Table of Contents

1. GENERAL SAFETY GUIDELINES

2. NOMENCLATURE
- 2.1 Motors
- 2.2 Variable/High Speed Drives
- 2.3 Submersible Motor Controls

3. INSTALLATION & SETUP
- 3.1 General Installation Guidelines
- 3.2 Proper Grounding
- 3.3 Corrosive Water and Ground
- 3.4 Check Valves
- 3.5 Start Up

4. ELECTRICAL POWER
- 4.1 Mixing Wire Size
- 4.2 Wire Splicing
- 4.3 Three-Phase Starters
- 4.4 Checking Motor Rotation
- 4.5 Three-Phase Current Balancing
- 4.6 Transformer Sizing
- 4.7 Using a Generator
- 4.8 Special Applications
- 4.9 Phase Converters
- 5.0 Motor Starters
- 6.0 Filters and Reactors for VFD

5. 4" PENTEK XE-SERIES MOTORS (60 HZ)
- 5.1 Motor Inspection
- 5.2 Testing
- 5.3 Storage and Transportation
- 5.4 Motor Specifications
- 5.5 Electrical
- 5.6 Dimensions
- 5.7 Fuse Sizing
- 5.8 Cable Lengths
- 5.9 Overload Protection
- 5.10 Motor Cooling
- 5.11 Starting Frequency

8. 4" T-SERIES SUBMERSIBLE MOTORS (60 HZ)
- 6.1 Motor Inspection
- 6.2 Testing
- 6.3 Storage and Transportation
- 6.4 Motor Specifications
- 6.5 Electrical
- 6.6 Dimensions
- 6.7 Fuse Sizing
- 6.8 Cable Lengths
- 6.9 Overload Protection
- 6.10 Motor Cooling
- 6.11 Starting Frequency

7. 6" PENTEK SUBMERSIBLE MOTORS (60 HZ)
- 7.1 Motor Inspection
- 7.2 Check Fluid Level
- 7.3 Testing
- 7.4 Storage
- 7.5 Drain and Fill Instructions
- 7.6 Motor Specifications
- 7.7 Dimensions
- 7.8 Fuse Sizing
- 7.9 Overload Protection
- 7.10 Motor Cooling
- 7.11 Starting Frequency

8. VARIABLE FREQUENCY DRIVES (50/60 HZ)
- 8.1 How Drives Work
- 8.2 PPC20
- 8.3 PENTEK PPC3 & PPC5 Drives
  - 8.3.1 PPC3 Specs
  - 8.3.2 PPC5 Specs
  - 8.3.3 Wiring Conections
  - 8.3.4 Transducer Connections
  - 8.3.5 PENTEK Assistant
  - 8.3.6 Timer Function
  - 8.3.7 Helpful Hints
  - 8.3.8 PPC3 & PPC5 Tank Sizing
- 8.4 Filters and Reactors

Table of Contents 2

9. SUBMERSIBLE MOTOR CONTROLS (50/60 HZ)

9.1 How It Works
9.2 Specifications
9.3 Mounting and Installation
9.4 Wiring Connections
9.5 3-Phase Motor Controls

10. MOTOR PROTECTION DEVICES (50/60 HZ)

10.1 How It Works
10.2 Specifications
10.3 Mounting and Installation
10.4 Wiring Connections
10.5 LED (Fault) Codes

11. TROUBLESHOOTING

11.1 System Troubleshooting
11.2 Motor Troubleshooting
11.2.1 Testing Insulation and Winding Resistance
11.3 Variable Speed Drive Troubleshooting
11.4 Motor Protection Troubleshooting
11.5 Submersible Controls Troubleshooting

APPENDIX

12.1 Sizing/Application
12.12 Submersible Pump/Motor/Tank and Variable Speed Drive
12.23 How to Select the Correct Pumping Equipment
12.24 Sizing Pressure Tanks

12.2 Installation Checklist and Record

SECTION 1: General Safety Guidelines

READ AND FOLLOW SAFETY INSTRUCTIONS!

⚠ **This is the safety alert symbol.** When you see this symbol on your pump or in this manual, be alert to the potential for personal injury.

⚠ DANGER warns about hazards that **will** cause serious personal injury, death or major property damage if ignored.

⚠WARNING warns about hazards that **can** cause serious personal injury, death or major property damage if ignored.

⚠ CAUTION warns about hazards that **will** or **can** cause minor personal injury or property damage if ignored.

The word **NOTICE** indicates special instructions which are important but not related to hazards.

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

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.

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

TABLE 2-1: Motor Nomenclature

Sample:

P6A0050A4 is a PENTEK 6" Stainless Steel Sleeved Motor with Cast Iron End Bells, 5 HP, 60 Hz., 460V, 3 PH

NAME PLATE EXAMPLE: **P 6 A _ 0 0 5 0 A 4**

BRAND
P = PENTEK

MOTOR SIZE
42 = 4 Inch, 2-Wire
43 = 4 Inch, 3-Wire
6 = 6 Inch
8 = 8 Inch

MOTOR MATERIAL
A = Stainless Steel Sleeve with Cast Iron End Bells
B = All Stainless Steel
T = 4 Inch Stainless Steel (”T” Series)

MOTOR PROTECTION (if equipped)
P = Electronic Protection

HORSEPOWER

0005 = 0.5 HP	0200 = 20 HP
0007 = 0.75 HP	0250 = 25 HP
0010 = 1 HP	0300 = 30 HP
0015 = 1.5 HP	0400 = 40 HP
0020 = 2 HP	0500 = 50 HP
0030 = 3 HP	0600 = 60 HP
0050 = 5 HP	0750 = 75 HP
0075 = 7.5 HP	1000 = 100 HP
0100 = 10 HP	1250 = 125 HP
0150 = 15 HP	1500 = 150 HP

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

VOLTAGE
1 = 115V, 1 PH
2 = 230V, 1 PH
3 = 230V, 3 PH
4 = 460V, 3 PH
5 = 575V, 3 PH
6 = 380/460V, 3 PH
7 = 380V, 3PH
8 = 200V, 3 PH
9 = 200V, 1 PH

2.2 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.)	**4**A1	**1** (NEMA 1)
PPC3	**4** (460 V), 3 ph.)	4A1 = 4.1 amps (Amps A tenths)	**4** (NEMA 4)
PPC20	**5** (575 V), 3 ph.)		**12** (NEMA 12)
	1A (115V, 1ph.)		
	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.

2.3 SUBMERSIBLE MOTOR CONTROLS, NOMENCLATURE

The chart below shows the naming for a Submersible Motor control, Standard box, capacitor run, 10 horse power, 230 volt single phase drive.

SMC - CR 100 2 1

Series	Style	HP x 10	Voltage	Phase
SMC_(Std.)	**CR** (Cap Run)	**05** (0.5 hp)	**1** (115 v)	1 (Single)
SMCT (T Series)	**IR** (Induction Run)	**07** (.75 hp)	**2** (230 v)	
SMCP (P Series)	**CRP** (Cap Run with contactor)	**10** (1 hp)		
		15 (1.5 hp)		
		20 (2 hp)		
		30 (3 hp)		
		50 (5 hp)		
		75 (7.5 hp)		
		100 (10 hp)		
		150 (15 hp)		

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 must be installed in a vertical position only.
- 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.

The grounding should extend to the water-bearing layer to be effective.

Ground to casing if it is metal, and extends within 20' of motor.

If a metal drop pipe is used, then ground to the drop pipe.

Do not ground only to the supply ground or driven grounding rod. These will not protect the pump.

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).

- 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.

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.

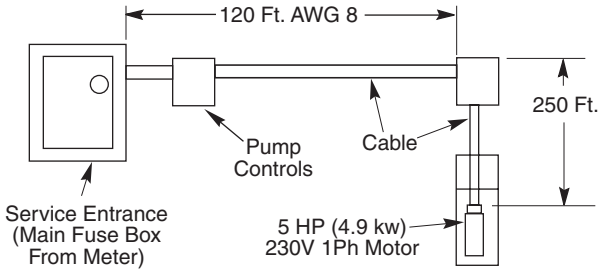


Figure 4-1: Mixing Wire Sizes: Example

For example: Installing a pump with a 6", 5 HP, 230 volt, single phase motor, with the motor setting at 250' (76.2 m) down the well and with 120' (36.5 m) of #8 cable buried between the service entrance and the well head. 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 7-7, a total of 269' (82 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 120' (36.5 m) of cable in the buried run is: 120'/269' = .446 = 45%.
2. With 45% of the allowable cable already used, 55% 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 250' (76.2 m) is less than 55% of the total length allowed for that size.
3. 250 ÷ 55% = 455 feet.
4. From Table 7-7 we find that the total allowable length for #4 cable is 667'.

   This is longer than needed. Therefore, #4 cable can be used for the 250' (76.2 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.

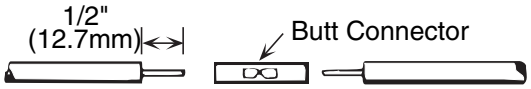


Figure 4-2: Insert Wires

   D. Insert motor lead ends and supply wire ends into butt connectors. Match wire colors between supply wires and motor leads.

Figure 4-3: Indent Connectors

   E. Using crimping pliers, indent butt connector lugs to attach wires.
   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: 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: Twist Wires

2. Heat shrink splice (For wire sizes #14, 12 and 10 AWG (2, 3 and 5mm²):
   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).

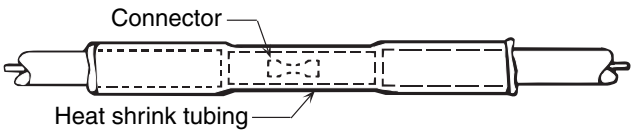


Figure 4-6: Heat-Shrink Tubing Applied

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

4.3 THREE-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.

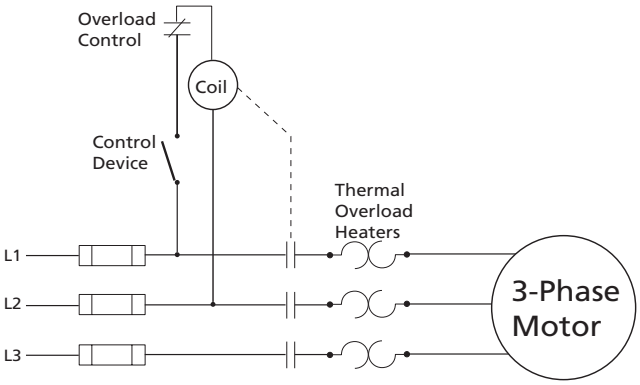


Figure 4-7: Line Voltage Control

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.

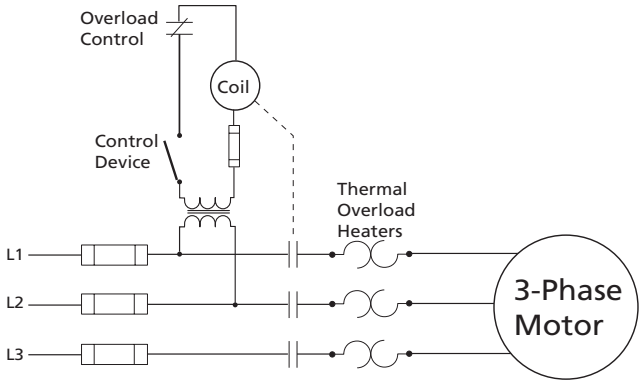


Figure 4-8: Low Voltage Control

Separate Voltage Control

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

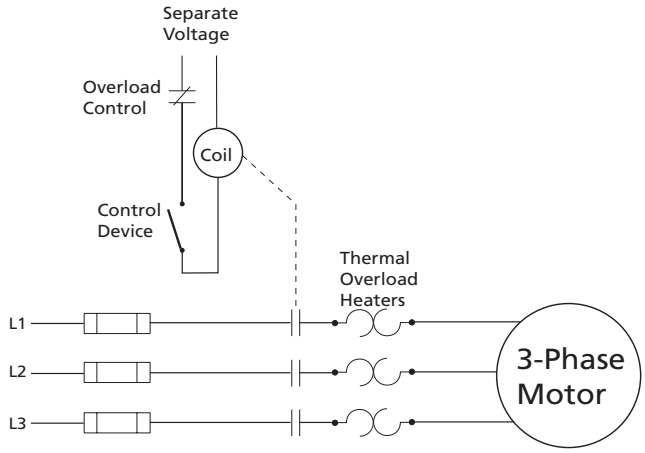


Figure 4-9: Separate Voltage Control

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.

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 or destroy the pump and will void the warranty.

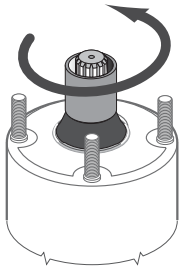


Figure 4-10: Motor Rotation

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.

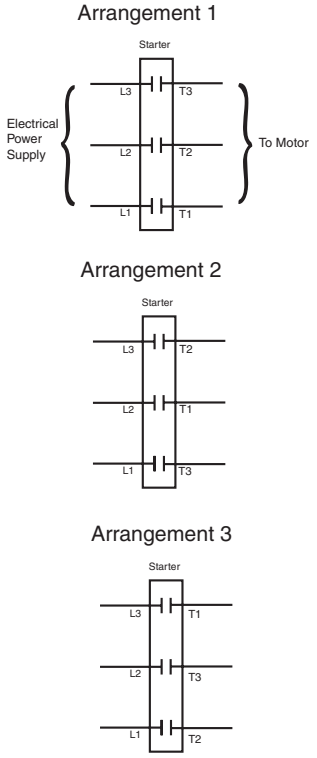


Figure 4-11: 3-Phase Current Unbalance: Example

Use this worksheet to calculate current unbalance for your 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	0.3	0.0	0.0
Deviation L2	1.4	0.4	0.7
Deviation L3	1.0	0.3	0.6
% Current Unbalance			
Largest Deviation	1.4 ÷ 16.7	0.3 ÷ 16.7	0.7 ÷ 16.7
% Unbalance +	8.4%	1.8%	4.2%

4.6 TRANSFORMER SIZING

The power supply to the installation must be capable of furnishing enough power to the pump and associated equipment.

Three-phase power may be furnished either through a Delta-Delta, Wye-Delta or open Delta configuration. The Delta-Delta uses three transformers to supply power to the facility. The Wye-Delta and open Delta configuration use only two transformers.

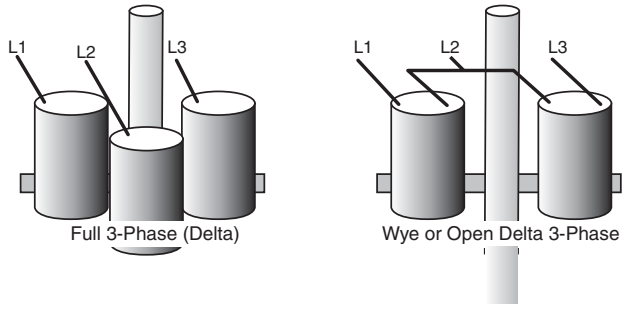


Figure 4-12: Three Phase Power

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 the chart below. 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	Required KVA	KVA Rating (smallest) For Each Transformer	
			Open WYE or D 2 Transformers	Closed 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 HP	Externally Regulated		Internally Regulated	
	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 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 **Electrocution Hazard.** Use transfer switches when the generator is used as a backup to the power grid. contact your power company for proper use of standby or backup generators.

4.8 SPECIAL APPLICATIONS

4.8.1 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.

4.8.2 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 - 60 Hz

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:

Disconnect power to the motor for this test.

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

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.

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	Rating					Full Load		Maximum (S.F. Load)	
		HP	kW	Volts	Hz.	Service Factor	Amps	Watts	Amps	Watts
4" 2-Wire	P42B0005A1	1/2	0.37	115	60	1.6	7.4	845	9.5	1088
	P42B0005A2	1/2	0.37	230	60	1.6	3.7	834	4.7	1073
	P42B0007A2	3/4	0.55	230	60	1.5	5.0	1130	6.4	1459
	P42B0010A2	1	0.75	230	60	1.4	Data not yet Available			
	P42B0015A2	1-1/2	1.1	230	60	1.3				
CSIR 3-Wire	P43B0005A1	1/2	0.37	115	60	1.6	Y - 11.0 B - 11.0 R - 3.0	637	Y - 12.6 B - 12.6 R - 0	916
	P43B0005A2	1/2	0.37	230	60	1.6	Y - 5.5 B - 5.5 R - 0	745	Y - 6.3 B - 6.3 R - 0	1033
	P43B0007A2	3/4	.55	230	60	1.5	Y - 7.2 B - 7.2 R - 0	1014	Y - 8.3 B - 8.3 R - 0	1381
	P43B0010A2	1	0.75	230	60	1.4	Y - 8.4 B - 8.4 R - 0	1267	Y - 9.7 B - 9.7 R - 0	1672
CSCR 3-Wire	P43B0005A2	1/2	0.37	230	60	1.6	Y - 4.1 B - 4.1 R - 2.2	727	Y - 4.9 B - 4.4 R - 2.1	959
	P43B0007A2	3/4	0.55	230	60	1.5	Y - 5.1 B - 5.0 R - 3.2	1012	Y - 6.3 B - 5.6 R - 3.1	1303
	P43B0010A2	1	0.75	230	60	1.4	Y - 6.1 B - 5.7 R - 3.3	1209	Y - 7.2 B - 6.3 R - 3.3	1532
	P43B0015A2	1-1/2	1.1	230	60	1.3	Y - 9.7 B - 9.5 R - 1.4	1693	Y - 11.1 B - 11.0 R - 1.3	2187

5.5 ELECTRICAL

PENTEK Part Number	Winding		Efficiency %		Power Factor %		Locked Rotor Amps	KVA Code
	M = Main Resistance*	S = Start Resistance	F.L.	S.F.	F.L.	S.F.		
P42B0005A1	M 1.4-1.7		49	61	100	100	36.4	K
P42B0005A2	M 4.6-5.6		50	62	97	98	19.5	K
P42B0007A2	M 3.5-4.3		54	65	97	99	24.8	J
P42B0010A2	Data not yet Available		Data not yet Available					
P42B0015A2								
P43B0005A1	M 1.1-1.4	S 5.7-7.0	58	65	54	69	49.6	N
P43B0005A2	M 4.0-4.9	S 16.3-19.9	50	57	58	71	22.3	M
P43B0007A2	M 2.7-3.3	S 11.1-13.6	55	61	61	72	32.0	L
P43B0010A2	M 2.5-3.1	S 10.6-13.0	59	62	66	75	41.2	L
P43B0015A2	M 1.9-2.4	S 7.4-9.1	66	67	80	86	47.8	J

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

5.6 4" MOTOR DIMENSIONS

TABLE 5-2: Single-Phase Motor Specifications (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Length (in)	Length (mm)	Weight (lbs)	Weight (kg)
4-Inch 2-Wire	P42B0005A1	1/2	0.37	11.0	279	19.2	8.7
	P42B0005A2	1/2	0.37	11.0	279	19.2	8.7
	P42B0007A2	3/4	0.56	12.4	314	22.7	10.3
	P42B0010A2	1	0.75	13.3	337	24.5	11.1
	P42B0015A2	1-1/2	1.10	14.9	378	28.9	13.1
4-Inch 3-Wire	P43B0005A1	1/2	0.37	10.0	253	18.9	8.6
	P43T0005A2	1/2	0.37	9.7	246	18.1	8.2
	P43T0007A2	3/4	0.56	10.8	275	21.4	9.7
	P43T0010A2	1	0.75	11.7	297	23.1	10.5
	P43T0015A2	1-1/2	1.10	13.6	345	27.4	12.4

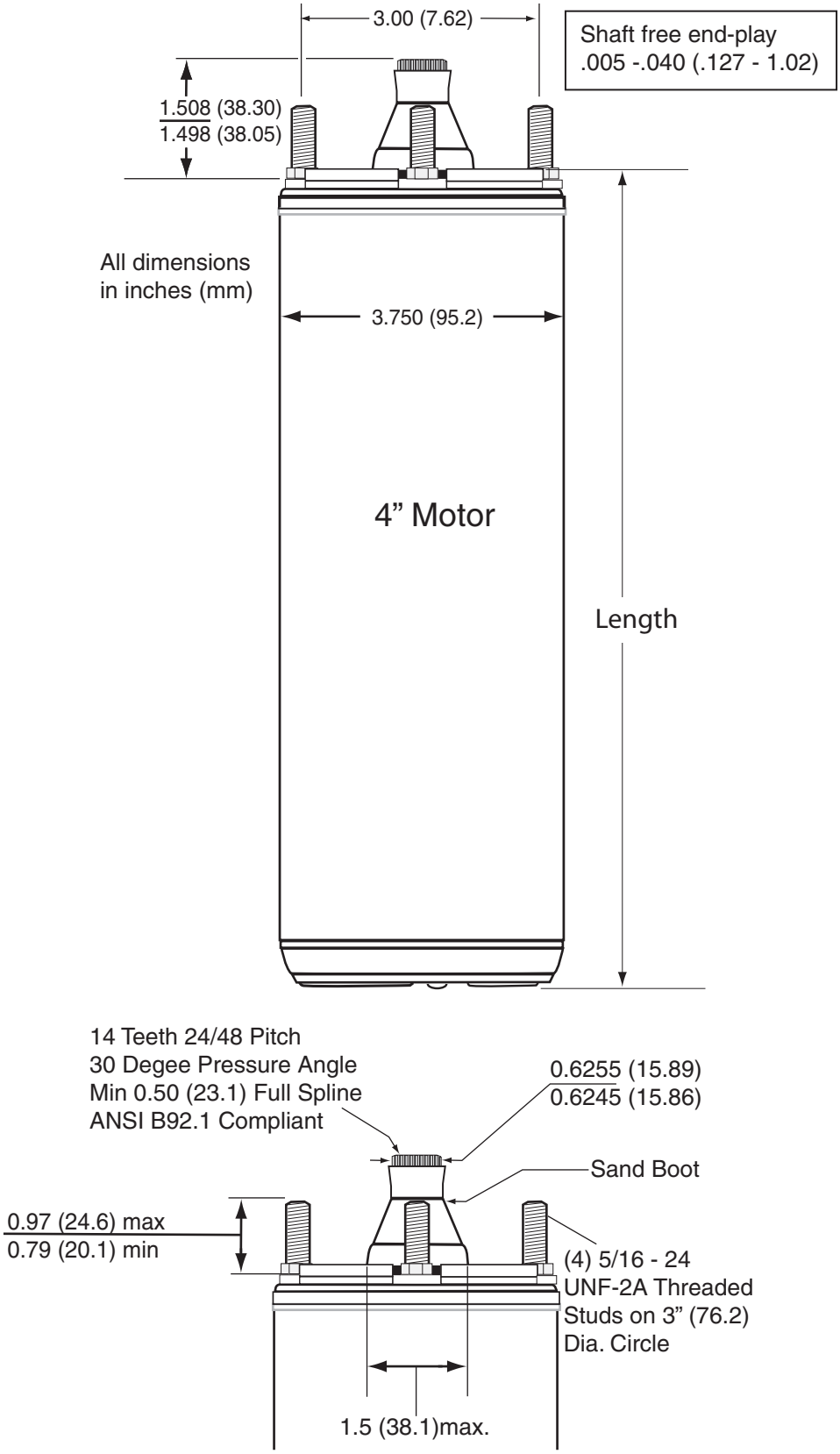


Figure 5-1: "XE" Series 4" Motor Dimensions

5.7 4" MOTOR FUSE SIZING

TABLE 5-3: Single-Phase Motor Fuse Sizing (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Volts and Circuit Breaker Amps (Maximum Rating per NEC)		
					Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
4" 2-Wire	P42B0005A1	0.5	0.37	115	30	20	25
	P42B0005A2	0.5	0.37	230	15	10	15
	P42B0007A2	0.75	0.55	230	20	15	20
	P42B0010A2	1	0.75	230	Data not yet Available		
	P42B0015A2	1.5	1.1	230			
4" 3-Wire	P43B0005A1	0.5	0.37	115	35	20	30
	P43B0005A2	0.5	0.37	230	20	10	15
	P43B0007A2	0.75	0.55	230	25	15	20
	P43B0010A2	1	0.75	230	30	20	25
	P43B0015A2	1.5	1.1	230	35	20	30

5.8 CABLE LENGTHS

TABLE 5-4: Cable Lengths, 2- and 3-wire Motors, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Feet (Single-Phase Motors)

3-Wire in Feet			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
	0.5	115	99	157	250	398	633	1006	1269	1599	2016	2543	3205
	0.5	230	361	575	914	1453	2310	3673	4633	5839	7360	9285	11701
	0.75	230	274	436	694	1103	1753	2788	3517	4432	5587	7048	8882
	1	230	235	373	593	944	1500	2385	3009	3793	4781	6030	7600
	1.5	230	207	329	523	832	1323	2104	2653	3344	4216	5318	6702

* Table data are generated per NEC standards.

2-Wire in Feet			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
	0.5	115	120	191	303	482	766	1218	1536	1936	2441	3079	3880
	0.5	230	485	770	1225	1947	3096	4923	6210	7827	9866	12446	15685
	0.75	230	356	566	899	1430	2274	3615	4561	5748	7245	9140	11518
	1	230	Data not yet Available										
	1.5	230											

TABLE 5-5: Cable Lengths, 2- and 3-wire Motors, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Meters (Single-Phase Motors)

3-Wire in Meters			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
	0.5	115	30	48	76	121	193	307	387	488	615	775	977
	0.5	230	110	175	278	443	704	1119	1412	1780	2243	2830	3567
	0.75	230	84	133	211	336	534	850	1072	1351	1703	2148	2707
	1	230	72	114	181	288	457	727	917	1156	1457	1838	2316
	1.5	230	63	100	160	254	403	641	809	1019	1285	1621	2043

2-Wire in Meters			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
	0.5	115	37	58	92	147	233	371	468	590	744	938	1183
	0.5	230	148	235	373	594	944	1501	1893	2386	3007	3793	4781
	0.75	230	108	172	274	436	693	1102	1390	1752	2208	2786	3511
	1	230	87	138	219	349	554	882	1112	1402	1767	2229	2809
	1.5	230	63	100	160	254	403	641	809	1019	1285	1621	2043

* Table data are generated per NEC (see 2005 NEC-Chapter 3, Tables 430.52, 430.248 and 430.250 for more information).
Cable lengths allow for a maximum 5% voltage drop at nameplate amperes.
Use of aluminum wire NOT recommended.

