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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.

SECTION 2: Nomenclature 3

2.1 MOTORS

TABLE 2-1: Motor Nomenclature

Sample:

P43B0010A2 is a PENTEK 4" Stainless Steel Motor
1 HP, 60 Hz., 230 V, 1 PH

NAME PLATE EXAMPLE: **P 43 B 0 0 1 0 A 2**

BRAND
P = PENTEK

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

MOTOR MATERIAL
B = All Stainless Steel

HORSEPOWER
0005 = 0.5 HP
0007 = 0.75 HP
0010 = 1 HP
0015 = 1.5 HP
0020 = 2 HP
0030 = 3 HP
0050 = 5 HP
0075 = 7.5 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
8 = 200V, 3 PH

SECTION 2: Nomenclature 4

2.2 DRIVES

2.2.1 Variable / High Speed Drive Nomenclature

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

PPC5-4-4A1-1

Series	Input Voltage	Output Amp Rating	Enclosure
PPC5	**2** (230 V, 3 ph.)	**4A1**	**1 (NEMA 1)**
PPC3	**4 (460 V), 3 ph.)**	4A1 = 4.1 amps (Amps A tenths)	**4** (NEMA 4)
	5 (575 V), 3 ph.)		**12** (NEMA 12)
	1 (230 V, 1 ph.)		**3** (NEMA3R)

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.

2.2.2 PID Variable frequency drive Nomenclature

PID-1-10A1-1:

PID – 1 – 10A1 – 1

Product Family
PID = Pentek IntelliDrive

Voltage Rating:
1 = 190–265 Volt 1-Phase In, 3-Phase Out
6 = 190–265 Volt 1-Phase In, 1-Phase Out

Max Amp Rating:
4A7 = 4.7 Amps
7A6 = 7.6 Amps
9A7 = 9.7 Amps
10A1 = 10.1 Amps
12A2 = 12.2 Amps

Enclosure Type:
1 = NEMA 1 (Indoor Rated)
3 = NEMA 3R (Outdoor Rated)

2.3 SUBMERSIBLE MOTOR CONTROLS

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)
SMC5 (50 Hz)	**IR** (Induction Run)	**07** (.75 hp)	**2** (230 v)	
	CRP (Cap Run with contactor)	**10** (1 hp)		
		15 (1.5 hp)		
		20 (2 hp)		
		30 (3 hp)		
		50 (5 hp)		
		75 (7.5 hp)		
		100 (10 hp)		
		150 (15 hp)		

SECTION 3: Installation and Setup 5

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.

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.

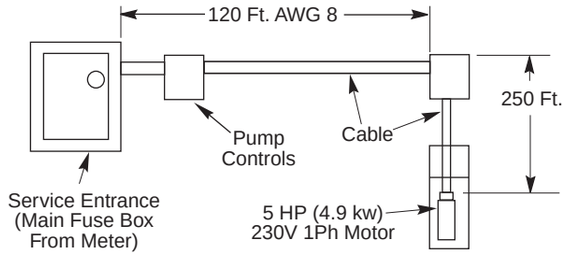

Figure 4-1: Mixing Wire Sizes: Example

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.

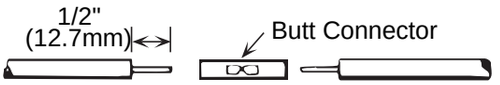

Figure 4-2: Insert Wires

   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).

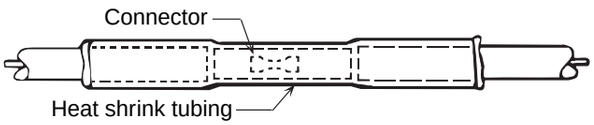

Figure 4-6: Heat-Shrink Tubing Applied

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.

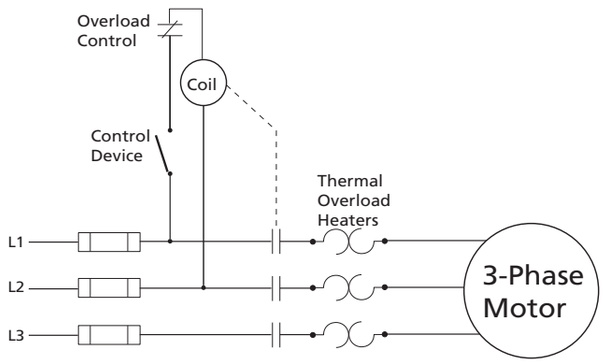

Figure 4-7: Line Voltage Control

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.

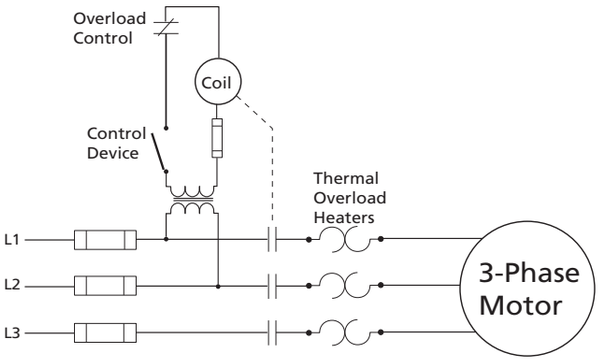

Figure 4-8: Low Voltage Control

Separate Voltage Control

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

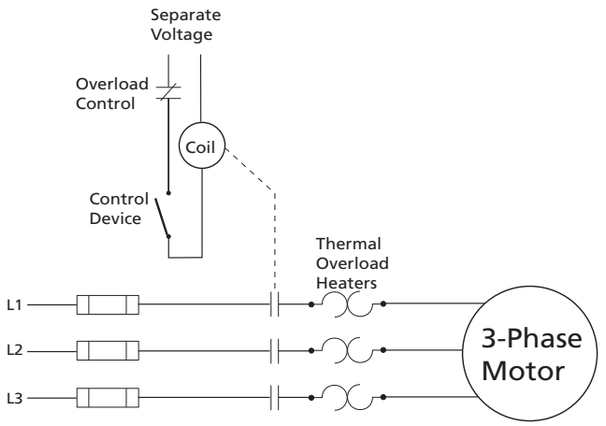

Figure 4-9: Separate Voltage Control

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.

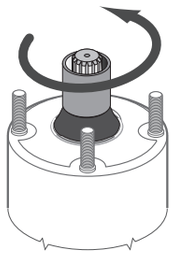

Figure 4-10: Motor Rotation

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.

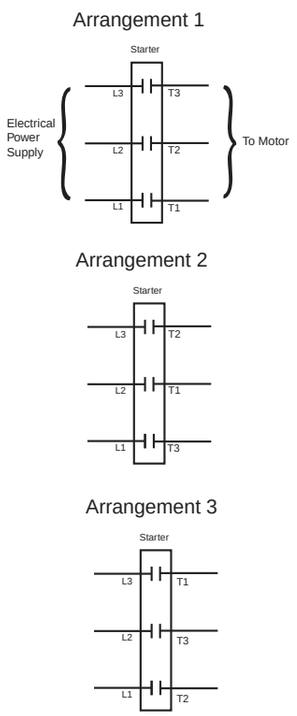

Figure 4-11: 3-Phase Current Unbalance: Example

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.

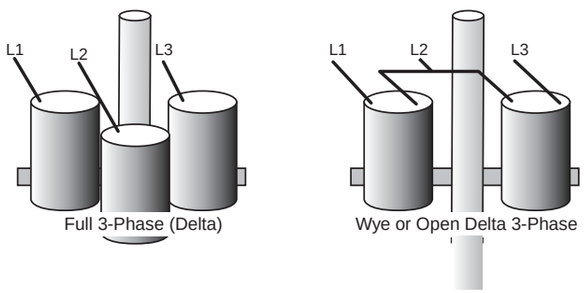

Figure 4-12: Three Phase Power

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 12

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	7.9	1679	9.1	1990
	P42B0015A2	1-1/2	1.1	230	60	1.3	9.2	2108	11.0	2520
CSIR 3-Wire	P43B0005A1	1/2	0.37	115	60	1.6	Y - 11.0 B - 11.0 R - 0.0	733	Y - 12.6 B - 12.6 R - 0	1021
	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	720	Y - 4.9 B - 4.4 R - 2.1	955
	P43B0007A2	3/4	0.55	230	60	1.5	Y - 5.1 B - 5.0 R - 3.2	1000	Y - 6.3 B - 5.6 R - 3.1	1300
	P43B0010A2	1	0.75	230	60	1.4	Y - 6.1 B - 5.7 R - 3.3	1205	Y - 7.2 B - 6.3 R - 3.3	1530
	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
	P43B0020A2	2	1.5	230	60	1.25	Y - 9.9 B - 9.1 R - 2.6	2170	Y - 12.2 B - 11.7 R - 2.6	2660
	P43B0030A2	3	2.2	230	60	1.15	Y - 14.3 B - 12.0 R - 5.7	3170	Y - 16.5 B - 13.9 R - 5.6	3620
	P43B0050A2	5	3.7	230	60	1.15	Y - 24.0 B - 19.1 R - 10.2	5300	Y - 27.0 B - 22.0 R - 10.0	6030

TABLE 5-2: THREE PHASE Motor Specifications (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM, 60° and 75° C.)

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

TABLE 5-3: SINGLE PHASE 4" Motor Electrical Parameters (115 and 230 Volt, 60 Hz, 3450 RPM, 2 and 3 wire)

Motor Type	PENTEK Part Number	Winding		Efficiency %		Power Factor %		Locked Rotor Amps	KVA Code
		M = Main Resistance*	S = Start Resistance	F.L.	S.F.	F.L.	S.F.		
PSC 2-W	P42B0005A1	M 1.3-1.8		49	61	99	99	36.4	K
	P42B0005A2	M 4.5-5.2		50	62	97	99	19.5	K
	P42B0007A2	M 3.0-4.8		55	65	97	99	24.8	J
	P42B0010A2	M 4.2-5.2		58	65	94	96	21.7	F
	P42B0015A2	M 1.9-2.3		59	64	99	99	42.0	H
CSIR 3-W	P43B0005A1	M 0.9-1.6	S 5.7-7.0	51	59	54	69	49.6	N
	P43B0005A2	M 4.2-4.9	S 17.4-18.7	50	58	58	71	22.3	M
	P43B0007A2	M 2.6-3.6	S 11.8-13.0	55	61	61	72	32.0	L
	P43B0010A2	M 2.2-3.2	S 11.3-12.3	59	62	66	75	41.2	L
CSCR 3-W	P43B0005A2	M 4.2-4.9	S 17.4-18.7	52	62	76	85	22.3	M
	P43B0007A2	M 2.6-3.6	S 11.8-13.0	56	65	85	90	32.0	L
	P43B0010A2	M 2.2-3.2	S 11.3-12.3	62	68	86	92	41.2	L
	P43B0015A2	M 1.6-2.3	S 7.9-8.7	66	67	80	85	47.8	J
	P43B0020A2	M 1.6-2.2	S 10.8-12.0	68	69	96	95	49.4	G
	P43B0030A2	M 1.1-1.4	S 2.0-2.5	72	72	96	97	76.4	G
	P43B0050A2	M0.62-0.76	S 1.36-1.66	71	71	97	98	101.0	E

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

TABLE 5-4: THREE PHASE Motor Electrical Parameters (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM, 60° and 75° C.)

Motor Type	Pentek Part Number	Line to Line Resistance (Ohms)	Efficiency %		Locked Rotor Amps	KVA Code
			FL	SF		
3-Phase	P43B0007A8	2.6-3.0	69	74	32.0	R
	P43B0010A8	3.4-3.9	66	70	29.0	M
	P43B0010A3	4.1-5.1	69	72	26.1	M
	P43B0010A4	17.8-18.8	65	69	13.0	M
	P43B0015A8	1.9-2.5	72	74	40.0	L
	P43B0015A3	2.8-3.4	75	76	32.4	L
	P43B0015A4	12.3-13.1	72	73	16.3	L
	P43B0015A5	19.8-20.6	73	74	11.5	J
	P43B0020A8	1.4-2.0	74	75	51.0	K
	P43B0020A3	1.8-2.4	75	75	44.0	K
	P43B0020A4	8.0-8.7	74	75	23.0	K
	P43B0020A5	9.4-9.7	78	78	21.4	M
	P43B0030A8	0.9-1.3	77	77	71.0	K
	P43B0030A3	1.3-1.7	77	77	58.9	J
	P43B0030A4	5.9-6.5	76	77	30.0	J
	P43B0030A5	9.4-9.7	78	78	21.4	J
	P43B0050A8	0.4-0.8	76	76	113.0	J
	P43B0050A3	.85-1.25	76	76	93.0	J
	P43B0050A4	3.6-4.0	77	77	48.0	J
	P43B0050A5	3.6-4.2	75	75	55.0	M
	P43B0075A8	0.5-0.6	74	74	165.0	J
	P43B0075A3	0.55-0.85	75	75	140.0	J
	P43B0075A4	1.9-2.3	76	76	87.0	L
	P43B0075A5	3.6-4.2	77	77	55.0	J

5.5 4" MOTOR DIMENSIONS

TABLE 5-5: SINGLE PHASE Motor Dimensions (115 and 230 Volt, 60 Hz, 3450 RPM)

Motor Type	PENTEK Part Number	HP	kW	Length (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
	P43B0005A2	1/2	0.37	9.7	246	18.1	8.2
	P43B0007A2	3/4	0.56	10.8	275	21.4	9.7
	P43B0010A2	1	0.75	11.7	297	23.1	10.5
	P43B0015A2	1-1/2	1.10	13.6	345	27.4	12.4
	P43B0020A2	2	1.50	15.1	383	31.0	14.1
	P43B0030A2	3	2.20	18.3	466	40.0	18.1
	P43B0050A2	5	3.70	27.7	703	70.0	31.8

TABLE 5-6: THREE PHASE Motor Dimensions (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM)

Motor Type	Pentek Part Number	HP	kW	Length Inches	Length mm	Weight Lb	Weight Kg
3-Phase	P43B0007A8	3/4	0.55	10.8	275	21.4	9.7
	P43B0010A8	1	0.75	11.7	297	23.1	10.5
	P43B0010A3	1	0.75	11.7	297	23.1	10.5
	P43B0010A4	1	0.75	11.7	297	23.1	10.5
	P43B0015A8	1 1/2	1.1	11.7	297	23.1	10.5
	P43B0015A3	1 1/2	1.1	11.7	297	23.1	10.5
	P43B0015A4	1 1/2	1.1	11.7	297	23.1	10.5
	P43B0015A5	1 1/2	1.1	11.7	297	23.1	10.5
	P43B0020A8	2	1.5	13.8	351	27.4	12.4
	P43B0020A3	2	1.5	13.8	351	27.4	12.4
	P43B0020A4	2	1.5	13.8	351	27.4	12.4
	P43B0020A5	2	1.5	15.3	389	32.0	14.5
	P43B0030A8	3	2.2	15.3	389	32.0	14.5
	P43B0030A3	3	2.2	15.3	389	32.0	14.5
	P43B0030A4	3	2.2	15.3	389	32.0	14.5
	P43B0030A5	3	2.2	15.3	389	32.0	14.5
	P43B0050A8	5	3.7	21.7	550	55.0	24.9
	P43B0050A3	5	3.7	21.7	550	55.0	24.9
	P43B0050A4	5	3.7	21.7	550	55.0	24.9
	P43B0050A5	5	3.7	27.7	703	70.0	31.8
	P43B0075A8	7 1/2	5.6	27.7	703	70.0	31.8
	P43B0075A3	7 1/2	5.6	27.7	703	70.0	31.8
	P43B0075A4	7 1/2	5.6	27.7	703	70.0	31.8
	P43B0075A5	7 1/2	5.6	27.7	703	70.0	31.8

