - -Automatic alternation of equal sized pumps
  - -32-bit RISC micro-controller
  - -USB port
  - -RS-232, RS-485, RS-422 communication ports
- (1) Thru-door control power disconnect
- (1) 24 Volt UL/C-UL, CE Approved Switching Power Supply
- (1) 120 Volt used control circuit transformer
- (1) Power on light
- (2) Common auxiliary alarm contacts
- **(2) Pump fail D-P switches**
- **(2) Boiler flow switches**
- **(·) BACnet Communication**
- **(2) RTD’s with sensing wells**

- **(1) 3 hp starter panel**

(1) Single power input lug box

(2) **Danfoss Series VLT-HVAC, variable speed drives with PWM, NEMA I, 5% line**

reactors, manual by-pass and fused disconnects

(1) Data industrial 225BR paddlewheel flow sensor with hot tap **- for remote mounting**

(1) Endraus Hauser Model PMD-75 differential pressure transmitter **- for remote mounting**

(1 set) 6” Type 304 Schedule 40 steel suction and discharge headers

(·) Split skid – Must fit through 5’ x 7’ opening

(·) Seismic Calculations with Colorado PE Stamp

(·) Factory startup and commissioning by a service technician plus all travel expenses – (1) 8-hour day – Requires 3-week advance notice

(1) Steel system skid with all necessary pipe supports, tubing and wiring for complete package

(·) Unit to be factory painted with machine grade **gray** finish coat

System to be completely, electrically and hydrostatically tested before shipment

(·) All welding to be done by ASME Section 9 certified welders

(·) Unit to be factory painted with machine grade finish coat

TIGERFLOW Systems, LLC complies with the Buy American Requirement of Section 1605 of the American Recovery & Reinvestment Act of 2009. Public Law 111-5 (ARRA) for manufactured goods. Systems are manufactured in Dallas, TX, USA.

Each **TIGERFLOW** package system is UL/C-UL listed as a system, so meeting OSHA and Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 (National Electric Code) Article 90-7; City of Los Angeles Approval Code #M-980006; CMR 248 Massachusetts State Plumbing Code Approval #P3-0910-108.

Seal Kit Part Number (See Note 1)	Seal Size	Used on:	Pump Construction	4030 Frame Size	4280/4380 Motor Frame Size	Seal Construction				
						Type	Elastomer	Trim	Seat Style (See Note 3)	Seat Material
816707-001	0.75	6 Series, 1000D	BF/AB				Buna	Brass	L-Cup	Ceramic
975000-991 (See Note 2)	1.25	4030/4280 Centerline Discharge, 4380 Numerical and 4360D w/Bracket 426988 or 426989	BF/AB/AI	S	56C, 143-215JM	21	**EPDM**	St. Stl.	O-Ring	**Ceramic**
810150-127						2	Viton			Ni-Resist
810150-137						2	Buna			
810150-128						21	EPDM			Tungsten
975000-993 (See Note 2)	1.625			M	254-326JM, 213-326JP	21	**EPDM**			**Ceramic**
810150-131						21	Viton			Ni-Resist
810150-138						2	Buna			
810150-132						21	EPDM			Tungsten
825458-001 (See Note 2)	1.25	4030/4280 Tangential Discharge, 4380 D & E and 4360D w/Bracket 426990 or 426991	BF/AB/AI	S	56C, 143-215JM	21	**Buna**	**St. Stl.**	**L-Cup**	**Ceramic**
825458-003						21	Viton			
810150-133			BF/AI/AB			2	Buna			Tungsten
811339-000 (See Note 2)	1.625		BF/AB	M	254-326JM, 213-326JP	2	**Buna**	**Brass**		**Ceramic**
811866-000 (See Note 2)			AI			2	Buna	Steel		
819299-000			BF/AB			2	Viton	Brass		
810150-139			BF/AI/AB			2	Buna	St. Stl.		Tungsten

Notes:
1. Seal Kit consists of rotating seal head, spring holder, stationary seal seat with O-ring or L-cup. Pump casing gasket and other minor hardware components possibly required to reassemble the pump are not included. Consult Service Parts Bulletins for more detail.
2. Standard seal used for the pump construction indicated. Other seals listed are optional.
3. O-ring and L-cup style seats are NOT interchangeable between tangential and centerline discharge pumps.

S.A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
Tel: (416) 755-2291
Fax: (416) 759-9101
Visit us at www.armstrongpumps.com

Armstrong Pumps Limited
Peartree Road, Stanway
Colchester, Essex
United Kingdom, C03 5JX
Tel: 01206-579491
Fax: 01206-760532

Armstrong Pumps Inc.
93 East Avenue
Buffalo, New York
U.S.A. 14120-6594
Tel: (716) 693-8813
Fax: (716) 693-8970

Armstrong Darling Inc.
2200 Place Transcanadienne
Montreal, Quebec
Canada, H9P 2X5
Tel: (514) 421-2424
Fax: (514) 421-2436

BARNARD
People building for People.
P.O. Box 99 • Bozeman, MT 59771-0099 • (406) 586-1995 • FAX (406) 586-3530

Eisenhower/Johnson Memorial Tunnel
Fixed Fire Suppression System
Design Build Project, NO. C 0703-360

Mechanical Spare Parts Provided

The Mechanical System and all associated components have no required spare parts for normal operation, nor for any ongoing testing and maintenance operations for use within 30 years.

Consumables

***The Mechanical System and all associated components have no required consumables for normal operation, nor for any ongoing testing and maintenance operations.**