5.9 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). These are manual overloads and must be manually reset if an overload condition occurs.

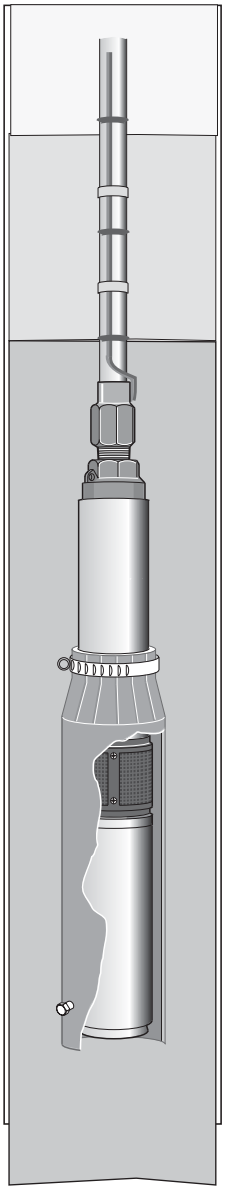


Figure 6-2: Flow Inducer Sleeve

5.10 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 OVER 3 HP

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. This will act like a smaller casing size, and force flow around the motor to aid cooling.

5.11 STARTING FREQUENCY

To extend the life of the pump motor and control, limit the number of starts to 300 per day.

If higher starting frequencies are necessary, consult your factory.

To prevent overheating, run motor for a minimum of one minute.

TABLE 5-6: Maximum starts in 24 hours

Motor Rating		Maximum Starts in 24 Hours	
HP	KW	Single Phase	Three Phase
1/5 to 3/4 HP	Up to .55	300	300
1 to 1-1/2	.75 thru 4	100	300

SECTION 6:

T-Series 4" Submersible Motors - 60 Hz

6.1 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. For star-delta starting, the delta-voltage of the motor must be equal to the supply voltage. Voltage must not vary more than +6%-10% from nameplate rated voltage. In case of doubt, consult dealer before installing motor.
- 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.

6.2 TESTING

Insulation Resistance

To check for insulation resistance:

Disconnect power to the motor for this test.

Connect an Ohm meter (resistance in Ω) between the power leads and the motor 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

6.3 STORAGE AND TRANSPORTATION

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.

6.4 T-SERIES 4" MOTOR SPECIFICATIONS

TABLE 6-1: Single Phase Motor Specifications (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	Rating					Full Load		Maximum (S.F. Load)	
		HP	kW	Volts	Hz.	Service Factor	Amps	Watts	Amps	Watts
4" 2-Wire	P42T0005A1	1/2	0.37	115	60	1.6	9.8	928	11	1126
	P42T0005A2	1/2	0.37	230	60	1.6	4.9	928	5.5	1126
	P42T0007A2	3/4	0.55	230	60	1.5	6.8	1200	7.4	1440
	P42T0010A2	1	0.75	230	60	1.4	7.9	1526	8.9	1820
4" 3-Wire	P43T0005A2*	1/2	0.37	230	60	1.6	Y - 4.9 B - 5.0 R - 3.0	928	Y - 5.5 B - 5.0 R - 2.9	1126
	P43T0007A2*	3/4	0.55	230	60	1.5	Y - 6.8 B - 7.2 R - 3.65	1200	Y - 7.4 B - 7.35 R - 3.6	1440
	P43T0010A2*	1	0.75	230	60	1.4	Y - 7.9 B - 7.9 R - 5.2	1526	Y - 8.9 B - 8.0 R - 5.1	1820
	P43T0015A2*	1-1/2	1.1	230	60	1.3	Y - 11.8 B - 12 R - 6.0	2120	Y - 12.7 B - 12.2 R - 5.9	2470
	P43T0020A2*	2	1.5	230	60	1.25	Y - 11.1 B - 9.6 R - 7.0	2448	Y - 12.8 B - 10.6 R - 6.9	2468
	P43T0030A2*	3	2.2	230	60	1.15	Y - 15.3 B - 12.4 R - 7.1	3360	Y - 17.1 B - 14.2 R - 6.9	3800
	P43T0050A2*	5	3.7	230	60	1.15	Y - 23.4 B - 19.7 R - 11.6	5150	Y - 25.9 B - 21.5 R - 11.4	5760

* Requires SMCT Single Phase PENTEK Control Box.

6.5 ELECTRICAL

PENTEK Part Number	Winding		Efficiency %		Power Factor %		Locked Rotor Amps	KVA Code
	M = Main Resistance	S = Start Resistance	F.L.	S.F.	F.L.	S.F.		
P42T0005A1	M 1.0		40	52	72	82	38	K
P42T0005A2	M 4.0		40	52	72	82	19	K
P42T0007A2	M 2.47		46	57	73	84	25	J
P42T0010A2	M 1.87		48	57	75	86	38	K
P43T0005A2	M3.7	S8.6	40	52	72	82	19	K
P43T0007A2	M2.5	S4.8	46	57	73	84	25	J
P43T0010A2	M1.9	S4.2	48	57	75	86	38	K
P43T0015A2	M1.45	S3.3	52	58	79	84	49	J
P43T0020A2	M1.3	S2.45	60	65	92	92	50	G
P43T0030A2	M1.1	S2.87	66	67	93	95	55	D
P43T0050A2	M 0.8	S 1.7	71	73	96	97	83	C

TABLE 6-2: T-Series Thee Phase Motor Specifications (230 and 460 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	Rating					Full Load		Maximum (S.F. Load)	
		HP	kW	Volts	Hz.	Service Factor	Amps	Watts	Amps	Watts
4" 3-Wire	P43T0030A4	3	2.2	460	60	1.15	5.6	3160	6.0	3570
	P43T0050A3	5	3.7	230	60	1.15	17.8	5230	22.0	5980
	P43T0050A4	5	3.7	460	60	1.15	8.9	5230	9.6	5980
	P43T0075A3	7-1/2	5.5	230	60	1.15	24.0	7100	26.0	8100
	P43T0075A4	7-1/2	5.5	460	60	1.15	12.0	7100	13.0	8100
	P43T0100A4	10	7.5	460	60	1.15	15.4	9300	16.6	10600

PENTEK Part Number	Line to Line Resistance (Ohms)	Efficiency		Power Factor		Locked Rotor Amps	KVA Code
		F.L.	S.F.	F.L.	S.F.		
P43T0030A4	5.72 - 4.68	71	72	70	74	40	L
P43T0050A3	0.90 - 0.73	77	78	74	78	132	L
P43T0050A4	3.70 - 3.02	77	78	74	78	66	L
P43T0075A3	0.62 - 0.50	78	80	75	80	180	L
P43T0075A4	2.60 - 2.10	78	80	74	80	90	L
P43T0100A4	2.20 - 1.80	80	81	76	82	110	K

TABLE 6-3: Motor Part Number Cross Reference

Motor Type	PENTEK Part Number	"T" Series Part Number
4" 2-Wire 1 Phase	P42T0005A1	TES-00020310
	P42T0005A2	TES-00020420
	P42T0007A2	TES-00020720
	P42T0010A2	TES-00020940
4" 3-Wire 1 Phase	P43T0005A2	TES-00460053
	P43T0007A2	TES-00460370
	P43T0010A2	TES-00461320
	P43T0015A2	TES-00461965
	P43T0020A2	TES-00463015
	P43T0030A2	TES-00464015
	P43T0050A2	TES-00475910

Motor Type	PENTEK Part Number	"T" Series Part Number
4" 3-Wire 3 Phase	P43T0030A4	TES-00464615
	P43T0050A3	TES-00476010
	P43T0050A4	TES-00476250
	P43T0075A3	TES-00477010
	P43T0075A4	TES-00477250
	P43T0100A4	TES-00478250

6.6 T-SERIES 4" MOTOR DIMENSIONS

TABLE 6-4: Single-Phase Motor Specifications (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Length (in)	Length (mm)	Diameter (in)	Diameter (mm)	Weight (lbs)	Weight (kg)
4-Inch 2-Wire	P42T0005A1	1/2	0.37	17.13	435	3.62	92	18.7	8.5
	P42T0005A2	1/2	0.37	17.13	435	3.62	92	18.7	8.5
	P42T0007A2	3/4	0.56	17.91	455	3.62	92	21.1	9.6
	P42T0010A2	1	0.75	19.69	500	3.62	92	24.2	11.0
4-Inch 3-Wire	P43T0005A2	1/2	0.37	10.47	266	3.62	92	17.6	8.0
	P43T0007A2	3/4	0.56	11.26	286	3.62	92	19.8	9.0
	P43T0010A2	1	0.75	13.03	331	3.62	92	24.2	11.0
	P43T0015A2	1-1/2	1.1	15.39	391	3.62	92	28.6	13.0
	P43T0020A2	2	1.5	16.18	411	3.62	92	30.8	14.0
	P43T0030A2	3	2.2	17.76	451	3.62	92	34.5	15.7
	P43T0050A2	5	3.7	26.93	684	3.62	92	58.3	26.5

TABLE 6-5: Three-Phase Motor Specifications (230 and 460 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Length (in)	Length (mm)	Diameter (in)	Diameter (mm)	Weight (lbs)	Weight (kg)
4-Inch 3-Wire	P43T0030A4	3	2.2	16.2	411	3.62	92	30.4	13.8
	P43T0050A3	5	3.7	24.2	614	3.62	92	50.6	23.0
	P43T0050A4	5	3.7	24.2	614	3.62	92	50.6	23.0
	P43T0075A3	7-1/2	5.5	26.9	684	3.62	92	58.5	26.6
	P43T0075A4	7-1/2	5.5	26.9	684	3.62	92	58.5	26.6
	P43T0100A4	10	7.5	30.1	764	3.62	92	67.3	30.6

6.7 T-SERIES 4" MOTOR DIMENSIONS

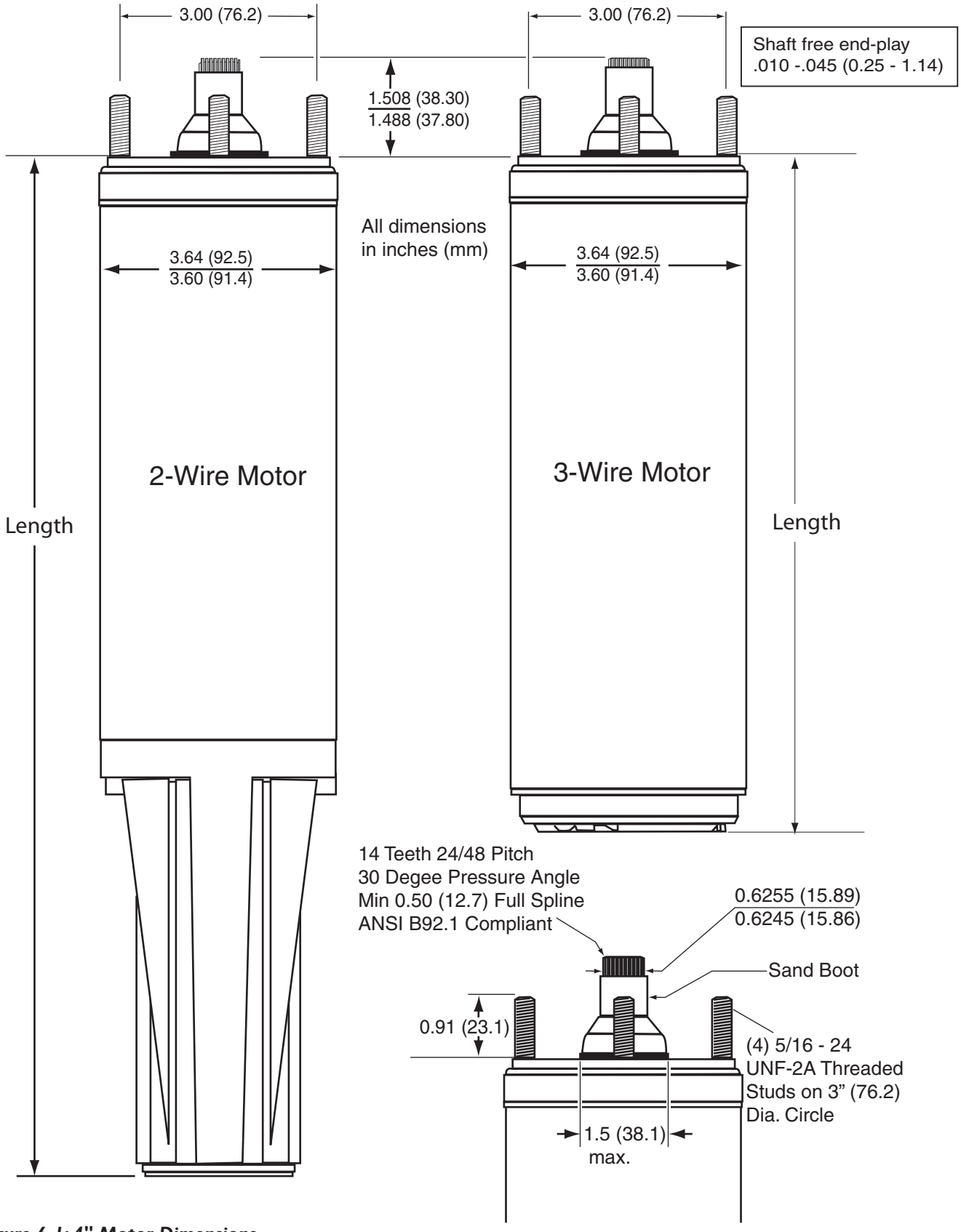


Figure 6-1: 4" Motor Dimensions

PN793 (Rev. 8/23/06)

6.8 4" MOTOR FUSE SIZING

TABLE 6-6: Single-Phase Motor Fuse Sizing (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Volts and Circuit Breaker Amps (Maximum Rating per NEC)		
					Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
4" 2-Wire	P42T0005A1	1/2	0.37	115	35	20	30
	P42T0005A2	1/2	0.37	230	20	10	15
	P42T0007A2	3/4	0.55	230	25	15	20
	P42T0010A2	1	0.75	230	30	20	25
4" 3-Wire	P43T0005A2	1/2	0.37	230	20	10	15
	P43T0007A2	3/4	0.55	230	25	15	20
	P43T0010A2	1	0.75	230	30	20	25
	P43T0015A2	1-1/2	1.1	230	35	20	30
	P43T0020A2	2	1.5	230	30	20	25
	P43T0030A2	3	2.2	230	45	30	40
	P43T0050A2	5	3.7	230	80	45	60

TABLE 6-7: Three-Phase Motor Fuse Sizing (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Volts and Circuit Breaker Amps (Maximum Rating per NEC)		
					Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
4" 3-Wire	P43T0030A4	3	2.2	460	15	10	15
	P43T0050A3	5	3.7	230	50	30	40
	P43T0050A4	5	3.7	460	25	15	20
	P43T0075A3	7-1/2	5.5	230	80	45	60
	P43T0075A4	7-1/2	5.5	460	40	25	30
	P43T0100A4	10	7.5	460	60	30	45

* Table data are generated per NEC (see 2005 NEC-Chapter 3, Tables 430.52, 430.248 and 430.250 for more information).

TABLE 6-8: Cable Lengths, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Feet (Single-Phase Motors)

			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
3-Wire	0.5	230	414	658	1047	1664	2646	4207	5307	6689	8438	10635	13420
	0.75	230	308	489	778	1237	1967	3127	3944	4971	6271	7905	9975
	1	230	256	407	647	1028	1635	2600	3280	4134	5214	6572	8294
	1.5	230	179	285	453	721	1146	1822	2298	2897	3654	4606	5812
	2	230	178	283	450	715	1137	1808	2280	2874	3626	4570	5767
	3	230	133	212	337	535	851	1353	1707	2151	2714	3421	4317
	5	230	0	0	222	353	562	893	1127	1420	1792	2258	2850

TABLE 6-9: Cable Lengths, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Feet (Single Motors)

			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
2-Wire	0.5	115	104	165	262	416	662	1052	1327	1672	2109	2659	3355
	0.5	230	414	658	1047	1664	2646	4207	5307	6689	8438	10635	13420
	0.75	230	308	489	778	1237	1967	3127	3944	4971	6271	7905	9975
	1	230	256	407	647	1028	1635	2600	3280	4134	5214	6572	8294

TABLE 6-10: Cable Lengths, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Feet (Three-Phase Motors)

			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
3-Wire	3	460	759	1207	1919	3051	4851	7713	9729	12263	15469	19498	24604
	5	230	119	189	300	477	758	1205	1520	1916	2417	3047	3844
	5	460	474	754	1199	1907	3032	4821	6081	7664	9668	12186	15378
	7.5	230	0	0	221	352	560	890	1123	1415	1785	2250	2839
	7.5	460	350	557	886	1408	2239	3560	4490	5660	7140	8999	11356
	10	460	274	436	694	1103	1753	2788	3517	4432	5591	7048	8893

* Table data are generated per NEC standards.
Cable lengths allow for a maximum 5% voltage drop at maximum nameplate amperes.
Use of aluminum wire NOT recommended.

6.9 T-SERIES 4" MOTOR OVERLOAD PROTECTION

3-Phase Motors

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 the (Table 6-12) below 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

6.10 MOTOR COOLING

PENTEK T-Series 4" motors are designed for minimum water flow of 0.98ft. /sec. past the motor. Maximum water temperature is 95° F (35° C).

4" MOTORS: MINIMUM COOLING WATER FLOW

I.D of casing	Flow (GPM) required
4	6.5
5	28
6	55
7	86
8	122
10	209
12	315
14	440
16	585

TABLE 6-12: Three-Phase Motor Overload Protection (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	NEMA Starter Size	Overload Heater Relays †				Adjustable Relays	
						PENTEK	Allen Bradley	Furnas	G.E.	Set Amps	Max. Amps
4" 3-Wire	P43T0030A4	3	2.2	460	0	13621A088	J22	K39	L680A	5.6	6.0
	P43T0050A3	5	3.7	230	1	13621A066	J34	K61	L199B	20.0	22.0
	P43T0050A4	5	3.7	460	0	13621A062	J27	K50	L111B	8.9	9.6
	P43T0075A3	7-1/2	5.5	230	1	13621A063	J38	K67	L293B	24.0	26.0
	P43T0075A4	7-1/2	5.5	460	1	13621A105	J31	K55	L147B	12.0	13.0
	P43T0100A4	10	7.5	460	1	13621A072	J33	K60	L199B	15.4	16.6

† Class 10 protection required. Warranty is voided if Class 10 protection is not used.

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 SMCT (Submersible Motor Controls). These are manual overloads and must be manually reset if an overload condition occurs.

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.

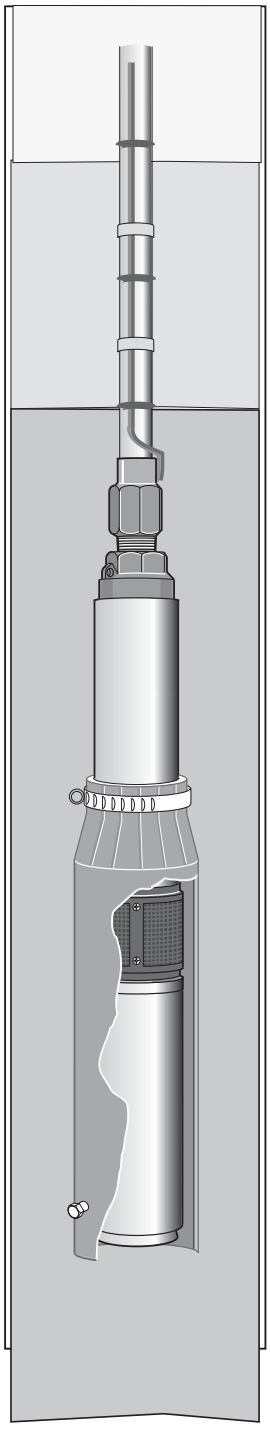


Figure 6-2: Flow Inducer Sleeve

6.11 STARTING FREQUENCY

To extend the life of the pump motor and control, limit the number of starts as shown in the table.

If higher starting frequencies are necessary, consult your factory.

To prevent overheating, run motor for a minimum of one minute.

Motor		Maximum Starts in 24 Hours	
HP	KW	Single Phase	Three Phase
1/2 - 3/4	0.37 - 0.55	300	300
1 - 5	0.75 - 3.7	100	300
7-1/2 - 10	5.5 - 7.5	50	100

SECTION 7:

P-Series 6" Submersible Motors - 60 Hz

7.1 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. For star-delta starting, the delta-voltage of the motor must be equal to the supply voltage. Voltage must not vary more than ±10% from nameplate rated voltage. In case of doubt, consult factory before installing motor.
- 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.
- For 6" motors, verify that motor is full of fluid (see “Drain and Fill Instructions”) before installation. Make this check on all 6" motors, even though the motor was filled at the factory.

7.2 CHECK FLUID LEVEL

To check fluid level, the motor must be upright.

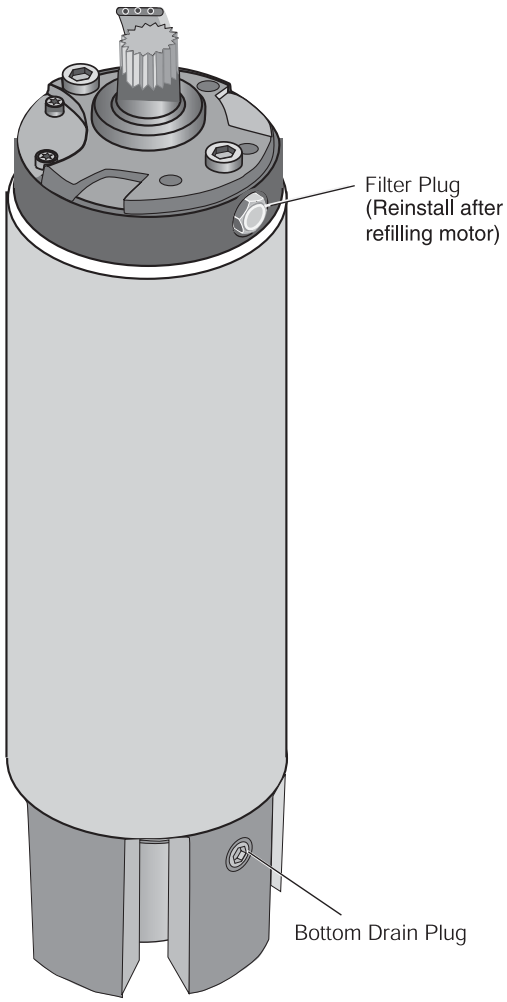


Figure 7-1: 6” Motor Fill and Drain Locations

1. Remove the 3/4" filter plug.
2. Fluid level should be up to the bottom of the threaded hole.
3. If fluid is not visible, top it with water.

   During operation, the antifreeze solution will gradually get replaced by well water. If a motor is removed from service, and will be exposed to freezing temperatures, antifreeze must be added to the pump. Consult factory for more information.

Drain and Fill Instructions

1. Motors must be completely filled with fluid before installation. Check each motor before installation to make sure that it is full of fluid, regardless of whether it was shipped pre-filled or empty. All motors and motor/pump units must be standing vertically while being filled unless special instructions are included with the unit.

   NOTICE: Prior to installation in a well, motor fluid should be checked and topped off with tap water if necessary. Do not use Reversed Osmosis (RO) water.
2. Fill or top up motor immediately prior to installation.
3. All motors shipped pre-filled from the factory contain anti-freeze protection down to -26° F (-32° C).
4. The filter valve protection cap is fitted for transportation and storage only. Remove it before installing the motor.
5. When filling motor with a mixture of water and anti-freeze, mix liquids in a clean container before filling motor. Do not fill motor with the separate fluids because they will not mix adequately.

7.3 TESTING

Insulation Resistance

To check for insulation resistance:

Disconnect power to the motor for this test.

Connect an Ohm meter (resistance in Ω) between the power leads and the motor 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

7.4 STORAGE

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.

6" Motors are best protected when stored filled. Replace filter cap, if necessary. Always check fluid level and refill as necessary before putting motor in service!

Do not kink or pull power supply or control cables.

Freeze Protection

If temperature may drop below freezing, filled motors should contain FDA-approved propylene glycol antifreeze adequate to prevent freezing. Consult factory for more information.

TABLE 7-1: Freezing Point

Freezing Point ° F	Freezing Point ° C	FDA Approved Glycol Volume %	Water Volume %
14	-10	25	75
9	-13	30	70
1	-17	35	65
-6	-21	40	60
-15	-26	45	55
-26	-32	50	50
-40	-40	55	45

Transportation

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.

