PENTAIR



PENTEK®
ELECTRONICS MANUAL
INSTALLATION • OPERATION • MAINTENANCE

WWW.PUMPS.COM

Table of Contents

SECTION 1: General Safety Guidelines

SECTION 2: Nomenclature
2.1 Motors
2.2 Drives
2.3 Submersible Motor Controls

SECTION 3: Installation and Setup
3.1 General Installation Guidelines
3.2 Proper Grounding
3.3 Corrosive Water and Ground
3.4 Check Valves
3.5 Start-Up

SECTION 4: Electrical Power
4.1 Mixing Wire Size with Existing Installation
4.2 Wire Splicing
4.3 3-Phase Starters
4.4 Checking Motor Rotation
4.5 3-Phase Current Balancing
4.6 Transformer Sizing
4.7 Using a Generator
4.8 Special Applications

SECTION 5: XE Series 4" Submersible Motors
5.1 Motor Inspection
5.2 Testing
5.3 Storage and Transportation
5.4 4" Motor Specifications
5.5 4" Motor Dimensions
5.6 4" Motor Fuse Sizing
5.7 Cable Lengths
5.8 4" Motor Overload Protection
5.9 Motor Cooling
5.10 Starting Frequency

SECTION 6: Pentek® 6" Submersible Motors
6.1 Motor Inspection
6.2 Testing
6.3 Storage and Drain/Fill Instructions
6.4 Motor Specifications
6.5 Motor Dimensions
6.6 Motor Fuse Sizing and Cable Selection
6.7 Overload Protection
6.8 Motor Cooling
6.9 Head Loss In Casing
6.10 Starting Frequency
6.11 Troubleshooting

SECTION 7: Hitachi® 6" Submersible Motors
7.1 Motor Inspection
7.2 Testing
7.3 Storage and Drain/Fill Instructions
7.4 Motor Specifications
7.5 Motor Dimensions
7.6 Motor Fuse Sizing and Cable Selection
7.7 Overload Protection
7.8 Motor Cooling
7.9 Head Loss In Casing
7.10 Starting Frequency
7.11 Troubleshooting

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives
8.1 General Safety
8.2 Description
8.3 Installation
8.4 Initial Startup Programming Procedure
8.5 Advanced Programming
8.6 I/O Connections
8.7 Wiring Sizing, Repair Parts, Specifications
8.8 Troubleshooting
8.9 Warranty

SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives
9.1 Pentek PPC-Series Drives
9.2 PPC3 Series Specifications
9.3 PPC5 Series Specifications
9.4 Wiring Connections
9.5 Transducer Connection
9.6 Pentek Assistant
9.7 Timer Function
9.8 Helpful Hints
9.9 PPC3 and PPC5 Tank Sizing
9.10 Reactors And Filters

SECTION 10: PPX NEMA Pump Panels
10.1 Description

SECTION 11: Submersible Motor Controls
11.1 How it Works
11.2 Specifications
11.3 Mounting and Installation
11.4 Wiring Connections and Replacement Parts

SECTION 12: Motor Protective Devices - 50/60 Hz
12.1 How They Work
12.2 Specifications
12.3 Mounting And Installation
12.4 Wiring Connections

SECTION 13: Troubleshooting
13.1 Pump And Motor Problem Analysis
13.2 Motor Troubleshooting Flow Charts
13.3 Testing Submersible Motor Insulation and Winding Resistance
13.4 Smart Pump Protector Troubleshooting
13.5 Submersible Controls Troubleshooting

SECTION 14: Appendix
14.1 Installation Checklist
14.2 Choosing A Pump System
14.3 Sizing Submersible Pump, Motor, and Tanks
14.4 How to Select the Correct Pumping Equipment
14.5 Sizing Tanks
14.6 Record of Installation

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.
All other brand or product names are trademarks or registered trademarks of Pentair Ltd.

SECTION 1: General Safety Guidelines

Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during installation, operation, and maintenance of the product. Always refer to the equipment owner's manual for safety information relevant to that product.

⚠ This is the safety alert symbol. When you see this symbol on your product or in this manual, look for one of the following signal words and be alert to the potential for personal injury!

⚠ DANGER indicates a hazard which, if not avoided, will result in death or serious injury.

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

⚠ CAUTION indicates a hazard which, if not avoided, could result in minor or moderate injury.

NOTICE addresses practices not related to personal injury.

Carefully read and follow all safety instructions in this manual and on product.

Keep safety labels in good condition.

Replace missing or damaged safety labels.

⚠ WARNING Fatal Electrical Shock Hazard.

- Ground motor, controls, all metal pipe and accessories connected to the motor, to the power supply ground terminal. Ground wire must be at least as large as motor supply cables.
- Disconnect power before working on the system.
- Do not use the motor in a swimming area.

⚠ WARNING



Hazardous voltage. Can shock, burn, or cause death.

Ground pump before connecting to power supply. Disconnect power before working on pump, motor or tank.

All work must be done by a trained and qualified installer or service technician.

SECTION 2: Nomenclature

2.1 Motors

Table 2-1: Motor Nomenclature

Sample:

P43B0010A2-01 is a PENTEK 4" Stainless Steel Motor

1 HP, 60 Hz., 230 V, 1 Ph., Rev. 1

Name Plate Example: P 43 B 0 0 1 0 A 2 -01

Brand
P = PENTEK

Motor Size
42 = 4 inch, 2-wire
43 = 4 inch, 3-wire

Motor Material
B = All stainless steel
S = CBM

Horsepower
0005 = 1/2 HP
0007 = 3/4 HP
0010 = 1 HP
0015 = 1-1/2 HP
0020 = 2 HP
0030 = 3 HP
0050 = 5 HP
0075 = 7-1/2 HP
0100 = 10 HP

Frequency
A = 60 Hz.
B = 50 Hz.
C = 50/60 Hz.

Voltage
1 = 115 V, 1 Ph.
2 = 230 V, 1 Ph.
3 = 230 V, 3 Ph.
4 = 460 V, 3 Ph.
5 = 575 V, 3 Ph.
8 = 200 V, 3 Ph

Revision Code

SECTION 2: Nomenclature

2.2 Drives

Variable / High Speed Drive Nomenclature

The chart below shows the naming for a PPC5, 460 volt, 4 amp drive with a NEMA 1 enclosure.

PPC5-4-4A1-1

Series	Input Voltage	Output Amp Rating	Enclosure
PPC5	**2** (230 V, 3 ph.)	**4A1**	**1 (NEMA 1)**
PPC3	**4 (460 V), 3 ph.)**	4A1 = 4.1 amps (Amps A tenths)	**12** (NEMA 12)
	5 (575 V), 3 ph.)		
	1 (230 V, 1 ph.)		

Note that the output current (amps) of the control must be greater than or equal to the maximum rated motor current. Output of all drives is 3-phase power.

PID Variable Frequency Drive Nomenclature

PID – 10

Product Family
PID = Pentek IntelliDrive

HP Rating:
10 = up to 1 HP
20 = up to 2 HP
50 = up to 5 HP

2.3 Submersible Motor Controls

The chart below shows the naming for a Submersible Motor control, Standard box, capacitor run, 5 horsepower, 230 volt single phase drive.

SMC - CR 50 2 1

Series	Style	HP x 10	Voltage	Phase
SMC_(Std.)	**CR** (Cap Run)	**05** (0.5 hp)	**1** (115 v)	1 (Single)
SMC5 (50 Hz)	**IR** (Induction Run)	**07** (.75 hp)	**2** (230 v)	
	CRP (Cap Run with contactor)	**10** (1 hp)		
		15 (1.5 hp)		
		20 (2 hp)		
		30 (3 hp)		
		50 (5 hp)		

SECTION 3: Installation and Setup

3.1 General Installation Guidelines

- In order to avoid abrasion to the power and control cables, pad the top of the well casing (a rubber pad is recommended) where the cable will pass over it; use a cable reel for cable control.
- The unit must always be easy to rotate in the hoisting gear.
- Lay power and control cables out straight on the ground (no loops) before installation. Guide cables during lowering so that they are not stretched or squeezed while pump is being installed. Make sure that cable insulation is not nicked or damaged before or during installation. Never use the electrical cables to move the motor/pump.
- The pump and motor are heavy. Make sure that all connections are secure and that the hoisting gear is adequate to do the job before starting to lift pump. Don't stand under the unit. Don't allow extra people into the area while hoisting the unit.
- If motor or pump/motor unit are attached to a supporting girder, do not remove girder until unit is vertical.
- Install pump at least 10' (3m) below the lowest water level during pumping, but at least 6' (2m) above the bottom of the well.
- 6" motors can be operated in vertical or horizontal (when lead wire is at 12:00 position facing motor flange) positions.
- 4" motors can be operated in vertical or horizontal positions. Note that the thrust bearing will have shorter life in a non-vertical application. In such an installation, keep frequency of starts to less than 10 per day.

3.2 Proper Grounding

⚠WARNING Hazardous voltage. Can shock, burn or cause death. Installation or service to electrical equipment should only be done by qualified electrician.

Control panels must be connected to supply ground

Proper grounding serves two main purposes:

1. It provides a path to ground in case of a ground-fault. Otherwise the current would present a shock or electrocution hazard.
2. It protects equipment from electrical surges.

Use wire the same size as, or larger than motor's current-carrying wires (consult Tables in the motor section).

Installations must comply with the National Electric Code as well as state and local codes.

All systems must have lightning (surge) protection with a secure connection to ground.

An above ground lighting (surge) protection must be grounded metal-to-metal and extend all the way to the water bearing layer to be effective. Do not ground the lightning (surge) protection to the supply ground or to a ground rod as this will provide little or no surge protection to the unit.

All motors are internally grounded and requires a 3 or 4-wire drop cable.

3.3 Corrosive Water and Ground

Some waters are corrosive, and can eventually corrode the ground wire. If the installation uses a metal well casing, any ground current will flow through it. In the case of plastic piping and casing, the water column would carry the current in a ground fault situation.

To prevent this, route the motor ground wire and the motor power leads through a GFCI with a 10 mA set point. In this way, the GFCI will trip when a ground fault has occurred AND the motor ground wire is no longer functional.

3.4 Check Valves

Check valve installation is necessary for proper pump operation. The pump should have a check valve on its discharge, or within 25 feet (7.62 m) of the pump. For very deep wells, locate a check valve at least every 200 feet (61 m) vertical.

- Use only spring type or gravity-poppet check valves. Swing type valves can cause water hammer problems.
- Do not use drain-back style check valves (drilled).

Check valves serve the following purposes:

- Maintain Pressure: Without a check valve, the pump has to start each cycle at zero head, and fill the drop pipe. This creates upthrust in the motor, and would eventually damage both the pump and motor.
- Prevent Water Hammer: If two check valves are used, and the lower one leaks, then a partial vacuum forms in the pipe. When the pump next starts, the flow fills the void area quickly, and creates a shock wave that can break piping and damage the pump. If you get water hammer on pump start, this may be the cause.
- Prevent Back-Spin: Without a functioning check valve, upon shutoff, the water drains back through the pump, and cause it to rotate backwards. This can create excessive wear on the thrust bearing, and if the pump restarts as water is flowing down the pipe, it will put an excessive load on the system.

SECTION 3: Installation and Setup

3.5 Start-Up

NOTICE: To avoid sand-locking pump, follow procedure below when starting pump for the first time. NEVER start a pump with discharge completely open unless you have done this procedure first.

1. Connect a pipe elbow, a short length of pipe and a gate valve to pump discharge at well head.
2. Make sure that controls will not be subjected to extreme heat or excess moisture.
3. Make sure power is OFF. DO NOT START PUMP YET.
4. Set gate valve on discharge 1/3 open; start pump.
5 Keep gate valve at this setting while water pumps out on ground. Let it run until water is clear of sand or silt. (To check solids in water, fill a glass from pump and let solids settle out).
6. When water is completely clear at 1/3 setting, open gate valve to approximately two-thirds open and repeat process.
7. When water is completely clear at 2/3 setting, open gate valve completely and run pump until water is completely clear.
8. Do not stop the pump until the water is clear. Otherwise sand will accumulate in the pump stages which may bind or freeze the pump.
9. Remove gate valve and make permanent installation.

NOTICE: The motor may draw higher than normal current while the riser pipe is filling. After the riser pipe is full, the amp draw should drop back to less than the allowed current given on the motor nameplate.

When pump is in service, the amp draw must be approximately equal to or lower than the service factor amps given on the motor nameplate. If not, recheck entire installation and electrical hook-up to find out why amp draw is higher than normal.

Motor Torque

The motor exerts a strong torque force on the downpipe and any other supporting structures when it starts. This torque is usually in the direction that would unscrew right-hand threads (the motor's reaction movement is clockwise as seen from above).

All pipe and pump joints must be tightened to safely handle the starting torque. Tighten all threaded joints to a minimum of 10 ft.-lb per horsepower. i.e. 20 HP = 200 ft.-lb; 50 HP = 500 ft.-lb.

Tack welding or strap welding may be required with higher horsepower pumps.

SECTION 4: Electrical Power

4.1 Mixing Wire Size with Existing Installation

Using two different cable sizes.

Sometimes conditions make it desirable to use more than one size cable, such as replacing a pump in an existing installation.

For example: Installing a pump with a 4", 5 HP, 230 volt, single phase motor, with the motor setting at 370' (112.8 m) down the well and with 160' (48.8 m) of #8 cable buried between the service entrance and the well head.

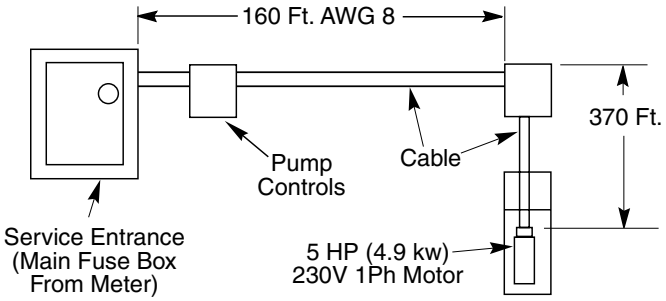


Figure 4-1: Mixing Wire Sizes: Example

In order to avoid replacing the buried cable, the question is: What size cable is required in the well? Calculate as follows:

1. According to Table 5-9, a total of 326' (112.8 m) of #8 cable is the maximum length cable to power a 5 HP motor. The percent of this total that has been used by the 160' (48.8 m) of cable in the buried run is: 160' / 326' = .49 or 49%.
2. With 49% of the allowable cable already used, 51% of the total length is left for use in the well. To avoid running a cable that is too small (gauge) and lowering the voltage to the motor, we have to find a cable size large enough so that 370' (112.8 m) is less than 51% of the total length allowed for that size.
3. 370 ÷ 51% = 726 feet.
4. From Table 5-9 we find that the total allowable length for #4 cable is 809' (246.6 m).

   This is longer than needed. Therefore, #4 cable can be used for the 370' (112.8 m) of cable in the well.

   Any combination of sizes can be used, provided that the total percentage of the length of the two sizes of cable is not less than 100% of the allowed lengths.

4.2 Wire Splicing

Splice wire to motor leads. Use only copper wire for connections to pump motor and control box.

1. Taped splice (for larger wire sizes)
   A. Stagger lead and wire length so that 2nd lead is 2" (50mm) longer than 1st lead and 3rd lead is 2" (50mm) longer than second.
   B. Cut off power supply wire ends. Match colors and lengths of wires to colors and lengths of motor leads.
   C. Trim insulation back 1/2" (13mm) from supply wire and motor lead ends (Figure 4-2).

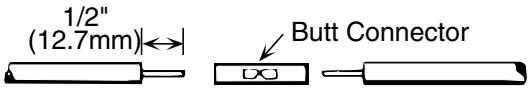


Figure 4-2: Insert Wires

   D. Insert motor lead ends and supply wire ends into butt connectors. Match wire colors between supply wires and motor leads.
   E. Using crimping pliers, indent butt connector lugs to attach wires (Figure 4-3).



Figure 4-3: Indent Connectors

   F. Cut Scotchfil™ electrical insulation putty into 3 equal parts and form tightly around butt connectors. Be sure Scotchfil overlaps insulated part of wire.
   G. Using #33 Scotch® tape, wrap each joint tightly; cover wire for about 1-1/2" (38mm) on each side of joint. Make four passes with the tape. When finished you should have four layers of tape tightly wrapped around the wire. Press edges of tape firmly down against the wire (Figure 4-4).



Figure 4-4: Wrap Splices

NOTICE: Since tightly wound tape is the only means of keeping water out of splice, efficiency of splice will depend on care used in wrapping tape.

NOTICE: For wire sizes larger than No. 8 (7mm^2), use soldered joint rather than Scotchfil putty, Figure 4-5.

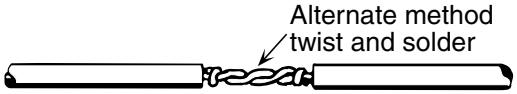


Figure 4-5: Twist Wires

Scotchfil™ is a trademark of 3M Company.
Scotch is a registered trademark of 3M Company.

2. Heat shrink splice (For wire sizes #14, 12 and 10 AWG (2, 3 and 5mm^2):
   A. Remove 3/8" (9.5mm) insulation from ends of motor leads and power supply wires.
   B. Put plastic heat shrink tubing over motor leads between power supply and motor.
   C. Match wire colors and lengths between power supply and motor.
   D. Insert supply wire and lead ends into butt connector and crimp. Match wire colors between power supply and motor. Pull leads to check connections.
   E. Center tubing over butt connector and apply heat evenly with a torch (match or lighter will not supply enough heat, Figure 4-6).

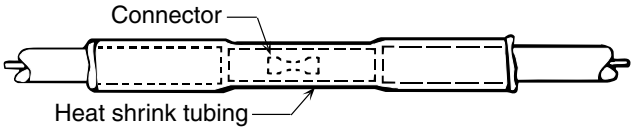


Figure 4-6: Heat-Shrink Tubing Applied

NOTICE: Keep torch moving. Too much concentrated heat may damage tubing.

4.3 3-Phase Starters

Starters are used to start the motor by engaging contacts that will energize each line simultaneously. The contacts are closed when the coil is energized.

Figures 4-7 through 4-9 show three types of starters used on the motors. The control device in the secondary circuit is typically a pressure switch. Other control could be provided by level control, timers or manual switches.

Line Voltage Control

This commonly-used control has a coil energized by line voltage. The coil voltage matches the line voltage.

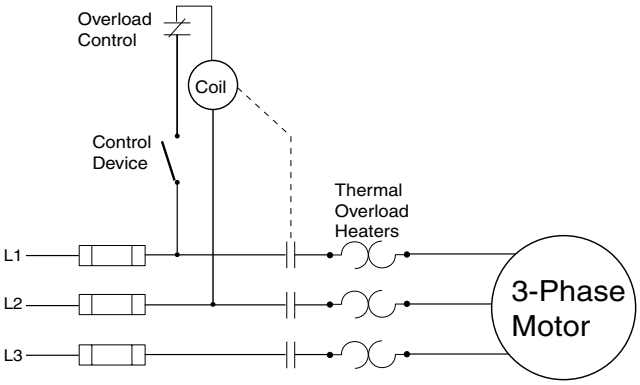


Figure 4-7: Line Voltage Control

Low Voltage Control

This starter arrangement uses a transformer to allow the coil to be energized by a lower voltage. Note that the secondary circuit must be fused, and the coil sized for the secondary voltage.

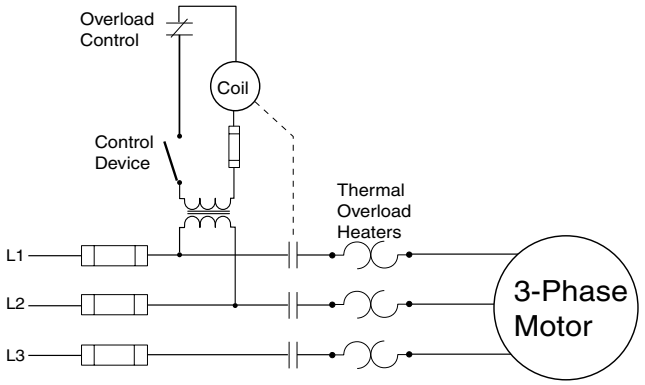


Figure 4-8: Low Voltage Control

Separate Voltage Control

This arrangement uses power from a separate source to energize the coil.

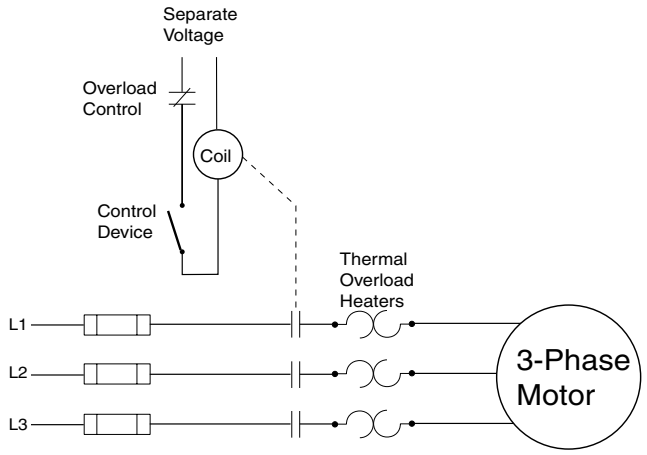


Figure 4-9: Separate Voltage Control

4.4 Checking Motor Rotation

To check rotation before the pump is installed, follow these steps:

During testing or checking rotation (**such as "bumping" or "inching"**) the number of "starts" should be limited to 3 and total run time of less than 15 seconds.

Bumping must be done while motor is in horizontal position and followed by a full 15 minute cooling-off period before any additional "starts" are attempted.

Energize the motor briefly, and observe the direction of rotation. It should be counter-clockwise when viewed from the pump (shaft) end.

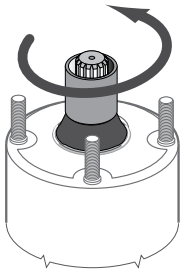


Figure 4-10: Motor Rotation

To check rotation after the pump is installed:

NOTICE: NEVER continuously operate a pump with the discharge valve completely closed (dead head). This can overload the motor due to lack of cooling, or destroy the pump and will void the warranty.

After energizing the motor, check the flow and pressure of the pump to make sure that the motor is rotating in the correct direction. To correct a wrong rotation, switch any two of the three cable connections (three-phase motor only). The setting that gives the most flow and pressure is correct.

A cooling-off period of 15 minutes is required between starts.

⚠WARNING Hazardous voltage. Disconnect power before working on wiring.

Input voltage, current and insulation resistance values should be recorded throughout the installation and should be used for preventive maintenance.

4.5 3-Phase Current Balancing

Current Unbalance Test

Before checking for current unbalance, the pump must be started, and rotation direction determined.

Determine current unbalance by measuring current in each power lead. Measure current for all three possible hookups (Figure 4-11). Use example and worksheet on the Installation Checklist and Record in Section 12 to calculate current unbalance on a three phase supply system and retain for future reference.

NOTICE: Current unbalance between leads should not exceed 5%. If unbalance cannot be corrected by rolling the leads, locate the source of the unbalance.

Here is an example of current readings at maximum pump loads on each leg of a three wire hookup. Make calculations for all three possible hookups.

A. For each hookup, add the readings for the three legs.

B. Divide each total by three to get average amps.

C. For each hookup, find current value farthest from average (Calculate the greatest current difference from the average).

D. Divide this difference by the average and multiply by 100 to obtain the percentage of unbalance.

   Use smallest percentage unbalance, in this case Arrangement 2 (Table 4.1).

Use the Current-Balance worksheet located in the Installation Record

After trying all three lead hookups, if the reading furthest from average continues to show on the same power lead, most of the unbalance is coming from the power source. Call the power company.

If the reading furthest from average changes leads as the hookup changes (that is, stays with a particular motor lead), most of the unbalance is on the motor side of the starter. This could be caused by a damaged cable, leaking splice, poor connection, or faulty motor winding.

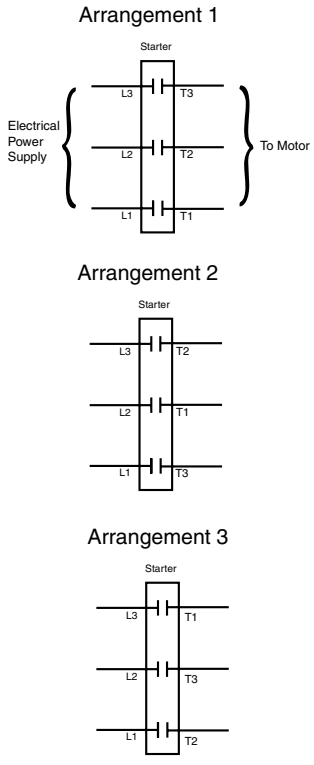


Figure 4-11: 3-Phase Current Unbalance: Example

SECTION 4: Electrical Power

Use this worksheet to calculate current unbalance for our installation.

Table 4-1: Electrical Current Unbalance Example

EXAMPLE	Arrangement 1 Amps	Arrangement 2 Amps	Arrangement 3 Amps
	L1–T1=17 L2–T2=15.3 L3–T3=17.7	L1–T3=16.7 L2–T1=16.3 L3–T2=17	L1–T2=16.7 L2–T3=16 L3–T1=17.3
Total Amps	50	50	50
Average Amps	50 ÷ 3 = 16.7	50 ÷ 3 = 16.7	50 ÷ 3 =16.7
From Average Amps Deviation L1 Deviation L2 Deviation L3	 0.3 1.4 1.0	 0.0 0.4 0.3	 0.0 0.7 0.6
% Current Unbalance Largest Deviation	1.4 ÷ 16.7	0.4 ÷ 16.7	0.7 ÷ 16.7
% Unbalance +	8.4%	2.4%	4.2%

4.6 Transformer Sizing

A full three-phase power supply is recommended for all three-phase motors and may consist of three individual transformers or one three-phase transformer. "Open" delta or wye connections which use only two transformers can be used, but are more likely to cause unbalanced current problems. Transformer ratings should be no smaller than listed in Table 4-2 for supply power to the motor alone.

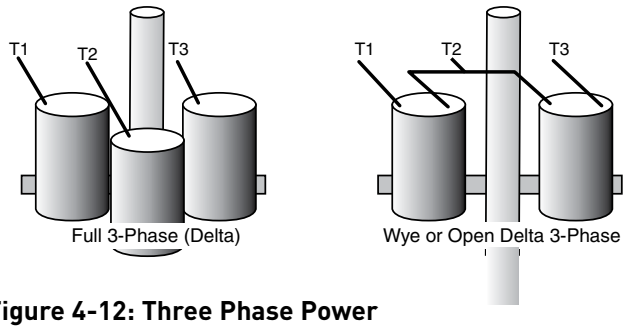


Figure 4-12: Three Phase Power

Transformers are rated by KVA capacity. This must be high enough capacity for the motor being installed. If the transformer capacity is too small, the motor will receive reduced voltage and may be damaged.

Any other loads in the system would be in addition to the motor alone.

Refer to Table 4-2. Note that the open delta configuration can only use 87% of the rated power of the two transformers.

Table 4-2: Transformer Capacity

HP	kW	KVA Rating (smallest) For Each Transformer		
		Required KVA	Open WYE or D 2 Transformers	WYE or D 3 Transformers
1/2	0.37	1.5	1.0	0.5
3/4	0.55	1.5	1.0	0.5
1	0.75	2.0	1.5	0.75
1-1/2	1.1	3.0	2.0	1.0
2	1.5	4.0	2.0	1.5
3	2.2	5.0	3.0	2.0
5	3.7	7.5	5.0	3.0
7.5	5.5	10.0	7.5	5.0
10	7.5	15.0	10.0	5.0
15	11.0	20.0	15.0	7.5
20	15.0	25.0	15.0	10.0
25	18.5	30.0	20.0	10.0
30	22.0	40.0	25.0	15.0
40	30.0	50.0	30.0	20.0
50	37.0	60.0	35.0	20.0
60	45.0	75.0	40.0	25.0

4.7 Using a Generator

Selecting a generator

Select a generator that can supply at least 65% of rated voltage upon start-up of the motor.

The chart shows ratings of generators, both externally and internally regulated. This chart is somewhat conservative. Consult the generator manufacturer if you are uncertain.

Table 4-3: Ratings of Generators

Motor	Externally Regulated		Internally Regulated	
HP	kW	KVA	kW	KVA
1/2	2.0	2.5	1.5	1.9
3/4	3.0	3.8	2.0	2.5
1	4.0	5.0	2.5	3.1
1-1/2	5.0	6.3	3.0	3.8
2	7.5	9.4	4.0	5.0
3	10.0	12.5	5.0	6.25
5	15.0	18.8	7.5	9.4
7-1/2	20.0	25.0	10.0	12.5
10	30.0	37.5	15.0	18.8
15	40.0	50.0	20.0	25.0
20	60.0	75.0	25.0	31.0
25	75.0	94.0	30.0	37.5
30	100.0	125.0	40.0	50.0
40	100.0	125.0	50.0	62.5
50	150.0	188.0	60.0	75.0
60	175.0	220.0	75.0	94.0

Frequency

It is highly important that the generator maintain constant frequency (Hz), since the motor's speed depends upon frequency.

A drop of just 1 to 2 Hz can noticeably lower pump performance. An increase of 1 to 2 Hz can cause overload conditions.

Voltage Regulation

There is a significant difference in the performance of internally and externally regulated generators.

An external regulator senses output voltage dips and triggers an increase in the voltage output of the generator.

An internal regulator, senses current and responds to increased current by supplying more voltage.

Generator Operation

Start the generator before starting the pump motor.

The pump motor must be stopped before turning off the generator.

If the generator runs out of fuel, and the pump is still connected, it will put excess strain on the thrust bearings as the generator slows.

⚠ WARNING Risk of electrocution. Use transfer switches when the generator is used as a backup to the power grid. Contact your power company or generator manufacturer for proper use of standby or backup generators.

4.8 Special Applications

Using Phase Converters

Phase converters allow three-phase motors to operate from one-phase supply. Various styles of phase converters are available. Many converters do not supply a properly balanced voltage, and using these will void the motor's warranty unless approval is obtained first.

Guidelines For Phase Converters:

- Current unbalance must be less than 5%.
- Converter to be sized to service factor capacity
- Maintain motor cooling with a cooling flow of at least 3' per second.
- Fuses and circuit breakers must be time-delay type.

Motor Starting with Reduced Voltage

Starting a motor with full voltage will bring it to full speed in less than 1/2 second. This can:

- Spike the load current, causing brief voltage dips in other equipment.
- Over-stress pump and piping components because of high torque.
- Cause water hammer.

Motor Starters (3-Phase Only)

Various types of motor starters are available. Autotransformers are recommended because of reduced current draw.

When motor starters are used, they should supply a minimum of 55% of rated voltage for adequate starting torque.

SECTION 5: XE Series 4” Submersible Motors

5.1 Motor Inspection

Check the motor for damage in shipping.

Before installation, check the following.

- Check over all tools, especially the hoisting gear, for wear or damage before hoisting unit.
- Inspect the motor cable for any nicks or cuts.
- Verify that motor nameplate data matches registration card information exactly.
- Verify that motor nameplate voltage is correct for available power supply voltage. Voltage must not vary more than +/-10% from nameplate rated voltage.
- Verify that the well diameter is large enough to accommodate the motor/pump unit all the way to the pump setting depth.
- For installations with tight well casings, make sure that riser pipe flanges are recessed to protect the power and control cables from abrasion and squeezing during installation.

  ⚠WARNING Heavy object. Lifting equipment must be capable of lifting motor and attached equipment.
- If the total length of the pump motor unit (without any riser pipe) exceeds 10’ (3m), the unit must be supported with a girder while hoisting. Do not remove supporting girder until unit is standing vertically in the hoist. Check for damage.

5.2 Testing

Insulation Resistance

To check for insulation resistance:

1. Disconnect power to the motor for this test.
2. Connect an Ohm meter (resistance in Ω) between the power leads and the motor ground or well casing.

20KΩ	Damaged motor, possible result of lightning strike.
500KΩ	Typical of older installed motor in well.
2 MΩ	Newly installed motor
10 MΩ	Used motor, measured outside of well
20 MΩ	New motor without cable

5.3 Storage and Transportation

The motors are filled with a non-toxic, Propylene Glycol and water solution to prevent damage from freezing temperatures. The solution will prevent damage from freezing temperatures to -40˚F (-40˚ C). Motors should be stored in areas that do not go below this temperature. The solution will become slushy between 0˚F (-17˚C) and -40˚F (-40˚C) but no damage occurs. If this occurs, allow the motor to sit in the well for several minutes before operating.

Storage site should be clean, well vented, and cool.

Keep humidity at the storage site as low as possible.

Protect motor and cables from direct sunlight.

Protect power supply cables and control cables from moisture by taping the cable ends with electrician’s tape.

Do not kink power supply or control cables.

Take care when moving unit (packed or unpacked) with crane or hoisting gear not to knock it against walls, steel structure, floors, etc. Do not drop motor.

Do not lift motor or motor/pump unit by power supply or control cables.

SECTION 5: XE Series 4” Submersible Motors

5.4 4” Motor Specifications

Table 5-1: Single Phase Motor Specifications (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	Pentek® Part Number	Full Load			Service Factor		
		Amps (Y/B/R)	Y Only	Watts	Amps (Y/B/R)	Y Only	Watts
PSC 2-Wire	P42B0010A2-01	7.9		1679	9.1		1990
	P42B0015A2-01	9.2		2108	11.0		2520
	P42B0005A1-01	7.9		910	9.8		1120
	P42B0005A2-01	4.0		845	4.7		1050
	P42B0007A2-01	5.0		1130	6.2		1400
	P42B0010A2-01	6.7		1500	8.1		1800
	P42B0015A2-01	9.0		2000	10.4		2350
	P42B0005A1	7.4		845	9.5		1088
	P42B0005A2	3.7		834	4.7		1073
	P42B0007A2	5.0		1130	6.4		1459
CSIR 3-Wire	P43B0005A1-01	8.8/8.8/0	8.8	675	10.9/10.9/0	10.9	980
	P43B0005A2-01	5.3/5.3/0	5.3	740	6.1/6.1/0	6.1	1050
	P43B0007A2-01	6.6/6.6/0	6.6	970	7.8/7.8/0	7.8	1350
	P43B0010A2-01	8.1/8.1/0	8.1	1215	9.4/9.4/0	9.4	1620
	P43B0005A1	11.0/11.0/0	11.0	733	12.6/12.6/0	12.6	1021
	P43B0005A2	5.5/5.5/0	5.5	745	6.3/6.3/0	6.3	1033
	P43B0007A2	7.2/7.2/0	7.2	1014	8.3/8.3/0	8.3	1381
	P43B0010A2	8.4/8.4/0	8.4	1267	9.7/9.7/0	9.7	1672
CSCR 3-Wire	P43B0005A2-01	4.2/4.1/1.8	4.2	7.15	4.8/4.3/1.8	4.8	960
	P43B0007A2-01	4.8/4.4/2.5	4.8	940	6.0/4.9/2.3	6.0	1270
	P43B0010A2-01	6.1/5.2/2.7	6.1	1165	7.3/5.8/2.6	7.3	1540
	P43B0015A2-01	9.1/8.2/1.2	9.1	1660	10.9/9.4/1.1	10.9	2130
	P43B0005A2	4.1/4.1/2.2	4.1	720	4.9/4.4/2.1	4.9	955
	P43B0007A2	5.1/5.0/3.2	5.1	1000	6.3/5.6/3.1	6.3	1300
	P43B0010A2	6.1/5.7/3.3	6.1	1205	7.2/6.3/3.3	7.2	1530
	P43B0015A2	9.7/9.5/1.4	9.7	1693	11.1/11.0/1.3	11.1	2187
	P43B0020A2	9.9/9.1/2.6	9.9	2170	12.2/11.7/2.6	12.2	2660
	P43B0030A2	14.3/12.0/5.7	14.3	3170	16.5/13.9/5.6	16.5	3620
	P43B0050A2	24/19.1/10.2	24.0	5300	27.0/22.0/10.0	27	6030

SECTION 5: XE Series 4” Submersible Motors

Table 5-2: Three Phase Motor Specifications (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM)

Pentek® Part Number	Rating					Full Load		Maximum Load (SF Load)	
	HP	kW	Volts	Hz	Service Factor	Amps	Watts	Amps	Watts
P43B0005A8	1/2	0.37	200	60	1.6	2.9	600	3.4	870
P43B0005A3			230			2.4	610	2.9	880
P43B0005A4			460			1.3	610	1.5	875
P43B0007A8	3/4	0.55	200		1.5	3.8	812	4.5	1140
P43B0007A3			230			3.3	850	3.9	1185
P43B0007A4			460			1.7	820	2.0	1140
P43B0010A8	1	0.75	200		1.4	4.6	1150	5.5	1500
P43B0010A3			230			4.0	1090	4.7	1450
P43B0010A4			460			2.2	1145	2.5	1505
P43B0015A8	1-1/2	1.1	200		1.3	6.3	1560	7.2	1950
P43B0015A3			230			5.2	1490	6.1	1930
P43B0015A4			460			2.8	1560	3.2	1980
P43B0015A5			575			2	1520	2.4	1950
P43B0020A8	2	1.5	200		1.25	7.5	2015	8.8	2490
P43B0020A3			230			6.5	1990	7.6	2450
P43B0020A4			460			3.3	2018	3.8	2470
P43B0020A5			575			2.7	1610	3.3	2400
P43B0030A8	3	2.2	200		1.15	10.9	2890	12.0	3290
P43B0030A3			230			9.2	2880	10.1	3280
P43B0030A4			460			4.8	2920	5.3	3320
P43B0030A5			575			3.7	2850	4.1	3240
P43B0050A8	5	3.7	200			18.3	4850	20.2	5515
P43B0050A3			230			15.7	4925	17.5	5650
P43B0050A4			460			7.6	4810	8.5	5530
P43B0050A5			575			7.0	5080	7.6	5750
P43B0075A8	7-1/2	5.6	200			27.0	7600	30.0	8800
P43B0075A3			230			24.0	7480	26.4	8570
P43B0075A4			460			12.2	7400	13.5	8560
P43B0075A5			575			9.1	7260	10.0	8310
P43B0100A4	10	7.5	460			15.6	9600	17.2	11000

SECTION 5: XE Series 4” Submersible Motors

Table 5-3: Single Phase 4” Motor Electrical Parameters (115 and 230 Volt, 60 Hz, 3450 RPM, 2 and 3 wire)

Motor Type	Pentek® Part Number	Winding		Efficiency %		Power Factor %		Locked Rotor Amps	KVA Code
		Main Resistance *	Start Resistance	FL	SF	FL	SF		
PSC 2-Wire	P42B0005A1-01	1.4-2.0		42.1	54	99.6	99.9	28	H
	P42B0005A2-01	6.1-7.2		45	58.5	92	97	16	J
	P42B0007A2-01	5.9-6.9		50.5	61	98	98	18	F
	P42B0010A2-01	4.2-5.2		50	59			24	
	P42B0015A2-01	1.8-2.4		56.5	62.5		99	44	H
	P42B0005A1	1.3-1.8		49	61	99		36.4	K
	P42B0005A2	4.5-5.2		50	62	97		19.5	
	P42B0007A2	3.0-4.8		55	65			24.8	J
	P42B0010A2	4.2-5.2		58		94	96	21.7	F
	P42B0015A2	1.9-2.3		59	64	99	99	42	H
CSIR 3-Wire	P43B0005A1-01	1.0-1.4	2.5-3.1	57	62	65	78	44	M
	P43B0005A2-01	5.1-6.1	12.4-13.7	52	58.5	61	75	21	L
	P43B0007A2-01	2.6-3.3	10.4-11.7	60	64.5	64	76	32	
	P43B0010A2-01	2.0-2.6	9.3-10.4	63	66	66		41	
	P43B0005A1	0.9-1.6	5.7-7.0	51	59	54	69	49.6	N
	P43B0005A2	4.2-4.9	17.4-18.7	50	58	58	71	22.3	M
	P43B0007A2	2.6-3.6	11.8-13.0	55	61	61	72	32	L
	P43B0010A2	2.2-3.2	11.3-12.3	59	62	66	75	41.2	
CSCR 3-Wire	P43B0005A2-01	5.1-6.1	12.4-13.7	54.5	61.5	77	87	21	
	P43B0007A2-01	2.6-3.3	10.4-11.7	62	69	86	91	32	
	P43B0010A2-01	2.0-2.6	9.3-10.4	66	71	86		41	
	P43B0015A2-01	2.1-2.5	10.0-10.8	68	69	81	87	49	J
	P43B0005A2	4.2-4.9	17.4-18.7	52	62	76	85	22.3	M
	P43B0007A2	2.6-3.6	11.8-13.0	56	65	85	90	32	L
	P43B0010A2	2.2-3.2	11.3-12.3	62	68	86	92	41.2	
	P43B0015A2	1.6-2.3	7.9-8.7	66	67	80	85	47.8	J
	P43B0020A2	1.6-2.2	10.8-12.0	68	69	96	95	49.4	G
	P43B0030A2	1.1-1.4	2.0-2.5	72	72		97	76.4	
	P43B0050A2	0.62-0.76	1.36-1.66	71	71	97	98	101	E

* Main winding is between the yellow and black leads. Start winding is between the yellow and red leads.

