



SKS Parallel SelfSensing with Modulating Pump Controller

302-397

Installation, Operation, and Maintenance Manual

SUPERSEDES: NEW

EFFECTIVE: August 10, 2023

Plant ID No. 001-5055

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1 SAFETY REQUIREMENTS



CAUTION: These instructions should be read completely prior to installation of the equipment. A copy of these instructions should be retained on file for future reference.



WARNING: Electrical shock hazard. Disconnect ALL power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

This pump is intended for the circulation of water or other suitable HVAC media. It is not intended for hazardous, corrosive, or flammable liquids.

Pump must not be operated until all piping and/or electrical connections are in place.

Proper care and suitable equipment should be used to move and install this heavy equipment.

Care should be taken when installing pipe systems to avoid placing an excessive load on the pump unions.

Refer to motor installation instructions to determine proper terminal connections in order to obtain correct pump rotation.

When the system piping is used as an earth bonding path for the building electrical services (check local codes), the pump should not be relied upon as part of the circuit. A properly installed bridging connection should be provided.

If electrical connection is to be made using any means other than rigid conduit, proper strain relief must be provided (min 100N tension).

Pump should be installed according to local electrical and safety codes using appropriate size wire and suitable over current protection. It should use a lockable isolator or circuit breaker conforming to applicable electrical codes.

It is recommended that the pump be fitted with a suitable "emergency stop" per the requirements of applicable electrical codes.

2 GENERAL INSTALLATION REQUIREMENTS

2.1 Receiving Pump

Inspect for shipping damage. If a shortage or damage occurs, contact carrier immediately.

2.2 Location

Install vertically with motor up. Consult factory for horizontal mounting.

Pump should be accessible for inspection and repair work, head room must be provided for the use of hoist or tackle as necessary.

Lift pump by slinging through motor eye bolts and securing through pump adapter.

NOTE: In no case should any part of motor be covered with insulation.

2.3 Foundation

The pump must always be supported.

Pumps with smaller motors may be suspended in the piping, provided the piping is supported adjacent to the pump.

For pumps with larger motors, the pump should be attached to a support utilizing the tapped hole or holes in the bottom of the pump casing.

NOTE: Piping loads shall not be applied to the pump.

Pump must be allowed to move with piping movement. Expansion of piping must be taken into account when piping and suitable devices should be employed. Do not rigidly connect the pump to the floor.

NOTE: Provide vibration isolation pads under floor mounted supports. Do not support unit by the motor eye-bolts.

3 MAINTENANCE

3.1 Routine Inspections

Routine inspections should be made on a regular basis. Inspections made while pump is running should reveal potential failures.

- Inspect motor bearings for any sign of temperature rise. Temperature should not exceed 160°F. Temperature rise may indicate the early stages of bearing problems.
- Listen for any unusual noise:
 1. Air trapped in pump.
 2. Hydraulic noise.
 3. Mechanical noise in motor and/or pump.
- Check suction gauge reading and confirm that it is normal.

- Check discharge gauge reading and confirm that it is normal. If gauge readings are abnormal find out why.

NOTE: Suction and discharge gauges should read the same with pump stopped.

3.2 Close-Coupled Pumps

The pump section is attached directly to the motor shaft and does not contain bearings.

3.3 Close-Coupled Motors

The motor must be lubricated in accordance with the manufacturer's recommendations. Do not over lubricate the motor bearings as this could cause premature bearing failure.

3.4 Mechanical Seal

The mechanical seal is the "John Crane" Type 21 General Purpose Seal for the 175 psig pressure rating.

A "John Crane" Type 2 General Purpose Seal is used for the 300 psig pressure rating.

4 DISASSEMBLY AND REASSEMBLY

4.1 General

If the pump has been maintained and serviced properly, breakdowns requiring pump disassembly should occur only rarely.

- If a problem occurs, the cause should be determined, if possible, before disassembling. (See "Problem Analysis")
- If the pump is being disassembled, all parts must be carefully handled, avoid heavy blows and shocks.
- All parts must be carefully cleaned and inspected for wear. Recondition or replace parts where necessary.

4.2 Disassembly

- Drain liquid from casing by removing drain plug.



CAUTION: Allow pump to cool and secure suction and discharge valves before working on pump!

Remove recirculation line.

Remove bolts holding cover/adaptor to casing, pry cover/adaptor and motor assembly from casing.

Remove impeller bolt in a counterclockwise direction. Remove impeller and key.

In all cases of mechanical seal arrangement, after removing the sleeve and its seal assembly, the seal rotating element may be drawn off the shaft sleeve.

NOTE: Apply silicone grease on the OD of the sleeve in the area between the seal and the end of the sleeve. This will help removal of the old seal. The stationary element is to be removed from the cover.

All parts must be cleaned and inspected for wear. Replace parts where necessary.

4.3 Reassembly

Be certain that all parts to be replaced are free from burrs, with screw threads and connecting faces clear and free from damage.

Insert stationary element of seal into cover adapter, slip cover adapter over shaft and engage rabbit of motor.

Note: Do not touch the seal surfaces because this may result in leakage. Do not contaminate seal faces with fingerprints.

Lubricate smaller OD of shaft sleeve with silicone grease. Do not use petroleum oil or grease.

Place spring on shaft sleeve to abut against sleeve shoulder. Slide rotary seal on sleeve until it contacts spring.

Slide the shaft sleeve on the shaft, larger bore first. Be certain the O-ring is correctly seated in the groove.

Assemble impeller key and impeller on shaft. Refit with new impeller washer on impeller bolt and tighten carefully. Be certain that the impeller rotates freely by hand.

Apply a few spots of gasket adhesive to gasket surface of cover. Place a new casing gasket against gasket surface and press against adhesive.

Assemble cover adapter complete with motor into casing. Insure that gasket is seated correctly. Install hex-headed cap screws into casing tapings and tighten uniformly.

Reconnect recirculation line and drain plug.

5 PUMP PIPING - GENERAL



CAUTION: NEVER connect any 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 connecting pipe flanges must be square to the pipe work 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.

Lay out 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.

6 APPLICATION

Working Pressure:	175 psig
Optional Working Pressure:	300 psig
Temperature:	250°F Standard 300°F Hi Temperature

7 MECHANICAL INSTALLATION

7.1 Location

In open systems, locate the unit as close as practical to the liquid supply source, 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.

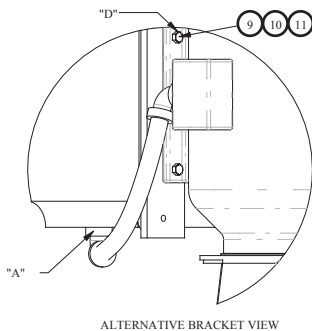
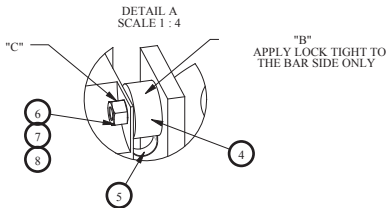
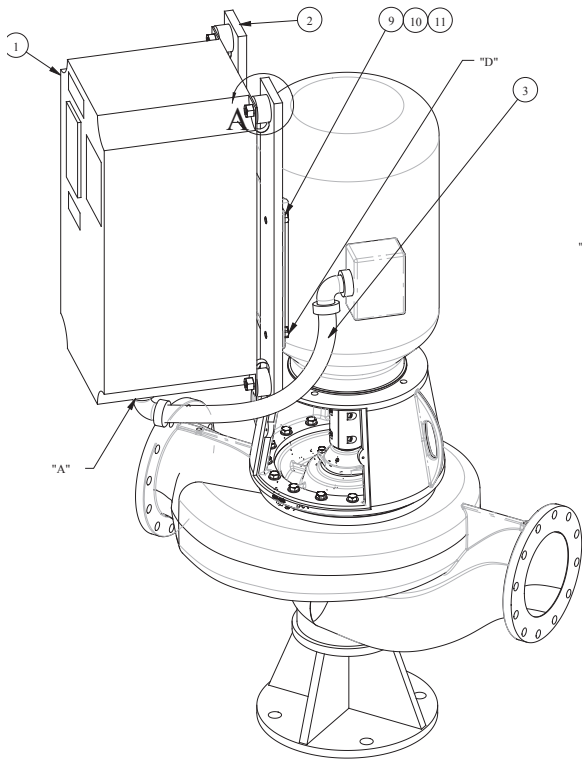
Airflow into the motor and/or motor fan should not be obstructed.

7.2 VFD Mounting to Pump

For instructions on mounting the VFD directly to the pump, see the diagrams and notes on the following page.

Figure 7-1: VFD Mounting to Pump

- 1.Items specified on this drawing are specifically for the SKV or SKS product series.
- 2.Assemble safety strap onto isolation mount stud to produce orientation shown in the assembly drawing.
- 3.Apply 'Loctite' to isolation mount stud threads (1 place) on all 4x parts.
- 4.Assemble threaded stud with 'Loctite' into bar bracket until surfaces are in contact without gaps.
- 5.Use strap wrench for isolation mounts. Screw mount into bar bracket (#2) until the rubber face is flush against the bar. Torque the mount 1/4 of a full turn.
- 6.Support VFD & assemble onto 4 isolation mounts simultaneously, assemble lockwashers & nuts, torque to specifications "C", remove VFD support.
- 7.Assemble the motor so the feet are angled between 22.5° to 45° offset from the flanges, as shown below.
- 8.Assemble the motor so the VFD and motor conduit box are hanging over the outlet volute.
- 9.* = all "D" bolt connections are SAE J429 grade #2 steel - nickel plated.



TORQUE REQUIREMENTS				
ALL TORQUE VALUES ARE +/- 15%				
SIZE	"A" MOTOR POWER WIRES TO VFD (In-lbs / Nm)	"B" VIBRATION MOUNT TO BAR BRACKET (In-lbs / Nm)	VIBRATION MOUNT THREAD SIZE	"C" VFD NUT TO VIBRATION MOUNT (Ft-lbs / Nm)
A5	5 / 0.6	SEE NOTE #7	M6 X 1	4.3 / 5.8
B1	16 / 1.8		M8 X 1.25	11.3 / 15.3
B2	40 / 4.5		M8 X 1.25	11.3 / 15.3
C1	89 / 10		M8 X 1.25	11.3 / 15.3
C2	124 / 14		M8 X 1.25	11.3 / 15.3

TORQUE REQUIREMENTS		
ALL TORQUE VALUES ARE +/- 15%		
MOTOR SIZE	BOLT SIZE	"D" MOTOR BOLT TO BAR BRACKET (FT-LBS / NM)*
143-145	5/16 X 18	11.5 / 15.6
182-215	3/8 X 16	20 / 27
254-286	1/2 X 13	49 / 66
324-365	5/8 X 11	98 / 133
404-449	3/4 X 10	173 / 235

SKV or SKS BOM Assembly		
ITEM #	DESCRIPTION	QTY
1	VFD	1
2	BAR BRACKET	2
3	WIRE HARNESS - MOTOR POWER	1
4	VIBRATION ISOLATION MOUNT	4
5	SAFETY STRAP	4
6	NUT (VFD)	4
7	LOCK WASHER (VFD)	4
8	WASHER (VFD)	4
9	SCREW (MOTOR)	4
10	LOCK WASHER (MOTOR)	4
11	WASHER (MOTOR)	4
N/A	"LOCTITE" (242; P/N 24231)	N/A

7.3 VFD Mounting to Wall

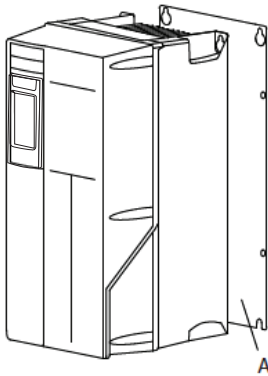
7.3.1 Lifting

- 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.

7.3.2 Mounting

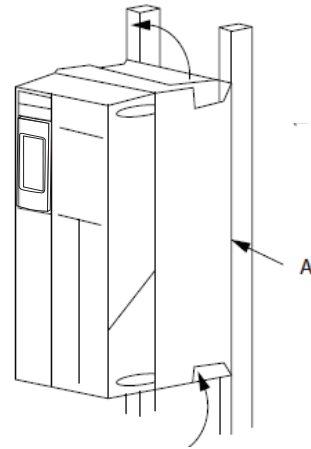
- Mount the unit vertically.
- The frequency converter allows side by side installation.
- Ensure that the strength of the mounting location will support the unit weight.
- Mount the unit to a solid flat surface or to the optional back plate to provide cooling airflow (see Figure 7-2 and Figure 7-3).
- Improper mounting can result in overheating and reduced performance.
- Use the slotted mounting holes on the unit for wall mounting, when provided.

Figure 7-2: Proper Mounting with Back Plate



Item A is a back plate properly installed for required airflow to cool the unit.

Figure 7-3: Proper Mounting with Railings



NOTE: Back plate is required when mounted on railings.

7.3.3 Tightening Torques

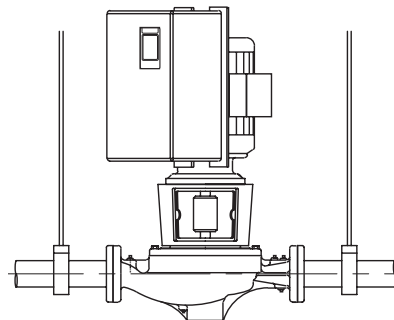
See “12.2 Connection Tightening Torques” on page 49 for proper tightening specifications.

7.4 Pump Piping – Detailed

In order to achieve the full added value of the Vertical In-Line pump design, it is important that you ensure the pump is affixed to the system piping by the pump flanges and the pump and motor assembly is allowed to float freely with the expansion and contraction of the piping system. Should any vertical in-line pump use supports to the structure, it is imperative that no pipe strain is imposed on the pump flanges. Compliant mounts such as springs or “waffle”-style isolation pads should be used under the pipe supports if the pump is not truly pipe mounted.

Various installation arrangements are detailed in the figures that follow.

Figure 7-4: Hanger Supported, Pipe Mounted

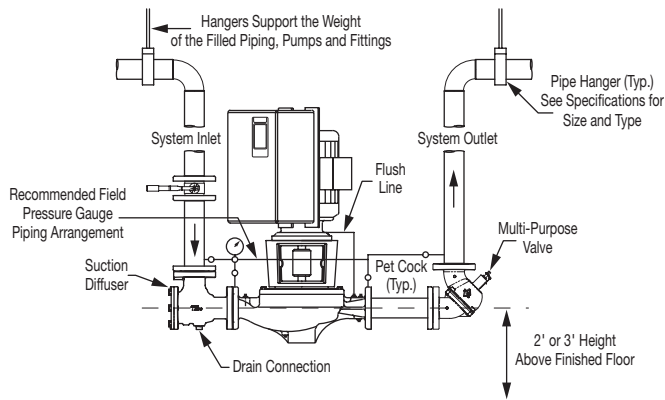


NOTE: The pump should not be rigidly attached to the base/pad structure unless flexibility couplings are used.

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. (Figure 7-4)

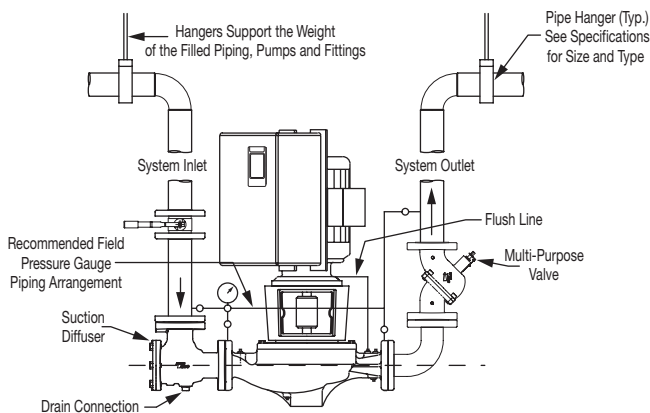
Piping for smaller in-line pumps (typically 15 hp and below) is hung close to the ceiling in many mechanical rooms. Larger pumps are often mounted near ground level for ease of maintenance. Figure 7-5 illustrates such an arrangement with the piping supported at the ceiling and the vertical pump installed with a Taco Suction Diffuser (RSP) and Plus Two Multi-Purpose Valve.

Figure 7-5: Pipe Mounted, Supported at Ceiling



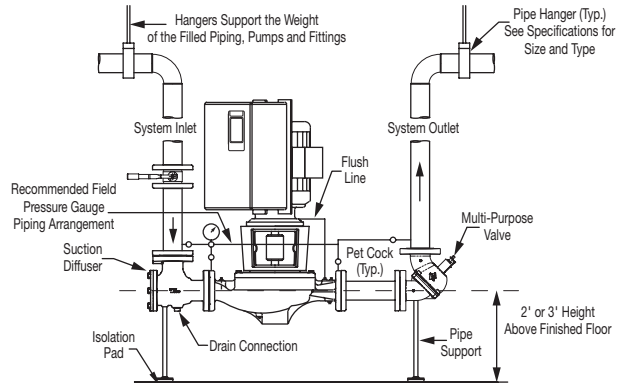
Should additional space saving be required, the discharge spool piece and Plus Two Multi-Purpose Valve may be replaced by a long-radius elbow and the Plus Two Multi-Purpose Valve field converted to a straight pattern configuration and installed in the vertical discharge pipe (Figure 7-6).

Figure 7-6: Discharge Elbow for Minimum Footprint



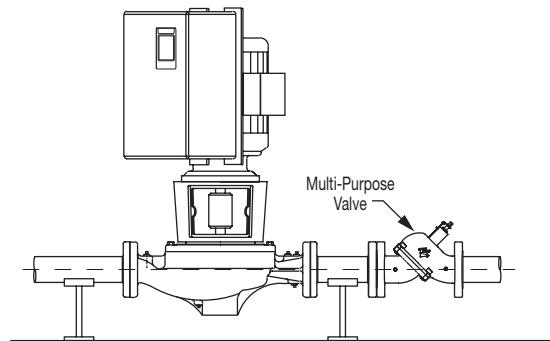
A similar arrangement to Figure 7-5 with additional floor mounted pipe-stools isolated from the structure by 'waffle' style isolation pads under the Suction Diffuser (RSP) and Plus Two Multi-Purpose Valve is illustrated in (Figure 7-7).

Figure 7-7: With Additional Pipe Supports



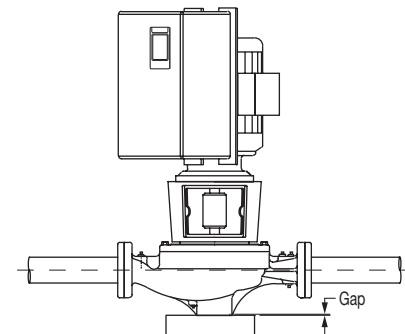
Floor mounted saddle supports (Figure 7-8) are typical for condenser water pumps where cooling tower base is near mechanical room elevation.

Figure 7-8: With Additional Pipe Supports



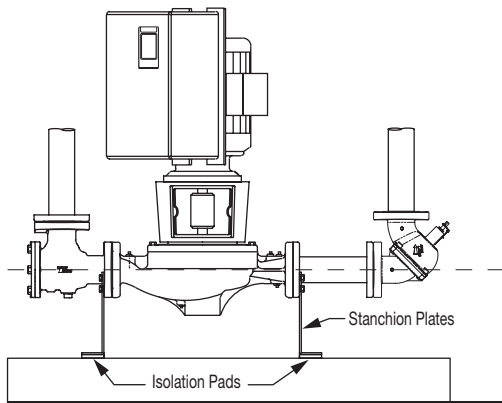
Where required, additional floor support may be used as shown in Figure 7-9. Install a "waffle" isolation pad under the pump. **NOTE:** The pump should not be rigidly attached to the base/pad structure.

