# SCI Parallel SelfSensing with Modulating Pump Controller

302-395

## Installation, Operation, and Maintenance Manual

SUPERSEDES: NEW

EFFECTIVE: August 10, 2023

Plant ID No. 001-5053

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NOTE: This is an interactive manual. Clicking on a section below will take you directly to the page. Click on this icon TOC to return to the Table of Contents

# 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. Discon-nect 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

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 foundation using lead anchors.

**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

**CAUTION:** Overgreasing bearings can cause premature bearing failures. Do not mix dissimilar greases. Do not lubricate while pump is running. Do not remove or install drain plug while pump is running.

On Close-Coupled Pumps, motor bearings carry both pump and motor load. Therefore, it is of the utmost importance to have the bearings properly lubricated at all times.

The recommended lubricants for CI/CE motors are Chevron “SRI No. 2” and Shell “Dolium R”.

Ball Bearings:

Ball bearings are greased at the factory. Grease will not flow out during shipment, so no checking will be required at start-up.

Regrease bearings as indicated by motor manufacturer’s instructions. Normally greasing is required every two (2) years or 3,000 hours of operation. On motors, grease is usually introduced with a grease gun through a grease fittings.

## 3.4 Mechanical Seal

Mechanical seals are the most delicate component of the pump. Special care has to be given to them to assure trouble-free operation.

The sealing element of a mechanical seal consists of a carbon washer rotating against a stationary ring.

Surfaces of both are highly lapped to assure sealing.

Any dirt that penetrates between the two mating parts will cause a rapid wear of the seal faces and will ultimately result in seal leakage.

New heating systems are usually contaminated by various materials such as construction debris, welding slugs, pipe joint compound, mill scale, etc. It is of utmost importance that such systems be cleaned out thoroughly before putting pump into continuous operation.

Cleaning of a heating system is simple and easy. First flush out system with cold water at city pressure to remove all loose foreign matter that penetrated into the system. Afterwards, boil out system with chemicals to remove dirt adhering to pipes.

Chemicals most commonly used for this procedure are sodium triphosphate, sodium carbonate, or caustic soda but any non-foaming detergents as used in dishwashers can be applied.

Fill system with clean water, add cleaning chemicals (1 lb. for every 40 to 50 gallons of water or manufacturer’s instruction). Start pump and heat up system. Let system run for a few hours and then drain and refill with fresh water. Your pumps are now ready for continuous duty.

# 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/adapter to casing, pry cover/adapter 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.

Remove bolts holding cover/adapter to casing, pry cover/adapter 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

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<br>300°F Hi Temperature |

# 7 MECHANICAL INSTALLATION

## 7.1 Location

Locate pump in an easily accessible place with sufficient space around it for maintenance and servicing. On larger pumps allow head room for the use of hoists or overhead cranes. Locate pump on a dry and clean place so that motor will be protected from moisture and dust.

On closed heating systems, place compression tank at the suction side of the pump. When pump head is less than 20 feet, it is permissible to connect compression tank to discharge side of the pump.

On open systems, install pump close to liquid supply and make suction piping as short and as straight as possible.

## 7.2 Foundation

The foundation serves to carry the pump weight and to absorb vibration. Normally, the foundation is made of a concrete block, preferably tied in with the floor or ground. Make the foundation block about 4" longer and 4" wider than the base of the frame. Height of the block may vary from 2/3 to 1 times the width of the foundation. When foundation is poured, provide a hole near each of the four (4) corners. To simplify installation and maintenance use lead Anchors. Place the front Anchor about 2" from the edge of the foundation to clear overhanging casings.

## 7.3 Pump Piping – Detailed

Correct piping is of prime importance for the proper operation and long life of the pump. Stresses induced by piping will cause excessive wear of seals and bearings that could ultimately destroy these elements.

Both suction and discharge piping should be suspended close to the pump connections so that no pipe weight rests on the pump. Pipe flanges and pump flanges **must** align perfectly before connections are made. Piping should **never** be drawn by force into place.

Thermal expansion of piping requires special attention on heating installations. If no room is provided for pipe expansion, stresses are induced in the piping that will exert a load on the pump. Forces created by pipe stresses can exceed by far the load exerted through pipe and water weight. Stress forces can distort pump, bend shafts, wear out seals and impeller wear rings and ultimately burn out bearings. To protect pump from thermal pipe stresses, provide spring hangers and flexible connectors that are suitable to compensate for pipe expansion.

Install gate valves on both suction and discharge side of the pump to allow servicing without draining the system. Also provide a flanged nipple (Spool) between gate valve and suction end of the pump to enable you to take the pump apart without disturbing piping. In order to have them easily accessible, the pump and flange nipples should not be covered with insulation.

On open pumping systems drawing water from a level below the pump (suction lift), install a foot valve with strainer. On open systems where the pump is located below the suction water level (suction head), install a check valve in the discharge line close to the pump.

### 7.3.1 Pump Setting

To set pump attach Anchor Blocks finger tight to pump frame and place in position with Anchor Blocks suspended freely in the four holes in the concrete foundation.

Next, level pump by inserting four wedges, one under each corner of the frame. At the same time, also check level and square-ness of suction and discharge flanges. If everything checks out, pour concrete (right up to the bottom of the frame) into the four holes at the corners and let set for thirty six (36) to forty eight (48) hours before tightening bolts

**WARNING: UNEXPECTED STARTUP HAZARD** Disconnect and lockout power before servicing. Failure to follow these instructions could result in serious personal injury or death, or property damage.

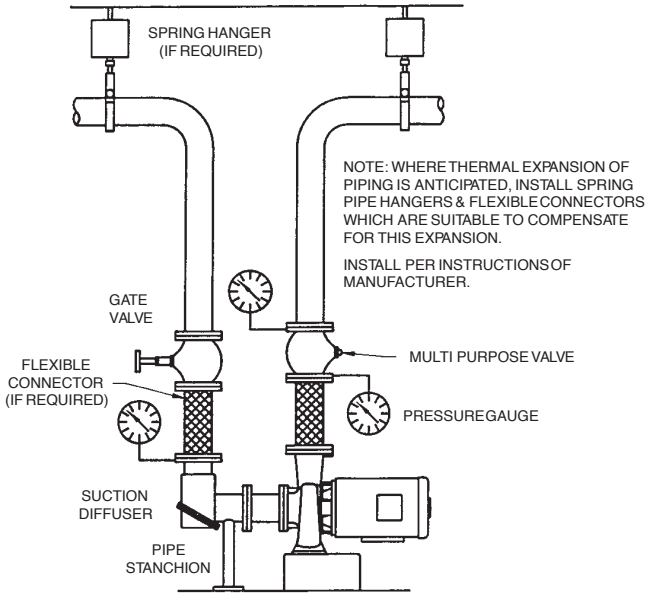



**Fig. 7-1 Typical Installation - Vertical Piping**

### 7.3.2 Connecting Pipes

Piping may now be connected to pump. Make certain that pump and pipe flanges are strictly parallel and properly spaced for the gaskets that will be used. Also check that pipes are supported properly and **do not** rest on pump flanges. **Never** draw pipes by force to pump flanges.

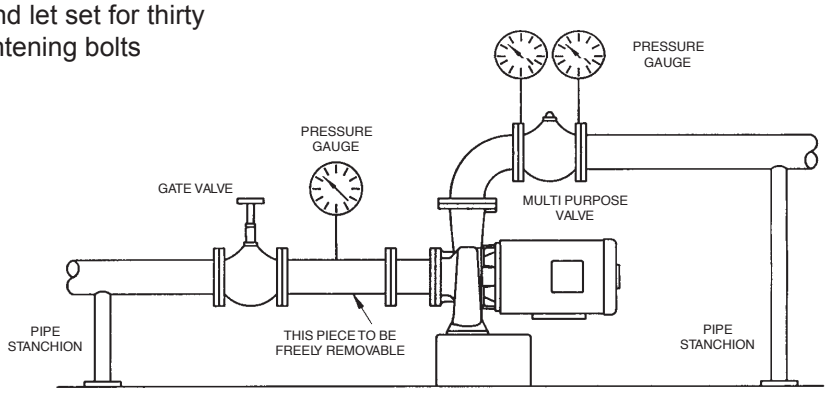



**Fig. 7-2 Typical Installation - Horizontal Piping**

## 7.4 VFD Mounting to Wall

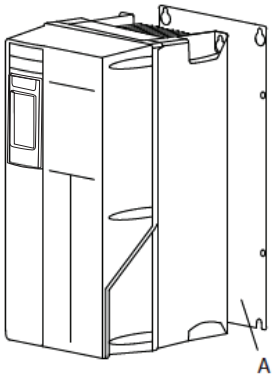
### 7.5.1 Lifting

- 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.

### 7.5.2 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 7-3 and Figure 7-4).
- Improper mounting can result in overheating an reduced performance.
- Use the slotted mounting holes on the unit for wall mounting, when provided.

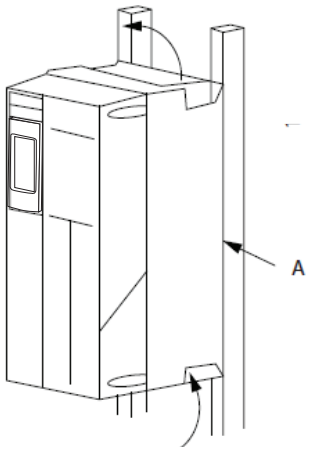
**Figure 7-3: Proper Mounting with Back Plate**




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

**Item A is a back plate properly installed for required air-flow to cool the unit.**

**Figure 7-4: Proper Mounting with Railings**




**NOTE:** Back plate is required when mounted on railings.

### 7.4.3 Tightening Torques

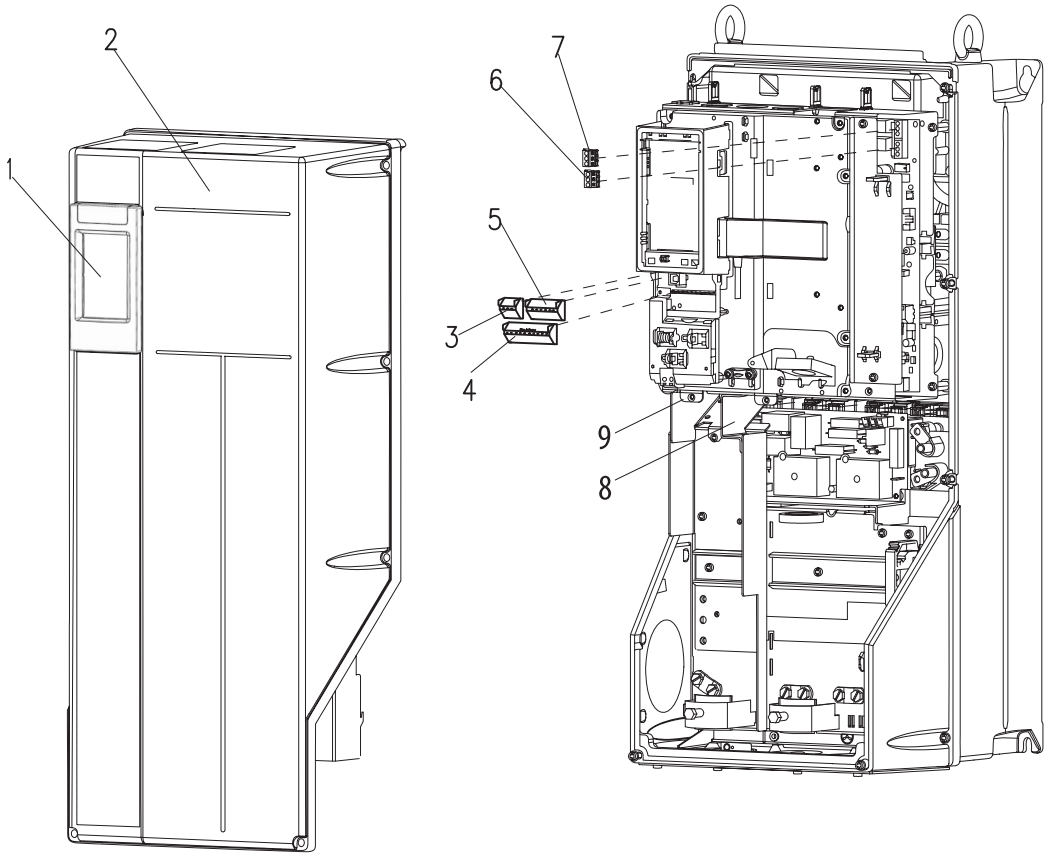
See “12.2 Connection Tightening Torques” on page 48 for proper tightening specifications.

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

# 8 ELECTRICAL CONNECTIONS

## 8.1 Exploded Views

**Figure 8-1: Exploded View A Size**




| Item # | Description |
|---|---|
| 1 | Modulating Pump Controller |
| 2 | VFD Face Cover |
| 3 | Communication Terminals, 3 pins, #s; 61,68,69 |
| 4 | Communication Terminals, 10 pins, #s; 12,13,18,19,27,29,32,33,20,37 |
| 5 | Communication Terminals, 6 pins, #s; 39,42,50,53,54,55 |
| 6 | Relay Terminal, #1, #s; 01,02,03 |
| 7 | Relay Terminal, #2, #s; 04,05,06 |
| 8 | Motor Output Plug (only for Type 1 / IP21 enclosures) |
| 9 | Power Input Plug (only for Type 1 / IP21 enclosures) |

**~Danfoss accessory bags only contain item #s 3 to 7 (or #s 3 to 9 if type A).**
**~ All hardware (screws, clamps, grommets, etc.) included in the accessory bags.**

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

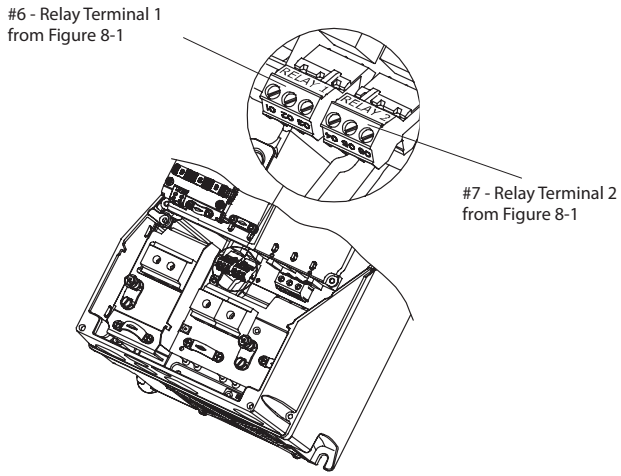
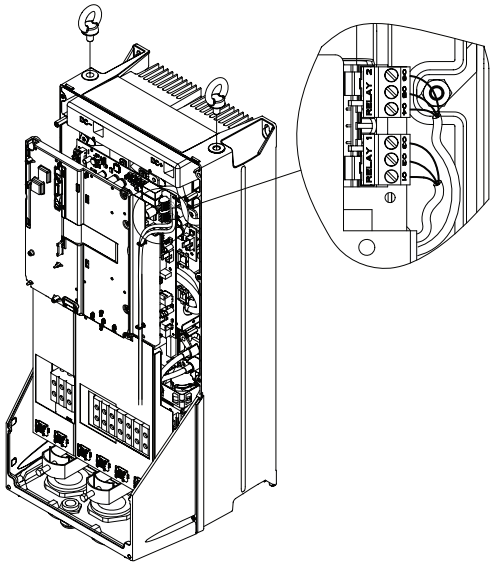