SECTION 5: XE Series 4” Submersible Motors

Table 5-4: Three Phase Motor Electrical Parameters (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM)

Pentek® Part Number	Line to Line Resistance Ohms	% Efficiency		Locked Rotor Amps	KVA Code
		FL	SF		
P43B0005A8	4.1-5.2	62	68.5	22	R
P43B0005A3	5.72-7.2	61	68	17.3	
P43B0005A4	23.6-26.1			9	
P43B0007A8	2.6-3.0	69	74	32	
P43B0007A3	3.3-4.3	66	71	27	
P43B0007A4	14.4-16.2	69	73.5	14	
P43B0010A8	3.4-3.9	66	70	29	M
P43B0010A3	4.1-5.1	69	72	26.1	
P43B0010A4	17.8-18.8	65	69	13	
P43B0015A8	1.9-2.5	72	74	40	L
P43B0015A3	2.8-3-4	75	76	32.4	
P43B0015A4	12.3-13.1	72	73	16.3	
P43B0015A5	19.8-20.6	73	74	11.5	J
P43B0020A8	1.4-2.0	74	75	51	K
P43B0020A3	1.8-2.4	75		44	
P43B0020A4	8.00-8.67	74		23	
P43B0020A5	9.4-9.7	78	78	21.4	M
P43B0030A8	0.9-1.3	77	77	71	K
P43B0030A3	1.3-1.7			58.9	J
P43B0030A4	5.9-6.5	76		30	
P43B0030A5	9.4-9.7	78	78	21.4	
P43B0050A8	0.4-0.8	76	76	113	
P43B0050A3	.85-1.25			93	
P43B0050A4	3.58-4.00	77	77	48	
P43B0050A5	3.6-4.2	75	75	55	M
P43B0075A8	0.5-0.6	74	74	165	J
P43B0075A3	0.55-0.85	75	75	140	
P43B0075A4	1.9-2.3	76	76	87	L
P43B0075A5	3.6-4.2	77	77	55	J
P43B0100A4	1.8-2.2	79	80	110	K

SECTION 5: XE Series 4” Submersible Motors

5.5 4” Motor Dimensions

Table 5-5: Single Phase Motor Dimensions (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	Pentek® Part Number	HP	kW	Length		Weight	
				Inches	mm	Lb	Kg
4-Inch 2-Wire	P42B0005A1-01	1/2	0.37	10.5	267	18.1	8.2
	P42B0005A2-01						
	P42B0007A2-01	3/4	0.55	11.9	302	21.4	9.7
	P42B0010A2-01	1	0.75	12.5	318	23.2	10.5
	P42B0015A2-01	1-1/2	1.1	14.2	361	27.3	12.4
	P42B0005A1	1/2	0.37	11.0	279	19.2	8.7
	P42B0005A2						
	P42B0007A2	3/4	0.55	12.4	314	22.7	10.3
	P42B0010A2	1	0.75	13.3	337	24.5	11.1
	P42B0015A2	1-1/2	1.1	14.9	378	28.9	13.1
4-inch 3-Wire	P43B0005A1-01	1/2	0.37	9.6	244	17.9	8.1
	P43B0005A2-01			9.2	234	16.7	7.6
	P43B0007A2-01	3/4	0.55	10.3	262	19.8	9.0
	P43B0010A2-01	1	0.75	11.2	284	22.0	10.0
	P43B0005A1	1/2	0.37	10.0	253	18.9	8.6
	P43B0005A2			9.7	246	18.1	8.2
	P43B0007A2	3/4	0.55	10.8	275	21.4	9.7
	P43B0010A2	1	0.75	11.7	297	23.1	10.5
	P43B0005A2-01	1/2	0.37	9.2	234	16.7	7.6
	P43B0007A2-01	3/4	0.55	10.3	262	19.8	9.0
	P43B0010A2-01	1	0.75	11.2	284	22.0	10.0
	P43B0015A2-01	1-1/2	1.1	12.8	325	26.0	11.8
	P43B0005A2	1/2	0.37	9.7	246	18.1	8.2
	P43B0007A2	3/4	0.55	10.8	275	21.4	9.7
	P43B0010A2	1	0.75	11.7	297	23.1	10.5
	P43B0015A2	1-1/2	1.1	13.6	345	27.4	12.4
	P43B0020A2	2	1.5	15.1	383	31.0	14.1
	P43B0030A2	3	2.2	18.3	466	40.0	18.1
	P43B0050A2	5	3.7	27.7	703	70.0	31.8

SECTION 5: XE Series 4” Submersible Motors

Table 5-6: Three Phase Motor Dimensions (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM)

Pentek® Part Number	HP	kW	Length		Weight	
			Inches	mm	Lb	Kg
P43B0005A8	1/2	0.37	10	254	18.9	8.6
P43B0005A3						
P43B0005A4						
P43B0007A8	3/4	0.55	10.8	275	21.4	9.7
P43B0007A3						
P43B0007A4						
P43B0010A8	1	0.75	11.7	297	23.1	10.5
P43B0010A3						
P43B0010A4						
P43B0015A8	1-1/2	1.1				
P43B0015A3						
P43B0015A4						
P43B0015A5						
P43B0020A8	2	1.5	13.8	351	27.4	12.4
P43B0020A3						
P43B0020A4						
P43B0020A5			15.3	389	32	14.5
P43B0030A8	3	2.2				
P43B0030A3						
P43B0030A4						
P43B0030A5						
P43B0050A8	5	3.7	21.7	550	55	24.9
P43B0050A3						
P43B0050A4						
P43B0050A5			27.7	703	70	31.8
P43B0075A8	7-1/2	5.6				
P43B0075A3						
P43B0075A4						
P43B0075A5						
P43B0100A4	10	7.5	30.7	780	78	35.4

SECTION 5: XE Series 4” Submersible Motors

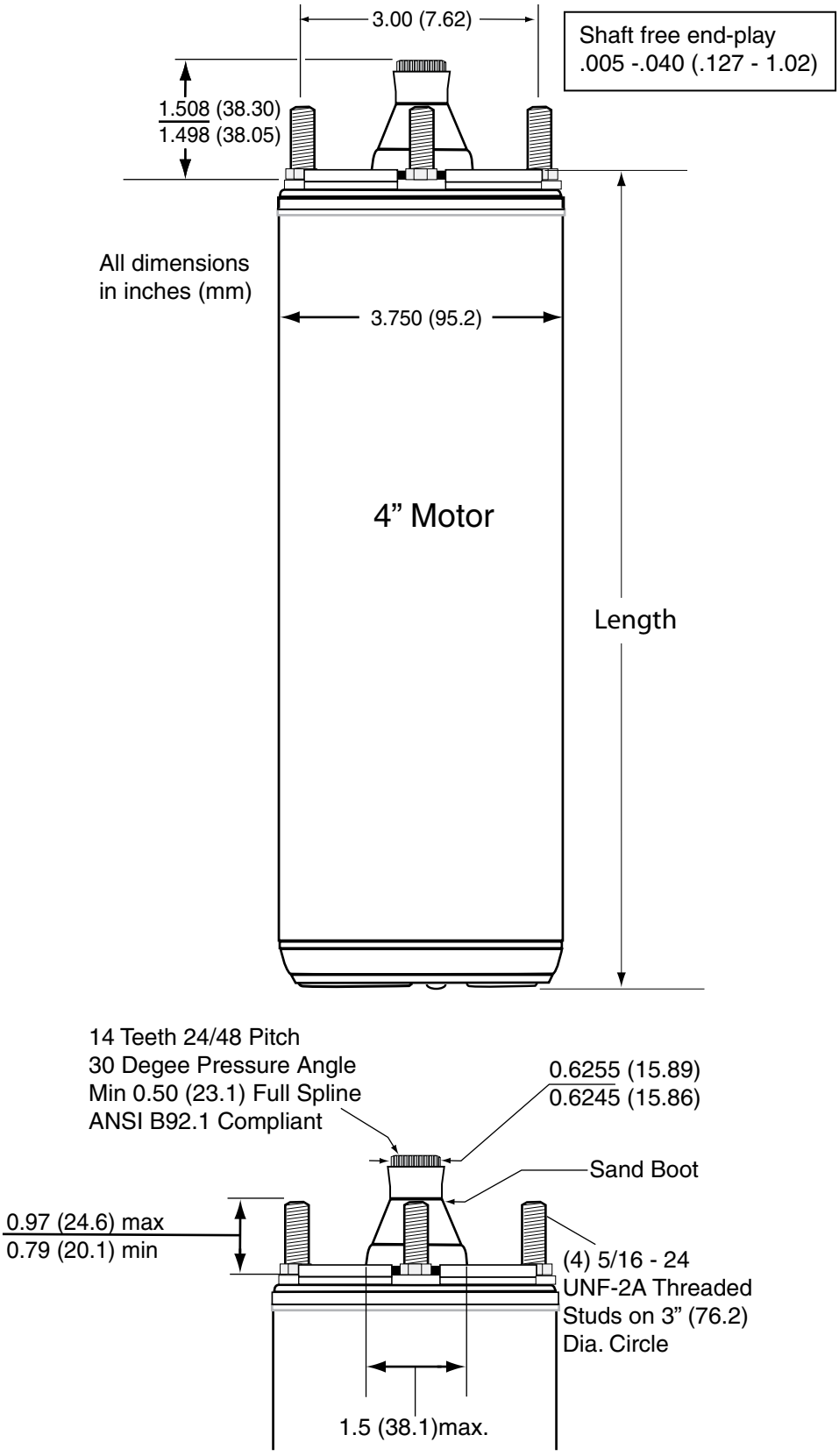


Figure 5-1: XE Series 4” Motor Dimensions – Single and Three Phase

SECTION 5: XE Series 4” Submersible Motors

5.6 4” Motor Fuse Sizing

Table 5-7: SINGLE PHASE Motor Fuse Sizing (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	Pentek® Part Number	HP	kW	Volts	Fuse Sizing Based on NEC		
					Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
4-Inch PSC 2-Wire	P42B0005A1-01	1/2	0.37	**115**	**30**	**20**	**25**
	P42B0005A2-01			230	15	10	15
	P42B0007A2-01	3/4	0.55		20	15	20
	P42B0010A2-01	1	0.75		25		
	P42B0015A2-01	1-1/2	1.1		35	20	30
	P42B0005A1	1/2	0.37	**115**	**25**	**15**	**20**
	P42B0005A2			230	15	10	10
	P42B0007A2	3/4	0.55		20		15
	P42B0010A2	1	0.75		25	15	20
	P42B0015A2	1-1/2	1.1		30		25
4-Inch CSIR 3-Wire	P43B0005A1-01	1/2	0.37	**115**	**30**	**20**	**30**
	P43B0005A2-01			230	15	10	15
	P43B0007A2-01	3/4	0.55		20		20
	P43B0010A2-01	1	0.75		25	15	25
	P43B0005A1	1/2	0.37	**115**	**30**	**20**	**30**
	P43B0005A2			230	15	10	15
	P43B0007A2	3/4	0.55		20		20
	P43B0010A2	1	0.75		25	15	25
4-Inch CSCR 3-Wire	P43B0005A2-01	1/2	0.37		15	10	10
	P43B0007A2-01	3/4	0.55		20		15
	P43B0010A2-01	1	0.75				
	P43B0015A2-01	1-1/2	1.1		30	15	25
	P43B0005A2	1/2	0.37		15	10	10
	P43B0007A2	3/4	0.55		20		15
	P43B0010A2	1	0.75				
	P43B0015A2	1-1/2	1.1		30	15	25
	P43B0020A2	2	1.5		30	20	25
	P43B0030A2	3	2.2		45	25	40
	P43B0050A2	5	3.7		70	40	60

SECTION 5: XE Series 4” Submersible Motors

Table 5-8: THREE PHASE Motor Fuse Sizing (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM)

Pentek® Part Number	HP	kW	Volts	Fuse Sizing Based on NEC		
				Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
P43B0005A8	1/2	0.37	200	10	6	10
P43B0005A3			230	6	6	6
P43B0005A4			460	3	3	3
P43B0007A8	3/4	0.55	200	15	10	10
P43B0007A3			230	6	6	6
P43B0007A4			460	3	6	3
P43B0010A8	1	0.75	200	15	10	10
P43B0010A3			230	10	6	10
P43B0010A4			460	6	3	6
P43B0015A8	1-1/2	1.1	200	20	10	15
P43B0015A3			230	15	10	15
P43B0015A4			460	10	6	6
P43B0015A5			575	6	3	6
P43B0020A8	2	1.5	200	25	15	20
P43B0020A3			230	15	15	20
P43B0020A4			460	15	6	10
P43B0020A5			575	10	6	10
P43B0030A8	3	2.2	200	35	20	30
P43B0030A3			230	25	15	25
P43B0030A4			460	15	10	15
P43B0030A5			575	10	10	10
P43B0050A8	5	3.7	200	60	35	50
P43B0050A3			230	45	30	40
P43B0050A4			460	25	15	20
P43B0050A5			575	20	15	20
P43B0075A8	7-1/2	5.6	200	80	50	70
P43B0075A3			230	70	45	60
P43B0075A4			460	40	25	35
P43B0075A5			575	25	20	25
P43B0100A4	10	7.5	460	45	25	35

SECTION 5: XE Series 4” Submersible Motors

5.7 Cable Lengths

Table 5-9: Cable Lengths, SINGLE PHASE 115 and 230 Volt, 60 Hz, 3450 RPM, 2- and 3-wire Motors, 60° and 75° C. Service Entrance to Motor: Maximum Length in Feet

Motor Type	Pentek® Part Number	HP	Volt	Wire Size, AWG										
				14	12	10	8	6	4	3	2	1	0	00
PSC 2-Wire	P42B0005A1-01	1/2	**115**	**112**	**178**	**284**	**449**	**699**	**1114**	**1401**	**1769**	**2229**	**2814**	**3550**
	P42B0005A2-01		230	464	739	1178	1866	2903	4628	5818	7347	9256	11684	
	P42B0007A2-01	3/4		353	562	897	1420	2210	3523	4429	5594	7046	8895	11222
	P42B0010A2-01	1		271	430	686	1087	1692	2697	3390	4281	5394	6808	8590
	P42B0015A2-01	1-1/2		211	335	535	847	1318	2100	2640	3335	4201	5303	6690
	P42B0005A1	1/2	**115**	**115**	**183**	**293**	**463**	**721**	**1150**	**1445**	**1825**	**2299**	**2902**	**3662**
	P42B0005A2		230	466	742	1183	1874	2915	4648	5843	7379	9295	11733	
	P42B0007A2	3/4		342	545	869	1376	2141	3413	4291	5419	6826	8617	10871
	P42B0010A2	1		241	383	611	968	1506	2400	3018	3811	4801	6060	7646
	P42B0015A2	1-1/2		199	317	505	801	1246	1986	2496	3153	3972	5013	6325
CSIR 3-Wire	P43B0005A1-01	1/2	**115**	**101**	**160**	**255**	**404**	**629**	**1002**	**1260**	**1591**	**2004**	**2530**	**3192**
	P43B0005A2-01		230	359	571	912	1444	2246	3581	4502	5685	7162	9040	
	P43B0007A2-01	3/4		281	447	713	1129	1757	2800	3521	4446	5601	7070	8920
	P43B0010A2-01	1		233	371	592	937	1458	2324	2921	3689	4648	5867	7402
	P43B0005A1	1/2	**115**	**87**	**138**	**221**	**349**	**544**	**867**	**1090**	**1376**	**1734**	**2188**	**2761**
	P43B0005A2		230	348	553	883	1398	2175	3467	4359	5505	6935	8753	
	P43B0007A2	3/4		264	420	670	1061	1651	2632	3309	4178	5264	6644	8383
	P43B0010A2	1		226	359	573	908	1413	2252	2831	3575	4504	5685	7173
CSCR 3-Wire	P43B0005A2-01	1/2		457	726	1158	1835	2855	4551	5721	7225	9102	11489	
	P43B0007A2-01	3/4		365	581	927	1468	2284	3641	4577	5780	7281	9191	11596
	P43B0010A2-01	1		300	478	762	1206	1877	2992	3762	4751	5985	7554	9531
	P43B0015A2-01	1-1/2		201	320	510	808	1257	2004	2519	3182	4008	5059	6383
	P43B0005A2	1/2		447	711	1135	1797	2796	4458	5604	7078	8916	11254	
	P43B0007A2	3/4		348	553	883	1398	2175	3467	4359	5505	6935	8753	11044
	P43B0010A2	1		304	484	772	1223	1903	3034	3814	4817	6068	7659	9663
	P43B0015A2	1-1/2		197	314	501	793	1234	1968	2474	3124	3936	4968	6268
	P43B0020A2	2		180	286	456	722	1123	1790	2251	2843	3581	4520	5703
	P43B0030A2	3		133	211	337	534	830	1324	1664	2102	2648	3342	4217
	P43B0050A2	5				206	326	507	809	1017	1284	1618	2042	2577

* Table data are generated per NEC standards.

SECTION 5: XE Series 4” Submersible Motors

Table 5-10: Cable Lengths, THREE PHASE 230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM Motors, 60° and 75° C. Service Entrance to Motor: Maximum Length in Feet

Pentek® Part Number	HP	Volt	Wire Size, AWG										
			14	12	10	8	6	4	3	2	1	0	00
P43B0005A8	1/2	200	657	1045	1667	2641	4109						
P43B0005A3		230	756	1202	1917	3037	4725	7532	9469				
P43B0005A4		460	2922	4648	7414								
P43B0007A8	3/4	200	423	674	1074	1702	2648						
P43B0007A3		230	562	894	1426	2258	3513	5601	7041	8892			
P43B0007A4		460	2191	3486	5560	8806							
P43B0010A8	1	200	346	551	879	1392	2166	3454	4342				
P43B0010A3		230	466	742	1183	1874	2915	4648	5843	7379			
P43B0010A4		460	1753	2789	4448	7045							
P43B0015A8	1-1/2	200	265	421	672	1064	1655	2638	3317				
P43B0015A3		230	359	571	912	1444	2246	3581	4502	5685	7162	9040	
P43B0015A4		460	1370	2179	3475	5504							
P43B0015A5		575	2283	3631	5792								
P43B0020A8	2	200	217	344	549	870	1354	2158	2714	3427	4317	5449	
P43B0020A3		230	288	459	732	1159	1803	2874	3613	4563	5748	7256	9155
P43B0020A4		460	1153	1835	2926	4635	7212						
P43B0020A5		575	1336	2126	3390	5370							
P43B0030A8	3	200	159	253	403	638	993	1583	1990	2513	3166	3996	
P43B0030A3		230	217	345	551	872	1357	2163	2719	3434	4326	5460	6889
P43B0030A4		460	827	1315	2098	3323	5171						
P43B0030A5		575	1660	2641	4212	6671							
P43B0050A8	5	200	94	150	239	379	590	940	1182	1493	1881	2374	2995
P43B0050A3		230	125	199	318	503	783	1248	1569	1982	2496	3151	3976
P43B0050A4		460	516	820	1308	2072	3224	5140					
P43B0050A5		575	721	1147	1829	2897	4507						
P43B0075A8	7-1/2	200	64	101	161	255	397	633	796	1005	1266	1598	2017
P43B0075A3		230			211	334	519	827	1040	1314	1655	2089	2635
P43B0075A4		460	325	516	824	1305	2030	3236	4068	5138	6472		
P43B0075A5		575	548	871	1390	2202	3426						
P43B0100A4	10	460	255	405	647	1024	1593	2540	3193	4033	5080		

* Table data are generated per NEC standards.

5.8 4” Motor Overload Protection

Single Phase Motors

Single phase motors have overload protection either in the motor or in the control box. Motors less than or equal to 1 HP have built-in protection. This automatic protection will continue to cycle under a locked or stalled rotor condition.

Single phase motors larger than 1 HP use overload protection located in the SMC (Submersible Motor Controls) section. These are manual overloads and must be manually reset if an overload condition occurs.

5.9 Motor Cooling

Pentek® 4” XE Series motors are designed to operate to a maximum SF (Service Factor) horsepower in water up to 86° F (30° C).

4” motors: Minimum cooling water flow 3 HP and over

I.D of casing	Flow GPM (LPM) required
4	1.2 (4.5
5	7 (26.5)
6	13 (49)
7	20 (76)
8	30 (114)
10	50 (189)
12	80 (303)
14	110 (416)
16	150 (568)

If the flow is less than specified, a flow-inducer sleeve can be installed, as shown in Figure 5-2. The sleeve will act like a smaller casing size to force flow around the motor to aid cooling.

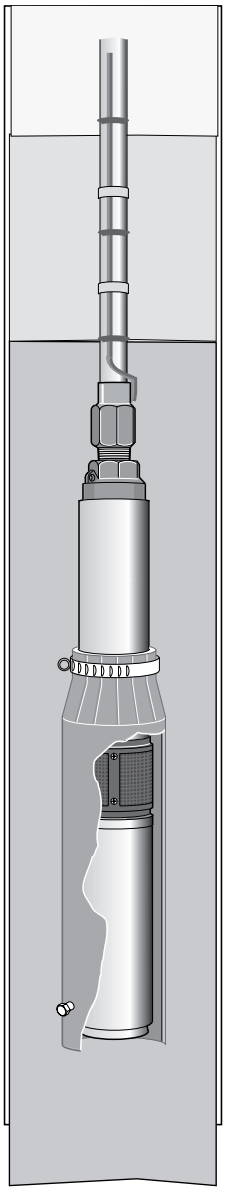


Figure 5-2: Flow Inducer Sleeve

5.10 Starting Frequency

Recommended motor starting frequency is shown below. Motor, pressure switch, tank, and pump life may be extended by limiting starts per hour and starts per day. Proper tank sizing is critical to control pump cycle times. Excessive or rapid cycling creates heat which can prematurely damage motors, switches, and controls.

Motor Starting Frequency				
HP	Single Phase		Three Phase	
	Starts/hr	Starts/24hr	Starts/hr	Starts/24hr
1/2 thru 3/4	12.5	300	12.5	300
1 thru 5	4.2	100		
7.5 thru 200			4.2	100

A one (1) minute minimum run time for pumps and motors up to 1.5 HP and two (2) minutes for 2HP and larger motors is recommended to dissipate heat build-up from starting current.

SECTION 6: Pentek® 6" Submersible Motors

6.1 Motor Inspection

Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during installation, operation, and maintenance.

⚠ This is the safety alert symbol. When you see this symbol in this manual, look for one of the following signal words and be alert to the potential for personal injury!

⚠DANGER indicates a hazard which, if not avoided, will result in death or serious injury.

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

⚠ CAUTION indicates a hazard which, if not avoided, could result in minor or moderate injury.

NOTICE addresses practices not related to personal injury.

Carefully read and follow all safety instructions in this manual.

Keep safety labels in good condition. Replace missing or damaged safety labels.

California Proposition 65 Warning

⚠WARNING This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

APPLICATION LIMITS

Maximum Immersion Depth: 985 ft. (300 m)

Maximum Water Temperature: 95°F (35°C)

pH content of the water: 6.5–8

Minimum Cooling Flow Rate: 0.5 feet per second (fps) (0.15meters per second (mps)).

Required line voltage at the motor under operating conditions (±10%).

NOTICE When calculating voltage at the motor, be sure to allow for voltage drop in the cable.

The sum of the absolute values of the voltage and frequency must not vary from the sum of the nominal values by more than ±10%.

Operating with current unbalanced on the three legs of the circuit can overheat and damage the motor and will void the warranty. Current imbalance must not exceed 5% maximum.

Maximum Sand Content: 50ppm (max. size 0.1–0.25mm)

Maximum Chlorine Ion Content: 500ppm

6.2 Testing

ELECTRICAL
(See Table 1, Page 4, for Motor Electrical Specifications)

1. **⚠WARNING Risk of electrical shock if the cable is damaged.** Inspect the motor cable for any nicks or cuts. Do not use the motor cable to pull, lift, or handle the motor. Protect the motor cable during storage, handling, moving, and installation of the motor.
2. Inspect the motor to determine that it is the correct horsepower, voltage, and size for the job and that there is no shipping damage. Verify that the motor nameplate voltage matches the available power supply voltage. The nameplate rated voltage must not vary more than ± 10% from the power supply voltage.
3. On all new installations and after the motor has sat idle for a long period of time, check the motor's internal electrical resistance with a megohmmeter with lead wires connected. Prior to installation, the motor should have an insulation value of at least 500 megohms. After installation, the motor and power cable should have a minimum insulation value of 1 megohm. If the minimum values are below the listed values, contact the factory before starting the motor.
4. Fuses or circuit breakers and overload protection are required. Fuses or circuit breakers and overloads must be sized in accordance with National Electrical Code (NEC) or Canadian Electrical Code (CEC) requirements, as applicable, and with all applicable local codes and ordinances. See Section 6 for these specifications.
5. Wire and ground the motor in accordance with National Electrical Code (NEC) or Canadian Electrical Code (CEC) requirements, as applicable, and with all applicable local codes and ordinances.

6.3 Storage and Drain/Fill Instructions

LIFTING

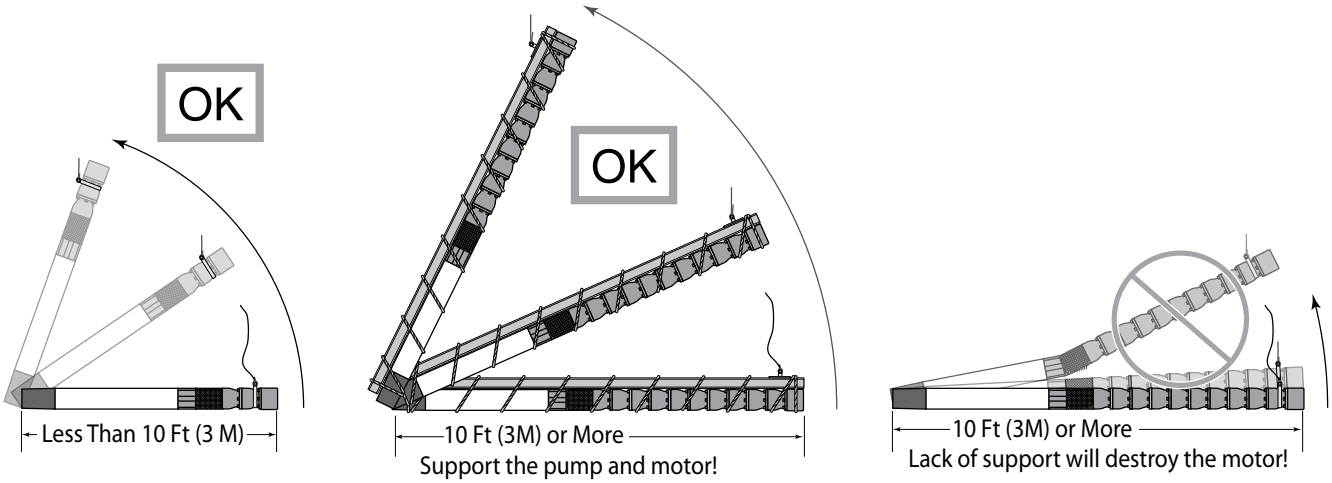
1. **⚠WARNING Heavy Object.** Lifting equipment must be capable of lifting motor and attached equipment. Check over all tools, especially the hoisting gear, for wear or damage before hoisting the unit.

2. If the total length of the pump and motor unit (without any riser pipe attached) exceeds 10ft (3m), support the unit with a girder while hoisting (see Figure 1). Do not remove the supporting girder until the unit is standing vertically in the hoist. Check for damage.

SECTION 6: Pentek® 6” Submersible Motors

6.3 Storage and Drain/Fill Instructions

Figure 1: When the pump and motor together (without any riser pipe) are 10ft (3m) long or more, support the assembly before lifting to avoid bending it in the middle. Never try to lift the motor or pump by the motor cables.



MOTOR STORAGE AND INSTALLATION

1. The motor is filled at the factory with anti-freeze which will protect it in temperatures down to –22ºF (-30ºC). Do not install, transport or store the motor below these temperatures if the motor is filled. If storage is necessary at temperatures below –22ºF (-30ºC), drain the anti-freeze from the motor.
2. Verify that the motor is full before installing. If not, fill it with clean water (see below). Installing a motor that is not filled with liquid will void the warranty. Before installation, check all water fill and drain plugs, mounting bolts, and cable connections for tightness. Refill the motor with clean water as follows:

   A. Stand the motor on end (vertically) and remove the fill plug with a 5mm hexagonal nut driver.

   B. Turn the motor shaft by hand while rocking the motor back and forth (see Figure 2).

   C. Pour in clean water until the motor is as full as possible.

   D. Repeat the turning/rocking procedure.

   E. Check the liquid level. If necessary, add more clean water.

   F. When the motor is full, re-install the fill plug. Tighten it with the 5mm hexagonal nut driver.

⚠ CAUTION Support motor while rocking to prevent motor from falling over.

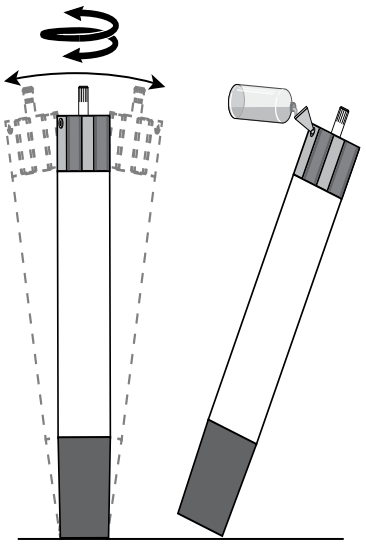


Figure 2: Rock Motor gently from side to side while turning shaft by hand (A), then fill with clean water (B). Repeat until full.

SECTION 6: Pentek® 6” Submersible Motors

6.3 Storage and Drain/Fill Instructions

NOTICE To avoid damaging the motor thrust bearing, do not hammer on the shaft, coupling, or slinger. Check the motor rotation by hand to make sure that it turns freely.

1. To avoid damage to the motor diaphragm, make sure that the bottom of the motor does not touch the dirt or mud at the bottom of the well. Install the motor at least 10’ above the well bottom.
2. To install the motor horizontally, lay it down with the lead wires at 12 o’clock when you are facing the motor shaft. To prevent any load on the shaft and bearings and to avoid any damaging vibrations to the motor, mount the motor solidly on the pump end and make sure that the pump and motor are accurately aligned.
3. Install the motor so that during operation water flows past all parts of it at a rate of at least 0.5 fps (0.15 mps). If the well will not provide this flow, install a sleeve on the motor to channel water past it (see Figure 3). Do not try to operate the motor in mud or sand. To do so will damage the motor and void the warranty.
4. Electrical connections: Connect the three motor leads to the three hot motor leads (black, brown, and blue) in the incoming cable. Connect the ground wire (green and yellow) in accordance with NEC or CEC requirements (as applicable) and in accordance with all applicable local codes and ordinances. Apply power momentarily to check rotation. If the motor runs backwards, interchange any two power leads to reverse direction of rotation.

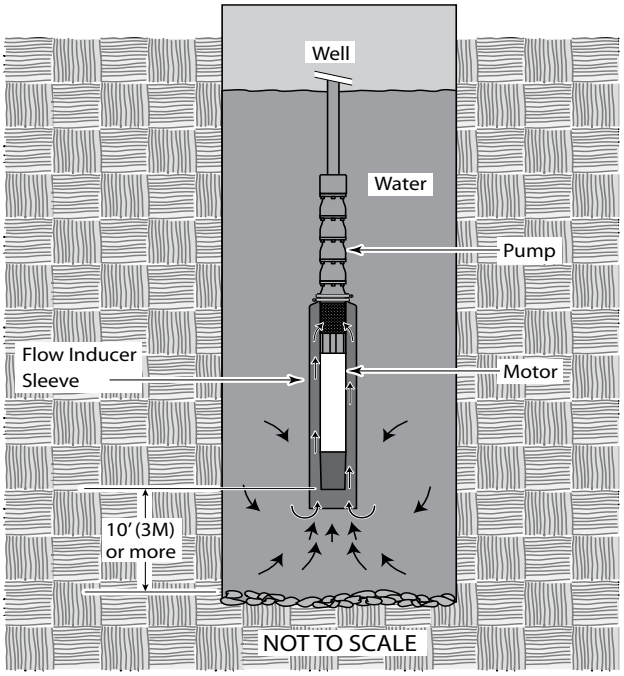


Figure 3: If flow past motor is less than .5 fps (0.15 mps), install a flow inducer sleeve as shown. Flow must be at least .5 fps (0.15 mps) for adequate motor cooling. The flow inducer sleeve should not touch the side of the motor.

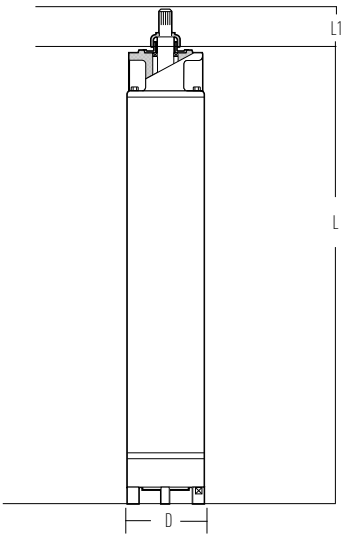
SECTION 6: Pentek® 6" Submersible Motors

6.4 Motor Specifications

Ordering Information

MOTOR TYPE	PHASE	NOTE	PENTEK MODEL #	HP	KW	HZ	VOLTS	SERVICE FACTOR 1.00			SERVICE FACTOR 1.15			LOCKED ROTOR AMPS	THRUST LOAD	KVA CODE	INSULATION CLASS	WINDING RESISTANCE (OHM)	RPM	LENGTH		WEIGHT	
								AMPS	EFF. %	P.F. %	AMPS	EFF. %	P.F. %							IN	MM	LBS	KG
6"	Three	Motors are 60 Hz only	6PM2-5-2	5	4	60	230	15 .2	75	83	16.4	77	85	102.1	1763	K	F	0.7873	3460	22.7	577	90	41
			6PM2-7-2	7-1/2	6			21.2	79	85	23.2	79	86	146.4		J		0.5389	3460	24.9	632	102	46
			6PM2-10-2	10	8			30.8	77	81	33.0	78	83	187.6	3485	J		0.3964	3440	29.2	741.5	116	53
			6PM2-15-2	15	11			43.2	78	84	47.0	78	86	281.8		J		0.2782	3450	31.8	807.5	121	55
			6MP2-20-2	20	15			57.4	79	85	63.0	79	87	394.5		J		0.2101	3450	35.1	892.5	147	67
			6PM2-25-2	25	19			69	81	86	76.0	80	88	480.2		J		0.1605	3450	38.0	964.5	165	75
			6PM2-30-2	30	22			76.6	84	88	85.0	84	89	614.2		K		0.1445	3500	41.8	1,060.5	190	86
		Motors are dual rated 50 Hz & 60 Hz	6PM2-5-4	5	4	50	380	8.9	75	87				45.6	1763	K		2.9674	2820	22.7	577	90	41
						60	460	10.6	75	83	8.2	77	85	51.1					3460				
			6PM2-7-4	7-1/2	6	50	380	12.5	79	87				66.8		J		1.9828	2820	24.9	632	102	46
						60	460	15.4	79	85	11.6	79	86	73.2					3460				
			6PM2-10-4	10	8	50	380	17.8	78	85				85.6	3485	J		1.4648	2800	29.2	741.5	116	53
						60	460	15.4	77	81	16.5	78	83	93.8					3440				
			6PM2-15-4	15	11	50	380	25.6	77	87				127		J		0.9916	2810	31.8	807.5	131	55
						60	460	21.6	78	84	23.5	78	86	140.9					3450				
			6PM2-20-4	20	15	50	380	34	78	89				170.2		J		0.7192	2810	35.1	892.5	147	67
						60	460	28.5	79	85	31.5	79	87	197.3					3450				
			6MP2-25-4	25	19	50	380	41	79	89				219		J		0.5640	2820	38.0	964.5	165	75
						60	460	34.5	81	86	38.0	80	88	240.1					3450				
			6PM2-30-4	30	22	50	380	46	83	90				276.8		K		0.5036	2880	41.8	1060.5	190	86
						60	460	38	84	88	42.5	84	89	307.1					3500				
			6PM2-40-4	40	30	50	380	62.5	83	90				393.1	6182	K		0.3958	2860	47.1	1197	209	95
						60	460	52.7	84	88	58.0	84	89	439.7					3490				
			6PM2-50-4	50	37	50	380	77.6	83	90				449.8		K		.3295	2840	49.9	1267	292	132
						60	460	64.3	85	87	70.8	85	89	500.5					3480				

6.5 Motor Dimensions



Nominal diameter	6"/152.4 mm
Effective diameter	5.43"/138 mm
Shaft extension length	2.87" / 73 mm

For lengths, refer to Ordering Information tables.
Dimensions are for estimating purposes only.

SECTION 6: Pentek® 6" Submersible Motors

6.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																						60°
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																						
MOTOR			FUSE		AWG													MCM				
VOLTS / HZ	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																						
230 V 60 Hz	5	3.7	45	25	154	245	391	620	965	1538	1933	2442	3076	3883	4899	6184	7791	9198				
	7.5	5.5	60	40	-	174	277	438	682	1087	1367	1726	2174	2745	3463	4372	5508	6502	7806	9124		
	10	7.5	90	50	-	-	-	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	80	-	-	-	216	337	537	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407
	20	15	175	110	-	-	-	-	251	400	503	636	801	1011	1275	1610	2028	2394	2874	3360	3842	4780
	25	18.5	225	125	-	-	-	-	-	332	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	250	125	-	-	-	-	-	-	373	471	593	749	945	1193	1503	1775	2130	2490	2847	3543
460 V 60 Hz or 380 V 50 Hz	5	3.7	20	10	617	982	1566	2480	3859	6152	7734	9767										
	7.5	5.5	30	20	436	694	1107	1753	2728	4349	5467	6904	8698									
	10	7.5	45	25	307	488	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	70	40	-	343	546	865	1347	2147	2699	3408	4293	5419	6837	8631						
	20	15	90	50	-	-	408	646	1005	1601	2013	2543	3203	4043	5101	6439	8113	9578				
	25	18.5	110	60	-	-	-	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	125	70	-	-	-	479	745	1187	1492	1884	2374	2997	3781	4773	6013	7099	8522	9961		
	40	30	150	100	-	-	-	-	546	870	1093	1381	1740	2196	2770	3497	4406	5202	6244	7299	8345	

Lengths only meet the US National Electrical Code ampacity requirements for individual conductors rated 60° C in free air or water, NOT in magnetic enclosures, conduit or direct buried. Refer to NEC Table 310.15(B)(17) for more information.

CABLE SELECTION																						75° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																						
MOTOR			FUSE		AWG													MCM				
VOLTS / HZ	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																						
230 V 60 Hz	5	3.7	45	25	-	245	391	620	965	1538	1933	2442	3076	3883	4899	6184	7791	9198				
	7.5	5.5	60	40	-	-	277	438	682	1087	1367	1726	2174	2745	3463	4372	5508	6502	7806	9124		
	10	7.5	90	50	-	-	-	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	80	-	-	-	-	337	537	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407
	20	15	175	110	-	-	-	-	-	400	503	636	801	1011	1275	1610	2028	2394	2874	3360	3842	4780
	25	18.5	225	125	-	-	-	-	-	-	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	250	125	-	-	-	-	-	-	-	471	593	749	945	1193	1503	1775	2130	2490	2847	3543
460 V 60 Hz or 380 V 50 Hz	5	3.7	20	10	617	982	1566	2480	3859	6152	7734	9767										
	7.5	5.5	30	20	436	694	1107	1753	2728	4349	5467	6904	8698									
	10	7.5	45	25	-	488	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	70	40	-	-	546	865	1347	2147	2699	3408	4293	5419	6837	8631						
	20	15	90	50	-	-	-	646	1005	1601	2013	2543	3203	4043	5101	6439	8113	9578				
	25	18.5	110	60	-	-	-	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	125	70	-	-	-	-	745	1187	1492	1884	2374	2997	3781	4773	6013	7099	8522	9961		
	40	30	150	100	-	-	-	-	-	870	1093	1381	1740	2196	2770	3497	4406	5202	6244	7299	8345	

Lengths only meet the US National Electrical Code ampacity requirements for individual conductors rated 75° C in free air or water, NOT in magnetic enclosures, conduit or direct buried. Refer to NEC Table 310.15(B)(17) for more information.