Figure 7-9: Additional Floor Support



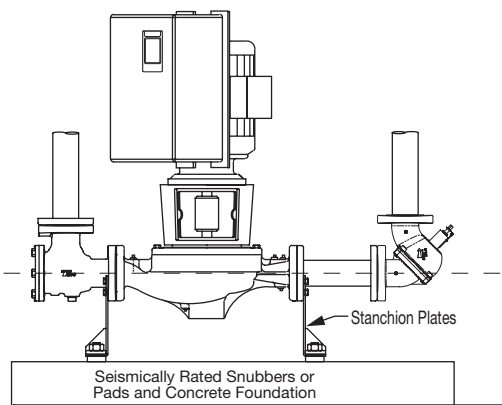
Stanchion plates at the pump suction and discharge ports may be supplied for installation convenience. Isolation pads must be used under the legs and monitored as pipe hangers are adjusted to ensure the pump flanges are not supporting the piping. Bolting to the floor or housekeeping pad is not recommended. If the stanchions are bolted down the bolts must be isolated from the stanchion or inertia base and flexible pipe connectors used (Figure 7-10).

Figure 7-10: With Stanchion Plates



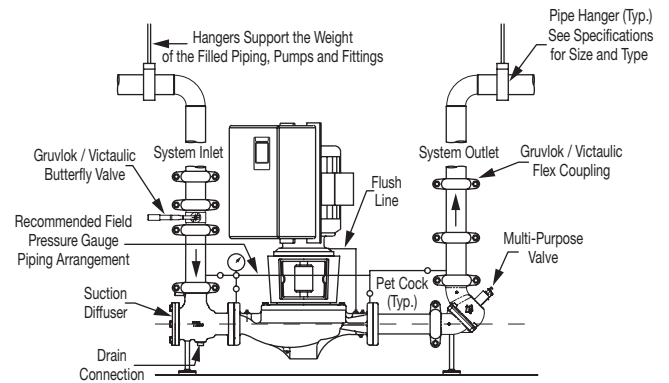
An installation with stanchion plates for seismically active regions is illustrated in Figure 7-11. Seismically rated isolation pads or snubbers with bolts isolated from the stanchion plates are installed to restrain the pump during a seismic event. Pipe hangers carry the weight of the equipment as seismic components are designed only to restrain the equipment during a seismic event.

Figure 7-11: Installation in Seismically Active



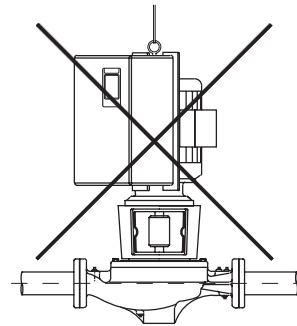
In systems utilizing grooved pipe, flange adapter locking devices or welded flanges at the pump should be used to prevent the possibility of pipe mounted pumps rotating in the piping (Figure 7-12).

Figure 7-12: Mounting in Grooved Pipe Systems



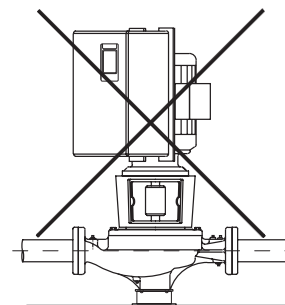
DO NOT support the unit by the motor eye bolts (Figure 7-13) or by any other part of the motor.

Figure 7-12: Motor Lifting Hook Supported



Connecting the pump to a permanent rigid base (Figure 7-14) is not recommended unless isolated from the piping by flexible connectors and the base isolated from the building structure on an inertia base. (Figure 7-14 is generally acceptable when using plastic piping.)

Figure 7-14: Mounted on Rigid Base without Flexible Connectors

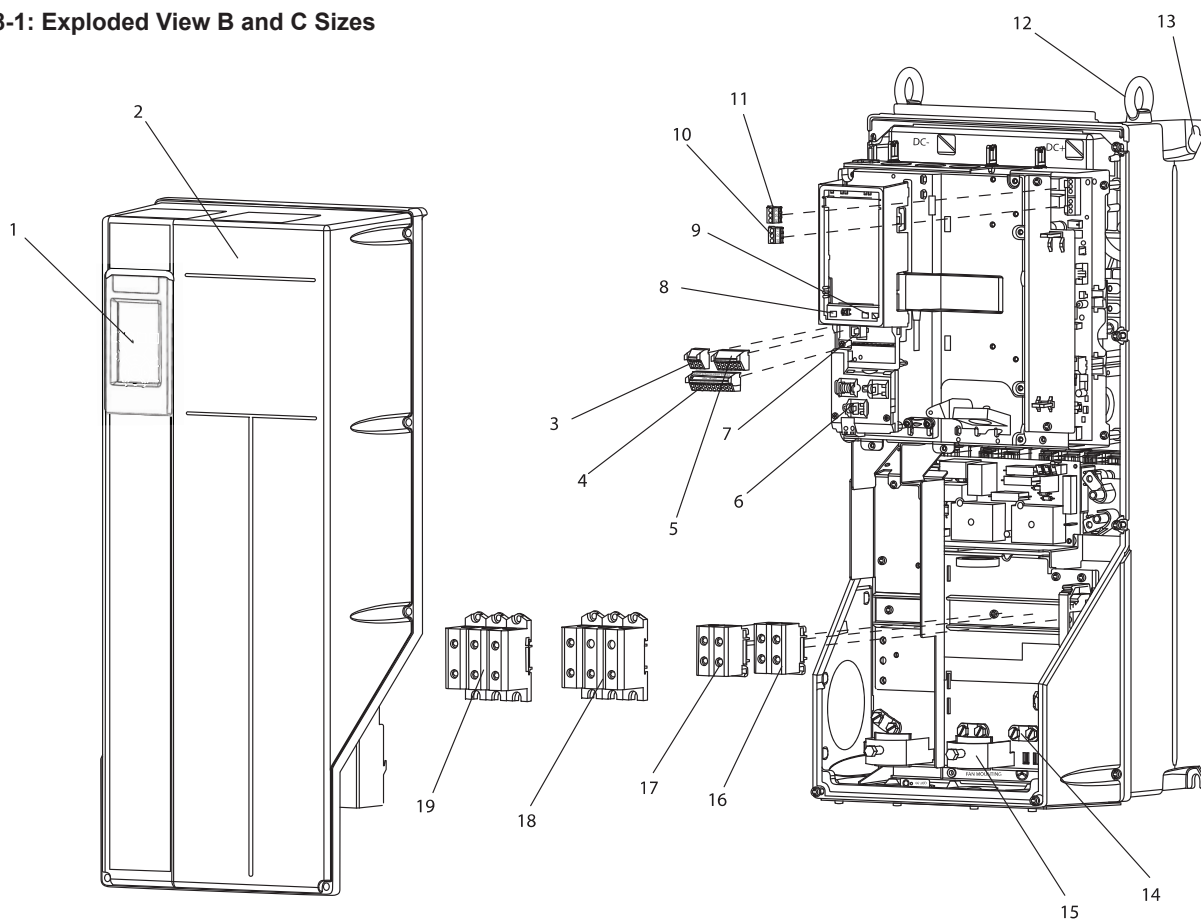


NOTE: The pump should not be rigidly attached to the base/pad structure unless flexibility couplings are used.

8 ELECTRICAL CONNECTIONS

8.1 Exploded View

Figure 8-1: Exploded View B and C Sizes



1	Modulating pump controller	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 24 V 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)		

Figure 8-2: Relay connection: terminals for a5, b1 and b2 units

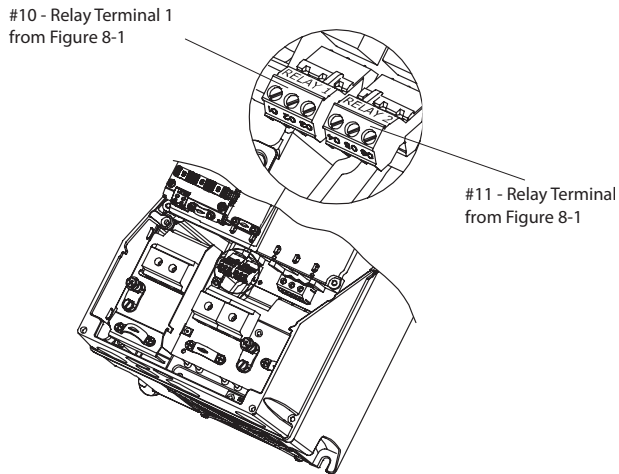
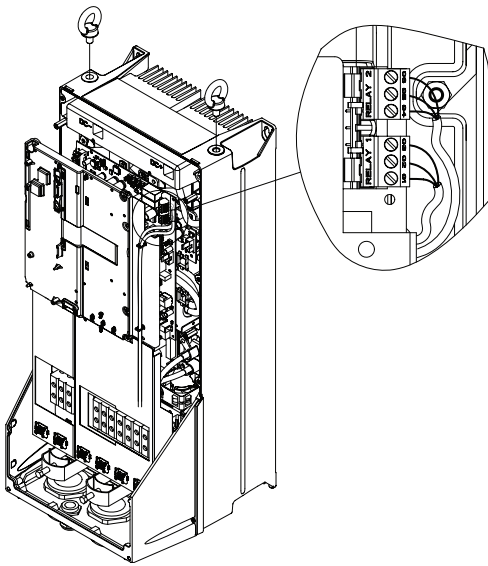


Figure 8-3: Relay Connection Terminals for c1 and c2 Units



8.2 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 8-4: Basic Wiring Schematic Drawing



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.

Figure 8-5 shows a typical bypass electrical connection.

Figure 8-5: Bypass Wiring Schematic Drawing for A2-A3 Frames

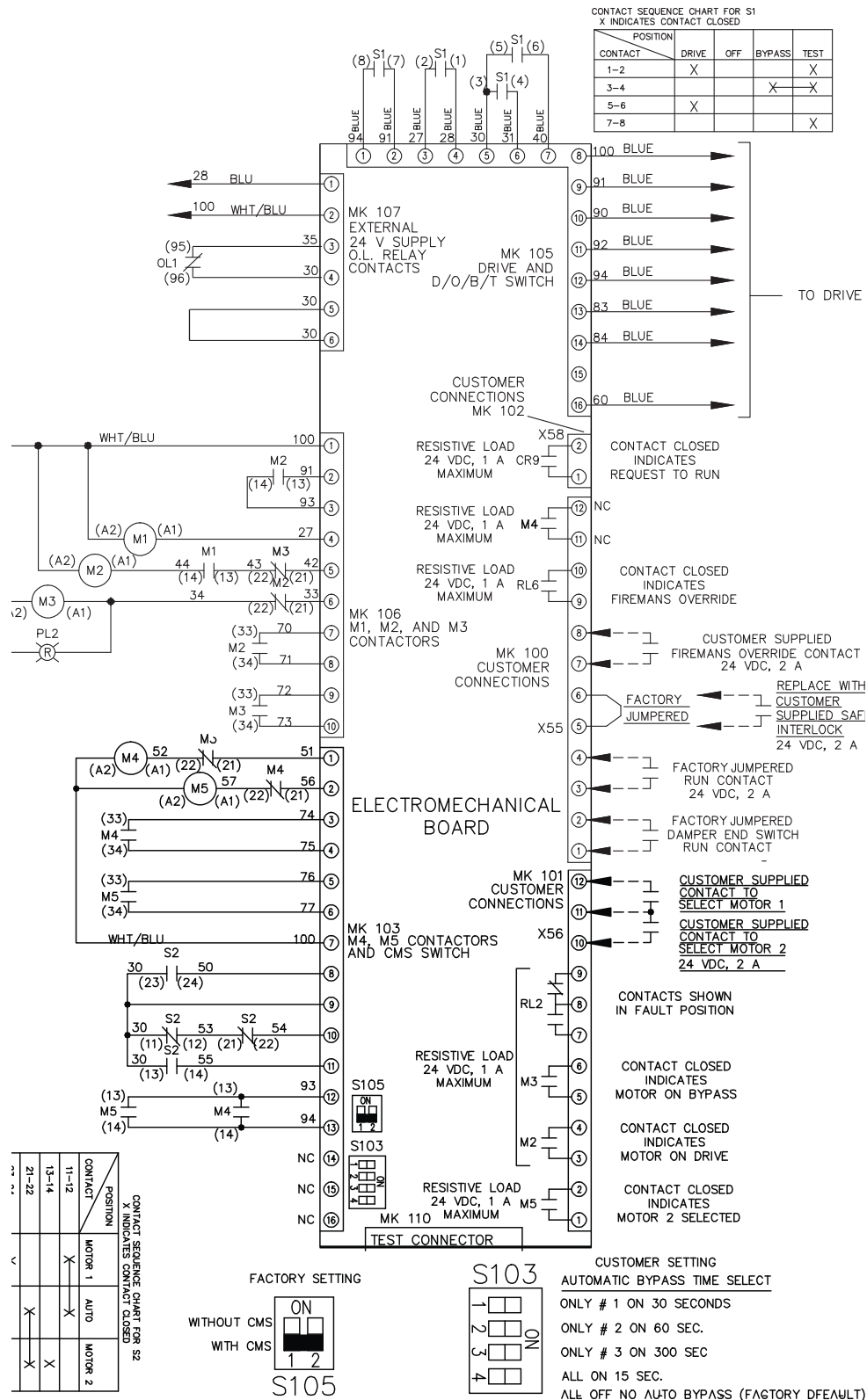
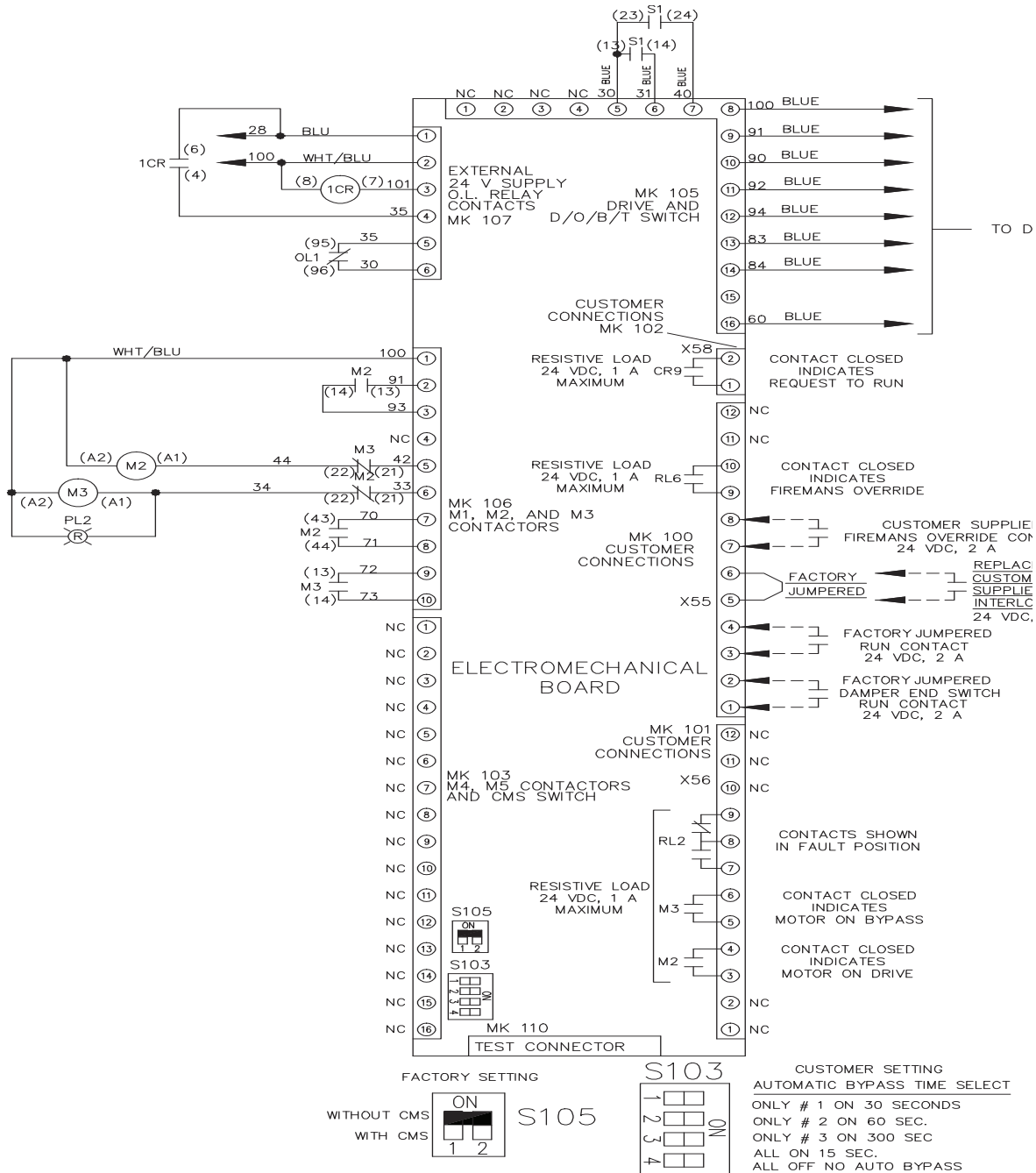


Figure 8-6 shows a typical bypass electrical connection

Figure 8-6: Bypass Wiring Schematic Drawing for B2-C1 Frames



DANGER: 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, start-up, 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.

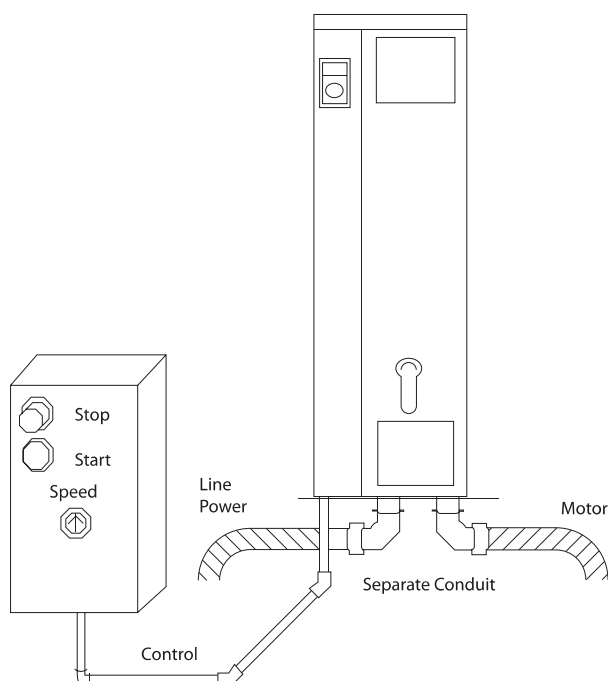
For your safety, comply with the following requirements:

- 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.

8.2.1 Overload and Equipment Protection

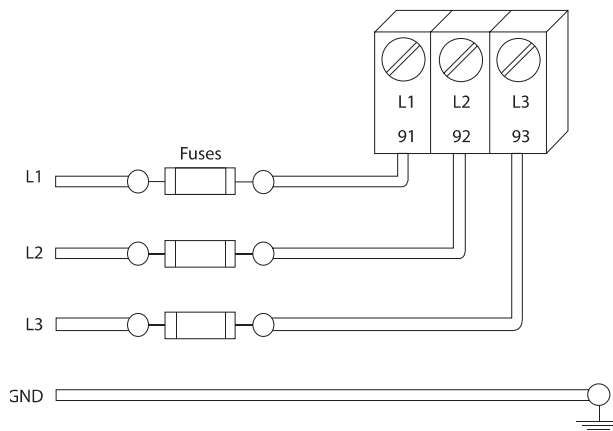
- An electronically activated function within the adjustable frequency drive provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See “9.8 Warnings and Alarms” on page 43 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 8-4.

Figure 8-7: Proper Electrical Installation Using Flexible Conduit



All adjustable frequency drives must be provided with short-circuit and overcurrent protection. Input fusing is required to provide this protection, see Figure 8-8. If not factory supplied, fuses must be provided by the installer as part of installation.

Figure 8-8: Adjustable Frequency Drive Fuses



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 167°F [75 °C] rated copper wire.

8.3 Grounding Requirements



DANGER: 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 the 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 dedicated ground wire is required for input power, motor power and control wiring.