7.6 6" MOTOR SPECIFICATIONS

TABLE 7-2: Single-Phase Motor Specifications (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Service Factor	Full Load				Service Factor Load				Locked Rotor	KVA Code	Winding Resistance (Ohms) Main (M)/Start (S)
						Amps	Watts	Eff. (%)	P.F. (%)	Amps	Watts	Eff. (%)	P.F. (%)			
6-Inch	P6A0050A2*	5	3.7	230	1.15	Y 24.1 B 20.2 R 11.6	5,218	71	95	Y 28.1 B 24.0 R 11.1	6,122	70	95	105.5	E	M=0.73-0.90 S=1.8-2.2
	P6A0075A2*	7.5	5.5	230	1.15	Y 32.0 B 20.2 R 15.5	6,899	80	94	Y 36.4 B 30.3 R 15.1	7,914	80	95	152.5	E	M=0.45-0.55 S=1.24-1.52
	P6A0100A2*	10	7.5	230	1.15	Y 45.3 B 36.8 R 20.1	9,915	76	96	Y 51.9 B 42.8 R 19.7	11,382	76	96	203.5	E	M=0.36-0.44 S=.96-1.18
	P6A0150A2*	15	11	230	1.15	Y 68.0 B 58.0 R 26.1	14,400	77	92	Y 75.8 B 65.1 R 25.5	16,250	77	92	296.8	E	M=0.61-0.75 S=0.21-0.26

TABLE 7-3: Three-Phase Motor Specifications (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Service Factor	Full Load				Service Factor Load				Locked Rotor	KVA Code	Winding Resistance (Ohms) Main (M)/Start (S)
						Amps	Watts	Eff. (%)	P.F. (%)	Amps	Watts	Eff. (%)	P.F. (%)			
6-Inch	P6A0050A3	5	3.7	230	1.15	16.45	5,300	69	81	18.41	6,050	70	83	61.5	E	1.31-1.61
	P6A0075A3	7.5	5.5	230	1.15	23.52	7,500	73	81	26.20	8,640	73	83	96.4	F	0.85-1.04
	P6A0100A3	10	7.5	230	1.15	30.90	9.670	78	79	34.15	11,100	77	82	134.7	F	0.57-0.70
	P6A0150A3	15	11	230	1.15	43.10	13,634	80	78	49.00	15,780	80	81	208.4	F	0.35-0.43
	P6A0200A3	20	15.0	230	1.15	59.36	18,450	81	78	65.25	21,250	81	82	306.3	G	0.24-0.29
	P6A0250A3	25	18.5	230	Data not yet Available											
	P6A0300A3	30	22.0	230												
	P6A0050A4	5	3.7	460	1.15	7.60	4,869	76	81	8.40	5,593	76	83	38.9	G	4.25-5.20
	P6A0075A4	7.5	5.5	460	1.15	10.80	7,201	76	84	12.60	8,615	73	86	47.8	F	3.23-3.95
	P6A0100A4	10	7.5	460	1.15	14.80	9,828	76	83	16.50	11,184	77	85	79.8	H	2.00-2.45
	P6A0150A4	15	11.0	460	1.15	19.70	12.690	87	81	22.50	14,900	85	83	96.5	F	1.57-1.93
	P6A0200A4	20	15.0	460	1.15	27.50	18,145	83	83	31.50	21,220	81	85	145.1	G	1.01-1.23
	P6A0250A4	25	18.5	460	1.15	Data not yet Available										
	P6A0300A4	30	22.0	460	1.15											
	P6A0400A4	40	30.0	460	1.15											
	P6A0500A4	50	37.0	460	1.15											
	P6A0600A4	60	45.0	460	1.15											

* Requires SMCP Series PENTEK 1-phase Controller

7.7 6" MOTOR DIMENSIONS

TABLE 7-4: 6" Motor Dimensions (60 Hz, 3450 RPM)

Single-Phase

Motor Type	PENTEK Part Number	HP	kW	Volts	Length* (in)	Length* (mm)	Weight* (lbs)	Weight* (kg)
6"	P6A0050A2	5	3.7	230	26	648	100	46
	P6A0075A2	7.5	5.5	230	28	711	116	53
	P6A0100A2	10	7.5	230	30	752	126	57
	P6A0150A2	15	11.0	230	36	907	163	74

Three-Phase

Motor Type	PENTEK Part Number	HP	kW	Volts	Length* (in)	Length* (mm)	Weight* (lbs)	Weight* (kg)
6"	P6A0050A3	5	3.7	230	25	622	94	43
	P6A0075A3	7-1/2	5.5	230	27	673	105	48
	P6A0100A3	10	7.5	230	28	711	114	52
	P6A0150A3	15	11.0	230	32	818	137	62
	P6A0200A3	20	15.0	230	37	937	163	74
	P6A0250A3	25	18.5	230	40	1026	182	83
	P6A0300A3	30	22.0	230	46	1166	217	99
	P6A0050A4	5	3.7	460	27	508	110	50
	P6A0075A4	7-1/2	5.5	460	28	701	113	52
	P6A0100A4	10	7.5	460	30	757	127	58
	P6A0150A4	15	11.0	460	30	770	129	59
	P6A0200A4	20	15.0	460	36	902	160	73
	P6A0250A4	25	18.5	460	Data not yet Available			
	P6A0300A4	30	22.0	460				
	P6A0400A4	40	30.0	460				
	P6A0500A4	50	37.0	460				
	P6A0600A4	60	45.0	460				

* Motor length and weight are approximate and excludes packaging. Numbers are rounded.

6" MOTOR DIMENSIONS

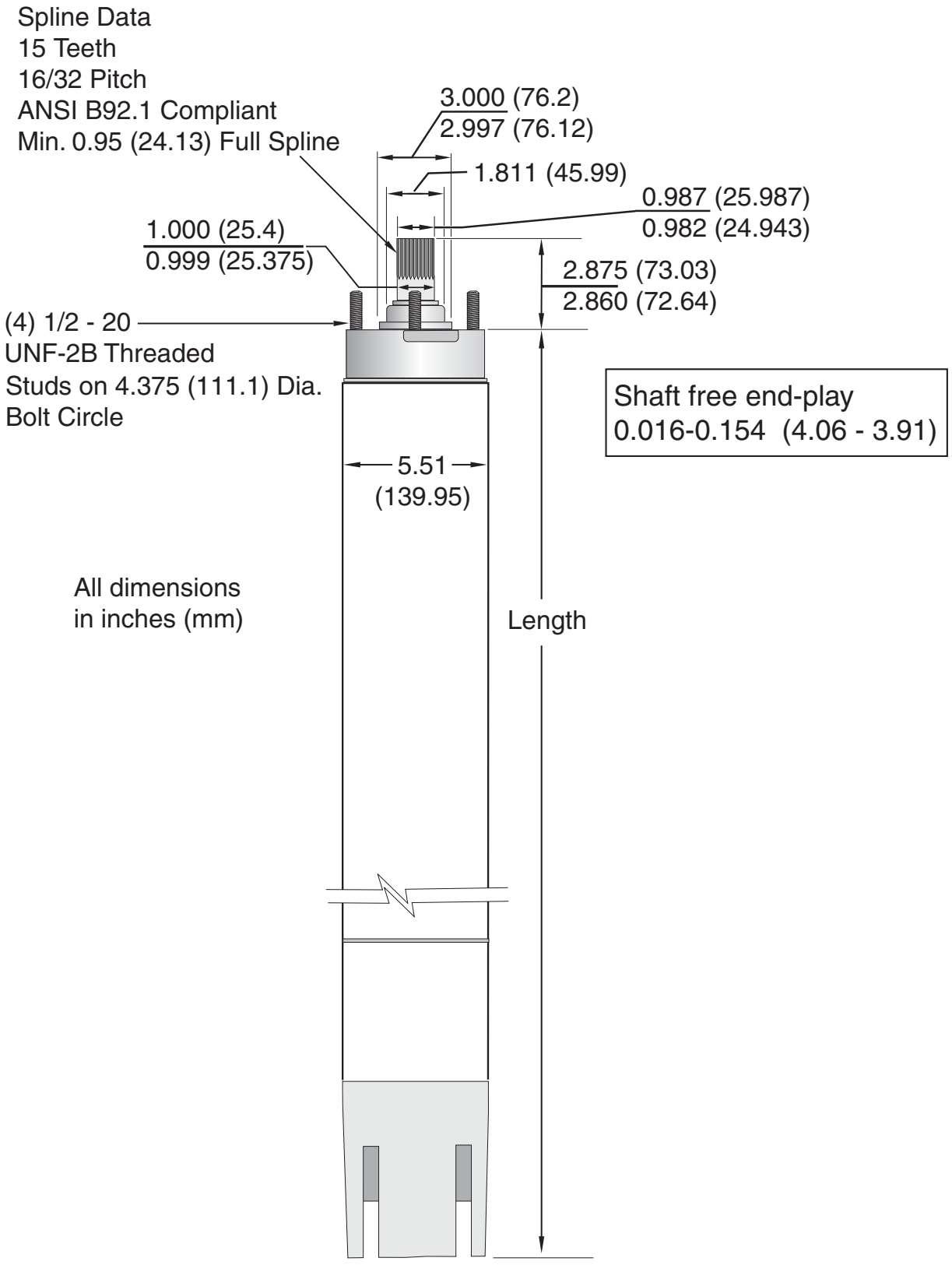


Figure 7-2: 6" Motor Dimensions

PN793 (Rev. 8/23/06)

7.8 6" MOTOR FUSE SIZING

TABLE 7-5: Single-Phase Motor Fuse Sizing (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Volts and Circuit Breaker Amps (Maximum Rating per NEC)		
					Standard Fuse	Dual Element (Time Delay) Fuse	Inverse Time Breaker
6"	P6A0050A2	5	3.7	230	80	45	60
	P6A0075A2	7.5	5.5	230	125	70	100
	P6A0100A2	10	7.5	230	150	80	125
	P6A0150A2	15	11.0	230	200	125	175

TABLE 7-6: Three-Phase Motor Fuse Sizing (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	Volts and Circuit Breaker Amps (Maximum Rating per NEC)		
					Standard Fuse	Dual Element (Time Delay) Fuse	Inverse Time Breaker
6"	P6A0050A3	5	3.7	230	50	30	45
	P6A0050A4	5	3.7	460	25	15	20
	P6A0075A3	7.5	5.5	230	80	45	60
	P6A0075A4	7.5	5.5	460	35	20	30
	P6A0100A3	10	7.5	230	100	60	80
	P6A0100A4	10	7.5	460	45	30	40
	P6A0150A3	15	11.0	230	150	80	110
	P6A0150A4	15	11.0	460	70	40	60
	P6A0200A3	20	15.0	230	200	110	150
	P6A0200A4	20	15.0	460	90	50	70
	P6A0250A3	25	18.5	230	Data not yet Available		
	P6A0250A4	25	18.5	460			
	P6A0300A3	30	22.0	230			
	P6A0300A4	30	22.0	460			
	P6A0400A4	40	30.0	460			
	P6A0500A4	50	37.0	460			
	P6A0600A4	60	45.0	460			

TABLE 7-7: Cable Lengths, 60° and 75° C.
Service Entrance to Motor: Maximum Length in Feet (Single-Phase Motors)

Volts	HP	kW	60 and 75 °C Insulation-AWG Copper Wire Size												
			14	12	10	8	6	4	3	2	1	0	00	000	0000
230	5	3.7			205	326	518	823	1039	1309	1652	2082	2627	3311	4176
	7-1/2	5.5				251	400	636	802	1011	1275	1607	2028	2556	3224
	10	7.5					280	446	562	709	894	1127	1422	1793	2261
	15	11						305*	385	485	612	772	974	1227	1548

TABLE 7-8: Cable Lengths, 60° and 75°C.
Service Entrance to Motor: Maximum Length in Feet (Three-Phase Motors)

Volts	HP	kW	60 and 75 °C Insulation-AWG Copper Wire Size												
			14	12	10	8	6	4	3	2	1	0	00	000	0000
230	5	3.7	124	197	313	497	791	1257	1585	1998	2521	3177	4009	5054	6374
	7-1/2	5.5			220	349	555	883	1114	1404	1771	2233	2817	3551	4479
	10	7.5			169	268	426	678	855	1077	1359	1713	2161	2725	3436
	15	11				187	297	472	596	751	947	1194	1506	1899	2395
	20	15					0	355	447	564	711	896	1131	1426	1798
	25	Data not yet available													
	30														
460	5	3.7	542	862	1371	2179	3465	5509	6949	8759	11050	13927	17574	22153	27940
	7-1/2	5.5	361	575	914	1453	2310	3673	4633	5839	7366	9285	11716	14769	18626
	10	7.5	276	439	698	1109	1764	2805	3538	4459	5625	7090	8947	11278	14224
	15	11	0	322	512	814	1294	2057	2594	3270	4125	5200	6561	8270	10431
	20	15			365	581	924	1469	1853	2336	2947	3714	4687	5907	7451
	25	Data not yet available													
	30														
	40														
	50														
	60														

Table data are generated per NEC standards.
Cable lengths allow for a 5% voltage drop at maximum nameplate amperes.
Use of aluminum wire NOT recommended.
* This length only usable for 75 °C wire.

7.9 6" MOTOR 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 the chart below 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.

TABLE 7-11: Three-Phase Motor Overload Protection (60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Volts	NEMA Starter Size	Overload Heater Relays†				Adjustable Relays	
						PENTEK	Allen Bradley	Furnas	G.E.	Set Amps	Max. Amps
6"	P6A0050A3	5	3.7	230	1	13621A066	J32	K60	L199B	17.1	18.4
	P6A0050A4	5	3.7	460	0	13621A094	J25	K49	L910B	7.8	8.4
	P6A0075A3	7-1/2	5.5	230	1	13621A095	J36	K64	L293B	24.3	26.2
	P6A0075A4	7-1/2	5.5	460	1	13621A065	J29	K54	L147B	11.7	12.6
	P6A0100A3	10	7.5	230	2	13621A058	J38	K70	L390B	31.7	34.2
	P6A0100A4	10	7.5	460	1	13621A066	J32	K58	L181B	15.3	16.5
	P6A0150A3	15	11.0	230	2	13621A096	J42	K75	L520B	45.2	49.0
	P6A0150A4	15	11.0	460	2	13621A095	J35	K64	L265B	20.9	22.5
	P6A0200A3	20	15.0	230	3	13621A077	J44	K78	L787B	60.5	65.3
	P6A0200A4	20	15.0	460	2	13621A058	J38	K69	L352B	29.2	31.5
	P6A0250A3	25	18.5	230		Data not yet available					
	P6A0250A4	25	18.5	460							
	P6A0300A3	30	22.0	230							
	P6A0300A4	30	22.0	460							
	P6A0400A4	40	30.0	460							
	P6A0500A4	50	37.0	460							
	P6A0600A4	60	45.0	460							

* Table data are generated per NEC and Heater Manufacturer Recommendations (see 2005 NEC-Chapter 3, Tables 430.52, 430.248, 430.250, Allen Bradley, Siemens (Furnas) and G.E. catalogs for more information).

† Class 10 protection required. Warranty is voided if Class 10 protection is not used.

7.10 MOTOR COOLING

PENTEK 6" motors are designed for minimum water flow of 0.5 ft. /sec. past the motor. Maximum water temperature is 86° F (30° 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.

7.11 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.

7.12 VARIABLE FREQUENCY DRIVES

For pumps controlled by variable frequency drives, refer to section 8.4, Reactors and Filters.

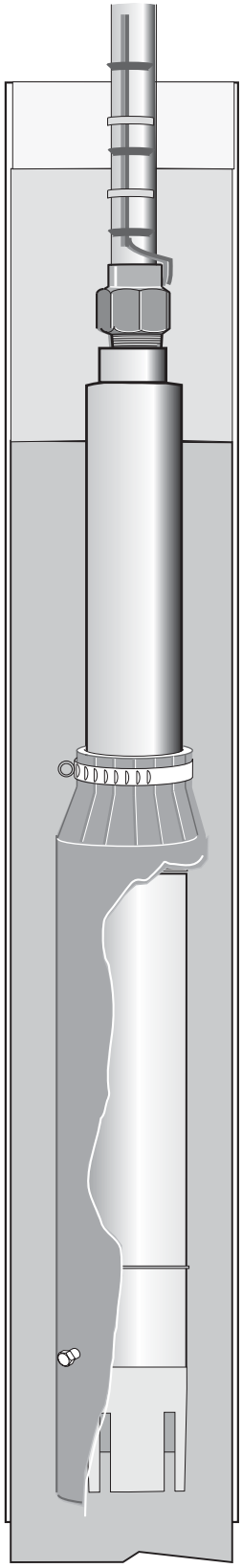


Figure 7-3: Flow Inducer Sleeve

SECTION 8:

VFD

8.1 HOW DRIVES WORK

The PENTEK Pump controllers (PPC series) convert constant voltage/frequency power into variable voltage/frequency power. The variable voltage/frequency power is supplied to the motor to cause it to operate at variable speeds.

The incoming AC voltage is rectified, filtered and routed to a bank of capacitors. The capacitor bank is refered to as the DC bus. The DC bus voltage is approximately 1.414 times the incoming AC voltage. i.e 230V 60 Hz input will result in a DC Bus voltage of approximately 325V (1.414 times 230V).

The drive uses an IGBT (Insulated Gate Bipolar Transistor) to control the application of the DC bus voltage to the motor.

By varying the duration and polarity of voltage pulses, the IGBT provides the proper voltage/frequency to operate the motor at different speeds. The methodology of adjusting the duration of voltage pulses is commonly called PWM (Pulse Width Modulation).

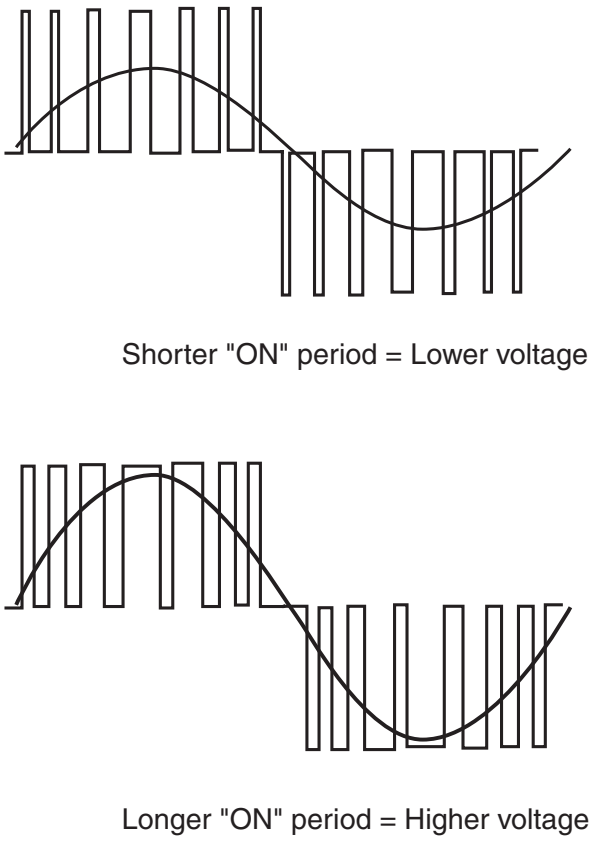


Figure 8-4: Pulse Width Modulation Waveforms

8.2 PPC20

8.2.1 How the PPC20 Drive Works

This Drive provides constant water pressure under varying service conditions. Motor speed varies to deliver constant water pressure (within the limits of the pump) despite variations in water demand and flow.

When the system flow demand is light, the pump runs at a relatively low speed. As system demand increases, the motor speed increases to maintain the preset system pressure.

In general, when there is a demand for water, the Drive will be operating. However, with light demand, the pump may cycle on and off at its minimum speed. This will not damage either the motor or the pressure transducer.

NOTICE: Do not use power factor correction capacitors with this Drive; they will damage both the motor and the Drive. Power factor correction is provided by the drive.

All wiring to Drive must be in liquid tight conduit with liquid tight connectors and fittings to maintain the box's NEMA 4 rating.

8.2.2 PPC20 Specifications

INPUT TO DRIVE

Volts/Hz/Phase:	
PPC20-1-6A8-4	230V/50-60Hz/1ø
PPC20-1A-6A0-4	115V/50-60Hz/1ø
Maximum RMS Current	16 Amps
Circuit Breaker Rating	20 Amps
Internal Fusing:	
PPC20-1-6A8-4	BAF-15 (250 volts, 15 amps)
PPC20-1A-6A0-4	BAF-30 (250 volts, 30 amps)

OUTPUT POWER TO MOTOR

PPC20-1-6A8-4	230V, 6.8A, 3ø Output
PPC20-1A-6A0-4	230V, 6.0A, 3ø Output
Frequency	Variable: 30-60, 30-80 or 30-200 Hz

MAX. LENGTH OF WIRE, DRIVE TO MOTOR*

14 AWG	300'(91m)
12 AWG	400'(122m)
10 AWG	625'(191m)

PRESSURE SETTING

Drive is Factory Preset to	60 psi(4.1 BAR)
Adjustable Range	25-95 psi(1.7-6.5 BAR)
Tank Precharge	70% of Pressure Set Point (42 psi [2.9 BAR] pre-charge for factory-set 60 psi [4.1 BAR] set point)

* Longer cable lengths may be possible when reactors or filters are used on the load side (See Section 8.4).

AMBIENT CONDITIONS (CONTINUOUS DUTY)

Operating Temperature Range	
PPC20-1-6A8-4	-4° F to 131° F(-20 to 55° C)
PPC20-1A-6A0-4	-4° F to 104° F(-20 to 40° C)
Storage Temperature Range	-40° F to 185° F (-40 to 85° C)
Humidity Range	10% to 90%
AUXILIARY RELAY RATING:	250 Volts, 16 Amps
DIMENSIONS:	13-3/8" H x 10-7/8" W x 5-7/8" D
WEIGHT:	20 lbs. (9 kg)
ENCLOSURE:	NEMA4, IPX4, radiant cooled
INTERNAL OVERLOAD PROTECTION:	Trips at 8.5 Amps (125% of Maximum Power Output)

8.2.3 PPC20 Mounting and Installation

1. Disconnect the electrical power at the main circuit breaker.
2. If there is water in the system, drain it.
3. The system requires a pressure tank; for best pressure regulation, use a 6 gallon tank or larger. You can also use an existing tank of much larger capacity. Set the tank pre-charge at 70% of the set-point pressure (42 psi when the Drive is set at 60 psi). See Table 8-1.
4. Install the pressure transducer in a tank tee or in a tee in the water main downstream from the tank and less than 10 feet from it. Do not install any elbows between the tank and the pressure transducer. The Drive includes a 10 foot length of cable to connect the transducer to the Drive.

   NOTICE: If you have a pressure gauge in the system, make sure that the gauge and the transducer are on the same level. If the gauge is higher or lower than the transducer, the gauge pressure will not match the transducer's signal. The Drive will, of course, always be governed by the transducer's signal.
5. The Drive weighs about 20 pounds. Mount it on a solid support with two mounting screws.

   NOTICE: Mount the NEMA 4 drive with the wiring ports down to protect the interior from dust and rain. Leave at least 4" of clearance to the front and sides of the box for heat radiation. To maintain the NEMA 4 rating, you must use liquid-tight conduit and fittings for all connections to the Drive.

   NOTICE: Allow access to the 115V or 230V 1ø electrical supply wiring and to the submersible motor wiring. Use only copper wire rated at 60° C or higher. Maximum wire length between the Drive and the pump motor will depend on the motor used, but must meet National Electrical Code (NEC) requirements and State and local codes (See Section 8.2.2).

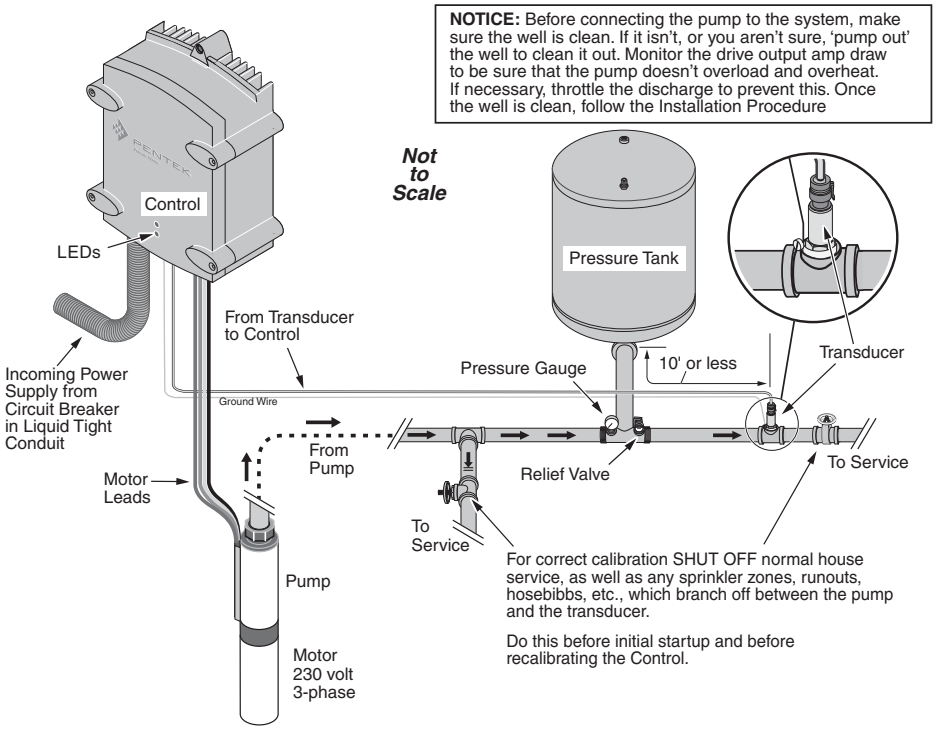


Figure 8-2: PPC20 General Layout

8.2.4 Wiring Connections

NOTICE: The input wiring to the Drive must meet NEC requirements for a 115V or 200-240V/50 or 60Hz/1ø circuit carrying 16 amps. For correct wire sizing from the Drive to the motor, consult your motor manufacturer and the NEC, as well as section 8.2.2.

⚠WARNING Hazardous voltage inside Drive; can shock, burn, or kill. Capacitors inside the Drive will hold lethal voltage (up to 380 volts) even after power has been disconnected. After disconnecting the power, allow 5 minutes for the capacitors to discharge before removing the Drive cover. The ground terminals in the Drive must be connected to the motor, metal plumbing, or other metal near the motor, using a wire at least as large as the motor cable wires as shown in Section 8.1.2. Disconnect the incoming power before working on or around the system.