**Figure 8-3 Relay Connection Terminals for c1 and c2 Units**



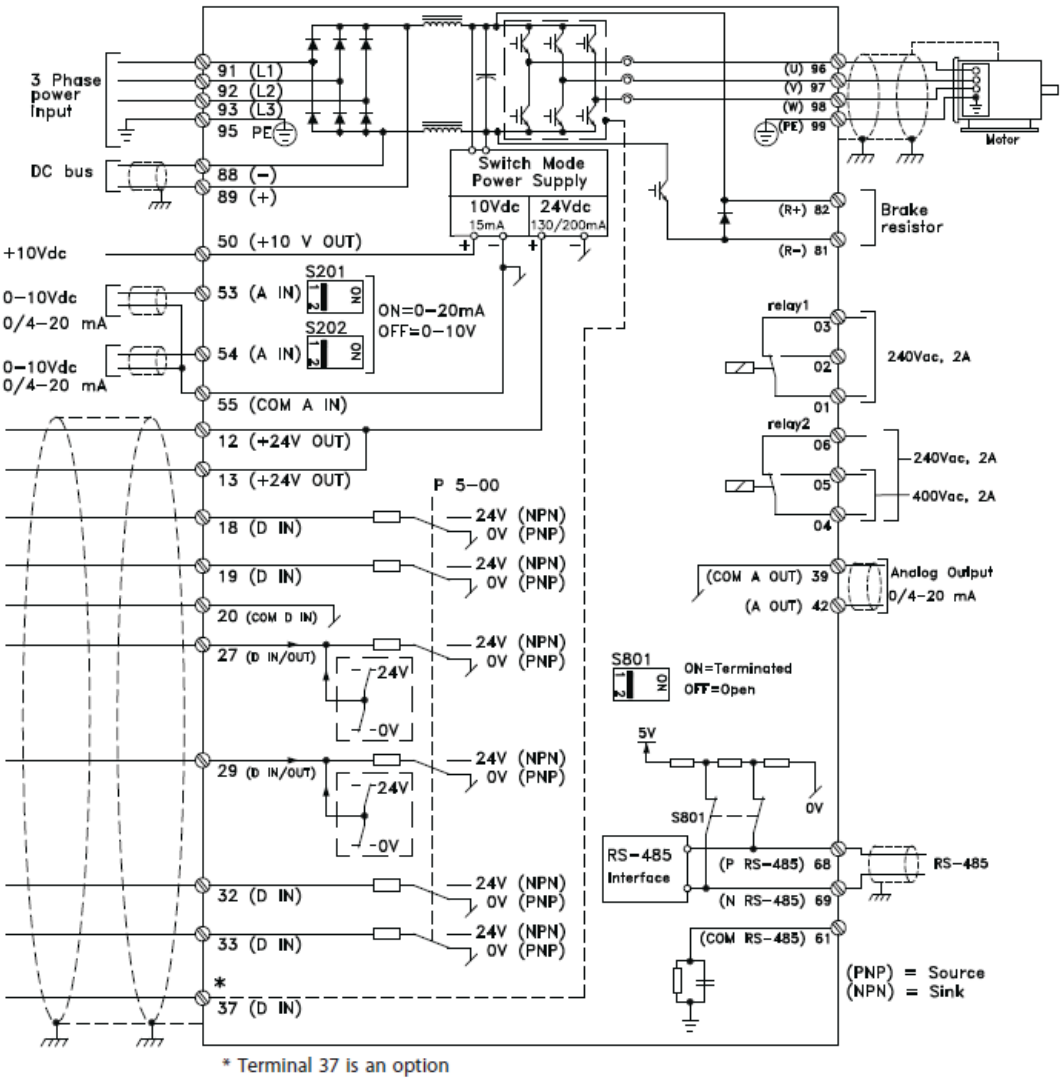
## 8.2 Electrical Installation

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 shows the main drive electrical connection.

**Figure 8-4: Basic Wiring Schematic Drawing**




**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.

Figure 8-5 shows a typical bypass electrical connection.

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

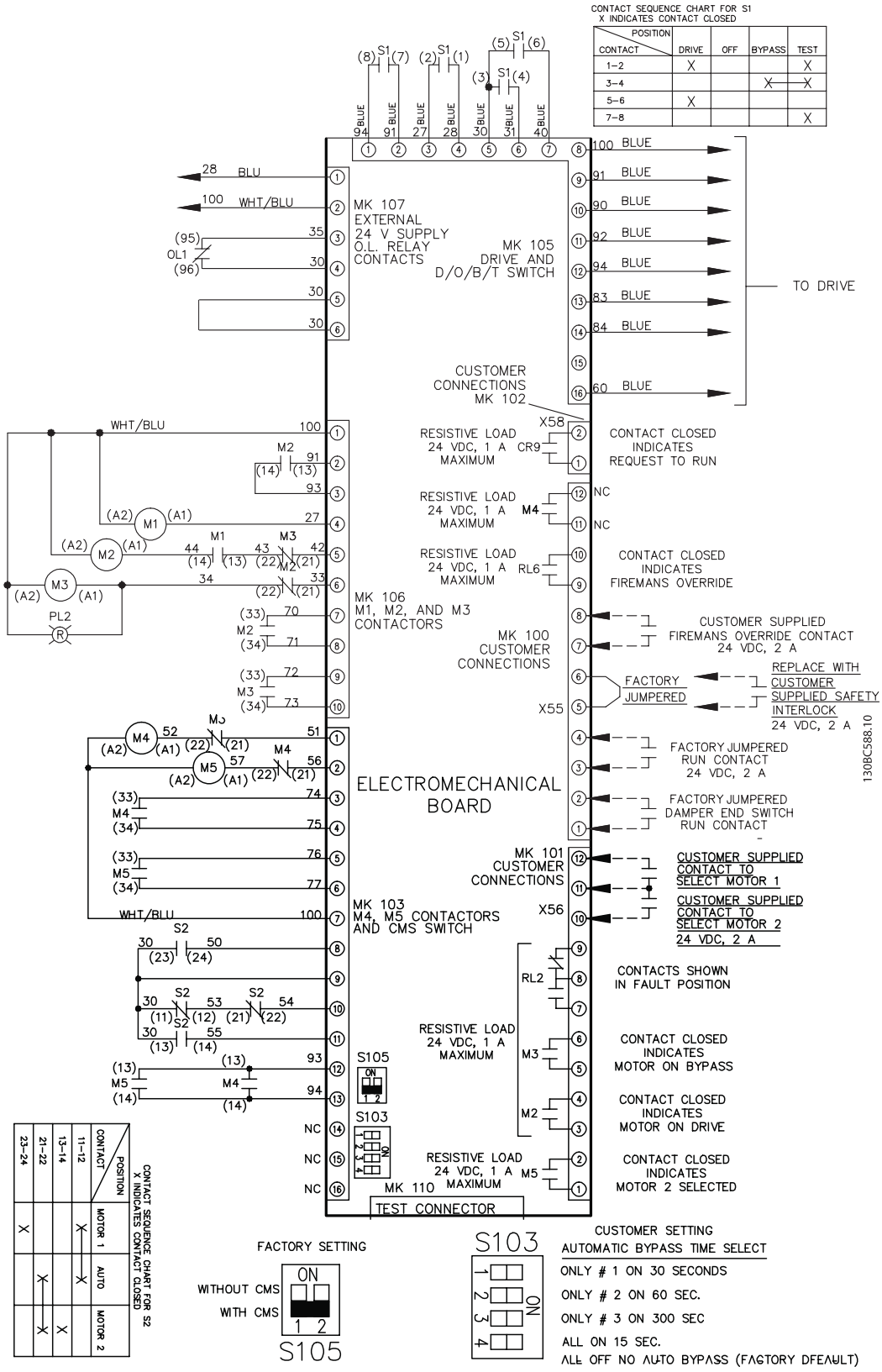
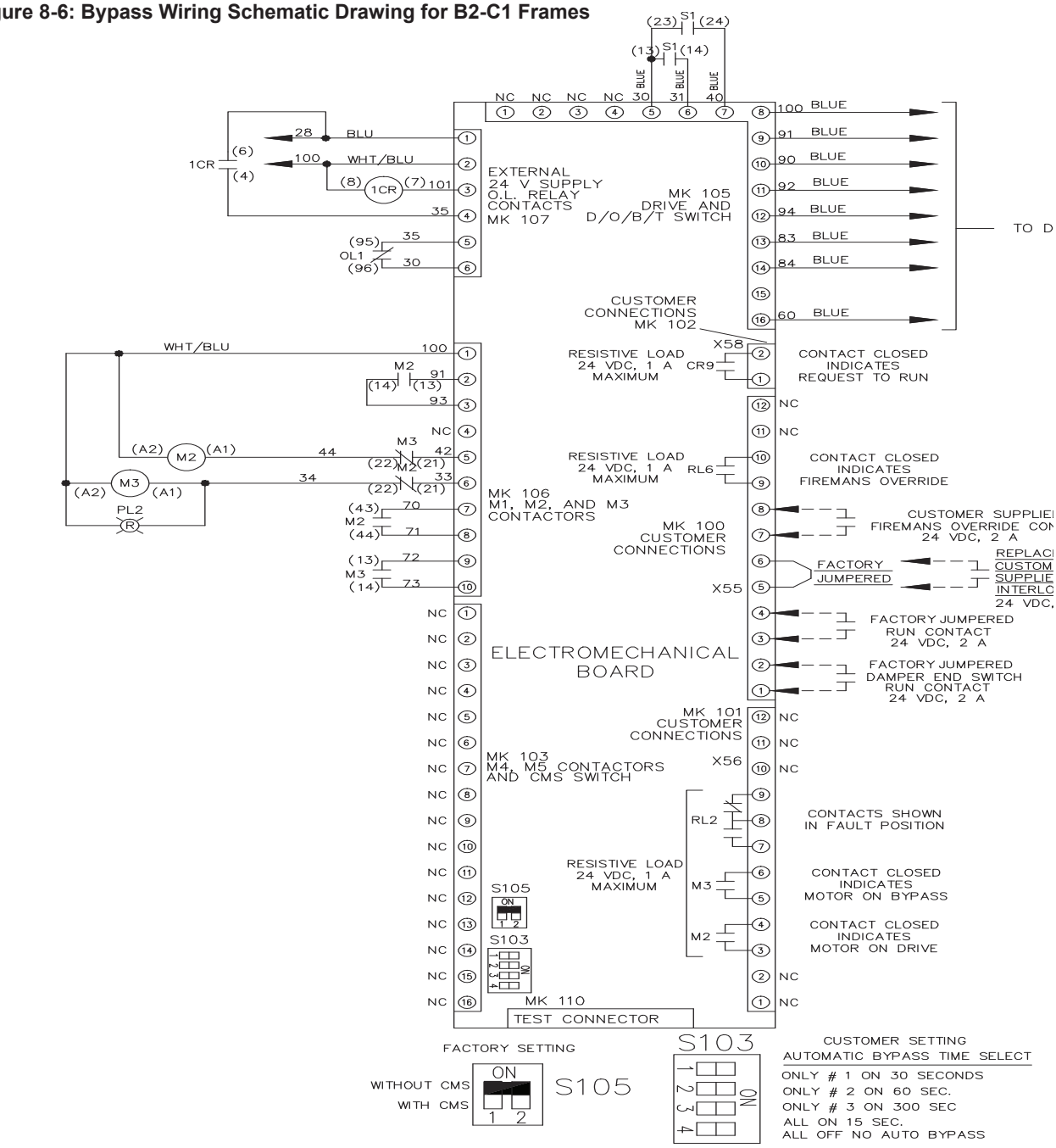


Figure 8-6 shows a typical bypass electrical connection.

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

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**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.

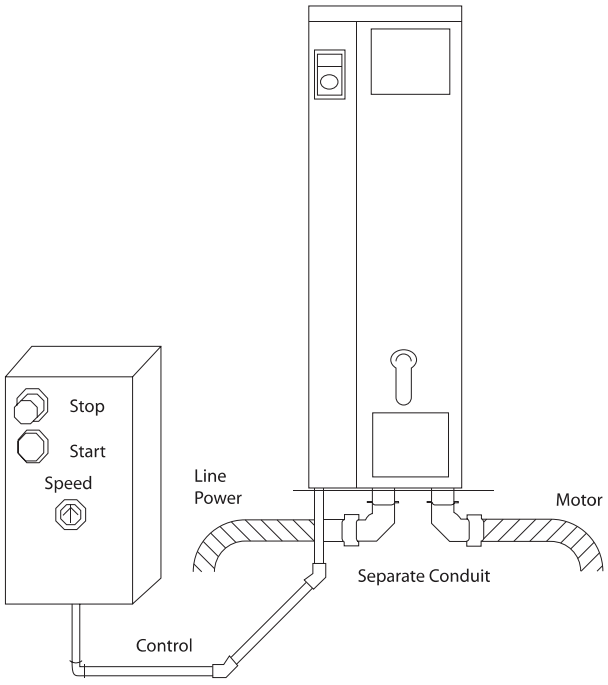
**For your safety, comply with the following requirements:**

- 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

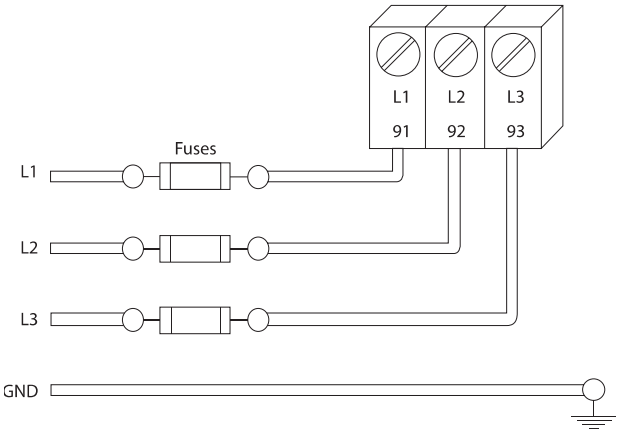
- An electronically activated function within the adjustable frequency drive provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See 9.8 Warnings and  Alarms" on page 41 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 8-7.

**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 estab-lished, 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.

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/ICE61800-5-1(Power Drive System Prodcut 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.