SECTION 6: Pentek® 6" Submersible Motors

6.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																							60° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																							
MOTOR			FUSE		AWG													MCM					
VOLTS	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																							
230 V 60 Hz	5	3.7	45	25	-	-	391	620	965	1538	1933	2442	3076	3883	4899	6184	7791	9198				
	7.5	5.5	60	40	-	-	277	438	682	1087	1367	1726	2174	2745	3463	4372	5508	6502	7806	9124		
	10	7.5	90	50	-	-	-	-	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	80	-	-	-	-	-	537	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407
	20	15	175	110	-	-	-	-	-	-	503	636	801	1011	1275	1610	2028	2394	2874	3360	3842	4780
	25	18.5	225	125	-	-	-	-	-	-	-	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	250	125	-	-	-	-	-	-	-	-	593	749	945	1193	1503	1775	2130	2490	2847	3543
460 V 60 Hz or 380 V 50 Hz	5	3.7	20	10	617	982	1566	2480	3859	6152	7734	9767										
	7.5	5.5	30	20	436	694	1107	1753	2728	4349	5467	6904	8698									
	10	7.5	45	25	-	-	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	70	40	-	-	546	865	1347	2147	2699	3408	4293	5419	6837	8631						
	20	15	90	50	-	-	-	646	1005	1601	2013	2543	3203	4043	5101	6439	8113	9578				
	25	18.5	110	60	-	-	-	-	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	125	70	-	-	-	-	745	1187	1492	1884	2374	2997	3781	4773	6013	7099	8522	9961		
	40	30	150	100	-	-	-	-	-	-	1093	1381	1740	2196	2770	3497	4406	5202	6244	7299	8345	

Lengths meet the US National Electrical Code ampacity requirements for either individual conductors or jacketed rated 60° C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable. Refer to NEC Table 310.15(B)(16) for more information.

* = motors are 8" diameter

CABLE SELECTION																							75° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																							
MOTOR			FUSE		AWG													MCM					
VOLTS	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																							
230 V 60 Hz	5	3.7	45	25	-	245	391	620	965	1538	1933	2442	3076	3883	4899	6184	7791	9198				
	7.5	5.5	60	40	-	-	277	438	682	1087	1367	1726	2174	2745	3463	4372	5508	6502	7806	9124		
	10	7.5	90	50	-	-	-	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	80	-	-	-	-	337	537	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407
	20	15	175	110	-	-	-	-	-	400	503	636	801	1011	1275	1610	2028	2394	2874	3360	3842	4780
	25	18.5	225	125	-	-	-	-	-	-	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	250	125	-	-	-	-	-	-	-	471	593	749	945	1193	1503	1775	2130	2490	2847	3543
460 V 60 Hz or 380 V 50 H	5	3.7	20	10	617	982	1566	2480	3859	6152	7734	9767										
	7.5	5.5	30	20	436	694	1107	1753	2728	4349	5467	6904	8698									
	10	7.5	45	25	-	488	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	70	40	-	-	546	865	1347	2147	2699	3408	4293	5419	6837	8631						
	20	15	90	50	-	-	-	646	1005	1601	2013	2543	3203	4043	5101	6439	8113	9578				
	25	18.5	110	60	-	-	-	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	125	70	-	-	-	-	745	1187	1492	1884	2374	2997	3781	4773	6013	7099	8522	9961		
	40	30	150	100	-	-	-	-	-	870	1093	1381	1740	2196	2770	3497	4406	5202	6244	7299	8345	

Lengths meet the US National Electrical Code ampacity requirements for either individual conductors or jacketed rated 75° C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable. Refer to NEC Table 310.15(B)(16) for more information.

SECTION 6: Pentek® 6" Submersible Motors

6.7 Overload Protection

208 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	7.5	30	13.5	6.5–13.5	PPX-1A-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1A-27-30R	34 x 21 x 7	85
2	10	60	50	25–50	PPX-2A-50-60R	34 x 21 x 7	90
3	25	100	70	35–70	PPX-3A-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3A-135-100R	47.5 x 25 x 9	195
4	40	200	135	65–135	PPX-4A-135-200R	47.5 x 25 x 9	195

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

230-240 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	7.5	30	13.5	6.5–13.5	PPX-1B-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1B-27-30R	34 x 21 x 7	85
2	15	60	50	25–50	PPX-2B-50-60R	34 x 21 x 7	90
3	30	100	70	35–70	PPX-3B-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3B-135-100R	47.5 x 25 x 9	195

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

460-480 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	10	30	13.5	6.5–13.5	PPX-1C-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1C-27-30R	34 x 21 x 7	85
2	25	60	50	25–50	PPX-2C-50-60R	34 x 21 x 7	90
3	50	100	70	35–70	PPX-3C-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3C-135-200R	47.5 x 25 x 9	195
4	100	200	135	65–135	PPX-4C-135-200R	47.5 x 25 x 9	195
5	200	400	270	130–270	PPX-5C-270-400R	52 x 22 x 10	285

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

575-600 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	10	30	13.5	6.5–13.5	PPX-1D-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1D-27-30R	34 x 21 x 7	85
2	25	60	50	25–50	PPX-2D-50-60R	34 x 21 x 7	90
3	50	100	70	35–70	PPX-3D-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3D-135-100R	47.5 x 25 x 9	195
4	100	200	135	65–135	PPX-4D-135-200R	47.5 x 25 x 9	195
5	200	400	270	130–270	PPX-5D-270-400R	52 x 22 x 10	285

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

SECTION 6: Pentek® 6" Submersible Motors

6.7 Overload Protection

Submersible motors must have Class 10 overload protection that will disconnect the power within 10 seconds in the case of a locked rotor. To accomplish this, fixed-heater overloads are used. Refer to Section 10 for appropriate heaters. The chart is based upon total line amps. Divide the motor amps by 1.732 when using a 6-lead motor with a Y-Delta Starter. Notice: General Electric overload heaters are only usable with general electric overload relays. Do not adjust relays to exceed nameplate amps.

6.8 Motor Cooling

Pentek 6" motors are designed for minimum water flow of 0.5 ft. /sec. past the motor. Maximum water temperature is 95° F (35° C).

6" MOTORS: MINIMUM COOLING WATER FLOW

I.D of casing	Flow (GPM) required
6	9
7	25
8	40
10	85
12	140
14	200
16	280

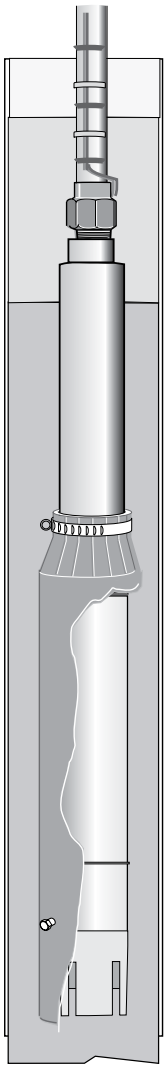
If the flow is less than specified, a flow-inducer sleeve can be installed. This will act like a smaller casing size, and force flow around the motor to aid cooling. Always use a flow-inducer sleeve when the pump is in open water.

6.9 Head Loss In Casing

Use the chart below to account for the head loss around the pump.

Head loss in feet for flow past motor

6" MOTORS		CASING INSIDE DIAMETER		
		6"	7"	8"
GPM	100	1.7		
	150	3.7		
	200	6.3	0.5	
	250	9.6	0.8	
	300	13.6	1.2	0.2
	400	23.7	2.0	0.4
	500		3.1	0.7
	600		4.4	1.0



6.10 Starting Frequency

To extend the life of the pump motor and control, limit the number of starts to 100 per 24 hours. If higher starting frequencies are necessary, consult your factory. To prevent overheating, run motor for a minimum of two minutes. For starting frequency, refer to section 5.10.

SECTION 6: Pentek® 6” Submersible Motors

6.11 Troubleshooting

Problem	Possible Causes	Solution
Motor does not start, but does not blow fuses or trip circuit breaker	Defective fuses or circuit breakers Loose or corroded terminals	Replace fuses or circuit breakers. Clean and tighten connections and motor lead terminals.
	Damaged or defective connections No incoming power	Repair or replace connections. Contact power company.
Motor starts, but fuses blow or circuit breakers trip	Wrong voltage	Make sure that nameplate rated voltage matches nominal power supply, and that actual supply voltage is within ±10% of nameplate voltage.
	Incorrect fuses or relay	Install correct fuses or relay.
	Incorrect connections	Re-connect motor wires correctly.
	Locked rotor or pump	Make sure that motor is at least 10ft above bottom of well, check well for sand.
	Insufficient insulation on motor cables	Install new motor cables; recheck resistance with Megohmeter.
Motor starts and runs, then blows fuse or trips circuit breaker	Incoming voltage more than 10% high or low sand in well	Confirm high or low voltage in motor cable, consult power company. Pull the pump and clean the well.
Motor does not start, but fuse blows or circuit breaker trips	Locked rotor or pump	Check for sand in well. Make sure that motor is at least 10ft above the bottom of the well. Pull pump and check for mechanical obstruction in the pump and for free rotation of the motor.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.1 Motor Inspection

The following conditions are stated to provide the owner with a list of criteria for maximum motor life and to assure motor warranty.

1. Maximum water temperature:

- A) 35°C (95°F): 6” (5~40HP) motors.
- B) 25°C (77°F): 6” (50,60HP), 8’’, 10”, 12’’ and 14” motors

2. PH content of the water between: 6.5 -8
3. Maximum chlorine content: 500 PPM

- Maximum Sulfuric acid iron content: 15 PPM
- Maximum Fluorine content: 0.8 PPM
- Maximum Electric conductivity: 118 µMHO/INCH

4. Maximum sand content: 50 PPM
5. Proper approved three phase overload protection. See Table 13.
6. Proper fusing for motor circuit protection. See Table C.
7. Proper line voltage during running conditions:
   60Hz: 460V, 230V ±10%
   50Hz: 380V ±10%
   at motor lead terminal. (Voltage drop of cable should be considered by user.)
   Combination of voltage and frequency variation: ±10% (sum of absolute values of voltage and frequency)
   Current unbalance between legs should not exceed 5% of the average.
8. Proper sizing of motor (current, thrust, voltage, etc.) and a 10 feet clearance from the bottom of the well are required.
9. In the case of horizontal installation, the motor is to be rigidly aligned with the pump and firmly mounted to prevent any load on the shaft and bearings and to avoid any damaging vibrations to the motor.
10. The motor must always be immersed in water so that a flow velocity of cooling water at a rate of 0.5 feet per second flows past any and all parts of the motor. The motor will not operate in mud or sand.
11. The power cables shall be sized large enough so that at rated current there will be less than a 5% voltage drop. See Table C. Cables must be waterproof submersible type.
12. For 3ø motor a balanced and properly sized transformer bank shall be provided. Improper electrical supply (for example, phase converter. V-connection transformer, etc.) or connections will void the warranty
13. Single-phase protection is recommended for protection of the installation. Any failure due to single phasing of the incoming voltage causing the motor to fail will void the warranty.
14. Surge suppressors are recommended in the interest of protecting the control panel, as well a.s the insulation system of the motor. Any motor failure due to lightning or other Acts of God will void the warranty.
15. Provide waterproof insulation splices between all lead wires and well cables.
16. In the event that a reduced voltage starter is used to start the motor, the following should be verified:

- Correct quick trip, class 10 or better, ambient compensated overloads are incorporated.
- Proper short circuit protection is utilized.
- The torque required by the motor and pump package is attainable by this type starter.
- The lead arrangement of the motor is acceptable with the proposed starter load connections.
- Verify that if any time delay relays are used in switching contactors in and out, that the time settings do not exceed 2 seconds; this could damage the motor.
- If a manual auto transformer starter is used, voltage should be minimum 60% of rated voltage, and switched to “Run”condition within 2 seconds. Double check Table B and C for correct protection.

17. Single-Phase Motors (5-15HP)
    Proper connections and correct capacitors and relays are necessary for single-phase motor starting and running. Connection diagram: Sec Fig. 1. Performance and recommendable capacitors: See Table D.

7.2 Testing

1. Do not use lead wires to pull, lift or handle the motor. The lead wires should be protected during storage, handling, moving and installation of the motor. 2)
2. Inspect the motor to determine that it is the correct HP, voltage and size for the job and that there is no shipping damage.
3. The factory-installed water in the motor is supplied with anti-freeze capable of temperatures to 0°C(-22°F). Do not install, transport or store below these temperatures. If storage is necessary below these temperatures, drain the water from the motor.
4. After long periods of idleness and on all new installations, check the electrical resistance and megger the motor with lead wires connected: see table A. Prior to installation, the motor should have an insulation value of at least 50 megohms. After installation, motor and power cable should have a minimum insulation value of 1 megohm. If minimum values are not obtained, contact factory.

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

7.2 Testing

5. Verify motor is filled with clean water before installing. The warranty is void if this is not done. Also check the tightness of all water filling and drain plugs, mounting bolts and cable connections.
6. Do not hammer the shaft, coupling or slinger since this may damage the thrust bearing. Check the rotation of the motor by hand to insure that it turns freely.
7. Do not drop the bottom end of the motor in the dirt or mud since this may plug up the diaphragm opening.
8. If motor is to be installed horizontal, make sure that the lead wires are at the 12 o’clock position when facing the motor shaft (in horizontal position).

NOTE:

There are no bearings that need oil or grease. The motor, being inaccessible, should be monitored through its electrical connections.

- A) Measure and record operating current and voltage.
- B) Measure and record the motor insulation resistance. Any resistance of less than 50 megohm (5,000,000) for a new motor should be evaluated or checked further by a qualified service shop.
- Lightning arrestors and/or surge capacitors will help prevent damage to the control box, cables, and motor.
- Single-phase protection will help in preventing motor failure due to adverse incoming primary power.
- Based on the values obtained in A and B above and the output flow rates and pressures of the pump, a complete picture of total performance can be obtained. This can be used to determine any pump and motor maintenance and overhauling which might be required.
- If the motor is to be stored, protect the unit from freezing by storing in an area with a temperature higher than -30°C (-22° F).

7.3 Storage and Drain Fill Instructions

1. After energizing the motor, check the flow and pressure of the pump to make sure that the motor is rotating in the correct direction. To correct a wrong rotation, switch any two of the three cable connections. (Three-phase motor only)
2. When starting the pump for the first time, inspect the water for sand. If sand appears, then continue to pump till the water clears up; otherwise, sand will accumulate in the pump stages and will bind or freeze the moving parts if water is allowed to flow back down the well.
3. During testing or checking rotation (such as “humping” or “inching”) the number of “starts” should be limited to 3, followed by a full 15 minute cooling-off period before any additional “starts” are attempted. Depending on the depth of the well and/or method of checking, these rotational checks or ‘’starts’’ may actually be full-fledged starts. If this is the case, then a full cooling-off period of 15 minutes is required between this type of start.
4. For automatic (pilot device) operation, the motor should be allowed to cool for 15 minutes between starts.
5. Input voltage, current and insulation resistance values should be recorded throughout the life of the installation and should be used as a from of preventive maintenance.

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.4 Motor Specifications

TABLE A. RESISTANCE DATA
Single Phase 2 Pole 230V/60Hz

Motor Size and Type	HP	Resistance (Ω)		
		R – Y	B – Y	R – B
6”, C	5	2.172	0.512	2.627
“	7.5	1.401	0.400	1.774
“	10	1.052	0.316	1.310
“	15	0.678	0.230	0.850

Three Phase 2 Pole

Motor Size and Type	HP	Volt	Resistance (Ω)
6”, C	5	230	.806
“	5	460	3.050
“	7.5	230	0.651
“	7.5	460	2.430
“	10	230	0.448
“	10	460	1.619
“	15	230	0.312
“	15	460	1.074
“	20	230	0.258
“	20	460	0.861
“	25	230	0.210
“	25	460	0.666
“	30	230	0.166
“	30	460	0.554
“	40	460	0.446
“	50	“	0.388
“	60	“	0.388
8”,W	40	“	0.372
“	50	“	0.331
“	60	“	0.278
“	75	“	0.218
“	100	“	0.164
“	125	“	0.132
“	150	“	0.115
10”, W	175	“	0.121
“	200	“	0.0929
“	250	“	0.0776
12”, W	300	“	0.0386

Three Phase 4 Pole

Motor Size and Type	HP	Volt	Resistance (Ω)
8”, W	7.5	230	.564
“	7.5	460	2.178
“	10	230	0.564
“	10	460	2.178
“	15	230	0.399
“	15	460	1.519
“	20	230	0.399
“	20	460	1.519
“	25	230	0.242
“	25	460	0.888
“	30	230	0.242
“	30	460	0.888
10”, W	40	230	0.408
“	50	460	0.408
“	60	460	0.288
“	75	“	0.257
“	100	“	0.171
	125	“	0.171
12”, W	150	“	0.138
“	175	“	0.119
“	200	“	0.0826
14”, W	250	“	0.0552
“	300	“	0.0517

Values are for normal temp. 68° (20°) with motor lead wires.

LEAD WIRE COLOR
R: Red
Y: Yellow
B: Black
G: Green (6” only)

MOTOR TYPE
C: CANNED
W: WATER TYPE

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

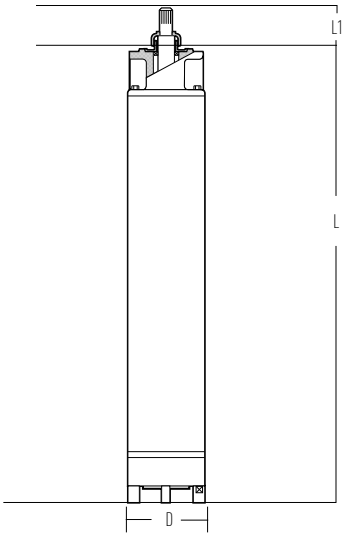
SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.4 Motor Specifications

Materials of Construction

PARTS	MATERIALS
Motor Sleeve	Stainless steel construction
Castings	Baked epoxy-coated gray iron
Fasteners	Stainless steel
Shaft	NEMA splined stainless steel
Flange	NEMA standard type
Rotor	Double epoxy-coated
Thrust Bearings	Kingsbury-type 420 stainless steel
Mechanical Seal	Nitrile rubber (NBR), grease packed
Diaphragm	Nitrile rubber
Sand Cap	Polyurethane
Sand Slinger	Stainless steel
Lead Wire (or Cable)	Double-insulated, heat and water-resistant, 167°F/75°C, 600V

Motor Dimensions



DIAMETER	HP	KW	VOLTS	PH	HZ	CATALOG NUMBER	SERVICE FACTOR	WINGING RESISTANCE (OHMS)	RATED INPUT AMPS	SERVICE FACTOR INPUT AMPS	SHAFT EXTENSION (L1)	LENGTH (L2)	DIAMETER (D)	THRUST CAPACITY	WEIGHT
6	5	3.7	200	3	60	6HIT2-5-8	1.15		17.5	19.5	2.87"	22.95"	5.5"	3,500	95
6	5	3.7	230	1	60	6HIT2-5-1	1.15	R-Y, B-Y, R-B, 2.172, 0.512, 2.627	24	27.5	2.87"	26.97"	5.5"	3,500	110
6	5	3.7	230	3	60	6HIT2-5-2	1.15	0.806	15	17	2.87"	22.95"	5.5"	3,500	95
6	5	3.7	460	3	60	6HIT2-5-4	1.15	3.05	7.5	8.5	2.87"	22.95"	5.5"	3,500	95
6	7.5	5.5	200	3	60	6HIT2-7-8	1.15		25.4	28.5	2.87"	24.80"	5.5"	3,500	99
6	7.5	5.5	230	1	60	6HIT2-7-1	1.15	R-Y, B-Y, R-B, 1.401, 0.400, 1.774	36	41	2.87"	29.92"	5.5"	3,500	128
6	7.5	5.5	230	3	60	6HIT2-7-2	1.15	0.651	22	26	2.87"	24.80"	5.5"	3,500	99
6	7.5	5.5	460	3	60	6HIT2-7-4	1.15	2.43	11	13	2.87"	24.80"	5.5"	3,500	99
6	10	7.5	200	3	60	6HIT2-10-8	1.15		33.3	37.2	2.87"	26.97"	5.5"	3,500	110
6	10	7.5	230	1	60	6HIT2-10-1	1.15	R-Y, B-Y, R-B, 1.052, 0.316, 1.310	50	58	2.87"	29.92"	5.5"	3,500	128
6	10	7.5	230	3	60	6HIT2-10-2	1.15	0.448	29	33	2.87"	26.97"	5.5"	3,500	110
6	10	7.5	460	3	60	6HIT2-10-4	1.15	1.619	14.5	16.5	2.87"	26.97"	5.5"	3,500	110
6	15	11	200	3	60	6HIT2-15-8	1.15		47.4	53.5	2.87"	29.92"	5.5"	3,500	128
6	15	11	230	1	60	6HIT2-15-1	1.15	R-Y, B-Y, R-B, 0.678, 0.230, 0.850	72	85	2.87"	33.46"	5.5"	3,500	148
6	15	11	230	3	60	6HIT2-15-2	1.15	0.312	42	46	2.87"	29.92"	5.5"	3,500	128
6	15	11	460	3	60	6HIT2-15-4	1.15	1.074	21	23	2.87"	29.92"	5.5"	3,500	128
6	20	15	200	3	60	6HIT2-20-8	1.15		61.2	69.5	2.87"	31.5"	5.5"	3,500	137
6	20	15	230	3	60	6HIT2-20-2	1.15	0.258	54	60	2.87"	31.5"	5.5"	3,500	137
6	20	15	460	3	60	6HIT2-20-4	1.15	0.861	27	30	2.87"	31.5"	5.5"	3,500	137
6	25	18.5	200	3	60	6HIT2-25-8	1.15		77.3	87.5	2.87"	36.22"	5.5"	3,500	161
6	25	18.5	230	3	60	6HIT2-25-2	1.15	0.21	68	76	2.87"	36.22"	5.5"	3,500	161
6	25	18.5	460	3	60	6HIT2-25-4	1.15	0.666	34	38	2.87"	36.22"	5.5"	3,500	161
6	30	22	200	3	60	6HIT2-30-8	1.15		91.8	104	2.87"	38.19"	5.5"	3,500	176
6	30	22	230	3	60	6HIT2-30-2	1.15	0.166	82	94	2.87"	39.19"	5.5"	3,500	176
6	30	22	460	3	60	6HIT2-30-4	1.15	0.554	41	47	2.87"	38.19"	5.5"	3,500	176
6	40	30	460	3	60	6HIT2-40-4	1.15	0.358	56	61	2.87"	40.55"	5.5"	5,000	187
8	50	37	460	3	60	8HIT2-50-4*	1.15	0.331	65	73	2.87"	45.28"	7.52"	5,000	353
8	60	45	460	3	60	8HIT2-60-4*	1.15	0.278	80	90	2.87"	48.03"	7.52"	5,000	408

*Models are 8" motors with 6" pump connection.



Hitachi Control Boxes

Type 1 NEMA Enclosure
In-Panel Circuit Breaker
Magnetic Contactor
Terminal Blocks for External Controls
UL Recognized

HP	KW	PH	VOLTS	CATALOG NUMBER
5	3.7	1	230	HIT-5CBD
7.5	5.5	1	230	HIT-7.5CBD
10	7.5	1	230	HIT-10CBD
15	11	1	230	HIT-15CBD

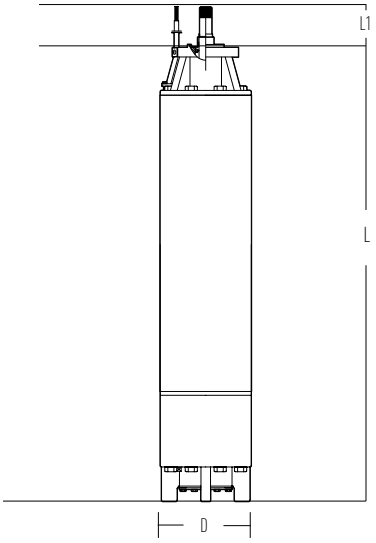
Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.4 Motor Specifications

Materials of Construction

PARTS	MATERIALS
Housing	Baked epoxy-coated gray iron
Fasteners	Stainless steel
Shaft	Splined or keyed stainless steel
Rotor	Double epoxy-coated
Thrust Bearings	Kingsbury-type 420 stainless steel
Mechanical Seal	Nitrile rubber (NBR), grease packed
Diaphragm	Nitrile rubber
Sand Slinger	Baked epoxy-coated gray iron
Lead Wire (or Cable)	Double-insulated, heat and water-resistant, 167°F/75°C, 600V



MOTOR DIAMETER	HP	KW	VOLTS	PH	HZ	RPM	CATALOG NUMBER	LENGTH (L)	SHAFT EXTENSION (L1)	DIAMETER (D)	THRUST CAPACITY	WEIGHT
8*	50	37	460	3	60	3600	86HIT2-50-4	45.28	2.875	5.5	10,000 **5,000	157
8*	60	45	460	3	60	3600	86HIT2-60-4	48.03	2.875	5.5	10,000 **5,000	182
8	7.5	5.5	460	3	60	1800	8HIT4-7-4	32.4	4	7.52	10,000	298
8	10	7.5	460	3	60	1800	8HIT4-10-4	32.4	4	7.52	10,000	298
8	15	11	460	3	60	1800	8HIT4-15-4	41.34	4	7.52	10,000	320
8	20	15	460	3	60	1800	8HIT4-20-4	41.34	4	7.52	10,000	320
8	25	18.5	460	3	60	1800	8HIT4-25-4	44.09	4	7.52	10,000	342
8	30	22	460	3	60	1800	8HIT4-30-4	44.09	4	7.52	10,000	342
8	40	30	460	3	60	3600	8HIT2-40-4	44.09	4	7.52	10,000	320
8	50	37	460	3	60	3600	8HIT2-50-4	46.44	4	7.52	10,000	353
8	60	45	460	3	60	3600	8HIT2-60-4	49.19	4	7.52	10,000	408
8	75	55	460	3	60	3600	8HIT2-75-4	53.15	4	7.52	10,000	463
8	100	75	460	3	60	3600	8HIT2-100-4	53.8	4	7.52	10,000	518
8	125	90	460	3	60	3600	8HIT2-125-4	66.14	4	7.52	10,000	595
8	150	110	460	3	60	3600	8HIT2-150-4	70.08	4	7.52	10,000	661
10	40	30	460	3	60	1800	10HIT4-40-4	49.21	4	8.52	10,000	507
10	50	37	460	3	60	1800	10HIT4-50-4	49.21	4	8.52	10,000	507
10	60	45	460	3	60	1800	10HIT4-60-4	59.84	4	8.52	10,000	639
10	75	55	460	3	60	1800	10HIT4-75-4	59.84	4	8.52	10,000	639
10	100	75	460	3	60	1800	10HIT4-100-4	69.68	5	8.52	10,000	794
10	125	90	460	3	60	1800	10HIT4-125-4	69.68	5	8.52	10,000	794
10	200	150	460	3	60	3600	10HIT2-200-4	69.68	5	8.52	10,000	816
10	250	185	460	3	60	3600	10HIT2-250-4	79.53	5	8.52	10,000	948
12	150	110	460	3	60	1800	12HIT4-150-4	56.3	5	10.53	10,000	959
12	200	150	460	3	60	1800	12HIT4-200-4	68.11	5	10.53	10,000	1235
12	300	225	460	3	60	3600	12HIT2-300-4	78.75	5	10.53	10,000	1455
14	250	185	460	3	60	1800	14HIT4-250-4	68.31	5	12.6	10,000	1698
14	300	225	460	3	60	1800	14HIT4-300-4	76.18	5	12.6	10,000	1940

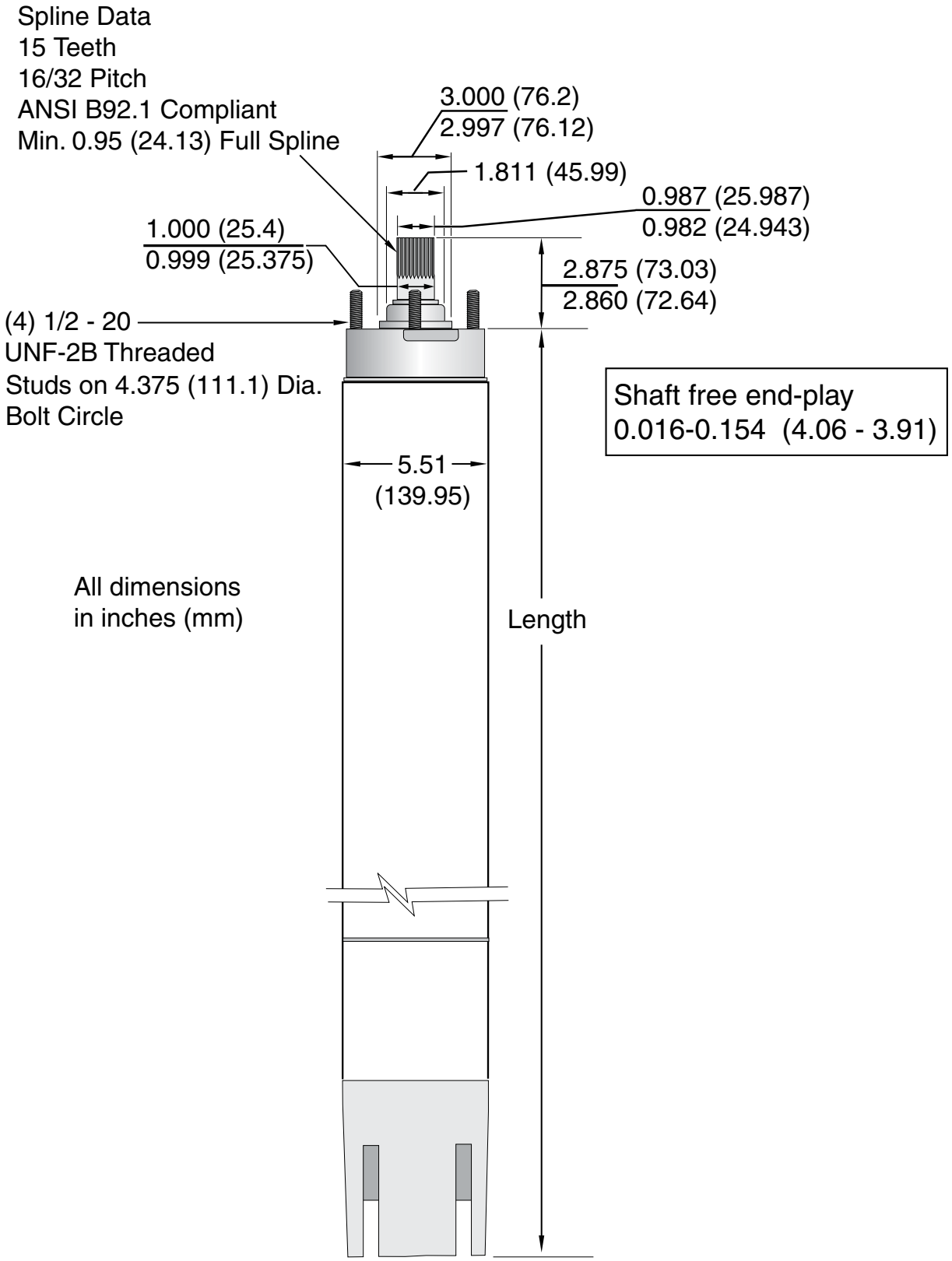
*Motor is 8" diameter, but constructed to operate with a 6" liquid end.

** 8" motors with 6" flange when using stainless steel bolts have a thrust rating of 5,000 lbs. A thrust value of 10,000 lbs. can be obtained using grade-8 heat-treated stainless steel bolts.

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.5 Motor Dimensions



Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Cable Selection Guide
Hitachi® 6"– 8" Submersible Motors

7.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																							60°
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																							
MOTOR					AWG													MCM					
VOLTS / HZ	HP	KW	FUSE STD	FUSE Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
THREE PHASE																							
230 V 60 Hz	5	4	45	25	149	237	378	598	931	1484	1865	2356	2967	3746	4726	5966	7516	8873					
	8	6	60	35	-	-	247	391	609	970	1220	1540	1940	2449	3090	3901	4914	5802	6965	8142	9308		
	10	8	80	45	-	-	-	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125	
	15	11	125	70	-	-	-	221	344	548	689	871	1097	1384	1746	2205	2778	3279	3937	4602	5261	6546	
	20	15	150	90	-	-	-	-	264	420	528	667	841	1061	1339	1690	2130	2514	3018	3528	4034	5019	
	25	19	200	100	-	-	-	-	-	332	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962	
	30	22	225	125	-	-	-	-	-	-	337	426	537	677	855	1079	1359	1605	1926	2252	2575	3203	
	40*	30	300	175	-	-	-	-	-	-	-	328	413	522	659	831	1047	1236	1484	1735	1984	2468	
460 V 60 Hz	5	4	20	10	595	947	1511	2393	3723	5935	7461	9422											
	8	6	30	15	389	619	988	1564	2434	3880	4878	6161	7761	9797									
	10	8	40	20	307	488	778	1233	1918	3057	3844	4854	6115	7719	9738								
	15	11	60	30	-	350	558	884	1376	2193	2757	3482	4387	5537	6986	8819							
	20	15	80	45	-	-	428	678	1055	1682	2114	2670	3363	4245	5356	6761	8518						
	25	19	100	50	-	-	-	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531				
	30	22	110	60	-	-	-	433	673	1073	1349	1704	2147	2710	3419	4316	5437	6419	7706	9008			
	40	30	150	80	-	-	-	-	519	827	1040	1313	1654	2088	2634	3325	4189	4946	5937	6940	7935	9873	
	40*	30	150	80	-	-	-	-	502	801	1007	1271	1601	2022	2550	3220	4056	4789	5749	6720	7683	9559	
	50	37	175	100	-	-	-	-	-	639	803	1014	1277	1612	2034	2568	3235	3819	4585	5359	6127	7623	
	50*	37	175	100	-	-	-	-	-	691	869	1097	1382	1745	2201	2779	3501	4133	4961	5799	6631	8250	
	60	45	225	125	-	-	-	-	-	-	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407	
	60*	45	225	125	-	-	-	-	-	-	705	890	1121	1415	1785	2254	2839	3352	4024	4704	5378	6691	
	75	55	250	150	-	-	-	-	-	-	-	735	926	1168	1474	1861	2344	2768	3323	3884	4441	5525	
	100	75	350	200	-	-	-	-	-	-	-	-	-	878	1108	1399	1762	2081	2498	2920	3338	4153	
	125	93	450	250	-	-	-	-	-	-	-	-	-	-	893	1127	1420	1676	2012	2352	2689	3346	
	150	111	500	275	-	-	-	-	-	-	-	-	-	-	-	-	1162	1371	1646	1924	2200	2737	

Lengths only meet the US National Electrical Code ampacity requirements for individual conductors rated 60° C in free air or water, NOT in magnetic enclosures, conduit or direct buried. Refer to NEC Table 310.15(B)(17) for more information.

* = motors are 8" diameter

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Cable Selection Guide
Hitachi® 6”– 8” Submersible Motors

7.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																							75° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																							
MOTOR					AWG														MCM				
			FUSE																				
VOLTS / HZ	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
THREE PHASE																							
230 V 60 Hz	5	4	45	25	149	237	378	598	931	1484	1865	2356	2967	3746	4726	5966	7516	8873					
	8	6	60	35	-	155	247	391	609	970	1220	1540	1940	2449	3090	3901	4914	5802	6965	8142	9308		
	10	8	80	45	-	-	195	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125	
	15	11	125	70	-	-	-	221	344	548	689	871	1097	1384	1746	2205	2778	3279	3937	4602	5261	6546	
	20	15	150	90	-	-	-	-	264	420	528	667	841	1061	1339	1690	2130	2514	3018	3528	4034	5019	
	25	19	200	100	-	-	-	-	208	332	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962	
	30	22	225	125	-	-	-	-	-	268	337	426	537	677	855	1079	1359	1605	1926	2252	2575	3203	
	40*	30	300	175	-	-	-	-	-	-	-	328	413	522	659	831	1047	1236	1484	1735	1984	2468	
460 V 60 Hz	5	4	20	10	595	947	1511	2393	3723	5935	7461	9422											
	8	6	30	15	389	619	988	1564	2434	3880	4878	6161	7761	9797									
	10	8	40	20	307	488	778	1233	1918	3057	3844	4854	6115	7719	9738								
	15	11	60	30	220	350	558	884	1376	2193	2757	3482	4387	5537	6986	8819							
	20	15	80	45	-	-	428	678	1055	1682	2114	2670	3363	4245	5356	6761	8518						
	25	19	100	50	-	-	338	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531				
	30	22	110	60	-	-	-	433	673	1073	1349	1704	2147	2710	3419	4316	5437	6419	7706	9008			
	40	30	150	80	-	-	-	-	519	827	1040	1313	1654	2088	2634	3325	4189	4946	5937	6940	7935	9873	
	40*	30	150	80	-	-	-	-	502	801	1007	1271	1601	2022	2550	3220	4056	4789	5749	6720	7683	9559	
	50	37	175	100	-	-	-	-	-	639	803	1014	1277	1612	2034	2568	3235	3819	4585	5359	6127	7623	
	50*	37	175	100	-	-	-	-	433	691	869	1097	1382	1745	2201	2779	3501	4133	4961	5799	6631	8250	
	60	45	225	125	-	-	-	-	-	537	675	852	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407	
	60*	45	225	125	-	-	-	-	-	561	705	890	1121	1415	1785	2254	2839	3352	4024	4704	5378	6691	
	75	55	250	150	-	-	-	-	-	-	582	735	926	1168	1474	1861	2344	2768	3323	3884	4441	5525	
	100	75	350	200	-	-	-	-	-	-	-	-	696	878	1108	1399	1762	2081	2498	2920	3338	4153	
	125	93	450	250	-	-	-	-	-	-	-	-	-	708	893	1127	1420	1676	2012	2352	2689	3346	
	150	111	500	275	-	-	-	-	-	-	-	-	-	-	-	922	1162	1371	1646	1924	2200	2737	

Lengths only meet the US National Electrical Code ampacity requirements for individual conductors rated 75° C in free air or water, NOT in magnetic enclosures, conduit or direct buried. Refer to NEC Table 310.15(B)(17) for more information.