- Use the clamps provided with 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.

8.3.1 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 3.5mA.

Grounding must be reinforced in one of the following ways:

- Ground wire of at least 0.0155 in² [10mm²]
- Two separate ground wires both complying with the dimensioning rules

See EN/IEC61800-5-1 and EN50178 for further information.

8.3.2 Using RCDs

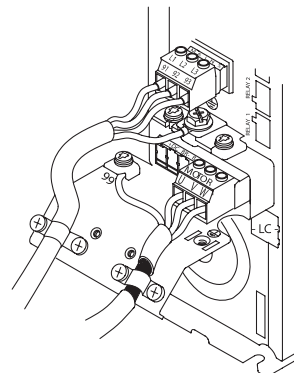
Where residual current devices (RCDs), also known as ground leakage circuit breakers (ELCBs), are used, comply with the following:

- 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

8.3.3 Grounding Using Shielded Cable

Grounding clamps are provided for motor wiring (see Figure 8-9).

Figure 8-9: Grounding Using Shielded Cable



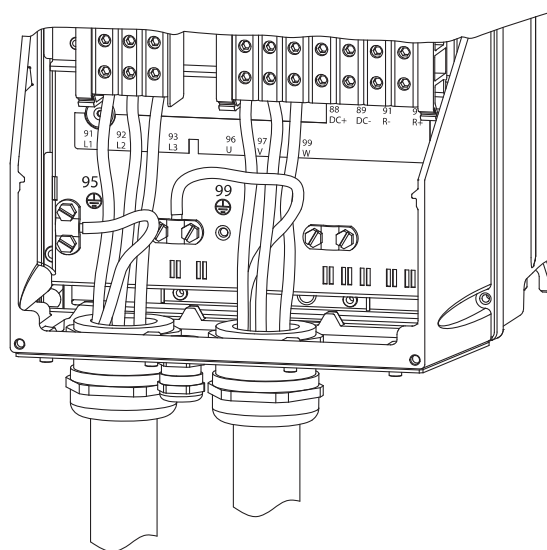
8.3.4 Grounding Using Conduit



DANGER: GROUNDING HAZARD! Do not use conduit connected to the adjustable frequency drive as a replacement for proper grounding. Ground currents are higher than 3.5 mA. Improper grounding can result in personal injury or electrical shorts.

Dedicated grounding clamps are provided (See Figure 8-10).

Figure 8-10: Grounding with Conduit



1. Use a wire stripper to remove the insulation for proper grounding.
2. Secure the grounding clamp to the stripped portion of the wire with the screws provided.
3. Secure the grounding wire to the grounding clamp provided.

8.3.5 Motor Connection

DANGER: 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 “12.1 Power-dependent Specifications” on page 47.
- 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.
- 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 8-11: Motor, Line Power and Ground Wiring for A-Frame Sizes

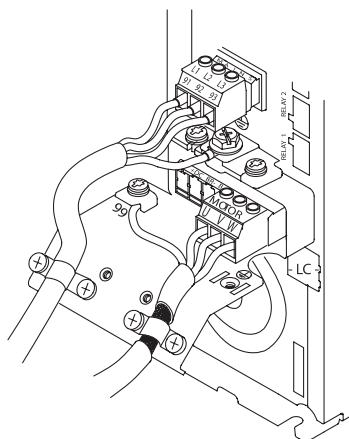


Figure 8-12: Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Shielded Cable

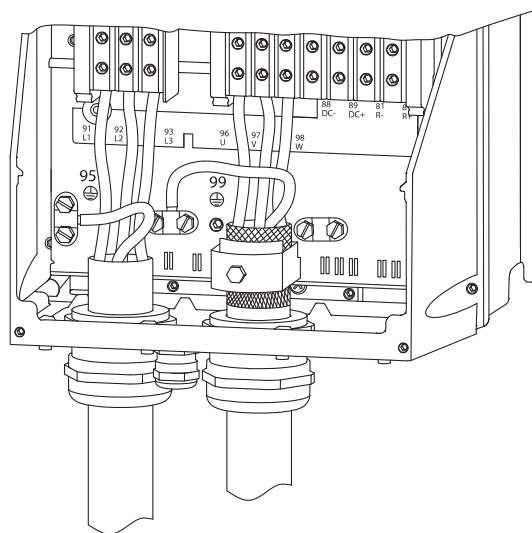
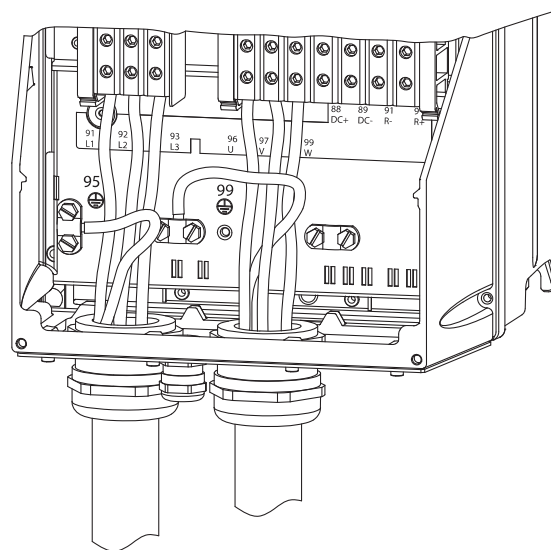


Figure 8-13: Motor, Line Power and Ground Wiring B-Frame Sizes and Above Using Shielded Cable or Conduit



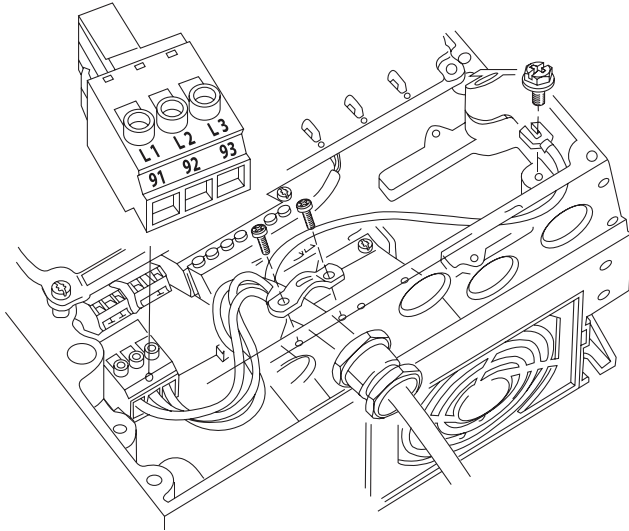
8.3.6 AC Line Power Connection

Size wiring based upon the input current of the adjustable frequency drive.

- 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 8-14).

- Depending on the configuration of the equipment, input power will be connected to the line power input terminals or the input disconnect.

Figure 8-14: Connecting to AC Line Power



- Ground the cable in accordance with grounding instructions provided in “8.3 Grounding Requirements” on page 14.
- 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 power or floating delta) or TT/TN-S line power 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.

8.3.7 Control Wiring

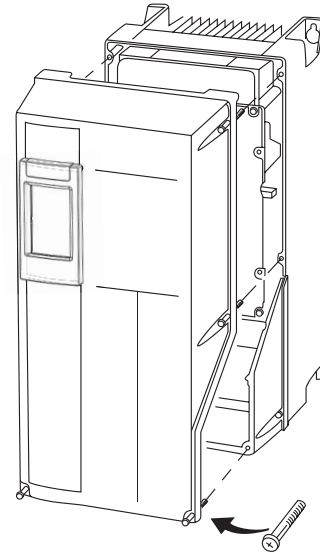
Isolate control wiring from high power components in the adjustable frequency drive.

If the adjustable frequency drive is connected to a thermistor, for PELV isolation, optional thermistor control wiring must be reinforced/ double insulated. A 24 VDC supply voltage is recommended.

Access

Remove front cover by loosening attaching screws. See “Figure 8-15: Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures”

Figure 8-15: Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures



Please see the table below before tightening the covers.

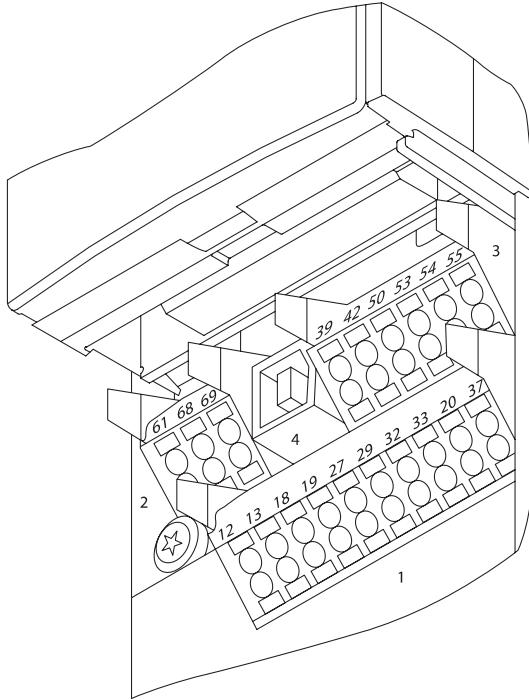
Table 1: Tightening Torques for Covers (Nm)

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				

Control Terminal Types

Figure 8-16 shows the removable adjustable frequency drive connectors.

Figure 8-16: Control Terminal Locations

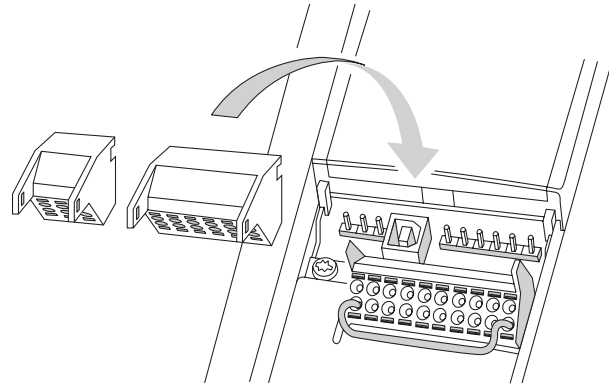


- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24V DC terminal supply voltage, and a common for optional customer supplied 24V DC voltage.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial 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.

Wiring to Control Terminals

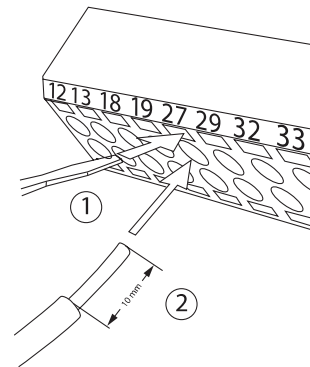
Control terminal connectors can be unplugged from the adjustable frequency drive for ease of installation, as shown in Figure 8-17.

Figure 8-17: Unplugging Control Terminals



1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in Figure 8-18.
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.

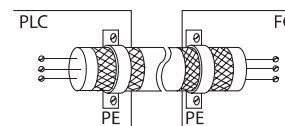
Figure 8-18: Connecting Control Wiring



Using Shielded Control Cables

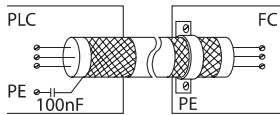
Correct Shielding

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.



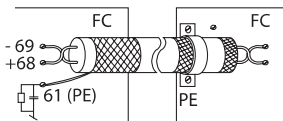
50/60 Hz ground loops

With very long control cables, ground loops may occur. To eliminate ground loops, connect one end of the shield-toground with a 100 nF capacitor (keeping leads short).



Avoid EMC noise on serial communication

To eliminate low-frequency noise between adjustable frequency drives, connect one end of the shield to terminal 61. This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce interference between conductors.



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.
- It is important to confirm that the control terminal is programmed for the correct function. See “9 Modulating Pump Controller” on page 23 for details on accessing parameters.
- The default terminal programming is intended to initiate adjustable frequency drive functioning in a typical operational mode.

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 24VDC 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 24 V 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

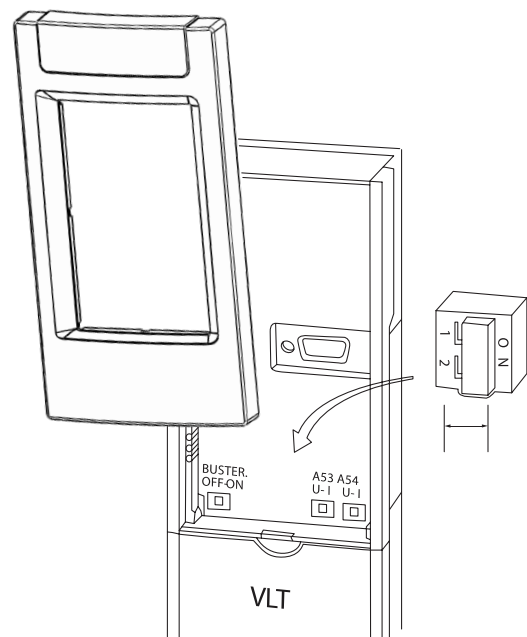
on terminal 27.

- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

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 8-17). 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 8-19: Location of Terminals 53 and 54 switches.



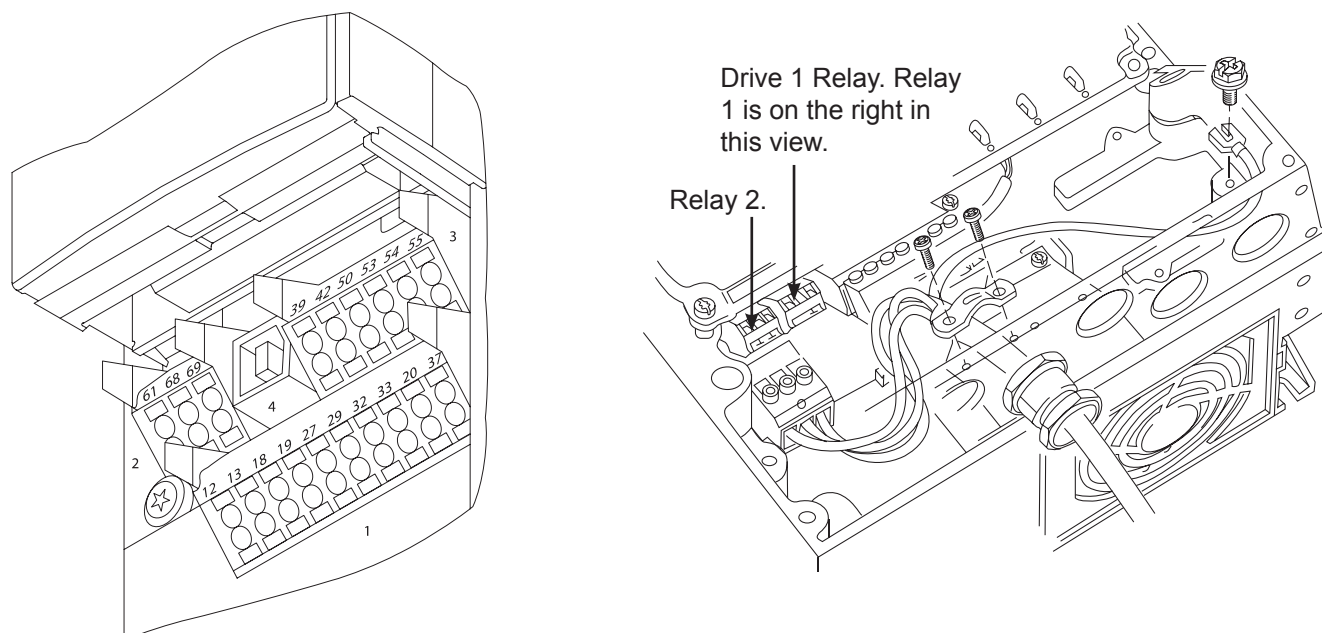
8.4 Typical Terminal Wiring Configurations

The unit connection blocks are shown in “Figure 8-16: Control Terminal Locations” on page 18.

Table 2: Control Terminal Information

	Terminal number	Parameter	Default setting	Description
Relay Outputs	01, 02, 03	5-40 Relay 1	[160] No Alarm	Form C Relay Output. Used for AC or DC voltages and either resistive or inductive loads. see the following section on relay wiring for contact current and voltage ratings.
	04, 05, 06	5-40 Relay 2	[5] Running	
Connector 1	12, 13	-	+24 V DC	24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Intended for digital inputs, external transducers.
	18	5-10	[8] Start	Start/Stop digital input signal for the drive. Connect input to 24 V to start. Open the input to stop the drive.
	19	5-11	[0] No Operation	Digital input (not used)
	27	5-12	[0] No Operation	Digital input (not used)
	29	5-13	[0] No Operation	Digital input (not used)
	32	5-14	[0] No Operation	Digital input (not used)
	33	5-15	[0] No Operation	Digital input (not used)
	20	-	Common	Common for digital inputs and reference for 24 V supply
Connector 2	61	-	Shield Connection	Integrated RC filter for cable shield. ONLY for connecting the shield when experiencing EMC problems.
	68	8-3	+	RS485 Interface (+)
	69	8-3	-	RS485 Interface (-)
Connector 3	39	-	AO Common	Common for analog output
	42	6-50	4-20mA Motor Freq	Analog output. Default setting is 4-20mA signal (500 ohms maximum) based on motor speed.
	50	-	+10 V DC	10 V DC analog supply voltage. 15mA max.
	53	6-1	[0] No Operation	Analog input 53.
	54	6-2	[0] No Operation	Analog input 54.
	55	-	AI Common	Common for analog input.

Figure 8-20: Control Terminal Connectors 1-4 and Relay Output Locations

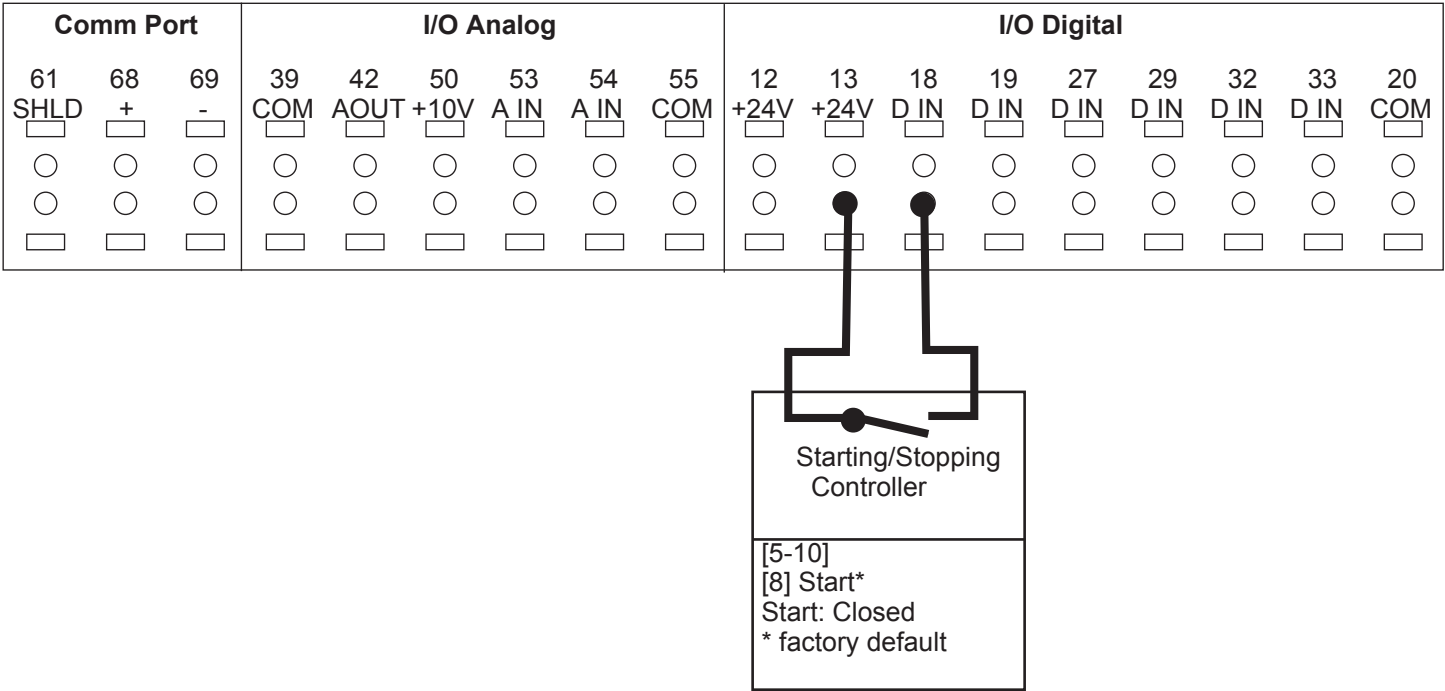


8.4.1 Factory default set-up

This configuration makes use of the controller factory default settings for input/output. The factory default settings are configured for Set-up 1, SelfSensing system curve control without an external transducer. No parameters need to be changed to use this configuration. Set-up 3, SelfSensing constant flow control, uses the same default settings.