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### 8.3.2 Using RCDs

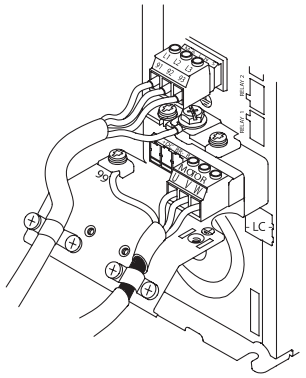
Where residual current devices (RCDs), also known as ground leakage circuit breakers (ELCBs), are used, comply with the following:

- 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 with Shielded Cable**

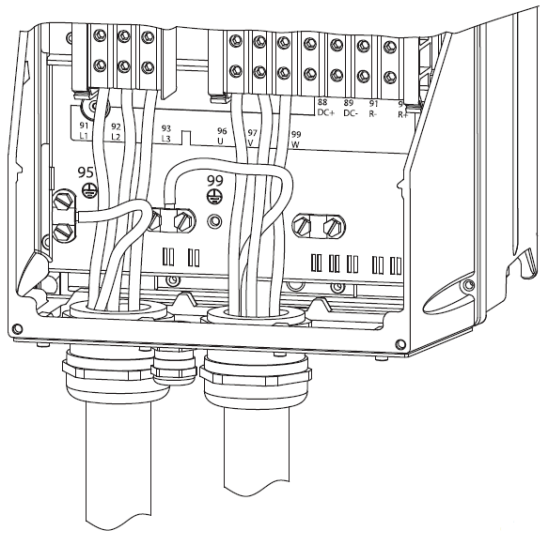


### 8.3.4 Grounding Using Conduit

**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 “12.2 Power-dependent Specifications” on page 46.
- 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**

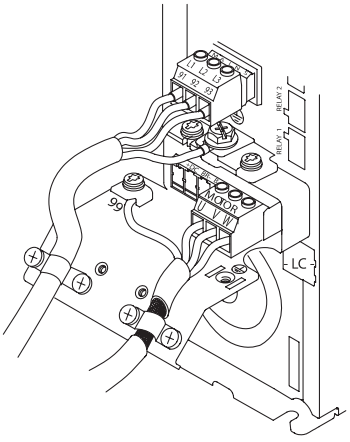



**Figure 8-12: Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Shielded Cable**

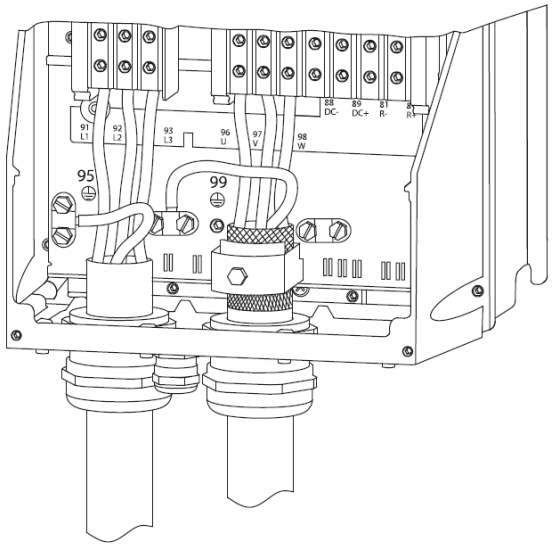
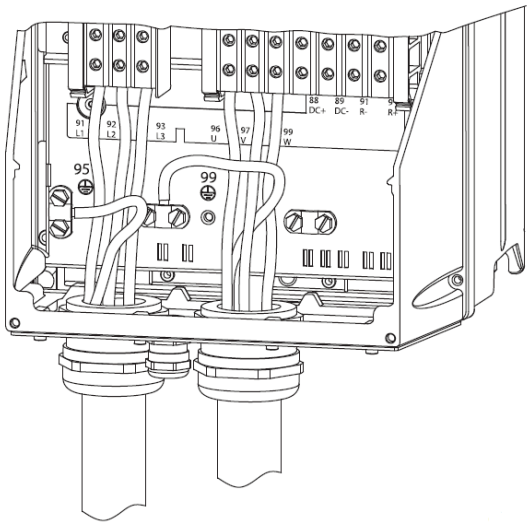



**Figure 8-13: Motor, Line Power and Ground Wiring B-Frame Sizes and Above Using Shielded Cable or Conduit**

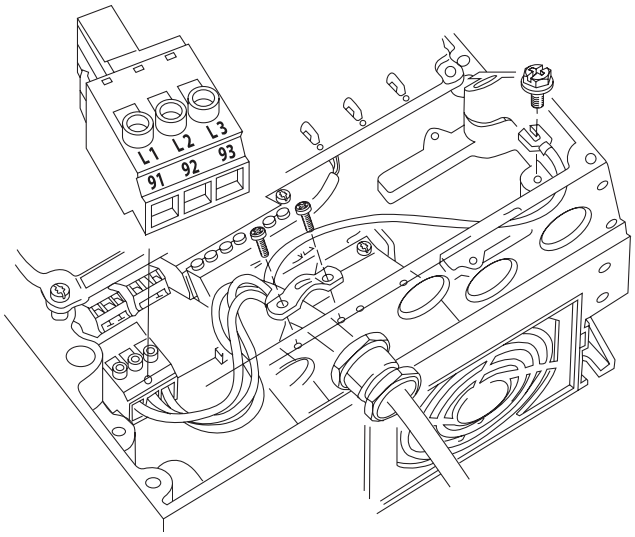



## 8.3.6 AC Line Power Connection

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 12.
- 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

## 8.3.7 Control Wiring

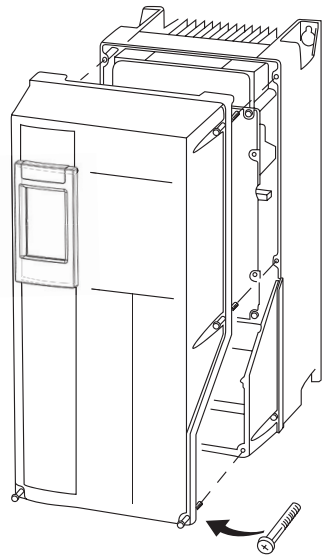
Isolate control wiring from high power components in the adjustable frequency drive.

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.

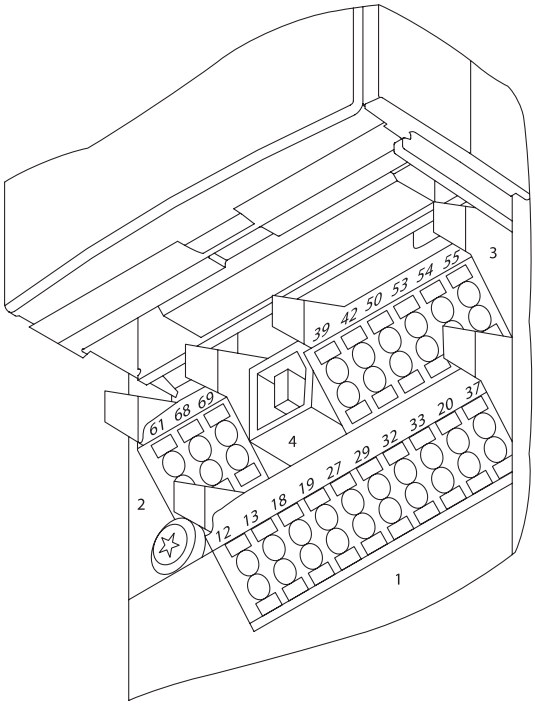
**Table 1: Tightening Torques for Covers (Nm)**

| 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<br>- Does not exist | | | | |

**Control Terminal Types**

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

**Figure 8-16: Control Terminal Locations**

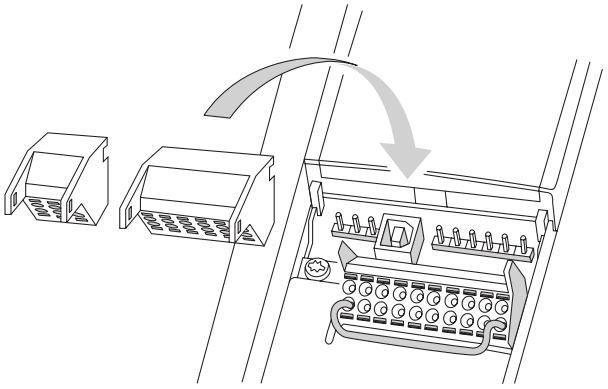



- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24V DC terminal supply voltage, and a common for optional customer supplied 24V DC voltage.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial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

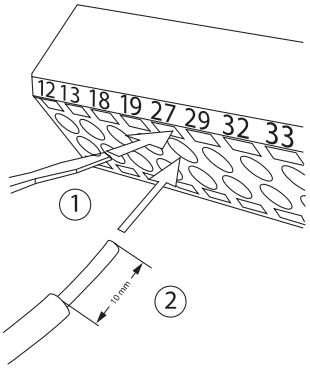
Control terminal connectors can be unplugged from the adjustable frequency drive for ease of installation, as shown in Figure 8-17.

**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.

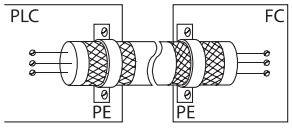
**Figure 8-18: Connecting Control Wiring**




**Using Shielded Control Cables**

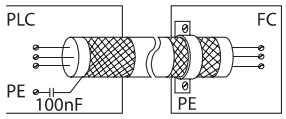
*Correct Shielding*

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.



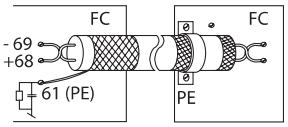
*50/60 Hz ground loops*

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 “Modulating Pump Controller” on page 21 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**

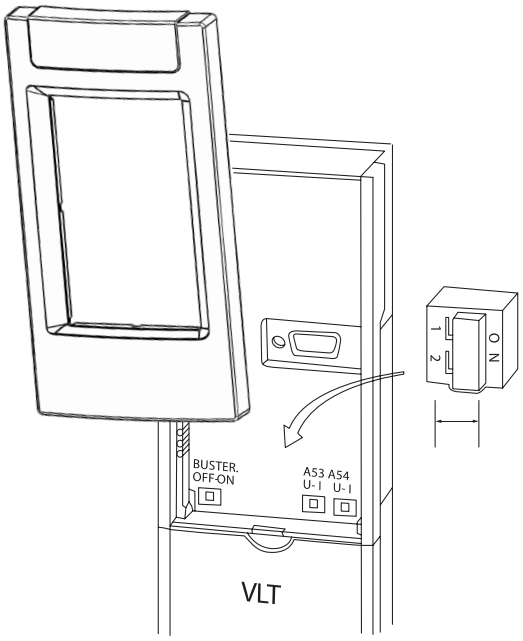
A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the adjustable frequency drive to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive an 24VDC external interlock command. In many appli cations, 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 8-19). 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.**



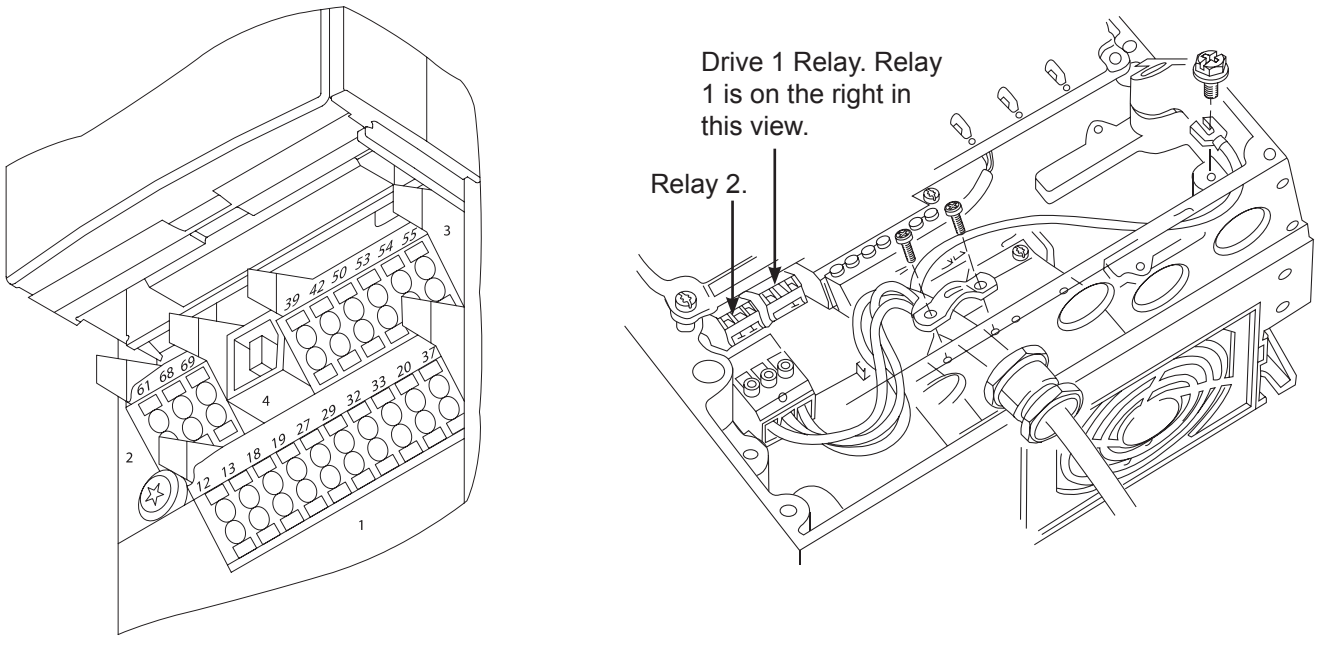
## 8.4 Typical Terminal Wiring Configurations

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

**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**

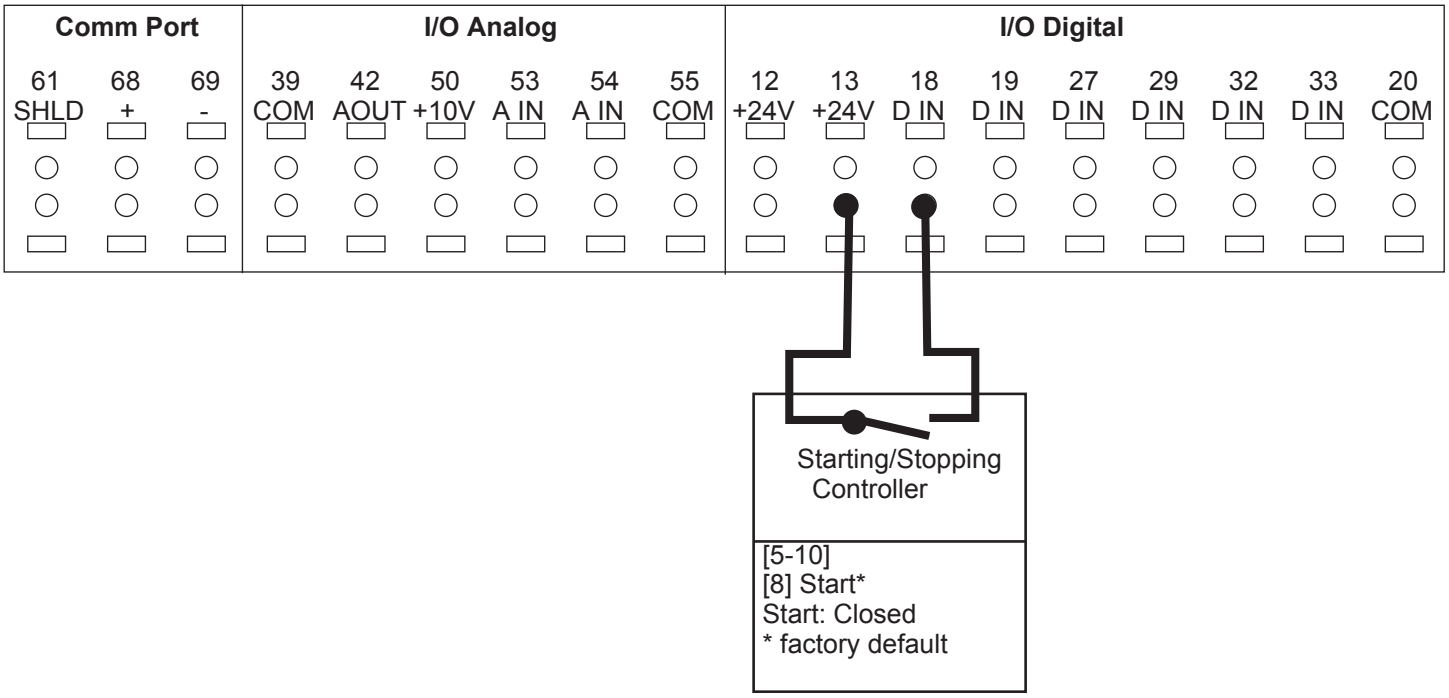


### 8.4.1 Factory default set-up

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*.