* = motors are 8" diameter

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Cable Selection Guide
Hitachi® 6"– 8" Submersible Motors

7.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																						60° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																						
MOTOR			FUSE		AWG													MCM				
VOLTS	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																						
230 V 60 Hz	5	4	45	25	-	-	378	598	931	1484	1865	2356	2967	3746	4726	5966	7516	8873				
	8	6	60	35	-	-	-	391	609	970	1220	1540	1940	2449	3090	3901	4914	5802	6965	8142	9308	
	10	8	80	45	-	-	-	-	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	70	-	-	-	-	-	548	689	871	1097	1384	1746	2205	2778	3279	3937	4602	5261	6546
	20	15	150	90	-	-	-	-	-	-	528	667	841	1061	1339	1690	2130	2514	3018	3528	4034	5019
	25	19	200	100	-	-	-	-	-	-	-	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	225	125	-	-	-	-	-	-	-	-	-	677	855	1079	1359	1605	1926	2252	2575	3203
	40*	30	300	175	-	-	-	-	-	-	-	-	-	-	-	831	1047	1236	1484	1735	1984	2468
460 V 60 Hz	5	4	20	10	595	947	1511	2393	3723	5935	7461	9422										
	8	6	30	15	-	619	988	1564	2434	3880	4878	6161	7761	9797								
	10	8	40	20	-	-	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	60	30	-	-	558	884	1376	2193	2757	3482	4387	5537	6986	8819						
	20	15	80	45	-	-	-	678	1055	1682	2114	2670	3363	4245	5356	6761	8518					
	25	19	100	50	-	-	-	-	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	110	60	-	-	-	-	-	1073	1349	1704	2147	2710	3419	4316	5437	6419	7706	9008		
	40	30	150	80	-	-	-	-	-	-	1040	1313	1654	2088	2634	3325	4189	4946	5937	6940	7935	9873
	40*	30	150	80	-	-	-	-	-	-	1007	1271	1601	2022	2550	3220	4056	4789	5749	6720	7683	9559
	50	37	175	100	-	-	-	-	-	-	-	-	1277	1612	2034	2568	3235	3819	4585	5359	6127	7623
	50*	37	175	100	-	-	-	-	-	-	-	1097	1382	1745	2201	2779	3501	4133	4961	5799	6631	8250
	60	45	225	125	-	-	-	-	-	-	-	-	-	1355	1709	2158	2719	3210	3853	4504	5149	6407
	60*	45	225	125	-	-	-	-	-	-	-	-	-	1415	1785	2254	2839	3352	4024	4704	5378	6691
	75	55	250	150	-	-	-	-	-	-	-	-	-	-	1474	1861	2344	2768	3323	3884	4441	5525
	100	75	350	200	-	-	-	-	-	-	-	-	-	-	-	-	1762	2081	2498	2920	3338	4153
	125	93	450	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2012	2352	2689	3346
	150	111	500	275	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2200	2737

Lengths meet the US National Electrical Code ampacity requirements for either individual conductors or jacketed rated 60° C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable. Refer to NEC Table 310.15(B)(16) for more information.

* = motors are 8" diameter

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Cable Selection Guide
Hitachi® 6"– 8" Submersible Motors

7.6 Motor Fuse Sizing and Cable Selection

CABLE SELECTION																						75° C
COPPER CABLE SIZE - From Main Breaker Panel to Motor (in feet)																						
MOTOR			FUSE		AWG													MCM				
VOLTS	HP	KW	STD	Dual Element	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
THREE PHASE																						
230 V 60 Hz	5	4	45	25	-	237	378	598	931	1484	1865	2356	2967	3746	4726	5966	7516	8873				
	8	6	60	35	-	-	247	391	609	970	1220	1540	1940	2449	3090	3901	4914	5802	6965	8142	9308	
	10	8	80	45	-	-	-	308	479	764	961	1213	1529	1930	2434	3073	3872	4571	5488	6415	7334	9125
	15	11	125	70	-	-	-	-	344	548	689	871	1097	1384	1746	2205	2778	3279	3937	4602	5261	6546
	20	15	150	90	-	-	-	-	-	420	528	667	841	1061	1339	1690	2130	2514	3018	3528	4034	5019
	25	19	200	100	-	-	-	-	-	-	417	527	664	838	1057	1334	1681	1985	2383	2785	3184	3962
	30	22	225	125	-	-	-	-	-	-	-	-	537	677	855	1079	1359	1605	1926	2252	2575	3203
	40*	30	300	175	-	-	-	-	-	-	-	-	-	-	659	831	1047	1236	1484	1735	1984	2468
460 V 60 Hz	5	4	20	10	595	947	1511	2393	3723	5935	7461	9422										
	8	6	30	15	389	619	988	1564	2434	3880	4878	6161	7761	9797								
	10	8	40	20	-	488	778	1233	1918	3057	3844	4854	6115	7719	9738							
	15	11	60	30	-	-	558	884	1376	2193	2757	3482	4387	5537	6986	8819						
	20	15	80	45	-	-	-	678	1055	1682	2114	2670	3363	4245	5356	6761	8518					
	25	19	100	50	-	-	-	535	833	1328	1669	2108	2655	3351	4228	5338	6725	7939	9531			
	30	22	110	60	-	-	-	-	673	1073	1349	1704	2147	2710	3419	4316	5437	6419	7706	9008		
	40	30	150	80	-	-	-	-	-	827	1040	1313	1654	2088	2634	3325	4189	4946	5937	6940	7935	9873
	40*	30	150	80	-	-	-	-	-	801	1007	1271	1601	2022	2550	3220	4056	4789	5749	6720	7683	9559
	50	37	175	100	-	-	-	-	-	-	803	1014	1277	1612	2034	2568	3235	3819	4585	5359	6127	7623
	50*	37	175	100	-	-	-	-	-	-	869	1097	1382	1745	2201	2779	3501	4133	4961	5799	6631	8250
	60	45	225	125	-	-	-	-	-	-	-	-	1073	1355	1709	2158	2719	3210	3853	4504	5149	6407
	60*	45	225	125	-	-	-	-	-	-	-	890	1121	1415	1785	2254	2839	3352	4024	4704	5378	6691
	75	55	250	150	-	-	-	-	-	-	-	-	-	1168	1474	1861	2344	2768	3323	3884	4441	5525
	100	75	350	200	-	-	-	-	-	-	-	-	-	-	-	1399	1762	2081	2498	2920	3338	4153
	125	93	450	250	-	-	-	-	-	-	-	-	-	-	-	-	1420	1676	2012	2352	2689	3346
	150	111	500	275	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1646	1924	2200	2737

Lengths meet the US National Electrical Code ampacity requirements for either individual conductors or jacketed rated 75° C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable. Refer to NEC Table 310.15(B)(16) for more information.

* = motors are 8" diameter

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.7 Overload Protection

208 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	7.5	30	13.5	6.5–13.5	PPX-1A-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1A-27-30R	34 x 21 x 7	85
2	10	60	50	25–50	PPX-2A-50-60R	34 x 21 x 7	90
3	25	100	70	35–70	PPX-3A-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3A-135-100R	47.5 x 25 x 9	195
4	40	200	135	65–135	PPX-4A-135-200R	47.5 x 25 x 9	195

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

230-240 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	7.5	30	13.5	6.5–13.5	PPX-1B-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1B-27-30R	34 x 21 x 7	85
2	15	60	50	25–50	PPX-2B-50-60R	34 x 21 x 7	90
3	30	100	70	35–70	PPX-3B-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3B-135-100R	47.5 x 25 x 9	195

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

460-480 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	10	30	13.5	6.5–13.5	PPX-1C-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1C-27-30R	34 x 21 x 7	85
2	25	60	50	25–50	PPX-2C-50-60R	34 x 21 x 7	90
3	50	100	70	35–70	PPX-3C-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3C-135-200R	47.5 x 25 x 9	195
4	100	200	135	65–135	PPX-4C-135-200R	47.5 x 25 x 9	195
5	200	400	270	130–270	PPX-5C-270-400R	52 x 22 x 10	285

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

575-600 VAC

NEMA SIZE	MAX HP OF CONTACTOR	DISCONNECT A	MAX TOTAL A OF PPX PANEL	O/L CURRENT RANGE	CATALOG NUMBER	DIMENSIONS H x W x D	WEIGHT (LBS.)
1	10	30	13.5	6.5–13.5	PPX-1D-13-30R	34 x 21 x 7	85
			27	13–27	PPX-1D-27-30R	34 x 21 x 7	85
2	25	60	50	25–50	PPX-2D-50-60R	34 x 21 x 7	90
3	50	100	70	35–70	PPX-3D-70-100R	47.5 x 25 x 9	195
			100	65–135	PPX-3D-135-100R	47.5 x 25 x 9	195
4	100	200	135	65–135	PPX-4D-135-200R	47.5 x 25 x 9	195
5	200	400	270	130–270	PPX-5D-270-400R	52 x 22 x 10	285

Note: For HPs with multiple part numbers, use motor amperage to select a panel.

Hitachi® is a registered trademark of Hitachi Industrial Equipment Systems Co., Ltd.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.7 Overload Protection

Submersible motors must have Class 10 overload protection that will disconnect the power within 10 seconds in the case of a locked rotor. To accomplish this, fixed-heater overloads are used. Refer to Section 10 for appropriate heaters. The chart is based upon total line amps. Divide the motor amps by 1.732 when using a 6-lead motor with a Y-Delta Starter. Notice: General Electric® overload heaters are only usable with General Electric overload relays. Do not adjust relays to exceed nameplate amps.

7.8 Motor Cooling

Hitachi 6” motors are designed for minimum water flow of 0.5 ft. /sec. past the motor. Maximum water temperature is 95° F (35° C).

6” MOTORS: MINIMUM COOLING WATER FLOW

I.D of casing	Flow (GPM) required
6	9
7	25
8	40
10	85
12	140
14	200
16	280

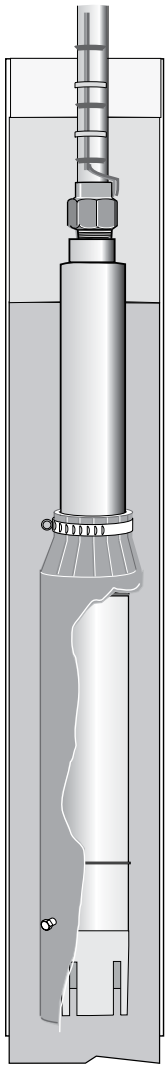
If the flow is less than specified, a flow-inducer sleeve can be installed. This will act like a smaller casing size, and force flow around the motor to aid cooling. Always use a flow-inducer sleeve when the pump is in open water.

7.9 Head Loss In Casing

Use the chart below to account for the head loss around the pump.

Head loss in feet for flow past motor

6” MOTORS		CASING INSIDE DIAMETER		
		6”	**7”**	**8”**
GPM	100	1.7		
	150	3.7		
	200	6.3	0.5	
	250	9.6	0.8	
	300	13.6	1.2	0.2
	400	23.7	2.0	0.4
	500		3.1	0.7
	600		4.4	1.0



7.10 Starting Frequency

To extend the life of the pump motor and control, limit the number of starts to 100 per 24 hours. If higher starting frequencies are necessary, consult your factory. To prevent overheating, run motor for a minimum of two minutes. For starting frequency, refer to section 5.10.

General Electric® is a registered trademark of General Electric Company.

SECTION 7: Hitachi® 6” and Larger Submersible Motors

7.11 Troubleshooting

Problem	Possible Causes	Solution
Motor does not start but does not blow fuses or relay	No power supply	Replace fuses, breakers or check for loose or corroded connections and motor lead terminals
	Defective connections	Correct connections
Fuses or relay blow when motor starts	Incorrect voltage	Apply correct voltage. Voltage must be plus or minus 10% of rated (Nameplate)
	Incorrect fuses or relay	Replace with proper fuses and relay
	Defective capacitors	Replace with proper capacitors
	Wrong connections	Correct wrong connections or short circuit.
		Locked rotor conditions
		Correct pump or well conditions
		Insulation resistance down
		Check the line and correct
Motor runs for a while and then blown fuses or relay.	Low voltage or high voltage	Apply rated voltage
	Defective capacitors	Replace with proper capacitors
	Different control box for the motor	Replace with proper control box
	Defective starting voltage relay	Replace with proper relay
	Pump is sand clogged	Pull pump and clean well
	Overheated protector	Shield the control box from heat source

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

8.1 General Safety

Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during installation, operation, and maintenance of the Pentek Intellidrive Variable Frequency Drive (VFD).

⚠ This is the safety alert symbol. When you see this symbol on your Pentek Intellidrive or in this manual, look for one of the following signal words and be alert to the potential for personal injury!

⚠ DANGER indicates a hazard which, if not avoided, will result in death or serious injury.

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

⚠ CAUTION indicates a hazard which, if not avoided, could result in minor or moderate injury.

NOTICE addresses practices not related to personal injury.

Carefully read and follow all safety instructions in this manual and on the Pentek Intellidrive.

Keep safety labels in good condition. Replace missing or damaged safety labels.

California Proposition 65 Warning

⚠ WARNING This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

⚠ WARNING **Risk of high-voltage electrical shock from EMI/RFI filter inside drive**. Can shock, burn or kill if the front cover of the Pentek Intellidrive is open or removed while power is connected to the Drive or the Drive is running. The front cover of the Drive must be closed during operation.

- Make all wiring connections, then close and fasten the cover before turning on power to drive.
- **NEVER** open the box when power is connected to Drive.
- Before doing any service or maintenance inside Drive or when connecting or disconnecting any wires inside Drive:
  1. DISCONNECT power.
  2. WAIT 5 minutes for retained voltage to discharge.
  3. Open box.
- Before starting any wiring or inspection procedures, check for residual voltage with a voltage tester.
- **NEVER** connect power wiring to Drive before mounting the box.
- **NEVER** handle or service Drive with wet or damp hands. Always make sure hands are dry before working on Drive.
- **NEVER** reach into or change the cooling fan while power is applied to Drive.
- **NEVER** touch the printed circuit board when power is applied to Drive.

⚠ WARNING **Risk of fire.** Can cause severe injury, property damage or death if installed with incorrect or inadequate circuit breaker protection. To ensure protection in the event of an internal fault in the Pentek Intellidrive, install the Drive on an independent branch circuit protected by a circuit breaker (see Table 2 for circuit-breaker sizing), with no other appliances on the circuit.

⚠ CAUTION **Risk of burns.** The Drive can become hot during normal operation. Allow it to cool for 5 minutes after shut-down and before handling it to avoid burns.

NOTICE To avoid damage to Drive or problems with Drive:

- Connect output cables to **3-wire 1-phase** and **3-phase** submersible motors as follows:
  Red to R, Yellow to Y, Black to B.
  Any other order will reverse the motor rotation and may damage the motor.
- Connect output cables to **2-wire 1-phase** submersible motors as follows:
  Connect to Y and B only.
  Connect Ground to green screw.
- Above ground 3-phase motors may have different lead colors. Generally connect output leads as follows:
  R to L1, Y to L2, B to L3.
  Verify rotation after startup.
- Do not modify equipment.
- Do not use power factor correction capacitors as they will damage both motor and Pentek Intellidrive.
- Do not remove any parts unless instructed to do so in Owner's Manual.
- Do not use a magnetic contactor on Drive for frequent starting/stopping.
- Do not install or operate Drive if it is damaged or parts are missing.
- Before starting Drive that has been in storage, always inspect it and test operation.
- Do not carry out a megger (insulation resistance) test on the control circuit of the Drive.
- Do not allow loose foreign objects which can conduct electricity (such as screws and metal fragments) inside Drive box at any time. Do not allow flammable substances (such as oil) inside Drive box at any time.
- Ground Drive according to the requirements of the National Electrical Code Section 250, IEC 536 Class 1, or the Canadian Electrical Code (as applicable), and any other codes and ordinances that apply.
- All installation, service work, and inspections must be done by qualified electrician.

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

8.2 Description

Specifications/Ratings

Input Voltage ..... 1-Phase 230VAC Nominal (190–265VAC)
Input Frequency 50/60Hz
Ambient Temperate Range ..... -4 to 122 °F (-20° to 50 °C)
Output Connections .....3-Phase, 3-Wire/1-Phase or 1-Phase/2-Wire
Max Motor Cable Length ..... 1,000 feet
Enclosure 3R

Table 1 - Specifications

Model	Motor Type	HP Range	Input Voltage	Maximum Output AMPS	Enclosure Type
PID10	2-WIRE* 1-PHASE	0.5–1 HP	190V – 265V	9.5A	NEMA 3R outdoor
	3-WIRE* 1-PHASE			7.5A	
	3-PHASE			5A	
PID20	2-WIRE* 1-PHASE	0.5–1.5 HP		11A	
	3-WIRE* 1-PHASE	0.5–2 HP		13.5A	
	3-PHASE			8.5A	
PID50	3-PHASE	0.5–5 HP		18A	
	2-WIRE	0.5 - 1.5		11A	
	3-WIRE	0.5-2		13.5A	

* Select drives by S.F. amps of pump motor.

The Pentek Intellidrive is specifically designed to operate 4" submersible pumps and 3-phase above ground pumps in water well and residential booster applications. Each Drive is rated for maximum output amp rating. Any use of Drive outside of intended design parameters will void warranty. If Drive is used with above ground motors not rated for a Variable Frequency Drive, maximize motor life by limiting lead length to 25 ft. Refer to pump Owner's Manual and the National Electrical Code for proper wire size.

Each carton contains:
- Pentek Intellidrive Variable Frequency Drive
- Pressure Transducer
- 10' Pressure Transducer Cable
- Quick Start Guide

PIDXX

Product Family
PID - PENTEK INTELLIDRIVE

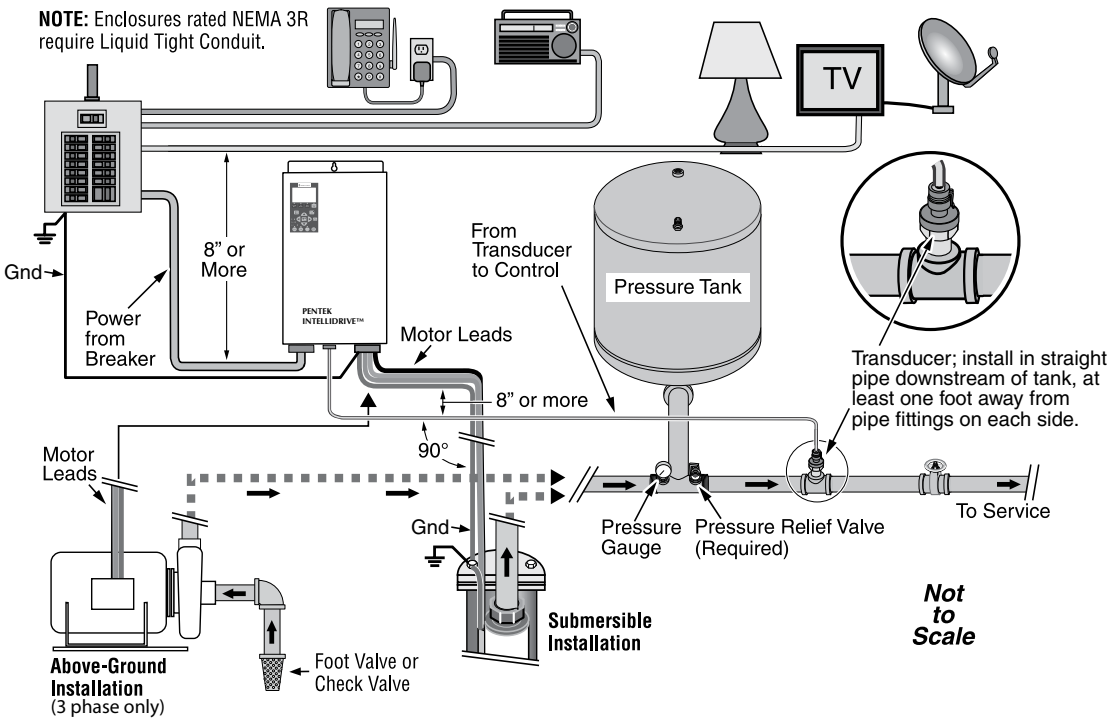
HP Range
10 = up to 1.0 HP
20 = up to 2.0 HP
50 = up to 5.0 HP

The PID10 will operate a 1-Phase 2-Wire, 1-Phase 3-Wire, and 3-Phase motor up to 1HP.

The PID20 will operate a 1-Phase 2-Wire up to 1.5HP and a 1-Phase 3-Wire or 3-Phase motor up to 2HP.

The PID50 will operate a 1-Phase 2-Wire up to 1.5HP, 1-Phase 3-Wire up to 2HP, or 3-Phase motor up to 5HP.

Figure 1 - A typical residential installation layout



SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

Transducer

The Pentek Intellidrive uses a 4-20mA, 0-100PSI pressure transducer to control motor speed (max is 300 PSI transducer).

The transducer (see Figure 1) senses pressure in the pipe and converts it to an electrical signal. The Drive senses and processes the signal in the PID (Proportional, Integration, Derivative) control. When operating in AUTOSTART mode, the Drive increases and decreases the speed of the pump motor as needed to maintain constant pressure in the piping system.

Keypad

The keypad programs the Drive, monitors the status of the pump, and displays faults if they occur. Each button has a unique function, as described in Figure 2. The LCD display shows a text display of the status of the Drive's operation. Other LEDs light up to indicate when certain buttons are pressed or certain events occur.

Fan

The Drive uses a thermostatically controlled internal fan which operates automatically when necessary to cool the Drive components.

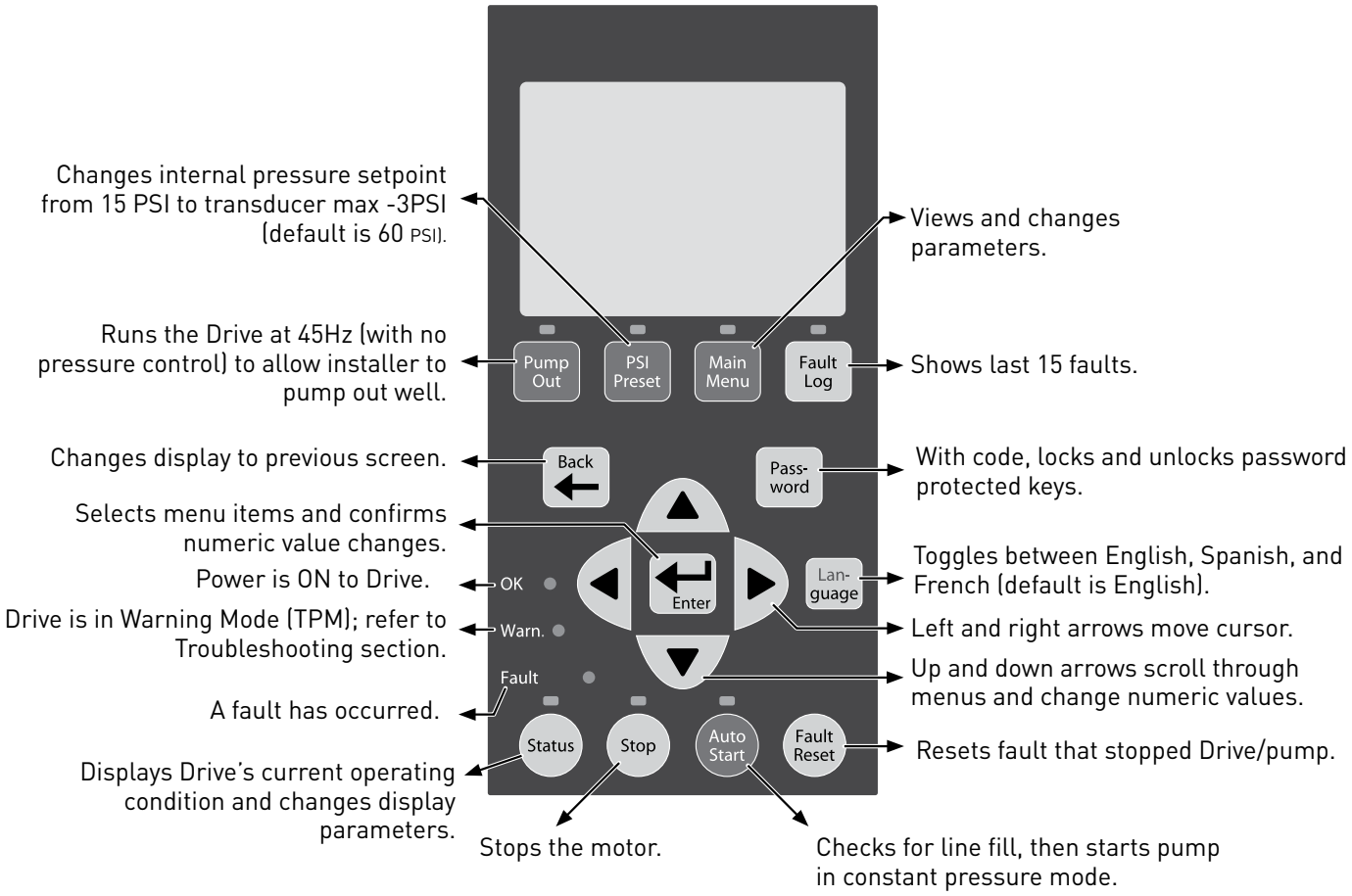


Figure 2 - Pentek Intellidrive keypad functions

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

8.3 Installation

Table 2 - Circuit breaker and wire sizes

Motor	Drive Model	Volts	Motor HP	Wire Size*		Circuit Breaker**	Generator (kVA)***
				Input	Output		
2-wire	PID10	230	1/2	14	14	15	2.2
			3/4	12	12		3.1
			1			20	4.4
	PID20		1-1/2	10	10	25	5.3
3-wire	PID10		1/2	14	14	15	2.3
			3/4	12	12		3.0
			1				3.5
	PID20		1-1/2	10	10	25	5.3
			2				5.8
3 phase	PID10		1/2	14	14	15	2.1
			3/4				2.8
			1	12			3.4
	PID20		1-1/2		12	20	4.4
			2	10		25	5.5
	PID50		3		10	30	7.3
			5	6	8	50	12.6

* AWG will change depending on the length of wire. See Tables 3-6.

** With properly-sized circuit breakers, the Drive is protected from short circuit on the input and the output. There is no risk of fire or electrical shock due to a short circuit. The Drive has NEC Class 10 overload protection.

*** Minimum 240V generator size.

NOTICE Information in Tables 3-6 applies ONLY to Pentek® motors. For other motors, refer to motor manufacturer specifications for wire sizing.

Table 3 - Service Entrance to Drive - 1 Phase, 2-Wire 40°C Ambient, and 5 percent Voltage Drop, 60C and 75C Insulation (copper only).

Motor Rating			Maximum Cable Length in feet (M)					
Volts	HP	SFA	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4AWG
230	1/2	4.7	447 (136)	712 (217)	1000 (305)	–	–	–
	3/4	6.2	341(104)	542 (165)	864 (263)	1000 (305)		
	1	8.1	261(79)	415 (126)	661 (202)	1000 (305)		
	1 1/2	10.4	203 (62)	323 (98)	515 (157)	816 (249)	1000 (305)	
	2	12.2	173 (53)	275 (84)	439 (134)	696 (212)	1000 (305)	
	3	10.1	209 (64)	333 (101)	530 (162)	840 (256)	1000 (305)	
	5	17.5	121(37)	192 (59)	306 (93)	485 (148)	754 (230)	1000 (305)

Table 4 - AWG Wire Sizing, Drive to 1-Phase, 2-Wire Motor, 40°C Ambient, and 5 percent Voltage Drop, 60C and 75C Insulation (copper only).

Motor P/N	Motor Rating			Maximum Cable Length in feet (M)				
	Volts	HP	SFA	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG
P42B0005A2-01	230	1/2	4.7	447 (136)	712 217)	1000 (305)	–	–
P42B0007A2-01		3/4	6.2	341 (104)	542 (165)	864 (263)	1000 (305)	
P42B0010A2-01		1	8.1	261 (80)	415 (126)	661 (201)	1000 (305)	
P42B0015A2-01		1 1/2	10.4	203 (62)	323 (98)	515 (157)	816 (249)	1000 (305)

Table 5 - AWG Wire Sizing, Drive to 3-Wire, 1-Phase Motor, 40°C Ambient, and 5 percent Voltage Drop, 60C and 75C Insulation (copper only).

Motor P/N	Motor Rating			Maximum Cable Length in feet (M)				
	Volts	HP	SFA	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG
P43B0005A2-01	230	1/2	4.8	440 (134)	700 (213)	1000 (305)	–	–
P43B0007A2-01		3/4	6	352 (107)	560 (171)	893 (272)	1000 (305)	
P43B0010A2-01		1	7.3	289 (88)	460 (140)	734 (224)	1000 (305)	
P43B0015A2-01		1 1/2	10.9	194 (59)	308 (94)	492 (150)	778 (237)	1000 (305)
P43B0020A2-01		2	12.2	173 (53)	275 (84)	439 (134)	696 (212)	1000 (305)

Table 6 - AWG Wire Sizing, Drive to 3-Phase Motor, 40°C Ambient, and 5 percent Voltage Drop, 60C and 75C Insulation (copper only).

Motor P/N	Motor Rating			Maximum Cable Length in feet (M)					
	Volts	HP	SFA	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG*
P43B0005A3	230	1/2	2.9	728 (222)	1000 (305)	–	–	–	–
P43B0007A3		3/4	3.9	541 (165)	861 (262)	1000 (305)			
P43B0010A3		1	4.7	449 (137)	715 (218)	1000 (305)			
P43B0015A3		1 1/2	6.1	346 (105)	551 (168)	878 (268)	1000 (305)		
P43B0020A3		2	7.6	278 (85)	442 (135)	705 (215)	1000 (305)		
P43B0030A3		3	10.1	209 64)	333 (101)	530 (162)	840 (256)	1000 (305)	
P43B0050A3		5	17.5			306 (93)	485 (148)	754 (230)	1000 (305)

*Installations that require wire gauge larger than 6 AWG will require an external junction box. Run 6 AWG wire from the Drive into the junction box, then make external connections with wire nuts to appropriately sized wire.

Mounting the Drive

To mount the Drive as shown in Figure 6, follow this procedure:

1. First, remove the cover by backing out screw at bottom of front cover.
2. Push on backplate with thumbs while pulling the cover toward you with index fingers, creating a gap. See Figures 3 and 4.

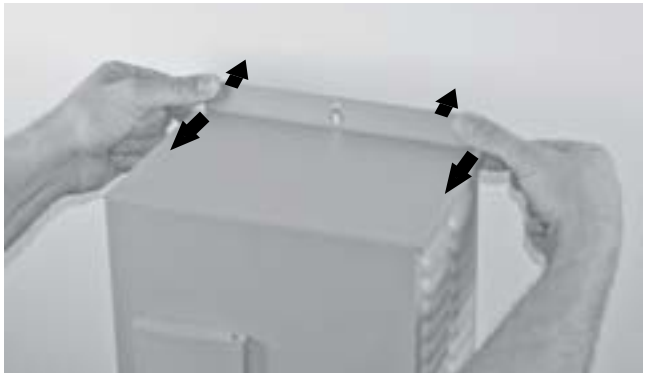


Figure 3 - Separate cover and backplate

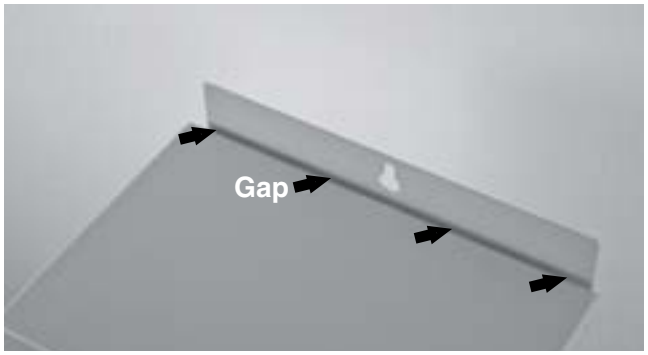


Figure 4 - Gap between cover and backplate

3. Pull bottom of cover towards you; lift up on cover and remove. See Figure 5.



Figure 5 - Pull out bottom of cover

4. With the cover removed, permanently mount the Drive using the top slotted hole, plus either the three bottom holes (for flat surface mounting) or the center bottom hole (for attaching to a post or stud). See Figure 6.
5. Ensure the Drive's ventilation holes are not blocked and there is enough space around it to allow free air flow (minimum 3" clearance on top, bottom, and sides). See Figure 6. Once the Drive is mounted, electrical wiring can be connected.

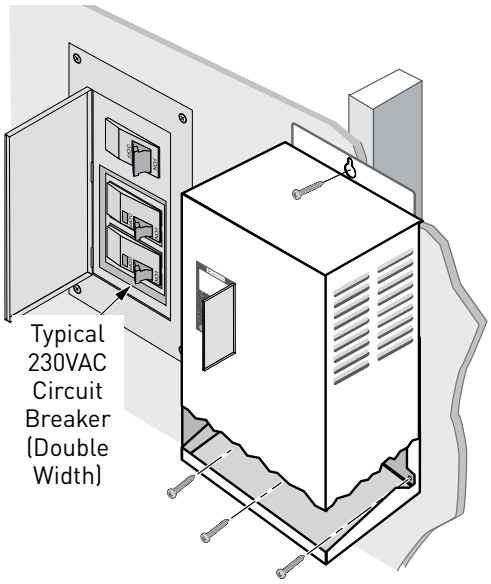


Figure 6 - Attaching Drive to wall

6. To reattach the Drive cover, hook the top of it on backplate (be sure to leave a gap). Lower bottom of cover into place. Push cover evenly against backplate, eliminating the gap. See Figure 7.

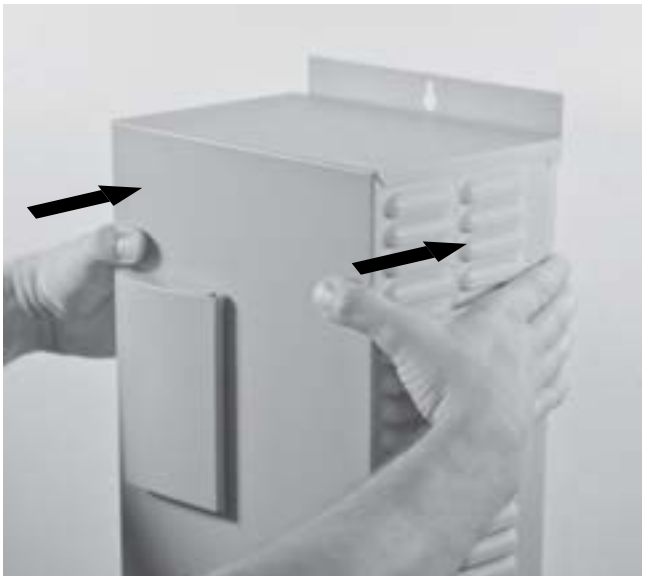


Figure 7 - Reattaching Drive cover

7. Replace screw at bottom of front cover.

Wiring

To allow for ease of wiring, the enclosure wiring area is free of electronics other than the terminals. Conduit holes and knockouts are located so that the wire can be fed straight through to the connectors, with minimal bending. The terminals accept 6-14 AWG wire.

Installations that require larger wire gauge than 6 AWG will require an external junction box. Run 6 AWG wire from the Drive into the junction box, then make external connections with wire nuts to appropriately sized wire.

NOTICE For convenience in wiring, the input and motor terminals unplug from the box. Pull them down to remove them for ease of access, as shown in Figure 8.

Verify that the terminal connectors are completely seated when you replace them. It is best practice to connect all output wires (larger wire gauge) first, then all input wires.

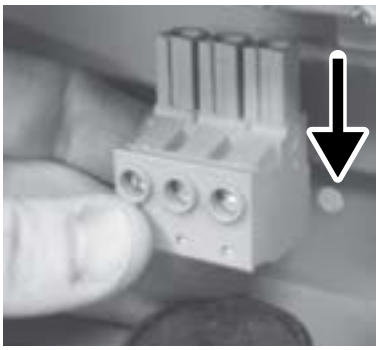


Figure 8 - Pull input and motor terminals down to remove, making wiring easier.

Pump Connections

If the Pentek Intellidrive is used with above ground motors not rated for Variable Frequency Drive use, maximize motor life by limiting lead length to 25 ft. Refer to the pump owner's manual, the National Electrical Code, and local codes for proper wire size.

The output of the Drive is single phase (2-wire or 3-wire) or 3-phase, depending on motor selection during startup.

The output power terminals (motor wire connections) are located on the lower right side of the Drive and are labeled R (Red), Y (Yellow), and B (Black). See Tables 2 through 6 for suggested wire sizes.

NOTICE 2-wire 1-phase connect to Y + B, not R + B.

Feed the motor cable through the 3/4" conduit hole on the bottom right side and into the appropriate terminals. If the wire is large enough to require a larger conduit hole, remove the 1-1/4" knockout and use the appropriate conduit connections. Attach the motor ground wire to the grounding screw, located to the upper right of the terminal block. Attach the motor power wires to the terminals as shown in Figure 9.

NOTICE Drive does not sense motor temperature and will not protect motor from over heating.

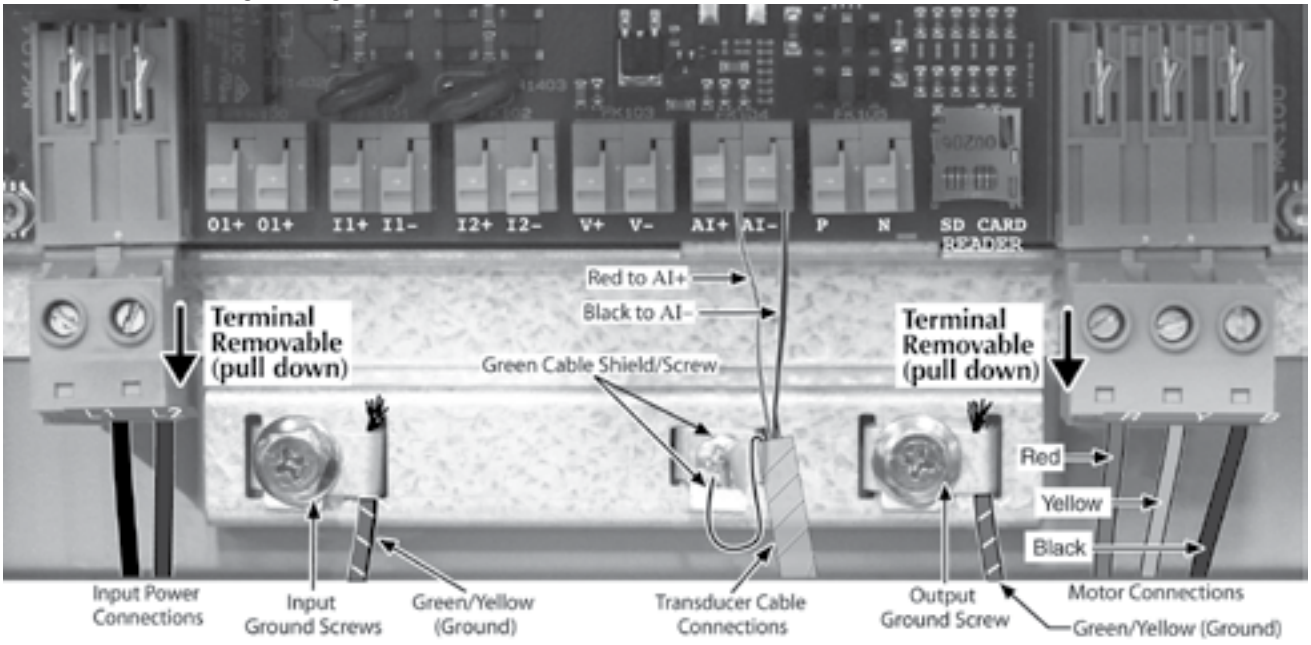


Figure 9 - Basic Wiring Connections for Startup

Submersible Motor: 3-Ph./ 3-W. 1-Ph., follow colors as above.
Submersible Motor: 1-Ph./ 2-W., connect to Y and B, any order.
Above-Ground Motors: L1 to R, L2 to Y, L3 to B; verify rotation.

Pressure Tank Recommendations

Minimum tank size is two gallons. Use a pre-charged pressure tank with Drive, as shown in Figure 1. The tank size must equal at least 20 percent of the pump's rated flow in gallons per minute (GPM), but cannot be less than two gallons capacity. For example, a pump rated at 7 GPM would require a tank of two gallons capacity or larger. A pump rated at 50 GPM would require a 10 gallon tank or larger. Tanks larger than 10 gallons can be used, but may require adjustment of Wake Delay parameter.

Table 7 - Control Pressure Set Point and Tank Pre-Charge Pressure Values (PSI).

Pressure Point Setting (PSI)	Precharge Pressure (PSI)	Pressure Point Setting (PSI)	Precharge Pressure (PSI)
25	18	65	46
30	21	70	49
35	25	75	53
40	28	80	56
45	32	85	60
50	35	90	63
55	39	95	67
60 (Default)	42	–	

NOTICE Set pressure tank's pre-charge to 70 percent of the system operating pressure. When using an external set point as well as an internal set point, pre-charge tank to 70 percent of the lower setpoint of the two. Some applications may require a different percentage when determining the setpoint.

Transducer Connections

A 0-100 PSI 4-20 mA transducer is provided with Drive. Install the transducer downstream of tank, as shown in Figure 1. Install transducer in a tee in a straight section of pipe with at least 1 foot of straight pipe on each side of the tee (i.e., all fittings must be at least 1 foot away from transducer).

Feed transducer cable through the open 1/2" conduit hole on bottom of the Drive enclosure.