Set-ups can be changed by modifying the parameter *0-10 Active Set-up*.

NOTE: The factory default settings require a start signal wired to DI18 (see below).



8.4.2 Relay Outputs

As shown above, each unit has two form C programmable relay outputs. The relay terminals can be found on the controller in various locations according to the frame size.

Figure 8-22: Wiring the Relay Terminals

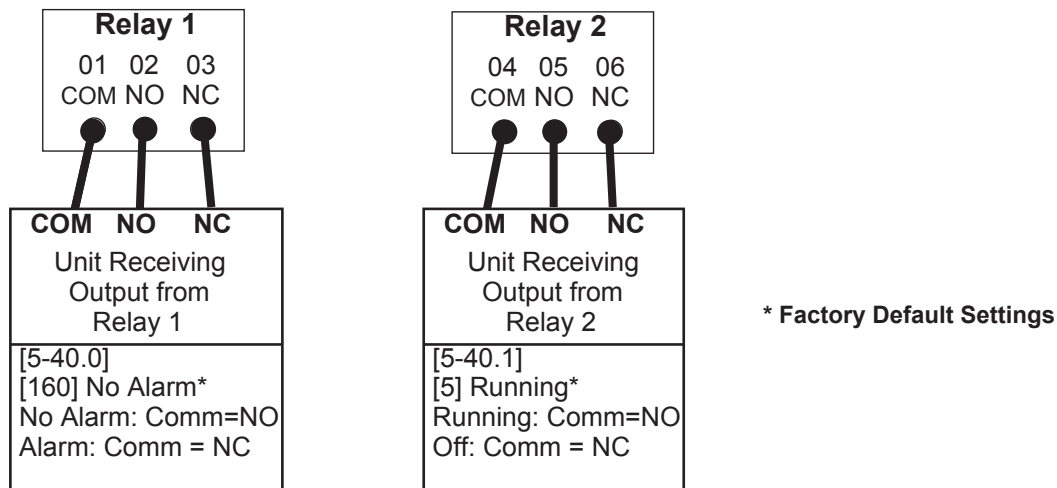


Table 3: Relay Terminal Specifications

Programmable relay outputs	2
Relay 01 Terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1) on 1–3 (NC), 1–2 (NO) (Resistive load)	240 V AC, 2A
Maximum terminal load (AC-15) (Inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2A
Maximum terminal load (DC-1) on 1–2 (NO), 1–3 (NC) (Resistive load)	60 V DC, 1A
Maximum terminal load (DC-13) (Inductive load)	24 V DC, 0.1A
Relay 02 Terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-2) on 4–5 (NO) (resistive load)	400 V AC, 2A
Maximum terminal load (AC-15) (Inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2A
Maximum terminal load (DC-1) on 4–5 (NO) (Resistive load)	80 V DC, 2A
Maximum terminal load (DC-13) on 4–5 (NO) (Inductive load)	24 V DC, 0.1A
Maximum terminal load (AC-1) on 4–6 (NC) (Resistive load)	240 V AC, 2A
Maximum terminal load (AC-15) on 4–6 (NC) (Inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2A
Maximum terminal load (DC-1) on 4–6 (NC) (Resistive load)	50 V DC, 2A
Maximum terminal load (DC-13) on 4–6 (NC) (Inductive load)	24 V DC, 0.1A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 10mA, 24 V AC 20mA
Environment according to EN 60664–1	overvoltage category III/pollution degree 2

9 MODULATING PUMP CONTROLLER

9.1 Modulating Pump Controller Wiring

For 2 Pump Parallel Operation:

Ensure that both terminating resistor switches are set to Enabled (towards the EN label for the canbus port).

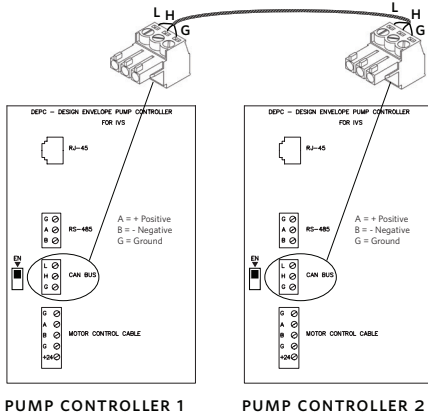
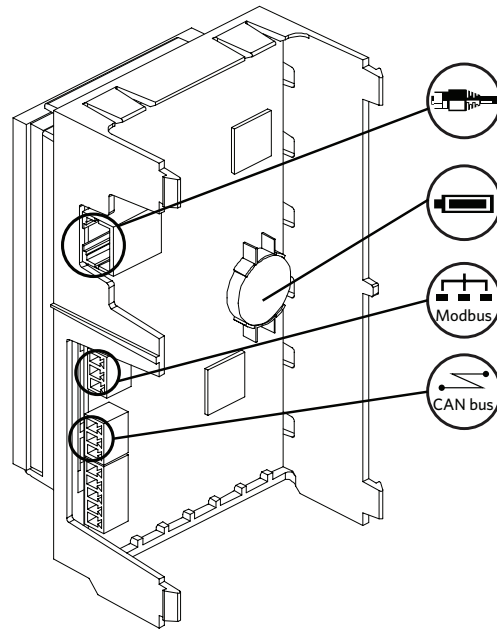


Figure 9-1 Controller Board



For 3 or 4 Pump Parallel Operation:

Ensure that only the first and last terminating resistor switches are set to Enabled (towards the EN label for the canbus port).

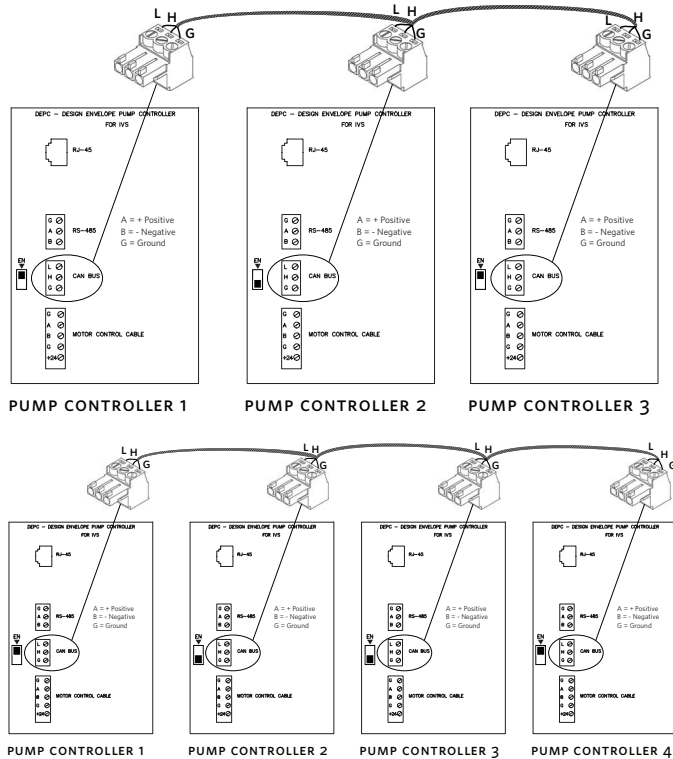
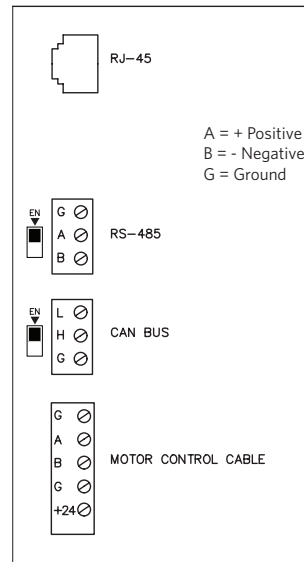


Figure 9-2 Controller Board



9.1.1 Battery

The battery is used to power the real-time clock whenever the pump is disconnected from mains power. It is recommended the battery be changed periodically every 2 to 3 years.

Note:

3 Wire CANbus connection up to 20 ft between pumps. Lengths above 20 ft should be 18 ga shielded wire. No more than 130 ft of communication wire between pumps.

9.1.2 Ethernet and WIFI Connectivity

For BACNet TCP/IP connection to building automation system, connect RJ-45 cable to this port per (Figure 9-1).

9.1.3 Parallel Pump Wiring

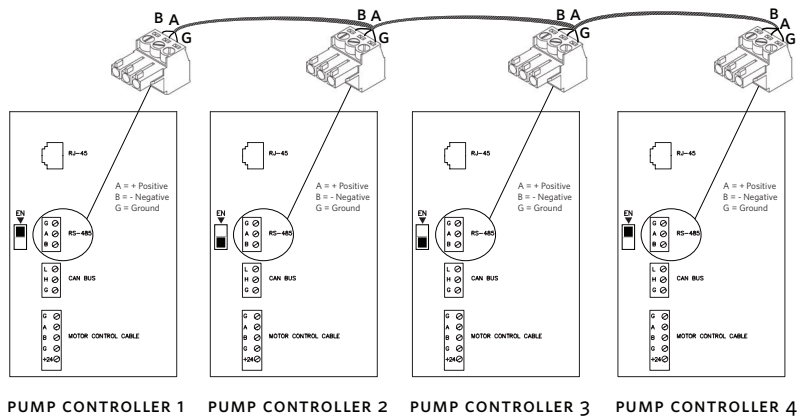
Connections, Low, High, and Ground as per (Figure 9-1) If the MPC requires a CAN BUS connection, ensure that the terminating resistor switch is set to Enabled, (towards the en label for the BAS ports). If multiple pumps are connected in parallel for CAN BUS (supplied by others) they should be daisy chained together. Ensure that only the first and last terminating resistor switches are set to Enabled.

9.1.4 RS 485 Wiring

For Modbus RTU or BACNet MS/TP connection to building automation system, connect RS485 cable to this port per (Figure 9-1). If the MPC is connected to the BAS, ensure that the terminating resistor switch is set to Enabled (towards the EN label for the BAS ports).

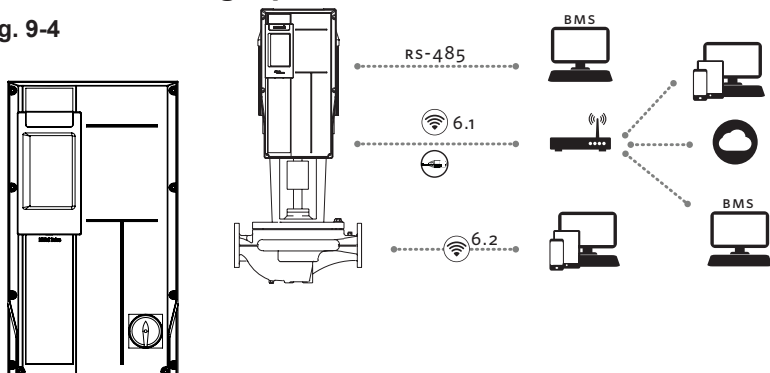
If multiple pumps are connected in parallel to the BAS, the BAS wiring (supplied by others) should be daisy chained together. Ensure that only the first and last terminating resistor switches are set to Enabled. See example below in (Figure 9-3).

fig. 9-3



9.1.5 Networking Options

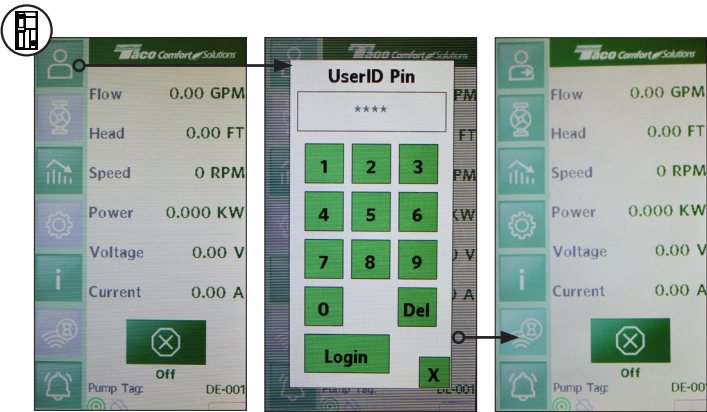
fig. 9-4



9.2 Touch Screen

9.2.1 Login

Default Password 1234



9.2.2 Logout

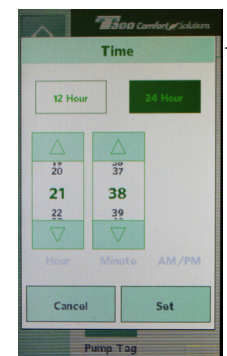
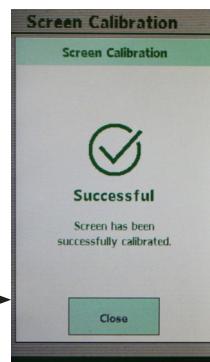
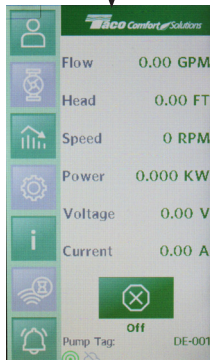
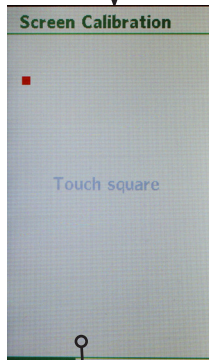
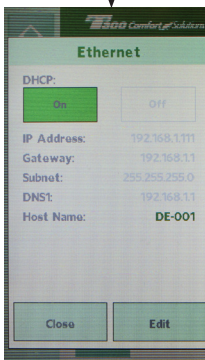
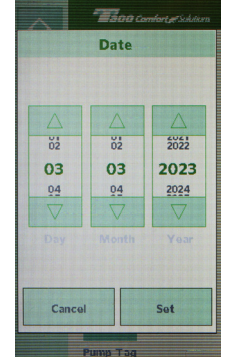
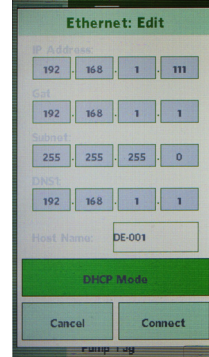
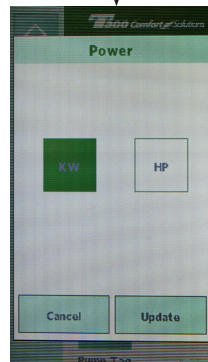
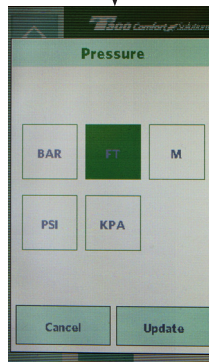
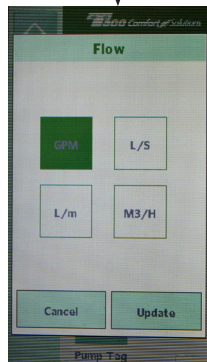
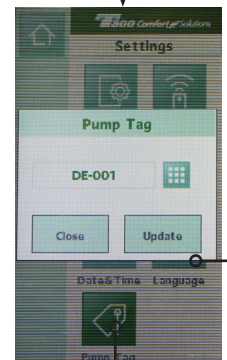
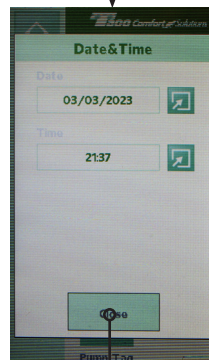
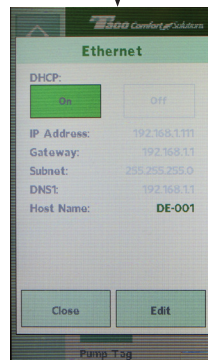
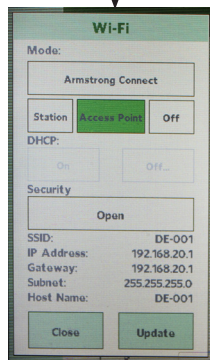
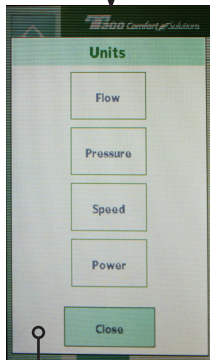
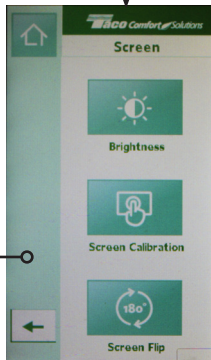
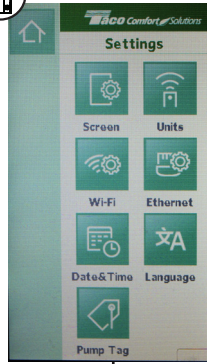