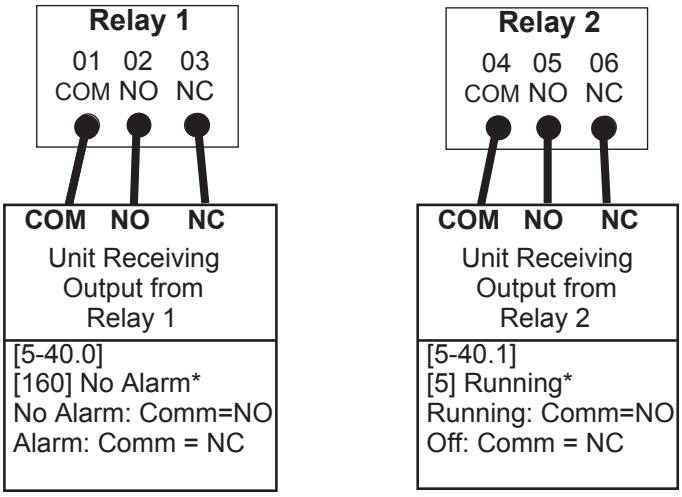
**NOTE:** The factory default settings require a start signal wired to DI18 (see below).



## 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 8-21: Wiring the Relay Terminals**




*** Factory Default Settings**

**Table 3: Relay Terminal Specifications**

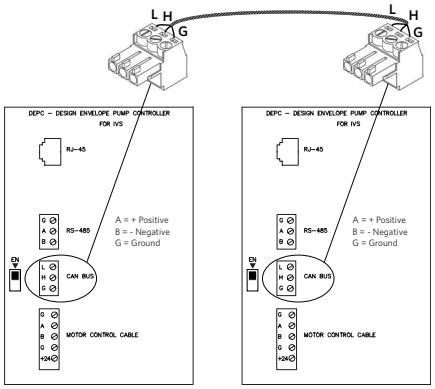
| | |
|---|---|
| Programmable relay outputs | 2 |
| Relay 01 Terminal number | 1–3 (break), 1–2 (make) |
| Maximum terminal load (AC-1) on 1–3 (NC), 1–2 (NO) (Resistive load) | 240 V AC, 2A |
| Maximum terminal load (AC-15) (Inductive load @ cosϕ 0.4) | 240 V AC, 0.2A |
| Maximum terminal load (DC-1) 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 @ cosϕ 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 @ cosϕ 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:**

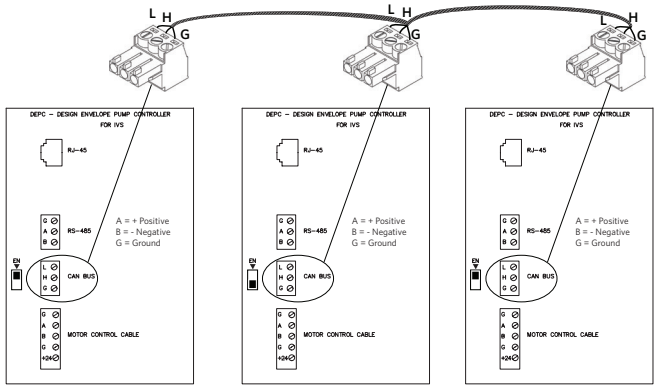
Ensure that both terminating resistor switches are set to Enabled (towards the EN label for the canbus port).



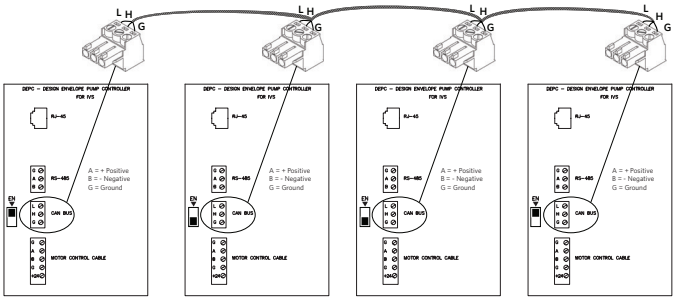

PUMP CONTROLLER 1 PUMP CONTROLLER 2

**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).




PUMP CONTROLLER 1 PUMP CONTROLLER 2 PUMP CONTROLLER 3




PUMP CONTROLLER 1 PUMP CONTROLLER 2 PUMP CONTROLLER 3 PUMP CONTROLLER 4

**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.

**Figure 9-1 Controller Board**

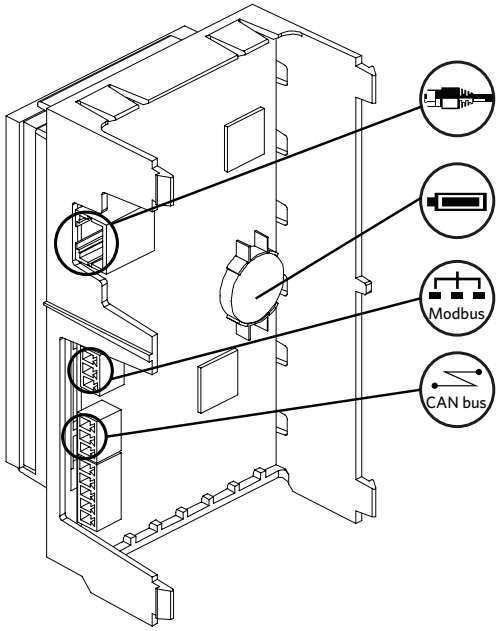
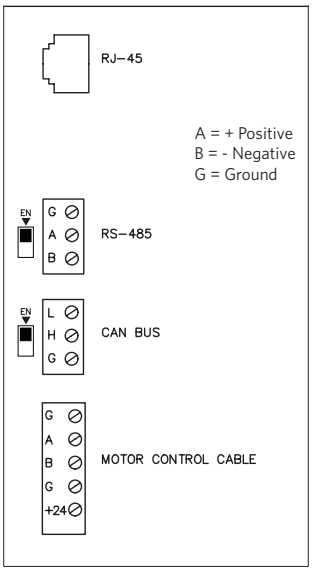



**Figure 9-2 Controller Board**




### 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.

### 9.1.2 Ethernet and WIFI Connectivity

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

### 9.1.3 Can Bus Wiring

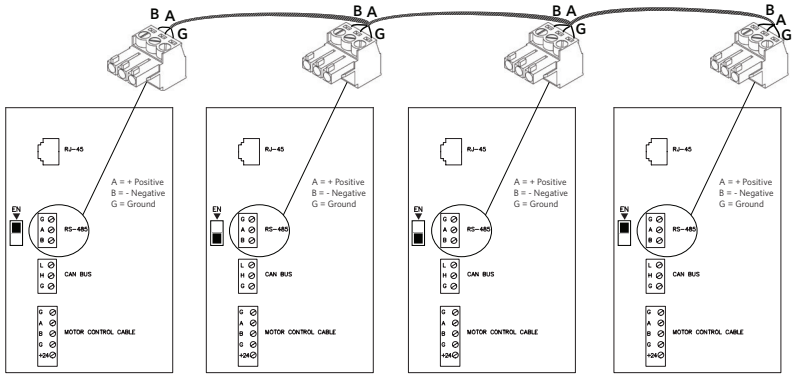
Connections, Low, High, and Ground as per (Figure 9-1) If the MPC requires a CAN BUS connection, ensure that the terminating resistor switch is set to Enabled, (towards the EN label for the BAS ports). If multiple pumps are connected in parallel for CAN BUS (supplied by others) they should be daisy chained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

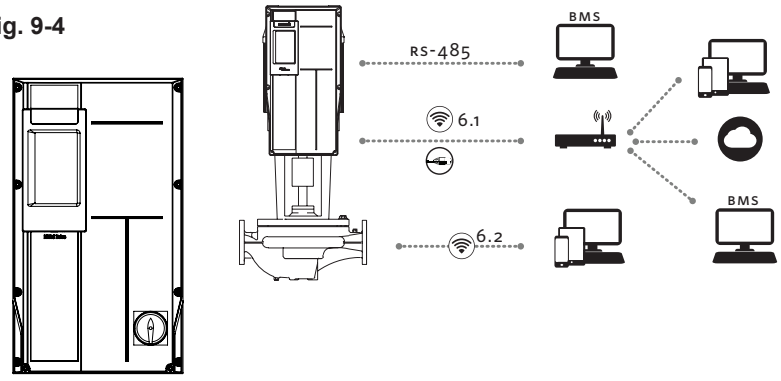
If multiple pumps are connected in parallel to the BAS, the BAS wiring (supplied by others) should be daisy chained together. Ensure that only the first and last terminating resistor switches are set to Enabled. See example below in (Figure 9-3).