As shown in Figure 9, connect the red wire of the transducer cable to AI+, connect black wire to AI–, and connect the green cable shield to the metal cable shield screw.

To connect the transducer wires:

1. Strip wire ½ inch
2. Push spring terminal up with finger or slotted screwdriver
3. Insert wires from bottom
4. Release spring terminal

Input Power Connections

The input power terminals are located on the lower left side and are marked L1 and L2 (see Figure 9). There is a ground screw for the input ground wire to the right of the connector (torque to 10 in lb). Feed wire through the 3/4" conduit hole on the bottom left side and into appropriate terminals. If wire is large enough to require a larger conduit hole, remove the 1-1/4" knockout and use appropriate conduit connections.

To determine the correct wire sizes for installation, see Table 3.

NOTICE The Pentek Intellidrive only accepts 230V single phase input power. If incoming power does not match this, have a qualified electrician alter supply voltage to 230V/1Ph before connecting it to the Drive. See specifications ratings in Section 8.2.

8.4 Initial Startup and Programming Procedures

Ensure that the cover is installed before operating the Pentek Intellidrive.

Most installations will only require the initial startup settings. However, the installer may need to set additional parameters. Information about accessing all parameters, explanations of their functions, and procedures for changing parameter values, will be found later in this section.

1. **Program the Drive**: Apply power to the Pentek Intellidrive. Setup Guide will appear in the display. Follow keypress sequence shown in Figure 10.

   NOTICE If Setup Guide does not appear, refer to Drive Reset Procedure, Figure 20.

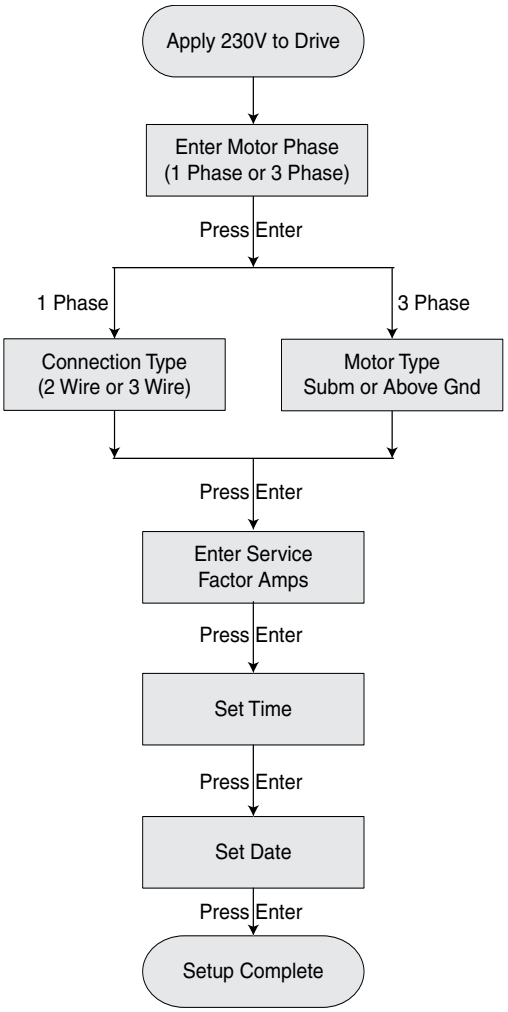


Figure 10 - Drive Setup Guide.

Service Factor Amps

To maximize pump performance, be sure to enter the correct Service Factor Amps (SF Amps) in the Pentek Intellidrive.

- Entering SF Amps **higher** than the motor rating lets the Drive supply more amps to the motor than the motor is designed for and may allow the motor to overheat (see Table 8).
- Entering SF Amps **lower** than the motor rating limits the output amps to less than the motor is designed for and will reduce the performance of the pump.
- For any 1-Phase 3-Wire motor, the correct Service Factor Amp rating for the Drive is Cap Start/Cap Run amps (see Table 8). This may not match the motor nameplate, which (for a Single Phase, 3-Wire motor) will generally be Cap Start/ Induction Run Amps.
- For any 3-Phase or 1 Phase, 2-Wire motor, use the motor nameplate Service Factor Amp rating.

NOTICE Pentek® submersible motors may differ from motors of the same horsepower from other manufacturers. **For 1-Phase, 3-Wire motors from all other submersible motor manufacturers, enter the motor manufacturer's CS/CR service factor amps for your motor.** For 3-Phase or 2-Wire 1-Phase motors, use the motor nameplate amp value. Also see Retro Fit Applications.

2. **Select 80 Hz Operation**, if necessary (See 60 Hz to 80 Hz Operation for more information):
   A. Press MAIN MENU button.
   B. Follow the keypress sequence shown in Figure 11.

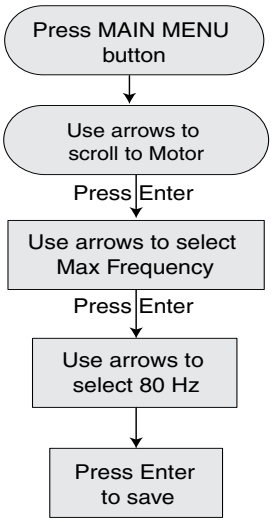


Figure 11 - Select 80 Hz (3-phase operation only).

3. **Pump out well** (if necessary):
   Direct pump's discharge to appropriate location not connected to system and press Pump Out. Drive will ask "Is a valve open?" Change "No" to "Yes", press enter. The pump will run at 45 Hz.
   Adjust frequency as appropriate:
   A. Press ENTER
   B. Change frequency value

Table 8 - Pentek Motor Service Factor Amps

Motor Type	PENTEK® Part Number	Rating @ 230V HP	Service Factor Amps
2-Wire	P42B0005A2-01	1/2	4.7
	P42B0007A2-01	3/4	6.2
	P42B0010A2-01	1	8.1
	P42B0015A2-01	1-1/2	10.4
	P42B0005A2	1/2	4.7
	P42B0007A2	3/4	6.4
	P42B0010A2	1	9.1
	P42B0015A2	1-1/2	11.0
CS/CR 3-Wire	P43B0005A2-01	1/2	4.8
	P43B0007A2-01	3/4	6.0
	P43B0010A2-01	1	7.3
	P43B0015A2-01	1-1/2	10.9
	P43B0005A2	1/2	4.9
	P43B0007A2	3/4	6.3
	P43B0010A2	1	7.2
	P43B0015A2	1-1/2	11.1
	P43B0020A2	2	12.2
3-Phase	P43B0005A3	1/2	2.9
	P43B0007A3	3/4	3.9
	P43B0010A3	1	4.7
	P43B0015A3	1-1/2	6.1
	P43B0020A3	2	7.6
	P43B0030A3	3	10.1
	P43B0050A3	5	17.5

NOTICE Above ground pumps should run at 60 Hz for this step (until pump is primed). Then adjust frequency as necessary.

C. Press ENTER again.

Run the Drive in this mode until the well discharge runs clear, then press STOP button to stop Drive.

⚠WARNING Risk of explosion. In Pump Out mode, pump runs at a constant speed. All pressure functions are not working, there is no sleep or Dry Run Protection which can cause very high pressure if flow is restricted.

4. **Verify installation:** Make sure that the system has properly-sized, pressure-relief valve and pressure tank.
   Make sure pressure tank's precharge is correct. See Table 7.
   Make sure pump discharge is connected to system.
5. **System Start:**
   A. Open valves at the ends of lines so that air will escape during pressurization.
   B. Press Auto Start; close valves at the ends of lines after all air has escaped.
   C. The system goes into Constant Pressure Operation as soon as the transducer registers the Dry Run Sensitivity parameter (default is 10 PSI). If system pressure does not reach that PSI value within 3 minutes, the Drive will stop. Press Auto Start again to restart line fill. If longer priming or line fill time is required, adjust Fill Time parameter. See Table 9.

Changing a Parameter Value

This procedure works for ANY parameter.

A. Press MAIN MENU button.
B. Follow the keypress sequence shown in Figure 12:

A shorthand way to remember this is:

- Press ENTER to change a value

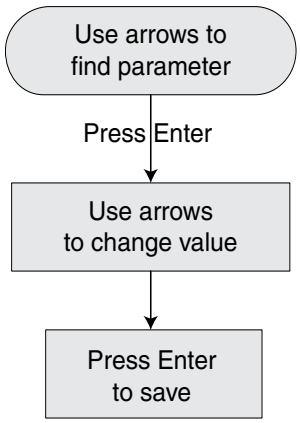


Figure 12 - Changing parameter value.

- Press ENTER again to save it
- If new value is not saved, any screen change will result in the loss of the new value.

Table 9 lists all available commands and parameters for the Pentek Intellidrive.

60 Hz to 80 Hz Operation

When installing the Pentek Intellidrive with a motor and liquid end of the same HP rating, operate it at 60 Hz (the default value). The Drive can be operated at frequencies of up to 80 Hz when the installation uses a 3-phase motor 2 times the size of the pump. For example, a 1 HP pump with a 2 HP 3-phase motor. This combination will equal the performance of a conventional 2 HP pump.

Press Main Menu and follow the keypress sequence shown in Figure 11. Be sure to press ENTER to save the new Max Frequency selected. The Drive will now use the new value selected.

NOTICE The Drive will not allow the output amps to go above the Service Factor Amps selected on the keypad. Because of this, some 80 Hz operations may be limited. This protects the motor and may be a common occurrence in a 80Hz operation.

8.5 Advanced Programming

Keypad Lock - Password

The password locks or unlocks the blue buttons on keypad. All Pentek Intellidrive units are shipped from factory with the default password 7777. It can be changed to any other 1 to 4 digit number. To reset password to a unique password for unit, unlock keypad (see below) and follow the keypress sequence shown in Figure 12 to make the change.

If installer does not press the password button, then the keypad will automatically lock 60 minutes after the Drive is powered up. The time out period is adjustable (see Table 9).

To unlock keypad press Password, use directional arrows to select numeric code and press ENTER.

NOTICE For more detailed information on keypad functions, see Figure 2.

Pump Out Operation

Press Pump Out. The Drive will start pump in a constant speed mode (default 45 Hz). The pump will run until STOP or Auto Start are pushed. If speed change is necessary, press enter, to highlight value use arrows to change value then press enter to save.

Setting the Pressure

NOTICE Default pressure setting is 60 PSI. If this value is changed, adjust tank pressure accordingly (see Table 7).

There are three ways to change the pressure setpoint:

1. While running the pump
- Follow keypress sequence shown in Figure 13 to make desired change. This parameter allows either Internal or External Setpoint to be changed, depending on which one is referenced at the time the change is made.
2. Via the PSI Preset (Figure 14)
3. Via the Main Menu (Main Menu/Settings/ Setpoint/Internal Setpoint)

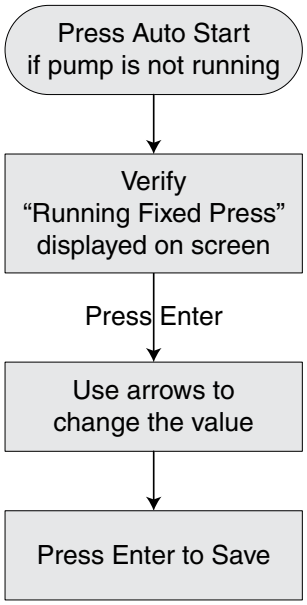


Figure 13 - Change PSI Setpoint while running pump.

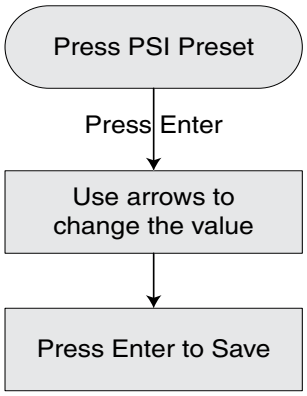


Figure 14 - Change PSI Internal Setpoint using PSI Preset.

Table 9 - Main Menu and Parameters

Menu Settings	Parameter	Unit of Measure	Value			Description
			Default	Min.	Max.	
Time/Date	Hour Format	Hours	12Hr	12Hr	24Hr	Selects 12 or 24 hour time scale.
	Time	HH:mm	1:00 AM	1	24	Sets current time. Used for time stamp in fault log.
	Date	MM/DD/YYYY	1/1/12	–	–	Sets current date. Used for date stamp in fault log.
PID Control	Proportional Gain	–	1500	0	10000	Sets the PID controller gain. Used in conjunction with all PID Control parameters to control how fast or slow the Drive reacts to pressure changes.
	Integration Time	Milliseconds	500 ms	20 ms	65000 ms	Sets the PID controller integration time. Used in conjunction with all PID Control parameters to control how fast or slow Drive reacts to pressure changes.
	Derivation Time	Milliseconds	60 ms	0 ms	10000 ms	Sets PID controller derivation time. Used in conjunction with all PID Control parameters to control how fast or slow Drive reacts to pressure changes.
	Derivative Limit	–	120	0	2000	Sets derivative filter time constant for PID controller.
Sleep	Boost Differential	PSI	3 PSI	3 PSI	10 PSI	First part of Boost Process. Pressure boost that happens before it goes to Wake Delay.
	Boost Delay	MM:SS	1 Min	30 Sec	5 Min	The time Drive takes to start Boost Process after system has stabilized.
	Wake Up Differential	PSI	5 PSI	5 PSI	15 PSI	Pressure amount below setpoint that wakes up Drive.
	Wake Delay	MM:SS	15 Sec	3 Sec	2 Min	Second part of the Boost Process. The time it takes to ramp down pressure during the Boost Process.
Password	Password Time Out	HrHr:mm	1 Hr	1 Min	6 Hr	Amount of time it takes to lock keypad (after last button is pressed).
	Password	–	7777	0000	9999	Password used to unlock keypad.

Table 9 - Continued

Menu Settings	Parameter	Unit of Measure	Value			Description
			Default	Min	Max	
Setpoints	Internal Setpoint	PSI	60 PSI	15 PSI	Max Sensor Value minus 3 PSI.	Main pressure setpoint used. Sets main system operational pressure. This parameter is accessed here, through PSI Preset button, or by pressing Enter button while in Constant Pressure operation.
	External Setpoint	PSI	40 PSI	15 PSI	Max Sensor Value minus 3 PSI.	Second pressure setpoint. When another pressure setting is desired other than Internal Setpoint. Additional programming needed in I/O section. Requires an external switch or timer to wired to I1 or I2 terminals. It is only active when there is voltage present I1 terminals
Sub Menu	**Parameter**	**Unit of Measure**	**Default**	**Max**	**Min**	**Description**
Motor	Motor Phase	_	1	1	3	Selects phase of motor to be operated. An additional sub menu will appear, based on phase selection, to select proper motor type.
	Connection Type	–	3 wire	3 wire	2 wire	Wire type for 1 phase motor operation only. Can only access by first setting Motor Phase parameter to 1 Phase.
	Motor Type	–	Subm	Subm	Above Gnd	Motor type for 3 phase motor operation only. Can only access by first setting Motor Phase parameter to 3 Phase.
	Service Factor Amps	A	00.0 A	00.0 A	Per drive and motor	Service factor amps (max. load) of motor the Drive is operating. Sets maximum allowed amps at output of Drive. See Table 8 for values.
	Min Frequency	Hz	30 Hz	30 Hz	1 below Max Hz	Minimum frequency (speed) motor will run.
	Max Frequency	Hz	60 Hz	1 above Min Hz	80 Hz	Maximum frequency (speed) motor will run. Up to 80Hz is only available on only when Motor Phase is set to 3 and motor type is Sub.
Sensor	Max Sensor Value	PSI	100 PSI	10 PSI	300 PSI	Maximum pressure value of transducer sensor used with Drive. Only change if different transducer is used with Drive, other than 100 PSI max scale.

Table 9 - Continued

Menu or Sub Menu	Parameter	Unit of Measure	Value			Description
			Default	Min	Max	
Ex Runtime	Excessive Runtime Detection	–	Enabled	Disabled	Enabled	Enables or disables Excessive Runtime Detection.
	Excessive Runtime Hours	Hours	24	1	100	Number of hours Drive can run before it faults on Excessive Runtime.
Dry Run	Auto Restart Delay	Minutes	10 Min	3 Min	60 Min	Time Drive waits to restart pump when Dry Run is detected.
	Number of Resets	–	3	0	5	Number of tries Drive attempts to restart pump when Dry Run condition is detected.
	Detection Time	M:SS	15 Sec	5 Sec	10 Min	Time the Drive takes to recognize Dry Run condition.
	Sensitivity	PSI	10	0	300	Pressure value that Dry Run condition is detected at. Dry Run fault will occur if this pressure cannot be met within Detection Time window. Lower pressure = less sensitivity.
	Fill Time	M:SS	1 M	15 S	10 M	Time allowed to fill (prime) pipes during Auto Line Fill process. Relates to Dry Run Sensitivity value**.** (Time starts after 55 Hz is reached).
I/O	Digital Input 1	–	Unused	–	–	Selects operation of Drive when terminal I1 or I2 is used. Select between Unused, Run Enabled, Ext Fault, and Setpoint. The Drive will respond to selected command when voltage is present at I1 or I2 terminal.
	Digital Input 2					
	Relay Output	–	Unused	–	–	Selects the operation of Drive when terminal O1 is used. Select between Unused, Run, and Fault. The Drive closes the Relay when Run or Fault is selected**.**
Over Press	Over Pressure	PSI	80 PSI	15 PSI	97 PSI	Sets Over Pressure Warning value. Change if higher than 80 PSI system pressure is needed.
No Ground	No Ground Detection	–	Enabled	Disabled	Enabled	Selects whether Ground Detection parameter is Enabled or Disabled. If Disabled is selected, it will revert back to Enabled after 72 hours. Warning LED will flash entire time it is Disabled.
Reset	Factory Reset	–	No	No	Yes	Resets all parameters to factory defaults. Displays Setup Guide after it is complete. Software version displayed here. Does not clear fault log.
SW Update	Software Update	–	Disabled	Disabled	Enabled	Used to update software, if necessary.

8.6 I/O Connections

The I/O terminals are located in the center of the wiring compartment, as shown previously in Figure 9.

The Digital Input connections (I1 and I2) are used to control the Drive based on the state of an external device, such as a flow switch, moisture sensor, alternator, or other device. Programming is needed to activate any of these functions (see Table 9).

The Output Relay (O1) is used to control an external device based on two states of Drive; either Running the pump or Faulted. Programming is needed to activate any of these functions (see Table 9).

Cable Installation

Three 1/2" conduit knockouts are provided on the bottom of the Drive enclosure for the I/O wires.

Break out the closest 1/2" knockout and route the wires through. Use a cord grip to prevent the wire from rubbing and causing a short.

NOTICE Never run low voltage I/O wire through the same conduit hole as the 230V input wires or motor wires.

To connect the external wires to the terminals:

1. Strip wire ½ inch
2. Push spring terminal up with finger or slotted screwdriver
3. Insert wires from bottom
4. Release spring terminal

Connection Examples

Figures 15-18 show various connection schemes for typical applications. Table 10 describes each I/O terminal, including purpose and rating.

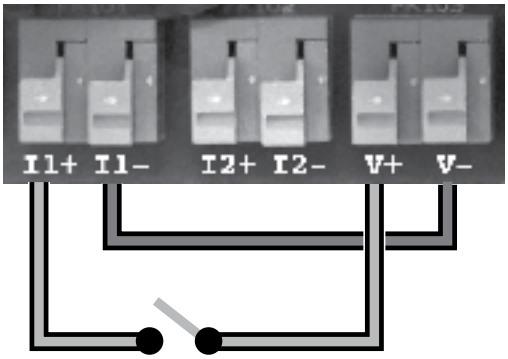


Figure 15 - Example Input with internal 24 volt supply

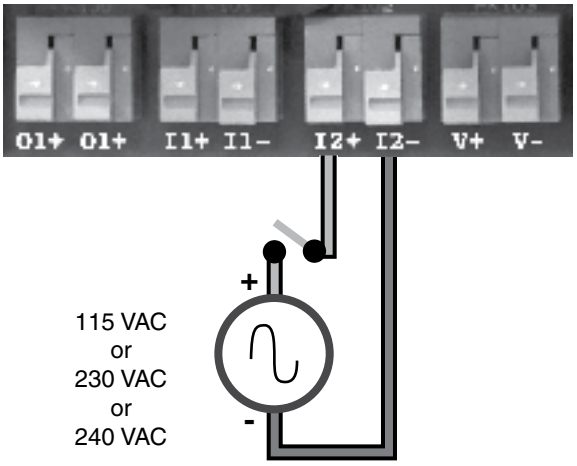


Figure 16 - Example external Input with external supply

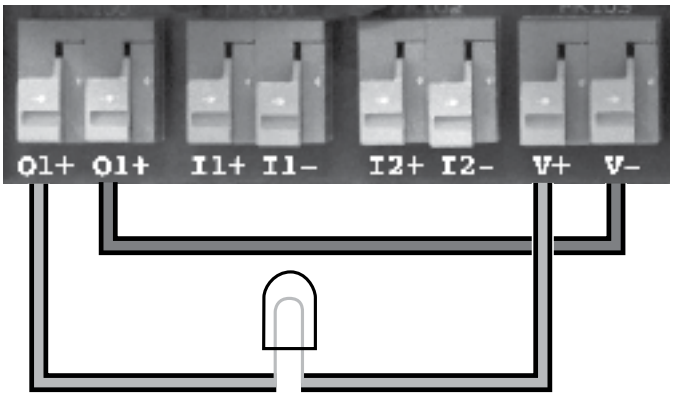


Figure 17 - Example Output relay with internal 24 volt supply

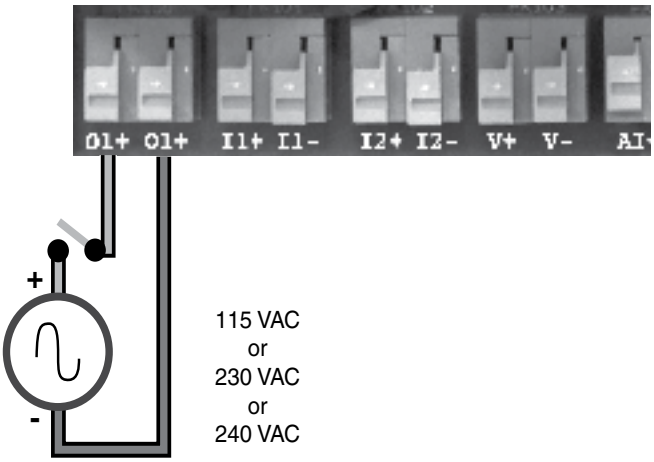


Figure 18 - Example Output with external supply

Table 10 - I/O Function, Connections, Ratings

Label	Function	Connection	Rating
AI+	Positive connection for transducer	Red transducer wire	24 Volt (supplied)
AI-	Negative connection for transducer	Black transducer wire	
V+	Positive side of 24 volt power supply. Used to power external devices.	Positive side of 24V external device, i.e., flow switch, moisture sensor, alternator, etc. Need to complete the circuit with V-. See Figures 15 and 17.	40mA maximum output
V-	Negative side of 24 volt power supply. Used to power external devices.	Typically to I1-, I2-, or O1-. Used with a flow switch, moisture sensor, alternator, etc. Need to complete the circuit with V+. See Figures 15 and 17.	
I1+	Positive (dry contacts) connection of Digital Input 1. Connect when using an external device to control Drive.	From an external device i.e., flow switch, moisture sensor, alternator, etc. Requires complete circuit connection with I1-. See Figures 15 and 16.	Accepts 24VDC and up to 230VAC
I1-	Negative (dry contacts) connection of Digital Input 1. Connect when using an external device to control Drive.	Can be from V- or from the negative side of an external power supply. Requires complete circuit connection with I1+. See Figures 15 and 16.	
I2+	Positive (dry contacts) connection of Digital Input 2. Connect when using an external device to control Drive.	From an external device, i.e., flow switch, moisture sensor, alternator, etc. Requires complete circuit connection with I2-. See Figures 15 and 16.	
I2-	Negative (dry contacts) connection of Digital Input 2. Connect when using an external device to control Drive.	Can be from V- or from the negative side of an external power supply. Requires complete circuit connection with I2+. See Figures 15 and 16.	
O1+	Output relay (dry contacts) connection. Programmed to close when pump is Running or Faulted.	Positive wires of an external device. See Figures 17 and 18.	Accepts up to 5 Amps at 24VDC and 8 Amps at up to 230VAC
O1+	Output relay (dry contacts) connection. Programmed to close when pump is Running or Faulted.	Positive wires of an external device. See Figures 17 and 18.	
P	Positive connection of an RS-485 communication device (see Figure 19).	Positive wire from RS-485 device.	Per RS-485 Standard
N	Negative connection of an RS-485 communication device (see Figure 19).	Negative wire from RS-485 device.	

RS-485 Communications

RS-485 is a US-based telecommunications standard for binary serial communications between devices. It is the protocol, or set of specifications, that needs to be followed to allow devices that implement the standard to speak to each other. A fully compliant RS-485 port is included in the Pentek Intellidrive system to permit serial connections among more than two devices on an RS-485 compliant network. Figure 19 shows two-wire connection to the Drive.

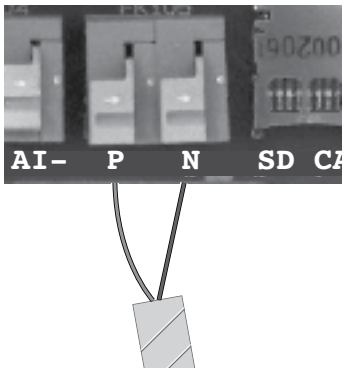


Figure 19 - Example RS-485 Connection

8.7 Wiring Sizing, Repair Parts, Specifications

Lightning/Surge Protection

Lightning arrestors or other surge suppressing devices can be used with this product. MOV (Metal Oxide Varistor), SOV (Silicon Oxide Varistor).

Accessories

Part Description	Qty	Part Number
Alternating Control Panel	1	VFD-ALT
Moisture Sensor	1	VFD-WS
Surge Protection Kits	1	VFD-SGA
300 PSI Transducer	1	U17-2000
Flow Switch	1	U17-1999

Retrofit Applications

When retrofitting an installation with the Pentek Intellidrive, most of the preceding text can be applied. As a convenience, the recommended Service Factor Amps for non-Pentek® motors is provided in Table 11. Always verify Service Factor Amp values from current manufacturer literature.

Table 11 - Service Factor Amps @ 230V

Motor Type	HP	Service Factor Rating, in Amps	
		CentriPro®[1]	Franklin Electric®[2]
2-Wire	1/2	4.7	N/A
	3/4	6.4	
	1	9.1	
	1-1/2	11.0	
CS/CR 3-Wire	1/2	4.9	4.3
	3/4	6.3	5.7
	1	7.2	7.1
	1-1/2	11.1	11.5
	2	12.2	13.2
3-Phase	1/2	2.9	2.9
	3/4	3.9	3.8
	1	4.7	4.7
	1-1/2	6.1	5.9
	2	7.6	8.1
	3	10.1	10.9
	5	17.5	17.8

[1] CentriPro SFA data was taken from the March 2012 BMAID manual on 4/2012.

[2] Franklin Electric SFA data was taken from the 7/2011 Franklin Electric AIM manual on 4/2012.

NOTICE The Pentek Intellidrive will not operate Franklin Electric 2-wire motors.

Repair Parts

Part Description	Qty	Part Number
Input Terminal Block Connector	1	PID-CON2
Output Terminal Block Connector	1	PID-CON3
Cooling Fan	1	PID-FAN-R
Pressure Transducer	1	U17-1561-R
10' Transducer Cable	1	U18-1593
25' Transducer Cable*	1	U18-1594
50' Transducer Cable*	1	U18-1595
100' Transducer Cable*	1	U18-1596
150' Transducer Cable*	1	U18-1597
200' Transducer Cable*	1	U18-1598
Keypad	1	PID-HMI-R

* Purchase Separately

CentriPro® is a registered trademark of Fluid Handling LLC.
Franklin Electric® is a registered trademark of Franklin Electric Co. Inc.
All other brand or product names are trademarks or registered trademarks of Pentair Ltd.

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

8.8 Troubleshooting

Fault	Possible Causes	Solution
Over Current	Shorted output	Check for any shorts in motor cables.
	Locked rotor	Check for debris in pump.
	Damaged wire insulation	Check motor wire insulation with a megger.
Over Voltage	Internal Drive short	With power to Drive off, measure outputs with ohmmeter to detect short.
	Power cycling on and off	Check for a generator or switching on input line.
	High line voltage	Measure incoming line voltage to Drive; should be between 190V and 265V.
Under Voltage	Low line voltage	
	Temporary loss of power	Check for local power outage.
	Excessive load current	Check motor is correctly sized for the application.
	Loss of a motor phase	Check correct voltage is present on all motor leads.
	Power was removed from Drive	Check correct voltage is present on all input lines.
Cannot Start Motor	Exceeding Service Factor Amps	Check Service Factor Amps entered are correct.
		Check pump and motor are correct.
	No Service Factor Amps value entered	Check Service Factor Amps entered and are correct.
	There is an open (connection) in motor wires	Check resistance of all motor wires is correct.
	Locked rotor	Pull pump check for debris in pump.
Dry Run	Operation at open discharge	May need to reduce Dry Run Sensitivity pressure or apply back pressure on transducer.
	Drive cannot read transducer signal	Check linearity of transducer, as it may be damaged. See Troubleshooting Guide for more information.
	Possible leak	Check for pipe break or large leak.
	Dry running pump	Check water level in well.
Ground Fault	Ground wire shorted to motor phase	Check the ground wire for short to motor phase wire or check insulation integrity with a megger.
	Long motor cable length	If motor cable length is more than 1000 ft a reactor or filter may be needed to limit capacitance between motor wires.
System Not Grounded	Ungrounded Drive	Ground Detect parameter can be disabled, but will reactivate after 72 hours.

*For additional Troubleshooting information, please visit www.sta-rite.com/resources/images/16455.pdf for a downloadable guide.

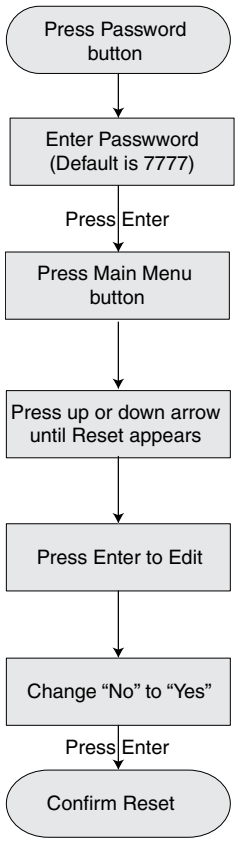
Fault	Possible Causes	Solution
Open Transducer	Intermittent connection	Check all transducer wires are securely connected or for damaged cable insulation.
	Open Connection	Check for proper wiring of all transducer wires and verify cable connector securely attached to transducer.
	Drive cannot read transducer signal	Check electrical system for ground loops or no ground connection.
	Transducer wires crossed	Check red is in AI+ and black is in AI-.
	Possible failed transducer	Check linearity of transducer; see Troubleshooting Guide for more information.
Shorted Transducer	Short in transducer wires	Check for shorted transducer wire or damaged insulation.
	Possible failed transducer	Check linearity of transducer; see Troubleshooting Guide for more information.
Over Temperature	Excessive heating in drive	Check ambient temperature is not above 50°C (122°F).
		Check for inoperable or unobstructed fan.
		Check vents are not obstructed.
Excessive Runtime	Leak detected	Check for leaks in pipe system.
	Application calls for long run times	Extend Excessive Runtime Hours limitation.
		Disable Excessive Runtime Fault.
Internal Fault	Internal voltages are out of range	Drive will auto reset and attempt to clear fault. Fault Reset can be pressed to clear fault as well. Then try to operate pump. If fault continues Drive may need replacement.
Hardware Fault	Internal hardware failure	Fault Reset can be pressed to clear fault. Then try to operate pump. If fault continues Drive may need replacement.
External Fault	The external device detected fault condition and closed the I1 or I2 input	Check external device. Must press Fault Reset to clear.
Low Amps	Under-sized pump	Increase Minimum Speed to 35 Hz.
	Low current draw from pump	
	Thermal protector open in motor (3 wire)	Wait 20 minutes then restart pump.
	Missing motor phase	Check all motor connections at the Drive.

Warning	Possible Causes	Solution
Warning LED flashing	Ungrounded Drive, with ground detection parameter disabled (will operate for 72 hours and then fault).	Verify ground wire is connected on both incoming voltage side and motor side of Drive.
		With the power disconnected, use an ohmmeter to verify which pipe the Drive's transducer is connected to. Also verify that the input ground wire is at the same potential, e.g., has approximately the same ohm reading.
		Verify the input ground is connected all the way back to electrical panel.
Jam Warning	Debris in pump stopping motor from turning (locked rotor).	Drive tries to free debris in pump by reversing or pulsing motor.
Over Pressure Warning	Pressure rising above Over Pressure setting.	Drive stops and waits 1 minute, then checks that pressure is below the Setpoint pressure. Below it restarts, if not checks again in another minute. Can increase over-pressure value.

Drive Reset Procedure

Follow the keypress sequence shown at right to test the Drive.

Figure 20 - Drive Reset Procedure



NOTICE In a domestic environment, this product may cause radio interference which may require supplementary mitigation measures.

SECTION 8: Pentek Intellidrive™ Variable Frequency Drives

8.9 Warranty

Limited Warranty

Pentair warrants to the original consumer purchaser ("Purchaser" or "You") of the products listed below, that they will be free from defects in material and workmanship for the Warranty Period shown below.

Product	Warranty Period
Water Systems Products — jet pumps, small centrifugal pumps, submersible pumps and related accessories	whichever occurs first: 12 months from date of original installation, 18 months from date of manufacture
Pentek Intellidrive	12 months from date of original installation, or 18 months from date of manufacture
Pro-Source® Composite Tanks	5 years from date of original installation
Pro-Source Steel Pressure Tanks	5 years from date of original installation
Pro-Source Epoxy-Line Tanks	3 years from date of original installation
Sump/Sewage/Effluent Products	12 months from date of original installation, or 18 months from date of manufacture

Our warranty will not apply to any product that, in our sole judgment, has been subject to negligence, misapplication, improper installation, or improper maintenance. Without limiting the foregoing, operating a three phase motor with single phase power through a phase converter will void the warranty. Note also that three phase motors must be protected by three-leg, ambient compensated, extra-quick trip overload relays of the recommended size or the warranty is void.

Your only remedy, and Pentair's only duty, is that Pentair repair or replace defective products (at Pentair's choice). You must pay all labor and shipping charges associated with this warranty and must request warranty service through the installing dealer as soon as a problem is discovered. No request for service will be accepted if received after the Warranty Period has expired. This warranty is not transferable.

PENTAIR IS NOT LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR CONTINGENT DAMAGES WHATSOEVER.

THE FOREGOING LIMITED WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE FOREGOING LIMITED WARRANTIES SHALL NOT EXTEND BEYOND THE DURATION PROVIDED HEREIN.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to You. This warranty gives You specific legal rights and You may also have other rights which vary from state to state.

This Limited Warranty is effective June 1, 2011 and replaces all undated warranties and warranties dated before June 1, 2011.

PENTAIR
293 Wright Street • Delavan, WI 53115
Phone (262) 728-5551 • Fax (262) 728-7323

SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives

9.1 Pentek® PPC-Series Drives

The Pentek Pump Controllers (PPC5 and PPC3 series) are pre-jumpered and include the **Pentek Assistant**, which simplifies programming and setup for constant pressure applications. The Pentek Assistant sets various parameters to Pentek defaults which are described in this manual. The Pentek Assistant also prompts the user for application-specific information.

For PPC3 and PPC5 troubleshooting, please refer to the ABB ACS350 or ACS550 manual as appropriate.

9.2 PPC3 Series Specifications

Three-phase PPC3 drives can be operated on single phase when the output amps are derated by 50%.

Table 9-1: Three-Phase/208-230V Output

Output Amps	Input Phase	Input Voltage	Enclosure Rating (NEMA)	Catalog Number
4.7	1	200-240	1	PPC3-1-4A7-1
6.7				PPC3-1-6A7-1
7.5				PPC3-1-7A5-1
9.8				PPC3-1-9A8-1
4.7	3			PPC3-2-4A7-1
6.7				PPC3-2-6A7-1
7.5				PPC3-2-7A5-1
9.8				PPC3-2-9A8-1
17.6				PPC3-2-17A6-1
24.6				PPC3-2-24A6-1
31.0				PPC3-2-31A0-1
46.2				PPC3-2-46A2-1

Table 9-2: Three-Phase/380-460V Output

Output Amps	Input Phase	Input Voltage	Enclosure Rating (NEMA)	Catalog Number
2.4	3	380-480	1	PPC3-4-2A4-1
3.3				PPC3-4-3A3-1
4.1				PPC3-4-4A1-1
5.6				PPC3-4-5A6-1
8.8				PPC3-4-8A8-1
12.5				PPC3-4-12A5-1
15.6				PPC3-4-15A6-1
23.1				PPC3-4-23A1-1
31.0				PPC3-4-31A0-1
38.0				PPC3-4-38A0-1
44.0				PPC3-4-44A0-1

NOTICE: For detailed specifications see users manual.

9.3 PPC5 Series Specifications

Table 9-3: Three-Phase/208-230V Output

Output Amps	Input Phase	Input Voltage	Enclosure Rating (NEMA)	Catalog Number
4.6	3	208-240	1	PPC5-2-4A6-1
			12	PPC5-2-4A6-12
6.6			1	PPC5-2-6A6-1
			12	PPC5-2-6A6-12
7.5			1	PPC5-2-7A5-1
			12	PPC5-2-7A5-12
11.8			1	PPC5-2-11A-1
			12	PPC5-2-11A-12
16.7			1	PPC5-2-16A-1
			12	PPC5-2-16A-12
24.2			1	PPC5-2-24A-1
			12	PPC5-2-24A-12
30.8			1	PPC5-2-30A-1
			12	PPC5-2-30A-12
46.2			1	PPC5-2-46A-1
			12	PPC5-2-46A-12
59.4			1	PPC5-2-59A-1
			12	PPC5-2-59A-12
74.8			1	PPC5-2-74A-1
			12	PPC5-2-74A-12
88.0			1	PPC5-2-88A-1
			12	PPC5-2-88A-12
114			1	PPC5-2-114A-1
			12	PPC5-2-114A-12
143			1	PPC5-2-143A-1
178				PPC5-2-178A-1
221				PPC5-2-221A-1
248				PPC5-2-248A-1

NOTICE: For detailed specifications see users manual. For single phase input, derate the output amps by 50%.

SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives

Table 9-4: 3-Phase/380-460V Output

Output Amps	Input Phase	Input Voltage	Enclosure Rating (NEMA)	Catalog Number
3.3	3	400-480	1	PPC5-4-3A3-1
			12	PPC5-4-3A3-12
4.1			1	PPC5-4-4A1-1
			12	PPC5-4-4A1-12
6.9			1	PPC5-4-6A9-1
			12	PPC5-4-6A9-12
8.8			1	PPC5-4-8A8-1
			12	PPC5-4-8A8-12
11.9			1	PPC5-4-11A-1
			12	PPC5-4-11A-12
15.4			1	PPC5-4-15A-1
			12	PPC5-4-15A-12
23			1	PPC5-4-23A-1
			12	PPC5-4-23A-12
31			1	PPC5-4-31A-1
			12	PPC5-4-31A-12
38			1	PPC5-4-38A-1
			12	PPC5-4-38A-12
44			1	PPC5-4-44A-1
			12	PPC5-4-44A-12
59			1	PPC5-4-59A-1
			12	PPC5-4-59A-12
72			1	PPC5-4-72A-1
			12	PPC5-4-72A-12
77			1	PPC5-4-77A-1
			12	PPC5-4-77A-12
96			1	PPC5-4-96A-1
			12	PPC5-4-96A-12
124			1	PPC5-4-124A-1
157				PPC5-4-157A-1
180				PPC5-4-180A-1
195				PPC5-4-196A-1
245				PPC5-4-245A-1

Table 9-5: 3-Phase/575V Output

Output Amps	Input Phase	Input Voltage	Enclosure Rating (NEMA)	Catalog Number
2.7	3	575	1	PPC5-5-2A7-1
			12	PPC5-5-2A7-12
3.9			1	PPC5-5-3A9-1
			12	PPC5-5-3A9-12
6.1			1	PPC5-5-6A1-1
			12	PPC5-5-6A1-12
9			1	PPC5-5-9A0-1
			12	PPC5-5-9A0-12
11			1	PPC5-5-11A-1
			12	PPC5-5-11A-12
17			1	PPC5-5-17A-1
			12	PPC5-5-17A-12
22			1	PPC5-5-22A-1
			12	PPC5-5-22A-12
27			1	PPC5-5-27A-1
			12	PPC5-5-27A-12
32			1	PPC5-5-32A-1
			12	PPC5-5-32A-12
41			1	PPC5-5-41A-1
			12	PPC5-5-41A-12
52			1	PPC5-5-52A-1
			12	PPC5-5-52A-12
62			1	PPC5-5-62A-1
			12	PPC5-5-62A-12
77			1	PPC5-5-77A-1
			12	PPC5-5-77A-12
99			1	PPC5-5-99A-1
			12	PPC5-5-99A-12
125			1	PPC5-5-125A-1
			12	PPC5-5-125A-12
144			1	PPC5-5-144A-1
			12	PPC5-5-144A-12

9.4 Wiring Connections

Three phase input power is connected to U1, V1, and W1. If single phase input is used connect to U1 and W1. The neutral and ground leads must be connected to drive terminal PE. Motor leads are connected to U2, V2, and W2. The motor ground must be connected to terminal GND. For detailed instructions, see Owner's Manual.