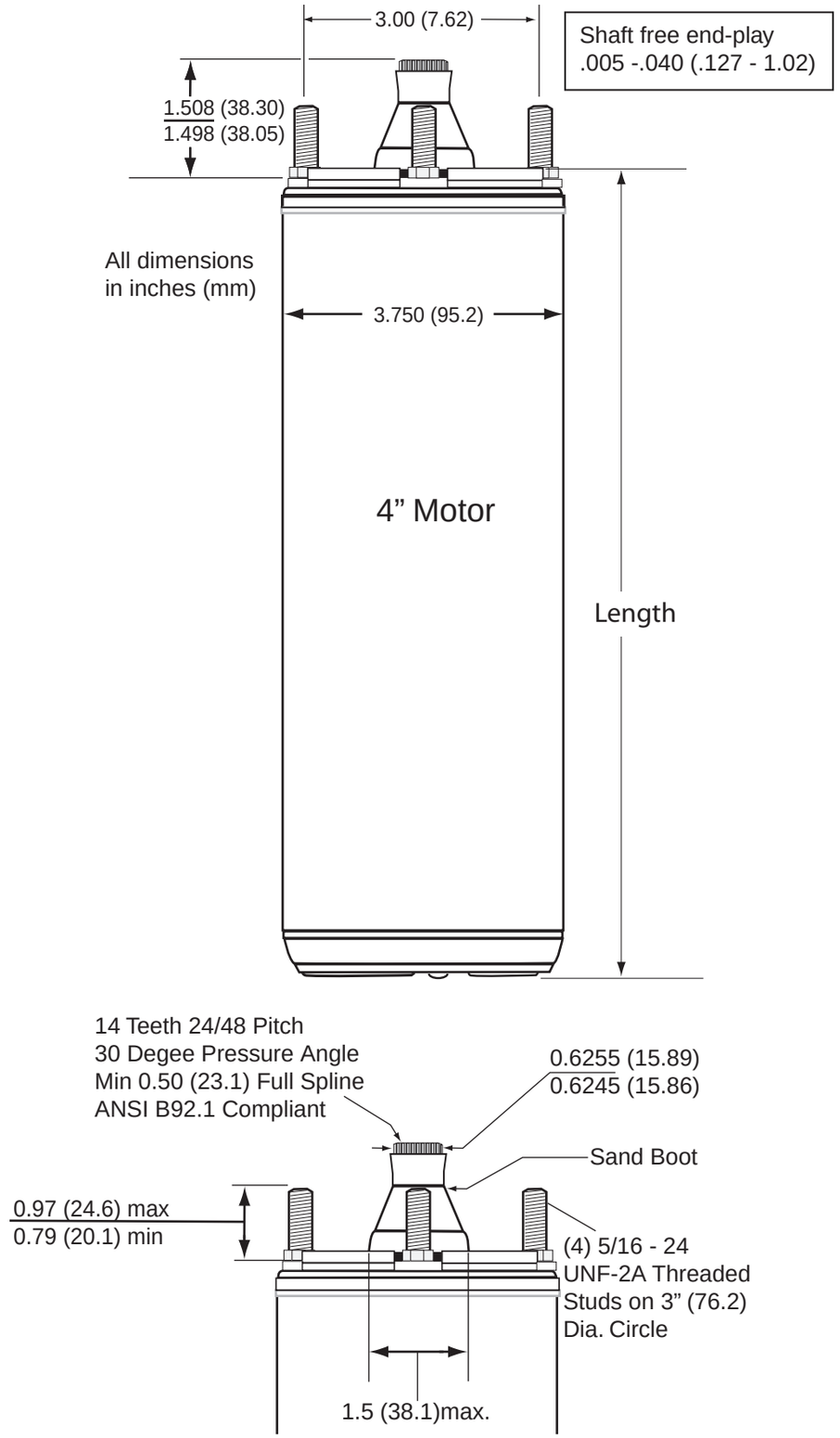

Figure 5-1: "XE" Series 4" Motor Dimensions – Single and Three Phase

5.6 4" MOTOR FUSE SIZING

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

Motor Type	PENTEK Part Number	HP	kW	Volts	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	25	15	20
	P42B0005A2	0.5	0.37	230	15	10	10
	P42B0007A2	0.75	0.55	230	20	10	15
	P42B0010A2	1	0.75	230	25	15	20
	P42B0015A2	1.5	1.1	230	30	15	25
4" 3-Wire **CSIR**	P43B0005A1	0.5	0.37	115	30	20	30
	P43B0005A2	0.5	0.37	230	15	10	15
	P43B0007A2	0.75	0.55	230	20	10	20
	P43B0010A2	1	0.75	230	25	15	25
4" 3-Wire **CSCR**	P43P0005A2	0.5	0.37	230	15	10	10
	P43B0007A2	0.75	0.55	230	20	10	15
	P43B0010A2	1.0	0.75	230	20	10	15
	P43B0015A2	1.5	1.1	230	30	15	25
	P43B0020A2	2.0	1.5	230	30	20	25
	P43B0030A2	3.0	2.2	230	45	25	40
	P43B0050A2	5.0	3.7	230	70	40	60

TABLE 5-8: THREE PHASE Motor Fuse Sizing (230, 460, 200 and 575 Volt, 60 Hz, 3450 RPM, 60° and 75° C.)

Motor Type	PENTEK Part Number	HP	kW	Volts	Fuse Sizing Based on NEC		
					Standard Fuse	Dual Element Time Delay Fuse	Circuit Breaker
3-Phase	P43B0007A8	3/4	0.55	200	15	10	10
	P43B0010A8	1	0.75	200	15	10	10
	P43B0010A3	1	0.75	230	15	6	10
	P43B0010A4	1	0.75	460	6	3	6
	P43B0015A8	1 1/2	1.1	200	20	10	15
	P43B0015A3	1 1/2	1.1	230	20	10	15
	P43B0015A4	1 1/2	1.1	460	8	6	6
	P43B0015A5	1 1/2	1.1	575	6	3	6
	P43B0020A8	2	1.5	200	25	15	20
	P43B0020A3	2	1.5	230	20	15	20
	P43B0020A4	2	1.5	460	15	6	10
	P43B0020A5	2	1.5	575	10	6	10
	P43B0030A8	3	2.2	200	35	20	30
	P43B0030A3	3	2.2	230	30	15	25
	P43B0030A4	3	2.2	460	15	10	15
	P43B0030A5	3	2.2	575	15	10	10
	P43B0050A8	5	3.7	200	60	35	50
	P43B0050A3	5	3.7	230	45	30	40
	P43B0050A4	5	3.7	460	25	15	20
	P43B0050A5	5	3.7	575	25	15	20
	P43B0075A8	7 1/2	5.6	200	80	50	70
	P43B0075A3	7 1/2	5.6	230	70	45	60
	P43B0075A4	7 1/2	5.6	460	40	25	35
	P43B0075A5	7 1/2	5.6	575	30	20	25

5.7 CABLE LENGTHS

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

3-Wire in Feet			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
	CSIR Control Boxes												
	1/2	115	87	138	221	349	544	867	1090	1376	1734	2188	2761
	1/2	230	348	553	883	1398	2175	3467	4359	5505	6935	8753	–
	3/4	230	264	420	670	1061	1651	2632	3309	4178	5264	6644	8383
	1	230	226	359	573	908	1413	2252	2831	3575	4504	5685	7173
	CSCR Control Boxes												
	1/2	230	447	711	1135	1797	2796	4458	5604	7078	8916	11254	–
	3/4	230	348	553	883	1398	2175	3467	4359	5505	6935	8753	11044
	1	230	304	484	772	1223	1903	3034	3814	4817	6068	7659	9663
	1 1/2	230	197	314	501	793	1234	1968	2474	3124	3936	4968	6268
	2	230	180	286	456	722	1123	1790	2251	2843	3581	4520	5703
	3	230	133	211	337	534	830	1324	1664	2102	2648	3342	4217
	5	230	–	–	206	326	507	809	1017	1284	1618	2042	2577

* 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
	1/2	115	115	183	293	463	721	1150	1445	1825	2299	2902	3662
	1/2	230	466	742	1183	1874	2915	4648	5843	7379	9295	11733	–
	3/4	230	342	545	869	1376	2141	3413	4291	5419	6826	8617	10871
	1	230	241	383	611	968	1506	2400	3018	3811	4801	6060	7646
	1 1/2	230	199	317	505	801	1246	1986	2496	3153	3972	5013	6325

SECTION 5: XE-Series 4" Submersible Motors - 60 Hz 20

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

			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
Three Phase	1	230	466	742	1183	1874	2915	4648	5843	7379			
	1 1/2	230	359	571	912	1444	2246	3581	4502	5685	7162	9040	
	2	230	288	459	732	1159	1803	2874	3613	4563	5748	7256	9155
	3	230	217	345	551	872	1357	2163	2719	3434	4326	5460	6889
	5	230	—	—	318	503	783	1248	1569	1982	2496	3151	3976
	7 1/2	230	—	—	—	334	519	827	1040	1314	1655	2089	2635
	1	460	1753	2789	4448	7045							
	1 1/2	460	1370	2179	3475	5504							
	2	460	1153	1835	2926	4635	7212						
	3	460	827	1315	2098	3323	5171						
	5	460	516	820	1308	2072	3224	5140					
	7 1/2	460	325	516	824	1305	2030	3236	4068	5138	6472		

			Wire Size, AWG										
	HP	Volt	14	12	10	8	6	4	3	2	1	0	00
Three Phase	3/4	200	423	674	1074	1702	2648						
	1	200	346	551	879	1392	2166	3454	4342				
	1 1/2	200	265	421	672	1064	1655	2638	3317				
	2	200	217	344	549	870	1354	2158	2714	3427	4317	5449	
	3	200	159	253	403	638	993	1583	1990	2513	3166	3996	
	5	200	94	150	239	379	590	940	1182	1493	1881	2374	2995
	7 1/2	200	64	101	161	255	397	633	796	1005	1266	1598	2017
	1 1/2	575	2283	3631	5792								
	2	575	1660	2641	4212	6671							
	3	575	1336	2126	3390	5370							
	5	575	721	1147	1829	2897	4507						
	7 1/2	575	548	871	1390	2202	3426						

* Table data are generated per NEC standards.

5.8 4" MOTOR OVERLOAD PROTECTION

Single Phase Motors

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

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

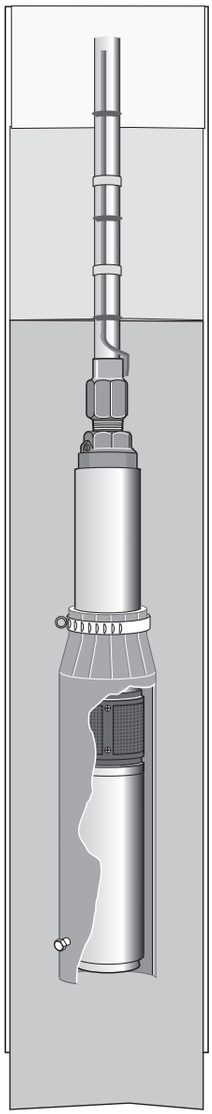

Figure 5-2: Flow Inducer Sleeve

5.9 MOTOR COOLING

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

4" MOTORS: MINIMUM COOLING WATER FLOW 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.

5.10 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 5-11: 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

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PID-1, PID-6 INTELLIDRIVE Series

6.1 GENERAL SAFETY

⚠ WARNING

Risk of high-voltage electrical shock from EMI/RFI Filter inside Drive. Make all wiring connections, then close and fasten the cover before turning on power to Drive.

DO NOT open the box when power is connected to the Drive.

Before doing any service or maintenance inside the Drive:
1. **DISCONNECT** power.
2. **WAIT 5 minutes** for retained voltage to discharge.
3. Open box.

Before connecting or disconnecting any wires inside the Drive:
1. **DISCONNECT** power.
2. **WAIT 5 minutes** for retained voltage to discharge.
3. Open box.

⚠ WARNING **Risk of high-voltage electrical shock from the EMI/RFI Filter if the front cover of the VFD is open or removed while power is connected to the VFD or the VFD is running. The front cover of the VFD must be closed during operation.**

- After allowing at least 5 minutes for the EMI/RFI Filter to discharge and before starting any wiring or inspection procedures, check for residual voltage with a voltage tester.

⚠ WARNING **Risk of electrical shock if VFD is connected to the power wiring before hanging the box.** Always hang the VFD box before connecting the wires to it.

⚠ WARNING **Risk of electrical shock if the VFD is handled or serviced with wet or damp hands.** Always make sure your hands are dry before working on the VFD. Perform all operations on the HMI with dry hands.

⚠ WARNING **Risk of electrical shock and hand injury**. Do not reach into or change the cooling fan while power is on to the VFD.

⚠ WARNING **Risk of electrical shock.** Do not touch the printed circuit board when power is on to the VFD.

⚠ WARNING **Fire hazard if installed with incorrect or inadequate circuit breaker protection.** To make sure of protection in the event of an internal fault in the VFD, install the VFD on an independent branch circuit protected by a circuit breaker (see Table 6-2, Page 23 for circuit breaker sizing), with no other appliances on the circuit.

⚠ CAUTION **Risk of burns.** The drive can become hot during normal operation. Allow it to cool for 10 minutes after shut-down before handling it to avoid burns.

NOTE: To avoid damage to the drive or problems with the drive:

- Connect the output cables to 3-wire and 3-phase motors as follows: Red to R, Yellow to Y, Black to B. Any other order will reverse the motor rotation and may damage the motor.
- Do not modify the equipment.
- Do not use power factor correction capacitors with this VFD; they will damage both the motor and the VFD.
- Do not remove any parts unless instructed to do so in the owner's manual.
- Do not use a magnetic contactor on the VFD for frequent starting/stopping of the VFD.
- Do not install or operate the VFD if it is damaged or parts are missing.
- Before starting a VFD that has been stored for a long time, always inspect it and test operation.
- Do not carry out a megger (insulation resistance) test on the control circuit of the VFD.
- Do not allow loose foreign objects which can conduct electricity (such as screws and metal fragments) inside the VFD box at any time. Do not allow flammable substances (such as oil) inside the VFD box at any time.
- Ground the VFD according to the requirements of the National Electrical Code Section 250, IEC 536 Class 1, or the Canadian Electrical Code (as applicable), and any other codes and ordinances that apply.
- All installation, service work, and inspections must be done by a qualified electrician.

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

⚠ WARNING

Hazardous voltage.

Drive internal components retain high voltage for up to 5 minutes after input power is disconnected.

EMI/RFI Filter carries high voltage when pump is running.

Disconnect power and wait 5 minutes before opening and removing VFD cover.

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PID-1, PID-6 INTELLIDRIVE Series

6.2 DESCPRIPTION

The PENTEK INTELLIDRIVE is specifically designed to operate 4″ submersible pumps in water well applications. Each drive is rated for horsepower and amp draw. Any use of the drive outside of its intended use and design parameters will void the warranty.

Transducer

The drive uses a 4-20mA, 0-100PSI pressure transducer to control the speed of the motor.

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

Fan

The PENTEK INTELLIDRIVE has a thermostatically controlled internal fan. The fan may not operate under normal operating conditions. It will automatically start when necessary to cool the drive.

Keypad

The Keypad programs the drive, monitors the status of the pump, and views faults if they occur. Each button has a unique function (see Page 22). The LCD display shows a text display of the status of the drive's operation. Other LEDs light up to indicate when certain buttons are pressed or certain events occur.