**fig. 9-3**




### 9.1.5 Networking Options

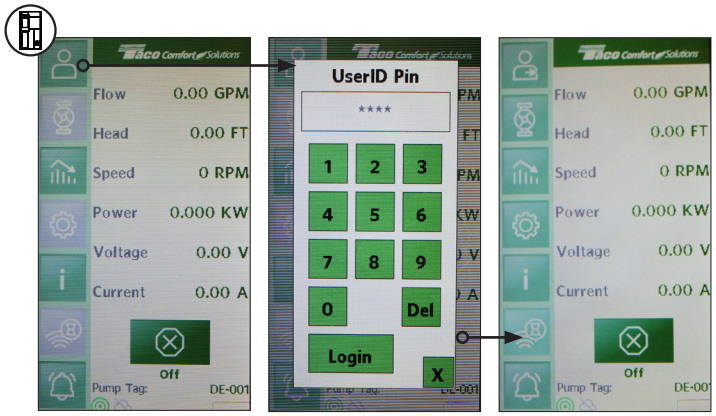
**fig. 9-4**



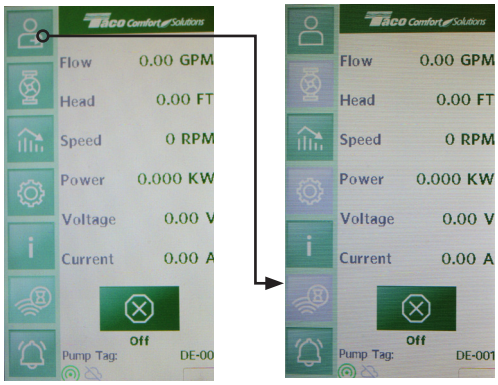
# 9.2 Touch Screen

## 9.2.1 Login

Default Password 1234



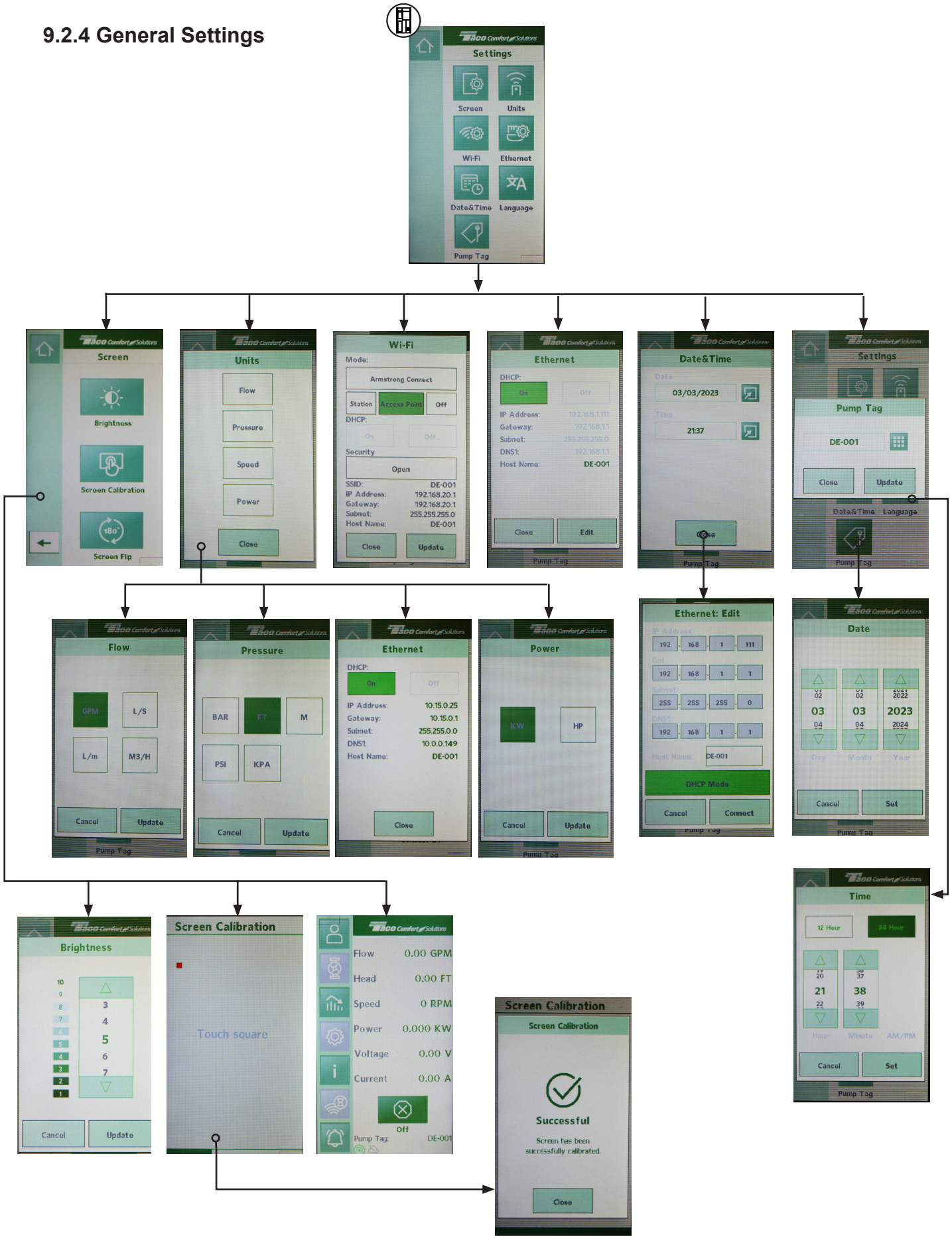

## 9.2.2 Logout



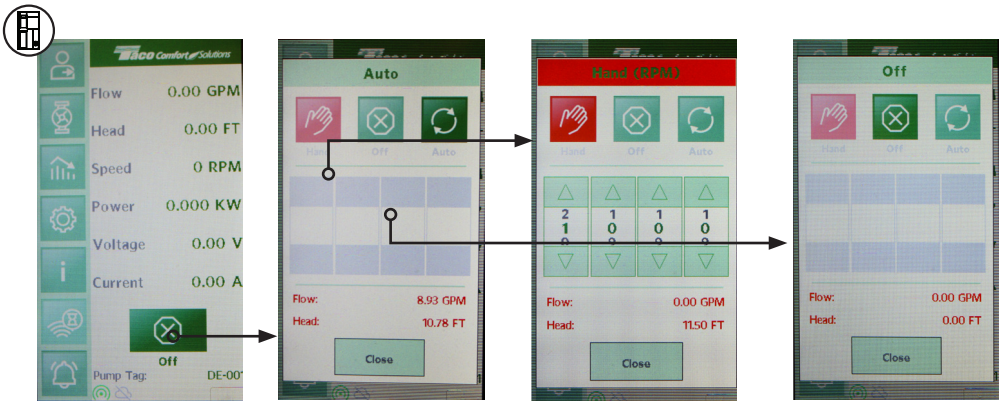
## 9.2.3 About


Click on **Reset** to reset Trip counters

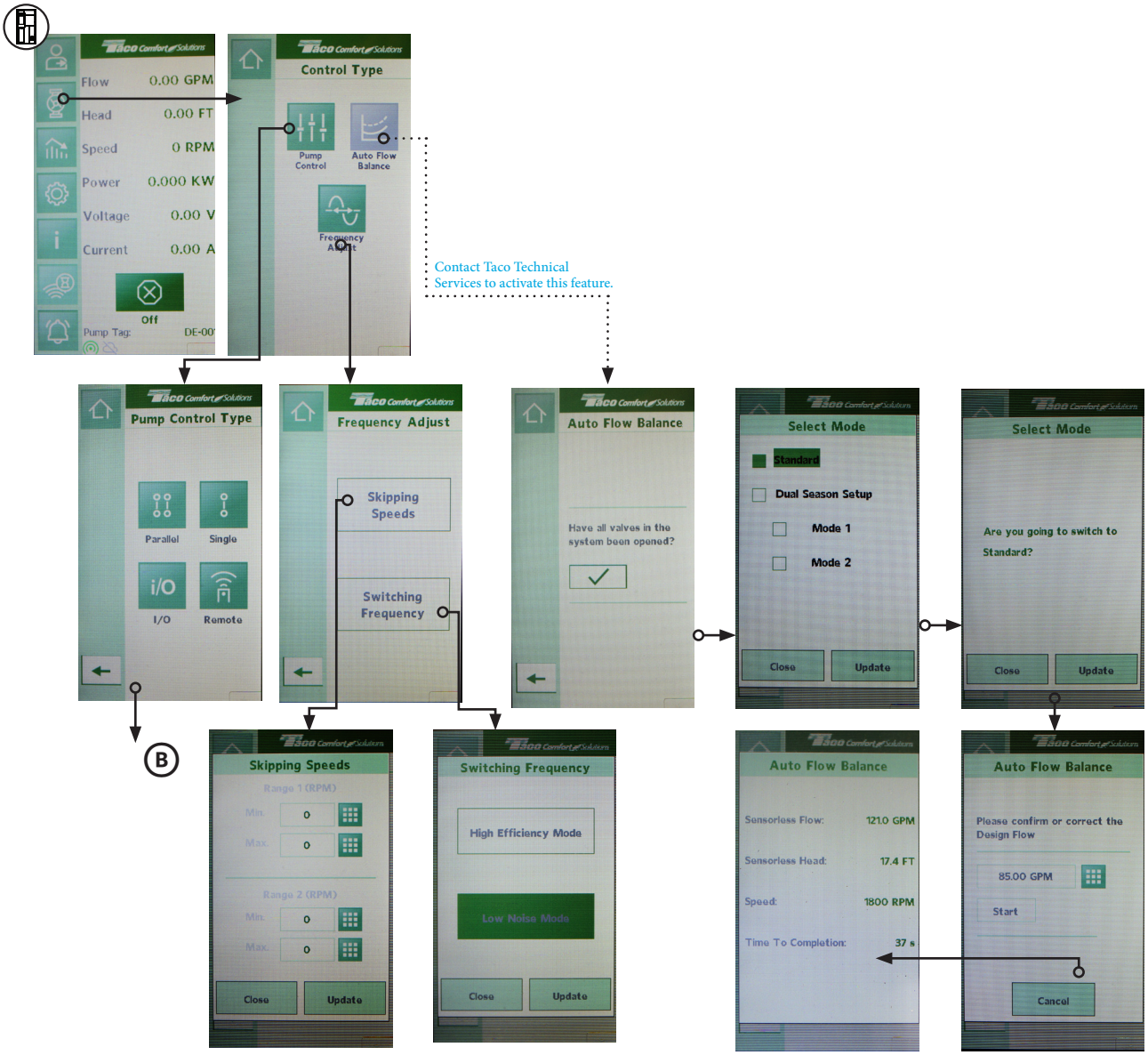
## 9.2.4 General Settings



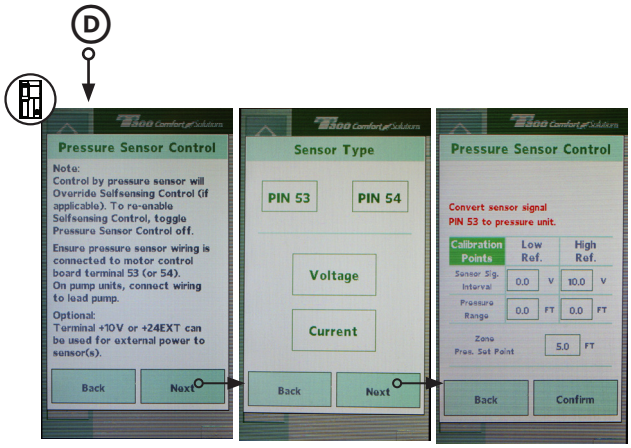
## 9.2.5 Manual/Auto Mode

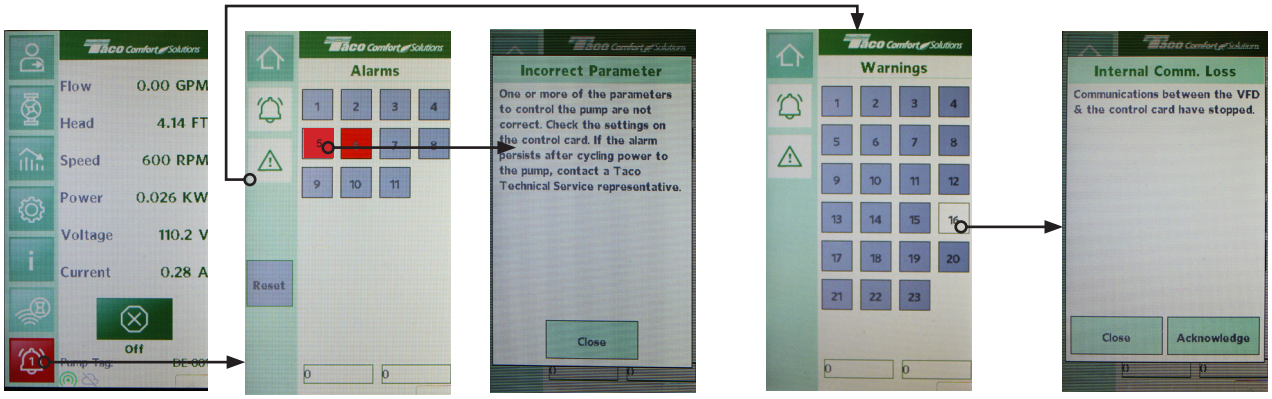


## 9.2.6 Pump Control




B
Pump Control Type
Important
Please use web interface
to access parallel control settings!
Close
Single Control Mode
Quadratic
Linear
Constant Flow
Constant Head
Min-Quadratic
Quadratic-Max
Min-Quad-Max
C
I/O
Test
Pressure Sensor Ctrl.
D
Remote
Modbus RTU
Modbus TCP/IP
BACnet MS/TP
BACnet IP
Disabled
IO Test
Analog Input 1: 0
AI1 Config. Set: Voltage
Analog Input 2: 8178
AI2 Config. Set: Voltage
Analog Output: 0
Dig. Input 1 : High
Dig. Input 2: Low
Dig. Output 1: Low
Dig. Output 2: Low
Relay. 1: High
Relay. 2: Low
Back
Modbus RTU
Address
1
Baud Rate
19200
Data Bits 8 Bits
Parity/Stop NONE
Stop Bits 1 Bit
Close
Modbus TCP/IP
Address
1
IP Address 10.15.0.25
Subnet Mask 255.255.0.0
Port 502
Close
BACnet MS/TP
MAC Address
1
Baud Rate
19200
Instance Number
1
Max Info. Frame
1
Max Master
127
Close
BACnet IP
Instance Number
1
Descriptor pump1
IP Address 10.15.0.25
Subnet Mask 255.255.0.0
Port Number 47808
Close
C
Select Mode
Standard
Dual Season Setup
Mode 1
Mode 2
Close
Update
Constant Flow
Design Flow
65.00 GPM
Constant Head
Design Head
65.00 FT
Are you going to switch to Standard?
Quadratic
Design Head
20.00 FT
Design Flow
65.00 GPM
Min. Head
5.00 FT
Linear
Design Head
20.00 FT
Design Flow
65.00 GPM
Min. Head
5.00 FT
Min-Quadratic
Design Head
20.00 FT
Design Flow
65.00 GPM
Min. Head
5.00 FT
Min. Flow
20.00 GPM
Quadratic-Max
Design Head
20.00 FT
Design Flow
65.00 GPM
Min. Head
5.00 FT
Min-Quad-Max
Design Head
20.00 FT
Design Flow
65.00 GPM
Min. Head
5.00 FT
Min. Flow
20.00 GPM


D
Pressure Sensor Control
Note:
Control by pressure sensor will Override Selfsensing Control (if applicable). To re-enable Selfsensing Control, toggle Pressure Sensor Control off.
Ensure pressure sensor wiring is connected to motor control board terminal 53 (or 54). On pump units, connect wiring to lead pump.
Optional:
Terminal +10V or +24EXT can be used for external power to sensor(s).
Back
Next
Sensor Type
PIN 53
PIN 54
Voltage
Current
Back
Next
Pressure Sensor Control
Convert sensor signal PIN 53 to pressure unit.
Calibration Points
Low Ref.
High Ref.
Sensor Sig. Interval
0.0
V
10.0
V
Pressure Range
0.0
FT
0.0
FT
Zone Pres. Set Point
5.0
FT
Back
Confirm

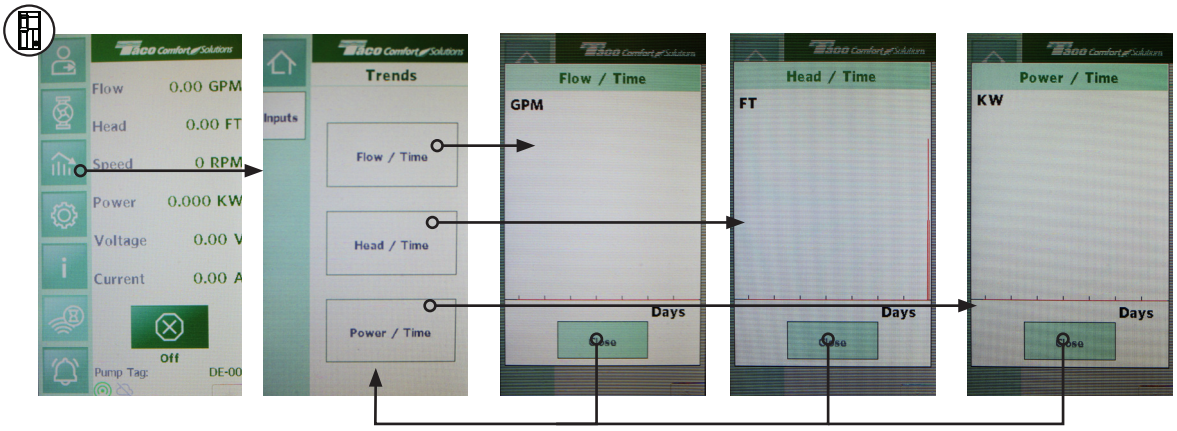

Flow 0.00 GPM
Head 4.14 FT
Speed 600 RPM
Power 0.026 KW
Voltage 110.2 V
Current 0.28 A
Off
Alarms
1 2 3 4
5 6 7 8
9 10 11
Reset
Incorrect Parameter
One or more of the parameters to control the pump are not correct. Check the settings on the control card. If the alarm persists after cycling power to the pump, contact a Taco Technical Service representative.
Close
Warnings
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16
17 18 19 20
21 22 23
Internal Comm. Loss
Communications between the VFD & the control card have stopped.
Close
Acknowledge

### 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.

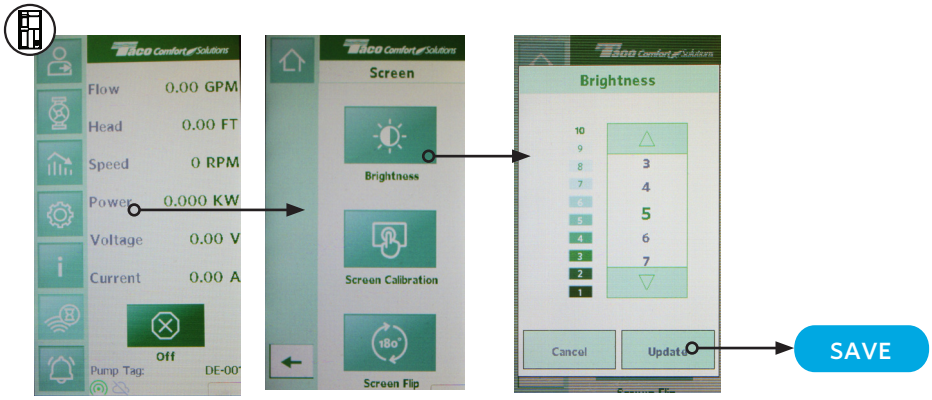



To see a more comprehensive view of the trends, the pump data can be exported in CSV format for review and analysis on a separate computing device.