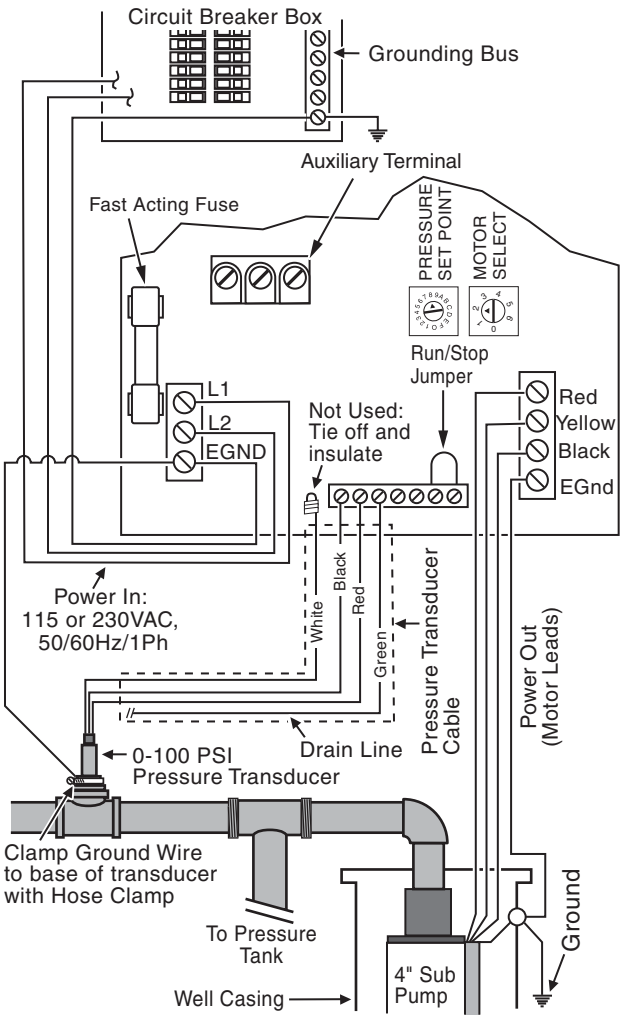


Figure 8-3: PPC20 Wiring Connections

⚠CAUTION Ground the Drive as shown for safety and to prevent current imbalance (ground loops) between Drive, motor, and transducer.

1. Power must be off at the main circuit breaker.
2. Make sure that the dedicated branch circuit for the Drive is protected by a 20 amp circuit breaker.
3. Remove the Drive cover; feed the wires through the appropriate conduit hubs and into the Drive. Connect them to the terminal blocks as shown in Figure 8-2. To maintain the NEMA 4 rating of the Drive Box, all wiring must be run to the Drive in liquid-tight conduit and fittings and must run into the Drive through liquid-tight connectors (included with the Drive).

TORQUE VALUES FOR TERMINALS:

- Torque the input power terminals to 16 lb.-in.
- Torque the motor output terminals to 12 lb.-in.
- Torque the auxiliary terminals, transducer terminals, and run/stop terminals to 5-7 lb.-in.
- All low voltage field wiring terminals to be wired with Class 1 wiring.

  NOTICE: If you must replace the Drive cover O-Ring, apply Scotch-Grip #847 adhesive to the O-Ring groove in the Drive cover. Apply one drop in each corner and midway across the top and bottom and one drop midway down each side. Follow the adhesive manufacturer's instructions for proper ventilation, preparation, and cleanup. Place the O-Ring in the groove and apply even clamping pressure all around the O-Ring.

4. Replace the Drive cover. Be sure that the O-Ring seats properly in the cover groove. Do not over-tighten the cover screws.
5. Connect the other end of the pressure transducer cable to the transducer. (See Figure 8-2).
6. Connect the ground wire from the base of the transducer to the electrical ground. (See Figure 8-3).
7. The pressure transducer is pre-calibrated; no adjustment is needed.

8.2.5 Start-up Operation

1. Pressure Central must have all lines in the system shut off in order to calibrate itself correctly. Check all sprinkler zones, service lines, household service, etc., to make sure that there are no open service lines in the system. If you find any open lines, shut them off before connecting the power to Pressure Central.

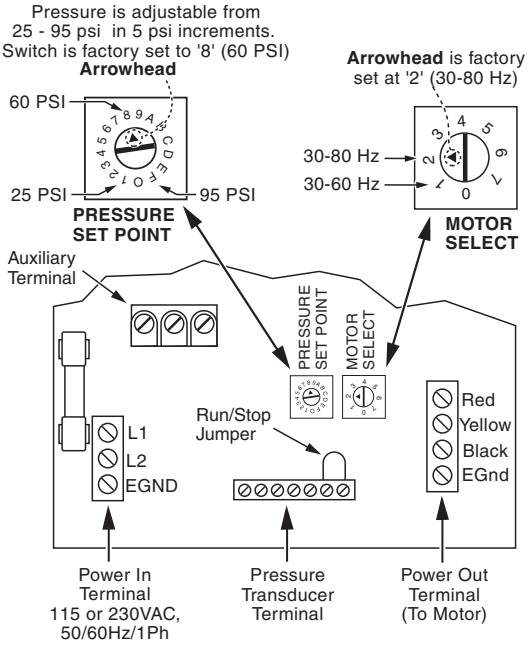


Figure 8-4: Pressure Set Point and Motor Select Settings

NOTICE: If, when the pump starts at calibration, there are any open lines *between Pressure Central and the transducer*, Pressure Central will accelerate the pump to full speed and keep it there, which can damage both the motor and the pump.

2. Turn on the power to Pressure Central at the circuit breaker box. Pressure Central will start the pump, perform a 30-second self-check, and pressurize the system. If the Pressure Set Point or the Motor Select Switch have changed since the last time Pressure Central was powered up, it will re-calibrate itself before going to normal operation.
3. Once Pressure Central is correctly calibrated, the pump will stop if there is no demand for water. If there is a demand for water, the pump will continue to run to maintain the system pressure.
4. When the unit calibrates, it will increase both the voltage and frequency to the motor. You will be able to see this with the pressure changing in the system. It will increase the pressure, shut off for a few seconds and then start up again. The unit may repeat this several times until the unit is calibrated.

NOTICE: If the phasing for the motor is not connected properly, the pump will rotate backwards and the unit may not calibrate itself correctly, even though it may appear that it is. You may still be able to produce the pressure at shutoff, but system performance may be low. Verify that the proper motor three-phase wiring is correct and the pump is rotating in the proper direction. Recalibrate the unit after the wiring is corrected.

NOTICE: Although the system maintains constant pressure at the transducer, additional demands (more faucets opened, more sprinklers on line, etc.) may cause pressure drops in other places in the system. This is due to limitations in the plumbing and will be more noticeable the further the demand sites are from the transducer. This is true of any system; it is not a system failure.

TPM MODE

You will see references to 'TPM Mode' in this manual. 'TPM Mode' (Temporary Performance Monitoring Mode) is the mode the Drive goes into when it senses a fault (such as a current overload) that would damage the Drive, pump, or motor if it continued to try to run normally. In TPM Mode, the Drive automatically reduces the pump speed (and hence the load on the motor and Drive) to a point that it can sustain without damage. TPM Mode provides reduced service in a situation that otherwise would either shut down the Drive or permanently damage the Drive, pump, or motor. If the condition causing the Drive to go into TPM Mode clears, the Drive will automatically return to normal operation. If the drive senses an excessive load for more than 3 hours, the drive will shut down. To recover, turn off power, wait one minute and then turn power on.

RECALIBRATION

Recalibration of the Drive is necessary after adjusting the Pressure Set Point or the Motor Select Switch because the Drive will not "see" the adjustment(s) until power has been turned off and turned back on again. Wait one minute between power down and power up to allow the Drive components to discharge.

The Drive will automatically run a 30-second self-check if you disconnect it from the power supply, wait one minute, and reconnect it. It will recalibrate itself if the Pressure Set Point or the Motor Select Switch have changed since the Drive was last powered up.

NOTICE: Pressure Central must have all lines in the system shut off and system pressure below the set point in order to calibrate itself correctly (you may have to bleed off some pressure before turning on the power). Check all sprinkler zones, service lines, household service, etc., to make sure that there are no open service lines in the system. If you find any open lines, shut them off before connecting the power to Pressure Central. If, when the pump starts at calibration, there are any open lines *between Pressure Central and the transducer*, Pressure Central will accelerate the pump to full speed and keep it there, which can damage both the motor and the pump.

PRESSURE SET POINT

The Pressure Set Point Switch is located in the Drive unit (see Figure 8-4). The pressure range is 25 - 95 psi. The switch can be set with a common small blade screwdriver. There are 16 settings, labeled 0 - 9 and A - F. The Set Point adjusts in 5 psi increments. The factory setting is 60 psi (arrowhead at the number 8).

NOTICE: The Drive must be recalibrated, (that is, you must disconnect the Drive from the power supply, wait one minute, and then reconnect it) after you adjust the pressure set point. The Drive will not acknowledge the new pressure set point until it has gone through one power off/1-minute wait/power on cycle.

NOTICE: You must adjust the tank pre-charge whenever the pressure set point has been changed. The tank pre-charge must be 70% of the pressure set point. (This value is the pressure set point multiplied by .70. For example: If the pressure set point is 60 psi, the tank pre-charge would be 60 X .70 = 42 or 42 psi. See Table 8-1, below).

TABLE 8-1: Drive Pressure Set Point and Tank Pre-Charge Pressure Values

Switch Setting	Pressure Point Setting (PSI)	Precharge Pressure
0	Not used	–
1	25	18
2	30	21
3	35	25
4	40	28
5	45	32
6	50	35
7	55	39
8	60	42
9	65	46
A	70	49
B	75	53
C	80	56
D	85	60
E	90	63
F	95	67

MOTOR SELECT SWITCH

This switch matches the control parameters to the motor you use. Settings are as follows:

1=30-60 Hz
2=30-80 Hz

The other settings are reserved for future use.

NOTICE: Allowing the motor operating speed to exceed the motor's design maximum speed can damage the pump and motor and will void the warranty.

RUN/STOP INTERFACE TERMINALS

The Run/Stop Terminal connections must be closed for the Drive to provide power to the pump's motor. A factory installed Run/Stop Terminal connector (jumper) is provided, located in the Run/Stop Terminal connection (see Figure 8-4). To install a device to control the Run/Stop Terminals, turn off the power to the Drive, remove the Run/Stop jumper, and replace it with the leads to the device.

For Example: A moisture/leak sensor device can be installed in the home or facility and connected to the Run/Stop Terminal in place of the Run/Stop jumper. If the moisture/leak sensor device detects a leak, the Drive will shut down and the pump will not run (and consequently will not pressurize the leaking system).

8.2.6 LED Fault Codes

TABLE 8-2: PENTEK PPC20 LED Codes (Fault Status)

The Drive has two LEDs set into the front of the Drive cover. The Green LED signals normal operation plus TPM Mode operation. The Red LED indicates general faults recorded by the Drive.

The sequence of flashes which the Fault Code emits allows for easy troubleshooting. The fault code light will continue to indicate the last recorded fault until the condition is corrected and the Drive is manually reset. The reset button is located on the underside of the Drive, to the left of the conduit hubs.

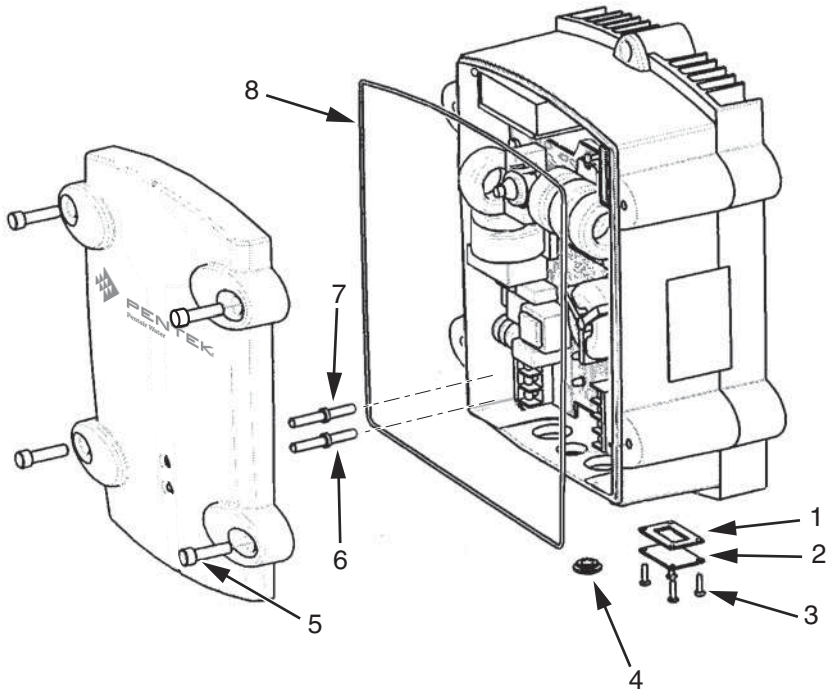
The Drive will return to normal operation if the fault corrects itself, but will continue to show a fault on the red LED indicator. Push the manual reset button for 1 second or more to stop the red LED from flashing. If the red LED continues to flash a fault code after you have pushed the manual reset button, the fault is still present and should be corrected.

LED Color	Flash Rate	Flash Pattern	Meaning of LED
Green	Intermediate	1/2 Sec. On, 1/2 Sec. Off	30-Second Power-Up Delay (Normal)
Green	Steady	On Continuously	Drive On, not driving motor (Normal)
Green	Slow	2 Sec. On, 1 Sec. Off	Drive On, Pump motor is running (Normal)
Green	Fast	2/10 Sec. On, 2 Sec. Off	Motor is running in TPM mode.
Red	Off	Off	No system faults.
Red	Slow	2 Sec. On, 1 Sec. Off	*Over voltage, Under voltage, Under Current (Running Dry)*
Red	Fast	2/10 Sec. On, 2 Sec. Off	*Over Current, Output short-circuit, Foreign object jamming pump*
Red	Combination	2/10 Sec. On, 1/2 Sec. Off 1 Sec. On, 1/2 Sec. Off	*Over temp., Transducer open/shorted, Excessive operation in TPM mode*
Red	Steady	On Continuously	*More than 15 faults in 30 minutes, Excessive load for more than 3 hours* Drive will shut down until reset.

NOTE 1: After any fault that stops the motor, the Drive will wait 30 seconds and then restart.

NOTE 2: Pressing "Clear Faults" will stop the light from blinking; it will not clear the fault(s) or erase the fault log.

8.2.7 PPC20 Replacement Parts



REPAIR PARTS LIST

Key No.	Part Description	Qty.	Part Number
1	RS232 Connection Gasket	1	U20-21
2	RS232 Connection Cover	1	U17-1340
3	RS232 Connection Screws 6-32x1/4"	4	U30-985SS
4	Switch Cover	1	U17-1339
5	Allen Head Screws 5/16-18x1-1/2 UNC	4	U30-984ZZPO
6	Light Tube A (Lower)	1	U17-1341
7	Light Tube B (Upper)	1	U17-1342
8	Controller Cover O-Ring	1	U20-22
•	3/4" Liquid Tight Conduit Connector	2	U17-1285
•	1/2" Liquid Tight Conduit Connector	1	U17-1284
•	1/2" NPT Liquid Tight Cord Grip (cable size 0.150"/0.250")	1	U17-1337
•	4-20 Milliamp, 0-100 psig Transducer	1	U17-1286-R
•	Transducer Weather Boot	1	U17-1338
•	10' - 18 gauge Shielded Transducer Cable	*	U18-1593
•	25' - 18 gauge Shielded Transducer Cable	*	U18-1594
•	50' - 18 gauge Shielded Transducer Cable	*	U18-1595
•	100' - 18 gauge Shielded Transducer Cable	*	U18-1596
•	150' - 18 gauge Shielded Transducer Cable	*	U18-1597
•	200' - 18 gauge Shielded Transducer Cable	*	U18-1598
•	115 Volt Fuse (Model PPC20-1A-6A0-4)**	1	BAF-30
•	230 Volt Fuse (Model PPC20-1-6A8-4)**	1	BAF-15

* Use the cable appropriate to your installation.
• Not Illustrated.
** Standard hardware item; purchase locally.

8.3 Pentek PPC3 and PPC5 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.

8.3.1 PPC3 Series Specifications

Table 8-3: 3-Phase/208-230V Output

Note: For detailed specifications see users manual.

OUTPUT AMPS	INPUT PHASE	INPUT VOLTAGE	ENCLOSURE RATING (NEMA)	CATALOG NUMBER
6.7	1	200-240	1	PPC3-1-6A7-1
7.5	1	200-240	1	PPC3-1-7A5-1
9.8	1	200-240	1	PPC3-1-9A8-1
6.7	3	200-240	1	PPC3-2-6A7-1
7.5	3	200-240	1	PPC3-2-7A5-1
9.8	3	200-240	1	PPC3-2-9A8-1
17.6	3	200-240	1	PPC3-2-17A6-1

Table 8-4: 3-Phase/380-460V Output

Note: For detailed specifications see users manual.

OUTPUT AMPS	INPUT PHASE	INPUT VOLTAGE	ENCLOSURE RATING (NEMA)	CATALOG NUMBER
4.1	3	380-480	1	PPC3-4-4A1-1
5.6	3	380-480	1	PPC3-4-5A6-1
8.8	3	380-480	1	PPC3-4-8A8-1
12.5	3	380-480	1	PPC3-4-12A5-1
15.6	3	380-480	1	PPC3-4-15A6-1

8.3.2 PPC5 Specifications.

PENTEK Pump Controller – PPC5 Series:

Table 8-5: 3-Phase/208-230V Output

Note: For detailed specifications see users manual.

OUTPUT AMPS	INPUT PHASE	INPUT VOLTAGE	ENCLOSURE RATING (NEMA)	CATALOG NUMBER
4.6	3	208-240	1	PPC5-2-4A6-1
4.6	3	208-240	12	PPC5-2-4A6-12
6.6	3	208-240	1	PPC5-2-6A6-1
6.6	3	208-240	12	PPC5-2-6A6-12
7.5	3	208-240	1	PPC5-2-7A5-1
7.5	3	208-240	12	PPC5-2-7A5-12
11.8	3	208-240	1	PPC5-2-11A-1
11.8	3	208-240	12	PPC5-2-11A-12
16.7	3	208-240	1	PPC5-2-16A-1
16.7	3	208-240	12	PPC5-2-16A-12
24.2	3	208-240	1	PPC5-2-24A-1
24.2	3	208-240	12	PPC5-2-24A-12
30.8	3	208-240	1	PPC5-2-30A-1
30.8	3	208-240	12	PPC5-2-30A-12
46.2	3	208-240	1	PPC5-2-46A-1
46.2	3	208-240	12	PPC5-2-46A-12
59.4	3	208-240	1	PPC5-2-59A-1
59.4	3	208-240	12	PPC5-2-59A-12
74.8	3	208-240	1	PPC5-2-74A-1
74.8	3	208-240	12	PPC5-2-74A-12
88.0	3	208-240	1	PPC5-2-88A-1
88.0	3	208-240	12	PPC5-2-88A-12
114	3	208-240	1	PPC5-2-114A-1
114	3	208-240	12	PPC5-2-114A-12
143	3	208-240	1	PPC5-2-143A-1
178	3	208-240	1	PPC5-2-178A-1
221	3	208-240	1	PPC5-2-221A-1
248	3	208-240	1	PPC5-2-248A-1

For single phase input, derate the output amps by 50%.

PENTEK PPC5 SERIES

Table 8-6: 3-Phase/380-460V Output

OUTPUT AMPS	INPUT PHASE	ENCLOSURE VOLTAGE	CATALOG RATING (NEMA)	CATALOG NUMBER
3.3	3	400-480	1	PPC5-4-3A3-1
3.3	3	400-480	12	PPC5-4-3A3-12
4.1	3	400-480	1	PPC5-4-4A1-1
4.1	3	400-480	12	PPC5-4-4A1-12
6.9	3	400-480	1	PPC5-4-6A9-1
6.9	3	400-480	12	PPC5-4-6A9-12
8.8	3	400-480	1	PPC5-4-8A8-1
8.8	3	400-480	12	PPC5-4-8A8-12
11.9	3	400-480	1	PPC5-4-11A-1
11.9	3	400-480	12	PPC5-4-11A-12
15.4	3	400-480	1	PPC5-4-15A-1
15.4	3	400-480	12	PPC5-4-15A-12
23	3	400-480	1	PPC5-4-23A-1
23	3	400-480	12	PPC5-4-23A-12
31	3	400-480	1	PPC5-4-31A-1
31	3	400-480	12	PPC5-4-31A-12
38	3	400-480	1	PPC5-4-38A-1
38	3	400-480	12	PPC5-4-38A-12
44	3	400-480	1	PPC5-4-44A-1
44	3	400-480	12	PPC5-4-44A-12
59	3	400-480	1	PPC5-4-59A-1
59	3	400-480	12	PPC5-4-59A-12
72	3	400-480	1	PPC5-4-72A-1
72	3	400-480	12	PPC5-4-72A-12
77	3	400-480	1	PPC5-4-77A-1
77	3	400-480	12	PPC5-4-77A-12
96	3	400-480	1	PPC5-4-96A-1
96	3	400-480	12	PPC5-4-96A-12
124	3	400-480	1	PPC5-4-124A-1
157	3	400-480	1	PPC5-4-157A-1
180	3	400-480	1	PPC5-4-180A-1
195	3	400-480	1	PPC5-4-196A-1
245	3	400-480	1	PPC5-4-245A-1

Table 8-7: 3-Phase/575V Output

OUTPUT AMPS	INPUT PHASE	ENCLOSURE VOLTAGE	CATALOG RATING (NEMA)	CATALOG NUMBER
2.7	3	575	1	PPC5-5-2A7-1
2.7	3	575	12	PPC5-5-2A7-12
3.9	3	575	1	PPC5-5-3A9-1
3.9	3	575	12	PPC5-5-3A9-12
6.1	3	575	1	PPC5-5-6A1-1
6.1	3	575	12	PPC5-5-6A1-12
9	3	575	1	PPC5-5-9A0-1
9	3	575	12	PPC5-5-9A0-12
11	3	575	1	PPC5-5-11A-1
11	3	575	12	PPC5-5-11A-12
17	3	575	1	PPC5-5-17A-1
17	3	575	12	PPC5-5-17A-12
22	3	575	1	PPC5-5-22A-1
22	3	575	12	PPC5-5-22A-12
27	3	575	1	PPC5-5-27A-1
27	3	575	12	PPC5-5-27A-12
32	3	575	1	PPC5-5-32A-1
32	3	575	12	PPC5-5-32A-12
41	3	575	1	PPC5-5-41A-1
41	3	575	12	PPC5-5-41A-12
52	3	575	1	PPC5-5-52A-1
52	3	575	12	PPC5-5-52A-12
62	3	575	1	PPC5-5-62A-1
62	3	575	12	PPC5-5-62A-12
77	3	575	1	PPC5-5-77A-1
77	3	575	12	PPC5-5-77A-12
99	3	575	1	PPC5-5-99A-1
99	3	575	12	PPC5-5-99A-12
125	3	575	1	PPC5-5-125A-1
125	3	575	12	PPC5-5-125A-12
144	3	575	1	PPC5-5-144A-1
144	3	575	12	PPC5-5-144A-12

8.3.3 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 Users Manual.

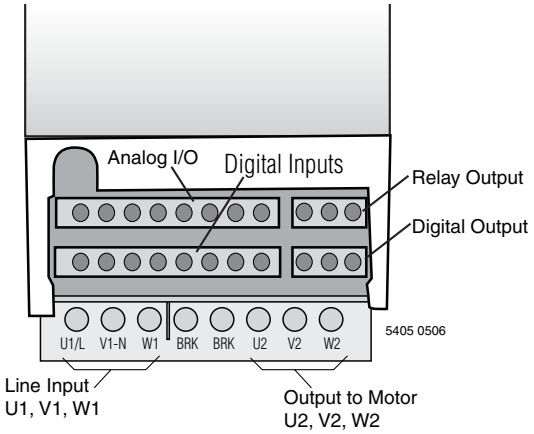


Figure 8.4 Typical Connections to PPC3

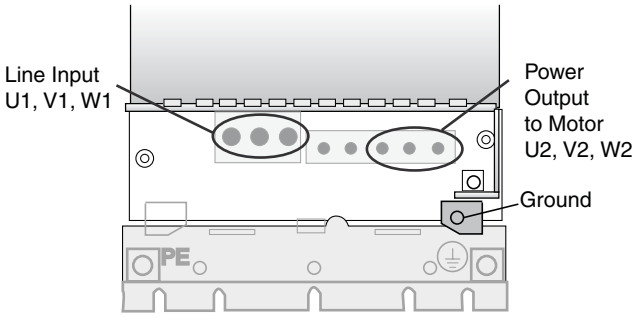


Figure 8.5 Typical Connections to PPC5

8.3.4 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.

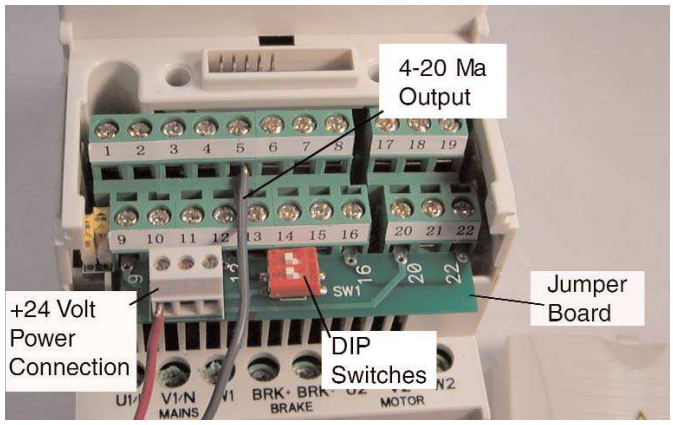


Figure 8.6 PPC3 Transducer Connection.