9.2.3 About

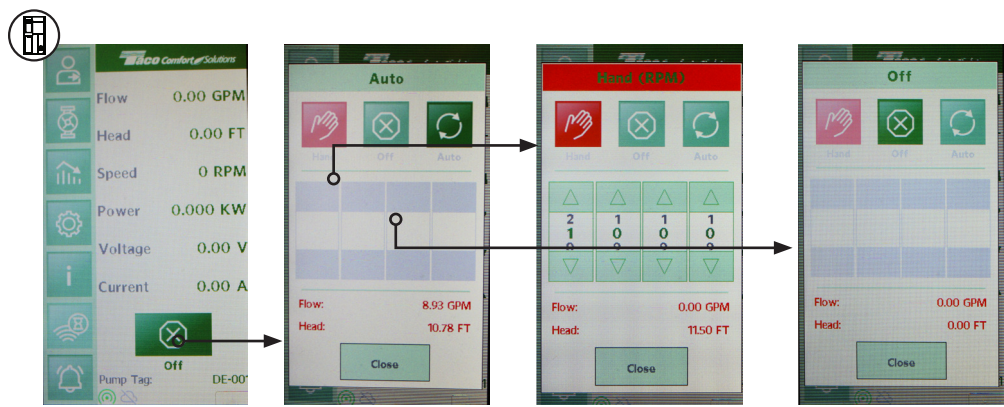


Click on **Reset** to reset Trip counters

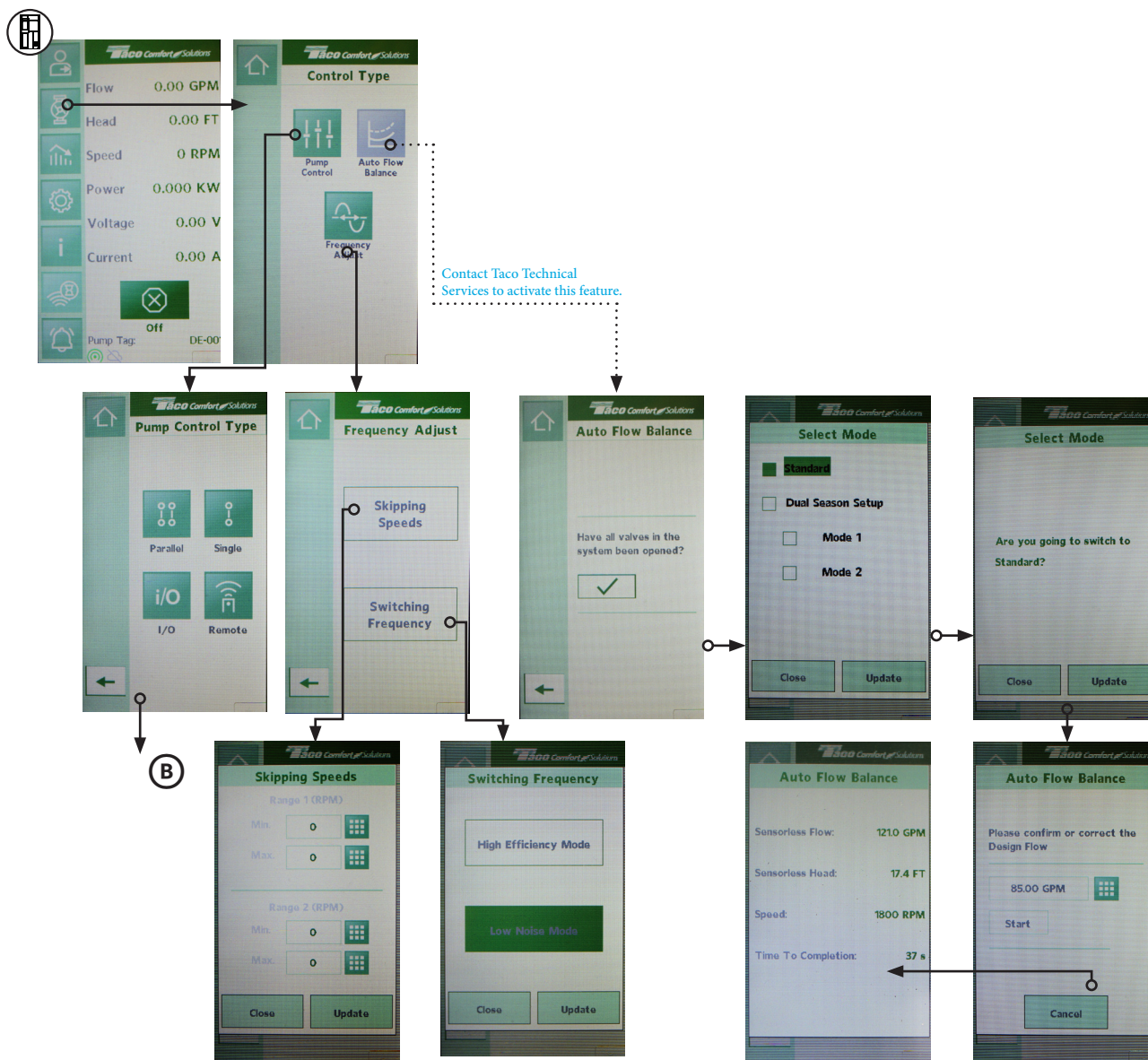
9.2.4 General Settings



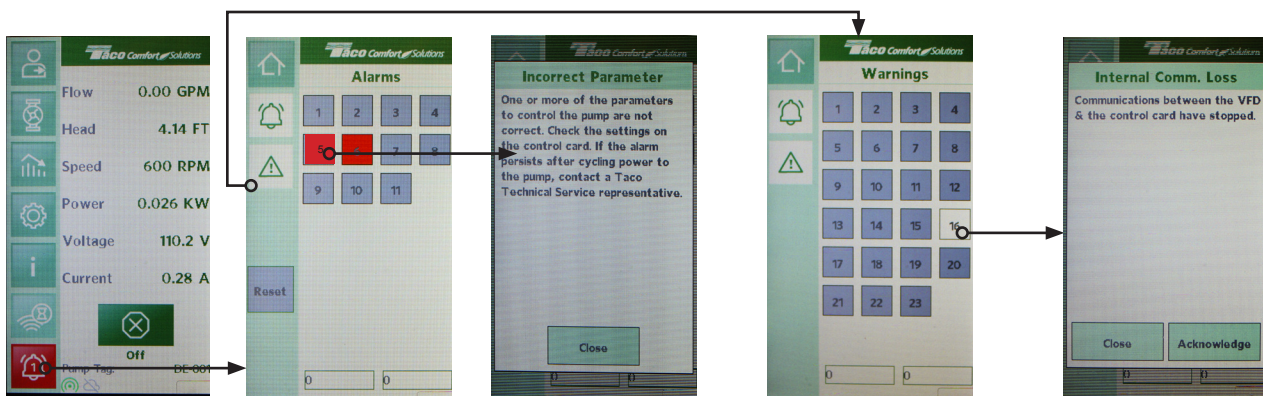
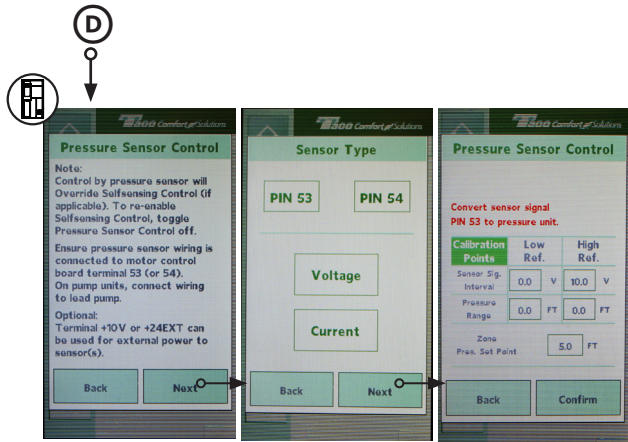
9.2.5 Manual/Auto Mode



9.2.6 Pump Control





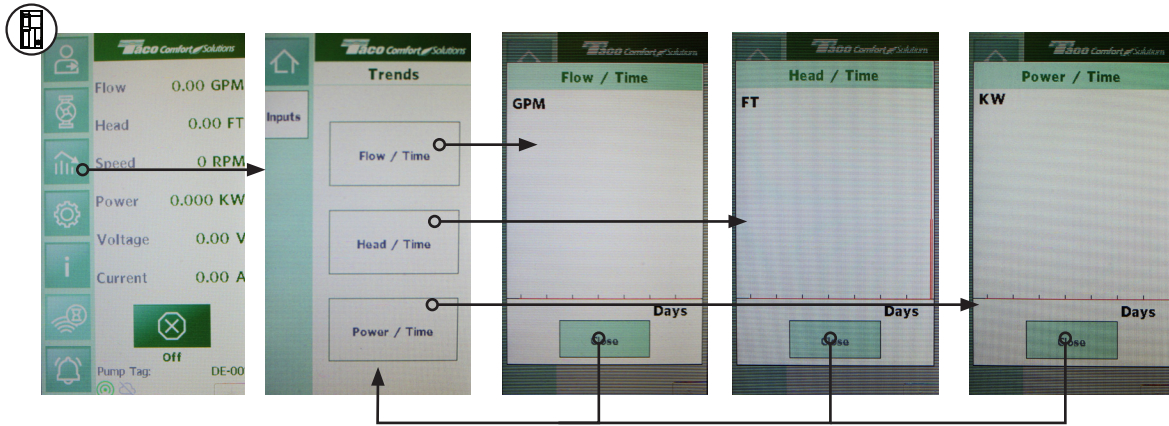


9.2.7 Trend-Graph

There are 3 parameters that can be trended on the touch screen interface:

- Power
- Flow
- Head

Which allows users to see a quick history of key performance data.

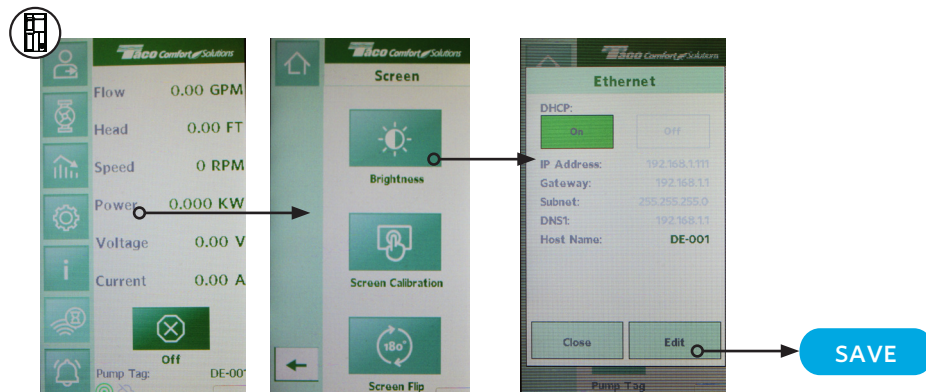


To see a more comprehensive view of the trends, the pump data can be exported in CSV format for review and analysis on a separate computing device.

9.2.8 Brightness Adjustment

To adjust the brightness of the touch screen interface, go to **Settings -> Brightness**.

10 = highest brightness, 1 = lowest brightness



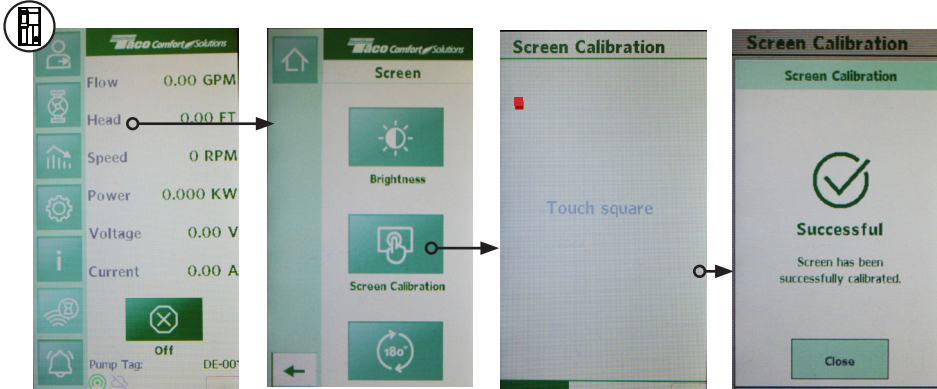
9.2.9 Touch Screen Calibration

If you are having issues with the touch screen, including:

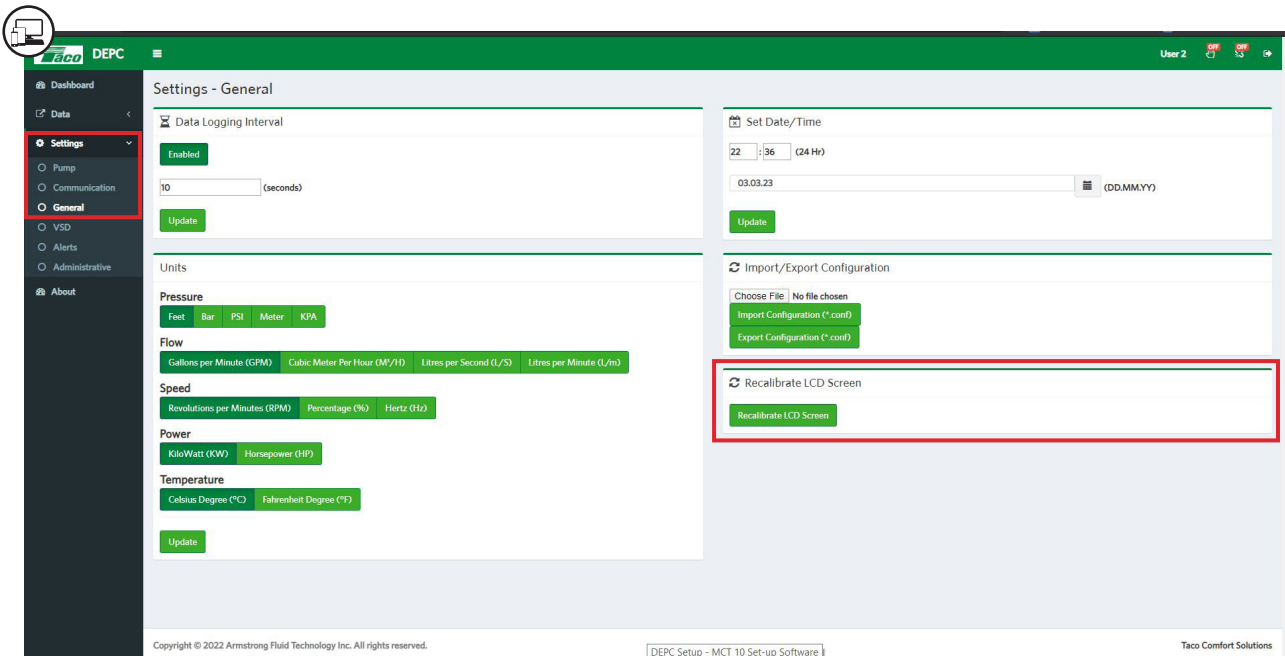
- Being unable to access items to the edge of the screen
- Some buttons from the display are unresponsive

The touch screen may require re-calibration. To calibrate the touch screen, go to **Settings -> Screen -> Calibration**

Follow the following 3-step calibration sequence (touching the squares) to reset the display coordinates.



If you are unable to access the Calibration function from the touch screen itself, connect the pump to the webserver and go to **Settings -> General -> Recalibrate LCD Screen**. This will trigger the calibration sequence on the touch screen of the pump. Follow the above 3-step calibration sequence to reset the display coordinates.



9.2.10 Data Logging

Data logs can be used for energy performance analyses or to troubleshoot system issues. The data logs can be used with a building automation system (BAS) or for each standalone pump. Each pump controller logs the following data parameters over pre-defined time intervals (default is 5 minutes).

- Speed (rpm)
- Power (kW)
- Current (A)
- Flow (gpm)
- Head (ft)
- Analog Input 1
- Analog Input 2
- Analog Output
- Digital Input
- Digital Output
- Alarms
- Warnings
- kW-hours

The MPC stores up to 3 months of data, at 5 min. intervals. More data storage is available on the cloud server if the pump is connected to the internet and has an active Pump Manager subscription.



Export Log File

Start date is: Friday, March 3, 2023

March 2023						
<	Sun	Mon	Tue	Wed	Thu	Fri
9	26	27	28	01	02	03
10	05	06	07	08	09	10
11	12	13	14	15	16	17
12	19	20	21	22	23	24
13	26	27	28	29	30	31
14	02	03	04	05	06	07

Export History

History is in csv format.

End date is: Friday, March 3, 2023

March 2023						
<	Sun	Mon	Tue	Wed	Thu	Fri
9	26	27	28	01	02	03
10	05	06	07	08	09	10
11	12	13	14	15	16	17
12	19	20	21	22	23	24
13	26	27	28	29	30	31
14	02	03	04	05	06	07

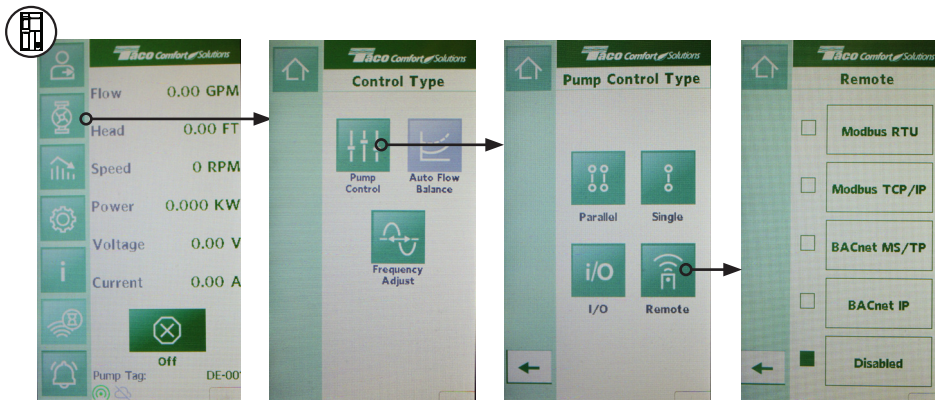
Connect the MPC to the Webserver, in the **Data -> Trends -> Export Log File** section.

Select the start date, the end date, and then click **Export History** to download the data log file in CSV format.

9.3 Networking Controls

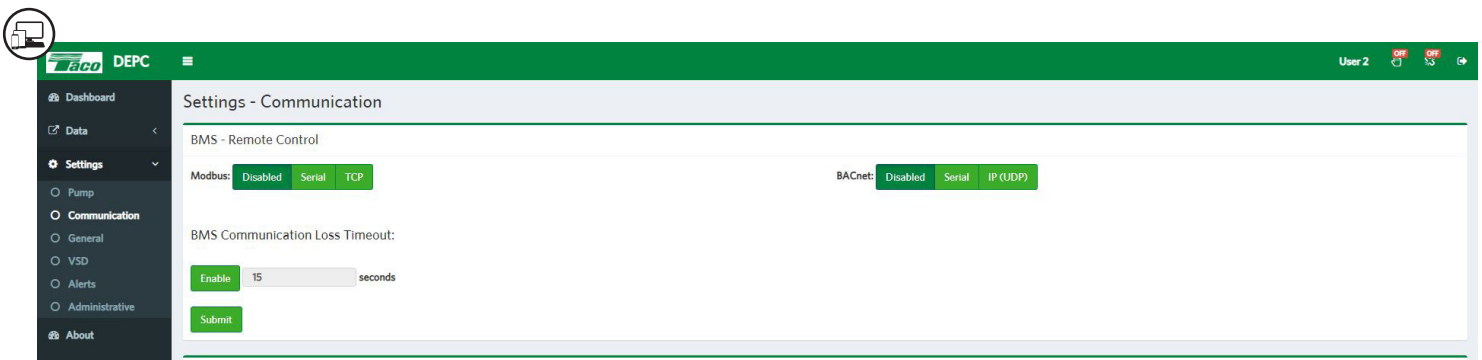
For connection to the building automation system (BAS), the pump needs to be properly configured to the network. Ensure the rs485 cable is connected to the controller board (Figure 9-1). Or if connecting to the bas via router, ensure that the RJ-45 cable is connected to the controller board (Figure 9-1)

The pump controls can be configured from the touchscreen or the webserver.



For BACNet MS/TP or TCP/IP: Enter the BACNet address, baud rate, and unique device instance number (as applicable)

For Modbus RTU or TCP/IP: Enter the Modbus address, baud rate, and parity stop bits (as applicable)

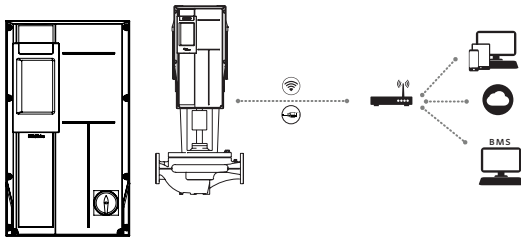


9.4 Web Interface

Taco Strongly recommends to use Google Chrome browser to access MPC web interface. Other browsers might be used but Google Chrome will guarantee the best operation.

9.4.1 Connecting Via Ethernet

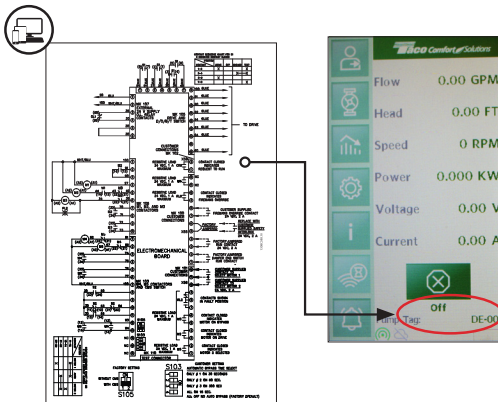
NOTE: Ethernet to router to computer only.



Connect your device to the router via wifi or by Ethernet cable.