### 9.2.8 Brightness Adjustment

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

10 = highest brightness, 1 = lowest brightness



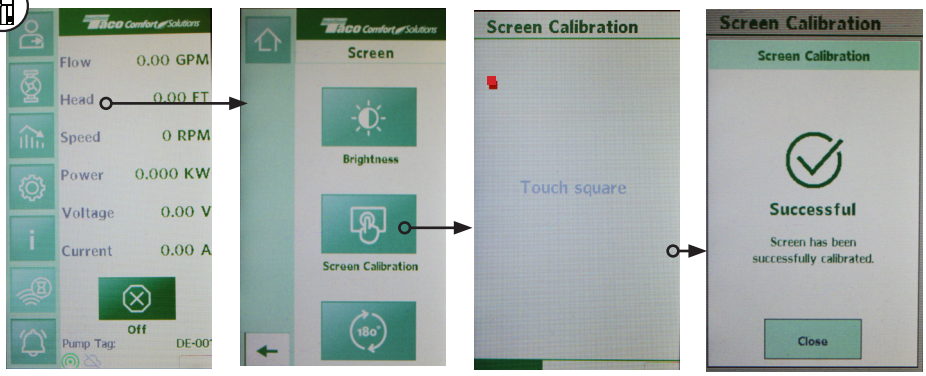
### 9.2.9 Touch Screen Calibration

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

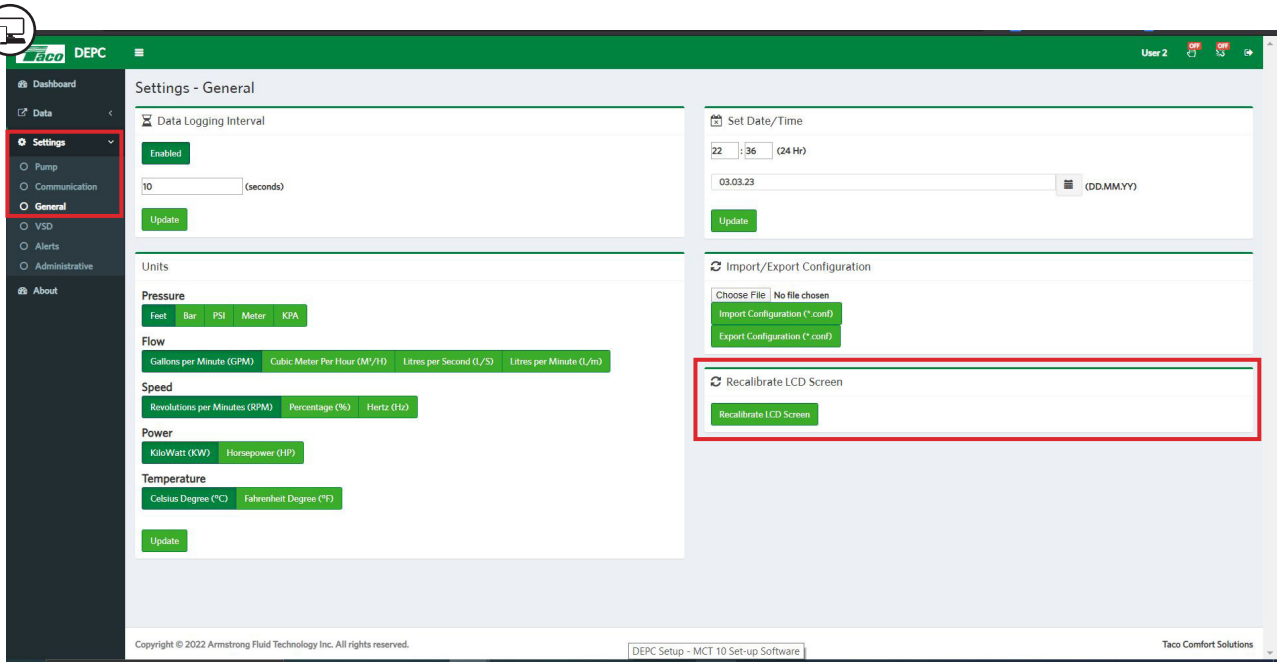
- Being unable to access items to the edge of the screen
- Some buttons from the display are unresponsive

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.

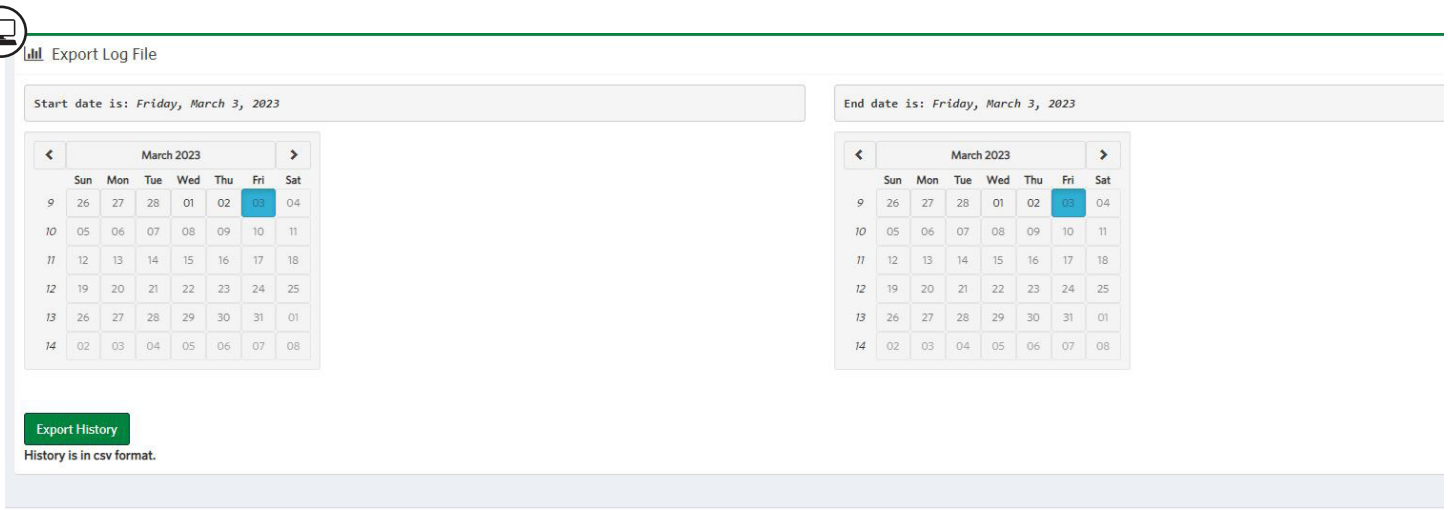


### 9.2.10 Data Logging

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 () 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.



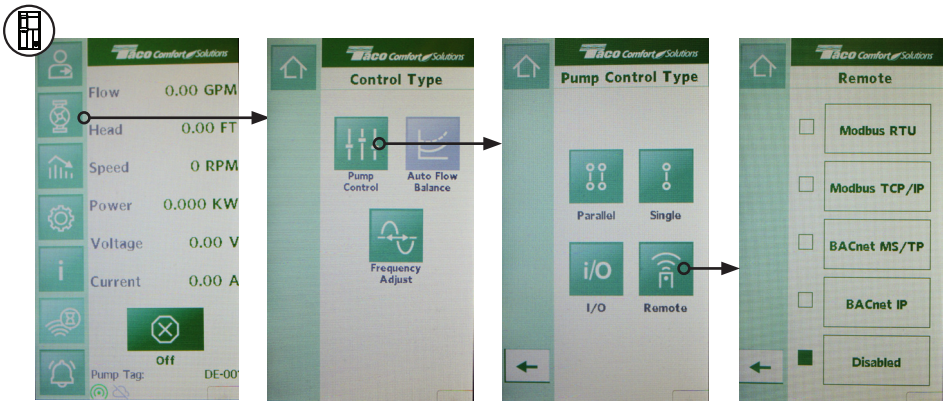

Connect the MPC to the Webserver, in the **Data -> Trends -> Export Log File section.**

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

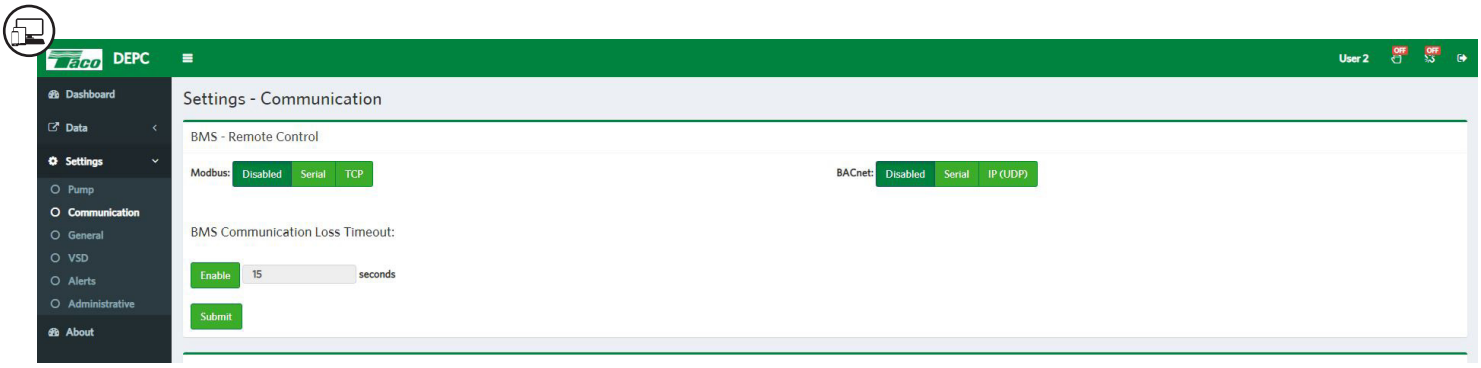
For connection to the building automation system (BAS), the pump needs to be properly configured to the network. Ensure the rs485 cable is connected to the controller board (Figure 9-1). Or if connecting to the bas via router, ensure that the RJ-45 cable is connected to the controller board (Figure 9-1)

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)

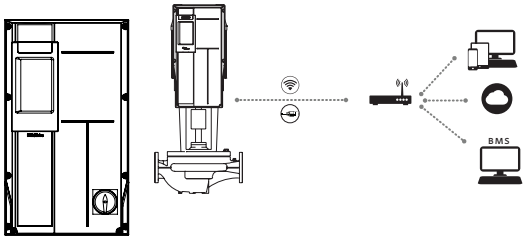


## 9.4 Web Interface

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

### 9.4.1 Connecting Via Ethernet

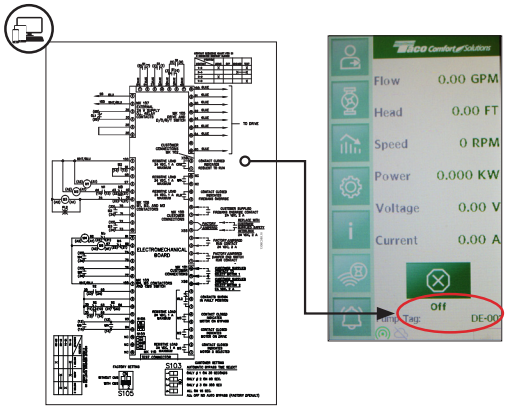
**NOTE:** Ethernet to router to computer only.




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

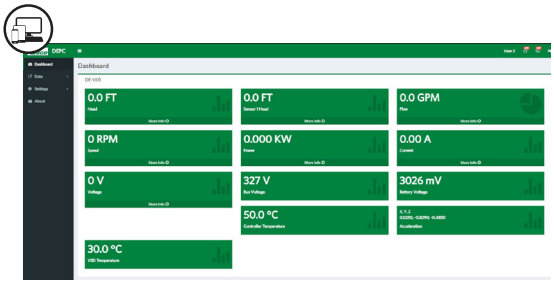
### 9.4.2 Connecting Via WIFI

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



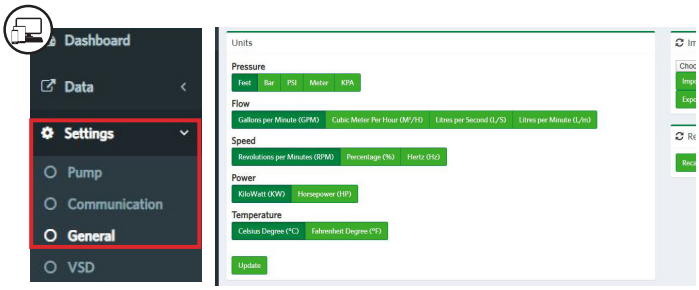

At the web browser address bar, type the Pump's IP **(from Pump's About (i) screen)**.

Default user level 1 Password: Pump321

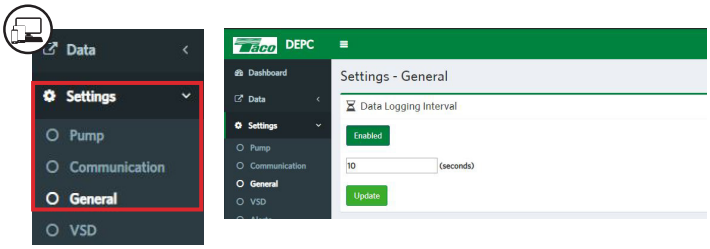



To access general controller settings:

Press settings → General, select desired units and click Update

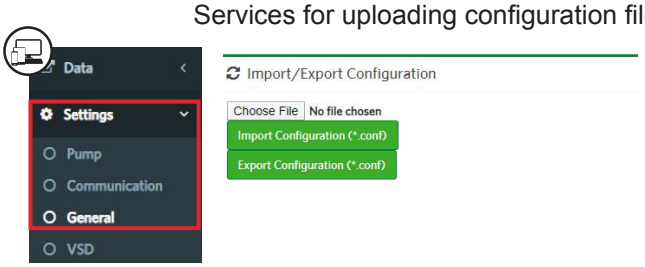



To set the interval for timer based recording: Press settings → General, click on enable and input the desired time (default is 10 seconds)

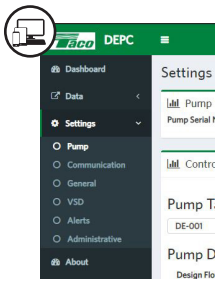


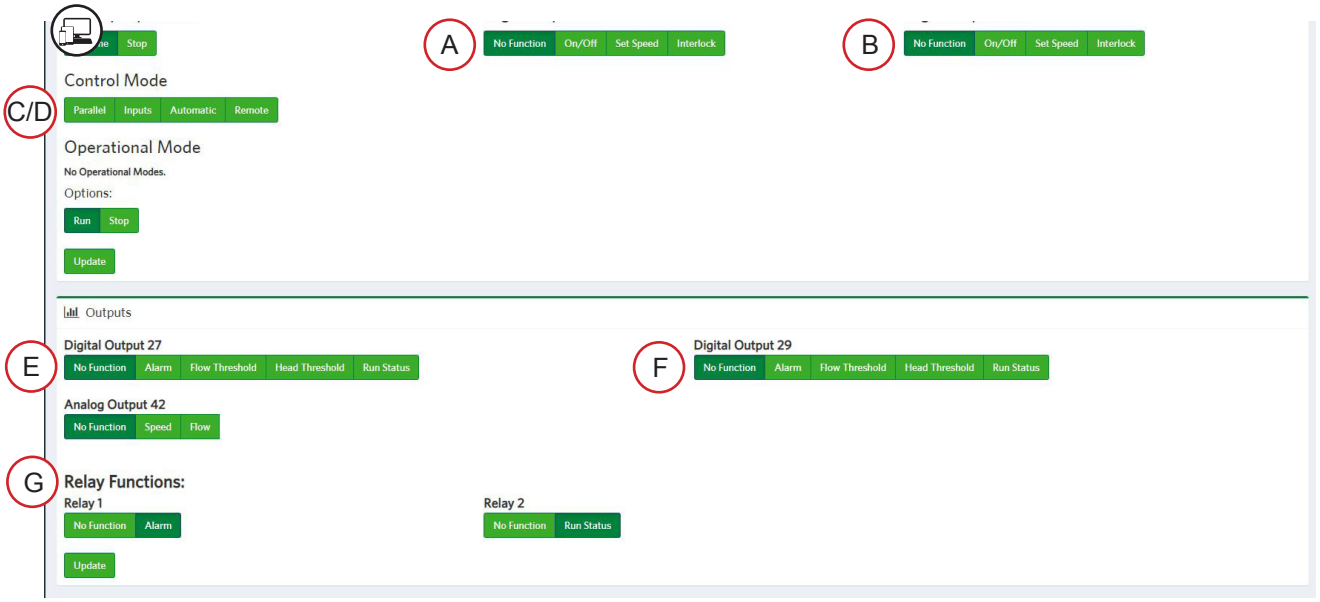

To Import/Export configuration files: Press Settings → General, select a file and click on Import Configuration to input. Click on Export Configuration to export

**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

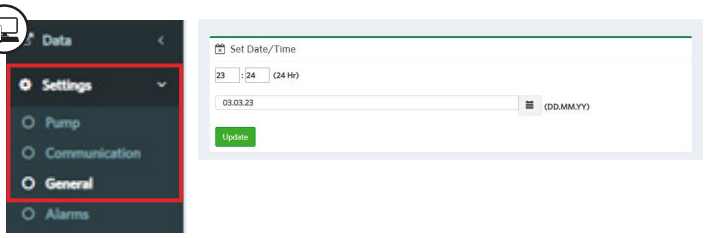
**For Digital Functions (E, F) that have been wired:**

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

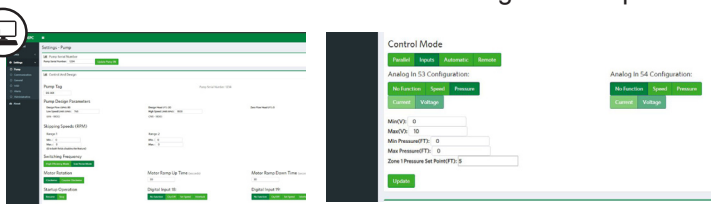
**For Relay Functions (G) that have been wired:**

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

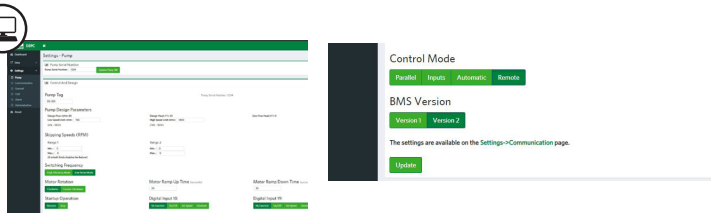
To modify Date/Time: click Settings → General and modify date and time




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.