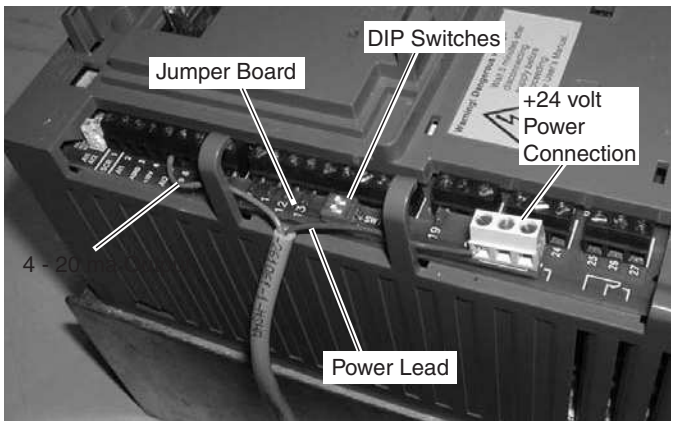


Figure 8.7 PPC5 Transducer Connection.

8.3.5 PENTEK Assistant

TABLE 8.3.5.1: 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
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

8.3.5.2 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

TABLE 8.2.7.2: 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 1	5 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
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

transducer. The 100% Value of a 200PSI transducer is 200PSI.

4023 PID Sleep Level: Operation below this rpm will cause the drive to stop.

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.

8.3.3 Mounting and Installation

STARTUP THE *PENTEK ASSISTANT*

Apply power to the unit, and follow the steps in section 8.3.5.4 after the Drive's screen is lit.

8.3.5.3 Using the PENTEK Assistant

Apply power to the unit and follow the steps in Section 8.3.5.4 for changing operation parameters, use the steps below to run the *PENTEK Assistant.*

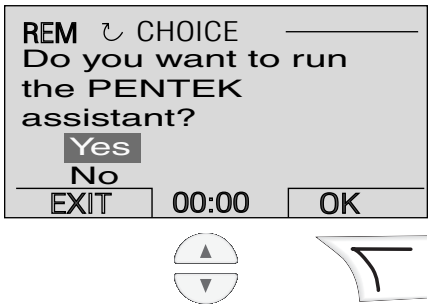
1. Use the MENU key to access the Menu List.
2. Select Assistants
3. Select *PENTEK Assistant.*
4. Follow the screen instructions to configure the system.

8.3.5.4 Step by step instructions

STEP 1

INITIAL STARTUP PANEL DISPLAY

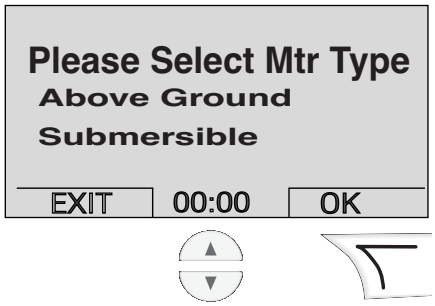
Upon initial drive power-up the user will be prompted to run the *PENTEK assistant.* Scroll to YES and then select OK. Wait while the assistant loads. On subsequent startups, the *PENTEK assistant* can be found in the ASSISTANTS menu.



STEP 2

MOTOR SELECTION SCREEN

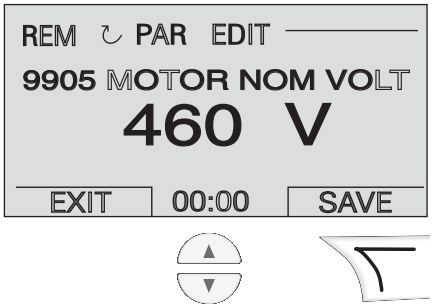
Scroll to select the type installation and then press OK.



STEP 3

MOTOR VOLTAGE SCREEN

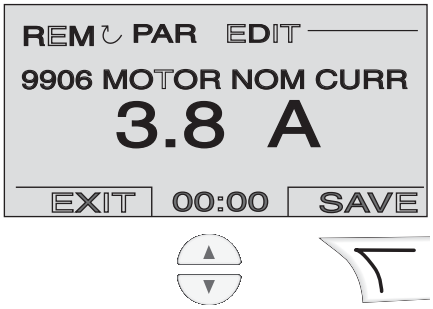
The screen shows motor voltage. Scroll to select the correct voltage for your motor as stated on the motor nameplate. This sample shows 460 volts. Press SAVE.



STEP 4

MOTOR CURRENT SCREEN

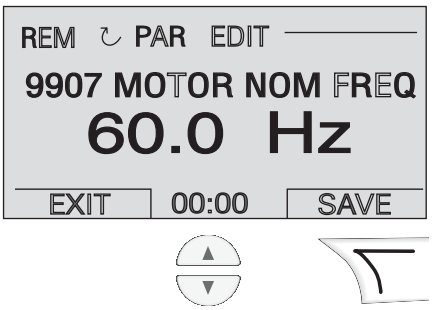
Enter the motor current from the motor nameplate (not maximum amps). Scroll to select the current and press SAVE.



STEP 5

MOTOR FREQUENCY SCREEN

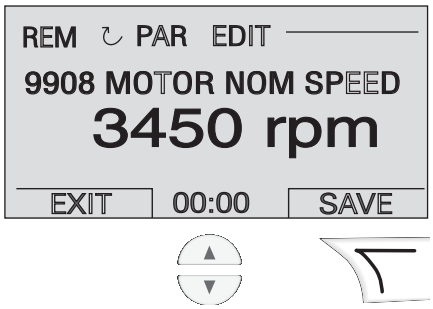
Enter the motor frequency (Hz) from the motor nameplate. Scroll to select the frequency and select SAVE.



STEP 6

MOTOR SPEED SCREEN

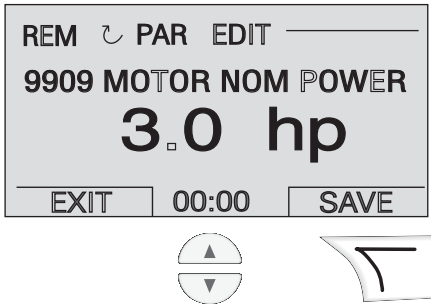
Enter the motor speed (RPM) from the motor nameplate. Scroll to select the speed and press SAVE. The sample here shows 3450 RPM.



STEP 7

MOTOR HORSEPOWER SCREEN

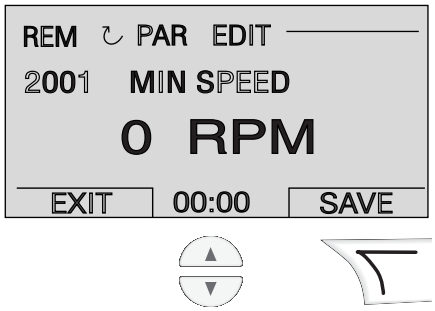
Enter the motor horsepower (HP) from the motor nameplate. Scroll to select the horsepower and press SAVE. The sample here shows 3.0 HP.



STEP 8

FOR SUBMERSIBLE PUMPS ONLY

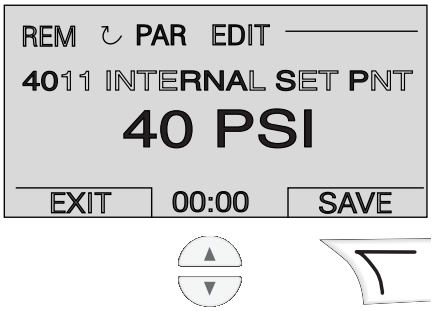
Enter the minimum speed allowed by the motor vendor (consult motor literature). This is to prevent motor bearing damage.



STEP 9

SCROLL TO SELECT CONSTANT PRESSURE POINT

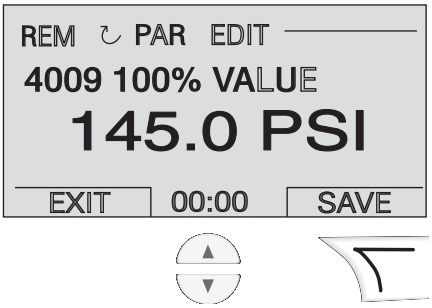
Example shows 40 PSI.

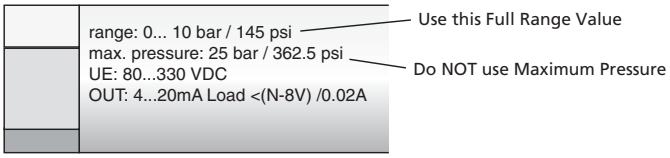


STEP 10

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 145 PSI.
NOTE: DO NOT choose maximum pressure.



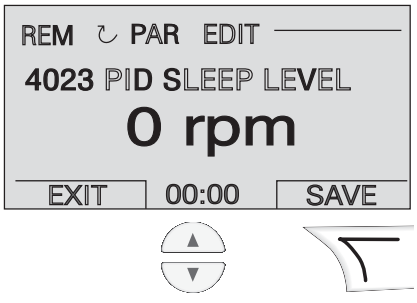


STEP 11

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 ACS550 Users Manual. Scroll to select the speed and then press SAVE. The sample here shows 0 RPM (waiting to be set).

⚠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.

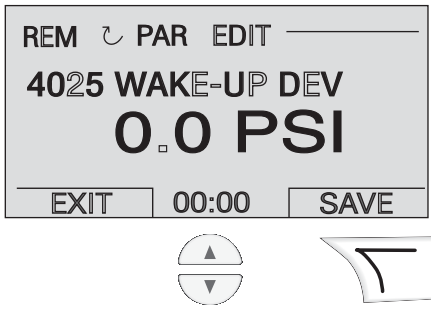


VFD

STEP 12

WAKE UP DEVIATION SCREEN

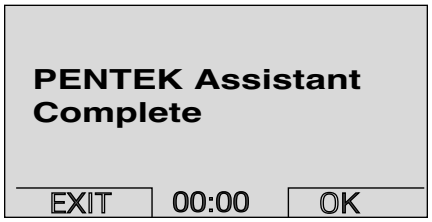
Enter the wake-up deviation. This is the amount pressure drops (PSI) below the pressure set point before the drive restarts. This sample is waiting to be set and shows 0 PSI.



STEP 13

ASSISTANT COMPETE

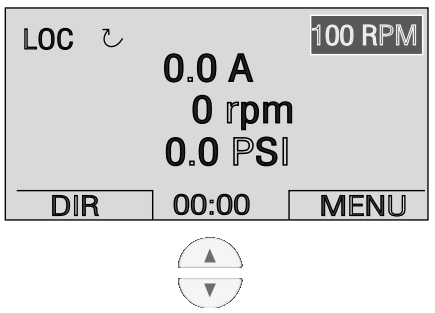
This ends setup of the *PENTEK Assistant.* The following steps complete the setup of the pump system.



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.

NOTICE: 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.

8.3.6 TIMER FUNCTION:

The PENTEK VFD 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

8.3.7 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, or see www.bec2.net.

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 VFD 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

8.3.8 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 precharge must be less than the pressure set point – wake up deviation.

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

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

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

8.4 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 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.
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.

	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	-	-	-	R	F	F
Submersible	-	R	R	F	F	F

Filters

NEMA 1, 230, 460 or 575 v	NEMA 1, CUL Listed	
Model	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

Reactors

Open Design 230 or 460 v	NEMA 1 230 or 460 v	
Model	Model	Rated Amps
KDRA1P	KDRA1PC1	3.4
DDRA2P	KDRA2PC1	4.8
KDRA3P	KDRA3PC1	7.6
KDRA4P	KDRA4PC1	11
KDRB1P	KDRB1PC1	14
KDRD1P	KDRD1PC2	21
KDRD2P	KDRD2PC2	27
KDRD3P	KDRD3PC2	34
KDRD4P	KDRD4PC2	40
KDRC1P	KDRC1PC2	52
KDRF1P	KDRF1PC3	65
KDRF2P	KDRF2PC3	77
KDRF3P	KDRF3PC4	96
KDRH1P	KDRH1PC4	124
KDRI1P	KDRI1PC4	156
KDRI2P	KDRI2PC4	180
KDRG1P	KDRG1PC4	240

NEMA 1 575 v	
Model	Rated Amps
KDRA31PC1	2.7
KDRA35PC1	3.9
KDRA33PC1	6.1
KDRA34PC1	9
KDRA36PC1	11
KDRD31PC2	17
KDRD32PC2	22
KDRD35PC2	27
KDRD33PC2	32
KDRD34PC2	41
KDRC31PC2	52
KDRF31PC3	62
KDRF32PC3	77
KDRF33PC4	99
KDRH31PC4	125
KDRI31PC4	144
KDRI32PC4	192
KDRG31PC4	242

SECTION 9:

Submersible Motor Controls (SMC) 50 & 60 Hz

SMC for PENTEK XE-Series and Franklin Electric Motors

60 Hz.

9.1 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.

Permanent Split Capacitor (PSC)

A PSC style control is the simplest of controls. The control consists only of a run capacitor. The run capacitor keeps the start (or auxiliary) windings in the circuit during both startup and run.

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 smoothes out operation of the motor and provides greater efficiency and a reduction in vibration and noise.

Plus Series Controls

PENTEK's 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 on and off the control. The switch takes the form of a magnetic contactor. The magnetic contactor uses a coil that physically closes the contacts when energized. The contactor allows the installer to use a pressure switch with a lower rating, since it is not switching the full amperage of the motor.

9.2 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.

9.3 MOUNTING AND INSTALLATION

Mounting and Installation

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

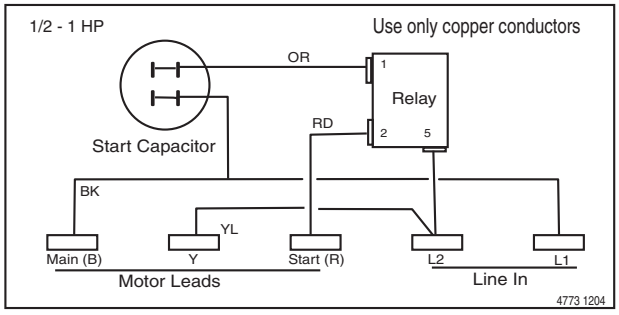
Submersible Motor Control Compatability

Motor Type	Submersible Motor Control Type			
	SMCT	SMC	Franklin	SMCP
PENTEK XE-Series	**NO**	Yes	Yes	**NO**
Franklin	**NO**	Yes	Yes	**NO**
PENTEK T-Series	Yes	**NO**	**NO**	**NO**
PENTEK 6"	**NO**	**NO**	**NO**	Yes

60 Hz.

9.4 WIRING CONNECTIONS AND REPLACEMENT PARTS

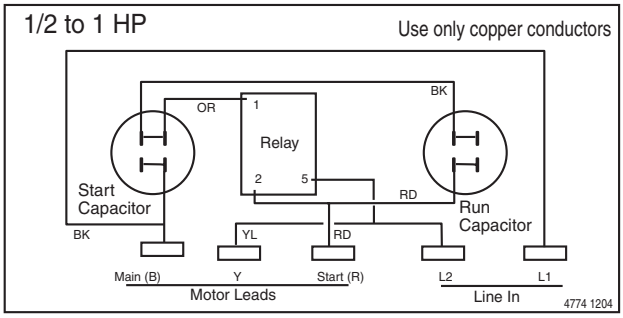
1/2 to 1 HP Capacitor Start, Induction Run



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, 50 Amp	U17-1311-R
115V	Relay, 50 Amp	U17-1343-R

1/2 to 1 HP Capacitor Start, Capacitor Run

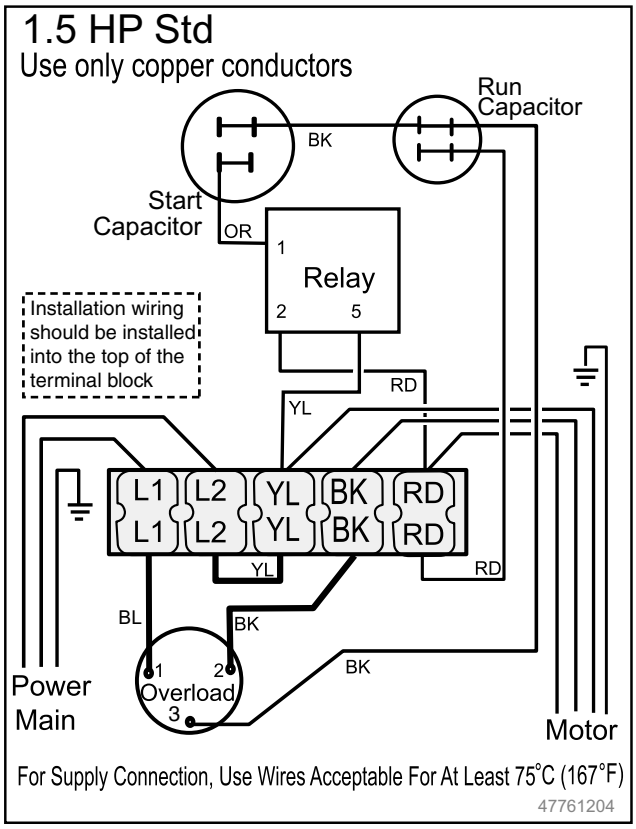


Models SMC-CR0521, SMC-CR0721, and SMC-CR1021

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, 50 Amp	U17-1311-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.



Model SMC-CR1521

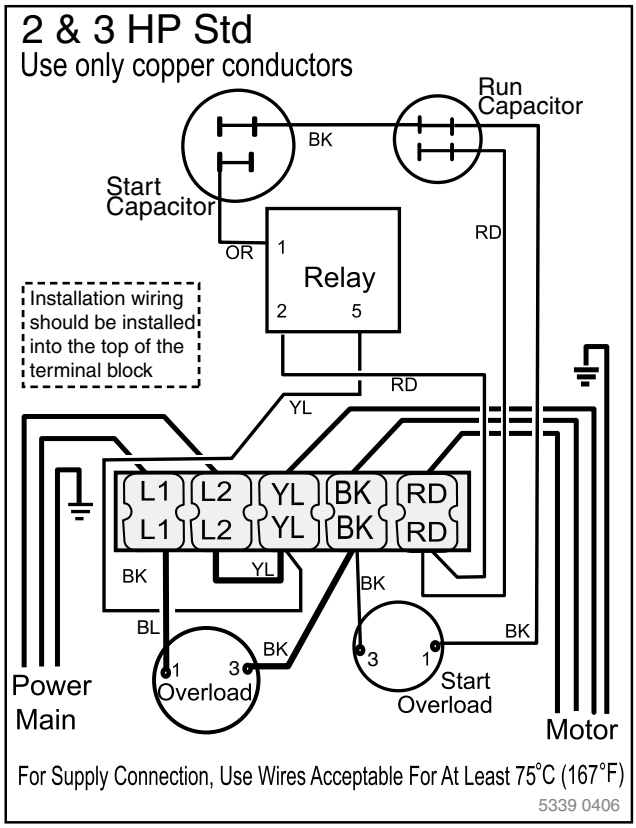
Description	Part Number
Start Capacitor, 105 µF, 330v	U17-1430-R
Run Capacitor, 10 µF, 370v	U17-1438-R
Overload Protector	U17-1313-R
Relay, 50 Amp	U17-1431-R

SMC

SMC for Franklin Electric Motors

60 Hz.

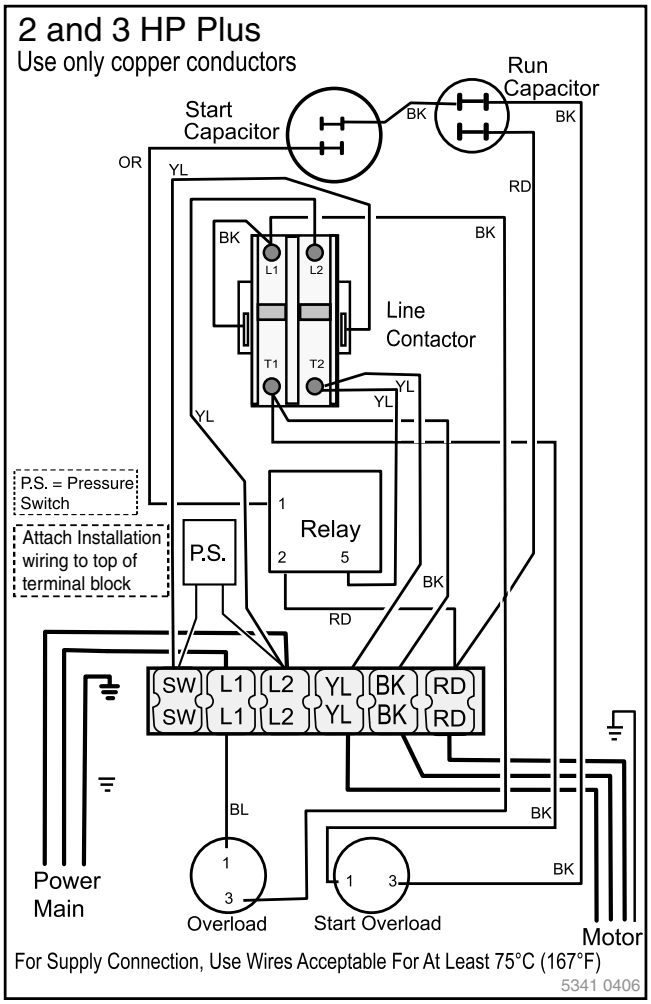
2 and 3 HP Standard



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	U17-1323R
Relay, 50 Amp	U17-1332-R

2 and 3 HP Plus



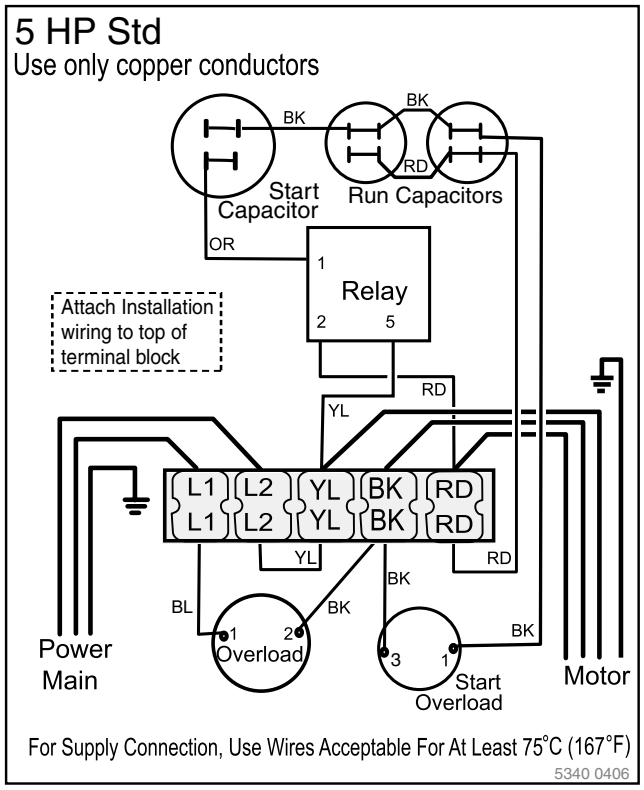
Models SMC-CRP2021 and SMC-CRP3021

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	U17-1323R
Relay, 50 Amp	U17-1332-R
Magnetic Contactor	P17-954-R

SMC for Franklin Electric 4" and 6" Motors

60 Hz.

5 HP Standard

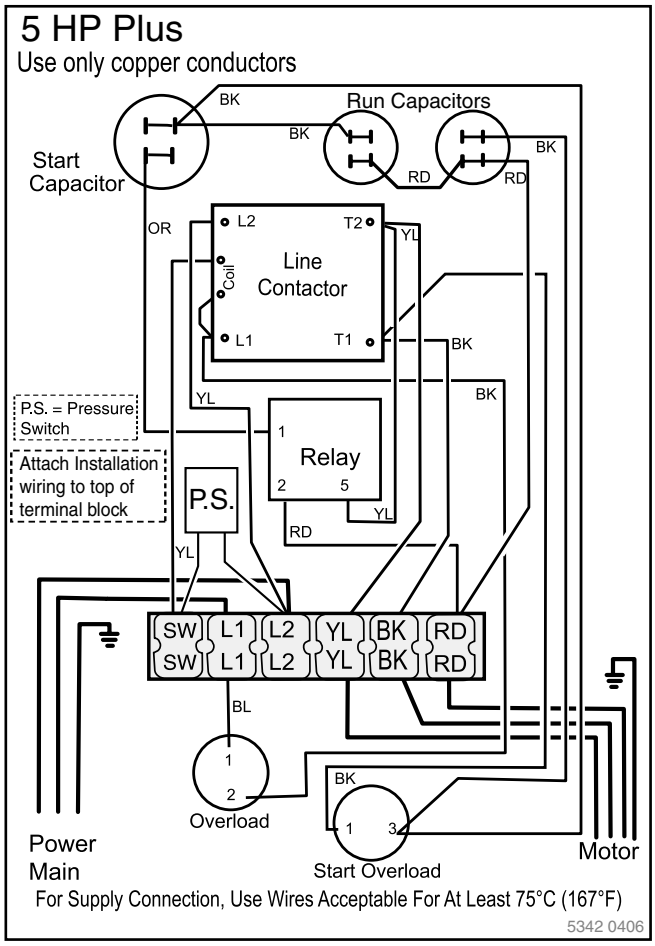


Model SMC-CR5021

Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1306-R
Run Capacitor, (2) 40 µF, 370v	U17-1294-R
Main Overload Protector	U117-1317A-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1434-R

If used with a Franklin 6" motor, a lightning arrestor must be used (part # P17-966-R)