Table 6-1: Model Number Structure

PID-1-10A1-1:

PID – 1 – 10A1 – 1

Product Family
PID = Pentek IntelliDrive

Voltage Rating:
1 = 190–265 Volt 1-Phase In, 3-Phase Out
6 = 190–265 Volt 1-Phase In, 1-Phase Out

Max Amp Rating:
4A7 = 4.7 Amps
7A6 = 7.6 Amps
9A7 = 9.7 Amps
10A1 = 10.1 Amps
12A2 = 12.2 Amps

Enclosure Type:
1 = NEMA 1 (Indoor Rated)
3 = NEMA 3R (Outdoor Rated)

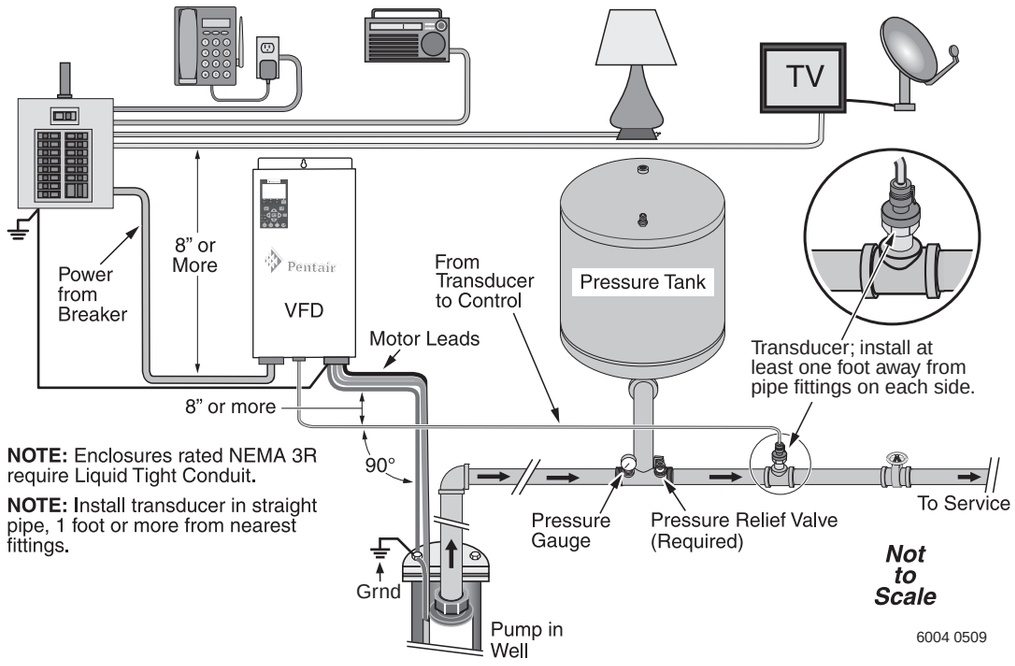

Figure 6-1: Overall Layout – Typical installation

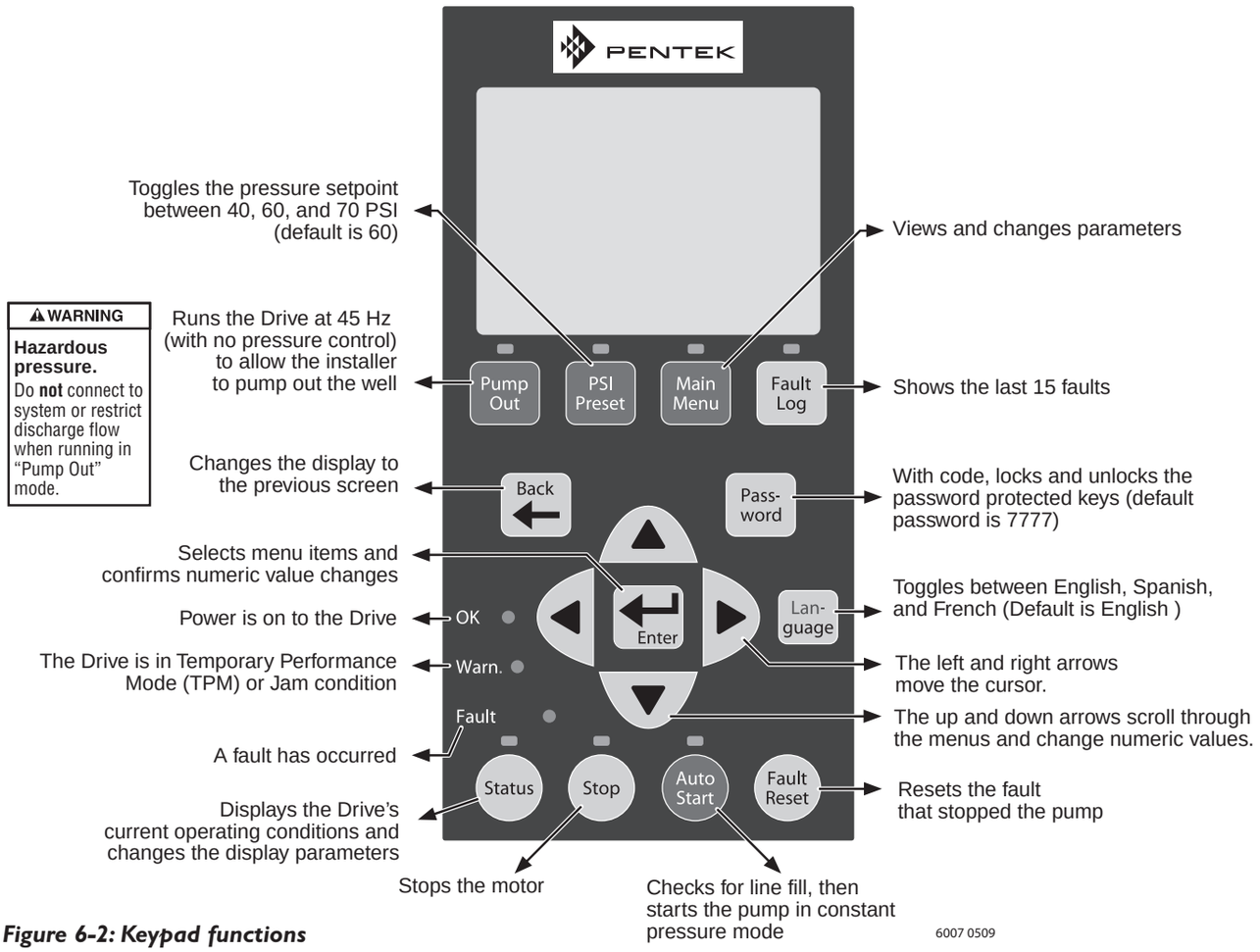

Figure 6-2: Keypad functions

6.3 INSTALLATION

Mounting (See Figure 6-3)

Mount the drive in an easily accessible area with temperature maintained between –4°F and 104°F (–20°C to 40°C). NEMA 1 enclosures must be mounted indoors; NEMA 3R enclosures may be mounted outdoors with the same ambient temperature limits.

To mount the drive, mark the location of the top keyhole on the wall or stud. Drive a screw into the structure and hang the drive on it. Back out the screw on the bottom of the front cover and lift the cover off. Mark the locations of the bottom two mounting holes. Mount the drive with screws in all three holes.

Be sure that the ventilation holes are not blocked and that there is enough space around the drive to allow free air flow (minimum 3" clearance, top, bottom, and sides). Once the drive is mounted, you are ready to connect the wires.

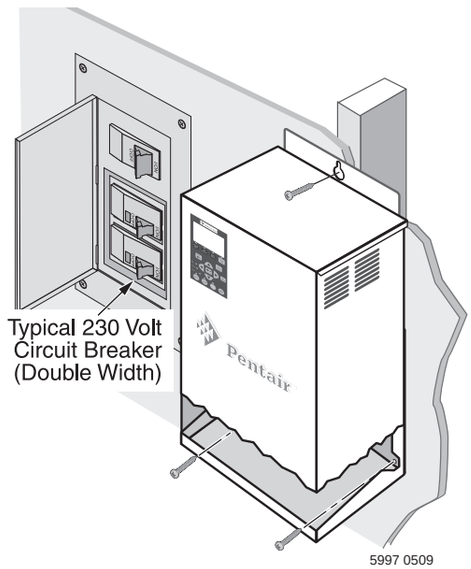

Figure 6-3

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PID-1, PID-6 INTELLIDRIVE Series

Table 6-2: Circuit Breaker and Wire Sizes

Controller Model No.	Motor Volts/Hz/Ph	H.P.	Amps	Wire Size CB to VFD (AWG)	C.B. Size (Amps)	Minimum 240VAC Generator Cap'y (kVA)
PID-1-4A7-X	230/60/3	1	4.7	12	20	4.2 kVA
PID-1-7A6-X	230/60/3 230/60/3	1.5 2	6.1 7.6	10	30	6.9
PID-1-10A1-X	230/60/3	3	10.1	8	40	9.1
PID-6-9A7-X	230/60/1 230/60/1 230/60/1	0.5 0.75 1	4.9 6.3 7.2	12	20	4.4
PID6-12A2-X	230/60/1 230/60/1	1.5 2	11.1 12.2	10	30	7.4

Wiring

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

NOTE: For convenience in wiring, the input and motor terminals unplug from the box. Pull them down to remove them for ease of access. See Figure 6-4.

BE SURE that when you replace them, they are completely pushed in and seated.

Note: The best practice is to connect all output wires first and all input wires last.

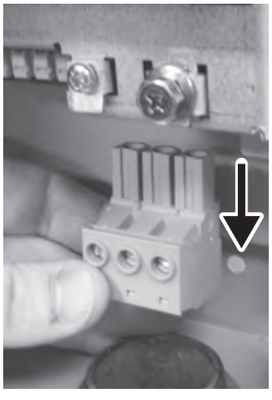


Figure 6-4: Pull the input and motor terminals down to unplug them for ease of wiring.

Output Connections (See Figure 6-5, Page 24):

See Tables 6-5 and 6-6, Page 32, for correct wires sizes, VFD to motor.

The output of **PID-1** Series drives is 230V **three phase** power.

The output of **PID-6** Series drives is 230V **single phase** power.

NOTE: PID-1 series drives will not operate single phase motors. PID-6 series drives will not operate three phase motors.

The output power terminals (motor wire connections) are located on the lower right side of the drive and are labeled R (Red), Y (Yellow), and B (Black). Feed the motor cable through the 3/4" conduit hole on the bottom right side and into the appropriate terminals. If the wire is large enough to require a larger conduit hole, remove the 1-1/4" knockout and use the appropriate conduit connections. Attach the motor ground wire to the grounding lug, located to the upper right of the terminal block. Attach the motor power wires to the terminals as shown in Figure 6-5, Page 24.

Pressure Tank Recommendations:

Minimum tank size is 5 gallons. Use a pre-charged pressure tank with the Drive. The tank size must equal at least 20% of the pump's rated flow in gallons per minute (GPM), but cannot be less than 5 gallons capacity. For example, a pump rated at 10 GPM would require a tank of 5 gallons capacity or larger. A pump rated at 50 GPM would require a 10 gallon tank or larger. A larger tank will reduce cycling of the pump.

Table 6-3: Control Pressure Set Point and Tank Pre-Charge Pressure Values (PSI)

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

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

Transducer Connections (See Figure 6-5):

Use the transducer provided with the drive. Install the transducer downstream of the tank. Install the transducer in a tee in a straight section of pipe with at least 1 foot of straight pipe on each side of the tee (that is, all fittings must be at least one foot away from the transducer).

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

The transducer terminals, marked AI+ and AI-, are located to the left of the output terminals. Connect the red wire of the transducer cable to AI+, connect the black wire to AI–, and connect the cable shield to the metal lug to the right. **NOTE:** Do not use the clear wire on the transducer cable for any connections; tape the end and tie it back to the cable with electrical tape so that it does not touch any other components or connections.

Note: To connect the wires;

1. If the wire ends are not pre-stripped, strip them back about 1/2".
2. Push the spring terminals up (back).
3. Insert the wires.
4. Release the spring terminals.

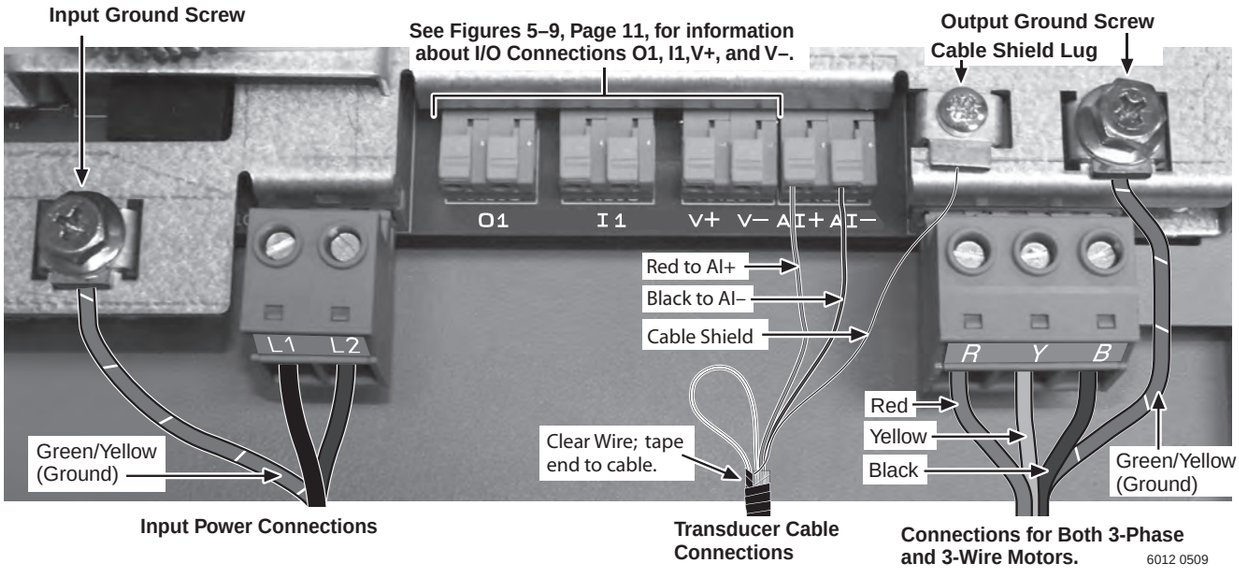


Figure 6-5: Basic Wiring Connections for Startup.

NOTE: Do not connect the clear wire on the transducer cable to any terminal; instead, tie it back with electrician's tape so that it cannot touch any other components or connections.

Input Connections (See Figure 6-5):
The input power terminals are located on the lower left side and marked L1 and L2 (see Figure 6-5); there is a ground lug for the input ground wire to the left of the connector. Feed the wire through the 3/4" conduit hole on the bottom left side and into the appropriate terminals. If the wire is large enough to require a larger conduit hole, remove the 1-1/4" knockout and use the appropriate conduit connections.

To determine the correct wire sizes for your installation, see Table 6-2, Page 23.

NOTE: The drive only accepts 230V single phase input power. If your incoming power does not match this, have a competent electrician alter it to 230V/1Ph before connecting the drive.

Lightning/Surge Protection

Lightning arrestors or other surge suppressing devices can be used with this product. MOV (Metal Oxide Varistor), SOV (Silicon Oxide Varistor), or a flashover type can be used when wired between the drive and the circuit breaker. If a lightning arrestor is to be used between the drive and the motor, a flashover type arrestor is recommended.

6.4 INITIAL STARTUP PROGRAMMING PROCEDURE

Be Sure that the cover is installed before operating the drive.

Most installations will only require the initial startup settings. However, the installer may need to set additional parameters occasionally. See "Advanced Programming", Page 26, for information about accessing all parameters, explanations of their functions, and procedures for changing parameter values, if necessary.

1. **Program the Drive:** Apply power to the PENTEK INTELLIDRIVE. "Setup Guide" will appear.
   A. Service Factor Amps (See Sidebar, "Service Factor Amps")
      1. Use **DIRECTIONAL Arrows** to enter the correct service factor amps (see Table 6-4)
      2. Press **ENTER** to save the entry.
   B. Current Time:
      1. Use **DIRECTIONAL Arrows** to scroll to correct time
      2. Press **ENTER** to save the time.
   C. Current Date:
      1. Use **DIRECTIONAL Arrows** to scroll to correct date
      2. Press **ENTER** to save the date.

Service Factor Amps (See Table 6-4)

To get the best performance out of your pump, be sure you enter the correct Service Factor Amps (SF Amps) in the PENTEK INTELLIDRIVE.

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

NOTE: PENTEK submersible motors may differ from motors of the same horsepower from other manufacturers. **For 3-Wire, 1-Phase motors from all other submersible motor manufacturers, enter the motor manufacturer's CS/CR service factor amps for your motor.** For 3-Phase motors, use the motor nameplate amps.

Table 6-4: Pentek Motor Service Factor Amps

Part Number	Volts/Hz/Ph	HP	S.F. Amps
Three Phase Motors			
P43B0010A3	230/60/3	1.0	4.7
P43B0015A3	230/60/3	1.5	6.1
P43B0020A3	230/60/3	2.0	7.6
P43B0030A3	230/60/3	3.0	10.1
3-Wire Single Phase Motors			
P43B0005A2	230/60/1	0.5	4.9
P43B0007A2	230/60/1	0.75	6 .3
P43B0010A2	230/60/1	1.0	7.2
P43B0015A2	230/60/1	1.5	11.1
P43B0020A2	230/60/1	2.0	12.2

- To change any values, press Back to return to the previous screen.
- To change any values after startup, go to Main Menu and edit the parameters as needed.

2. 80 Hz Operation (if necessary—See "60 to 80 Hz Operation," below):
   A. Press MAIN MENU button,
   B. Use DIRECTIONAL Arrows to scroll to motor; press ENTER.
   C. Use DIRECTIONAL Arrows to scroll to Set Max Frequency; press ENTER.
   D. Use DIRECTIONAL Arrows to change to 80 Hz; press ENTER.
3. **Pump out the well (if necessary):**

   Direct the pump's discharge to an appropriate location not connected to the system and press **Pump Out**. The pump will run at 45 Hz.

   Adjust frequency as appropriate:

   A. Press ENTER
   B. Change frequency value
   C. Press ENTER again.

   Run the drive in this mode until the well discharge runs clear, then press the **'Stop'** button to stop the drive.

   ⚠WARNING **Hazardous pressure.** In Pumpout mode, the pump runs at a constant speed, which can cause very high pressure if flow is restricted.
4. **Check List:**

   Make sure that the system has a properly sized relief valve and pressure tank.