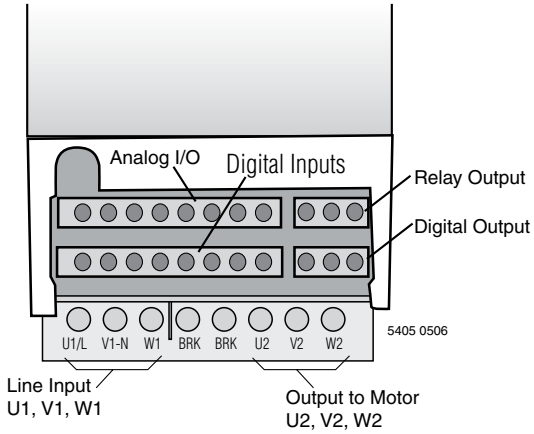


Figure 9-1 Typical Connections to PPC3

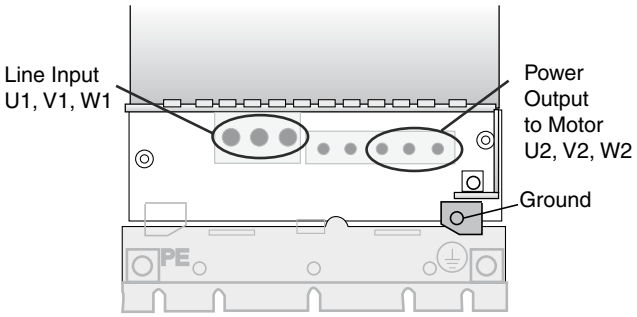


Figure 9-2 Typical Connections to PPC5

9.5 Transducer Connection

The **Pentek® Assistant** defaults to a 4-20mA transducer connected to AI2. The transducer is used to provide pressure feedback to the drive. Transducers offered by Pentek have either a red or brown power lead. The red or brown lead should be connected to the +24V power connection.

Transducers offered by Pentek have either a blue or black output lead. The blue or black lead should be connected to terminal 5. The Pentek U17-1286R transducer utilizes shielded cable. The bare lead may be covered with green shrink-wrap tubing. The bare lead is cable shielding, and should be connected to terminal 1. The translucent lead is unused, and should be tied off and insulated.

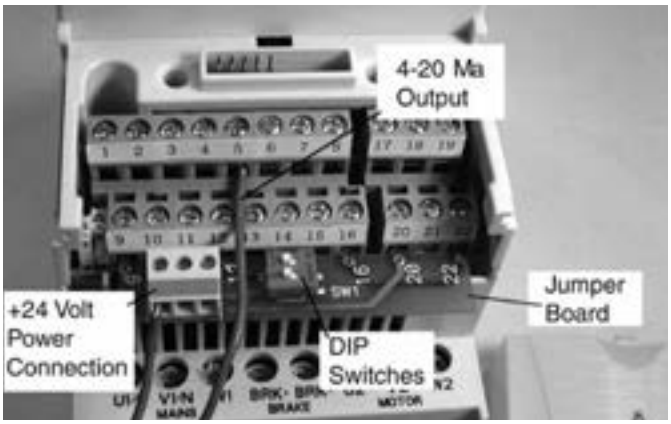


Figure 9-3 PPC3 Transducer Connection.

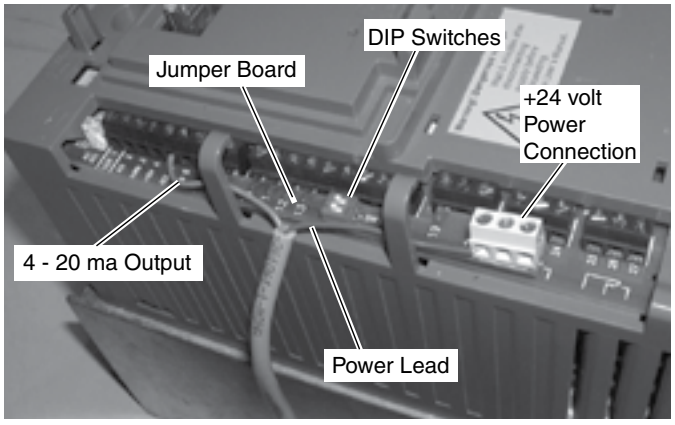


Figure 9-4 PPC5 Transducer Connection.

9.6 Pentek® Assistant

Table 9-6: PPC3 Parameters Changed Relative to PID Control Defaults

Parameter Code	Pentek Code
1002 Ext2 Commands	Keypad
1102 EXT1/EXT2 Sel	EXT2
1301 Minimum AI1	20%
1601 Run Enable	Not Sel
1805 DO Signal	Superv1 Over
1806 DO On Delay	10 Seconds (Above Ground)
1806 DO On Delay	60 Seconds (Submersible)
1807 DO Off Delay	2 sec
2001 Minimum Speed	0 (Above Ground)
2001 Minimum Speed	User Defined (Submersible)
2002 Maximum Speed	Sync
2202 Accel Time 1	5 sec (Above Ground)
2202 Accel Time 1	1 sec(Submersible)
3001 AI<Min	Fault
3003 External Fault 1	DI5
3006 Mot Therm Time	500 sec (Above Ground)
3006 Mot Therm Time	350 sec (Submersible)
3007 Mot Load Curve	100% (Above Ground)
3007 Mot Load Curve	112% (Submersible)
3013 Underload Function	Fault
3014 Underload Time	10 sec
3022 AI2 Fault Limi	10%
3201 Superv 1 Param	Output Freq
3202 SuperV 1 Lim Lo	per 9907
3203 SuperV 1 Lim Hi	per 9907

Parameter Code	Pentek Code
3401 Signal 1 Param	Current
3405 Output 1 Unit	A
3408 Signal 2 Param	Speed
3412 Output 2 Unit	RPM
3415 Signal 3 Param	PID 1 FBK
3419 Output 3 Unit	PSI
4001 Gain	1.0
4002 Integration Time	1.0
4006 Units	PSI
4010 Set Point Sel	Internal
4022 Sleep Selection	Internal
4024 PID Sleep Delta	10 sec
4027 PID Param Set	DI3
4101 Gain	1.0
4102 Integration Time	1.0 Sec
4106 Units	PSI
4109 100% value	Per 4009
4110 Set Point Sel	Internal
4111 Internal Setpoint	Per 4011
4122 Sleep Selection	Internal
4123 PID Sleep Level	Per 4023
4124 PID Sleep Delay	10 sec
4125 Wake-Up Deviation	Per 4025

9.6.1 Description of Information Required by the Pentek Assistant

9905 Motor Nom Voltage: This is the nominal voltage stated on the motor nameplate. If the motor is rated for operation at multiple voltages, select the voltage nearest the utility voltage. Ensure the motor connections correspond to the voltage selected.

9906 Motor Nom Current: This is the nominal current found on the motor nameplate. Do not use service factor amps.

9907 Motor Nom Freq: This is the nominal frequency found on the motor nameplate.

9908 Motor Nominal Speed: This is the nominal speed found on the motor nameplate. Use the number on the motor nameplate. Do not enter 3600, 1800, etc.

9909 Motor Nom Power: This is the nominal horsepower found on the motor nameplate. Do not include service factor unless the service factor is greater than 1.15.

2001 Min Speed (Required for Subs only): This is the minimum speed the motor is allowed to run. This minimum is set to prevent damage to the motor thrust bearings. Refer to motor literature to determine setting.

4011 Internal Setpoint: This is the pressure that the system will maintain.

4009 100% Value: This is the full scale reading of the transducer. The 100% Value of a 200PSI transducer is 200PSI.

4023 PID Sleep Level: Operation below this rpm will cause the drive to stop. Must never be below the shut-off head RPM.

4025 Wake-Up Dev: This is the pressure drop that will trigger the drive to restart. For example, if the set point is 60 PSI and the Wake-Up Deviation is 10 PSI, the drive will restart at 50 PSI.

Table 9-7: PPC5 Parameters Changed Relative to PID Control Defaults

Parameter Code	Pentek® Code
1002 EXT2 Commands	8-Keypad
1102 EXT1/EXT2 SEL	EXT2
1301 Minimum AI1	20%
1401 RELAY OUTPUT 1	SUPERV1 OVER
1404 RO 1 ON DELAY	10 S (above ground) 60 S (submersible)
1405 RO 1 OFF DELAY	2 S
1601 Run Enable	Not SeL
1605 USER PAR SET CHG	3-DI3
2001 Minimum Speed	User defined (above ground) 0 (submersible)
2002 MAXIMUM SPEED	SYNC
2202 ACCELER TIME	15 SEC (above ground) 1 SEC (submersible)
3001 AI<MIN FUNCTION	1-FAULT
3003 EXTERNAL FAULT 1	1-DI6
3004 EXTERNAL FAULT 2	5-DI5
3006 MOT THERM TIME	500 SEC (above ground) 350 SEC (submersible)
3007 MOT LOAD CURVE	100% (above ground) 112% (submersible)
3013 UNDERLOAD FUNC	1-FAULT
3014 UNDERLOAD TIME	10S
3022 AI2 FAULT LIMIT	10%
3201 SUPERV 1 PARAM	103-OUTPUT FREQ
3202 SUPERV 1 LIM LO	60
3203 SUPERV 1 LIM HI	60
3401 SIGNAL 1 PARAM	104-CURRENT

Parameter Code	Pentek Code
3402 SIGNAL 1 MIN	0
3404 OUTPUT 1 DSP FORM	5-+0.0
3405 OUTPUT 1 UNIT	1 – AMPS
3408 SIGNAL 2 PARAM	102-SPEED
3411 OUTPUT 2 DSP FORM	4-+0
3412 OUTPUT 2 UNIT	7 – RPM
3415 SIGNAL 3 PARAMETER	128-PID 1 SETPNT
3418 OUTPUT 3 DSP FORM	1 - ± 0.0
3419 OUTPUT 3 UNIT	25 – PSI
4001 GAIN	1.0
4002 INTEGRATION TIME	2.0
4006 UNIT	25 – PSI
4010 SET POINT SEL	0 – KEYPAD
4011 INTERNAL SETPOINT	USER DEFINED
4016 ACT1 INPUT	1-AI2
4017 ACT2 INPUT	1-AI2
4022 SLEEP SELECTION	7 – INT
4024 PID SLEEP DELAY	10 SEC
4027 PID 1 PARAM SET	3-DI3
4102 INTEGRATION TIME	1.0S
4106 UNIT	25-PSI
4109 100% Value	per 4009
4110 SET POINT SEL	19-INTERNAL
4111 INTERNAL SETPOINT	PER 4011
4122 SLEEP SELECTION	7-INT
4123 PID SLEEP LEVEL	per 4023
4124 PID SLEEP DELAY	10SEC
4125 WAKE-UP DEV	per 4025

9.6.2 Mounting and Installation

Startup the Pentek Assistant

Apply power to the unit, and follow the steps in section 9.6.3 after the Drive's screen is lit.

9.6.3 Using the Pentek Assistant

Apply power to the unit and follow the steps in Section 9.6.4 for changing operation parameters, use the steps below to run the Pentek Assistant.

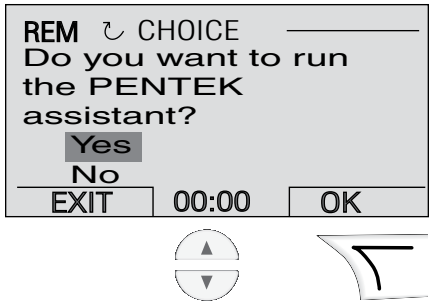
1. Use the MENU key to access the Menu List.
2. Select Assistants
3. Select Pentek Assistant.
4. Follow the screen instructions to configure the system.

9.6.4 Step By Step Programming Instructions

STEP 1

Initial Startup Panel Display

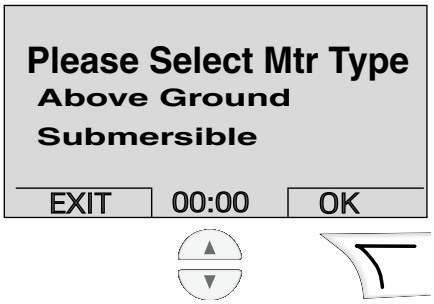
Upon initial drive power-up the installer will be prompted to run the Pentek® Assistant. Scroll to YES and then select OK. Wait while the program loads. On subsequent startups, the Pentek Assistant can be found in the ASSISTANTS menu.



STEP 2

Motor Selection Screen

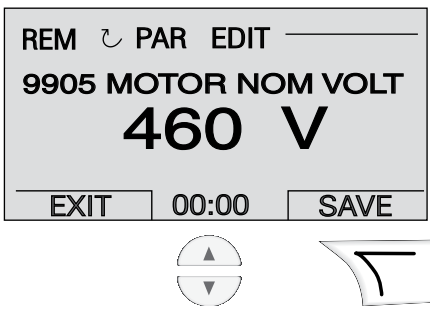
Scroll to select the type installation and then press OK.



STEP 3

Motor Voltage Screen

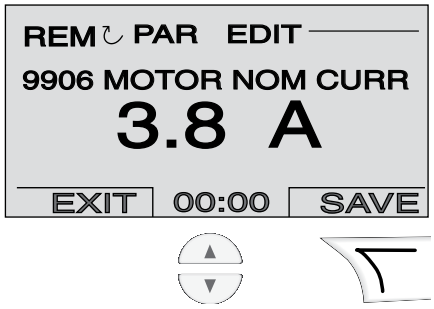
The screen shows motor voltage. Scroll to select the correct voltage for your motor as stated on the motor nameplate. This sample shows 460 volts. Press SAVE.



STEP 4

Motor Current Screen

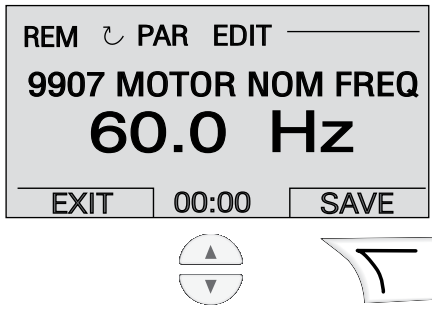
Enter the motor current from the motor nameplate (not maximum amps). Scroll to select the current and press SAVE unless it is a submersible (more than 1.15).



STEP 5

Motor Frequency Screen

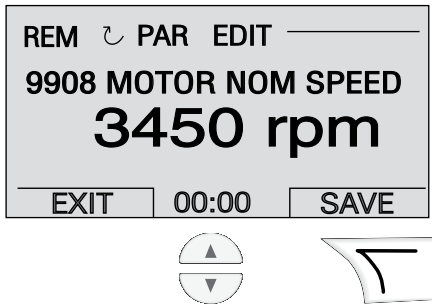
Enter the motor frequency (Hz) from the motor nameplate. Scroll to select the frequency and select SAVE.



STEP 6

Motor Speed Screen

Enter the motor speed (RPM) from the motor nameplate. Scroll to select the speed and press SAVE. The sample here shows 3450 RPM.

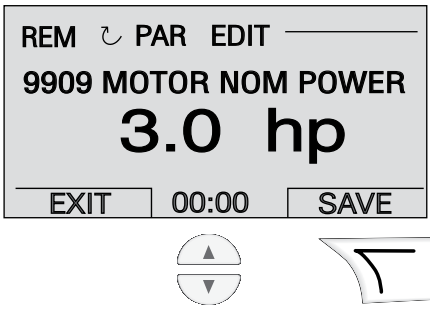


SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives

STEP 7

Motor Horsepower Screen

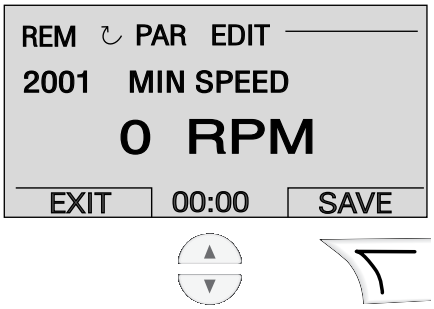
Enter the motor horsepower (HP) from the motor nameplate. Scroll to select the horsepower and press SAVE. The sample here shows 3.0 HP.



STEP 8

For Submersible Pumps Only

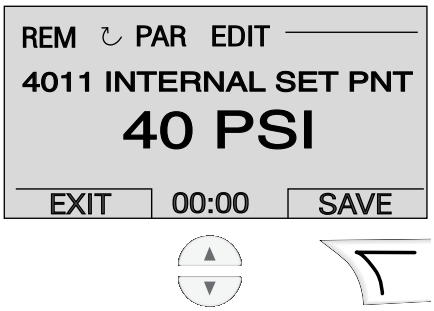
Enter the minimum speed allowed by the motor vendor (consult motor literature). This is to prevent motor bearing damage.



STEP 9

Scroll To Select Constant Pressure Point

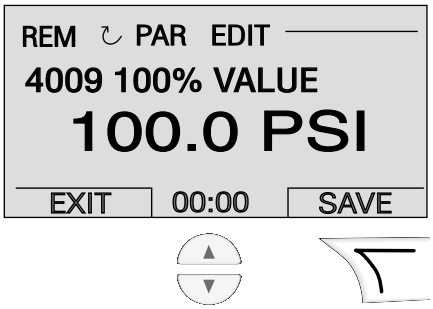
Example shows 40 PSI.



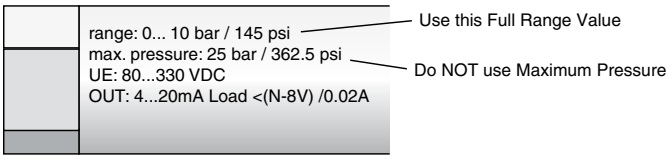
STEP 10

Transducer 100% Value

Enter the transducer's full range value which should be stated on the transducer body. Scroll to select the pressure and then press SAVE. The sample here shows 100 PSI.



NOTICE: DO NOT choose maximum pressure.

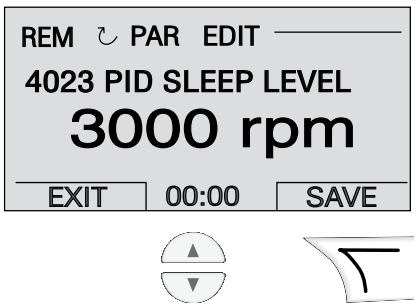


STEP 11

PID Sleep Level Screen

Enter the PID sleep level. This is a motor speed setting. If the motor speed falls below this RPM, the PID sleep function will be enabled. This is a Drive-assigned value. For additional information, refer to the PPC5 Users Manual. Scroll to select the speed and then press SAVE. The sample here shows 3000 RPM.

⚠ WARNING **Burn Hazard**. If the sleep level is set too low, the pump my run without flow. This can boil water inside the pump, causing dangerously high pressure and temperature.

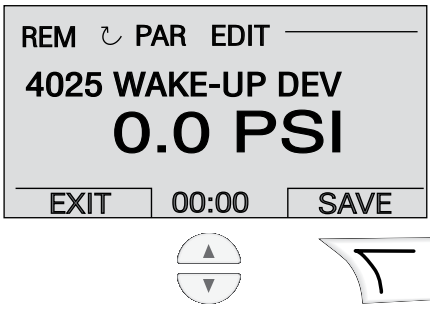


SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives

STEP 12

Wake up Deviation Screen

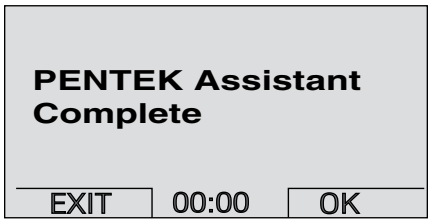
Enter the wake-up deviation. This is the amount pressure drops (PSI) below the pressure set point before the drive restarts. This sample is waiting to be set and shows 0 PSI.



STEP 13

Assistant Compete

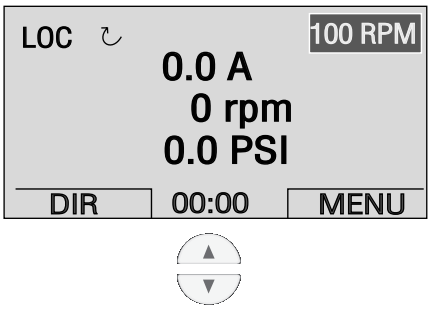
This ends setup of the Pentek® Assistant. The following steps complete the setup of the pump system.



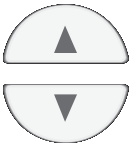
STEP 14

Check Motor Rotation

Press the Local/Remote button to change to local control. Check above-ground motors by viewing shaft rotation. For submersible (3-phase) motors, start and check performance. Reverse any two power leads and check again. The lead arrangement with best performance is correct.



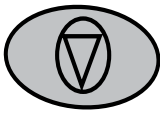
STEP 15



Check For System Harmonics

While the pump is running, scroll motor speed up to check for harmonics. Verify that harmonics do not exist above the PID sleep level.

STEP 16



Stop The Pump

Press the STOP button.

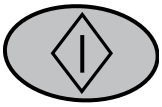
STEP 17



Change To Remote Operation

Press the Loc / Rem button to change to remote control.

STEP 18



Test System Setup

Press start to operate the pump. Test system to ensure proper system response and sleep function. Adjust group 40 parameters as needed.

NOTICE: The upper left hand corner of the display shows whether the drive is in local or remote control. In **LOC** mode the drive holds a constant speed which can be adjusted using the up/down buttons. The speed which will be held is in the upper right hand corner. In **REM** mode the drives holds a constant pressure.

TIP: For common parameters and menu items, use the Help key ? to display descriptions.

If you encounter Alarms or Faults, use the Help key or refer to the Diagnostic section of the ABB User's Manual.

9.7 Timer Function

The Pentek® PPC Series controller includes four timer functions. Each timer function can include up to four daily / weekly start and stop times.

The following example show the parameter changes required to use PID Set 2 on Monday, Wednesday, and Friday from 8:00AM to 10:00AM.

Parameter	Setting
3601 – Timers Enable	7 – Enabled
3602 – Start Time 1	8:00AM
3603 – Stop Time 1	10:00AM
3604 – Start Day 1	1-Monday
3605 – Stop Day 1	1-Monday
3606 – Start Time 2	8:00AM
3607 – Stop Time 2	10:00AM
3608 – Start Day 2	3-Wednesday
3609 – Stop Day 2	3 – Wednesday
3610 – Start Time 3	8:00AM
3611 – Stop Time 3	10:00AM
3612 – Start Day 3	5-Friday
3612 – Stop Day 3	5-Friday
3626 – Timer Func1SCR	7 = P3 +P2 + P1
4027 – PID 1 Param Set	8 = Timer Function 1

9.8 Helpful Hints

Alarm 2025 upon startup

This is a normal alarm, and occurs whenever motor data is changed. The alarm shows for about 15 seconds while the drive performs a motor calibration.

Fault 14 External Fault 1

External fault 1 is triggered when the VFD's output frequency exceeds motor nameplate frequency for more than 10 seconds. The ON delay parameter controls the time delay for this fault. If the system includes a large tank, or requires more time to reach the setpoint, increase parameter 1404 (PPC5) or 1806 (PPC3).

This fault is designed to protect against loss of prime, broken shafts, etc. To disable this fault, adjust parameter 2002 Maximum speed, to the motor nameplate rpm.

Sleep

The Pentek drive monitors pump speed to determine demand. The pump is shut off when the rpm goes below parameter 4023: PID Sleep Level. Always set parameter 4023 high enough to trigger sleep mode during low demand conditions. Note that the shut-off head at parameter 4023: RPM, must be higher than the pressure set-point.

The pressure setpoint can be determined by slowly closing the discharge valve to confirm that the RPM decreases to a level that triggers the sleep mode. The discharge head can also be found by using the BEC2 program on the BEC2.net website.

Systems that use small tanks, or have a flat performance curve, may cycle rapidly at intermediate flows. Correct this by increasing Parameter 4024: PID Sleep Delay.

DO NOT increase parameter 4024 to a level that will cause the pump to run with no demand. The water in the pump can overheat.

Sleep Options

Other devices such as flow or float switches can be used to trigger sleep mode. Parameter 4022 determines the method to trigger sleep mode. These options can be used for pump up, pump down, and other on/off applications.

Multiple Systems / Setpoints

The Pentek PPC Series Controller includes (2) independent process control sets (groups 40 and 41). Group 41 parameters can be selected using Digital Input (DI3). When first set-up, groups 40 and 41 are identical. A set can be changed later with parameters for a second process.

Constant Flow

After running the Pentek Assistant, the drive can be configured for constant flow by adjusting parameters 4006: Units, and 4009: 100% Value.

Constant Flow Example 1:

Using a 4-20ma velocity meter with a range of 0 to 10 ft/sec. We want the display to be ft/sec.

Set 4006 to ft/sec

Set 4009 to 10

Constant Flow Example 2:

Same setup as example 1, but we have a 4" pipe and want the display to be gpm.

Set 4006 to gpm

Set 4009 to 393 (this is the flow in a 4" pipe which results in a 10 ft/sec velocity).

Constant Flow Example 3:

Using a 4-20ma flow meter with a range of 0 to 100 gpm. We want the display to be gpm.

Set 4006 to gpm

Set 4009 to 100

SECTION 9: PPC Series 50/60 Hz Variable Frequency Drives

9.9 PPC3 and PPC5 Tank Sizing

These instructions are only for systems that require tanks. Pressure tanks are generally required to maintain system pressure during periods of low or no demand. Tank pre-charge must be less than the pressure set point – wake up deviation.

Tank can be sized using Boyle's law (V1 x P1 = V2 x P2). Units are in gallons and PSI.

Typically tanks are sized for approximately 20% of pump capacity. For example, a 150 gpm pump typically requires 30 gallon total tank size.

$$\textbf{Drawdown} = \frac{\textbf{Total Tank Size x (Precharge+14.7)}}{\textbf{(Setpoint+14.7 – Wake Up Deviation)}} - \frac{\textbf{Total Tank Size x (Precharge+14.7)}}{\textbf{(Setpoint+14.7)}}$$

9.10 Reactors And Filters

Variable frequency drives produce voltage spikes that are a function of voltage rise-time and length of motor cable. In extreme cases peak voltage may exceed three times the nominal operating voltage.

Reactors

A reactor is a resistance and inductance device that reduces voltage spikes. It does this by both increasing the voltage rise-time and improving the impedance match of the cable and motor.

Filters

A filter combines a reactor with a capacitor network. The capacitors absorb a portion of the voltage spikes. This further reduces the peak voltage seen at the motor.

When to Use a Reactor or Filter

The chart below is a general guideline when choosing between using a filter or reactor.

	Lead Length					
	up to 50'		50' to 150'		150' to 1000'	
Motor Type	230 V	460V	230V	460V	230V	460V
NEMA Above-Ground Std. Efficiency	-	-	R	R	F	F
NEMA Above-Ground Premium Efficiency			-			
Submersible		R	R	F		

R = Reactor F = Filter

The following list indicates a greater need for filters and reactors:

- Long motor leads are used
- Standard efficiency or submersible motors are used.
- The cost of replacing the motor is prohibitive.
- Using a submersible motor with a voltage rating greater than 230V.
- The quality and/or age of the motor is unknown.
- Condition of wiring and/or power quality is unknown.

Reactors

Open Design 230 or 460 V Model	NEMA 1 230 or 460 V Model	Rated Amps	NEMA 1 575 V Model	Rated Amps
KDRA1P	KDRA1PC1	3.4	KDRA31PC1	2.7
DDRA2P	KDRA2PC1	4.8	KDRA35PC1	3.9
KDRA3P	KDRA3PC1	7.6	KDRA33PC1	6.1
KDRA4P	KDRA4PC1	11	KDRA34PC1	9
KDRB1P	KDRB1PC1	14	KDRA36PC1	11
KDRD1P	KDRD1PC2	21	KDRD31PC2	17
KDRD2P	KDRD2PC2	27	KDRD32PC2	22
KDRD3P	KDRD3PC2	34	KDRD35PC2	27
KDRD4P	KDRD4PC2	40	KDRD33PC2	32
KDRC1P	KDRC1PC2	52	KDRD34PC2	41
KDRF1P	KDRF1PC3	65	KDRC31PC2	52
KDRF2P	KDRF2PC3	77	KDRF31PC3	62
KDRF3P	KDRF3PC4	96	KDRF32PC3	77
KDRH1P	KDRH1PC4	124	KDRF33PC4	99
KDRI1P	KDRI1PC4	156	KDRH31PC4	125
KDRI2P	KDRI2PC4	180	KDRI31PC4	144
KDRG1P	KDRG1PC4	240	KDRI32PC4	192
			KDRG31PC4	242

Filters

NEMA 1, 230, 460 or 575 V Model	NEMA 1, CUL Listed Model	Rated Amps
KLC4BE	KLCUL4BE	4
KLC6BE	KLCUL6BE	6
KLC8BE	KLCUL8BE	8
KLC12BE	KLCUL12BE	12
KLC16BE	KLCUL16BE	16
KLC25BE	KLCUL25BE	25
KLC35BE	KLCUL35BE	35
KLC45BE	KLCUL45BE	45
KLC55BE	KLCUL55BE	55
KLC80BE	KLCUL80BE	80
KLC110BE	KLCUL110BE	110
KLC130BE	KLCUL130BE	130
KLC160BE	KLCUL160BE	160
KLC200BE	KLCUL200BE	200
KLC250BE	KLCUL250BE	250

SECTION 10: PPX NEMA Pump Panels

10.1 Description

The PPX series of pump control panels consist of a manually operated fusible disconnect switch and a magnetic contactor with a solid-state overload housed in a NEMA enclosure. The fusible disconnect switch provides motor branch short-circuit protection. The contactor is proven in field applications where wide voltage fluctuations may occur. The overload relays provide motor overload protection.

The rainproof enclosure allows all routine operations to be performed from the outside without opening the door. The fusible disconnect switch handle is mechanically interlocked with the enclosure door to prevent opening the door before the handle is moved to the OFF position. For better access during repair or inspection, the cover may be removed by lifting the door upward and outward. A latch is provided to prop the door open on windy days.

The overload relay incorporates a dial for field adjustment of tripping current.



Figure 10-1: Typical NEMA Enclosure

Install in conformance with National Electrical Code and all local codes. Branch circuit protection must be provided.

These controllers have all components arranged for easy access from the front. The circuits are relatively simple and circuit components are selected for trouble-free operation. Periodically, depending on the environment and duty, the panel should be inspected and cleaned. Inspect all devices for loose bolts and nuts.

SECTION 10: PPX NEMA Pump Panels

Table 10-1: NEMA Full-voltage Combination Starters

NEMA size	Disconnect Amps	Max Total Amps	Overload Current Range (Amps)	Part Number
208V				
1	30	13.5	6.5-13.5	PPX-1A-13-30R
		27	13-27	PPX-1A-27-30R
2	60	50	25-50	PPX-2A-50-60R
3	100	70	35-70	PPX-3A-70-100R
		100	65-135	PPX-3A-135-100R
4	200	135	65-135	PPX-4A-135-200R
230-240V				
1	30	13.5	6.5-13.5	PPX-1B-13-30R
		27	13-27	PPX-1B-27-30R
2	60	50	25-50	PPX-2B-50-60R
3	100	70	35-70	PPX-3B-70-100R
		100	65-135	PPX-3B-135-100R
460-480V				
1	30	13.5	6.5-13.5	PPX-1C-13-30R
		27	13-27	PPX-1C-27-30R
2	60	50	25-50	PPX-2C-50-60R
3	100	70	35-70	PPX-3C-70-100R
		100	65-135	PPX-3C-135-200R
4	200	135	65-135	PPX-4C-135-200R
5	400	270	130-270	PPX-5C-270-400R
575-600V				
1	30	13.5	6.5-13.5	PPX-1D-13-30R
			13-27	PPX-1D-27-30R
2	60	50	25-70	PPX-2D-50-60R
3	100	70	35-70	PPX-3D-70-100R
		100	65-135	PPX-3D-135-100R
4	200	135	65-135	PPX-4D-135-200R
5	400	270	130-270	PPX-5D-270-400R

Includes complete starter with fusible switch, H-O-A selector switch, START push button, and electronic overload protection in Type 3R enclosure. Fuses are not included.

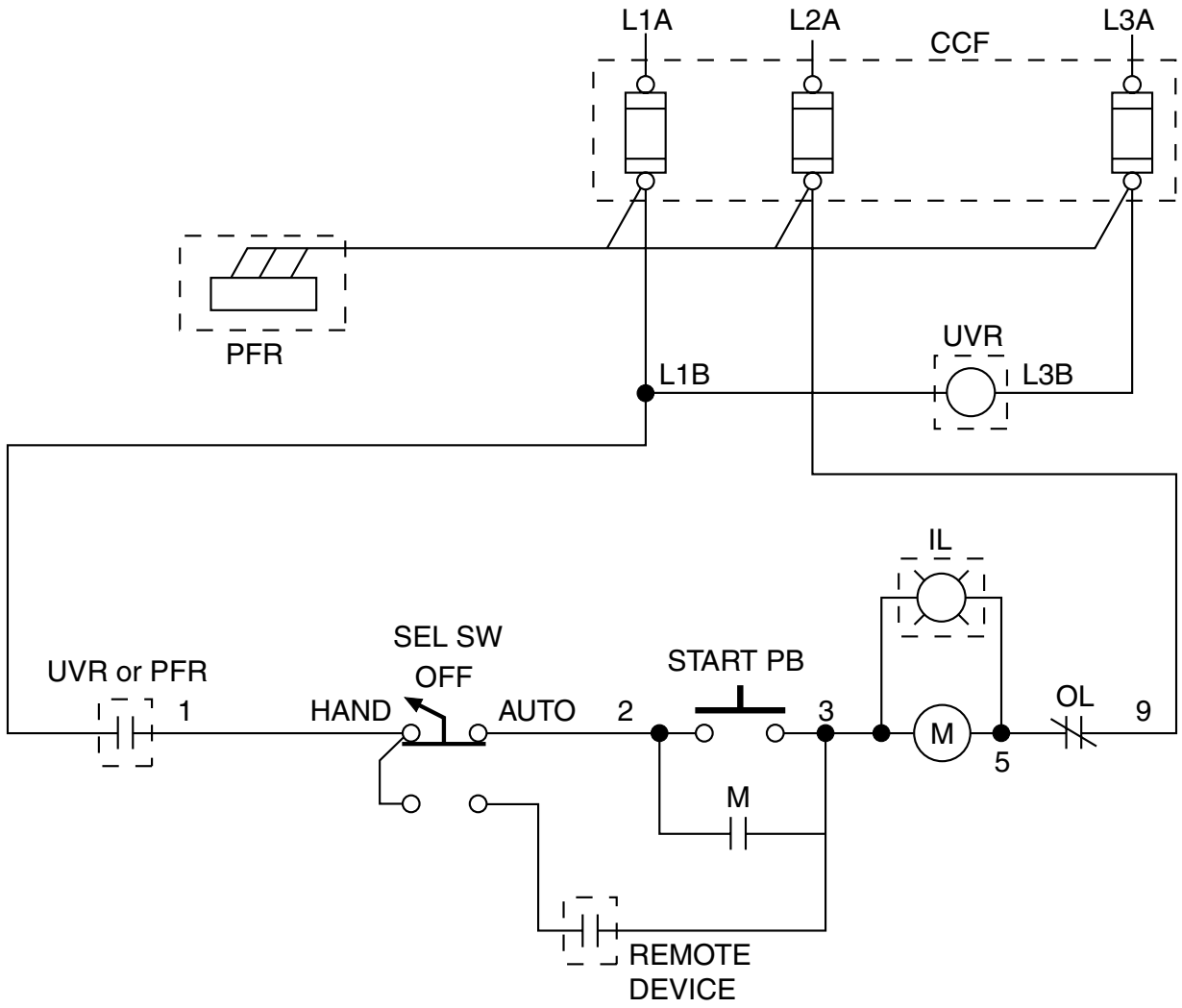


Figure 10-2: Typical PPX NEMA Size 1 through 5 Schematic Diagram

Key:

M = Motor Contactor

IL = Indicating Light

OL = Overload

CCF = Control Circuit Fusing

PFR = Phase Failure Relay

UVR = Undervoltage Relay

Dotted Line Box = If Used

SECTION 10: PPX NEMA Pump Panels

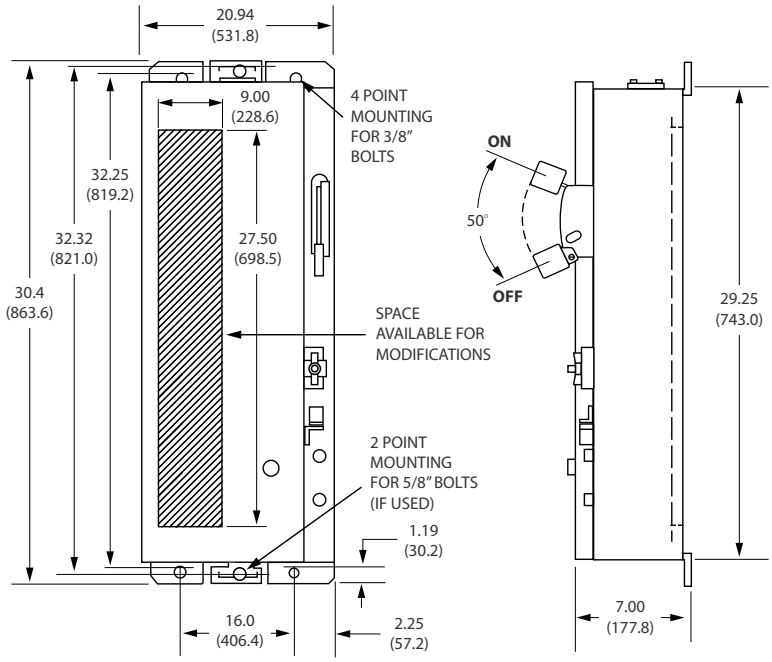


Figure 10-3: NEMA Sizes 1 and 2 Wide-Type Enclosures ; 85 lbs. (Size 1), 90 lbs. (Size 2)

Outlines, Dimensions in in. (mm), and Weights (lbs) - **For Estimating Only**

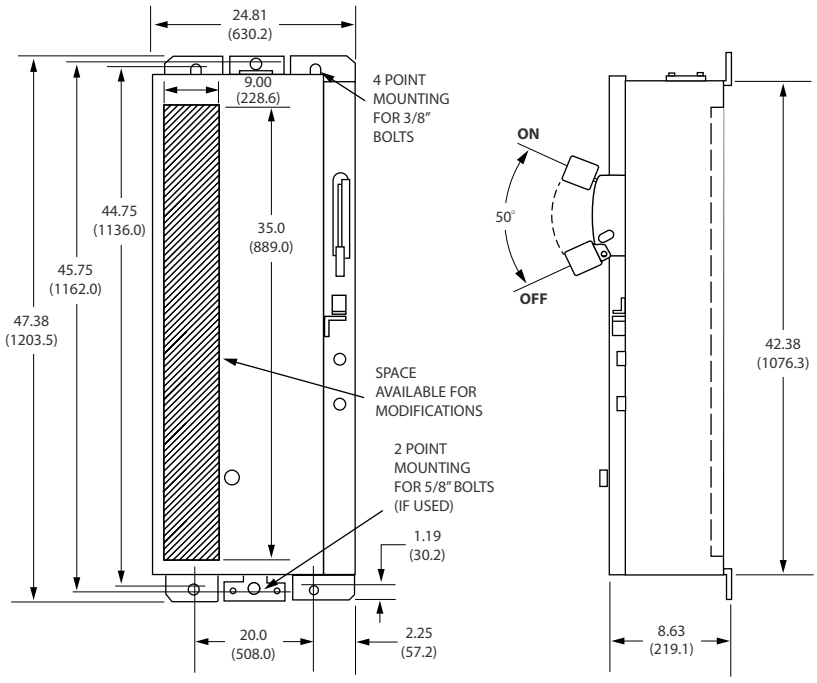


Figure 10-4: NEMA Sizes 3 and 4 Wide-Type Enclosures ; 195 lbs .