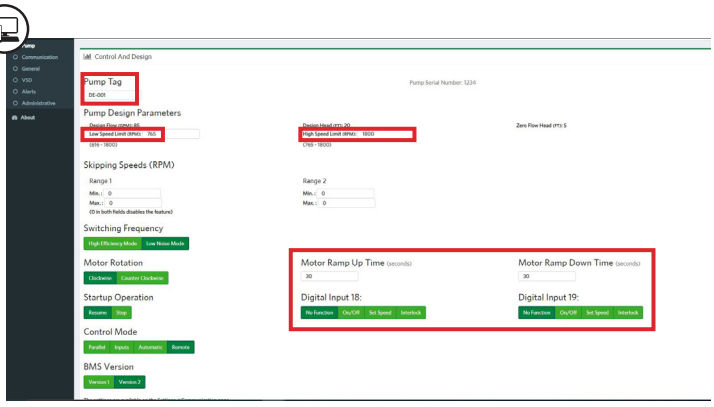



Settings → Pump,

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.**

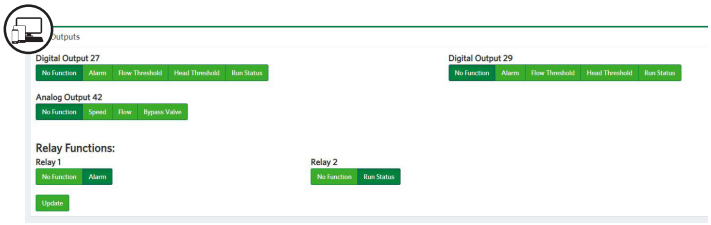



To modify output settings: Settings → Pump,

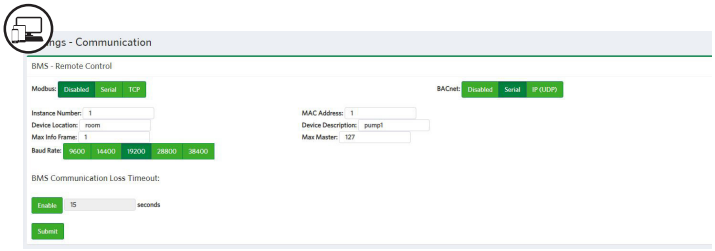
To modify digital outputs: select desired function,

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.**

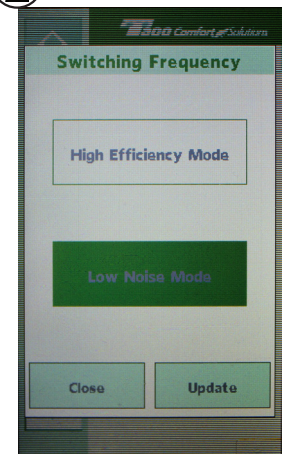



## 9.5.1 Switching Frequency

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**

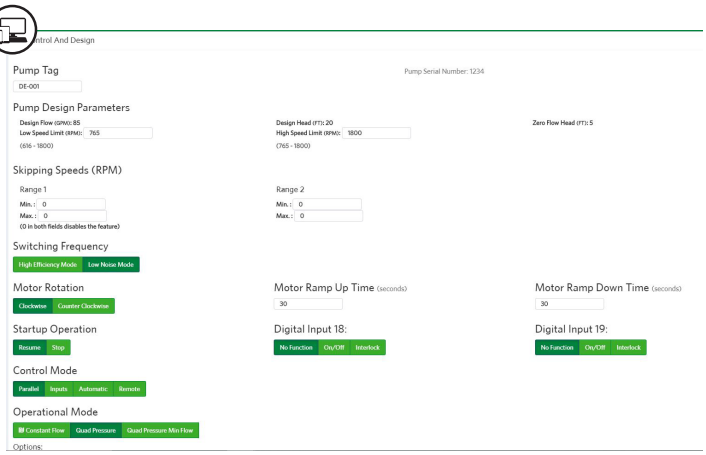
This frequency setting minimizes the losses in the drive and motor for optimum performance. However, at this lower setting, the motor may produce an audible high-pitched noise. If noise is produced and unacceptable, then the drive can be set to Low Noise Mode.

**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.

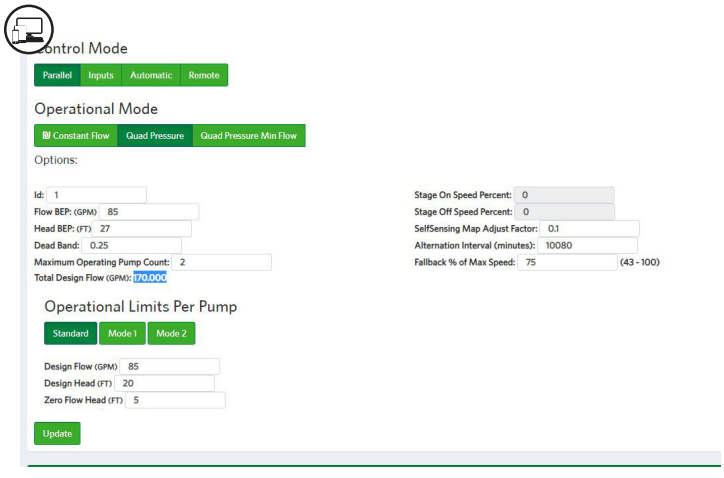



## 9.5.3 Fallback Percentage of Maximum Speed

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%).

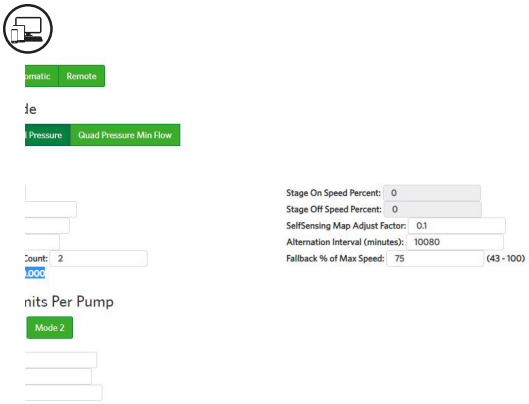
Note that only the disconnected pump will operate at constant speed, the other remaining pumps in the communication circuit will continue to operate in Parallel Sensorless mode to the control curve.

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




## 9.5.4 Standby Pumps

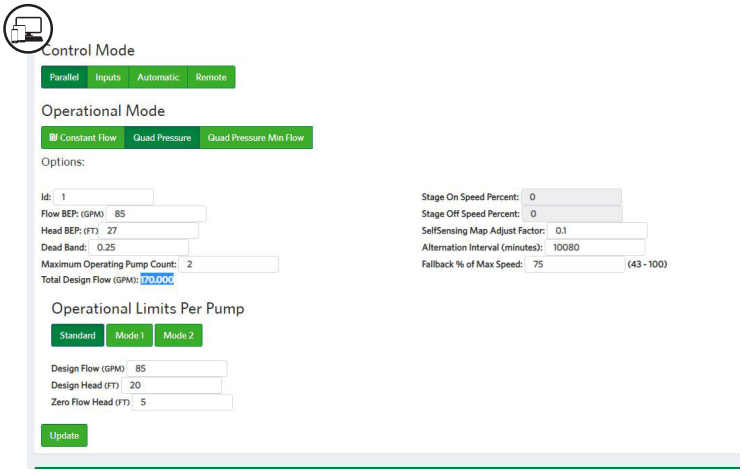
Scroll down to **Operational Mode** and input the **Maximum Operating Pump Count.** The remaining pumps will be Standby. Calculated Design Flow will automatically update based on the number of pumps inputted.




## 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.

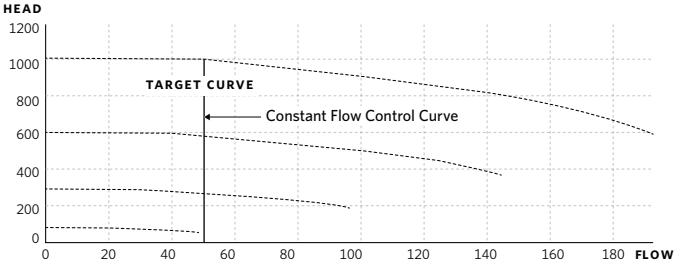
To change this setting, use the Webserver and go to Settings -> Pump, and then go the Control Mode section, under the Parallel tab, and input the Alternation Interval (in minutes) to the new value. Press update to complete the change. Connect the Webserver to the second pump and repeat.



# 9.6 Control Modes

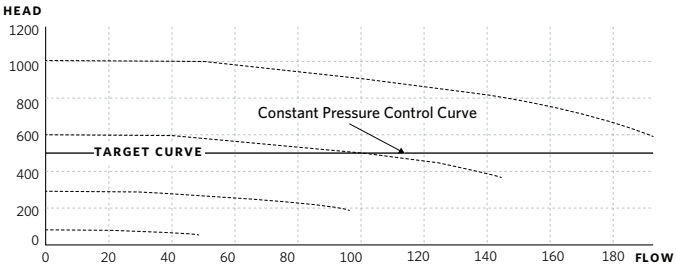
## 9.6.1 Constant Flow

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.



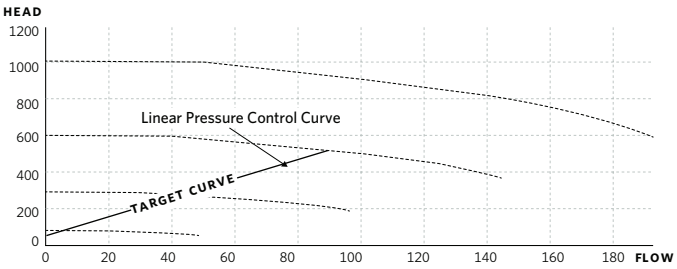

## 9.6.2 Constant Pressure

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

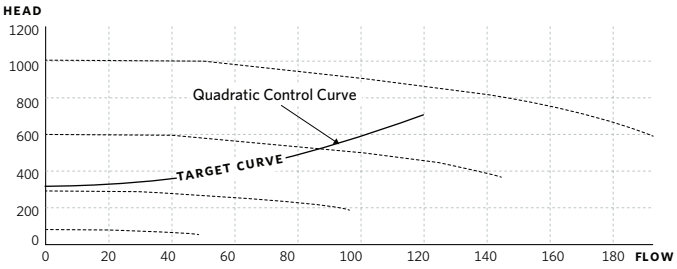
Linear Pressure Control is where the controller is set to control the speed according to a control 'curve' between max and min flow. This type of control will change the pump speed to ensure the pump operates on the projected linear control curve, where the pump head varies directly with the flow. This 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.

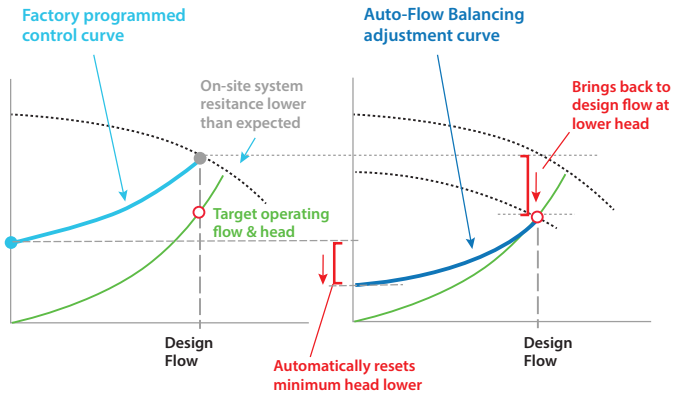



## 9.6.4 Quadratic Curve Control

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.

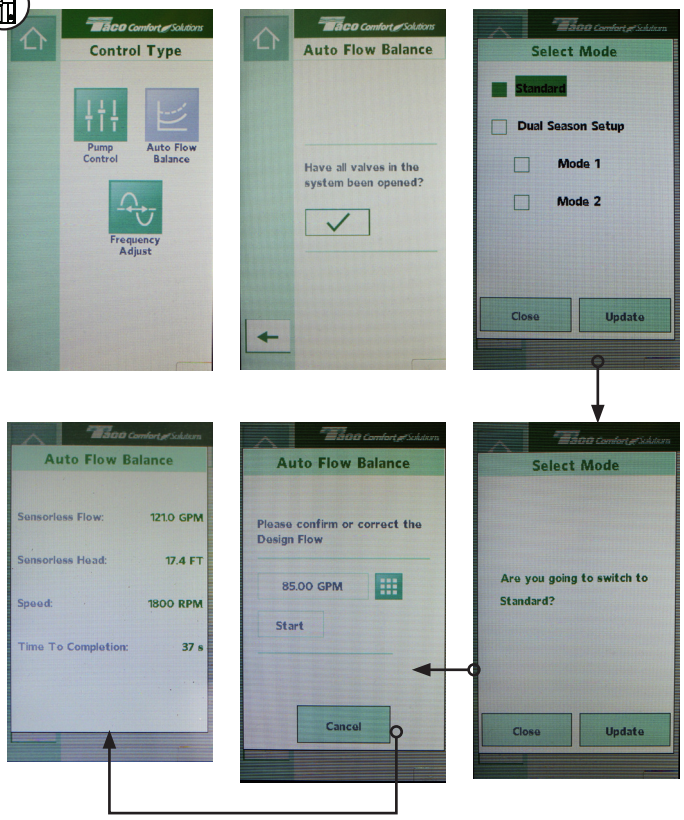



For buildings that are commissioned in multiple stages, or where the design flow changes each time, the Auto Flow Balancing function can be run at the beginning of each stage.