   Make sure that the pressure tank's precharge is correct. See Table 6-3, Page 24.

   Make sure that the pump discharge is connected to the system.
5. **System Start:**

   Open valves at the ends of lines so that air will escape during pressurization.

   Press **Auto Start**; close valves at the ends of lines after all air has escaped.

   The system goes into Constant Pressure Operation as soon as the transducer registers 10 PSI. If system pressure does not reach 10 PSI within 3 minutes, the drive will stop. Press AutoStart again to restart line fill.

60 to 80 Hz Operation (See 2, above):

When installing the PID-1 Series PENTEK INTELLIDRIVE with a motor and liquid end of the same HP rating, operate it at 60 Hz (the default value). The drive can be operated at frequencies of up to 80 Hz when the installation uses a large motor with a small pump (For example, a 1 HP pump with a 2 HP 3-Phase motor. This combination will equal the performance of a conventional 2 HP pump.).

Go to Main Menu as described in No. 2 (above). Be sure to press Enter to save the new Max Frequency selected. The drive will now use the new value selected.

NOTE: The drive will not allow the output amps to go above the Service Factor Amps selected on the keypad. Because of this, some 80 Hz operations may be limited by a "TPM: Service Amps" warning. This protects the motor and may be a common occurance.

6.5 ADVANCED PROGRAMMING

Locking & Unlocking the Keypad

Password: The password locks or unlocks the blue buttons on the keypad. All PENTEK IntelliDrive units are shipped from the factory with the default password '7777'. It can be changed to any other 1 to 4 digit number. To reset the password to a unique password for your unit, unlock the key pad (see below) and go to "SETTINGS/Password", Page 27.

If the installer does not press the PASSWORD button, then the Keypad will automatically lock 60 minutes after the drive is powered up. The timeout period is adjustable through the Main Menu/Settings/Password.

To unlock the keypad press PASSWORD, use the directional arrows to enter the proper numeric code, and press ENTER.

Note: For more detailed information on Keypad functions, see the "Parameters" section.

Changing a Parameter Value:

NOTE: This procedure works for ANY parameter.

1. Find the parameter and display the current parameter value on the screen.
2. Press **ENTER** to enable editing of the parameter.
3. Use the UP, DOWN, LEFT, and RIGHT arrows to change the parameter values.
4. Press **ENTER** again to save the new parameter value.

NOTE: A "shorthand" way to remember this is:

- Press **ENTER** to change a value;
- Press **ENTER** again to save it.
- If you don't save the new value, then as soon as you change the screen, you lose it.

Keypad Access Parameters

Pump Out Speed: Press **Pump Out**. The Drive will start the pump in a constant speed mode (default 45 Hz). The pump will run until you push **Stop** or **Auto Start**. If necessary to change the speed, Follow steps 2-4 above to change the parameter.

PSI Preset: Press **PSI Preset**; follow steps 2-4 above to change the parameter. The default is 60 PSI, but the parameter can be set to 40, 60, or 70 PSI.

Pressure Setpoint: Press **Auto Start**, then follow steps 2-4 under "Changing a Parameter Value," Page 26. Use the directional arrows to change the pressure by 1 or 10 PSI increments.

- **NOTE:** This parameter allows you to change either the Internal or the External Setpoint, depending on which one is referenced at the time you are making the change.
- **NOTE:** To change the setpoint before starting the pump, go to the Main Menu/Settings/Setpoints/ Internal Setpoint.
- **NOTE:** If this value is changed from the default value of 60 PSI, you must adjust the tank pressure accordingly (see Table 6-3, Page 24).

Language: Press **Language**; follow steps 2-4 under "Changing a Parameter Value," Page 26, using the UP or DOWN arrows to scroll through the available languages (English, French, or Spanish; default is English).

- **NOTE:** To change the setpoint before startup, go to the Main Menu under "Settings".

Main Menu Parameters

The Main Menu has six secondary menus (plus a Reset) that allow access to the Advanced Programming parameters: 1) SETTINGS, 2) MOTOR, 3) SENSOR, 4) PIPE BREAK, 5) DRY RUN, 6) I/O. The basic structure and navigation instructions are listed below. Use the UP and DOWN arrows to scroll to the next secondary menu or submenu, or to a parameter. Press Enter to go into a Submenu or to edit a parameter.

1) SETTINGS: (HAS 5 SUBMENUS)

Time (2 parameters):

Hour: Allows you to change the time of day.

Date: Allows you to change the calendar day.

PID Control: Changing these parameters is NOT recommended. These parameters control the drive's reaction to pressure changes in the system. They should be considered as a group. If it seems necessary to alter anything in this group, please call Pentek Customer Service at 1-866-9PENTEK (1-866-973-6835) BEFORE YOU START. Also, note that the last item on the main menu resets ALL parameters to the default values.

Sleep (5 parameters plus Reset):

Boost Differential: Raises the system pressure slightly before going into sleep mode. Units are in PSI. The default boost value is 3 PSI. (i.e., with Boost Differential set to 3 PSI and Pressure Setpoint set to 60 PSI, the system pressure will rise to 63 PSI before the drive goes to sleep). Maximum is 10 PSI, minimum is 3 PSI.

Boost Delay: The length of time (in seconds) that the drive monitors the system before boosting the pressure. Default is 60 seconds, maximum is 300 seconds, minimum is 30 seconds.

Wakeup Differential: The total pressure drop from the setpoint that the drive must see to come out of Sleep mode. The default setting is 5 PSI. (i.e., with the Wakeup Differential set to 5 PSI, the drive will wake up when the pressure in the system has dropped 5 PSI below the system Pressure Setpoint.) Maximum is 15 PSI, minimum is 5 PSI.

Wake Delay: The time it takes to ramp down to the Wake Up pressure. Default is 15 seconds, maximum is 120 seconds, minimum is 3 seconds.

Sleep 2 PSI: A setting to prevent Over-Pressure. If the system pressure rises enough that the drive reaches the Sleep 2 PSI setpoint, the drive will go to sleep for one minute. Default pressure is 80 PSI, maximum is 'Max Sensor' value minus 3 PSI, minimum is 15 PSI.

- **NOTE:** If the Internal or External Setpoint is set to a value that is near, at, or above the Sleep 2 PSI setpoint, you may experience nuisance tripping. In this case, raise the Sleep 2 PSI setpoint until the nuisance tripping stops.

Reset to defaults: Default value is NO. Change to YES to reset all Sleep parameters to their default values.

Password (2 parameters):

Password Timeout: Sets the time (in minutes) that the drive takes to lock out the password-protected (blue) buttons on the keypad. The range is 1 – 360 minutes; the default is 60 minutes. When drive programming is complete, a timer starts. Once it reaches the time set in this parameter the buttons automatically lockout.

Password: The Password locks or unlocks the blue buttons on the keypad. The password is a number (default is 7777) and can be changed to any 1- to 4-digit number.

Setpoints (2 Parameters):

Internal Setpoint: The main pressure setting used by the drive. The default value is 60 PSI. Maximum is the 'Max Sensor' value minus 3 PSI, minimum is 15 PSI.

External Setpoint: The Drive's pressure reference when the External Input is set to External Setpoint and the proper drive is connected to it (see I/O section, Pages 28 and 29). Default is 40 PSI, Maximum is 'Max Sensor' minus 3 PSI, minimum is 15 PSI.

2) MOTOR (3 Parameters plus Reset):

Service Factor Amps: The service factor amps of the motor. This value is entered during the setup process and can be changed if necessary. For your PENTEK motor, use the value listed in Table 6-4, Page 25. This value may differ slightly from the motor's nameplate amps. For other manufacturer's 3-wire, 1-Phase motors, use the Cap Start/Cap Run values supplied by the motor manufacturer. For 3-Phase motors, use motor manufacturer's service factor amps or nameplate amps.

Min Frequency: The minimum frequency that the drive will send to the motor (this translates to the slowest speed at which the motor will run). The default is 30 Hz. If necessary this value can be increased, but cannot exceed the Max Frequency value.

Max Frequency: This is the maximum frequency the drive will send to the motor (this translates to the highest speed at which the motor will run). The default is 60 Hz. If necessary the value can be raised up to 80 Hz. for 3-phase (PID-1) units.

Reset to defaults: Default value is NO. Change to YES to reset all Motor parameters to their default values.

3) SENSOR (2 Parameters plus Reset):

Min Pressure (PSI): The minimum pressure of the transducer (0 PSI). The default is 0 PSI. Do not change this value unless you are using a transducer other than the one shipped with the drive, and the transducer being used requires a different minimum setting.

Max Pressure (PSI): The maximum pressure of the transducer (300 PSI). The default is 100 PSI. Do not change this value unless you are using a transducer other than the one shipped with the drive, and the transducer being used requires a different maximum setting.

Reset to defaults: Default value is NO. Change to YES to reset all Sensor parameters to their default values.

4) PIPE BREAK (2 Parameters):

Pipe Break Detection: Detects a possible leak in the system. The Default value is ENABLED. Change to DISABLE to disable Pipe Break Detection.

Number of days with no sleep: The maximum number of days that the drive will operate without going to sleep. If the maximum is exceeded, the drive stops the pump with a Pipe Break Fault. Default is one day. Range is 1–24 days.

5) DRY RUN (3 Parameters):

Auto Reset Delay: The delay (in minutes) that the drive will wait before attempting to restart after a Dry Run Fault. Default is 10 minutes. Range is 3–60 minutes.

Number of Resets: The number of times that the drive will attempt to restart after a Dry Run Fault. Default is 3. Range is 0–5.

Reset Window (Read Only): The time window allowed for resets after a Dry Run Fault. This is calculated based on the values in the two parameters above (Auto Reset Relay and Number of Resets).

6) I/O (Two Submenus):

External Input (4 parameters – see Figures 6-6 through 6-9, Page 29).

NOTE: An external device must be connected before changing these parameters:

Unused: The default.

Setpoint: Used with devices like automatic sprinkler systems that start and stop on a timeclock. When the timeclock starts the system, SETPOINT tells the drive to operate at the External Setpoint pressure (under the Settings menu) until the external device switches off.

External Fault: Stops the pump and indicates EXTERNAL FAULT. Used to alert the user to problems with external devices.

Run Enable: Used with external switches (for example, float switches) connected to I1 to allow the drive to operate when the external switch is ON, and stops the drive when the external switch is OFF.

Relay Output (3 Settings—See Figures 6-6 through 6-9, page 29):

Unused: Selected when nothing is connected to the O1 terminals.

Running: Can turn an external device on or off when the drive is running the pump.

Fault: Can turn an external device (such as an alarm or autodialer) on or off if the drive has a fault.

Reset to Factory defaults:

Change NO to YES to reset all the parameters in the VFD (including all sub-menus) to the factory-set default values.

NOTE: This will display the startup menu. You must re-enter the information required for startup (see "Initial Startup Programming Procedure", Page 25).

6.6 I/O CONNECTIONS

The I/O terminals are located in the center of the wiring compartment, to the left of the transducer terminals. The Relay Output terminal is marked O1. The Relay Output terminal powers an external device (warning light, etc.). The External Input terminal is marked I1. The External Input terminal allows the Drive's operation to be coordinated with or limited by an external device (float switch, etc.). Each can be programmed for use with certain external devices; see "6) I/O (Two Submenus)," Page 28, the Parameters section (Page 26) for further information.

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

External Input Rating:

The unique design of the PENTEK INTELLIDRIVE allows this input to be 24V DC or 24-230V AC. Power can be supplied (24VDC) from terminals V+ and V– to the right of I/O terminal I1. See Figures 6-6 and 6-7.

Output Relay Rating:

The unique design of the PENTEK INTELLIDRIVE allows this output to be 24V DC or 24-230V AC. Power can be supplied (24VDC) from terminals V+ and V– to the right of I/O terminal I1. See Figures 6-8 and 6-9. The Output Relay is rated at 5A @ 30VDC or 8A @ 230VAC.

Note: To connect the wires to either terminal:

1. Strip the wires back about 1/2".
2. Push the spring terminals up (back).
3. Insert the wires.
4. Release the spring terminals.

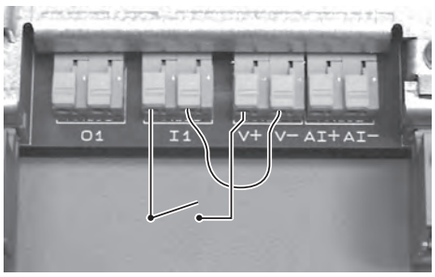


Figure 6-6: External Input using 24VDC and power from terminals V+/V–.

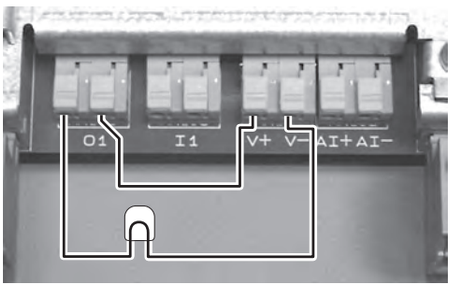


Figure 6-8: Output relay example using 24VDC supply.

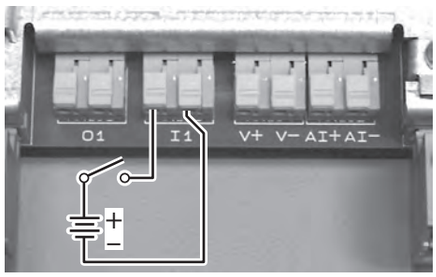


Figure 6-7: External Input using external power supply (can also be an A.C. source).

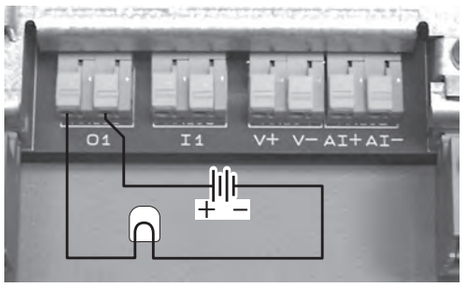


Figure 6-9: Output relay example using external supply.

NOTE: The external input and output relay can accept 24VDC. It also accepts AC voltage up to 230 volts.

6.7 TROUBLESHOOTING

Fault Display	Possible Causes	Actions
Over Current	Shorted output.	Check for any shorts in the motor cables.
	Motor current exceeded the S. F. Amp	Make sure that motor Service Factor Amps are correct.
	Motor oversized or pump undersized.	Make sure that pump and motor are sized correctly.
	Pump Jammed or locked rotor.	Pull pump; check for debris in pump
Over Voltage	Power is cycling on and off.	Check for a generator or for switching on the input line.
	Faulty check valve on pump.	Check for back flow in the system.
Under Voltage	Low input voltage.	Make sure that input voltage is above 190VAC
	No power for a short period of time.	Check for brown out conditions
	Excessive load current.	Make sure motor is sized correctly for the application
	Loss of a motor phase.	Make sure correct voltage is present on all motor leads.
	Loss of an input line.	Make sure correct voltage is present on all input lines.
Rotor Jam	Exceeding S.F. Amps	Make sure Service Factor Amps entered are correct. Make sure pump and motor are correct.
	Locked rotor.	Pull pump; check for debris in pump.
Dry Run	Well draws down too far, pump runs dry.	Check water depth.
	Under sized pump or motor.	Make sure pump and motor are sized correctly.
	Leak in the pipe system.	Check system for leaks.
	Intermittent transducer connection.	Check transducer cable for loose connections or damaged insulation.
	Cannot reach pressure setpoint.	May need to reduce pressure setpoint.
	Possible Leak	Check for a broken pipe or a large leak.
Ground Fault	Ground fault sensed in motor cables or in motor.	Make sure motor cable does not exceed max length in specifications. Check for damage or breaks in motor cables. Check motor.
	Motor cable too long	Length of cable limited to 1,000' unless a filter is used to reduce capacitance between motor wires.
Open Transducer	Intermittent connection.	Check transducer cable for loose connections or broken or damaged wires.
	Open Connection	Check transducer wires for correct connections and verify secure cable connection to transducer.
	Failed transducer.	Check voltage at the transducer terminals (12-24Vdc). If voltage is present, then transducer is faulty. Replace the transducer.
Shorted Transducer	Short in transducer wires.	Check for shorted transducer wires, reversed leads, or damaged insulation.
	Failed transducer.	Disconnect transducer from cable and press auto start; if the error now reads "Open Transducer" (and leads are not reversed) then replace the transducer. If it still reads "Shorted Transducer", then the cable has a short; replace the cable.