5 HP Plus



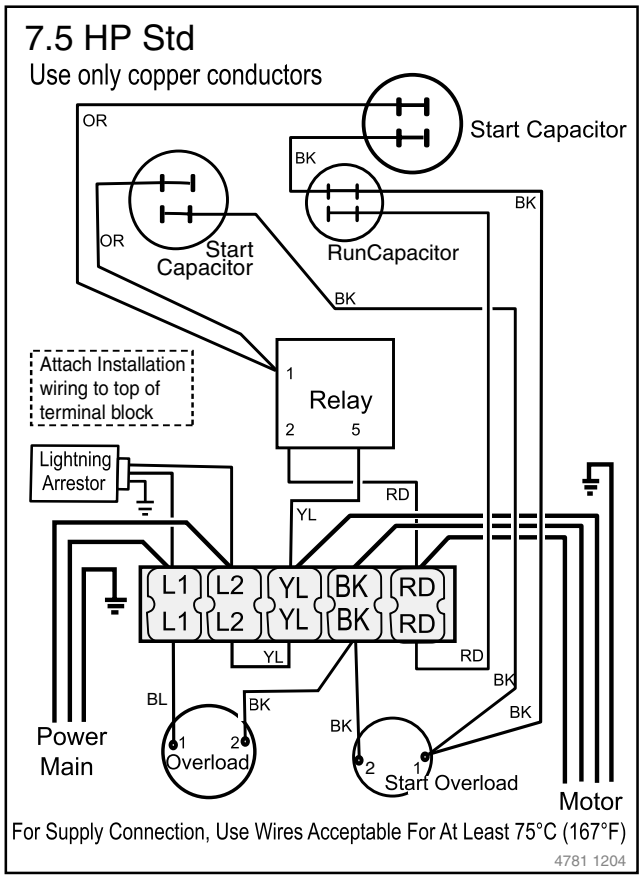
Model SMC-CRP5021

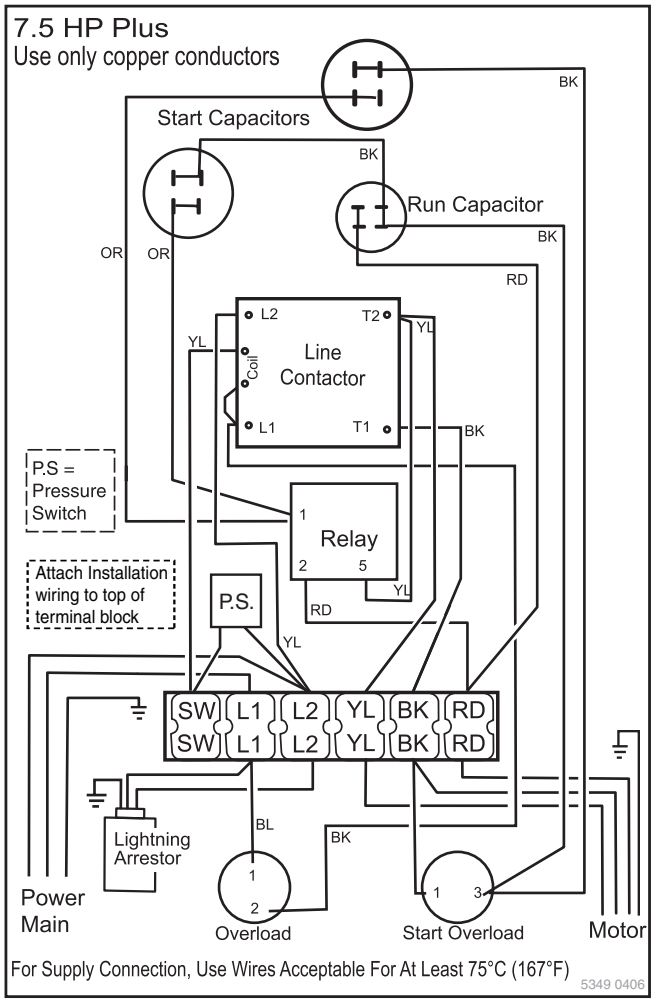
Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1437-R
Run Capacitor, (2) 40 µF, 370v	U17-1442-R
Magnetic Contactor	P17-953-R
Main Overload Protector	U117-1317B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1434-R

SMC for Franklin 6" Motors

60 Hz.

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





7.5 HP Standard

Description	Part Number
Start Capacitor, 216 µF, 330v	U17-1436-R
Start Capacitor, 270 µF, 330v	U17-1437-R
Run Capacitor, 45 µF, 370v	U17-1443-R
Main Overload Protector	U17-1317A-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1433-R
Lightning Arrestor	P17-966-R

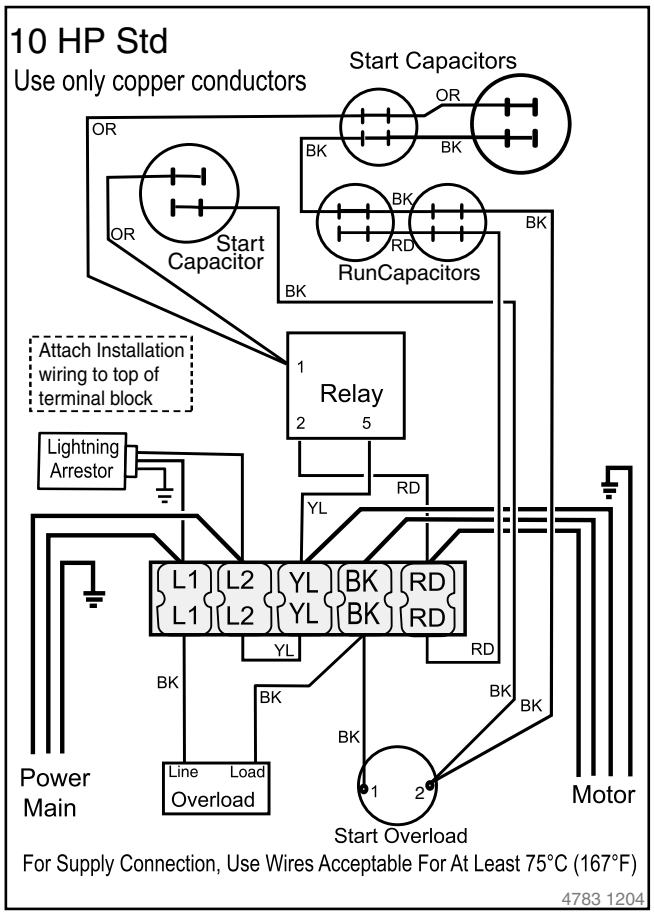
7.5 HP Plus Series

Description	Part Number
Start Capacitor, 216 µF, 330v	U17-1436-R
Start Capacitor, 270 µF, 330v	U17-1437-R
Run Capacitor, 35 µF, 370v	U17-1441-R
Magnetic Contactor	P17-952-R
Main Overload Protector	U17-1317B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1433-R
Lightning Arrestor	P17-966-R

SMC for Franklin 6" Motors

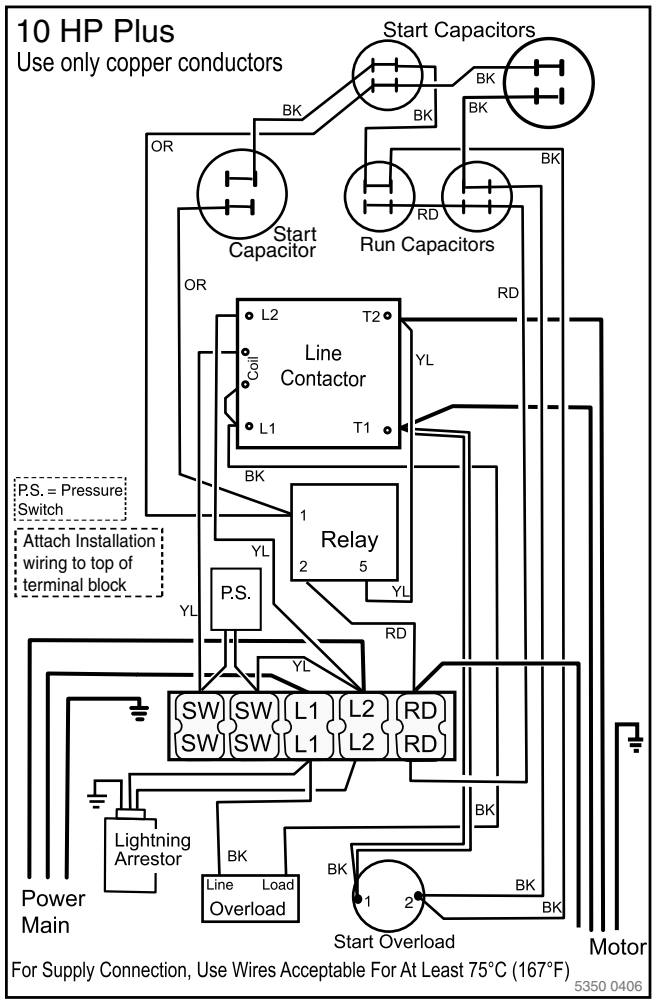
60 Hz.

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



10 HP Standard

Description	Part Number
Start Capacitors (2), 270 µF, 330v	U17-1437-R
Run Capacitors (2) 35 µF, 370v	U17-1441-R
Main Overload Protector	P17-955-R
Start Overload Protector	U117-1318C-R
Relay, 50 Amp	U17-1433-R
Lightning Arrestor	P17-966-R
Start Capacitor, 130 µF, 330v	U17-1426-R



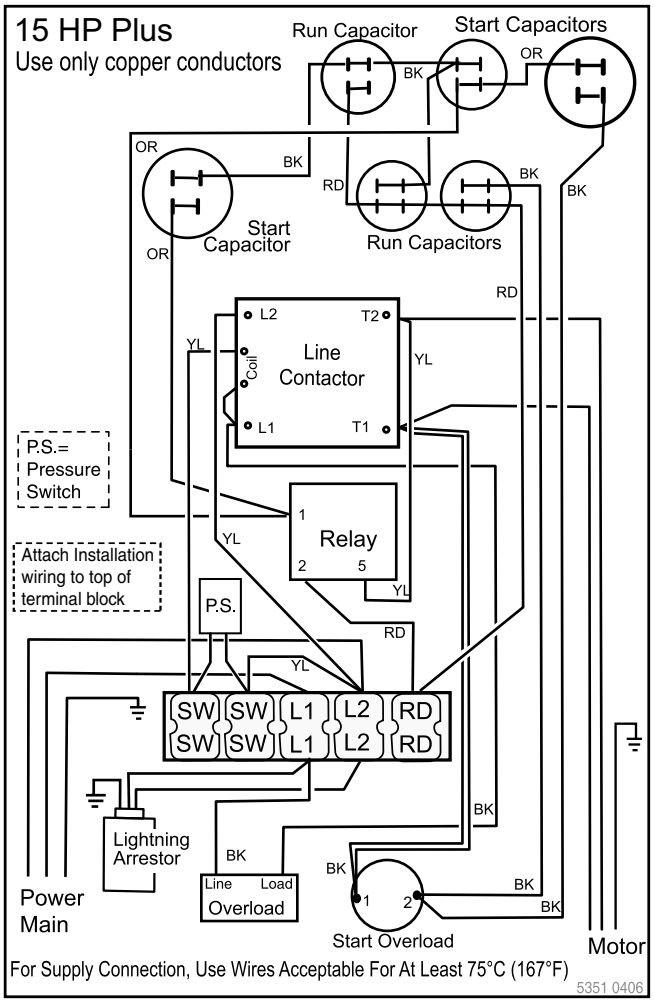
10 HP Plus Series

Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitors, (2) 130 µF, 330v	U17-1426-R
Run Capacitors, 35 µF, 370v	U17-1441-R
Magnetic Contactor	P17-952-R
Main Overload Protector	P17-955-R
Start Overload Protector	U117-1318D-R
Relay, 50 Amp	U17-1433-R
Lightning Arrestor	P17-966-R

SMC for Franklin 6" Motors

60 Hz.

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



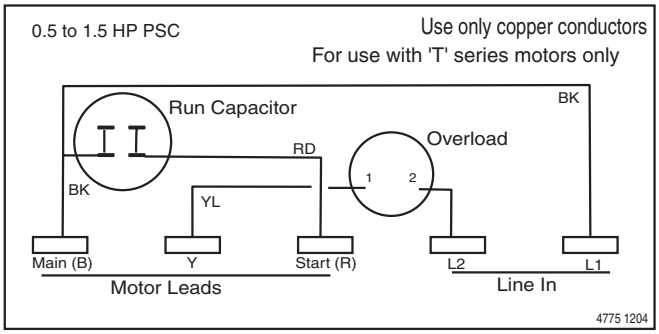
15 HP Plus Series

Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitor, 161 µF, 330v	U17-1427-R
Run Capacitors (3), 45 µF, 370v	U17-1443-R
Magnetic Contactor	P17-951-R
Main Overload Protector	P17-956-R
Start Overload Protector	U117-1318-R
Relay, 50 Amp	U17-1343-R
Lightning Arrestor	P17-966-R

SMCT Series for PENTEK 4" T-Series Motors

60 Hz.

1/2 to 1-1/2 HP PSC



Models SMCT-CR0521, SMCT-CR0721, SMCT-CR1021 and SMCT-CR1521

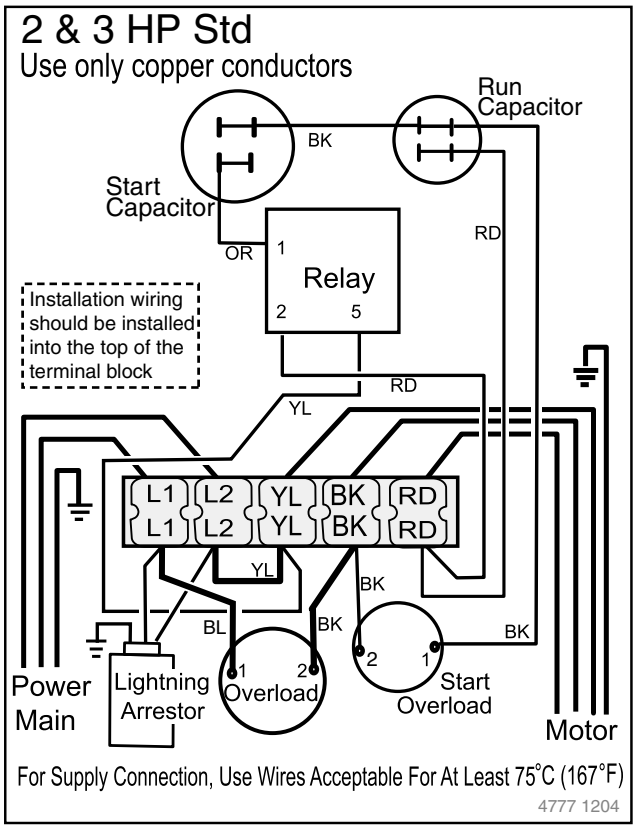
HP	Description	Part Number
1/2	Run Capacitor, 20 µF, 370v	U17-1291-R
3/4	Run Capacitor, 23 µF, 370v	U17-1292-R
1	Run Capacitor, 35 µF, 370v	U17-1293-R
1-1/2	Run Capacitor, 40 µF, 370v	U17-1294-R
1-1/2	Overload Protection	U18-1501-R

SMCT Series for PENTEK 4" T-Series Motors

60 Hz.

2 and 3 HP Capacitor Start, Capacitor Run

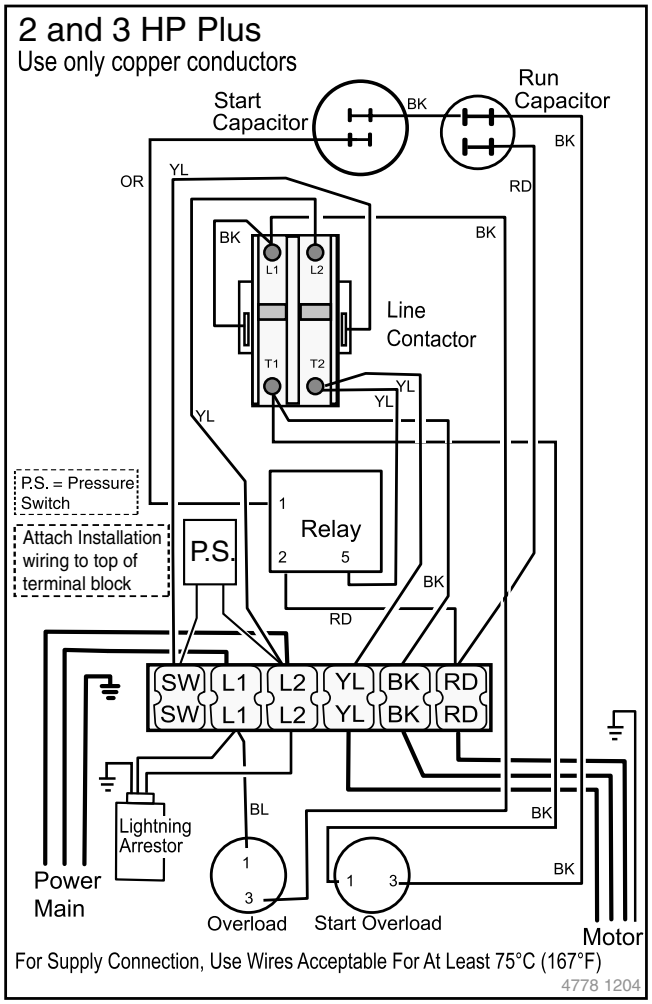
NOTICE: Attach installation wiring to the top of the terminal strip. Schematics may show otherwise for clarity.



Models SMCT-CR2021 and SMCT-CR3021

Description	Part Number
Start Capacitor, 208 µF, 330v	U17-1428-R
Run Capacitor, 50 µF, 370v	U17-1444-R
Main Overload Protector, 2 HP	U17-1319-R
Main Overload Protector, 3 HP	U17-1322-R
Start Overload Protector	U17-1323-R
Relay, 50 Amp	U17-1432-R
Lightning Arrestor	P17-966-R

2 and 3 HP Plus



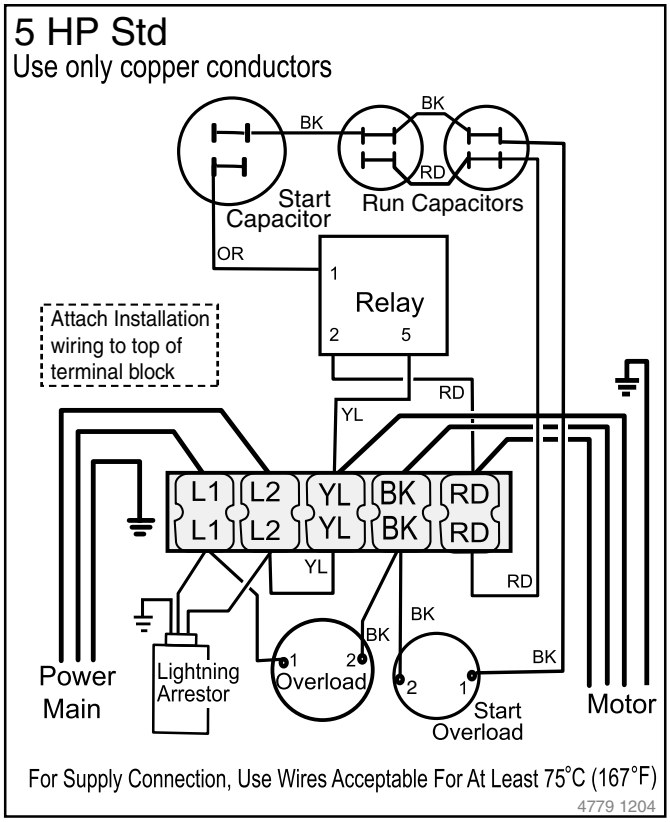
Models SMCT-CRP2021 and SMCT-CRP3021

Description	Part Number
Start Capacitor, 208 µF, 330v	U17-1428-R
Run Capacitor, 50 µF, 370v	U17-1444-R
Magnetic Contactor	P17-954-R
Main Overload Protector, 2 HP	U17-1319-R
Main Overload Protector, 3 HP	U17-1322-R
Start Overload Protector	U17-1323-R
Relay, 50 Amp	U17-1432-R
Lightning Arrestor	P17-966-R

SMCT Series for PENTEK 4" T-Series Motors

60 Hz.

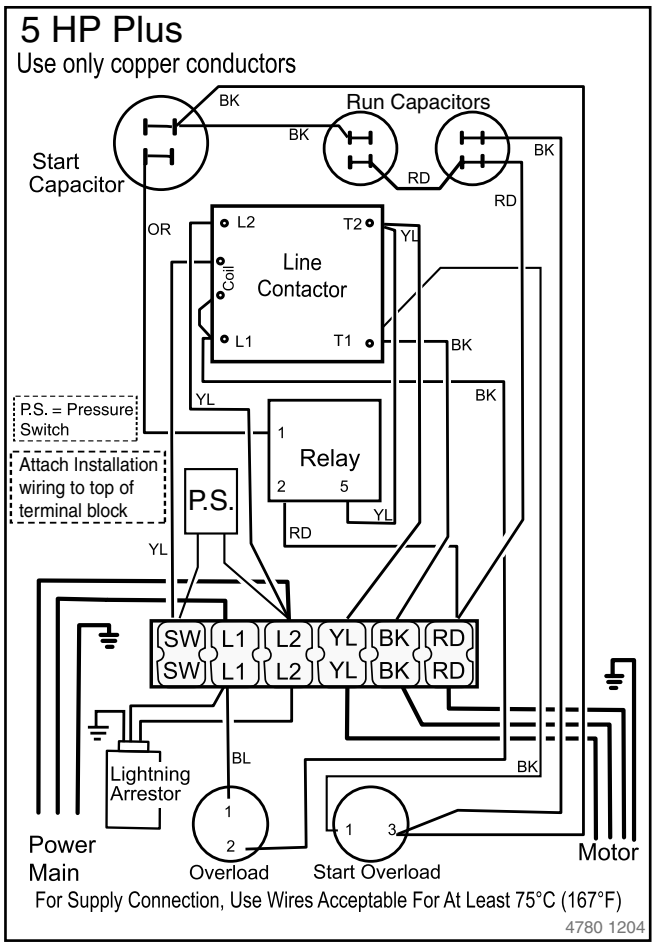
5 HP Standard



Modes SMCT-CR5021

Description	Part Number
Start Capacitors, (2) 40 µF, 370v	U17-1442-R
Run Capacitor, 270 µF, 330v	U17-1437-R
Main Overload Protector	U17-1317A-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1432-R
Lightning Arrestor	P17-966-R

5 HP Plus

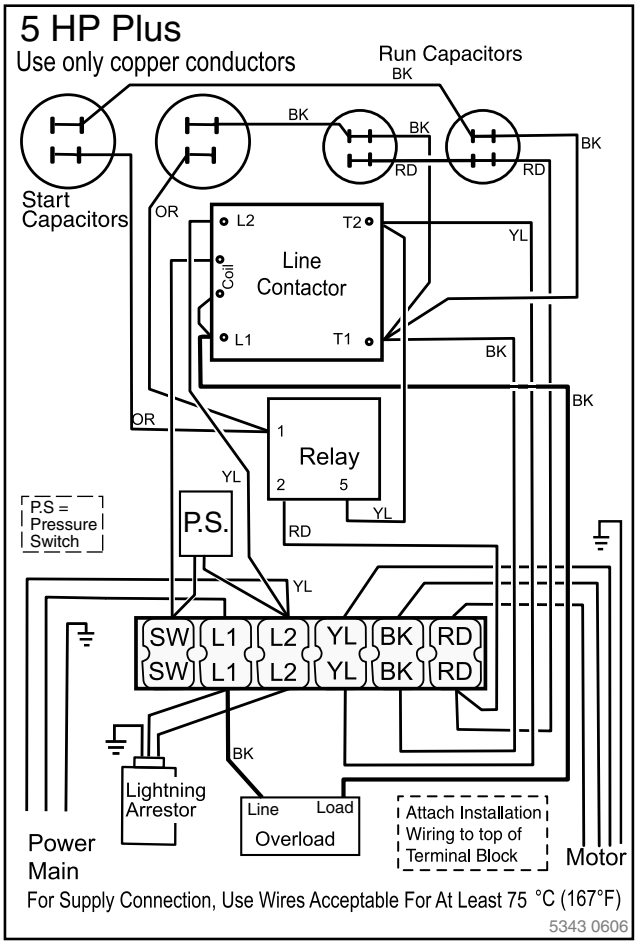


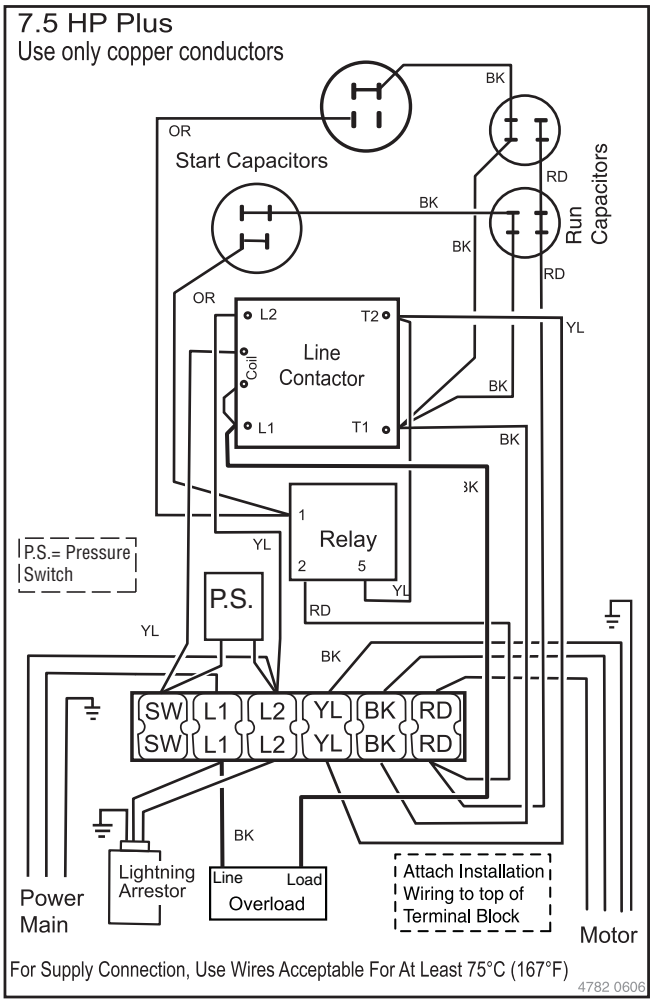
Model SMCT-CRP5021

Description	Part Number
Start Capacitors, (2) 40 µF, 370v	U17-1442-R
Run Capacitor, 270 µF, 330v	U17-1437-R
Magnetic Contactor	P17-953-R
Main Overload Protector	U17-1317B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1431-R
Lightning Arrestor	P17-966-R