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

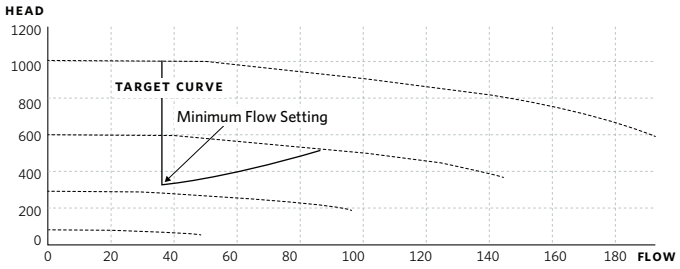
From the touch screen, go to **Control Type -> Auto Flow Balancing**, then follow the on-screen instructions. The Auto Flow Balancing scan takes approximately 3 minutes to complete.




## 9.6.5 Quadratic Curve Control With Minimum Flow Protection

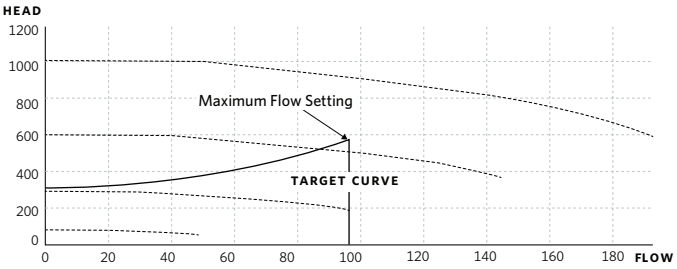
This configuration is designed for HVAC hydronic systems where flow sensitive equipment required a minimum flow for equipment stability; such as a chiller that cannot tolerate flow below a certain volume. This control will take advantage of the 9.6.4 Quadratic Curve Control mode, where the pump will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



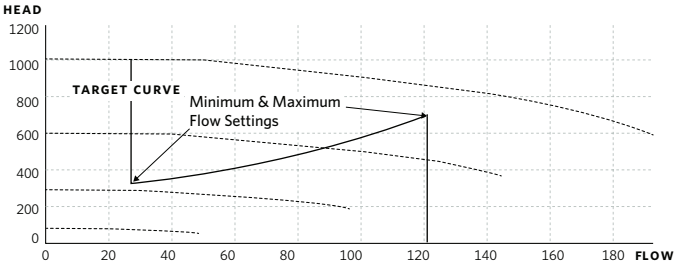

## 9.6.6 Quadratic Curve Control With Maximum Flow Protection

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

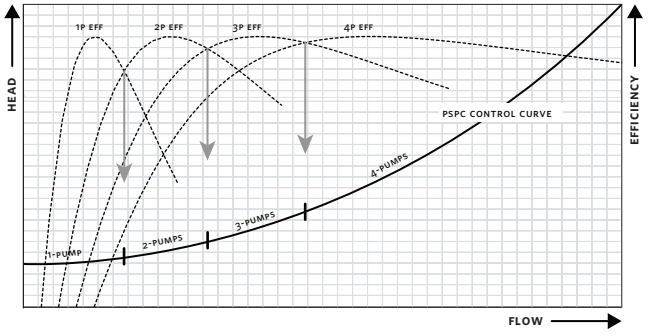
This control mode combines the control logic of 5.5 & 5.6 which takes the values of the quadratic control curve and protection for both the maximum & minimum flow limits. Pump controls can only control the flow to the motor limit or maximum / minimum speed limits of the unit, thus a dry-contact relay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



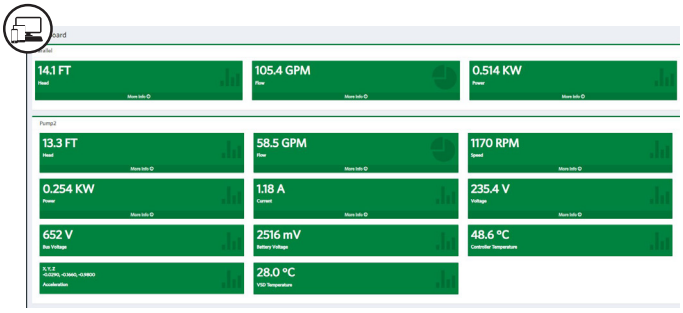

## 9.6.8 Parallel SelfSensing

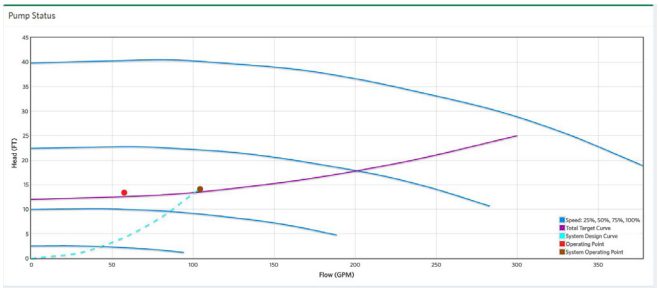
This configuration maps the quadratic control curve into the pump controls and ensures the system flow requirements are met, while staging the pumps on and off to maintain optimum pump energy usage. This is accomplished by operating the pumping units at the best pumping efficiency level for the required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



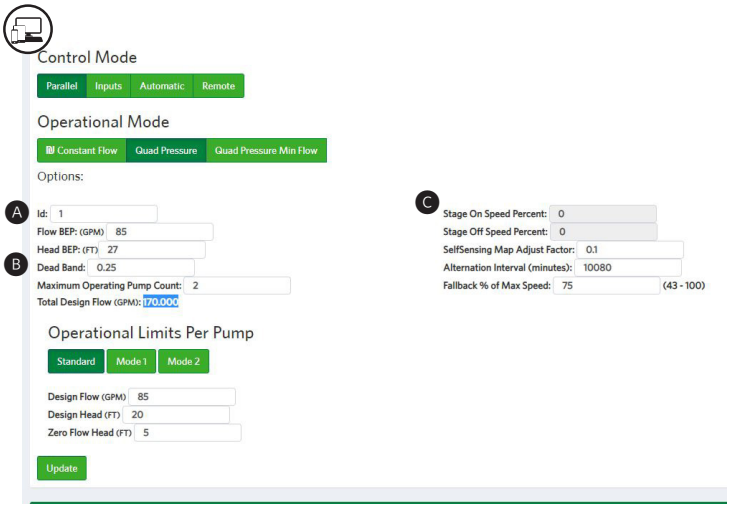

Start by installing a wiring bridge between the pumps (supplied by others). The wiring between the control cards is a canbus (3-wire) cable with terminal blocks at each end (3 position strain 3.81 mm).

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:




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

Ⓑ Dead Band: set to 0.25

Ⓒ 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 Ⓐ to Ⓒ.

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 Match Pump and Drive Tags

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

## 10.1 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 10-1: Example Tag


## 10.2 Mechanical Connections

For mechanical connections to pump, see section 7.4.

## 10.3 Electric Code Compliance

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

For electrical connections see Section “8 Electrical Connections” on page 7.

## 10.4 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 con-verter as well as the motor.
6. Inspect the frequency converter for loose connec-tions 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 4. Check mark those items when completed.

**Table 4: 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.<br>– Check function and installation of any sensors used for feedback to the frequency converter.<br>– 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. | |

**Table 4: Inspection Checklist (Cont.)**

| 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.<br>– Check function and installation of any sensors used for feedback to the frequency converter.<br>– 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.<br>– Check that control wiring is isolated from power and motor wiring for noise immunity.<br>– Check the voltage source of the signals, if necessary.<br>– 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.<br>– Humidity levels must be 5-95% non-condensing. | |
| Fusing and circuit breakers | – Check for proper fusing or circuit breakers.<br>– 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).<br>– Check for good earth connections(ground connections) that are tight and free of oxidation.<br>– 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.<br>– 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.<br>– Check for an unusual amount of vibration. | |

## 10.5 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.

**NOTE:** If the status line at the bottom of the LCP reads “AUTO REMOTE COASTING” or “Alarm 60 External Interlock” is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.

1.Confirm the input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.

2.Ensure that optional equipment wiring, if present, matches the installation application.

3.Ensure that all operator devices are in the OFF position. Panel doors should be closed or cover mounted.

4.Apply power to the unit. DO NOT start the frequency converter at this time. For units with a disconnect switch, turn to the ON position to apply power to the frequency converter.

# 11 SCI PUMP PROBLEM ANALYSIS

## 11.1 No Discharge

1. Pump not primed
2. Speed too low (when direct con-nected to electric motor, determine whether or not motor is across the line and receives full voltage)
3. System head too high
4. Suction lift higher than that for which pump is designed
5. Impeller completely plugged
6. Wrong direction of rotation
7. Air leak in the suction line
8. Air leak through stuffing box

## 11.2 Insufficient Discharge Flow

1. Air leaks in suction line or stuffing box
2. Speed too low (when direct connected to electric motor, determine whether or not motor is across the line and receives full voltage)
3. System head higher than anticipated
4. Insufficient NPSH. Suction lift too high. Check gauges. Also check for clogged suction line or screen.
5. Not enough suction head for hot or volatile liquids
6. Foot valve too small
7. Impeller partially plugged
8. Mechanical defects:

   Wearing rings worn Impeller damaged Foot valve or suction opening not submerged enough Wrong direction of rotation

## 11.3 Insufficient Discharge Pressure

1. Speed too low (when direct con-nected to electric motor, determine whether or not motor is across the line and receives full voltage)
2. System head less than anticipated.
3. Air or gas in liquid
4. Mechanical defects
   a. Wearing rings worn
   b. Impeller damaged
   c. Impeller diameter too small
   d. Wrong direction of rotation

## 11.4 Loss of Suction Following Period of Satisfactory Operation

1. Leak in suction line
2. Waterseal plugged
3. Suction lift too high or insufficient NPSH
4. Air or gas in liquid
5. Casing gasket defective
6. Clogging of strainer

## 11.5 Excessive Power Consumption

1. Speed too high
2. System head lower than rating pumps too much liquid
3. Specific gravity or viscosity of liquid is too high
4. Mechanical defects.
   a. Shaft bent
   b. Rotating elements bind
   c. Stuffing boxes too tight
   d. Wearing rings worn

## 11.6 Vibration

1. Air leak in suction line
2. Air or gas in liquid
3. Impeller partially plugged
4. Mechanical defects
   a. Damaged impeller
   b. Misalignment of pump and driver
   c. Bearing worn
   d. Rotor out of balance Shaft bent
5. Foundation not rigid

## 11.7 Motor Runs Hot

1. Speed too high
2. Specific gravity or viscosity liquid pumped is too high
3. Mechanical defects
   a. Shaft bent
   b. Rotating element binds
   c. Defects in motor Voltage and/or frequency lower than rating
   d. Misalignment of pump and driver

## 11.8 PUMP BEARINGS OVERHEAT

1. Contaminated lubricant
2. Mechanical defects:
   a. Shaft bent
   b. Rotor out of balance
   c. Misalignment of pump and driver

# 12 SPECIFICATIONS

## 12.1 Power-dependent Specifications

**Table 5: Line Power Supply 200-240 V AC**

| Line Power Supply 200-240 V AC - Normal overload 110% for 1 minute | | | | | |
|---|---|---|---|---|---|
| Adjustable frequency drive<br>Typical Shaft Output [kW] | **P1K1**<br>**1.1** | **P1K5**<br>**1.5** | **P2K2**<br>**2.2** | **P3K0**<br>**3** | **P3K7**<br>**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 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<br>Typical Shaft Output [kW] | **P5K5**<br>**5.5** | **P7K5**<br>**7.5** | **P11K**<br>**11** | **P15K**<br>**15** | **P18K**<br>**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 7: 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<br>Typical Shaft Output [kW] | **P22K**<br>**22** | **P30K**<br>**30** | **P37K**<br>**37** | **P45K**<br>**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 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<br>Typical Shaft Output [kW] | **P1K1**<br>**1.1** | **P1K5**<br>**1.5** | **P2K2**<br>**2.2** | **P3K0**<br>**3** | **P4K0**<br>**4** | **P5K5**<br>**5.5** | **P7K5**<br>**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)<br>(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 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<br>Typical Shaft Output [kW] | **P11K**<br>**11** | **P15K**<br>**15** | **P18K**<br>**18.5** | **P22K**<br>**22** | **P30K**<br>**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 10: 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<br>Typical Shaft Output [kW] | **P37K**<br>**37** | **P45K**<br>**45** | **P55K**<br>**55** | **P75K**<br>**75** | **P90K**<br>**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) [mm2 (AWG)] | | | 150 (300 MCM) | | |
| IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm2 (AWG)] | | | 95 (3/0) | | |

**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:** | **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)<br>(min. 0.2 (24)) | | | | | | | | |
| IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm2]/[AWG] | 4, 4, 4 (12, 12, 12)<br>(min. 0.2 (24)) | | | | | | | | |
| Max. cable cross-section with disconnect | 6, 4, 4 (12, 12, 12) | | | | | | | | |

**Table 12: 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) [mm2]/[AWG] | | | | | | | | | |
| Max. cable cross-section with disconnect | | | | | | | | | |

### 12.1.1 Line Power Supply 3 x 525-690 V AC

**Table 13: Line Power Supply 3 x 525-690 V AC**

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

**Table 14: 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<br>Typical Shaft Output [kW] | **P11K<br>11** | **P15K<br>15** | **P18K<br>18** | **P22K<br>22** | **P45K<br>45** | **P55K<br>55** |
| Typical Shaft Output [HP] at 575V | 16.4 | 20.1 | 24 | 33 | 60 | 75 |
| Max. cable size (line power, motor, brake) [mm2]/(AWG) [1)] | [35]/(1/0) | | | | [50]/(1) | |

**Table 15: Line Power Supply 3 x 525-690 V AC IP21-IP55/NEMA 1-NEMA 12**

| Normal overload 110% for 1 minute | | | | | |
|---|---|---|---|---|---|
| Adjustable frequency drive<br>Typical Shaft Output [kW] | **P30K<br>30** | **P37K<br>37** | **P45K<br>45** | **P55K<br>55** | **P75K<br>75** |
| Typical Shaft Output [HP] at 575V | 40 | 60 | 60 | 75 | 100 |
| Max. cable size (line power, motor, brake) [mm2]/(AWG) [1)] | [95]/(4/0) | | | | |

[1)] American Wire Gauge

## 12.2 Connection Tightening Torques

**Table 16: Tightening of Terminals**

| | Power (kW) | | | Torque (Nm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Enclosure** | **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 $in^2$ [95 $mm^2$] and y >= 0.147 $in^2$ [95 $mm^2$].

# Appendix A Modbus Register Map

| Function code | | Start Address | Modbus Register | Description | # of Registers | Change During Operation | Data Type | Unit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| Read | Write | | | | | | | | |
| 0×03 | 0×06 | | | | | | | | |
| **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 = m3/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;<br>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 rests the counter. |

| Function code | | Start Address | Modbus Register | Description | # of Registers | Change During Operation | Data Type | Unit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| Read | Write | | | | | | | | |
| 0×03 | 0×06 | | | | | | | | |
| **Control Settings** | | | | | | | | | |
| x | | 300 | 301 | Control Mode | 1 | Yes | uint16 | - | 1 = Parallel; 2 = Inputs; 3 = Remote;<br>4 = Constant Flow; 5 = Constant Pressure; 6 = Linear Pressure; 7 = Quadratic Pressure;<br>8 = Quad Pressure Maximum;<br>9 = Quad Pressure Minimum;<br>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 B 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 |
| **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 |

| Object ID | Object Name | Read/Write | Comments |
|---|---|---|---|
| **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 |

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