PID-1, PID-6 INTELLIDRIVE Series

Fault Display	Possible Causes	Actions
Hard Faults	Exceeded Max faults allowed in 30 minutes.	Check Fault log for list of faults. Correct issues. Press "Fault Reset".
	Any fault lasting continuously for 30 minutes (including auto reset faults lasting more than 30 minutes).	Look in the Fault Log for the fault preceding the Hard Fault to determine what caused the Hard Fault; refer to that fault's troubleshooting section.
Over Temperature	Excessive internal drive temperature.	Make sure that the ambient temperature is not above 60°C (104°F) Make sure that the fan is operational and unobstructed. Make sure that all vents are clear. Drive goes into TPM and limits the motor current until it is within the operating temperature.
Pipe Break	Leak detected. Application calls for long run times.	Check for any leaks in the pipe system. Extend run-time limitation: Go to 'Main Menu, Pipe Break, No. of Days without Sleep' to verify preset value and change if needed. Disable Pipe Break Fault: Go to 'Main Menu, Pipe Break, Disable Pipe Break Detection' to disable this function if needed.
Internal Fault	Internal voltages are out of range.	Drive will auto reset and try to clear fault; press Fault Reset to try to reset fault, then try to run pump. If fault continues, replace drive.
Hardware Fault	Internal hardware failure.	Press Fault Reset to try to reset fault, then try to run pump. If fault continues, replace drive.
External Fault	External device detected a fault condition and closed the I1 input.	Check the external device.
Open Lead	Motor has an open lead.	Make sure that all motor lead connections are tight and secure. Motor's thermal overload tripped. Wait for it to cool and then restart pump.

Warning	Cause	Drive Operation
Over Current	Motor current has exceeded S F Amps.	Drive goes into TPM and limits the motor current.
TPM: Service Amps	Motor current has exceeded S F Amps.	Drive goes into TPM and limits the motor current.
TPM: Speed Reduced	Drive internal temperature limit exceeded.	Drive goes into TPM and limits the motor current until it is within operating temperature range.
Jam Warning	Debris in pump has locked rotor.	Drive reverses or pulses motor to try to free it.
NOTE: No user action is required when a Warning is displayed.		

PID-1, PID-6 INTELLIDRIVE Series

6.8 WIRING SIZING, REPAIR PARTS, SPECIFICATIONS

Table 6-5: AWG Wire Sizing, VFD to 3-Phase Motor.

NOTE: Information in this Table applies ONLY to PENTEK motors. For other motors, refer to motor manufacturer's specifications for wire sizing.

VFD Model	PENTEK Motor	H.P.	Volts/Hz/Ph	Maximum Cable Length in Feet (Meters)				
				14AWG	12AWG	10AWG	8AWG	6AWG
3 Phase								
PID-1-4A7 PID-1-7A6	P43B0010A3	1.0	230/60/3	449(137)	715(218)	1000(305)		
PID-1-7A6	P43B0015A3	1.5	230/60/3	346(105)	551(168)	878(268)	1000(305)	
PID-1-7A6 PID-1-10A1	P43B0020A3	2.0	230/60/3	278(85)	442(135)	705(215)	1000(305)	
PID-1-10A1	P43B0030A3	3.0	230/60/3	209(64)	333(101)	530(162)	840(256)	1000(305)

Table 6-6: AWG Wire Sizing, VFD to 3-Wire, 1-Phase Motor.

NOTE: Information in this Table applies ONLY to PENTEK motors. For other motors, refer to motor manufacturer's specifications for wire sizing.

VFD Model	PENTEK Motor	H.P.	Volts/Hz/Ph	Maximum Cable Length in Feet (Meters)				
				14AWG	12AWG	10AWG	8AWG	6AWG
3-Wire, 1 Phase								
PID-6-9A7	P43B0005A2	0.5	230/60/1	431 (131)	686(209)	1000(305)		
PID-6-9A7	P43B0007A2	0.75	230/60/1	335(102)	533(162)	850(259)	1000(305)	
PID-6-9A7 PID-6-12A2	P43B0010A2	1.0	230/60/1	293(89)	467(142)	744(227)	1000(305)	
PID-6-12A2	P43B0015A2	1.5	230/60/1	190(58)	303(92)	483(147)	764(233)	1000(305)
PID-6-12A2	P43B0020A2	2.0	230/60/1	173(22)	275(84)	439(134)	696(212)	1000(305)

PID-1, PID-6 INTELLIDRIVE Series

Repair Parts

Part Description	Qty.	Part No.
Input Terminal Block Connector	1	PID-CON2
Output Terminal Block Connector	1	PID-CON3
Cooling Fan	1	PID-FAN
Pressure Transducer	1	U17-1561
10′ Transducer Cable	1	U18-1593
25′ Transducer Cable*	1	U18-1594
50′ Transducer Cable*	1	U18-1595
100′ Transducer Cable*	1	U18-1596
150′ Transducer Cable*	1	U18-1597
200′ Transducer Cable*	1	U18-1598
Cord Grip for Transducer Cable*	1	U17-1337
Keypad	1	PID-HMI

* Purchase Separately

Specifications

Drive:

Max Input Amps: 17A
Max Output Amps . . . . . .See Table 6-1, Page 21
Input/Output Terminal Capacity 6-14AWG
Input Frequency 50/60Hz
Input Voltage . . . . . .230VAC Nominal (190–265VAC)
Output Voltage:
PID-1 . . . . . .230VAC/30-80Hz/3 Ph
PID-6 . . . . . .230VAC/30-60Hz/1 Ph
Output Connections . . . . .3-Phase or 3-Wire/1-Phase
Max Motor Cable Length . . . . . .1,000 Ft.*
Ambient Temperature . .–4°F to 104°F(–20°C to 40°C)

Transducer:

Pressure Range: .0-100 Pounds per Square Inch (PSI)
Output Signal: 4-20mA
Pressure Port: . . . . . .1/4″ NPT
Rated Voltage 8–28VDC

* Limit with no external filter

SECTION 7: Variable Frequency Drives—PPC20 Series 36

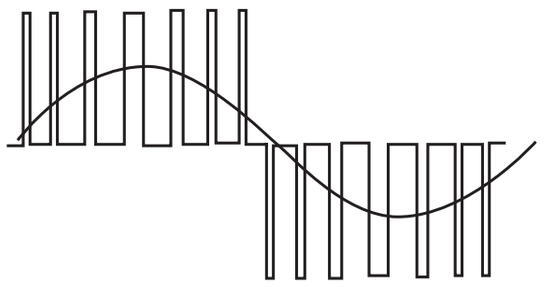
7.1 HOW DRIVES WORK

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.

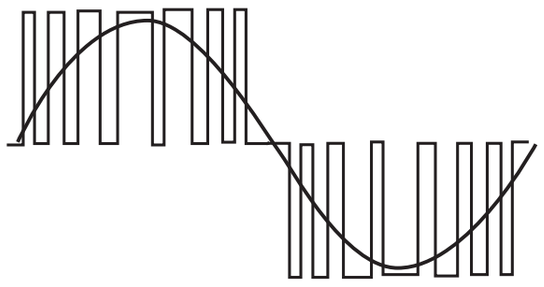
The incoming AC voltage is rectified, filtered and routed to a bank of capacitors. The capacitor bank is refered to as the DC bus. The DC bus voltage is approximately 1.414 times the incoming AC voltage. i.e 230V 60 Hz input will result in a DC Bus voltage of approximately 325V (1.414 times 230V).

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).



Shorter “ON” period = Lower voltage



Longer “ON” period = Higher voltage

Figure 7-1: Pulse Width Modulation Waveforms

7.2 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.

7.3 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)

7.4 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 7-1.
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 7.3).

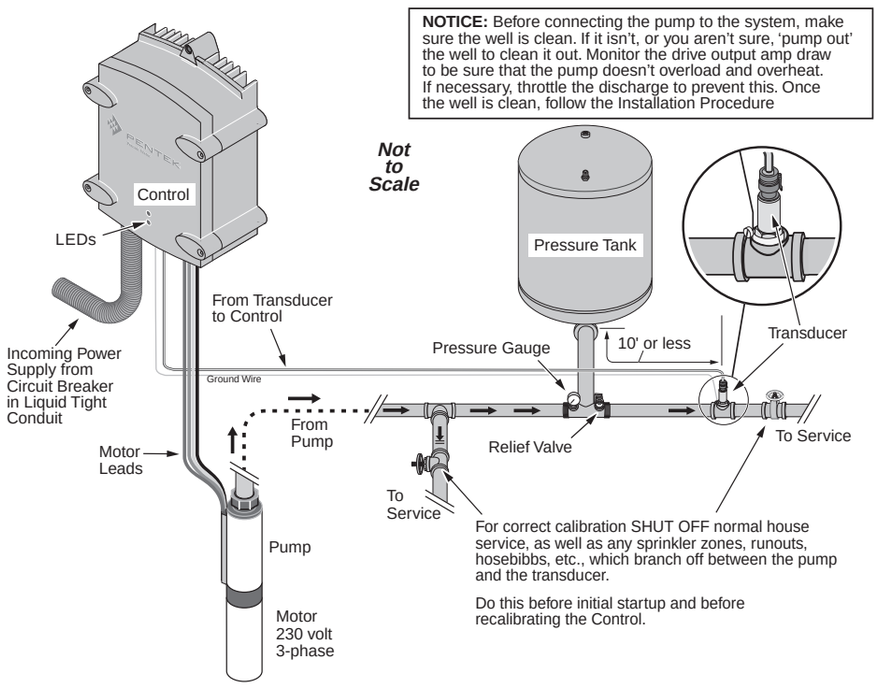


Figure 7-2: PPC20 General Layout

7.5 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 7.3.

⚠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. Disconnect the incoming power before working on or around the system.

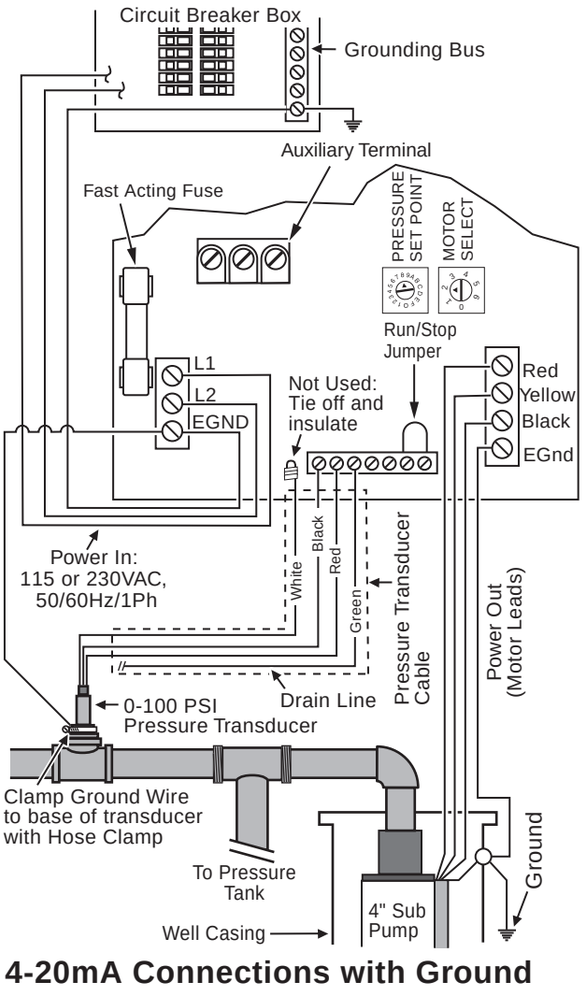


Figure 7-3: PPC20 Wiring Connections

⚠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 7-2).
6. Connect the ground wire from the base of the transducer to the electrical ground. (See Figure 7-3).
7. The pressure transducer is pre-calibrated; no adjustment is needed.

7.6 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.

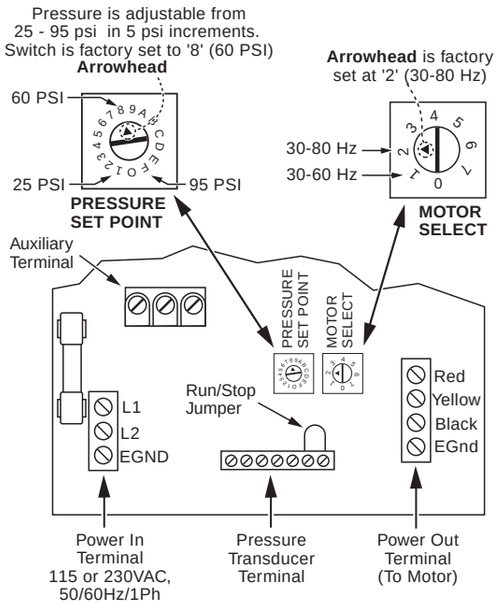


Figure 7-4: Pressure Set Point and Motor Select Settings

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.

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PRESSURE SET POINT

The Pressure Set Point Switch is located in the Drive unit (see Figure 7-4). 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 7-1, below).

TABLE 7-1: 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 7-4). 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).

7.7 LED FAULT CODES

TABLE 7-2: 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.

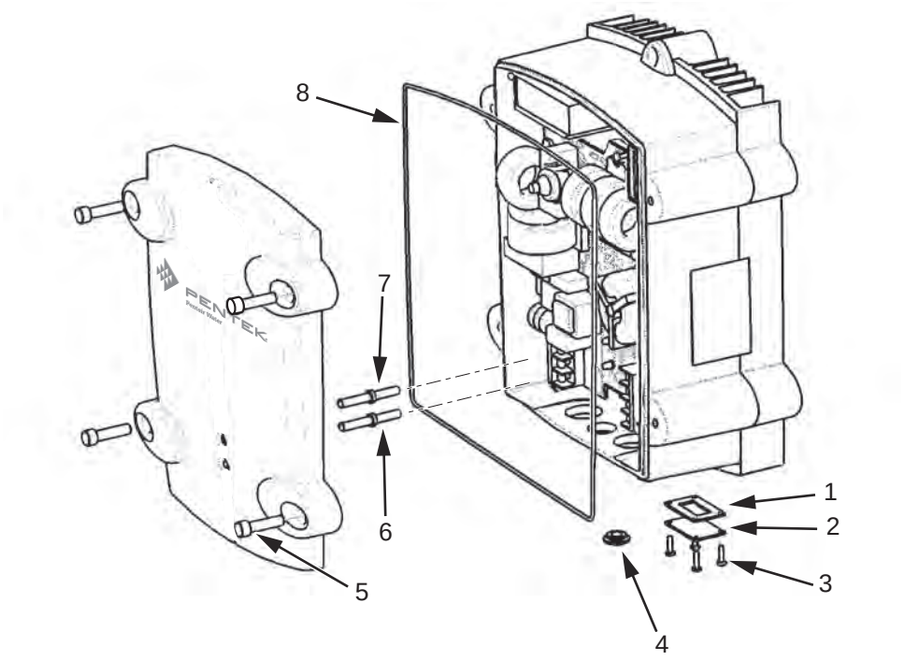
The Drive will return to normal operation if the fault corrects itself, but will continue to show a fault on the red LED indicator. Push the manual reset button for 1 second or more to stop the red LED from flashing. If the red LED continues to flash a fault code after you have pushed the manual reset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

7.8 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.

PPC3, PPC5

8.1 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.

8.2 PPC3 SERIES SPECIFICATIONS

Table 8-1: 3-Phase/208-230V Output

Note: For detailed specifications see users manual.

OUTPUT AMPS	INPUT PHASE	INPUT VOLTAGE	ENCLOSURE RATING (NEMA)	CATALOG NUMBER
4.7	1	200-240	1	PPC3-1-4A7-1
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
12.4	1	200-240	1	PPC3-1-12A4-1
18.5	1	200-240	1	PPC3-1-18A5-1
4.7	3	200-240	1	PPC3-2-4A7-1
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
24.6	3	200-240	1	PPC3-2-24A6-1
31.0	3	200-240	1	PPC3-2-31A0-1
46.2	3	200-240	1	PPC3-2-46A2-1

Table 8-2: 3-Phase/380-460V Output

Note: For detailed specifications see users manual.

OUTPUT AMPS	INPUT PHASE	INPUT VOLTAGE	ENCLOSURE RATING (NEMA)	CATALOG NUMBER
2.4	3	380-480	1	PPC3-4-2A4-1
3.3	3	380-480	1	PPC3-4-3A3-1
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
23.1	3	380-480	1	PPC3-4-23A1-1
31.0	3	380-480	1	PPC3-4-31A0-1
38.0	3	380-480	1	PPC3-4-38A0-1
44.0	3	380-480	1	PPC3-4-44A0-1

8.3 PPC5 SPECIFICATIONS.

PENTEK Pump Controller – PPC5 Series:

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
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%.