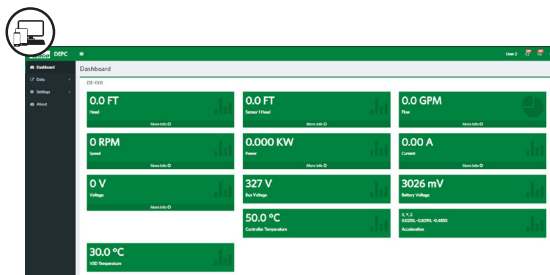
9.4.2 Connecting Via WIFI

1. Find pump ID WiFi connection
2. Connect to that WiFi
3. Then move onto the password below



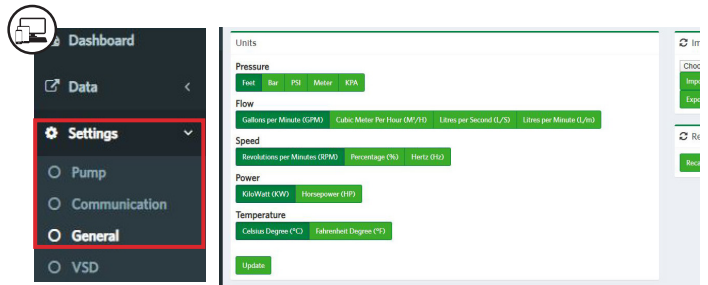
At the web browser address bar, type the Pump's IP (from Pump's About (i) screen).

Default user level 1 Password: Pump321

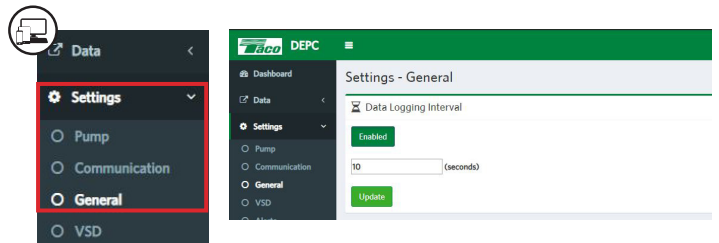


To access general controller settings:

Press settings → General, select desired units and click Update

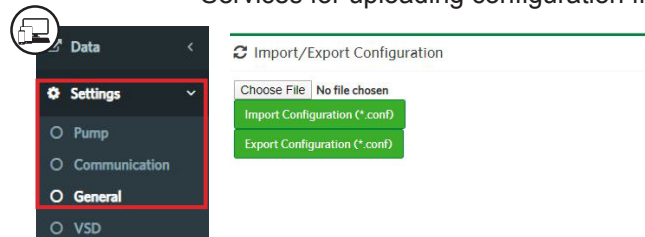


To set the interval for timer based recording: Press settings → General, click on enable and input the desired time (default is 10 seconds)



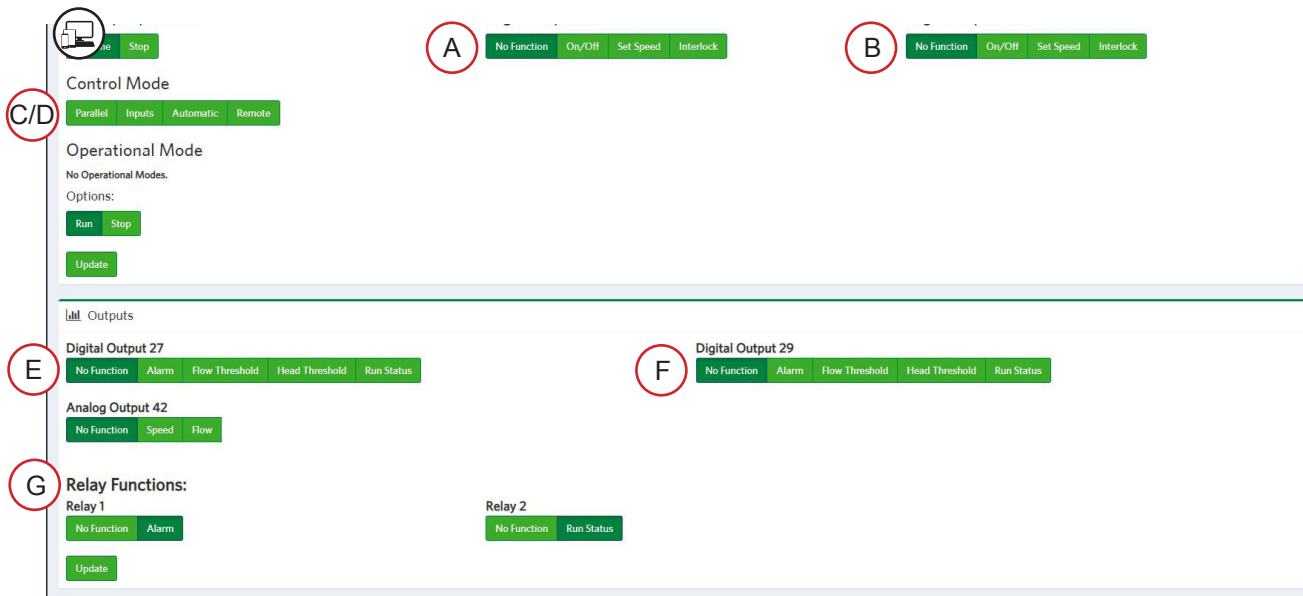
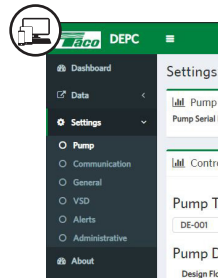
To Import/Export configuration files: Press Settings → General, select a file and click on Import Configuration to input. Click on Export Configuration to export

NOTE: Please contact Taco Technical Services for uploading configuration files.



9.5 WEBSERVER CONFIGURATION

Select **Pump** in the left side-menu



For Digital Inputs (A, B) that have been wired:

If On/Off control

1. Select On/Off or Interlock then
2. Select Update

For Set Speed control

1. Select Control Mode as Inputs, then
2. Select Set Speed in Digital Input 18/19, then
3. Enter rpm value in text box as applicable

For Analog Inputs (C, D) that have been wired:

1. Select Control Mode as Inputs, then select Speed or Pressure, for the control type
2. Select Current or Voltage
3. Enter values in the text box (as applicable),
4. Select Update

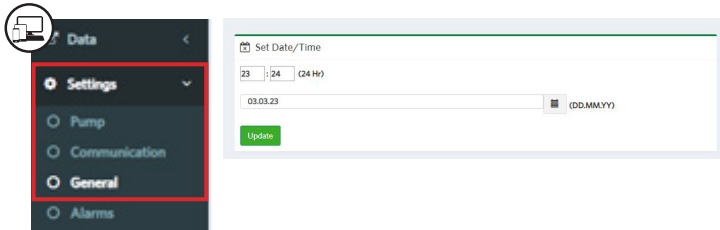
For Digital Functions (E, F) that have been wired:

1. Select one of Alarm, Flow Threshold, Head Threshold, or Run Status
2. Enter the threshold value in the text box (as applicable),
3. Select Update

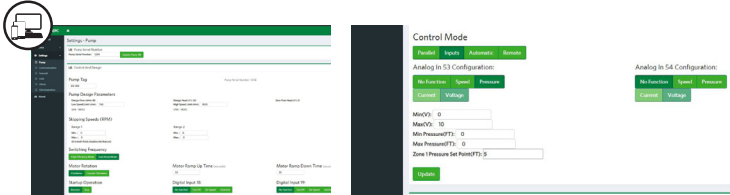
For Relay Functions (G) that have been wired:

2. Select Alarm or Run Status,
3. Select Update

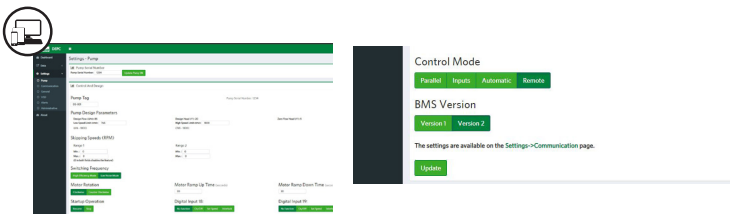
To modify Date/Time: click Settings → General and modify date and time



To access the control modes: Press settings → Pump



To select Version 1 or 2 of BMS settings, Click on Remote mode and select Version 1 or 2.

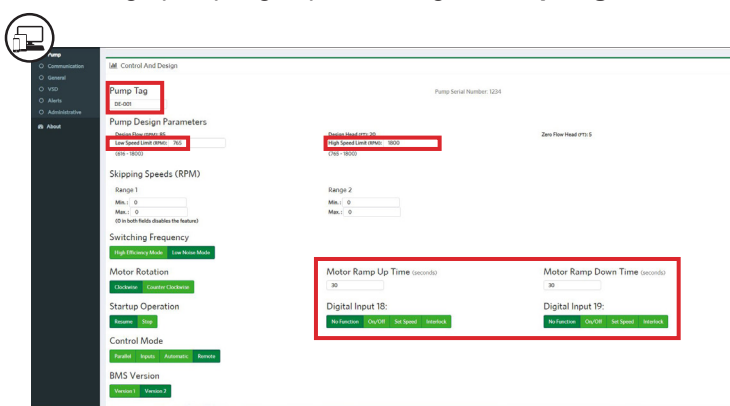


Settings → Pump,

To change motor ramp up and down settings, input in **Motor Ramp up Time** and **Motor Ramp Down Time**.

To change Pump high and Low Speed, input RPM in **High Speed Limit** and **Low Speed Limit**.

To change pump tag, input new tag in **Pump Tag**.

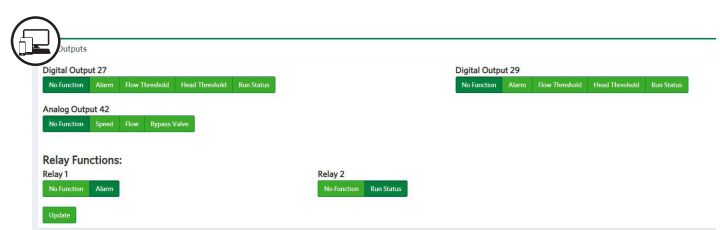


To modify output settings: Settings → Pump,

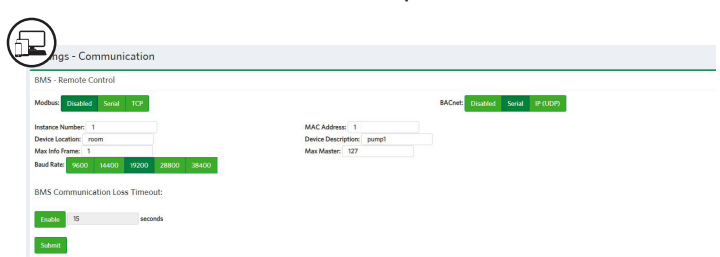
To modify digital outputs: select desired function,

To modify analog outputs: select speed/flow/bypass value.

To modify relay settings: select desired settings.



To set the BACnet max info from, Settings → Communication, enable BACnet Serial and input in **Max Info. Frame**.

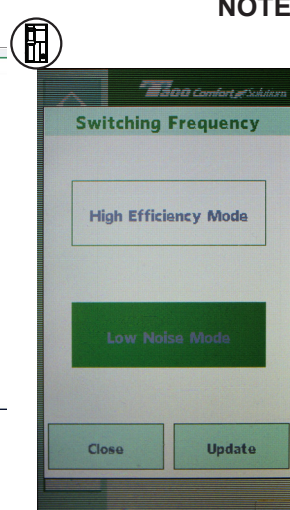


9.5.1 Switching Frequency

The Smart drive controls have an adjustable carrier frequency, or frequency at which the IGBTs are switched. The switching frequency affects the performance of the drive and motor and may produce an audible noise in some instances.

There are 2 pre-set modes available for the Switching Frequency.

NOTE: Refer to Section 9.2.6.



High Efficiency Mode - 5kHz

This frequency setting minimizes the losses in the drive and motor for optimum performance. However, at this lower setting, the motor may produce an audible high-pitched noise. If noise is produced and unacceptable, then the drive can be set to Low Noise Mode.

Low Noise Mode – 12kHz

This frequency setting increases electrical losses, but are less audible. Set the controls to the Low Noise Mode if the High Efficiency Mode results in unacceptable audible

noise.

9.5.2 Three Different Operational Modes Can Be Accessed

Constant Flow, Quadratic Pressure and Quadratic Pressure with Minimum Flow.

Control And Design

Pump Tag: DE-001

Pump Serial Number: 1234

Pump Design Parameters

Design Flow (GPM): 85

Low Speed Limit (RPM): 765 (65% - 1800)

Design Head (FT): 20

High Speed Limit (RPM): 1800 (765 - 1800)

Zero Flow Head (FT): 5

Skipping Speeds (RPM)

Range 1

Min.: 0

Max.: 0

(0 in both fields disables the feature)

Range 2

Min.: 0

Max.: 0

Switching Frequency

High Efficiency Mode Low Noise Mode

Motor Rotation

Clockwise Counter Clockwise

Startup Operation

Resume Stop

Control Mode

Parallel Inputs Automatic Remote

Operational Mode

Constant Flow Quad Pressure Quad Pressure Min Flow

9.5.3 Fallback Percentage of Maximum Speed

While operating multiple pumps in Parallel Sensorless mode, if any of the pumps are disconnected from the communication circuit (e.g. the pump is disconnected from the CANbus wire), the disconnected pump will now continue to operate at a pre-set constant speed – or the fallback speed. The fallback speed can be set to a percentage of the pump's maximum speed (between 40-100%).

Note that only the disconnected pump will operate at constant speed, the other remaining pumps in the communication circuit will continue to operate in Parallel Sensorless mode to the control curve.

This can be done in **Operational Mode** and input the **Fallback % of Max Speed**

Control Mode

Parallel Inputs Automatic Remote

Operational Mode

Constant Flow Quad Pressure Quad Pressure Min Flow

Options:

Id: 1

Flow BEP (GPM): 85

Head BEP (FT): 27

Dead Band: 0.25

Maximum Operating Pump Count: 2

Total Design Flow (GPM): 170.000

Stage On Speed Percent: 0

Stage Off Speed Percent: 0

SelfSensing Map Adjust Factor: 0.1

Alternation Interval (minutes): 10080

Fallback % of Max Speed: 75 (43 - 100)

Operational Limits Per Pump

Standard Mode 1 Mode 2

Design Flow (GPM): 85

Design Head (FT): 20

Zero Flow Head (FT): 5

Update

9.5.4 Standby Pumps

Scroll down to **Operational Mode** and input the **Maximum Operating Pump Count**. The remaining pumps will be Standby. Calculated Design Flow will automatically update based on the number of pumps inputted.

Control Mode

Parallel Inputs Automatic Remote

Operational Mode

Constant Flow Quad Pressure Quad Pressure Min Flow

Options:

Count: 2

nits Per Pump

Mode: 2

Stage On Speed Percent: 0

Stage Off Speed Percent: 0

SelfSensing Map Adjust Factor: 0.1

Alternation Interval (minutes): 10080

Fallback % of Max Speed: 75 (43 - 100)

9.5.5 Alternation

SelfSensing pumps with integrated parallel sensorless controls are pre-set to alternate lead-pump operation of each pump head to achieve equal run hours. The default alternation interval is 10,080 minutes (1 week). This can also be set or adjusted for multiple single pumps operating in sequence.

To change this setting, use the Webserver and go to Settings -> Pump, and then go the Control Mode section, under the Parallel tab, and input the Alternation Interval (in minutes) to the new value. Press update to complete the change. Connect the Webserver to the second pump and repeat.

Control Mode

Parallel Inputs Automatic Remote

Operational Mode

Constant Flow Quad Pressure Quad Pressure Min Flow

Options:

Id: 1

Flow BEP (GPM): 85

Head BEP (FT): 27

Dead Band: 0.25

Maximum Operating Pump Count: 2

Total Design Flow (GPM): 170.000

Stage On Speed Percent: 0

Stage Off Speed Percent: 0

SelfSensing Map Adjust Factor: 0.1

Alternation Interval (minutes): 10080

Fallback % of Max Speed: 75 (43 - 100)

Operational Limits Per Pump

Standard Mode 1 Mode 2

Design Flow (GPM): 85

Design Head (FT): 20

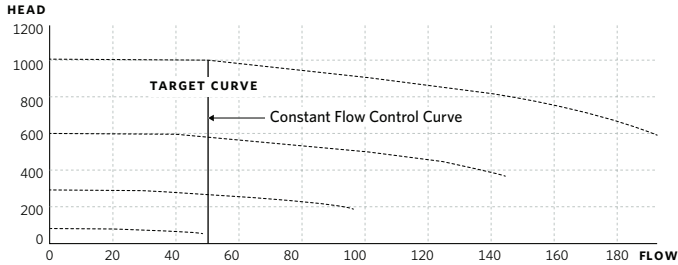
Zero Flow Head (FT): 5

Update

9.6 Control Modes

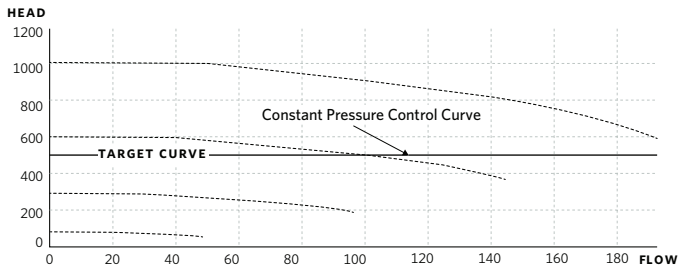
9.6.1 Constant Flow

SelfSensing pumps can be configured to maintain a constant pump flow in a system as the system head varies. This effectively simulates speed control by a flow meter in the piping.



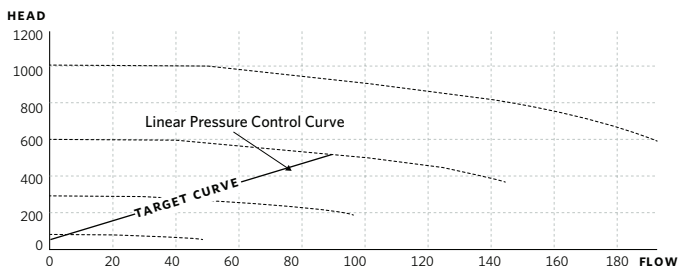
9.6.2 Constant Pressure

SelfSensing pumps can be configured to maintain a constant pump head in a system as the demand varies. This effectively simulates the mounting of a differential pressure sensor at, or near, the pump.



9.6.3 Linear Pressure

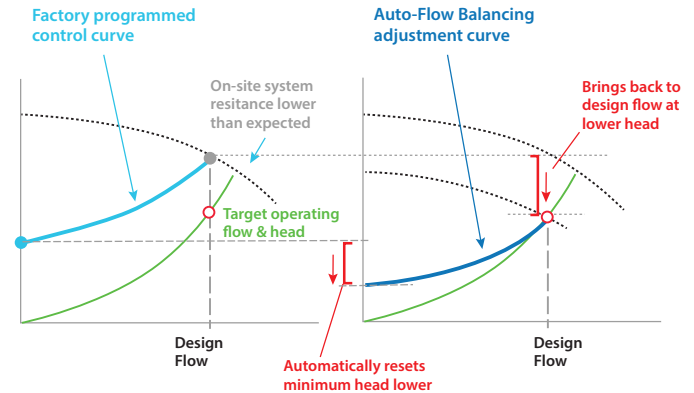
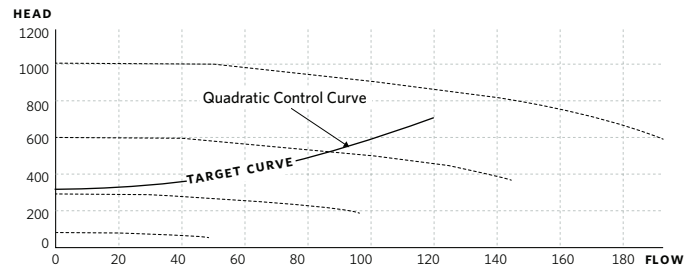
Linear Pressure Control is where the controller is set to control the speed according to a control 'curve' between max and min flow. This type of control will change the pump speed to ensure the pump operates on the projected linear control curve, where the pump head varies directly with the flow. This type of control is well known globally and is effective as far as the straight linear line will allow. For more realistic HVAC control with superior energy savings, consider the following control recommendation 9.5.4 Quadratic Curve Control.