SMCP for PENTEK 6" Motors

60 Hz.





5 HP Plus Series

SMCP-CRP-5021

Description	Part Number
Start Capacitor, 161 µF, 330v	U17-1427-R
Start Capacitor, 216 µF, 330v	U17-1436-R
Run Capacitors, 45 µF, 370v	U17-1443-R
Magnetic Contactor	P17-953-R
Overload Protector	P17-975-R
Relay, 50 Amp	U17-1503-R
Lightning Arrestor	P17-966-R

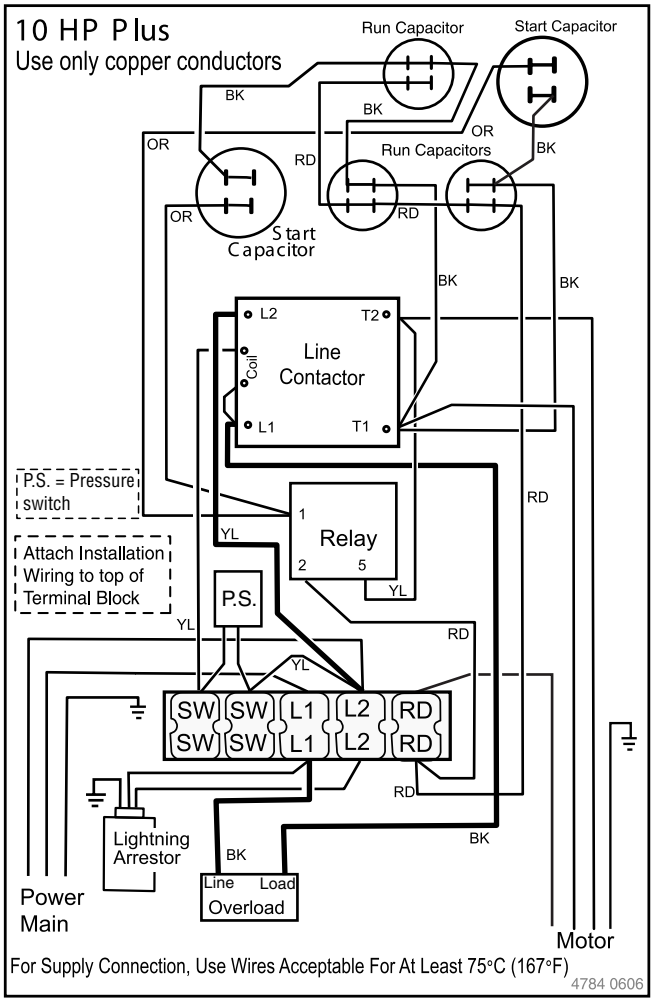
7.5 HP Plus Series

SMCP-CRP-7521

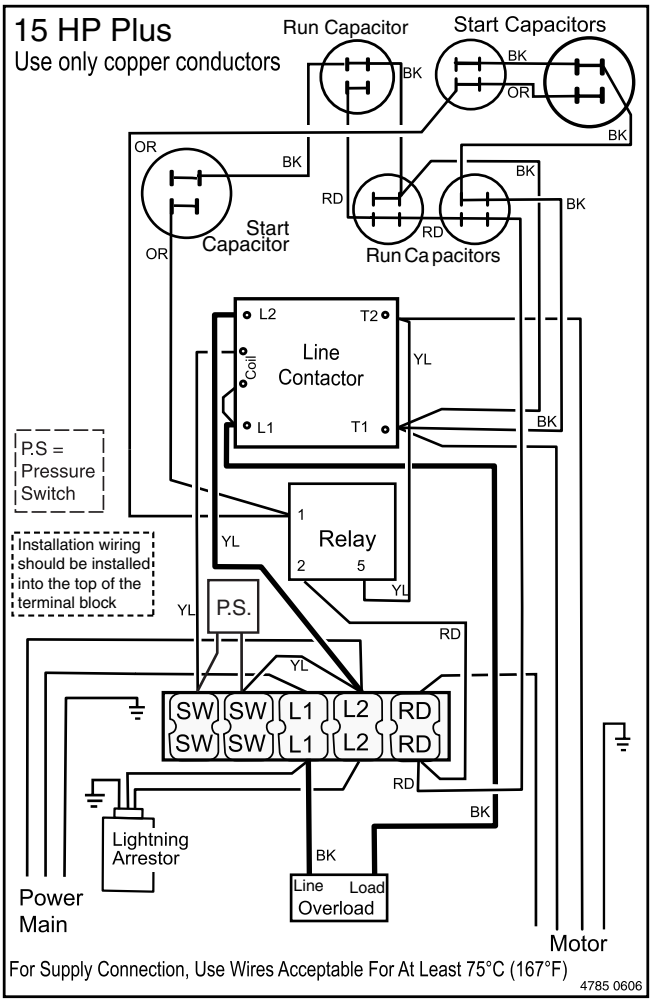
Description	Part Number
Start Capacitor, 130 µF, 330v	U17-1426-R
Start Capacitor, 270 µF, 330v	U17-1437-R
Run Capacitors, 55 µF, 370v	U17-1445-R
Magnetic Contactor	P17-952-R
Overload Protector	P17-976-R
Relay, 50 Amp	U17-1503-R
Lightning Arrestor	P17-966-R

SMCP for PENTEK 6" Motors

60 Hz.



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



10 HP Plus Series

SMCP-CRP-10021

Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitor, 50 µF, 370v	U17-1444-R
Run Capacitors, 45 µF, 370v	U17-1443-R
Magnetic Contactor	P17-952-R
Overload Protector	P17-977-R
Relay, 50 Amp	U17-1503-R
Lightning Arrestor	P17-966-R

15 HP Plus Series

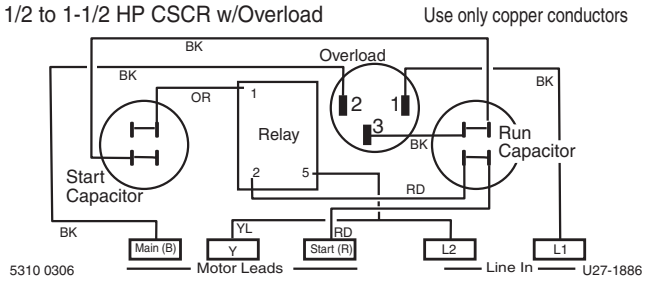
SMCP-CRP-15021

Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitor, 161 µF, 330v	U17-1427-R
Run Capacitors (3), 55 µF, 370v	U17-1445-R
Magnetic Contactor	P17-951-R
Overload Protector	P17-978-R
Relay, 50 Amp	U17-1503-R
Lightning Arrestor	P17-966-R

SMC5 for Franklin 50 Hz Motors

50 Hz.

1/2 through 1-1/2 HP Standard

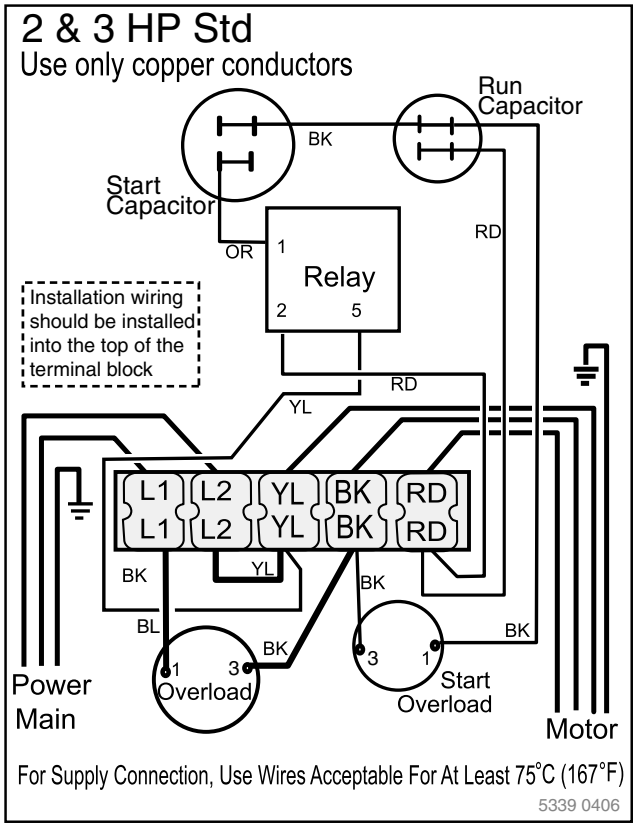


Description	Part Number
Start Capacitor, 59 µF, 270v, 1.0 HP	U17-1423-R
Start Capacitor, 105 µF, 270v, 1.5 HP	U117-1425-R
Run Capacitor, 23 µF, 370v, 1.0 HP	U17-1292-R
Run Capacitor, 10 µF, 370v, 1.5 HP	U17-1292-R
Main Overload Protector, Automatic, 1.0 HP	U17-1454-R
Main Overload Protector, Automatic, 1.5 HP	U17-1459-R
Relay, 50 Amp, 50 Hz., 220-240 Volts	U17-1421-R

SMC5 for Franklin 50 Hz Motors

50 Hz.

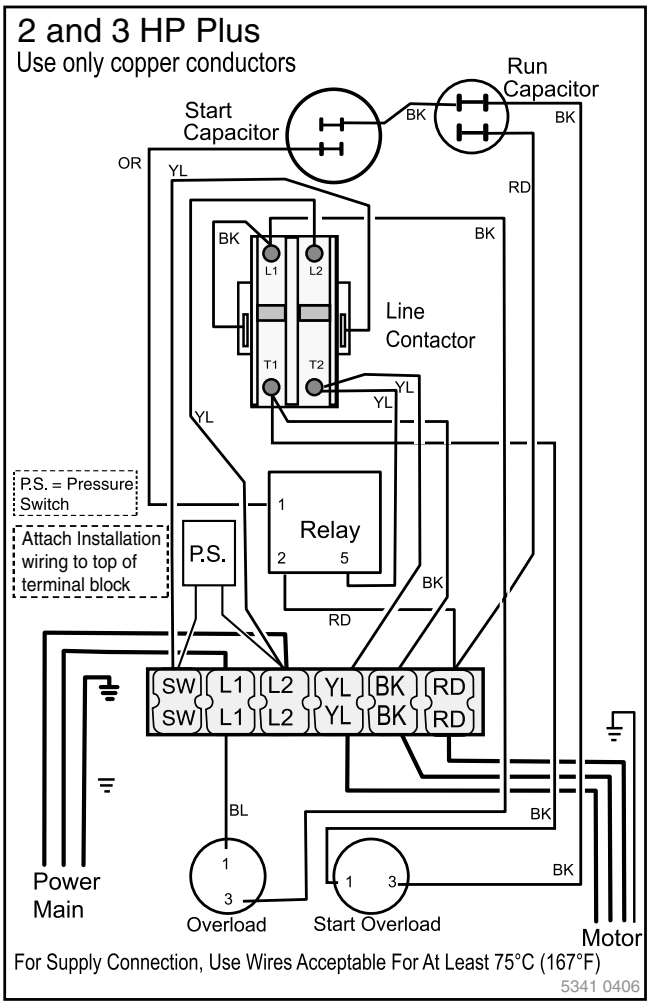
2 and 3 HP Standard



Models SMC5-CR2021, SMC5-CR3021

Description	Part Number
2 HP Start Capacitors, 200 µF, 350v	U17-1420-R
2 HP Run Capacitor, 20 µF, 230v	U17-1440-R
2 HP Main Overload Protector	U17-1321-R
2 HP Start Overload Protector	U17-1313-R
Relay, 50 Amp	U17-1458-R
3 HP Start Capacitors, 270 µF, 330v	U17-1437-R
3 HP Run Capacitor, 35 µF, 370v	U17-1441-R
3 HP Main Overload Protector	U117-1455A-R
3 HP Start Overload Protector	U17-1720-R

2 and 3 HP Plus



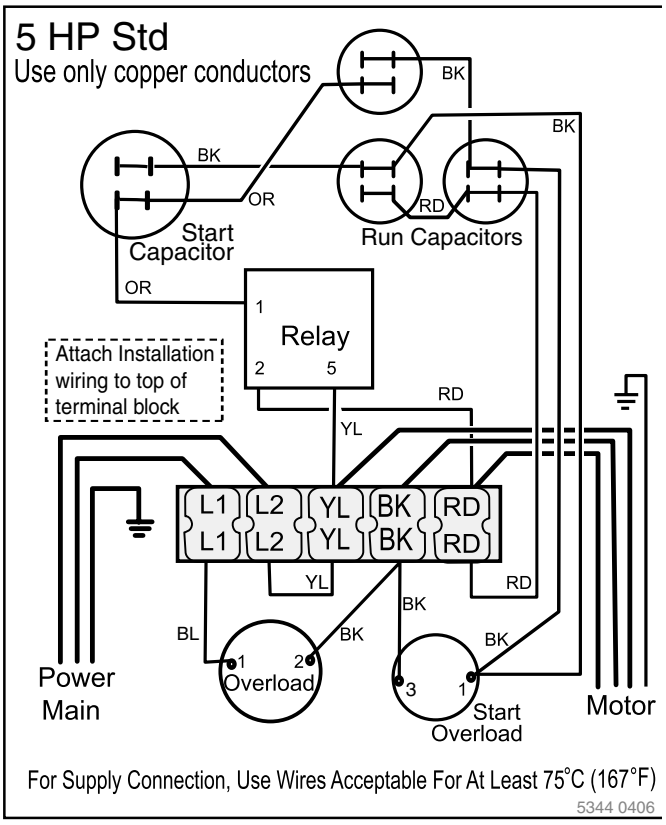
Models SMC5-CRP2021, SMC5-CRP3021

Description	Part Number
2 HP Start Capacitors, 200 µF, 350v	U17-1420-R
2 HP Run Capacitor, 20 µF, 230v	U17-1440-R
2 HP Main Overload Protector	U17-1321-R
2 HP Start Overload Protector	U17-1313-R
Relay, 50 Amp	U17-1450-R
3 HP Start Capacitors, 270 µF, 330v	U17-1437-R
3 HP Run Capacitor, 35 µF, 370v	U17-1441-R
3 HP Main Overload Protector	U117-1455B-R
3 HP Start Overload Protector	U17-1720-R
Magnetic Contactor	P17-954-R

SMC5 for Franklin 50 Hz Motors

50 Hz.

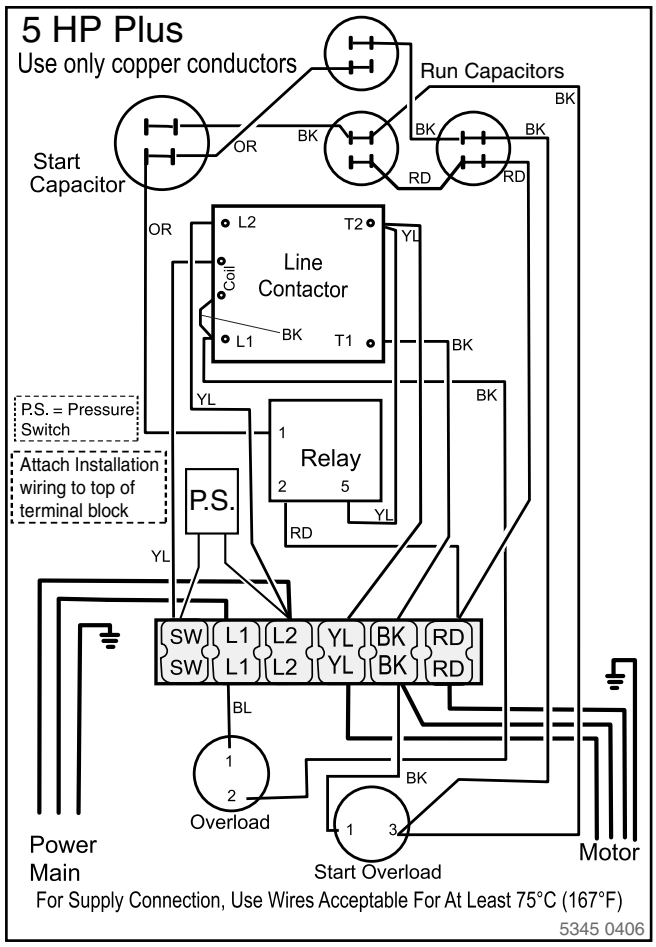
5 HP Standard



Models SMC5-CR5021

Description	Part Number
Start Capacitors, 216µF, 330v	U17-1436-R
Start Cap, 161µF, 330v	U17-1427-R
Run Capacitor, 35µF, 370v	U12-1441-R
Run Cap, 40 F, 370v	U12-1442-R
Main Overload Protector	U117-1456A-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1421-R

5 HP Plus



Models SMC5-CRP5021

Description	Part Number
Start Capacitors, 216µF, 330v	U17-1436-R
Start Cap, 161µF, 330v	U17-1427-R
Run Capacitor, 35µF, 370v	U12-1441-R
Run Cap, 40 F, 370v	U12-1442-R
Main Overload Protector	U117-1456B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1421-R

SECTION 10:

Motor Protection

10.1 HOW THEY WORK

PENTEK motor protectors are designed to protect single phase pumps from dry run, dead head, jammed impeller, and over & undervoltage 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.

10.2 SPECIFICATIONS

Specification	SPP-111	SPP-111-3RL	SPP-231	SPP-233	SPP-235-XX
1 Phase Line Voltage (±10%)	115 VAC	115 VAC	230 VAC	230 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	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz
Power Consumption (Maximum)	5 W	5 W	5 W	5 W	5 W
Operating Temperature	-40° to 158° F (-40° to +70° C)	-40° to 158° F (-40° to +70° C)	-40° to 158° F (-40° to +70° C)	-40° to 158° F (-40° to +70° C)	-40° to 158v F (-40° to +70° C)
Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 2, 4kV Contact, 6 kV Air	EC 1000-4-2, Level 2, 4kV Contact, 6 kV Air	IEC 1000-4-2, Level 2, 4kV Contact, 6 kV Air	IEC 1000-4-2, Level 2, 4kV Contact, 6 kV Air	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)	1.6 lbs (.73 kg)
Enclosure	None	NEMA 3R	None	NEMA 3R w/ LENS	NEMA 3R w/ LENS
Current Transformer Ratio	N/A	50:5	N/A	N/A SPP-235-100 -- 75:5 SPP-235-150 -- 100:5	SPP-235-75 – 50:5
OPERATING POINTS					
Overload	125 % of Calibration Point	125 % of Calibration Point	125 % of Calibration Point	125 % of Cal bration Point	125 % of Calibration Point
Underload (Dry Run)	~80% of Cal bration Point	~80% of Calibration Point	~80% of Cal bration Point	~80% of Cal bration Point	~80% of Calibration Point
Overvoltage Trip Point	132.5 VAC	265 VAC	265 VAC	265 VAC	265 VAC
Undervoltage Trip Point	95 VAC	190 VAC	190 VAC	190 VAC	190 VAC
Number of Restarts allowed in a 60 sec. Period before lockout (Rapid Cycle Timer)	4	4	4	4	4
Trip Delay Time Overload)	5s	5s	5s	5s	5s
Trip Delay Time (Dry Run)	2s	2s	2s	2s	2s
RESTART DELAY TIME					
Overvoltage/Undervoltage Delay	5s	5s	5s	5s	5s
All other faults (Dry Run Rec. Timer)	2-225 min	2-225 min	2-225 min	2-225 min	2-225 min
TERMINAL					
Wire Gauge	N/A	N/A	N/A	12-22	12-22
Maximum Torque	N/A	N/A	N/A	7 in- bs	7 in-lbs

10.3 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.

10.4 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's "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 10-1.

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.

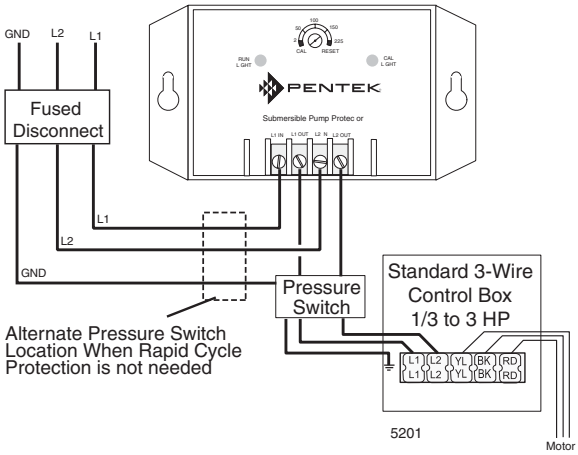


Figure 10-1: SPP233 Standard Control Box Connection

Settings

CALIBRATION/SETTINGS

NOTICE: Calibrate the Motor Protector during normal pumping conditions.

Turn the RESTART DELAY / CALIBRATION adjustment fully counter-clockwise to the "CAL." position.

Apply power to the Motor Protector®. The pump motor should be running at this point.

The Motor Protector is being calibrated when the CAL. LIGHT turns on (approximately 5 seconds). Within 10 seconds, proceed to step 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

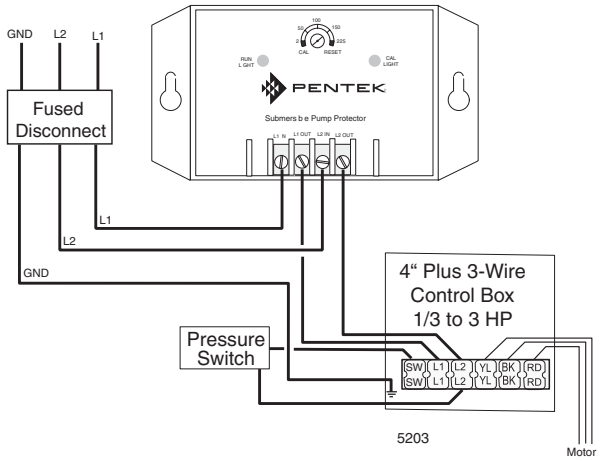


Figure 10-2: "Plus" Control Box Connection for SPP233

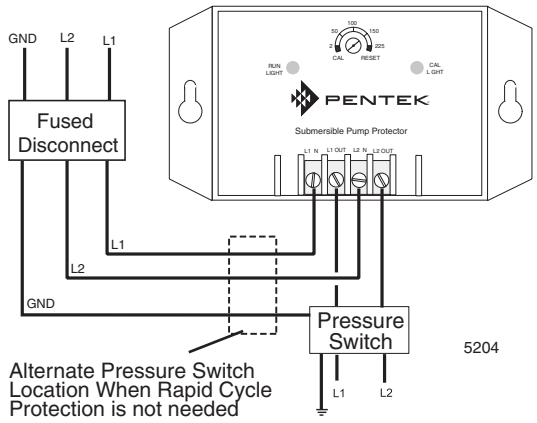


Figure 10-3: 2-Wire Connection for SPP233

the "CAL." position, the unit will trip off and stay off. Turn the adjustment out of the "CAL." position to start the pump.

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 the Diagnostics Table for instructions to diagnose a rapid cycling fault.

SECTION 11:

Troubleshooting

11.1 SYSTEM TROUBLESHOOTING

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	1. 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	1. 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

11.1 SYSTEM 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
Low or No Water Production (continued)	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	1. 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 2. 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.