SECTION 8: Variable Frequency Drives—50/60 Hz 44

PPC3, PPC5

PENTEK PPC5 SERIES

Table 8-4: 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 8-5: 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

PPC3, PPC5

8.4 WIRING CONNECTIONS

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

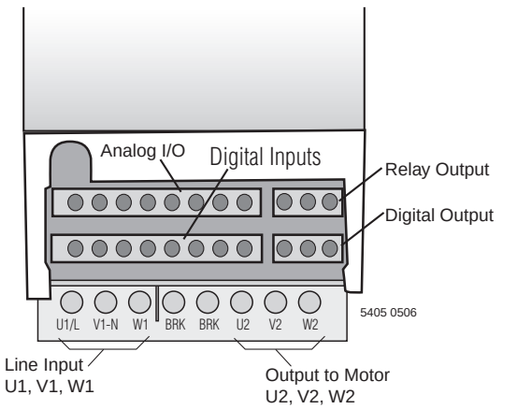


Figure 8-1 Typical Connections to PPC3

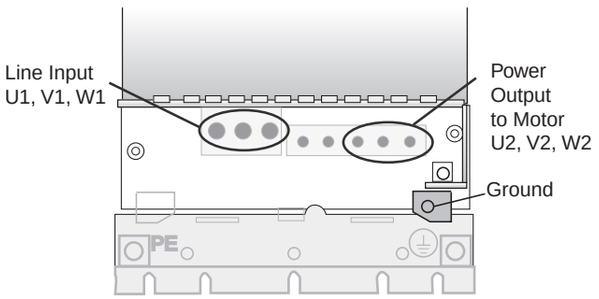


Figure 8-2 Typical Connections to PPC5

8.5 TRANSDUCER CONNECTION

The PENTEK Assistant defaults to a 4-20mA transducer connected to AI2. The transducer is used to provide pressure feedback to the drive. Transducers offered by PENTEK have either a red or brown power lead. The red or brown lead should be connected to the +24V power connection. Transducers offered by PENTEK have either a blue or black output lead. The blue or black lead should be connected to terminal 5. The PENTEK U17-1286R transducer utilizes shielded cable. The bare lead may be covered with green shrink-wrap tubing. The bare lead is cable shielding, and should be connected to terminal 1. The translucent lead is unused, and should be tied off and insulated.

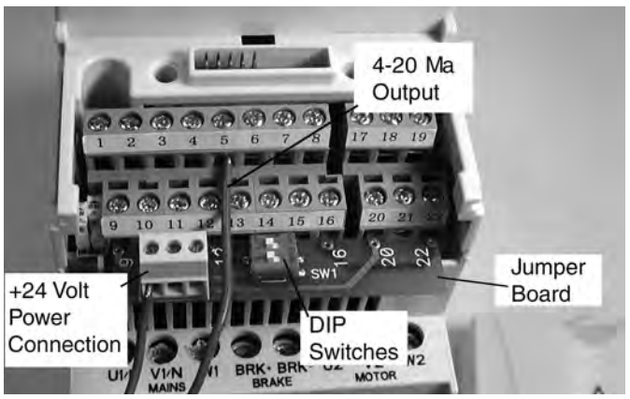


Figure 8-3 PPC3 Transducer Connection.

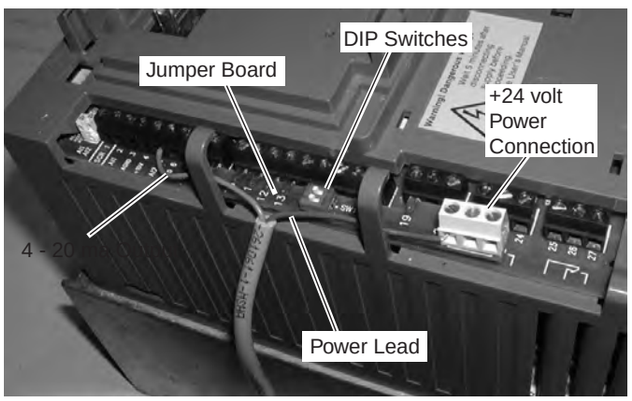


Figure 8-4 PPC5 Transducer Connection.

PPC3, PPC5

8.6 PENTEK ASSISTANT

TABLE 8-6: PPC3 PARAMETERS CHANGED RELATIVE TO PID CONTROL DEFAULTS

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

8.6.1 Description of Information Required by the *PENTEK Assistant*

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

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

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

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

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

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

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

4009 100% Value: This is the full scale reading of the

PPC3, PPC5

TABLE 8-7: PPC5 PARAMETERS CHANGED RELATIVE TO PID CONTROL DEFAULTS

Parameter Code	PENTEK Code
1002 EXT2 Commands	8-Keypad
1102 EXT1/EXT2 SEL	EXT2
1301 MINIMUM AI1	20%
1401 RELAY OUTPUT 1	SUPERV1 OVER
1404 RO 1 ON DELAY	10 S (above ground) 60 S (submersible)
1405 RO 1 OFF DELAY	2 S
1601 RUN ENABLE	NOT SEL
1605 USER PAR SET CHG	3-DI3
2001 MINIMUM SPEED	User defined (above ground) 0 (submersible)
2002 MAXIMUM SPEED	SYNC
2202 ACCELER TIME 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.

8.6.2 Mounting and Installation

STARTUP THE *PENTEK ASSISTANT*

Apply power to the unit, and follow the steps in section 8.6.3 after the Drive's screen is lit.

8.6.3 Using the PENTEK Assistant

Apply power to the unit and follow the steps in Section 8.6.4 for changing operation parameters, use the steps below to run the *PENTEK Assistant.*

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

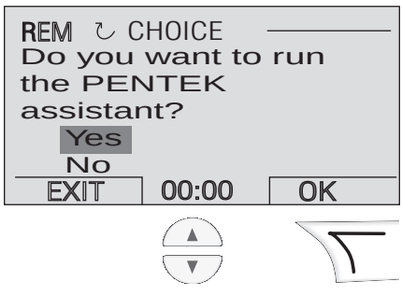
PPC3, PPC5

8.6.4 Step by step instructions

STEP 1

INITIAL STARTUP PANEL DISPLAY

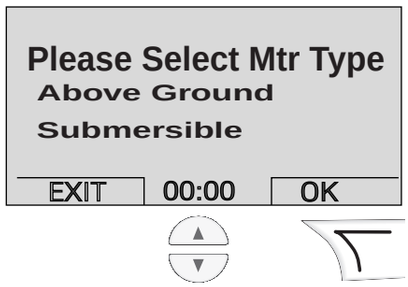
Upon initial drive power-up the user will be prompted to run the *PENTEK assistant.* Scroll to YES and then select OK. Wait while the assistant loads. On subsequent startups, the *PENTEK assistant* can be found in the ASSISTANTS menu.



STEP 2

MOTOR SELECTION SCREEN

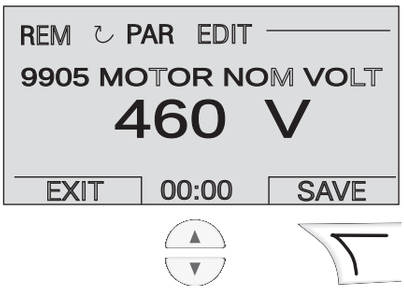
Scroll to select the type installation and then press OK.



STEP 3

MOTOR VOLTAGE SCREEN

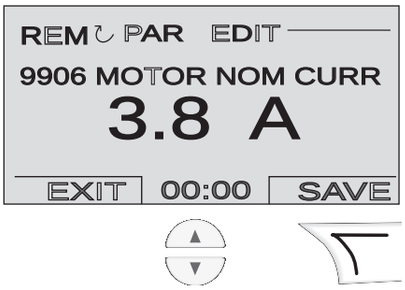
The screen shows motor voltage. Scroll to select the correct voltage for your motor as stated on the motor nameplate. This sample shows 460 volts. Press SAVE.



STEP 4

MOTOR CURRENT SCREEN

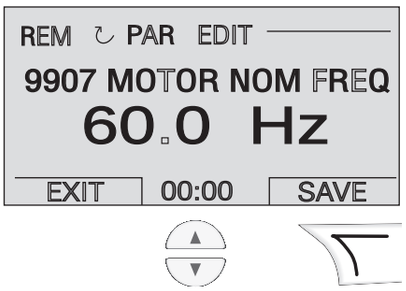
Enter the motor current from the motor nameplate (not maximum amps). Scroll to select the current and press SAVE.



STEP 5

MOTOR FREQUENCY SCREEN

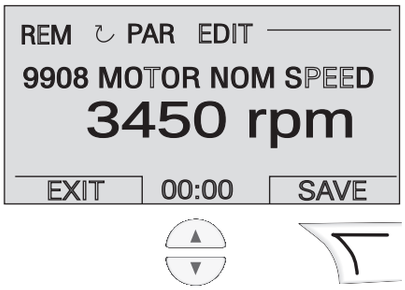
Enter the motor frequency (Hz) from the motor nameplate. Scroll to select the frequency and select SAVE.



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.

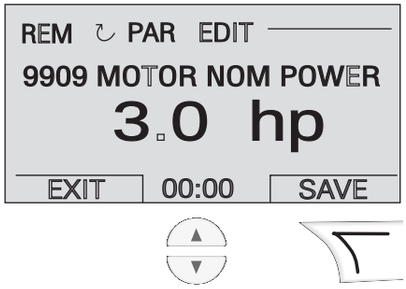


PPC3, PPC5

STEP 7

MOTOR HORSEPOWER SCREEN

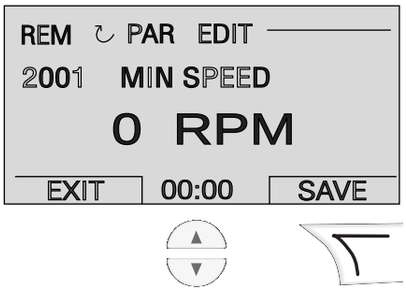
Enter the motor horsepower (HP) from the motor nameplate. Scroll to select the horsepower and press SAVE. The sample here shows 3.0 HP.



STEP 8

FOR SUBMERSIBLE PUMPS ONLY

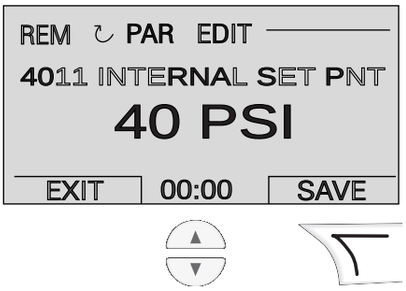
Enter the minimum speed allowed by the motor vendor (consult motor literature). This is to prevent motor bearing damage.



STEP 9

SCROLL TO SELECT CONSTANT PRESSURE POINT

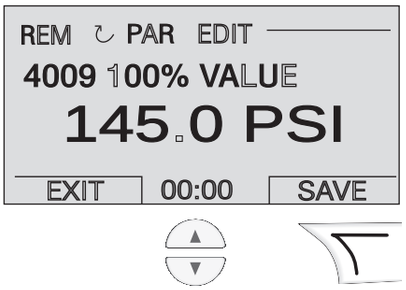
Example shows 40 PSI.

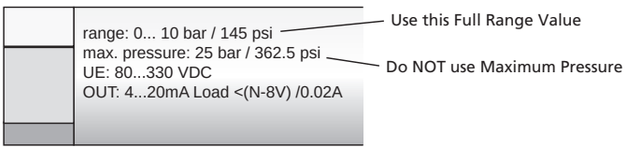


STEP 10

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.



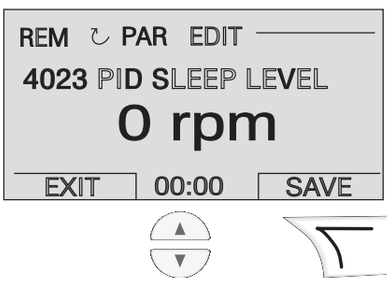


STEP 11

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.

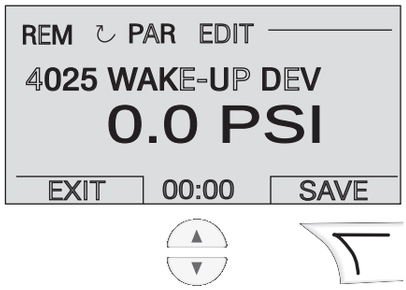


PPC3, PPC5

STEP 12

WAKE UP DEVIATION SCREEN

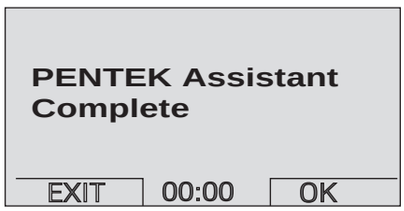
Enter the wake-up deviation. This is the amount pressure drops (PSI) below the pressure set point before the drive restarts. This sample is waiting to be set and shows 0 PSI.



STEP 13

ASSISTANT COMPETE

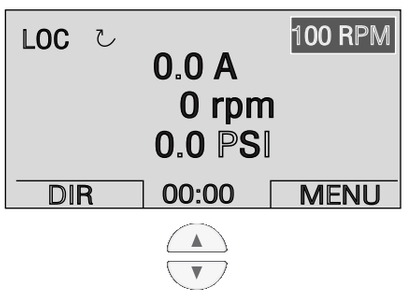
This ends setup of the *PENTEK Assistant.* The following steps complete the setup of the pump system.



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.



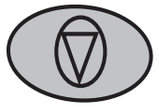
STEP 15

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.

8.7 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

8.8 HELPFUL HINTS

ALARM 2025 UPON STARTUP

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

FAULT 14 EXTERNAL FAULT 1

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

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

SLEEP

The PENTEK Drive monitors pump speed to determine demand. The pump is shut off when the rpm goes below parameter 4023: PID Sleep Level. Always set parameter 4023 high enough to trigger sleep mode during low demand conditions. Note that the shut-off head at parameter 4023: RPM, must be higher than the pressure set-point. The pressure setpoint can be determined by slowly closing the discharge valve to confirm that the RPM decreases to a level that triggers the sleep mode. The discharge head can also be found by using the BEC2 program, 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

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PPC3, PPC5

8.9 PPC3 AND PPC5 TANK SIZING

These instructions are only for systems that require tanks. Pressure tanks are generally required to maintain system pressure during periods of low or no demand. Tank 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.

8.10 REACTORS AND FILTERS

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

Reactors

A reactor is a resistance and inductance device that reduces voltage spikes. It does this by both increasing the voltage rise-time and improving the impedance match of the 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—60 Hz 53

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.