SECTION 9: PPX NEMA Pump Panels

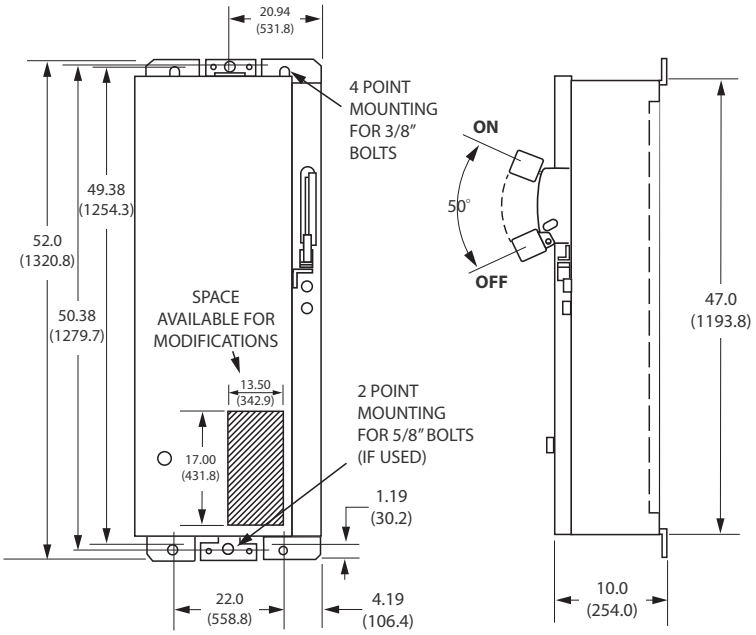


Figure 10-5 NEMA Size 5 Wide-Type Enclosures; 285 lbs

Outlines, Dimensions in in. (mm), and Weights (lbs) - **For Estimating Only**

SECTION 11: Submersible Motor Controls

11.1 How it Works

Submersible Motor Controls act as an above ground control system for you submersible motor. They provide easy access to the "brains" of your motor, so you can monitor, adjust and perform maintenance without removing the motor.

There are three main groups of motor controls. Each of these controls has a slightly different function, although all serve the main purpose of providing control for the motor.

Capacitor Start / Induction Run (CSIR)

A CSIR control uses a starting capacitor and a switch. When voltage is first applied, the switch is closed and the start capacitor is in the circuit. This provides extra torque to bring the motor up to speed. The switch is often referred to as a potential relay. The relay's coil senses voltage across the windings. When the windings get close to full speed, they magnetize the coil and physically breaks the connection to the start windings. This takes not only the start windings out of the circuit, but the starting capacitor as well. The motor then runs on the main winding alone.

Capacitor Start / Capacitor Run (CSCR)

A CSCR control functions very similar to a CSIR control except that in addition to the starting capacitor, it also uses a running capacitor. This allows the start winding to act as an auxiliary winding during operation. This smooths out operation of the motor and provides greater efficiency and a reduction in vibration and noise.

Plus Series Controls

The Pentek® PLUS series controls combine a CSCR design and a control circuit to provide not only starting power to the motor, but a switch to turn the control on and off. The switch takes the form of a magnetic contactor that uses a coil that physically closes the contacts when energized. The contactor allows the installer to use a pressure switch with a lower current rating, since it is not switching the full amperage of the motor.

11.2 Specifications

All Pentek Submersible Motor Controls are rated for Indoor or Outdoor use and employ NEMA 3R enclosures. They are rain-tight and resistant to weathering and corrosion.

The controls are rated for operation in temperatures up to 50° C (122° F). DO NOT locate the control box in direct sunlight.

The terminals can accept up to #4 AWG copper wire rated for at least 75° C. Internal wiring conforms to appliance wiring standards UL 1015 which is resistant to acids, oils, alkalies, moisture and fungus.

Pentek Submersible Motor controls are agency recognized and tested to rigorous safety standards.

For specific ratings of individual components please see the repair parts portion of the manual.

11.3 Mounting and Installation

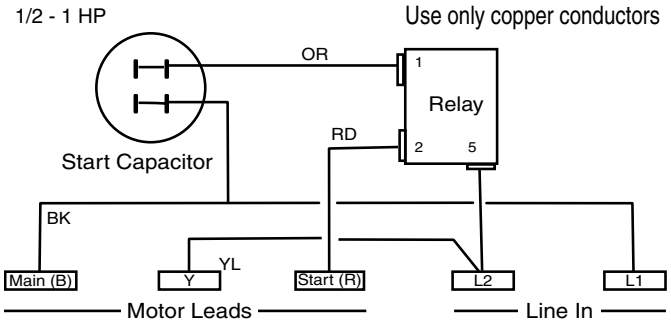
- Mount the control boxes to a secure backing.
- Mount controls vertical and plumb.
- In order to maintain NEMA 3R, plug all unused openings.

SECTION 11: Submersible Motor Controls

60 Hz.

11.4 Wiring Connections and Replacement Parts

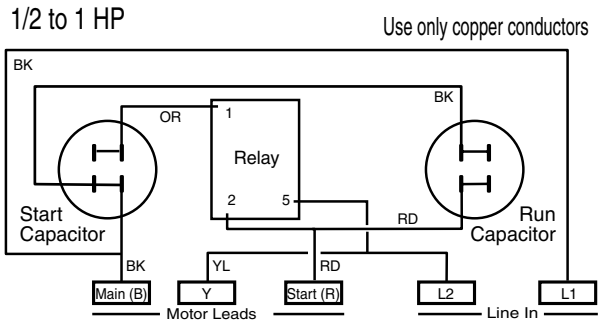
1/2 to 1 HP Capacitor Start, Induction Run



Models SMC-IR0511, SMC-IR0521, SMC-IR0721 and SMC-IR1021

HP	Description	Part Number
1/2	Start Capacitor, 250 µF, 125v	U17-1429-R
1/2	Start Capacitor, 59 µF, 270v	U17-1423-R
3/4	Start Capacitor, 86 µF, 270v	U17-1424-R
1	Start Capacitor, 105 µF, 270v	U17-1425-R
230V	Relay	U17-1592-R
115V	Relay	U17-1593-R

1/2 to 1 HP Capacitor Start, Capacitor Run

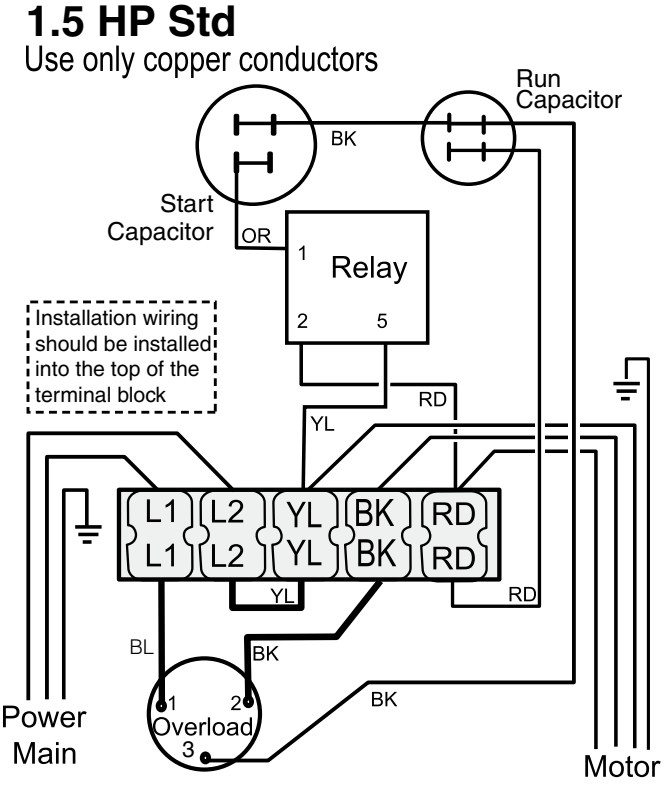


Models SMC-CR0521, SMC-CR0721, and SMC-CR1021

HP	Description	Part Number
1/2	Start Capacitor, 43 µF, 270v	U17-1422-R
3/4	Start Capacitor, 59 µF, 270v	U17-1423-R
1	Start Capacitor, 86 µF, 270v	U17-1424-R
1/2	Run Capacitor, 15 µF, 370v	U17-1419-R
3/4	Run Capacitor, 23 µF, 370v	U17-1292-R
1	Run Capacitor, 23 µF, 370v	U17-1292-R
All	Relay	U17-1592-R

1-1/2 HP Capacitor Start, Capacitor Run

NOTICE: Attach installation wiring to the top of the terminal strip. Schematics may show otherwise for clarity.



For Supply Connection, Use Wires Acceptable For At Least 75°C (167°F)

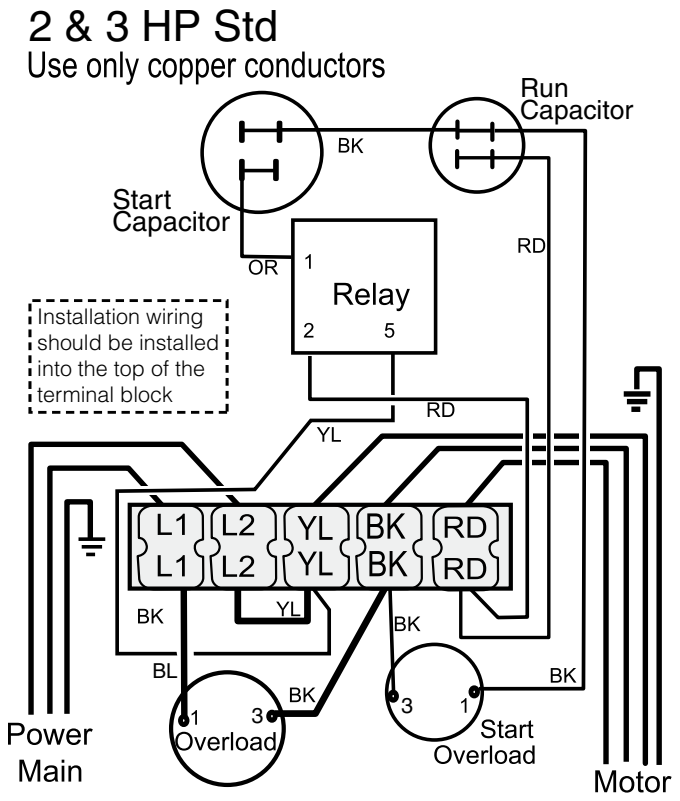
Model SMC-CR1521

Description	Part Number
Overload Protector	U17-1313-R
Relay	U17-1592-R
Start Capacitor, 105 µF, 330v	U17-1430-R
Run Capacitor, 10 µF, 370v	U17-1438-R

SECTION 11: Submersible Motor Controls

60 Hz.

2 and 3 HP Standard

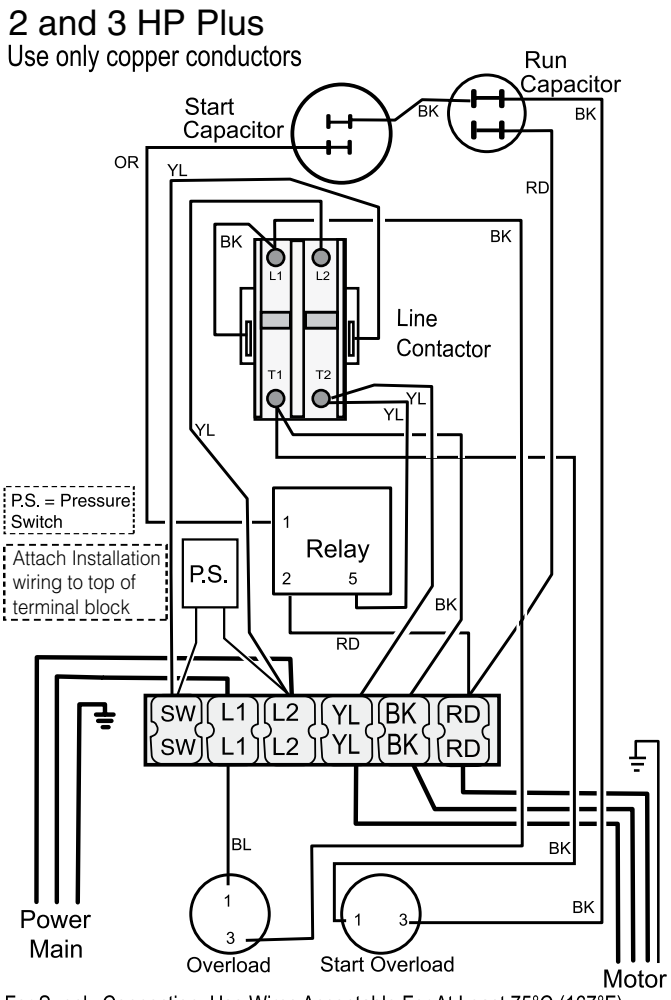


For Supply Connection, Use Wires Acceptable For At Least 75°C (167°F)

Models SMC-CR2021 and SMC-CR3021

Description	Part Number
Start Capacitor,105 µF, 330v, 2 HP	U17-1430-R
Start Capacitor, 208 µF, 330v, 3 HP	U17-1428-R
Run Capacitor, 20 µF, 370v, 2 HP	U17-1440-R
Run Capacitor, 45 µF, 370v, 3 HP	U17-1443-R
Main Overload Protector, 2 HP	U17-1319-R
Main Overload Protector, 3 HP	U17-1322-R
Start Overload Protector, 2 HP	U17-1320-R
Start Overload Protector, 3 HP	U17-1323-R
Relay - 2 HP	U17-1592-R
Relay - 3 HP	U17-1432-R

2 and 3 HP Plus



For Supply Connection, Use Wires Acceptable For At Least 75°C (167°F)

Models SMC-CRP2021 and SMC-CRP3021

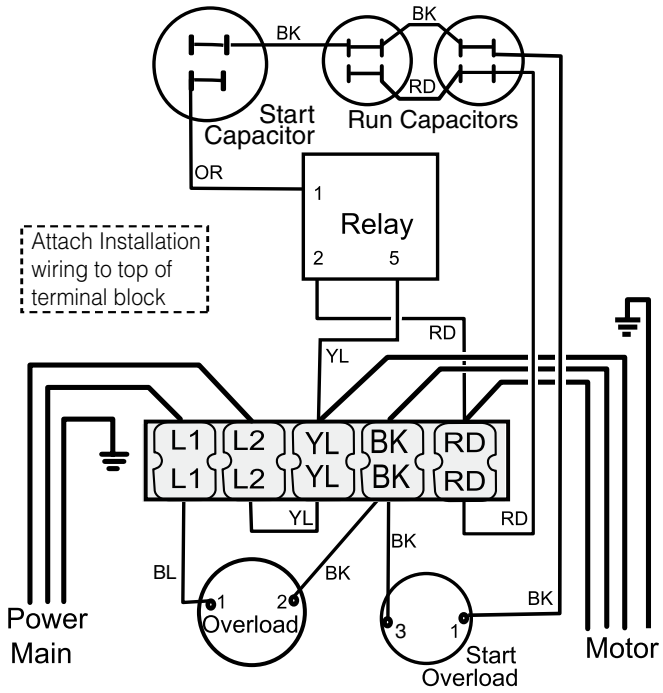
Description	Part Number
Start Capacitor,105 µF, 330v, 2 HP	U17-1430-R
Start Capacitor, 208 µF, 330v, 3 HP	U17-1428-R
Run Capacitor, 20 µF, 370v, 2 HP	U17-1440-R
Run Capacitor, 45 µF, 370v, 3 HP	U17-1443-R
Main Overload Protector, 2 HP	U17-1319-R
Main Overload Protector, 3 HP	U17-1322-R
Start Overload Protector, 2 HP	U17-1320-R
Start Overload Protector, 3 HP	U17-1323-R
Relay - 2 HP	U17-1592-R
Relay - 3 HP	U17-1432-R
Magnetic Contactor	P17-954-R

SECTION 11: Submersible Motor Controls

60 Hz.

5 HP Standard

5 HP Std
Use only copper conductors



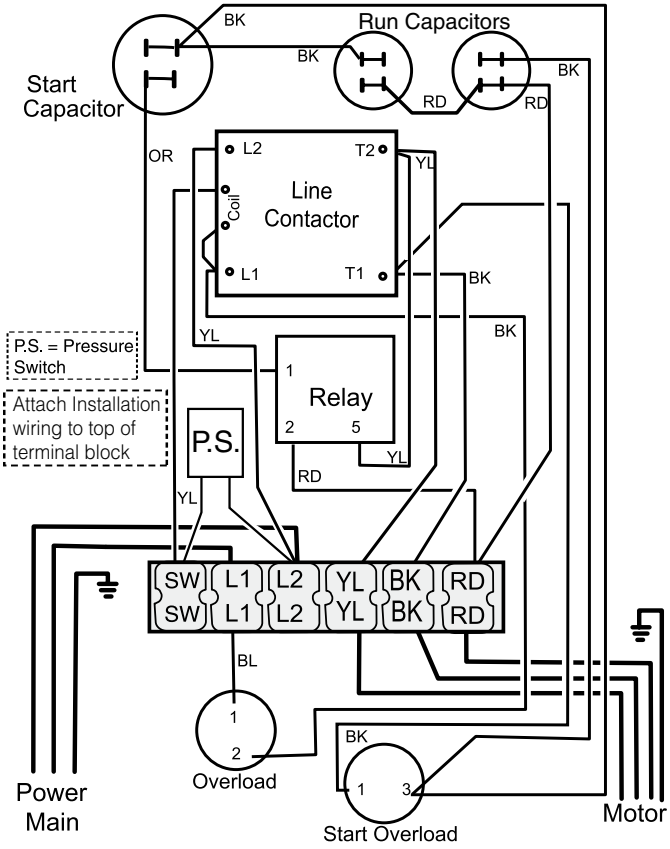
For Supply Connection, Use Wires Acceptable For At Least 75°C (167°F)

Model SMC-CR5021

Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1437-R
Run Capacitor, 80 µF, 370v	U17-1502-R
Main Overload Protector	U117-1456A-R
Start Overload Protector	U17-1321-R
Relay	U17-1432-R

5 HP Plus

5 HP Plus
Use only copper conductors



For Supply Connection, Use Wires Acceptable For At Least 75°C (167°F)

Model SMC-CRP5021

Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1437-R
Run Capacitor, (2) 40 µF, 370v	U17-1442-R
Magnetic Contactor	P17-953-R
Main Overload Protector	U117-1456B-R
Start Overload Protector	U17-1321-R
Relay	U17-1432-R

SECTION 12: Motor Protective Devices - 50/60 Hz

12.1 How They Work

Pentek® motor protectors are designed to protect single phase pumps from dry run, dead head, jammed impeller, and over & under voltage conditions.

A calibration adjustment allows the motor protector to be calibrated to specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A micro drive based voltage and current sensing circuit monitors for power fluctuations, over-current, and under-current conditions. When an abnormality, such as loss of suction, is detected, the motor protector deactivates its output relay and immediately disconnects the pump motor. The motor protector then activates its user-selectable "Restart Delay" (Dry run recovery) timer. When the timer counts to zero or power is removed and reapplied, the motor protector reactivates its output relay and turns the pump back on.

An infrared LED communicates directly with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays 16 parameters including calibration point, trip point, running points, and last fault.

NOTICE: The use of flow restrictors or unusually high head pressures at the time of calibration may interfere with the detection of dead head conditions.

12.2 Specifications

Parameter	SPP-111P	SPP-111P-3RL	SPP-231P	SPP-233P	SPP-235P-XX
1 Phase Line Voltage (±10%)	115 VAC		230 VAC		
Load Range	1/3 - 1/2 HP (.25 - .37 kW)	1/3 - 1 HP (.33-.75 kW)	1/3 - 1 HP (.25 - .75 kW)	1/3 - 3 HP .25 - 2.24 kW)	5 - 15 HP (3.73 - 11.19 kW)
Frequency	50-60 Hz				
Power Consumption (Maximum)	5 W				
Operating Temperature	-40° to 158° F (-40° to +70° C)				
Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 2, 4kV Contact, 6 kV Air				
Output Contact Rating (SPST)	1/2 HP @ 115 VAC (17 AMPS MAX)	1 HP @ 115 VAC (17 AMPS MAX)	1 HP @ 240 VAC (17 AMPS MAX)	3 HP @ 240 VAC (17 AMPS MAX)	480 VA @ 240 VAC
Weight	.63 lbs (.28 kg)	1.6 lbs (.73 kg) w/enclosure	.63 lbs (.28 kg)	1.6 lbs (.73 kg)	
Enclosure	None	NEMA 3R	None	NEMA 3R w/ LENS	
Current Transformer Ratio	N/A	N/A	N/A	N/A	SPP-235-75 – 50:5 SPP-235-100 - 75:5 SPP-235-150 - 100:5
Operating Points					
Overload	125 % of Calibration Point				
Underload (Dry Run)	~80% of Calibration Point				
Overvoltage Trip Point	132.5 VAC	265 VAC			
Undervoltage Trip Point	95 VAC	190 VAC			
Number of Restarts allowed in a 60 sec. Period before lockout (Rapid Cycle Timer)	4				
Trip Delay Time (Overload)	5s				
Trip Delay Time (Dry Run)	2s				
Restart Delay Time					
Overvoltage/Undervoltage Delay	5s				
All other faults (Dry Run Rec. Timer)	2-225 min				
Terminal					
Wire Gauge	N/A			12-22	
Maximum Torque				7 in-lbs	

12.3 Mounting And Installation

Mount the Pentek® Motor Protector in a convenient location in or near the motor control panel. If the location is wet or dusty, then the Pentek Motor Protector should be mounted in a NEMA 3R, 4, or 12 enclosure.

12.4 Wiring Connections

1. Connect one line from the fused disconnect to the Motor protector's "L1 IN" terminal. Run a wire from the "L1 OUT" terminal to the other in-line controls such as a pressure or float switch. See Figure 10-1.
2. Connect the other line from the fused disconnect to Motor Protector "L2 IN" terminal. Run a wire from the "L2 OUT" terminal to the other in-line controls such as pressure or float switches. See Figure 12-1.

NOTICE: The Motor Protector may not detect a dead head (blocked pipe) condition on applications where the pump is undersized for a given motor or flow restrictors are used on high stage pumps or low yield wells.

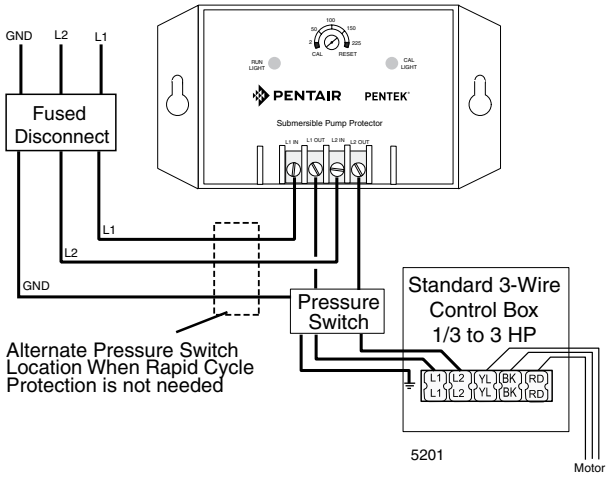


Figure 12-1: SPP233 Standard Control Box Connection

Calibration/Settings

NOTICE: Calibrate the Motor Protector during normal pumping conditions.

1. Turn the RESTART DELAY / CALIBRATION adjustment fully counter-clockwise to the "CAL." position.
2. Apply power to the Motor Protector. The pump motor should be running at this point.
3. The Motor Protector is being calibrated when the CAL. LIGHT turns on (approximately 5 seconds). Within 10 seconds, proceed to step 4.
4. Set the RESTART DELAY / CALIBRATION adjustment to the desired Restart Delay (Dry Well Recovery Time). If you leave the RESTART DELAY / CALIBRATION adjustment in the "CAL." position, the unit will trip off and stay off. Turn the adjustment out of the "CAL." position to start the pump.

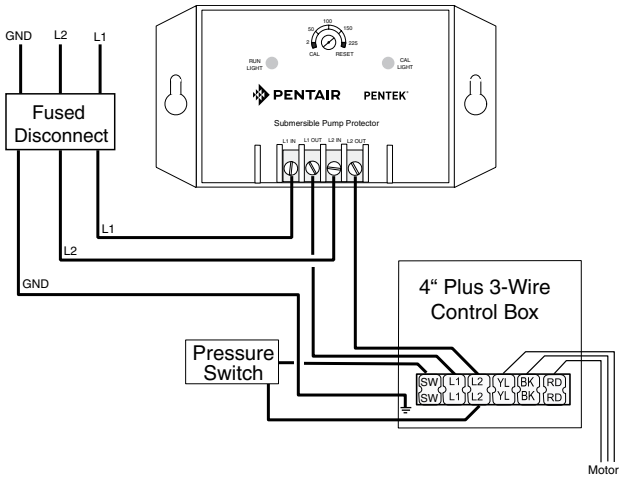


Figure 12-2: "Plus" Control Box Connection for SPP233

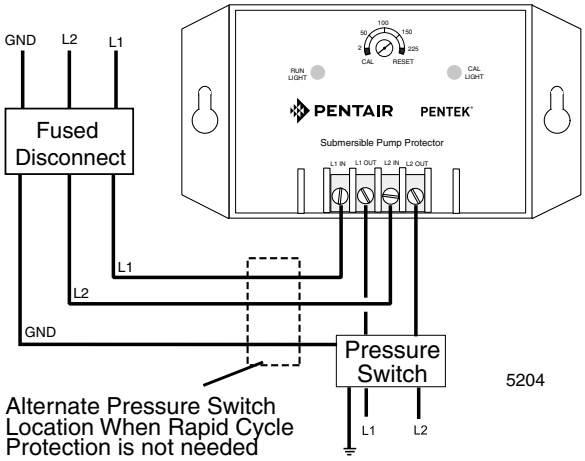


Figure 12-3: 2-Wire Connection for SPP233

Manual Reset Mode: If the RESTART DELAY / CALIBRATION adjustment is set to "RESET", the Motor protector is in Manual Reset mode. After the Motor Protector shuts down due to a voltage or load problem, the RESTART DELAY / CALIBRATION adjustment must be rotated out of the "RESET" position to restart the pump.

NOTICE: Any restart delay can be by-passed by rotating the RESTART DELAY / CALIBRATION adjustment to the "RESET" position and back to the desired Restart Delay setting.

Rapid Cycling Protection: Rapid cycling is defined as more than four restarts in a 60 second period. The Motor Protector will lockout upon detecting a rapid cycling condition until power is removed and re-applied to the L1 IN and L2 IN terminals. See Diagnostics Table for instructions to diagnose a rapid cycling fault.

SECTION 13: Troubleshooting

13.1 Pump And Motor Problem Analysis

Problem	Possible Cause	Check And Restore
Pump Won't Start.	No voltage (check with voltmeter). Typically will be no startup noise.	1. Main power supply off. 2. Blown fuse or tripped circuit breaker. 3. Wiring damage, loose connection. 4. Burnt contactor points.
	Locked pump.	1. Check for sand in system. 2. Crooked well (submersible)
Overloads Trip.	Low or high voltage.	1. Check with voltmeter. (±10% of nameplate voltage). Request power company correct problem. 2. Determine if wire size is correct for voltage and amperage.
	High ambient temperature or direct sunlight.	1. Improve cooling for motor and controls. 2. Use ambient compensated overloads.
	Incorrect pump sizing – mismatched motor.	1. Check pump (gpm) make sure near B.E.P. - "Best Efficiency Point". 2. Recheck pump and motor model numbers prior to installation. Keep a written record.
	High cycling rate.	1. Pressure control equipment malfunction. 2. Hole in piping system. 3. Pressure/storage tank failure.
	Damaged motor control.	Check components per troubleshooting.
Fuses Blow or Breaker Trips.	Short or Ground.	1. Fuses give superior protection and should be used in preference to circuit breakers when possible. 2. Inspect wiring for visible signs of heat damage (discoloration, damage to insulation). 3. Disconnect power and check with ohmmeter or megohmmeter to ground.
	Improper sizing.	Consult manufacturer's information / sizing chart for proper size and replace as required.
Low or No Water Production.	No rotation.	1. Motor not turning (see "Pump won't start" above. 2. Broken shaft coupling. Ammeter will show "low" amps.
	Restriction in piping.	1. Check valve sticking. 2. Check valve installed backward. 3. Broken check valve poppet or flapper lodged in piping system downstream.
	Plugged inlet.	1. Intake screen encrusted with minerals. 2. Insufficient clearance between pump and well casing for high capacity pump. Calculate intake velocity and limit to less than 5 feet per second.

SECTION 13: Troubleshooting

Pump And Motor Problem Analysis (Continued)

Problem	Possible Cause	Check And Restore
Low or no water production (continued)	Well drawdown.	1. Install air line upon reinstalling unit if not already present for measuring depth with tire pump and gage. 2. Measure dynamic (drawdown) level with string or resistance meter. 3. Select different pump if appropriate.
	Well collapsed.	1. Unit is pumping dirty or sandy water. 2. Lift with pump hoist, check pull weight and resistance
	Pump selection.	1. Recheck operating conditions by comparing to pump curve. 2. Operate within ±5 percentage points of efficiency from B.E.P.
	Hole in well piping.	1. Listen for sucking sound at well head when pump shuts off. 2. Well pipe empties when submersible pump is pulled from well.
	Wrong rotation.	1. Three phase motor - exchange any two of the three leads in the three phase motor starter panel. 2. Single phase motor - recheck motor and control panel wiring diagrams. Change wiring as appropriate. 3. Proper rotation for motors for sub. and centrifugal pumps with CW rotation is CCW when looking at the shaft end of the motor. 4. Make a visual flow check or observe flow meter. Amperage is not a reliable indicator of wrong rotation.
	Improper sizing.	Consult manufacturer's performance charts or curves.
	Hole in distribution piping.	1. Observe pressure loss with system shut off. 2. Look for wet spot or depression along pipe path.
Pump runs all the time.	Drawdown.	1. Check for surging, irregular amperage readings with amprobe. 2. Look for bursts of air in water. 3. Listen for surging sounds in piping.
	Control equipment.	1. Control equipment incorrectly selected or installed. 2. Welded electrical contact points. 3. Pressure switch supply pipe/tube plugged with rust/scale/ice. ⚠WARNING **Hazardous pressure and risk of explosion and scalding.** If pump is running continuously at no flow (with discharge shut off), water may boil in pump and piping system. Under steam pressure, pipes may rupture, blow off of fittings or blow out of pump ports and scald anyone near.

SECTION 13: Troubleshooting

Pump And Motor Problem Analysis (Continued)

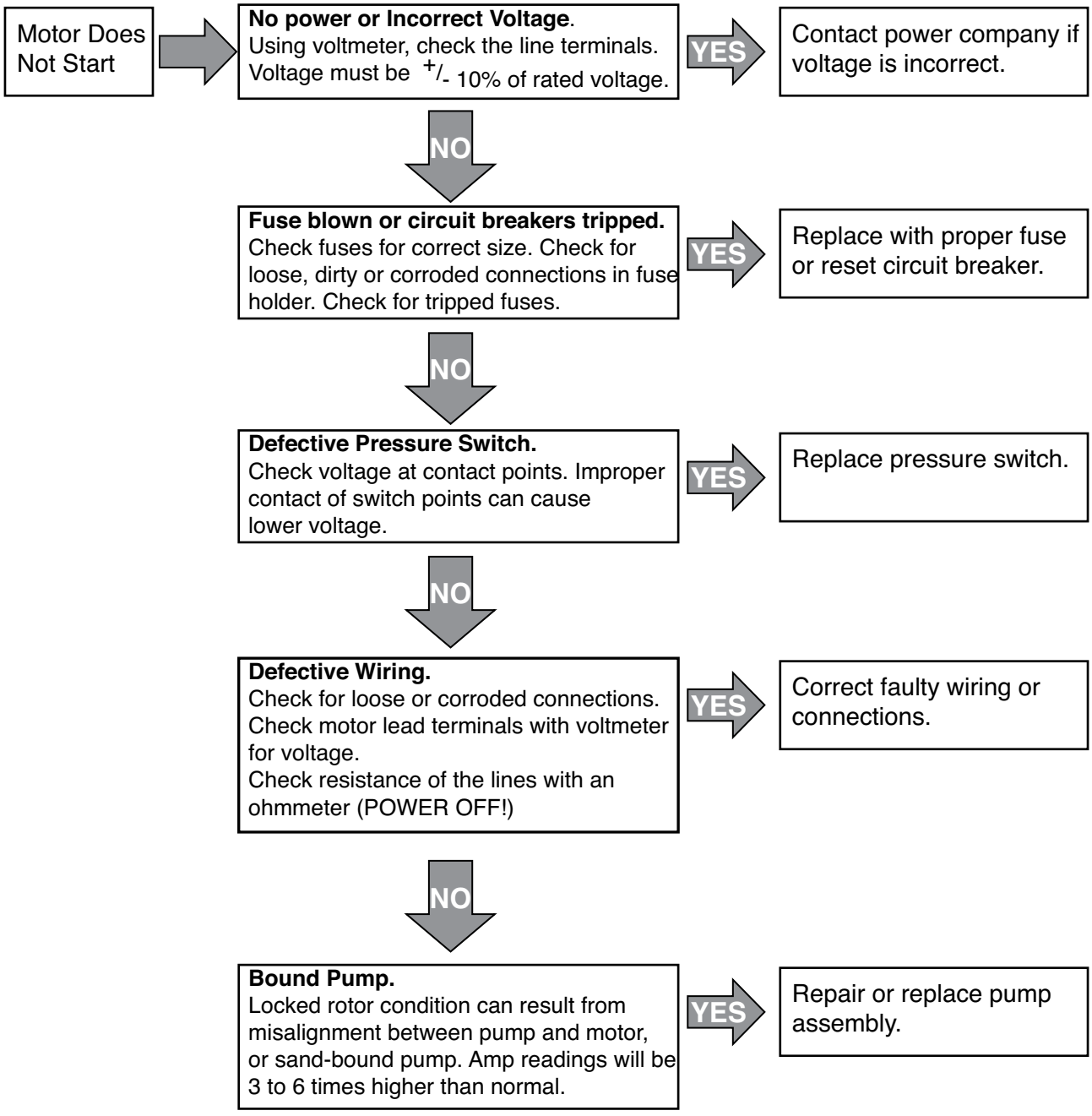
Problem	Possible Cause	Check And Restore
Pump runs all the time (continued)	Pump wear.	1. Check amperage - generally lower unless severe bearing damage has occurred. 2. Verification may require removal of pump for service and visual inspection.
Electric shock.	Grounded wiring or motor.	1. PROCEED WITH CAUTION! 2. Remove rings and other jewelry from hands before working with live power circuits. 3. Wear insulated boots and gloves. 4. Disconnect the power, check with ohmmeter. 5. Progressively check wire at each splice point (or obvious damage point). 6. When ground disappears, the fault is behind the point of discovery. 7. Check motor leads to motor shell with cable splice removed to determine if ground fault is in motor or supply cable.
	Moisture.	Protect motor, motor starter and control devices from condensation or direct water spray.
Ammeter reads high on two leads, zero on the 3rd.	Three phase motor "single phasing".	1. One power lead is not live or online. 2. Check with local utility company to see if having problems. 3. Check local power installation for transformer problems. 4. Will not be able to observe this condition very long. Very destructive to motor windings. Motor stator will soon be destroyed if single phasing protection is not installed. 5. This problem usually requires a replacement motor. 6. Determine source, install or replace protective gear.
Overload trip – ammeter reads high on all leads.	Binding or dragging.	1. High volume of sand or other abrasives in well. Check by observing water output. 2. Severe damage to motor thrust bearing due to cavitation or abrasives. Usually very noisy. 3. Damage to motor control system.
	Power supply problems.	1. Check with voltmeter while pump is running for ±10% voltage variance. 2. Extreme grounding of motor or supply cable. Check with ohmmeter or megohmmeter. 3. Poor wiring connections. Check splice, and terminal screws for looseness. Watch for discolored cable.

SECTION 13: Troubleshooting

13.2 Motor Troubleshooting Flow Charts

Troubleshooting Flow Chart

Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.

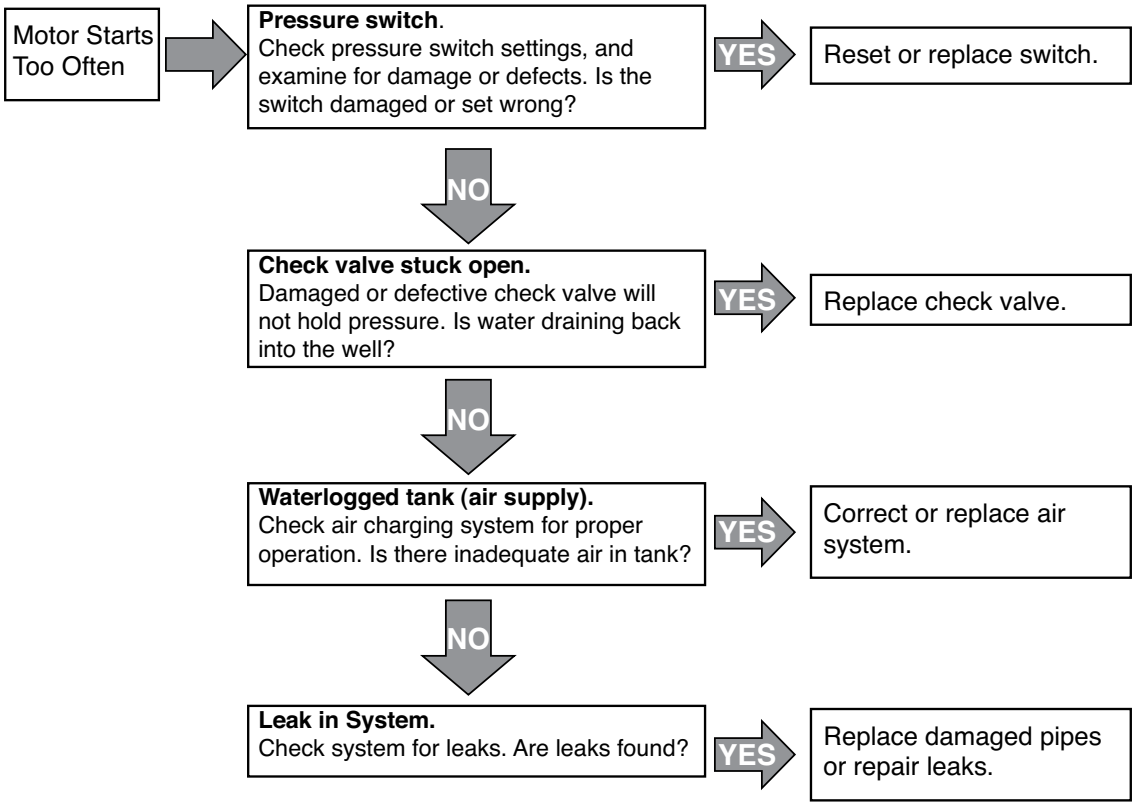


SECTION 13: Troubleshooting

Motor Troubleshooting Flow Charts (continued)

Troubleshooting Flow Chart (Continued)

Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.