9.6.4 Quadratic Curve Control

Quadratic Pressure Control is where the controller is set to control the speed according to a control curve between max and min flow. It is widely recognized that fitting a differential pressure sensor at the most remote load, across the supply piping and return piping encompassing the valve and coil set, is the benchmark scheme for energy efficiency.

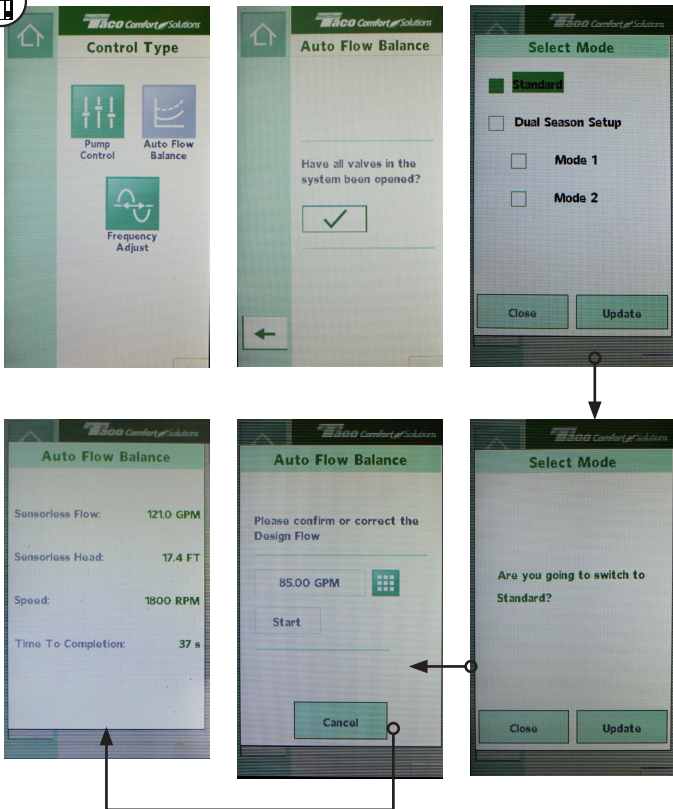
SelfSensing pumps can replicate this control without the need for the remote sensor. As the flow required by the system is reduced, the pump automatically reduces the head developed according to the pre-set control curve.



For buildings that are commissioned in multiple stages, or where the design flow changes each time, the Auto Flow Balancing function can be run at the beginning of each stage.

Note: Auto Flow Balancing only works in single pump operation. Contact Taco Technical Services to activate this feature.

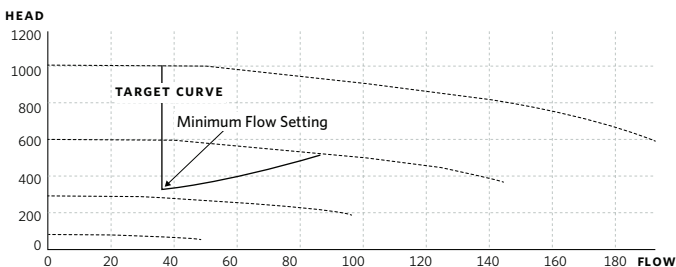
From the touch screen, go to **Control Type -> Auto Flow Balancing**, then follow the on-screen instructions. The Auto Flow Balancing scan takes approximately 3 minutes to complete.



9.6.5 Quadratic Curve Control With Minimum Flow Protection

This configuration is designed for HVAC hydronic systems where flow sensitive equipment required a minimum flow for equipment stability; such as a chiller that cannot tolerate flow below a certain volume. This control will take advantage of the 9.6.4 Quadratic Curve Control mode, where the pump will increase speed to maintain a minimum flow setting as the system load is shutting down.

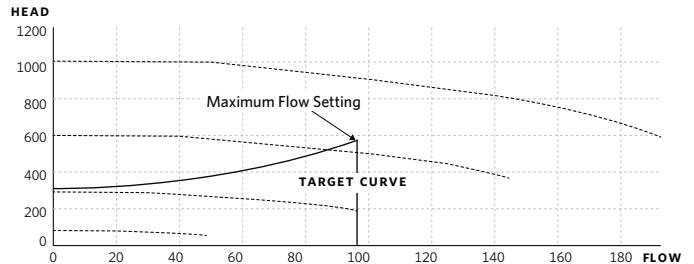
Pump controls can only control the flow to the maximum speed or motor limit;



9.6.6 Quadratic Curve Control With Maximum Flow Protection

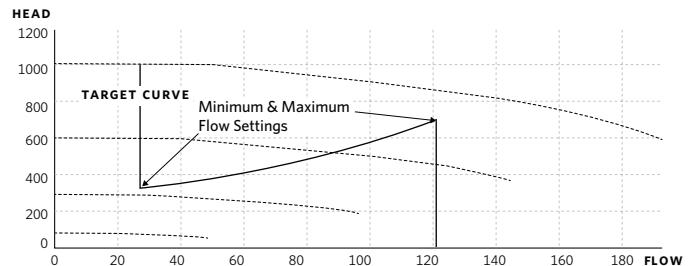
This configuration is ideal for HVAC hydronic systems where pumps are generally oversized and a flow limit is required for system equipment stability and resulting energy savings. This control will take advantage of the 9.6.4 Quadratic Curve Control mode, where the pump will decrease speed to

maintain a maximum flow setting. This will prevent over-pumping and save energy costs. Over-pumping is common in HVAC systems as pumps are typically oversized for the application. Pump controls can only control the flow to a minimum speed; thus a dry-contact relay is supplied which will close when maximum flow is reached, which can be used for an alarm or other device.



9.6.7 Quadratic Curve Control With Minimum & Maximum Flow Protection

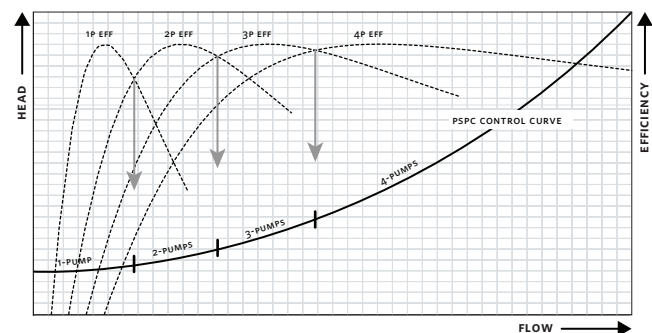
This control mode combines the control logic of 5.5 & 5.6 which takes the values of the quadratic control curve and protection for both the maximum & minimum flow limits. Pump controls can only control the flow to the motor limit or maximum / minimum speed limits of the unit, thus a dry-contact relay is supplies which will close when either the minimum or maximum flow is reached, which can be used for an alarm or other device.



9.6.8 Parallel SelfSensing

This configuration maps the quadratic control curve into the pump controls and ensures the system flow requirements are met, while staging the pumps on and off to maintain optimum pump energy usage. This is accomplished by operating the pumping units at the best pumping efficiency level for the required flow.

This control is available for 2, 3, or 4 units operating in parallel.



Both individual pumps and total parallel flow can be monitored by accessing the dashboard.



Start by installing a wiring bridge between the pumps (supplied by others). The wiring between the control cards is a canbus (3-wire) cable with terminal blocks at each end (3 position strain 3.81 mm).

For connection of 3 or 4 pumps, the canbus connectors should be daisy-chained together.

Wiring bridge supplied by others.

9.7 Set Control Mode

From the Webserver, choose Settings -> Pump, set control mode to Parallel with the following parameter values:

Control Mode

Parallel Inputs Automatic Remote

Operational Mode

Constant Flow Quad Pressure Quad Pressure Min Flow

Options:

A ID: 1

Flow BEP: (GPM) 85

Head BEP: (FT) 27

B Dead Band: 0.25

Maximum Operating Pump Count: 2

Total Design Flow (GPM): 170.000

Operational Limits Per Pump

Standard Mode 1 Mode 2

Design Flow (GPM) 85

Design Head (FT) 20

Zero Flow Head (FT) 5

Update

C Stage On Speed Percent: 0

Stage Off Speed Percent: 0

SelfSensing Map Adjust Factor: 0.1

Alternation Interval (minutes): 10080

Fallback % of Max Speed: 75 (43 - 100)

A ID: 1 to 255, the lower number is the lead pump e.g. enter 1 for lead pump, 2 for lag pump

B Dead Band: set to 0.25

C Sensorless Map Adjust Factor: set to 0.1

Click update to save all changes. Connect the Webserver to the second pump and then repeat above steps A to C.

Note: If WIFI connected, steps outlined in Section 9.4.2 through 9.7 must be repeated for each MPC in the system.

9.8 Warnings and Alarms

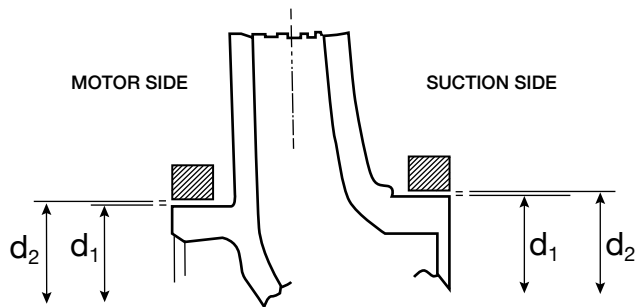
9.8.1 Alarm Summary for Interfaces

Alarm Number	Name	Alarm Description
1	VSD over temperature	The temperature of a VSD or motor component is exceeding the thermal alarm limit. Turn off the power to the pump and verify that the motor, fan and VSD cooling is functioning correctly. Verify that the pump is not overloaded. Wait until hot components have cooled before returning to service and if the alarm persists after powering up contact a Taco Technical Service representative.
2	VSD over current	The VSD has detected current exceeding the safe limit. Turn the pump off. (If there is a discharge from the output phases to earth it can be verified by checking for any faults with a megohmmeter between ground and the motor leads). If a current limit has been exceeded in the VSD check that the motor can be turned. If the pump is being overloaded reduce the pump speed using hand mode control. If the alarm persists after powering up contact a Taco Technical Service representative.
3	External VSD voltage	The voltage into the VSD is out of range. Verify that the correct voltage required to operate the VSD is present by measuring each of the 3 phases. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
4	Internal VSD voltage	An internal voltage generated by VSD is out of range. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
5	Internal VSD	An internal error in the VSD has occurred. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
6	VSD parameter	One or more of the parameters to control the VSD are not correct. Check the settings on the control card. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
7	VSD startup	An error occurred during the startup of the motor. Turn off the power to the pump and verify that the motor can be turned by using hand mode control. If the alarm persists after powering up contact a Taco Technical Service representative.
8	Other VSD	There has been an unknown alarm condition generated by the VSD. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
9	VSD communication	There is a communication issue between the control card and VSD. Turn off the power to the pump and check the connections between the control card and the VSD.
10	VSD speed	The speed set by the VSD is not within tolerance. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
11	VSD initialization failure	The control card was not able to receive the initial parameters correctly. Please try to restart the pump. If the alarm persists after restart, contact a Taco Technical Service representative.

9.8.2 Warning Summary for Interfaces

Warning Number	Name	Warning Description
1	VSD over temperature	The temperature of a VSD or motor component is near the thermal warning limit. Check that the motor, fan and VSD cooling is functioning correctly. Verify that the pump is not overloaded. If the warning persists, contact a Taco Technical Service representative.
2	VSD over current	The VSD has detected current exceeding the warning limit. Turn the pump off. (If there is a discharge from the output phases to earth it can be verified by checking for any faults with a megohmmeter between ground and the motor leads.) If a current limit has been exceeded in the VSD check that the motor can be turned. If the pump is being overloaded reduce the pump speed using hand mode control. If the warning persists after powering up contact a Taco Technical Service representative.
3	External VSD voltage	The voltage into the VSD is out of range. Verify that the correct voltage required to operate the VSD is present by measuring each of the 3 phases. If the warning persists, contact a Taco Technical Service representative.
4	Internal VSD voltage	An internal voltage generated by VSD is out of range. If the warning persists, contact a Taco Technical Service representative.
5	Internal VSD	An internal warning in the VSD has occurred. If the warning persists, contact a Taco Technical Service representative.
6	Reserved	
7	VSD startup	A warning occurred during the startup of the motor. Turn off the power to the pump and verify that the motor can be turned using hand mode control. If the warning persists after powering up contact a Taco Technical Service representative.
8	Other VSD	There has been an unknown warning condition generated by the VSD. If the alarm persists, contact a Taco Technical Service representative.
9	VSD communication	There is a communication issue between the control card and VSD.
10	VSD speed	The speed set by the VSD is not within tolerance. If the alarm persists, contact a Taco Technical Service representative.
11	VSD wiring	There is an issue in wiring to the VSD. Check the wiring to the motor from the VSD. If any I/O are used on the VSD, verify that there is continuity and no shorts for the connections.
12	System over temperature	The temperature measured by the control card is approaching the recommended operating conditions.
13	System under temperature	The temperature measured by the control card is approaching the recommended operating conditions.
14	Battery under voltage	The battery voltage is low. Replace the battery with cr2032 type cell.
15	BMS communication loss	BMS communication has been lost.
16	VSD communication loss	The communication with the VSD and the control card has stopped.
17	Invalid VSD parameter	The control card has specified an invalid VSD parameter.
18	VSD initialization failure	The initialization of the VSD through Modbus has failed. Cycle power to the pump to re-initialize.
19	VSD speed set failure	The speed could not be set by the controller. Check the connections between the VSD and control card.
20	VSD start set failure	The controller could not start the motor. Check the connections between the VSD and control card.
21	Sensorless error	The sensorless map that was entered has an error please refer to the I & O Manual for further details.
22	Hand mode timeout	The pump has been in hand mode too long. Consider setting to automatic mode to save energy.

10 CASING/IMPELLER WEAR RING CLEARANCES



PUMP SIZE	WEAR RING-SUCTION SIDE				CLEARANCE	
	DIA d1		DIA d2			
	MAX	MIN	MAX	MIN	MAX	MIN
1506	2.363	2.361	2.377	2.375	.016	.012
1507	2.738	2.736	2.752	2.750	.016	.012
2006	2.863	2.861	2.877	2.875	.016	.012
2007	2.938	2.936	2.952	2.950	.016	.012
2009	3.363	3.361	3.377	3.375	.016	.012
2011	3.488	3.486	3.502	3.500	.016	.012
3006	3.238	3.236	3.252	3.250	.016	.012
3007	3.688	3.686	3.702	3.700	.016	.012
3009	3.613	3.611	3.627	3.625	.016	.012
3011	3.988	3.986	4.002	4.000	.016	.012
3013	3.738	3.736	3.752	3.750	.016	.012
4007	4.238	4.236	4.252	4.250	.016	.012
4009	4.611	4.609	4.627	4.625	.018	.014
4011	4.738	4.736	4.752	4.750	.016	.012
4013	4.613	4.611	4.627	4.625	.016	.012
5007	4.988	4.986	5.002	5.000	.016	.012
6009	5.861	5.859	5.877	5.875	.018	.014
6011	5.861	5.859	5.877	5.875	.018	.014
6013	5.861	5.859	5.877	5.875	.018	.014
8011	7.234	7.232	7.252	7.250	.020	.016
8013	7.734	7.732	7.752	7.750	.020	.016

11 SKS PUMP PROBLEM ANALYSIS

11.1 No Discharge

- 1.Pump not primed.
- 2.Speed too low.
- 3.System head too high.
- 4.Suction lift higher than pump is designed.
- 5.Impeller completely clogged.
- 6.Incorrect direction of rotation.
- 7.Air leak in suction line.

11.2 Insufficient Discharge Flow

- 1.Air leak in suction line.
- 2.Speed too low.
- 3.System head higher than anticipated.
- 4.Insufficient NPSH. Suction lift too high. Check gauges.
Also check for clogged suction line or screen.
- 5.Impeller partially plugged.
- 6.Mechanical defects.
 - a.Worn wear rings
 - b.Impeller damaged.
 - c. Incorrect direction of rotation.

11.3 Insufficient Discharge Pressure

- 1.Speed too low.
- 2.System head less than anticipated.
- 3.Air in system.
- 4.Mechanical defects.
 - a.Worn wear rings.
 - b.Impeller damaged.
 - c. Impeller diameter too small.
 - d.Incorrect direction of rotation.

11.4 Loss of Suction

- 1.Leak in suction line.
- 2.Suction lift too high.
- 3.Insufficient NPSH.
- 4.Air in system.
- 5.Casing gasket defective.

11.5 Excessive Power Consumption

- 1.Speed too high.
- 2.System head lower than rating.
- 3.Specific gravity of liquid too high.
- 4.Mechanical defects.
 - a.Shaft bent.
 - b.Rotating elements bind.
 - c. Worn wear ring.

11.6 Vibration

- 1.Air leak in suction line.
- 2.Air in system.
- 3.Impeller partially plugged.
- 4.Foundation not rigid.
- 5.Mechanical defects.
 - a.Damaged impeller.
 - b.Motor bearings worn.
 - c. Rotor out of balance.
 - d.Shaft bent.

11.7 Motor Runs Hot

- 1.Speed too high.
- 2.Specific gravity of liquid too high.
- 3.Mechanical defects.
 - a.Shaft bent.
 - b.Rotating elements bind.
 - c. Defective motor.
 - d.Voltage lower than rating.