SMC

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

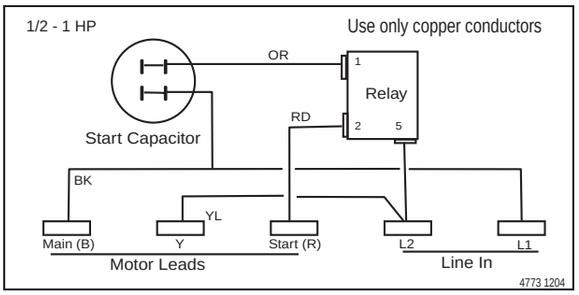
Motor Type	Submersible Motor Control Type			
	SMCT	SMC	Franklin	SMCP
PENTEK XE-Series	**NO**	Yes	Yes	**NO**
Franklin	**NO**	Yes	Yes	**NO**
PENTEK T-Series	Yes	**NO**	**NO**	**NO**
PENTEK 6"	**NO**	**NO**	**NO**	Yes

SMC for PENTEK XE-Series and Franklin Electric Motors

60 Hz.

9.4 WIRING CONNECTIONS AND REPLACEMENT PARTS

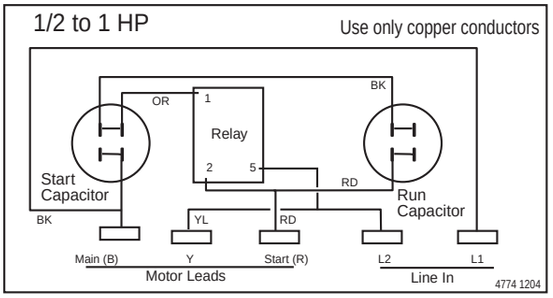
1/2 to 1 HP Capacitor Start, Induction Run



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

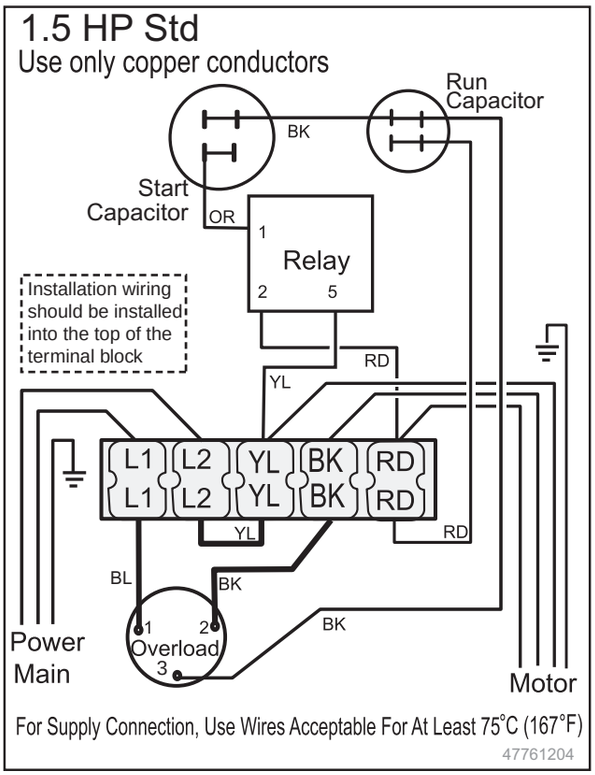


Models SMC-CR0521, SMC-CR0721, and SMC-CR1021

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	U17-1311-R

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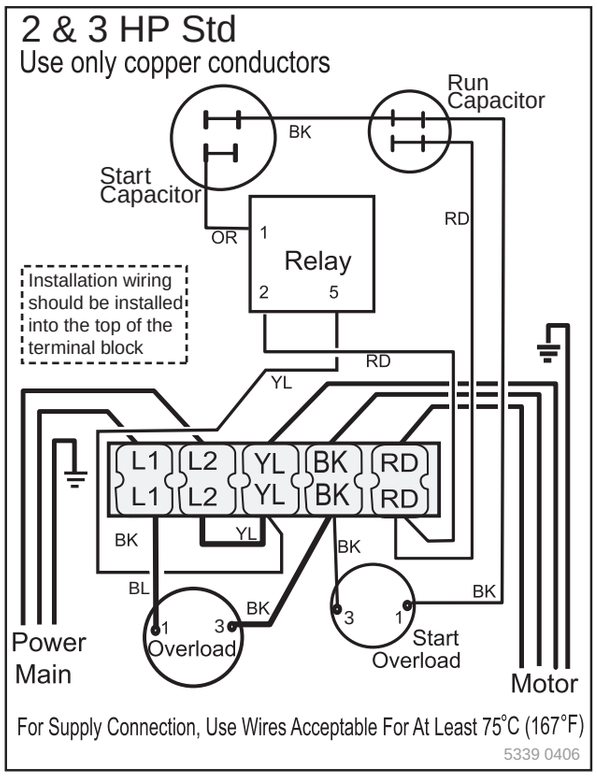
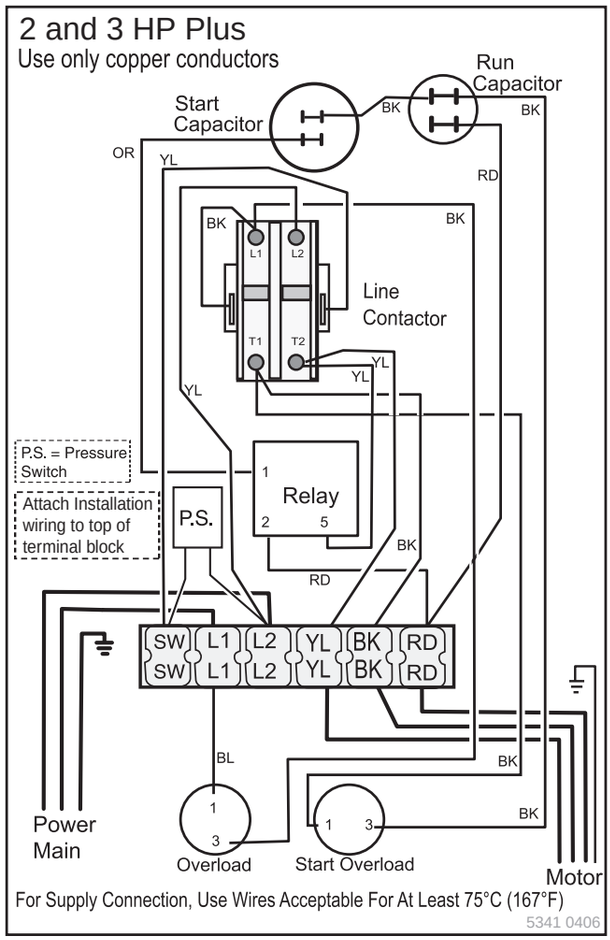
2 and 3 HP Standard



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	U17-1311-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	U17-1311-R
Magnetic Contactor	P17-954-R

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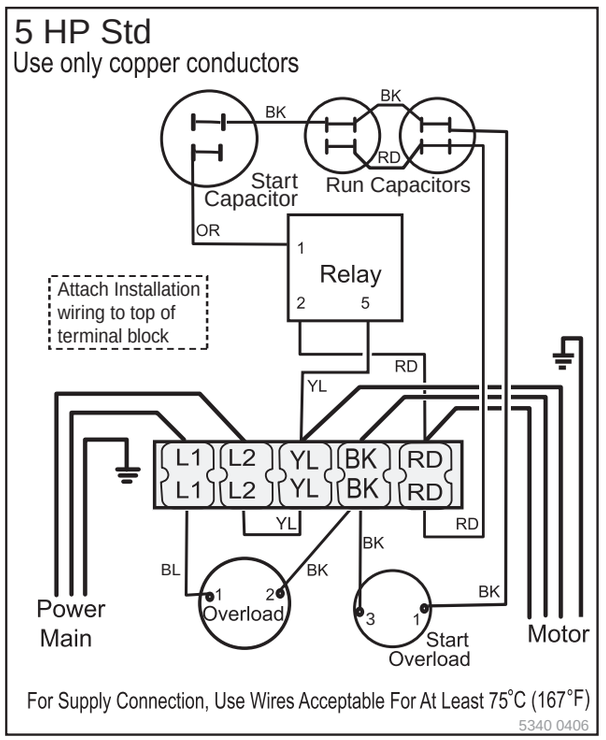
60 Hz.

5 HP Standard

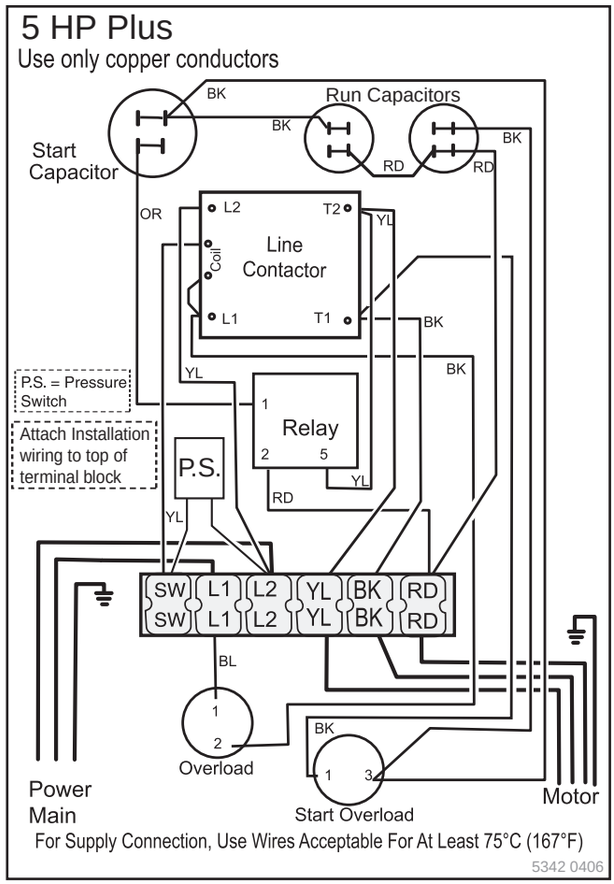


Model SMC-CR5021

Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1437-R
Run Capacitor, (2) 30 µF, 370v	U17-1502-R
Main Overload Protector	U117-1456A-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1311-R

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

5 HP Plus



Model SMC-CRP5021

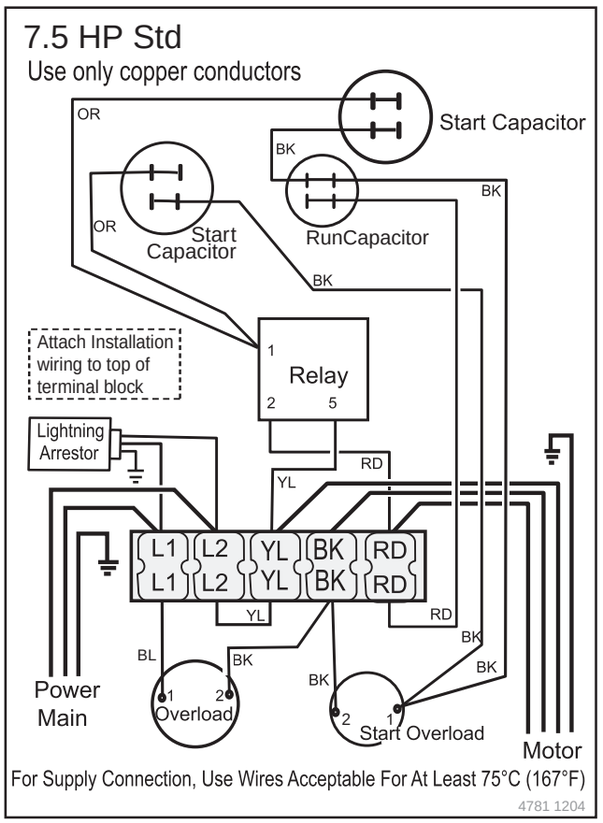
Description	Part Number
Start Capacitors, 270 µF, 330v	U17-1437-R
Run Capacitor, (2) 40 µF, 370v	U17-1442-R
Magnetic Contactor	P17-953-R
Main Overload Protector	U117-1456B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1311-R

SMC for Franklin Electric Motors

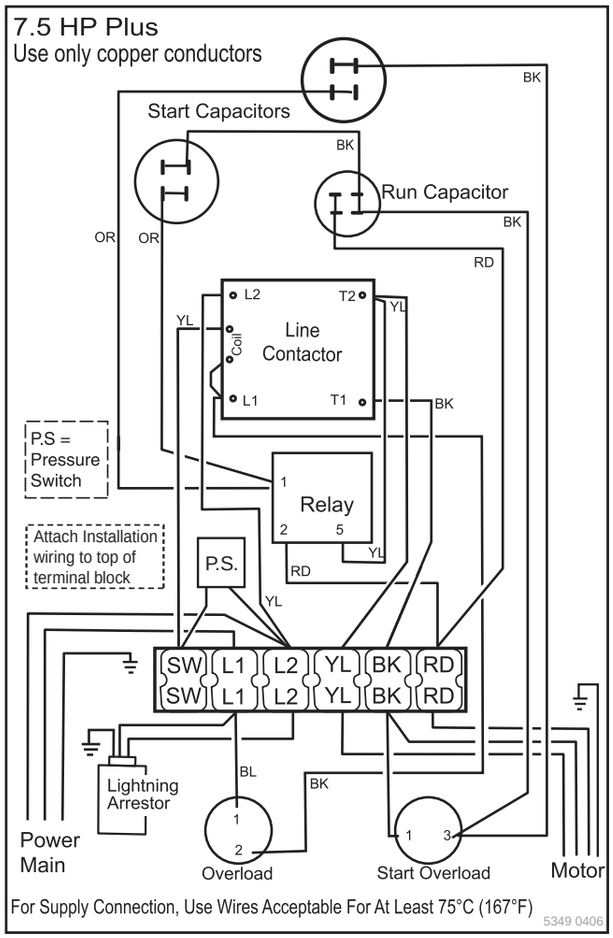
60 Hz.

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

7.5 HP Standard



7.5 HP Plus Series



Model SMC-CR7521

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	U17-1311-R
Lightning Arrestor	P17-966-R

Model SMC-CRP7521

Description	Part Number
Start Capacitor, 216 µF, 330v	U17-1436-R
Start Capacitor, 270 µF, 330v	U17-1437-R
Run Capacitor, 45 µF, 370v	U17-1447-R
Magnetic Contactor	P17-952-R
Main Overload Protector	U17-1317B-R
Start Overload Protector	U17-1321-R
Relay, 50 Amp	U17-1311-R
Lightning Arrestor	P17-966-R

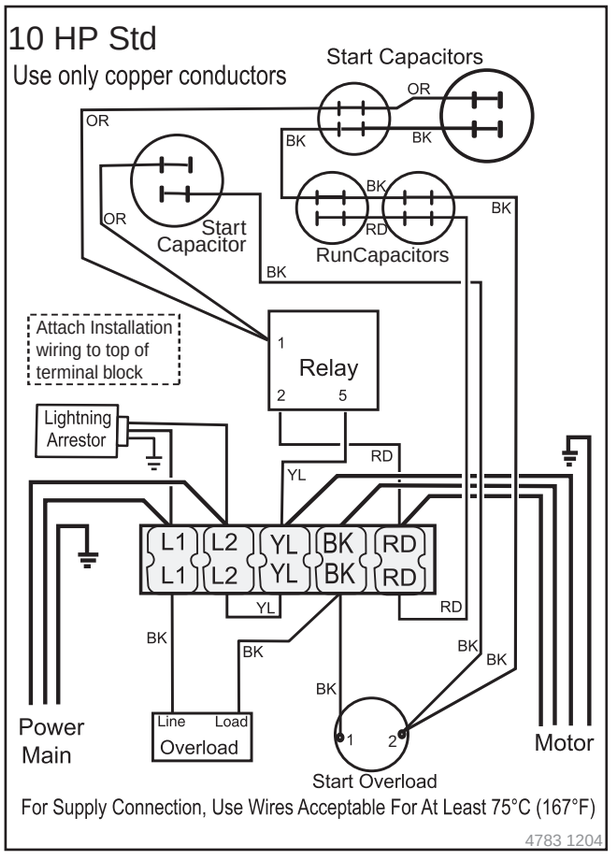
SECTION 9: Submersible Motor Controls—60 Hz 58

SMC for Franklin Electric Motors

60 Hz.

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

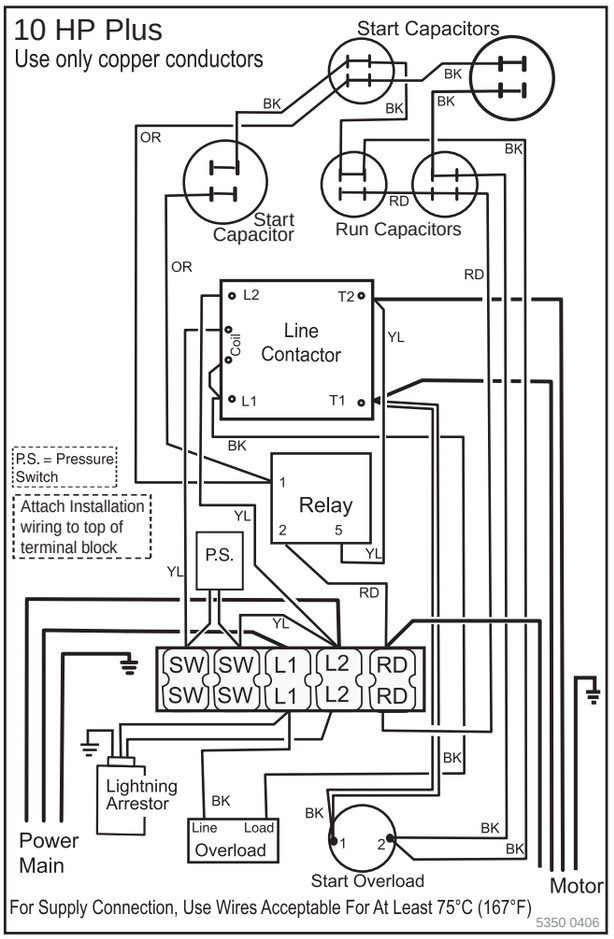
10 HP Standard



Model SMC-CR10021

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	U17-1311-R
Lightning Arrestor	P17-966-R
Start Capacitor, 130 µF, 330v	U17-1426-R