11.1 SYSTEM TROUBLESHOOTING

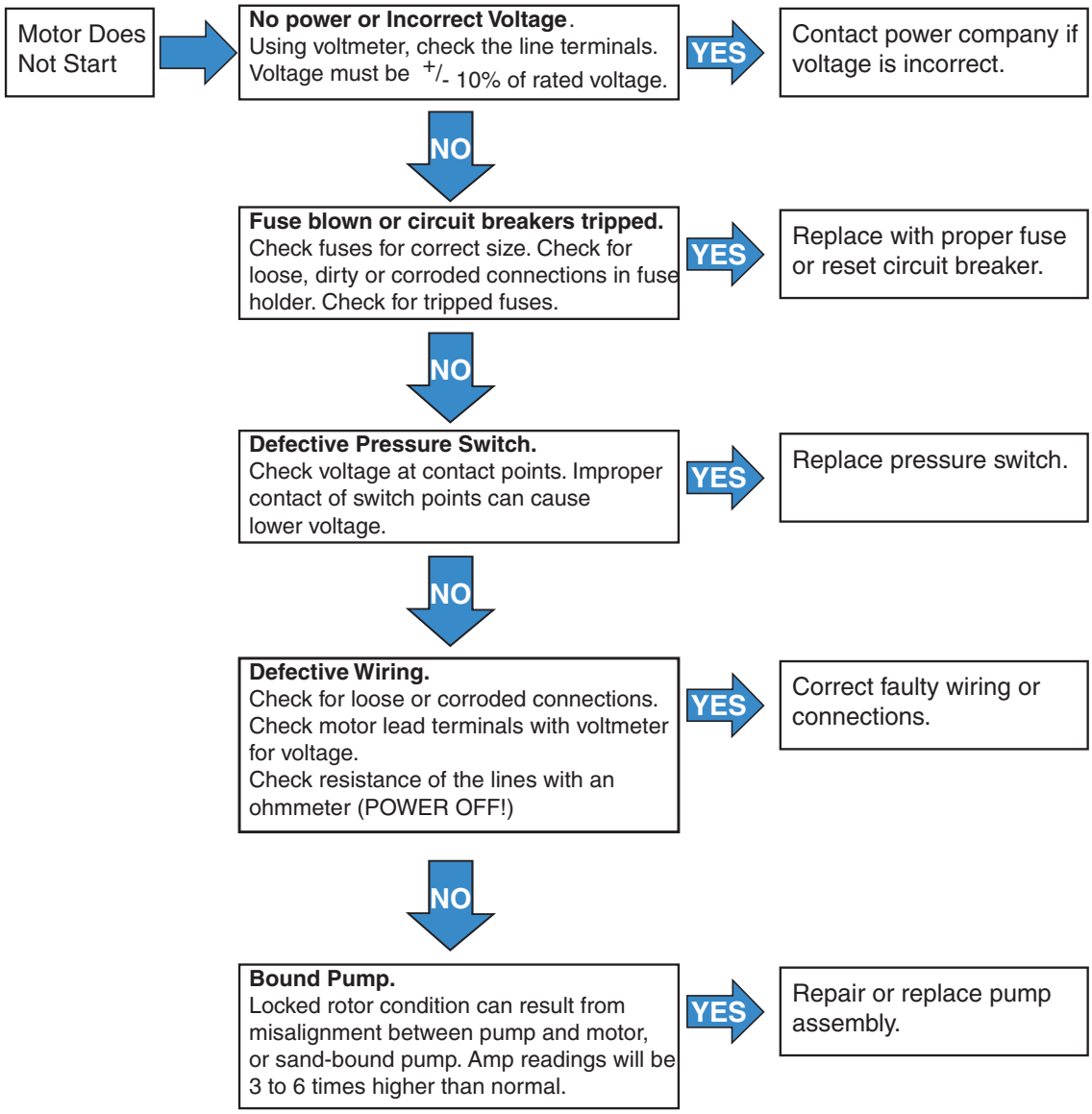
PUMP AND MOTOR PROBLEM ANALYSIS (Continued)

PROBLEM	POSSIBLE CAUSE	CHECK AND RESTORE
Pump Runs All The Time (Con't)	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	1. 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

11.2 MOTOR TROUBLESHOOTING FLOW CHARTS

Troubleshooting Flow Chart

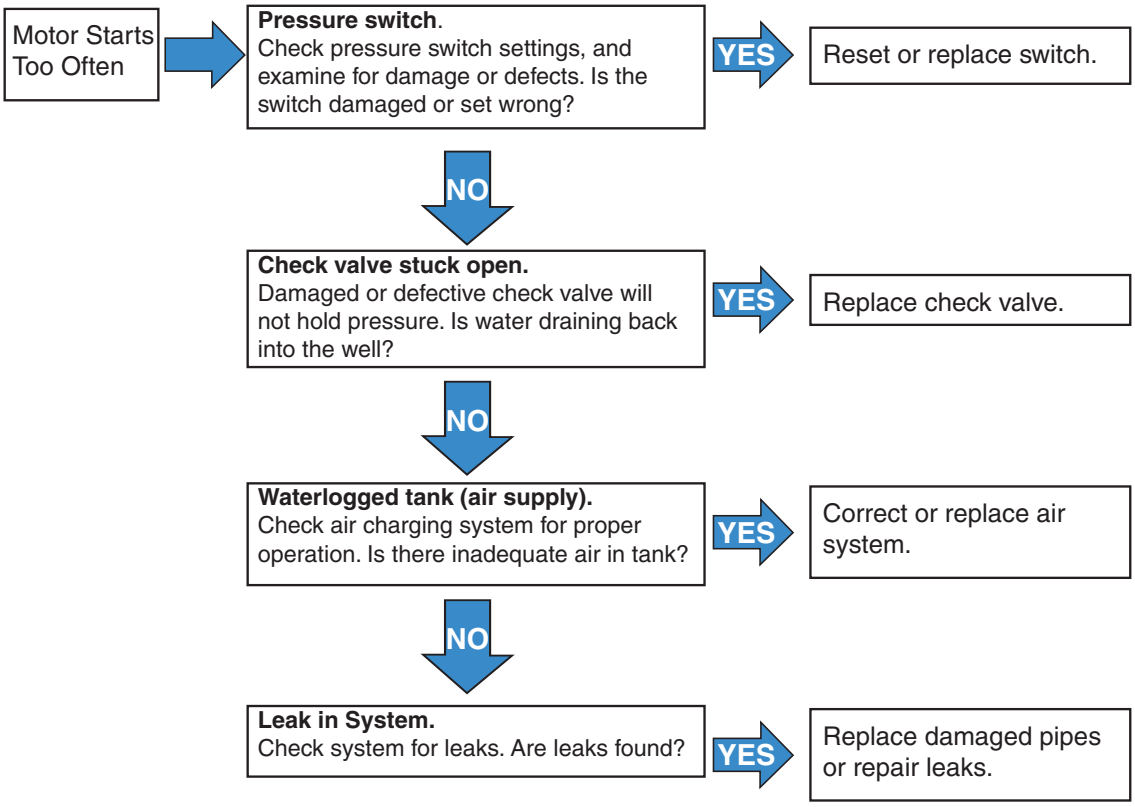
Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.



11.2 MOTOR TROUBLESHOOTING FLOW CHARTS

Troubleshooting Flow Chart (Continued)

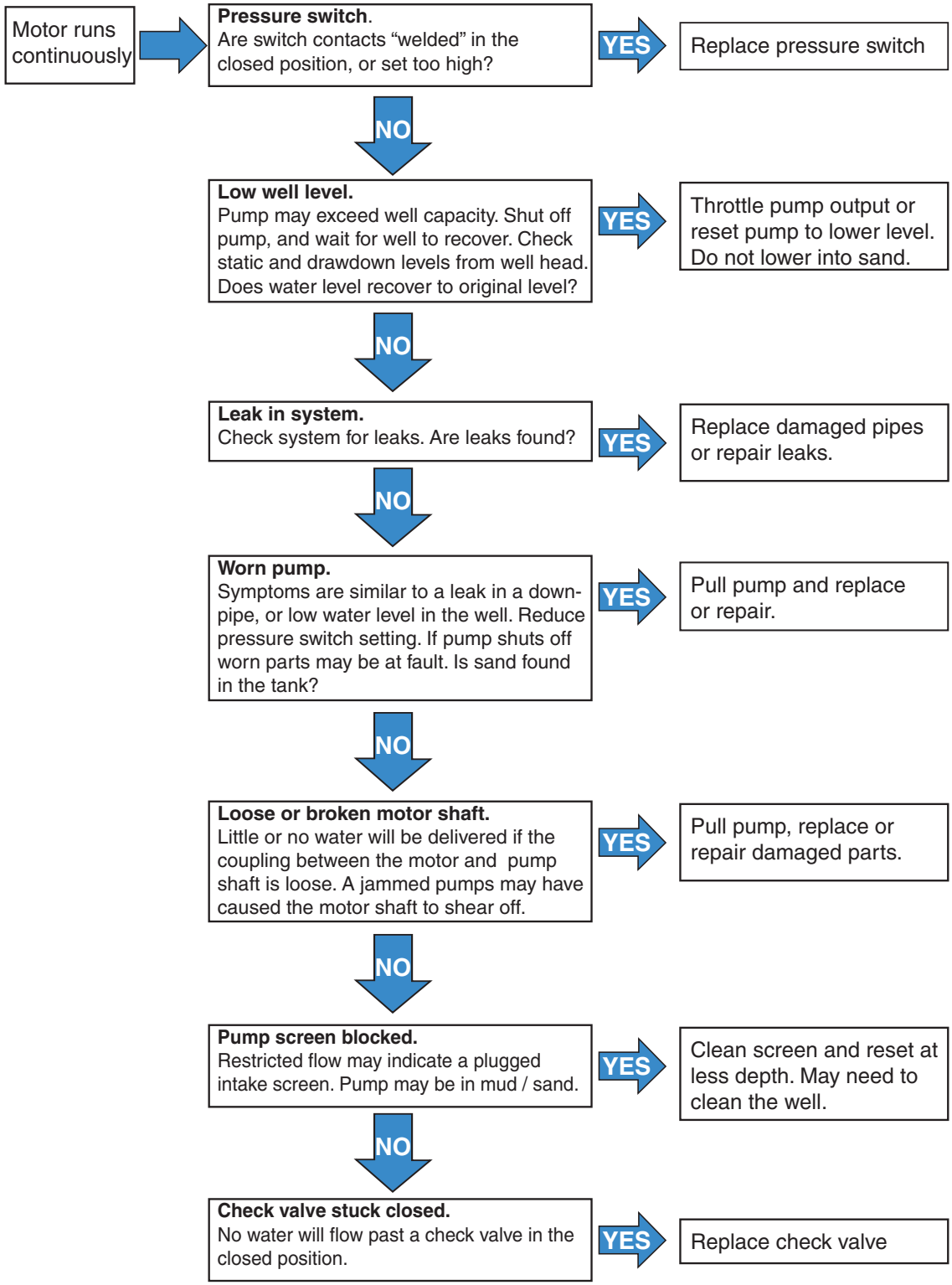
Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.



11.2 MOTOR TROUBLESHOOTING FLOW CHARTS

Troubleshooting Flow Chart (Continued)

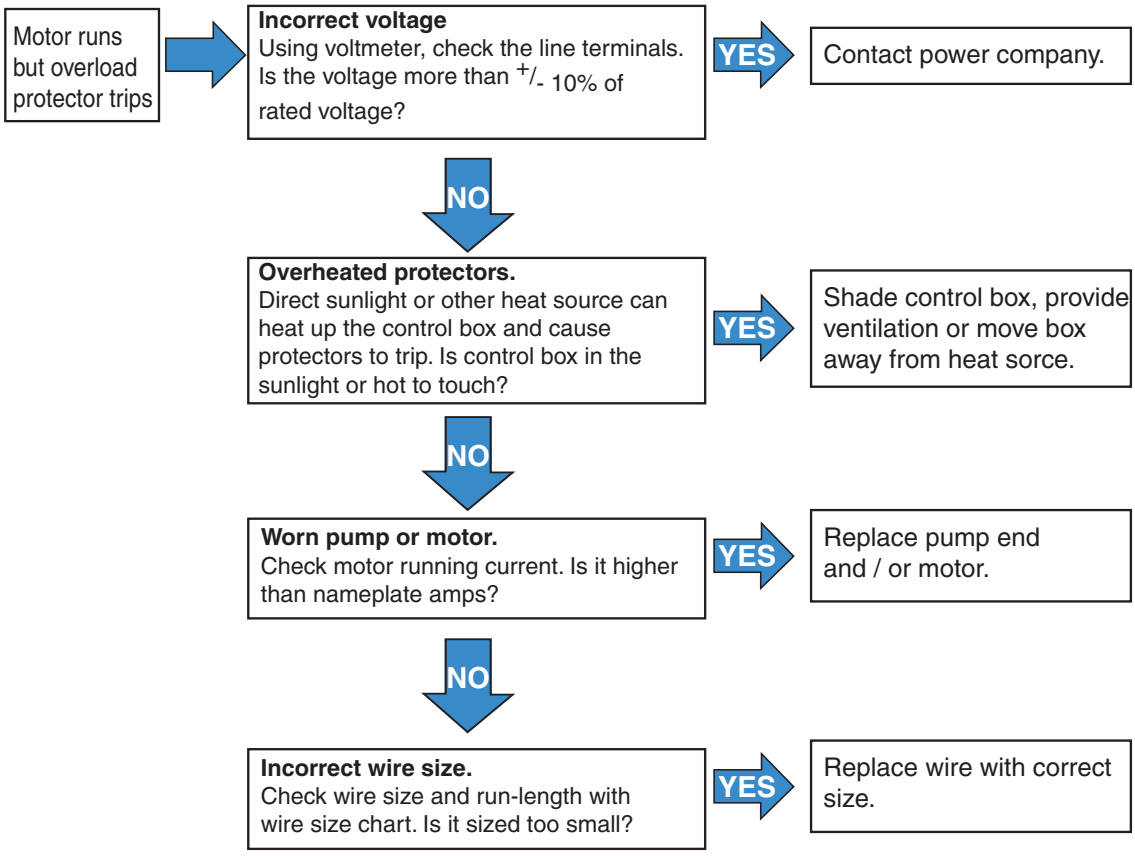
Follow the arrow from the symptom on the left, to the inspection in the middle box.
If the middle box describes to symptom, proceed to the box on the right for the solution.



11.2 MOTOR TROUBLESHOOTING FLOW CHARTS

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.



11.2.1 Testing 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 Tables 6-5, 7-2 or 7-3.

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.

11.3 VARIABLE SPEED DRIVE TROUBLESHOOTING

For the PPC20 Variable Speed Drive, Refer to section 8.1.6 for LED Fault codes.

For the PPC3 & PPC5, refer to the ABB ACS350 or ACS550 manual as appropriate for diagnostic information.

11.4 MOTOR PROTECTION 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 condition 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.

11.5 SUBMERSIBLE CONTROLS TROUBLESHOOTING

Individual Component Diagnostics

POTENTIAL RELAYS

Measure Coil Resistance (Red-Yellow or 2 to 5). It should measure according to the specification printed on the wiring diagram.

Measure contact resistance (Red-Orange 1 to 2). It 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. Greater values indicates degradation of the 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.

Medium and Large Box

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

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

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 (T-Series, 230V +6%/-10%, for others +/- 10%)	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
	Mis-wired 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 will make 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 (T-Series +6%/-10%)	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 12:

Appendix

INSTALLATION CHECKLIST

This checklist can be used to preview and verify steps in the installation of PENTAIR™ pumps. Refer to appropriate section of the manual for more detailed 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, Tables 5-1 through 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.

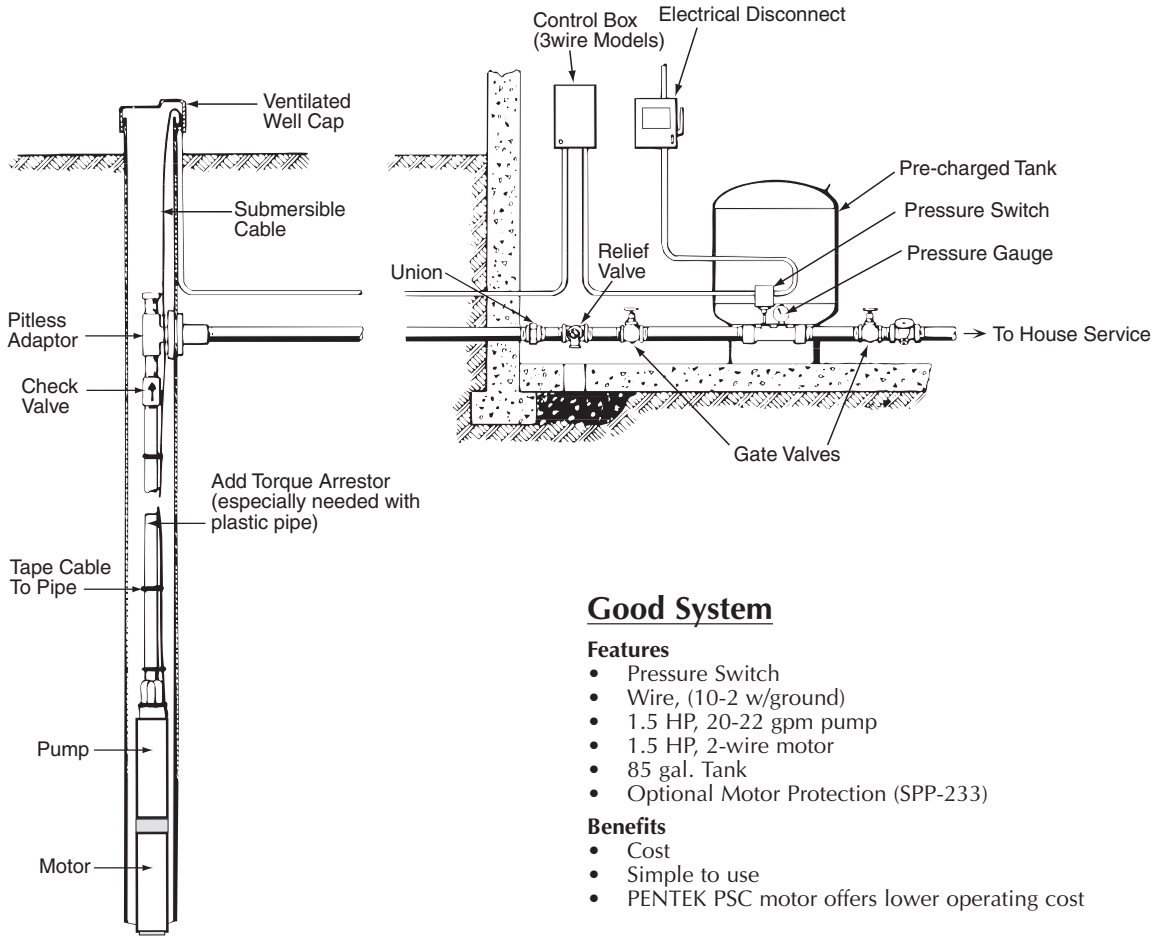
Check Valves

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.



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 discconnect 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-233)

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, 20-32 gpm pump
- 1.5 HP, 3-wire motor
- 85 gal. Tank
- Optional Motor Protection (SPP-233)

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/PPC controller
- Pressure Transducer
- Wire, (12-3 w/ground)
- .75 HP, 15-18 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

MOTOR AND PUMP SIZING AND APPLICATION

3.1 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. Tank drawdown should be enough to keep pump off for one minute (4″ motors) 15 minute (6″ motors).
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.

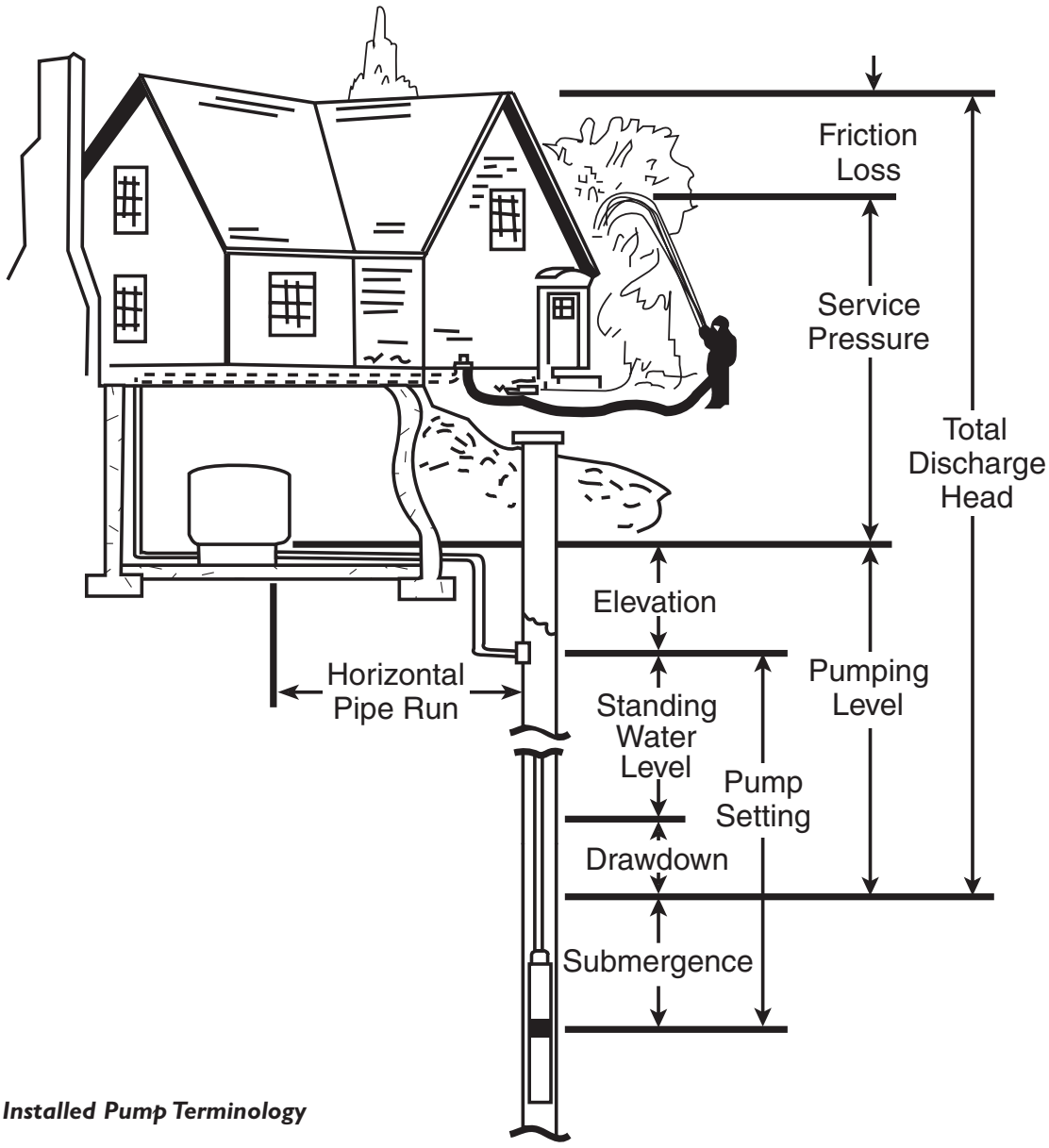


Figure 3-1: Installed Pump Terminology

3.2 HOW TO SELECT THE CORRECT PUMPING EQUIPMENT

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 PUMPING LEVEL?* The vertical distance in feet from the pump to the water level while the pump is operating. If the pump is installed away from the well and is on higher ground, this elevation must also be included. Most wells draw down while being pumped so 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. – halfway 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 hour (GPM x 60) 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 3-1, Page 4, for average water requirements.

Submersible Pump Installation

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

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

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 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.

Pumping Level – distance from drawdown level to service inlet.

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

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

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

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

Selecting a Pump

NOTICE: 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 3-1: 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 draw-down 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 (4) 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

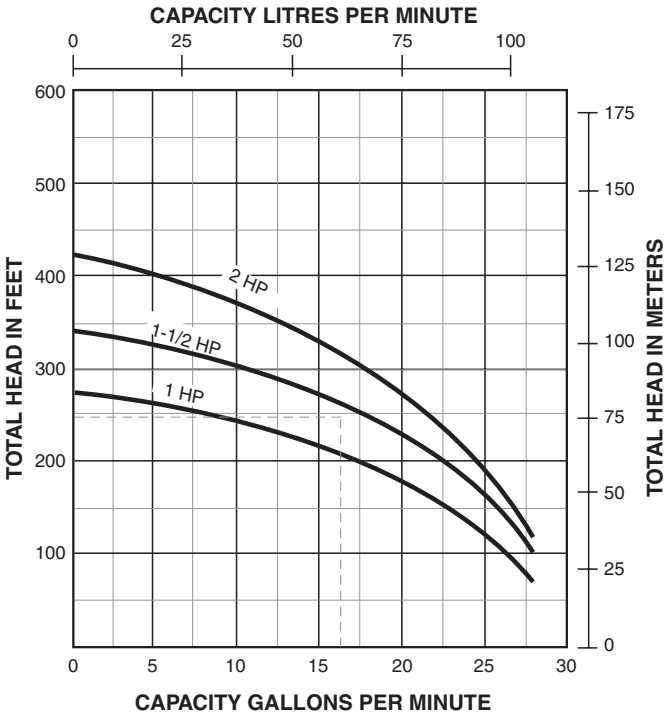
- In the friction loss charts, find the loss of head for 173 feet of 1 1/4″ pipe at 16 gpm. (3.96 per 100′) = 3.96 x 1.73 = 6.8 (round to 7.0)

Add:	7	Friction loss
	100	Pumping level
	139	60 PSI service pressure required (60 x 2.31=138.6. Round to 139)
=	246.0	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.



3.3 SIZING TANKS

Tanks should be sized to allow the pump to be off for at least one minute between starts.

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:

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

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:*

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

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

TABLE 3-2: 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.

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

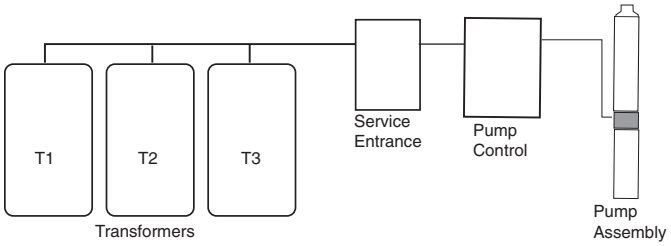
Length _____ ft.

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 _____

Appendix

Motor Current - Balance Worksheet

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

Installation Record

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 _____

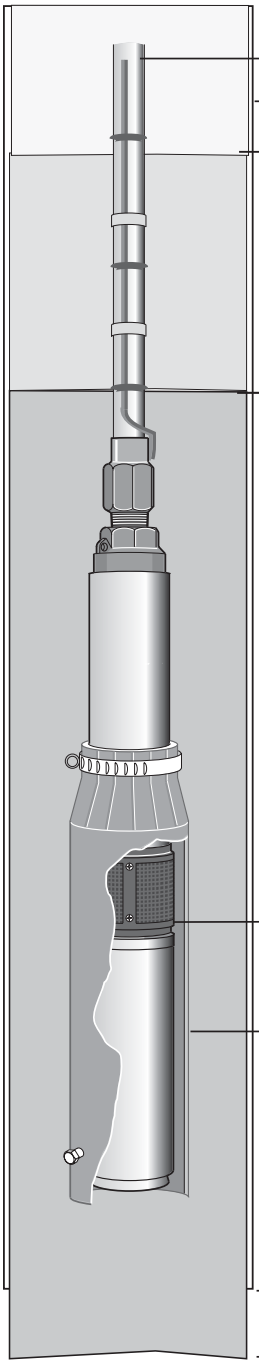
VFD (Variable Frequency Drive) Information

Drive Manufacture _____

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 _____