12 SPECIFICATIONS

12.1 Power-dependent Specifications

Table 4: Line Power Supply 200-240 V AC

Line Power Supply 200-240 V AC - Normal overload 110% for 1 minute					
Adjustable frequency drive Typical Shaft Output [kW]	P1K1 1.1	P1K5 1.5	P2K2 2.2	P3K0 3	P3K7 3.7
IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))				
IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)]	4, 4, 4 (12, 12, 12)				
Max. cable cross-section with disconnect	6, 4, 4 (10, 12, 12)				

Table 5: Line Power Supply 3 x 200-240 V AC

Line Power Supply 3 x 200-240 V AC - Normal overload 110% for 1 minute					
Adjustable frequency drive Typical Shaft Output [kW]	P5K5 5.5	P7K5 7.5	P11K 11	P15K 15	P18K 18.5
IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)]	10, 10 (8,8-)		35,-,- (2,-,-)	35 (2)	50 (1)
IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² (AWG)]	10, 10 (8,8-)		35, 25, 25 (2, 4, 4)	50 (1)	
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² (AWG)]	16, 10, 16 (6, 8, 6)		35,-,- (2,-,-)	50 (1)	

Table 6: Line Power Supply 3 x 200-240 V AC

Line Power Supply 3 x 200-240 V AC - Normal overload 110% for 1 minute				
Adjustable frequency drive Typical Shaft Output [kW]	P22K 22	P30K 30	P37K 37	P45K 45
IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)]	150 (300 MCM)			
IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² (AWG)]	150 (300 MCM)			
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² (AWG)]	95 (3/0)			

Table 7: Line Power Supply 3 x 380-480 V AC

Line Power Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute							
Adjustable frequency drive Typical Shaft Output [kW]	P1K1 1.1	P1K5 1.5	P2K2 2.2	P3K0 3	P4K0 4	P5K5 5.5	P7K5 7.5
Typical Shaft Output [HP] at 460 V	1.5	2.0	2.9	4.0	5.0	7.5	10
IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)] ¹⁾	4, 4, 4 (12, 12, 12) (min. 0.2 (24))						
IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ² (AWG)] ¹⁾	4, 4, 4 (12, 12, 12)						
Max. cable cross-section with disconnect	6, 4, 4 (10, 12, 12)						

Table 8: Line Power Supply 3 x 380-480 V AC

Line Power Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute					
Adjustable frequency drive Typical Shaft Output [kW]	P11K 11	P15K 15	P18K 18.5	P22K 22	P30K 30
Typical Shaft Output [HP] at 460 V 15 20 25 30 40	15	20	25	30	40
IP20 max. cable cross-section (line power, brake, motor and load sharing)	16, 10, - (8, 8, -)		35, -, - (2, -, -)		35 (2)
IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² (AWG)]	10, 10, 16 (6, 8, 6)		35, 25, 25 (2, 4, 4)		50 (1)
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² (AWG)]	10, 10, - (8, 8, -)		35, -, - (2, -, -)		50 (1)

Table 9: Line Power Supply 3 x 380-480 V AC

Line Power Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute					
Adjustable frequency drive Typical Shaft Output [kW]	P37K 37	P45K 45	P55K 55	P75K 75	P90K 90
Typical Shaft Output [HP] at 460 V 15 20 25 30 40	50	60	75	100	125
IP20 max. cable cross-section (line power, brake, motor and load sharing)	50 (1)		150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² (AWG)]			150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² (AWG)]			95 (3/0)		

Table 10: With brake and load sharing 95 / 4/0

Line Power Supply 3 x 525-600 V AC - Normal overload 110% for 1 minute									
Size:	P1K1	P1K5	P2K2	P3K0	P3K7	PK40	P5K5	P7K5	P11K
Typical Shaft Output [kW]	1.1	1.5	2.2	3	3.7	4	5.5	7.5	11
IP20 max. cable cross-section (line power, motor, brake and load sharing) [mm ²]/[AWG]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))								
IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ²]/[AWG]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))								
Max. cable cross-section with disconnect	6, 4, 4 (12, 12, 12)								

Table 11: With brake and load sharing 95 / 4/0

Line Power Supply 3 x 525-600 V AC - Normal overload 110% for 1 minute									
Size:	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	15	18.5	22	30	37	45	55	75	90
IP20 max. cable cross-section (line power, motor, brake and load sharing) [mm ²]/[AWG]									
IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ²]/[AWG]									
Max. cable cross-section with disconnect									

12.1.1 Line Power Supply 3 x 525-690 V AC

Table 12: Line Power Supply 3 x 525-690 V AC

Normal overload 110% for 1 minute							
Adjustable frequency drive Typical Shaft Output [kW]	P1K1 1.1	P1K5 1.5	P2K2 2.2	P3K0 3	P4K0 4	P5K5 5.5	P7K5 7.5
IP20 max. cable cross-section (line power, motor, brake and load sharing) [mm ²]/(AWG)	[0.2-4]/(24-10)						

Table 13: Line Power Supply 3 x 525-690 V AC IP20-Chassis/IP21-IP55/NEMA 1-NEMA12

Normal overload 110% for 1 minute						
Adjustable frequency drive Typical Shaft Output [kW]	P11K 11	P15K 15	P18K 18	P22K 22	P45K 45	P55K 55
Typical Shaft Output [HP] at 575V	16.4	20.1	24	33	60	75
Max. cable size (line power, motor, brake) [mm ²]/(AWG) ¹⁾	[35]/(1/0)				[50]/(1)	

Table 14: Line Power Supply 3 x 525-690 V AC IP21-IP55/NEMA 1-NEMA 12

Normal overload 110% for 1 minute					
Adjustable frequency drive Typical Shaft Output [kW]	P30K 30	P37K 37	P45K 45	P55K 55	P75K 75
Typical Shaft Output [HP] at 575V	40	60	60	75	100
Max. cable size (line power, motor, brake) [mm ²]/(AWG) ¹⁾	[95]/(4/0)				

¹⁾ American Wire Gauge

12.2 Connection Tightening Torques

Table 15: Tightening of Terminals

Enclosure	Power (kW)			Torque (Nm)						
	200-240 V	380-480/500 V	525-600 V	525-690 V	Line Power	Motor	DC Connection	Brake	Ground	Relay
A2	1.1-2.2	1.1-4.0			0.6	0.6	0.6	1.8	3	0.6
A3	3.0-3.7	5.5-7.5	1.1-7.5	1.1-7.5	0.6	0.6	0.6	1.8	3	0.6
A4	1.1-2.2	1.1-4.0			0.6	0.6	0.6	1.8	3	0.6
A5	1.1-3.7	1.1-7.5	1.1-7.5		0.6	0.6	0.6	1.8	3	0.6
B1	5.5-11	11-18	11-18		1.8	1.8	1.5	1.5	3	0.6
B2	15	22-30	22-30	11-30	4.5	4.5	3.7	3.7	3	0.6
B3	5.5-11	11-18	11-18		1.8	1.8	1.8	1.8	3	0.6
B4	15-18	22-37	22-37	11-37	4.5	4.5	4.5	4.5	3	0.6
C1	18-30	37-55	37-55		10	10	10	10	3	0.6
C2	37-45	75-90	75-90	37-90	14/24 ¹⁾	14/24 ¹⁾	14	14	3	0.6
C3	22-30	45-55	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

¹⁾ For different cable dimensions x/y, where x ≤ 0.147 in² [95 mm²] and y ≥ 0.147 in² [95 mm²].

APPENDIX A: ON-SITE DRIVE MOUNTING TO WALL OR PUMP

Follow the steps below for on-site drive mounting to wall or to pump.

A.1 Match Pump and Drive Tags



IMPORTANT: Ensure the pump tag matches the VFD tag. The pump and drive will have identical tags as shown below.

Figure A-1: Example Tag

			SHOP ORDER		
			DOE BASIC MODEL NO.		
			MODEL NO.		
CAPACITY GPM	HEAD FEET	IMPELLER DIA			
MFG DATE	MOTOR HP	RPM			
			PEI _{CL}		
TACO INC., CRANSTON, R.I. U.S.A.			953-5229		

A.2 Mechanical Connections

For mechanical connections to pump, see section 7.2.

For mechanical connections to wall, see section 7.3.

A.3 Electric Code Compliance

Installation must be in compliance with national and local electric codes.

For electrical connections see Section “8 Electrical Connections” on page 9.

A.4 Before Start Safety Inspection



DANGER: 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 in same conduit, there is potential for leakage current to charge capacitors within the frequency converter, even when disconnected from mains 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 frequency converter 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 frequency converter as well as the motor.
6. Inspect the frequency converter 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 frequency converter and motor.



CAUTION: Before applying power to the unit, inspect the entire installation as detailed in Table 16 on page 51. Check mark those items when completed.

Table 16: Inspection Checklist

Inspect for	Description	Check?
Auxiliary equipment	– Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the frequency converter 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 frequency converter. – 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 that top and bottom clearance is adequate to ensure proper air flow 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 earth wire(ground wire) from its chassis to the building earth (ground). – Check for good earth connections(ground connections) that are tight and free of oxidation. – Earthing (Grounding) to conduit or mounting the back panel to a metal surface is not a suitable earth (ground).	
Input and output power wiring	– Check for loose connections. – Check that motor and mains are in separate conduit or separated screened cables.	
Panel interior	– Inspect 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.	

A.5 Applying Power to the Frequency Converter



DANGER: HIGH VOLTAGE! Frequency converters contain high voltage when connected to AC mains. Installation, start-up and maintenance should be performed by qualified personnel only. Failure to comply could result in death or serious injury.

Appendix B Modbus Register Map

Function code		Start Address	Modbus Register	Description	# of Registers	Change During Operation	Data Type	Unit	Notes
Read	Write								
0x03	0x06								
Status									
x		100	101	Actual Speed	1	n/a	uint16	1 RPM	The current speed of the VFD in RPM.
x		101	102	Actual Speed	1	n/a	uint16	0.1 %	The current speed of the VFD in % of the nominal motor speed.
x		102	103	Motor Power	2	n/a	uint32	0.01	Units as configured on Pump Control Module.
x		104	105	Motor Input Voltage	1	n/a	uint16	0.1 V	Voltage delivered by the VSD to the motor.
x		105	106	Motor Input Current	2	n/a	uint32	0.01 A	Current delivered by the VSD to the motor.
x		107	108	Sensorless Head	2	n/a	uint32	0.01	Units as configured on Pump Control Module.
x		109	110	Sensorless Flow	2	n/a	uint32	0.01	Units as configured on Pump Control Module.
x		111	112	Total Flow	2	n/a	uint32	0.01	Used for Parallel sensorless mode
x		113	114	Total Power	2	n/a	uint32	0.01	Used for Parallel sensorless mode
x		115	116	Number of Running Pumps	1	n/a	uint16	-	Used for Parallel sensorless mode
x		116	117	Max Sensorless Flow	2	n/a	uint32	0.01	Units as configured on Pump Control Module.
x		118	119	Max Sensorless Head	2	n/a	uint32	0.01	Units as configured on Pump Control Module.
x		122	123	Status	1	n/a	uint16	-	Bit:0 = pump run status (0=not rotating, 1=rotating)
I/O									
x		200	201	Digital In	1	n/a	uint16	-	Digital input 1 is bit 0 and input 2 is bit 1.
x		201	202	Analog In 1	2	n/a	uint32	0.01 V, 0.01 mA	Units as configured on Pump Control Module
x		203	204	Analog In 2	2	n/a	uint32	0.01 V, 0.01 mA	Units as configured on Pump Control Module
x		205	206	Analog Out 1	1	n/a	uint16	0.01 mA	
x		206	207	Digital Out	1	n/a	uint16	-	Digital output 1 is bit 0 and output 2 is bit 1.
x		207	208	Relays	1	n/a	uint16	-	Relay 1 is bit 0 and relay 2 is bit 1.
Units									
x		250	251	Flow Units	1	n/a	uint16	-	1 = l/s; 2 = m ³ /h; 3 = g/m
x		251	252	Pressure Units	1	n/a	uint16	-	1 = bar; 2 = kPa; 3 = psi; 4 = ft; 5 = m
x		252	253	Power Units	1	n/a	uint16	-	1 = kw; 2 = hp
x		253	254	Speed Units	1	n/a	uint16	-	1 = rpm; 2 = %
x		254	255	Temperature Units	1	n/a	uint16	-	1 = Degrees Celsius; 2 = Degrees Fahrenheit
Counters									
x		275	276	Total Pump Running Hours	2	n/a	uint32	1 h	
x	x	277	278	Trip Pump Running Hours	2	n/a	uint32	1 h	Writing 0 to this register resets the counter.
x		279	280	Total Controller Running Hours	2	n/a	uint32	1 h	
x		281	282	Present Controller Running Hours	2	n/a	uint32	1 h	The running hours since the controller was powered on.
x		283	284	Total Pump Running kWh Counter	2	n/a	uint32	1 kWh	
x	x	285	286	Trip Pump Running kWh Counter	2	n/a	uint32	1 kWh	Writing 0 to this register resets the counter.

Function code		Start Address	Modbus Register	Description	# of Registers	Change During Operation	Data Type	Unit	Notes
Read	Write								
0x03	0x06								

Control Settings

x		300	301	Control Mode	1	Yes	uint16	-	1 = Parallel; 2 = Inputs; 3 = Remote; 4 = Constant Flow; 5 = Constant Pressure; 6 = Linear Pressure; 7 = Quadratic Pressure; 8 = Quad Pressure Maximum; 9 = Quad Pressure Minimum; 10 = Quadratic Pressure Max/Min
x	x	301	302	HOA State	1	Yes	uint16	-	0 = Off; 1 = Hand; 2 = Auto
x	x	302	303	Active Parameters	1	Yes	uint16	-	1 = standard; 2 = mode 1 (heating mode); 3 = mode 2 (cooling mode)
x	x	303	304	Minimum Speed Limit	1	Yes	uint16	0.1	In RPM
x	x	304	305	Maximum Speed Limit	1	Yes	uint16	1	In RPM
x	x	305	306	Hand Mode Speed	1	Yes	uint16	0.1	Units as configured on Pump Control Module.
x	x	306	307	BMS Set Speed	1	Yes	uint16	0.1	Units as configured on Pump Control Module.

Alarms and Warnings

x		400	401	Alarms	2	n/a	uint32	-	Refer to Alarms Table for Bit Positions
x		402	403	Warnings	2	n/a	uint32	-	Refer to warnings table for Bit Positions
	x	404	405	Acknowledge Warnings	2	Yes	uint32	-	32-bit field corresponding to the warning field

Parameters

x		500	501	Standard Mode – Zero Flow Head	2	Yes	uint32	0.01	Value for standard active mode. Units as configured on Pump Control Module.
x		502	503	Standard Mode – Design Head	2	Yes	uint32	0.01	Value for standard active mode. Units as configured on Pump Control Module.
x		504	505	Standard Mode – Design Flow	2	Yes	uint32	0.01	Value for standard active mode. Units as configured on Pump Control Module.
x		506	507	Standard Mode – Minimum Flow	2	Yes	uint32	0.01	Value for standard active mode. Units as configured on Pump Control Module.
x		508	509	Mode 1 – Zero Flow Head	2	Yes	uint32	0.01	Value for active mode 1. Units as configured on Pump Control Module.
x		510	511	Mode 1 – Design Head	2	Yes	uint32	0.01	Value for active mode 1. Units as configured on Pump Control Module.
x		512	513	Mode 1 – Design Flow	2	Yes	uint32	0.01	Value for active mode 1. Units as configured on Pump Control Module.
x		514	515	Mode 1 – Minimum Flow	2	Yes	uint32	0.01	Value for active mode 1. Units as configured on Pump Control Module.
x		516	517	Mode 2 – Zero Flow Head	2	Yes	uint32	0.01	Value for active mode 2. Units as configured on Pump Control Module.
x		518	519	Mode 2 – Design Head	2	Yes	uint32	0.01	Value for active mode 2. Units as configured on Pump Control Module.
x		520	521	Mode 2 – Design Flow	2	Yes	uint32	0.01	Value for active mode 2. Units as configured on Pump Control Module.
x		522	523	Mode 2 – Minimum Flow	2	Yes	uint32	0.01	Value for active mode 2. Units as configured on Pump Control Module.

Information

x		900	901	Pump Name / Tag name	8	n/a	ascii	-	The pump name as a series of ascii characters.
x		908	909	Serial Number	7	n/a	ascii	-	Serial No. of the Pump represented by ascii characters
x		915	916	Firmware Version	1	n/a	uint16	00.00	Divide the number by 100 to get the major.minor version of the depc.
x		916	917	Hardware Version	1	n/a	uint16	-	The Pump Control Module hardware version.

Function code		Start Address	Modbus Register	Description	# of Registers	Change During Operation	Data Type	Unit	Notes
Read	Write								
0×03	0×06								
x		917	918	bms Modbus Version	1	n/a	uint16	-	Version of the Taco Modbus registers used.
x		918	919	Firmware Patch Version	1	n/a	uint16	00	Patch version of the MPC. To be appended to firmware version register.

Appendix C BACNet Objects

Object ID	Object Name	Read/Write	Comments
Status			
av:100	Actual Speed	Read	In RPM
av:101	Actual speed	Read	In %
av:102	Motor Power	Read	Unit as configured in Pump Control Module
av:103	Motor Input Voltage	Read	In Volts
av:104	Motor Input Current	Read	In Amps
av:105	Sensorless Head	Read	Unit as configured in Pump Control Module
av:106	Sensorless Flow	Read	Unit as configured in Pump Control Module
av:107	Total Flow	Read	Used for Parallel sensorless mode
av:108	Total Power	Read	Used for Parallel sensorless mode
av:109	No. Of Running Pumps	Read	Used for Parallel sensorless mode
av:110	Max Sensorless Flow	Read	Unit as configured in Pump Control Module
av:111	Max Sensorless Head	Read	Unit as configured in Pump Control Module
bv:2	Run Status	Read	1 → pump is running
Counters			
av:275	Total Pump Running Hours	Read	
av:276	Trip Pump Running Hours	Read/Write	Writing 0 to this register resets the counter.
av:277	Total Controller Running Hours	Read	
av:278	Present Controller Running Hours	Read	The running hours since the controller was powered on.
av:279	Total Pump Running kWh Counter	Read	
av:280	Trip Pump Running kWh Counter	Read/Write	Writing 0 to this register resets the counter.
Control Settings			
av:300	Control Mode	Read	1 = Parallel; 2 = Inputs; 3 = Remote; 4 = Constant Flow; 5 = Constant Pressure; 6 = Linear Pressure; 7 = Quadratic Pressure; 8 = Quadratic Pressure with Maximum Flow; 9 = Quadratic Pressure with Minimum Flow; 10 = Quadratic Pressure with Minimum and Maximum Flow
av:301	HOA State	Read/Write	0 = OFF; 1 = Hand Mode; 2 = Auto
av:302	Active Parameters	Read/Write	1 = standard; 2 = mode 1 (heating mode); 3 = mode 2 (cooling mode)
av:303	Minimum Speed Limit	Read	in RPM
av:304	Maximum Speed Limit	Read	in RPM
av:305	Hand Mode Speed	Read/Write	Unit as configured in Pump Control Module.
av:306	bms Set Speed	Read/Write	Unit as configured in Pump Control Module.
bv:14	Start/Stop	Read/Write	Start/stop of pump

Object ID	Object Name	Read/Write	Comments
Alarms and Warnings			
av:400	Alarms	Read	Refer to Alarms Table for Bit Positions
av:401	Warnings	Read	Refer to Warnings Table for Bit Positions
av:402	Acknowledge Warnings	Read/Write	32-bit field corresponding to the warning field
Parameters			
av:500	Standard Mode – Zero Flow Head	Read/Write	Value for standard active mode. Unit as configured in Pump Control Module
av:501	Standard Mode – Design Head	Read/Write	Value for standard active mode. Unit as configured in Pump Control Module
av:502	Standard Mode – Design Flow	Read/Write	Value for standard active mode. Unit as configured in Pump Control Module
av:503	Standard Mode – Minimum Flow	Read/Write	Value for standard active mode. Unit as configured in Pump Control Module
av:504	Mode 1 – Zero Flow Head	Read/Write	Value for active mode 1. Unit as configured in Pump Control Module
av:505	Mode 1 – Design Head	Read/Write	Value for active mode 1. Unit as configured in Pump Control Module
av:506	Mode 1 – Design Flow	Read/Write	Value for active mode 1. Unit as configured in Pump Control Module
av:507	Mode 1 – Minimum Flow	Read/Write	Value for active mode 1. Unit as configured in Pump Control Module
av:508	Mode 2 – Zero Flow Head	Read/Write	Value for active mode 2. Unit as configured in Pump Control Module
av:509	Mode 2 – Design Head	Read/Write	Value for active mode 2. Unit as configured in Pump Control Module
av:510	Mode 2 – Design Flow	Read/Write	Value for active mode 2. Unit as configured in Pump Control Module
av:511	Mode 2 – Minimum Flow	Read/Write	Value for active mode 2. Unit as configured in Pump Control Module
av:520	Control Setpoint	Read/Write	Value and unit as configured on pump control mode (constant pressure or constant flow)
Information			
av:900	BMS BACnet Version	Read	Version of the Taco BACnet points used.
i/o			
ai:0	Analog In 1	Read	As configured in Pump Control Module
ai:1	Analog In 2	Read	As configured in Pump Control Module
av:113	Analog Out 1	Read	As configured in Pump Control Module
bi:0	Digital In 1	Read	As configured in Pump Control Module
bi:1	Digital In 2	Read	As configured in Pump Control Module
bv:15	Digital Out 1	Read	As configured in Pump Control Module
bv:16	Digital Out 2	Read	As configured in Pump Control Module
bv:0	Relay 1	Read	As configured in Pump Control Module
bv:1	Relay 2	Read	As configured in Pump Control Module

LIMITED WARRANTY STATEMENT

Taco, Inc. (Taco) 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).

Motors provided on commercial pumps are not covered by this warranty, and are warranted by the motor manufacturer. For complete details on motor warranty returns, the purchaser should contact the motor manufacturer's local service repair center or contact the motor manufacturer directly.

Seals provided on commercial pumps are not covered by this warranty.

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 accident, disaster, neglect, misuse, misapplication, inadequate operating environment, repair, attempted repair, modification or alteration, or other abuse, will not be covered by this warranty.

Taco products are not intended for use to support fire suppression systems, life support systems, critical care applications, commercial aviation, nuclear facilities or any other applications where product failure could lead to injury to person, loss of life, or catastrophic property damage and should not be sold for such purposes.

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.

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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.

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