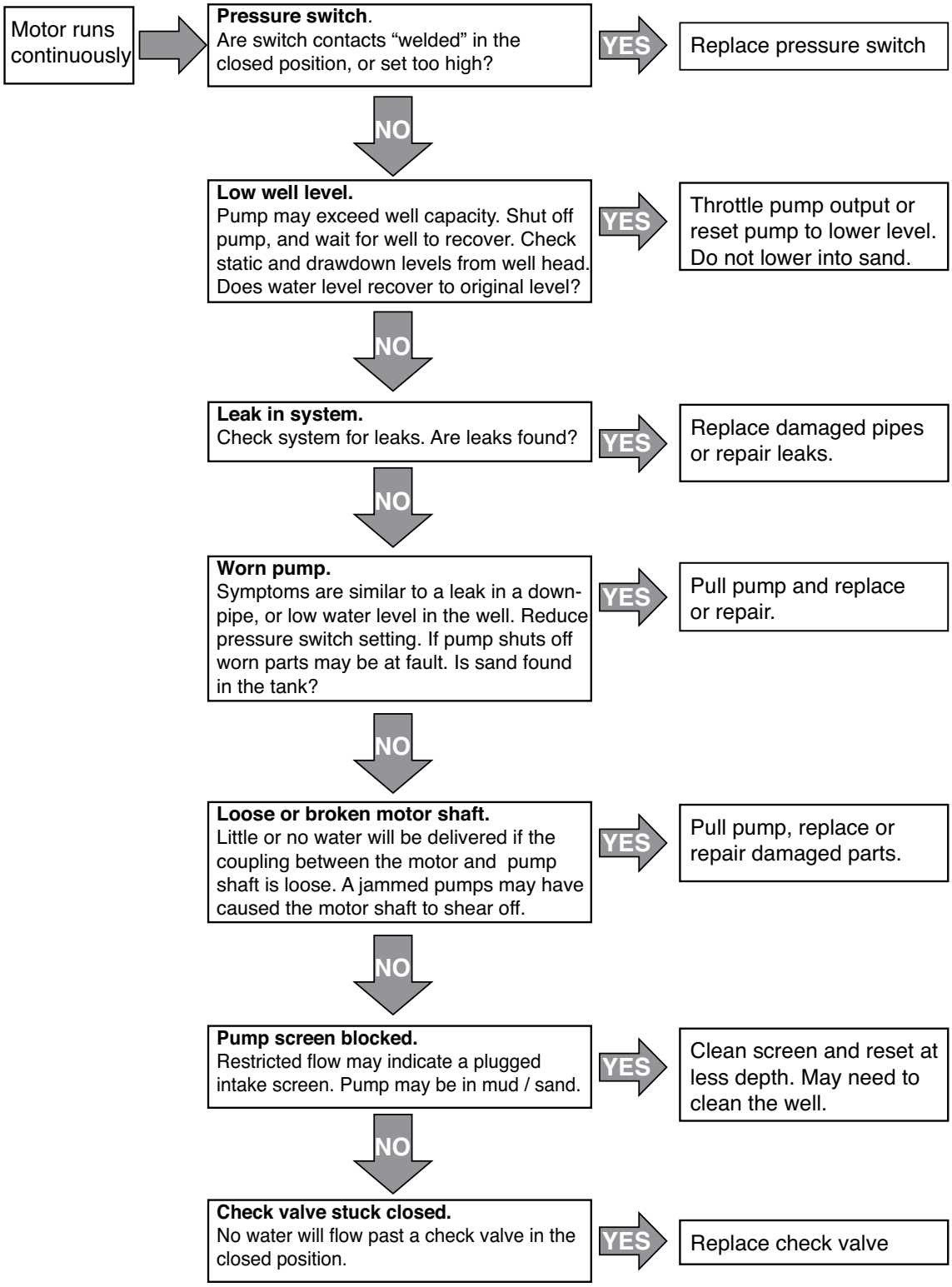


SECTION 13: Troubleshooting

Motor Troubleshooting Flow Charts (continued)

Troubleshooting Flow Chart (Continued)

Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.

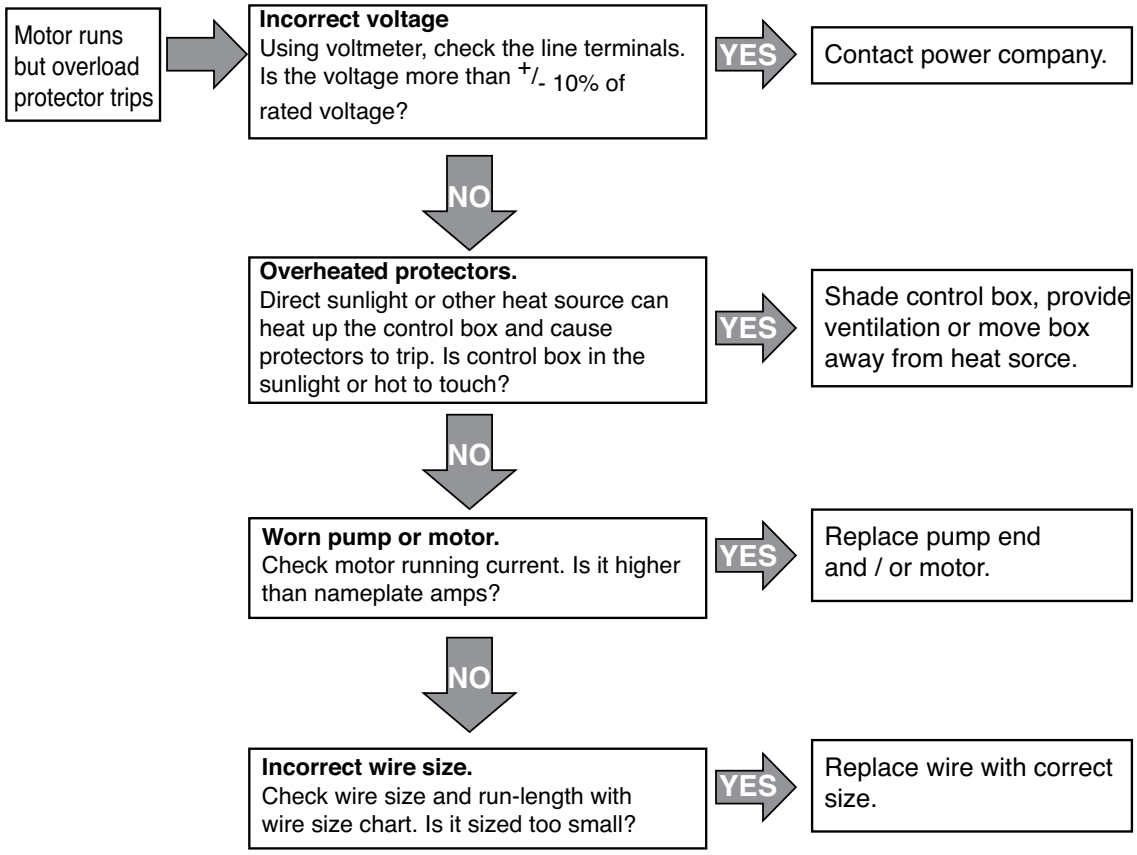


SECTION 13: Troubleshooting

Motor Troubleshooting Flow Charts (continued)

Troubleshooting Flow Chart (Continued)

Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.



13.3 Testing Submersible Motor Insulation and Winding Resistance

Insulation Resistance

1. Turn off power!
2. Set the ohmmeter to RX100K ohms.
3. Zero the ohmmeter.
4. Connect one lead to the metal drop pipe (or to ground if the pipe is plastic).
5. Connect the other lead to any motor lead.
6. Check each power lead.
7. Compare results to the following table.

Resistance	Indicates
20K ohm	Damaged motor, possible result of lightning strike.
500K ohm	Typical of older installed motor in well.
2 M ohm	Newly installed motor
10 M ohm	Used motor, measured outside of well
20 M ohm	New motor without cable

Winding Resistance

1. Turn off power!
2. Set the ohmmeter to RX1 ohm range. For values over 10, use the RX10 ohm scale.
3. Zero the ohmmeter.
4. Compare results to resistance shown in motor specifications table.

Three Phase Motors

Measure each line to each other (three readings). Compare these to the line-to-line resistance shown in motor specification table.

- If all leads measure within the table specifications, the leads and motor are okay.
- If a lead shows a higher resistance, then there is an open in the cable or winding. Check for secure cable connections.
- If a lead shows lower resistance, then there is a short circuit in the cable or winding.

Single Phase Motors: 3-wire

- Measure the main winding (black to yellow).
- Measure the start winding (red to yellow).
- Compare these readings with the motor specification table.
- If the readings vary widely (some high, some low), the leads may be switched. Confirm that the cable colors are correct.

Single Phase Motors: 2-wire

- Measure the resistance between the two lines.
- Compare the reading with the motor specification table.
- If the reading shows a high resistance, there may be an open in the cable or motor. Check for secure cable connections.
- If the reading shows very low resistance, there may be a short in the cable or motor.

SECTION 13: Troubleshooting

13.4 Smart Pump Protector Troubleshooting

RUN Light	CAL. Light	Problem Or Function	Corrective Action
On Steady	Off	RUN: Pump is running, no problems in operation.	None
On Steady	On Steady	CAL: The motor protector is in the calibration process	None
Off	On Steady	CAL COMPLETE: The motor protector is calibrated, RESTART DELAY / CALIBRATION pot was left in "CAL." position. Pump is off.	Pump will restart as soon as the RESTART DELAY / CALIBRATION pot is rotated out of the "CAL." position.
Off	Off	OFF / MANUAL RESTART: The motor is not running. Either the Motor protector has tripped on dry run, dead head, or overload while the RESTART DELAY / CALIBRATION pot was in the "RESET" position, or source power is not present.	If pot is in the "RESET" position, rotate out of that position. If the "CAL" light blinks, check for an overload condition. If the RUN" light blinks, look for a dry run or dead head condition. If no lights come on, check incoming power for adequate voltage.
Blinking	Off	DRY RUN / DEAD HEAD: The motor protector has shut the pump off due to a dry run or dead head condition. The unit is timing through the restart delay and will try to restart.	Check for restricted flow or inadequate supply of liquid.
Off	Blinking	OVERLOAD: The motor protector has shut the pump off due to an overload condition. The unit is timing through the restart delay and will try to restart if line voltage is at an acceptable level.	Check for low or high voltage or jammed pump impeller. If these conditions do not exist, recalibrate the unit while it is drawing higher amps (Amps should not exceed SFA).
Blinking alternately with the CAL. Light	Blinking alternately with the RUN Light	VOLTAGE FAULT: The motor protector is preventing the pump from starting due to voltage problems. The voltage is being monitored and the unit will remain in this mode until the voltage is at an acceptable level.	If the unit remains in this state for more than 5 seconds, check for high or low voltage.
Blinking in unison with the CAL. Light	Blinking in unison with the RUN Light	RAPID CYCLE: The motor protector has shut down on rapid cycling. Power must be removed and reapplied to reset the unit.	Check for broken bladder on the pressure tank (if used), or check for defective pressure or float switch.

13.5 Submersible Controls Troubleshooting

Individual Component Diagnostics

Potential Relays

Using ohm meter - Coil Resistance (2 to 5) should measure according to the specification printed on the wiring diagram.

Using ohm meter - Contact resistance (1 to 2) should measure close to zero; higher values indicate deterioration of the contacts.

When the SMC first starts a faint click should be heard very shortly after the pump activates

Start Capacitor

Using a capacitor meter – measured capacitance should be within +20% of the rating printed on the capacitor (or consult parts list for ratings).

Using ohm meter – the meter should quickly show low resistance (ohms) and move slowly to show higher resistance. Resistance should not be zero or open.

Physical Inspection – A foul smell or a buildup of black soot indicates that a start capacitor has vented usually because of heat or prolonged use.

Run Capacitor

Using a capacitor meter – measured capacitance should be within +/- 6% of the rating printed on the capacitor (or consult parts list for ratings).

Using ohm meter – the meter should quickly show low resistance (ohms) and move slowly to show higher resistance. Resistance should not be zero or open.

Physical Inspection – Run capacitors have a built in fail safe device that disconnects the capacitor in case of overheat, in the case of such an event the capacitor will bulge.

Overloads

Push overload to ensure that it is reset.

Using ohm meter – connection resistance should measure close to zero.

Magnetic Contactor

Using ohm meter – Coil Resistance should measure per specification on wiring diagram.

Using ohm meter – Resistance between T1 & L1 and T2 & L2 should measure close to zero with contacts manually closed. Greater values indicates degradation of contacts.

Physical Inspection – Contacts should be free to move up and down.

Measurements while running

Small Box – Measurements cannot be taken while running, line voltage can be monitored with the cover off, by placing a voltmeter across L1 & L2. Winding resistance can be taken while motor is connected and should correspond to manufacturers specification.

⚠ WARNING **Fatal electrical shock hazard.** Only qualified persons should perform the following procedure.

Medium and Large Box - To take measurements while running, remove the cover. Turn on the pump and allow to cycle as usual. L1 to L2 should measure 230V +/- 10%, it should not dip during operation. A clamp-on ammeter can be used to measure amp draw along any number of circuits.

The larger yellow wire or main leads can be used to measure amp draw of the system, draw should spike and then come in less than 1 second. Orange lead amp draw should start out high and then drop out to become zero. If the reading stays high there is a relay problem.

The voltage between Red and Yellow should measure approximately 330V - higher values indicate no load; lower values indicate the motor (CSCR or PSC only) is not up to speed. Note that winding resistance cannot be measured while the motor is attached to the control box.

SECTION 13: Troubleshooting

Submersible Controls Troubleshooting

Problem	Possible Cause	Corrective Action
Pump fails to turn ON – no amp draw.	Damaged magnetic contactor, specifically the coil.	Plus Series only - replace coil.
	Damaged pressure switch.	All models - replace pressure switch.
	Loose connection.	Check to ensure that all connections are made and all screws tightened to 20 in-lbs.
	Damaged motor.	Check winding resistance.
Motor draws amps significantly higher than service factor.	Damaged relay (welded contacts, bad coil).	Replace relay.
	Wrong Control (e.g. 2 HP used on a 1 HP pump).	Install correct control.
	Bad run capacitor (blown).	Replace run capacitor.
	Miswired motor (e.g. Red and Black swapped).	Verify motor wiring.
	Voltage outside of operational norms.	Verify incoming voltage.
	Drop cable too small.	Replace drop cable with proper size wire for installation.
Overload trips within 10 seconds of Startup.	Locked (stalled) rotor condition.	Check installation.
	Miswired control.	Check to ensure connections match wiring diagram.
	Mis-matched motor & liquid end.	Verify installation.
	Wrong control used on motor.	Replace with correct control.
	Damaged relay.	Check per above.
	Damaged Start Capacitor.	Check per above.
Overload Trips After 10 seconds of Startup.	Rapid cycle.	Check installation.
	High ambient.	Do not mount in direct sunlight, provide proper ventilation.
	Damaged Run Capacitor.	Check per above.
	Chattering Relay/Bad Coil makes a clicking noise during operation.	Check per above.
	Wiring too small for current/drop length.	Check installation.
	Wrong control used on motor.	Replace with correct control.
Pump performance is low.	Installation/liquid end problem.	Check per installation manual.
	Damaged motor.	Verify and replace.
	Voltage outside of operational norms.	Check with voltmeter.
	Drop cable too small for run length.	Check installation.
	Damaged or Incorrect Run Capacitor.	Check per above.
	Wrong control used.	Replace with correct control.
Start capacitor vents contents.	Line voltage outside of operational norms.	Verify incoming voltage.
	Damaged relay.	Check and replace the relay or wires if they failed.
	Wire too small for drop length.	Use a low-voltage relay.

SECTION 14: Appendix

14.1 Installation Checklist

This checklist can be used to preview and verify steps in the installation of Pentek® equipment. Refer to appropriate section of the manual for more information.

Electrical Power

- ❏ Verify that the electrical service transformers KVA rating is adequate per the Table 4-2.
- ❏ Verify that motor voltage and frequency on the nameplate match the power supply voltage.
- ❏ Verify that fuse sizes are appropriate for the installation
- ❏ Verify that the pump, casing and power supply are all grounded.
- ❏ Inspect lightning arrestors for proper sized wire and grounding. Do not rely solely on a grounding rod in the earth.
- ❏ Verify that the cable size from the power supply box to the pump is the correct size. See tables in section 5-4.

Motor

- ❏ Lead Condition.
- ❏ Check insulation resistance.
- ❏ Verify nameplate information for the service needed.
- ❏ Verify that the motor is correctly sized to pump.
- ❏ Verify that fuses, heaters and other electrical components are appropriate for the amp load.
- ❏ Fluid level.

Pump and Motor Assembly

- ❏ Verify pump shaft rotation.
- ❏ Verify that the pump rating matches the site requirements.
- ❏ Visually inspect pump and motor for electrical lead condition and splice condition.

Installation

- ❏ Verify that the pipe joints are tight.
- ❏ Verify that check valves have been installed.
- ❏ Verify that the cable is supported with straps or tape at least every 10 feet (3.05 m).
- ❏ Pump cooling.
- ❏ Start the pump and observe any noise, vibration, leaks or overheating.
- ❏ Verify that the pump performance is as specified, that the electrical current is balanced and within specifications.

Check Valves

Check valve installation is necessary for proper pump operation. The pump should have a check valve on its discharge, or within 25 feet (7.62 m) of the pump. For very deep wells, locate a check valve at least every 200 feet (61 m).

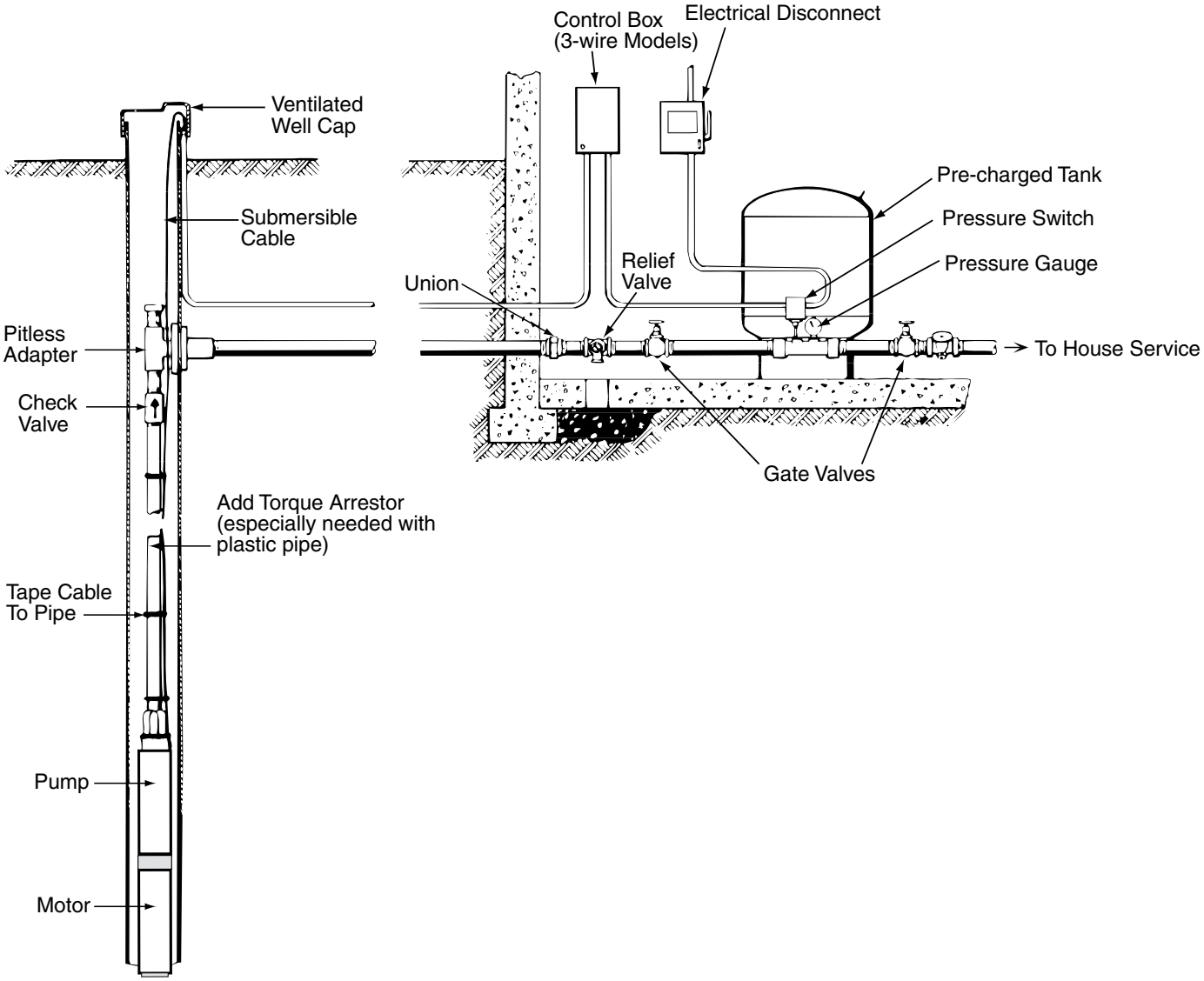
- DO NOT install the check valve midway between the pump and the ground surface. Vibration in the piping will resonate and may damage or destroy the piping or pump. Adjust check valve spacing to avoid a mid-point placement.
- Use only spring type check valves. Swing type valves can cause water hammer problems.
- Do not use drain-back style check valves (drilled).

Check valves serve the following purposes:

- Maintain Pressure: Without a check valve, the pump has to start each cycle at zero head, and fill the down pipe. This creates upthrust in the motor, and would eventually damage both the pump and motor.
- Prevent Water Hammer: If two check valves are used, and the lower one leaks, then a partial vacuum forms in the pipe. When the pump next starts, the flow fills the void area quickly and creates a shock wave that can break piping and damage the pump.
- Prevent Back-Spin: Without a functioning check valve, upon shutoff, the water drains back through the pump, and cause it to rotate backwards. This can create excessive wear on the thrust bearing, and if the pump restarts as water is flowing down the pipe, it will put an excessive load on the pump.

14.2 Choosing A Pump System

A typical well application can be set up using one of three electrical configurations for single-phase power. The samples below are based upon a system using a 1.5 HP, 20-22 gpm pump, with 400 feet of wire from electrical disconnect to the motor. All configurations shown are suitable methods for residential applications.



"Good" System

Features
- Pressure Switch
- Wire, (10-2 w/ground)
- 1.5 HP, 20-22 gpm pump
- 1.5 HP, 2-wire motor
- 85 gal. Tank
- Optional Motor Protection (SPP-233P)

Benefits
- Cost
- Simple to use
- PENTEK PSC motor offers lower operating cost

"Better" System

Features
- Control Box
- Pressure Switch
- Wire, (10-3 w/ground)
- 1.5 HP, 20-22 gpm pump
- 1.5 HP, 3-wire motor
- 85 gal. Tank
- Optional Motor Protection (SPP-233P)

Benefits
- Capacitors and switches can be replaced without removing pump
- CSCR control offers higher efficiency
- Higher starting torque than 2-wire

"Best" System

Features
- VFD
- Pressure Transducer
- Wire, (12-3 w/ground)
- 1.5 HP, 20-22 gpm pump
- 1.5 HP, 3-Phase motor
- 6 gal. Tank

Benefits
- "City-like" pressure
- Lower operating costs
- Soft start/stop
- Motor protection built into VFD

14.3 Sizing Submersible Pump, Motor, and Tanks

Sizing a Submersible Pump

The following steps should be taken relative to properly sizing the system.

1. Determine gpm of system and well.
2. Size of well casing and type.
3. Determine service pressure requirements.
4. Determine voltage and phase.
5. Determine discharge pipe size.
6. Calculate friction head loss.
7. Determine (total discharge) head.
8. Select the submersible pump for the above criteria, and appropriate controls for the pump.
9. Select the proper size tank for minimum one minute pump run time.
10. For starting frequency, refer to Section 5.10.
11. Determine the distance from the service entrance panel to the pump motor.
12. Determine the size wire required based on the motors maximum load amps and the distance from the service entrance to the motor.

14.4 How to Select the Correct Pumping Equipment

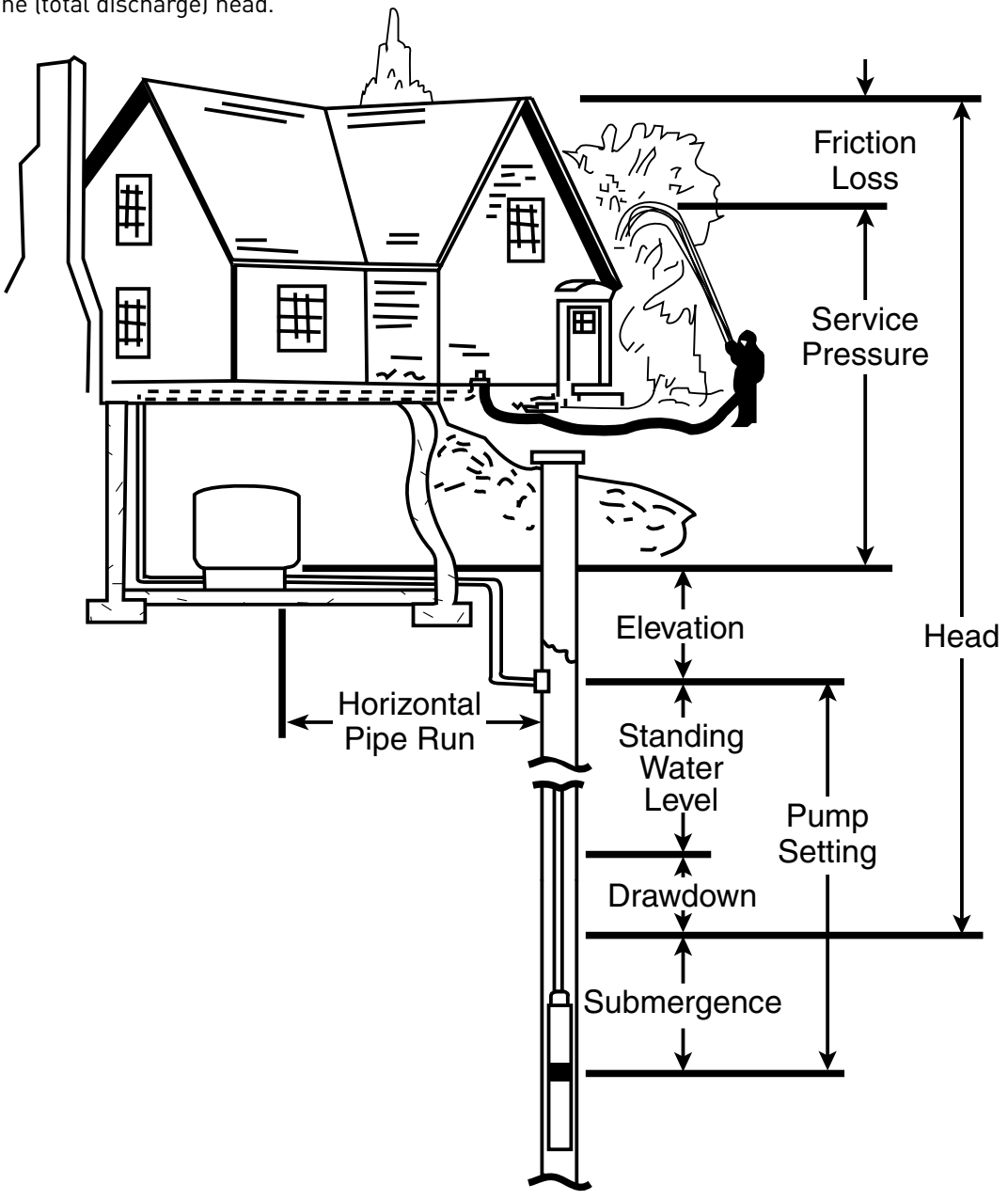


Figure 12-1: Common Pump Terminology

SECTION 14: Appendix

The answer to four basic questions will help select the proper pump.

1. **What is the size of the well?** The inside diameter of the well must be known so that the proper size pump and drop pipe can be determined.
2. **What is the submergence?** The vertical distance in feet from the pump to the water level while the pump is operating (see Figure 12-1). If the pump is installed away from the well and is on higher ground, this elevation must also be included. This must not be confused with the standing water level.
3. **What should the average discharge pressure be?** Usual average discharge pressure is 50 lbs. – half way between the 40 lbs. to 60 lbs. switch setting of most water systems. More pressure is needed when the tank is installed away from the pump and at a higher level, or when house or yard fixtures are above the pump and tank, and a larger pump must be used.
4. **What capacity is required?** The discharge capacity of the pump in gallons per minute that is needed for satisfactory service. The pump should have enough capacity so that it can deliver the total water requirement in 2 hours of continuous operation. See Table 12-1 for average water requirements.

Installation Terminology

Standing or Static Water Level – distance from top of well to natural water level when pump is not operating.

Drawdown Distance – distance water level drops while pump is operating.

Drawdown or Pumping Water Level – standing water level plus drawdown.

Submergence – distance submersible pump intake screen is installed below drawdown level.

Elevation – vertical distance between top of well and service inlet.

Pump Setting – distance from top of well to pump inlet screen.

Service Pressure – pressure required (in PSI) at service inlet.

Friction Loss – loss of pressure due to friction of water flowing through pipe and fittings.

Head – discharge head (in feet) delivered when pump is operating at desired capacity.

Horizontal Pipe Run – horizontal distance between service inlet and well.

"**Top of Well**" also means **"Pitless Adapter Level"** or well exit.

"Service Inlet" also means **"Storage Tank Inlet"**.

Selecting a Pump

TIP: PSI can be converted to equivalent feet of head by multiplying by 2.31.

i.e. 60 psi = 138.6 feet of head

To choose a motor for your submersible pump you first must know:

- Flow required in Gallons per Minute
- Total head (Pumping level, friction losses and service pressure required)

Friction loss must be calculated, and depends upon total length, diameter and type of pipe plus additions for each fitting (valves, elbows...) in the line.

Refer to the product catalog for friction loss charts.

Table 12-1: Average Water Requirements

Average Water Requirements For General Service Around The Home And Farm

Each person per day, for all purposes . . . . . 50 gal.
Each horse, dry cow or beef animal . . . . . 12 gal.
Each milking cow . . . . . 35 gal.
Each hog per day . . . . . 4 gal.
Each sheep per day . . . . . 2 gal.
Each 100 chickens per day . . . . . 4 gal.

Average Amount Of Water Required By Various Home And Yard Fixtures

Drinking fountain, continuously flowing . . . . . 50 to 100 gal. per day
Each shower bath . . . . . Up to 60 gal.
To fill bathtub . . . . . 30 gal.
To flush toilet . . . . . 2.5-6 gal.
To fill lavatory . . . . . 2 gal.
To sprinkle 1/4" of water on each 1000 square feet of lawn . . . . . 160 gal.
Dishwashing machine, per load . . . . . 3 gal.
Automatic washer, per load . . . . . Up to 50 gal.
Regeneration of domestic water softener 50-100 gal.

Average Flow Rate Requirements By Various Fixtures

(gpm equals gal. per minute, gph equals gal. per hour)

Fixture	New (at 60 PSI)	Older Style
Shower	2.5 gpm	4 to 6 gpm
Bathtub	3 gpm	4 to 8 gpm
Toilet	1.6 gpm	4 to 5 gpm
Lavatory	2.5 gpm	1 to 3 gpm
Kitchen sink	2.2 gpm	2 to 3 gpm
1/2" hose and nozzle		200 gph
3/4" hose and nozzle		300 gph
Lawn sprinkler		120 gph

EXAMPLE

Assume we want 16 GPM at 60 PSI from a pump drawdown level (pumping level) 100 feet below the service inlet.

We have a 35 foot horizontal run of 1 1/4" plastic pipe with two gate valves and four 90° elbows.

To find the Friction losses we must refer to friction loss charts for pipe and fittings.

We find:

- 135 feet of pipe for the total pipe run (100 + 35).
- 10 equivalent feet of pipe for the gate valves (2 x5)
- 28 equivalent feet of pipe for the elbows (7x 4)

Add these for the total equivalent length of pipe = 173

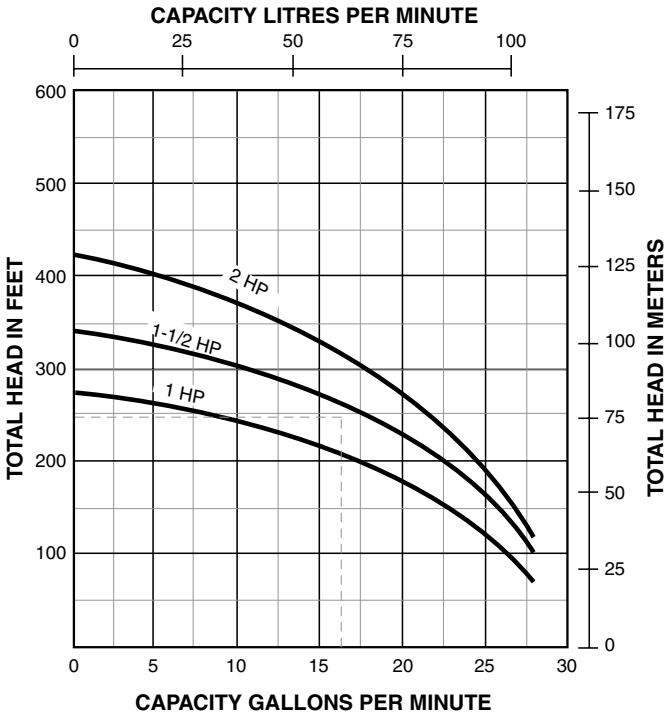
- In the friction loss charts, find the loss of head for 173 feet of 1 1/4" pipe at 16 gpm. (3.96 per 100') = 3.96 x 1.73 = 6.8 (round to 7.0)

Add:	7	Friction loss
	100	Pumping level
	139	60 PSI service pressure required (60 x 2.31=138.6. Round to 139)
=	246	Total Dynamic Head.

From this sample curve we would choose the 1 1/2 HP pump.

Locate a pump with a best efficiency point near the desired flow rate (16 GPM) that meets the total head requirements (246 TDH).

Selecting a pump in this manner gives you the most efficient pump for your application.



Sample Pump Curve

14.5 Sizing Tanks

Tank should be sized to accomodate starting frequency in Section 5.10.

Refer to the dealer catalog for tank selection. Otherwise, the following procedure can be used.

Drawdown based on Boyle's Law

Procedure:

1. Identify drawdown multiplier relating to specific application.
2. Insert multiplier (X) into the following formula:

$$\frac{\text{Pump GPM x Min Run Time}}{\text{Multiplier (X)}} = \text{Minimum Tank Capacity Required}$$

Example: An example of a 20 GPM pump with a minimum run time of 1 minute, installed on a 50 - 70 PSIG system pressure range:

$$\frac{\text{20 GPM x 1 minute}}{\text{.24 (factor)}} = \text{83.3 minimum U.S. gallon tank capacity}$$

NOTICE: Drawdown will be affected by operating temperature of the system, accuracy of the pressure switch and gauge, the actual pre-charge pressure and the rate of fill.

Table 12-2: Drawdown Volume Multiplier (Approximate)

Pump Off Pressure PSI	Pump Start Pressure – PSI							
	10	20	30	40	50	60	70	80
20	0.26							
30	0.41	0.22						
40		0.37	0.18					
50		0.46	0.31	0.15				
60			0.40	0.27	0.13			
70			0.47	0.35	0.24	0.12		
80				0.42	0.32	0.21	0.11	
90				0.48	0.38	0.29	0.19	0.10
100					0.44	0.35	0.26	0.17

Tank sizing for Variable Frequency Drives

Variable Frequency Drives (VFD) may require slightly different methods for figuring tank size. Refer to Section 8 for VFD information.

SECTION 14: Appendix

14.6 Record of Installation

Outside Power:

Transformer 1 _____ KVA

Transformer 2 _____ KVA

Transformer 3 _____ KVA

Cables

From Service Entrance to Pump Control:

Size _____ AWG/MCM

Length _____ ft.

Temp. Rating _____ °F / °C (circle one)

Check appropriate boxes

❏ Copper ❏ Aluminum

❏ Jacketed ❏ Individual Conductors

From Pump Control to Motor:

Size _____ AWG/MCM

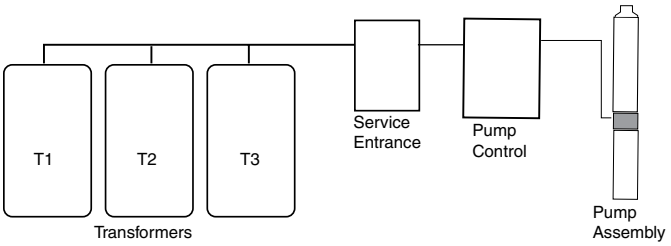
Length _____ ft.

Temp. Rating _____ °F / °C (circle one)

Check appropriate boxes

❏ Copper ❏ Aluminum

❏ Jacketed ❏ Individual Conductors



Pump Motor Control Panel

Manufacturer / Model _____

Circuit Protection:

❏ Circuit Breaker: _____ Amps

❏ Fuse _____ Amps

❏ Std. _____ ❏ Delay _____

Starter

Manufacturer _____ Size _____

Type

❏ Autotransformer

❏ Full Voltage

❏ Other _____

Time to full voltage _____ sec.

Heaters

Manufacturer _____

Qty: _____ Amp setting _____

Installation Data

Controls grounded to:

❏ Motor ❏ Well Head

❏ Power Supply ❏ Buried Rod

Grounding wire size _____ AWG / MCM

Date _____

Location _____

Motor serial number:

Motor Current - Balance Worksheet

	Arrangement 1 Amps	Arrangement 2 Amps	Arrangement 3 Amps
	L1–T1 =	L1–T3 =	L1–T2 =
	L2–T2 =	L2–T1 =	L2–T3 =
	L3–T3 =	L3–T2 =	L3–T1 =
Total Amps			
Average Amps			
From Average Amps			
Deviation L1	————	————	————
Deviation L2	————	————	————
Deviation L3	————	————	————
% Current Unbalance Largest Deviation			
% Unbalance +	%	%	%

SECTION 14: Appendix

Record of Installation

Installer _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

E-mail _____

Who to contact? _____

Owner _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

E-mail _____

Who to contact? _____

Installation

Well Identification _____

Water Temperature _____

Date Installed _____

Signature _____

Pump Information

Model _____

GPM _____ @ft. TDH

PSI _____

Date code _____

Motor Nameplate Information

Manufacture _____

Model _____

HP _____

Voltage _____

Phase _____

Max Amps _____

Date code _____

Serial Number _____

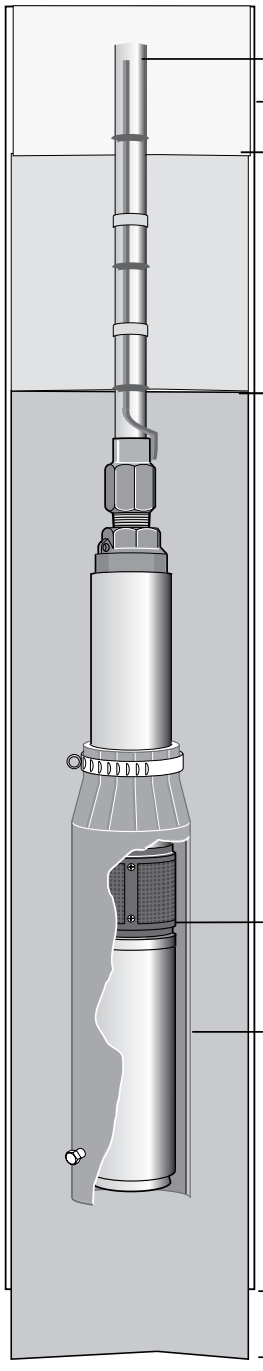
VFD (Variable Frequency Drive) Information

Drive Manufacturer _____

Model Number _____

❏ Input Filters _____

❏ Output Filters _____



Down Pipe Dia. _____

Casing Dia. _____

Static Water Level. _____

Total Dynamic Head _____

Drawdown Water Level. _____

Check Valve Locations

_____

_____

Perforated Casing

From _____

To _____

Well Screen

From _____

To _____

Pump Inlet depth _____

Flow Sleeve Dia. _____

Casing Depth _____

Well Depth _____

NOTES

NOTES



293 WRIGHT STREET, DELAVAN, WI 53115 WWW.PUMPS.COM
PH: 262-728-5551 ORDERS FAX: 262-728-7323

Because we are continuously improving our products and services, Pentair reserves the right to change specifications without prior notice.

© 2013 Pentair Ltd. All Rights Reserved.

PN793 (08/20/13)