10 HP Plus Series



Model SMC-CRP10021

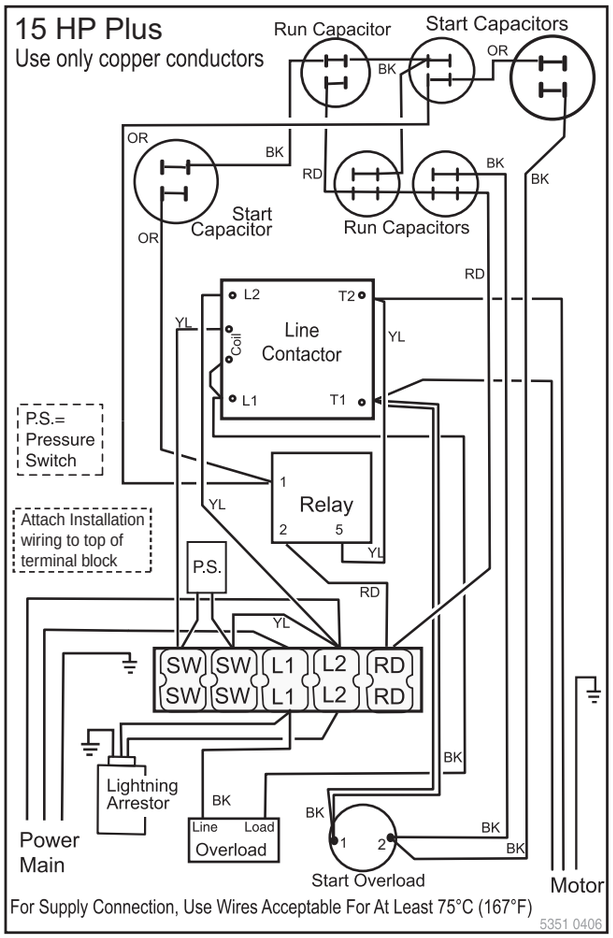
Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitors, (2) 130 µF, 330v	U17-1426-R
Run Capacitors, 35 µF, 370v	U17-1441-R
Magnetic Contactor	P17-952-R
Main Overload Protector	P17-955-R
Start Overload Protector	U117-1318D-R
Relay, 50 Amp	U17-1311-R
Lightning Arrestor	P17-966-R

SMC for Franklin Electric Motors

60 Hz.

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

15 HP Plus Series



Model SMC-CRP15021

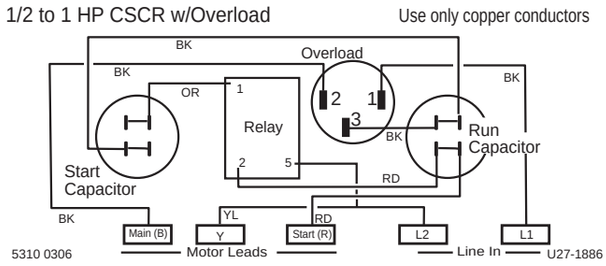
Description	Part Number
Start Capacitors, (2) 270 µF, 330v	U17-1437-R
Start Capacitor, 161 µF, 330v	U17-1427-R
Run Capacitors (3), 45 µF, 370v	U17-1443-R
Magnetic Contactor	P17-951-R
Main Overload Protector	P17-956-R
Start Overload Protector	U117-1318E-R
Relay, 50 Amp	U17-1311-R
Lightning Arrestor	P17-966-R

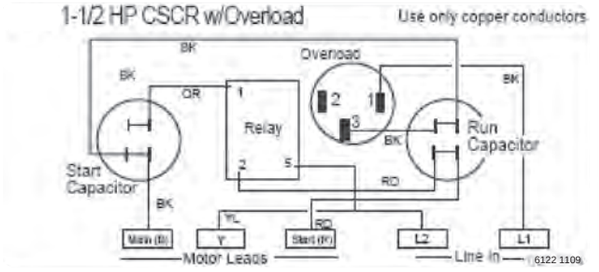
SECTION 9: Submersible Motor Controls—50 Hz 60

SMC5 for Franklin Electric Motors

50 Hz.

1/2 through 1 HP Standard





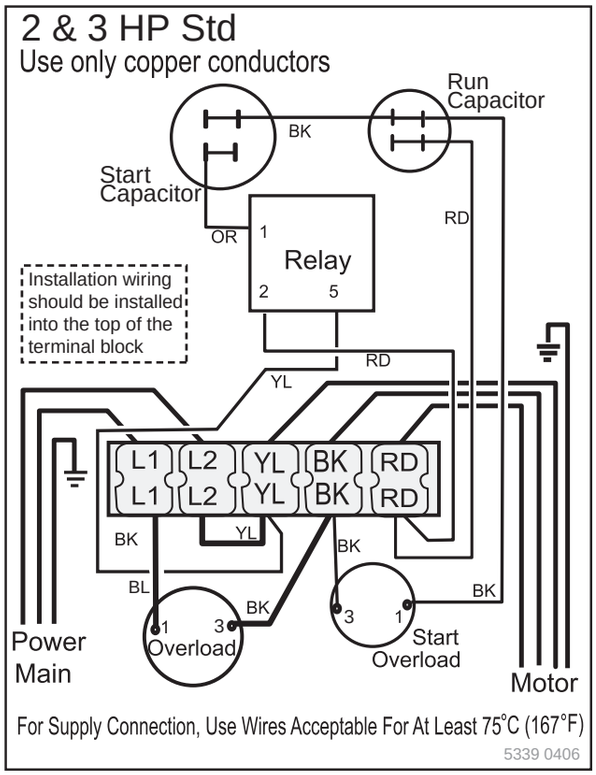
Models SMC5-CR0521, SMC5-CR0721, SMC5-CR1021, SMC5-CR1521

Description	Part Number
Start Capacitor, 43 µF, 270v, 0.5/0.75 HP	U17-1422-R
Start Capacitor, 59 µF, 270v, 1.0 HP	U17-1423-R
Start Capacitor, 105 µF, 270v, 1.5 HP	U117-1425-R
Run Capacitor, 10 µF, 370v, 0.5 HP	U17-1418-R
Run Capacitor, 15 µF, 370v, 0.75 HP	U17-1419-R
Run Capacitor, 23 µF, 370v, 1.0 HP	U17-1292-R
Run Capacitor, 20 µF, 370v, 1.5 HP	U17-1440-R
Main Overload Protector, Automatic, 0.5/1.0 HP	U17-1504
Main Overload Protector, Automatic, 1.0 HP	U17-1454-R
Main Overload Protector, Automatic, 1.5 HP	U17-1554-R
Relay, 50 Amp, 50 Hz., 220-240 Volts	U17-1421-R

SMC5 for Franklin Electric Motors

50 Hz.

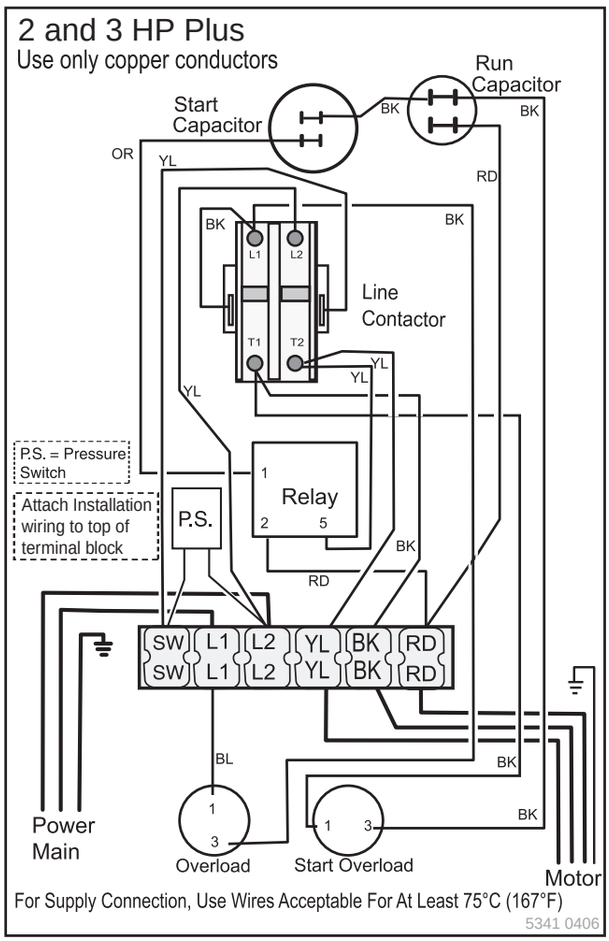
2 and 3 HP Standard



Models SMC5-CR2021-01, SMC5-CR3021-01

Description	Part Number
2 HP Start Capacitors, 208 µF, 330v	U17-1428-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	U17-1421-R
3 HP Start Capacitors, 270 µF, 320v	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	U17-1320-R

2 and 3 HP Plus



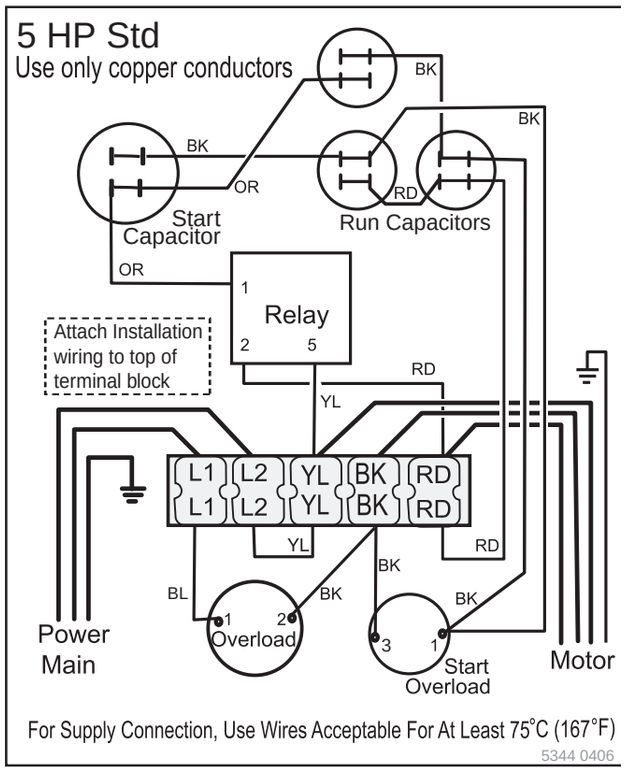
Models SMC5-CRP2021-01, SMC5-CRP3021-01

Description	Part Number
2 HP Start Capacitors, 200 µF, 350v	U17-1428-R
2 HP Run Capacitor, 20 µF, 370v	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	U117-1455B-R
3 HP Start Overload Protector	U17-1320-R
Magnetic Contactor	P17-954-R

SMC5 for Franklin Electric Motors

50 Hz.

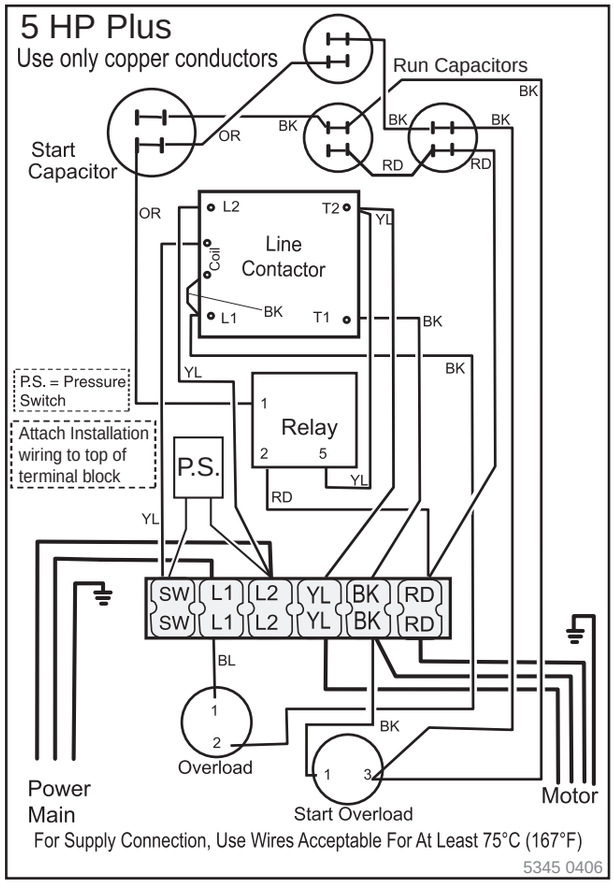
5 HP Standard



Models SMC5-CR5021-01

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

5 HP Plus



Models SMC5-CRP5021-01

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

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-111P	SPP-111P-3RL	SPP-231P	SPP-233P	SPP-235P-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 bs (.73 kg) w/enclosure	63 bs (.28 kg)	1.6 lbs (.73 kg)	1.6 bs (.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 Calibration Point	125 % of Calibration Point
Underload (Dry Run)	~80% of Cal bration Point	~80% of Calibration Point	~80% of Calibration Point	~80% of Calibration 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-lbs	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.

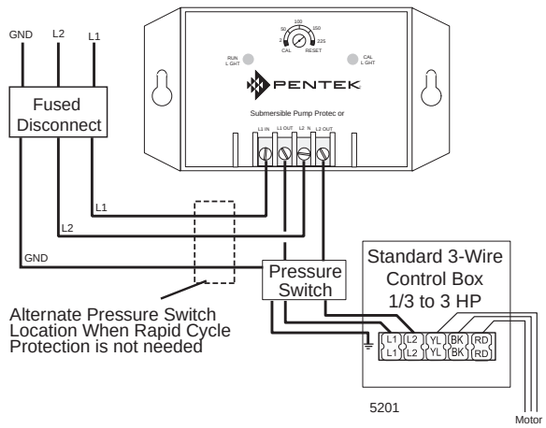


Figure 10-1: SPP233 Standard Control Box Connection

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

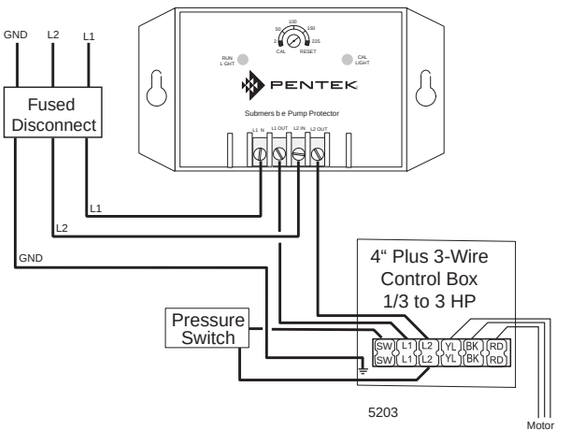


Figure 10-2: "Plus" Control Box Connection for SPP233

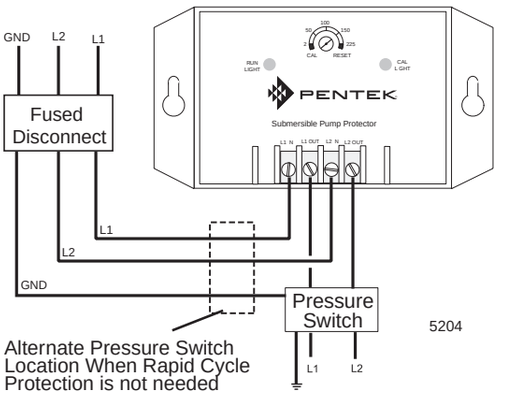


Figure 10-3: 2-Wire Connection for SPP233

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.

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

PUMP AND MOTOR PROBLEM ANALYSIS (Continued)

PROBLEM	POSSIBLE CAUSE	CHECK AND RESTORE
Low or No Water Production (continued)	Well drawdown	1. Install air line upon reinstalling unit if not already present for measuring depth with tire pump and gage 2. Measure dynamic (drawdown) level with string or resistance meter 3. Select different pump if appropriate
	Well collapsed	1. Unit is pumping dirty or sandy water 2. Lift with pump hoist, check pull weight and resistance
	Pump selection	1. Recheck operating conditions by comparing to pump curve 2. Operate within ±5 percentage points of efficiency from B.E.P.
	Hole in well piping	1. Listen for sucking sound at well head when pump shuts off 2. Well pipe empties when submersible pump is pulled from well
	Wrong rotation	1. Three phase motor - exchange any two of the three leads in the three phase motor starter panel 2. Single phase motor - recheck motor and control panel wiring diagrams. Change wiring as appropriate 3. Proper rotation for motors for sub. and centrifugal pumps with CW rotation is CCW when looking at the shaft end of the motor 4. Make a visual flow check or observe flow meter. Amperage is not a reliable indicator of wrong rotation
	Improper sizing	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.

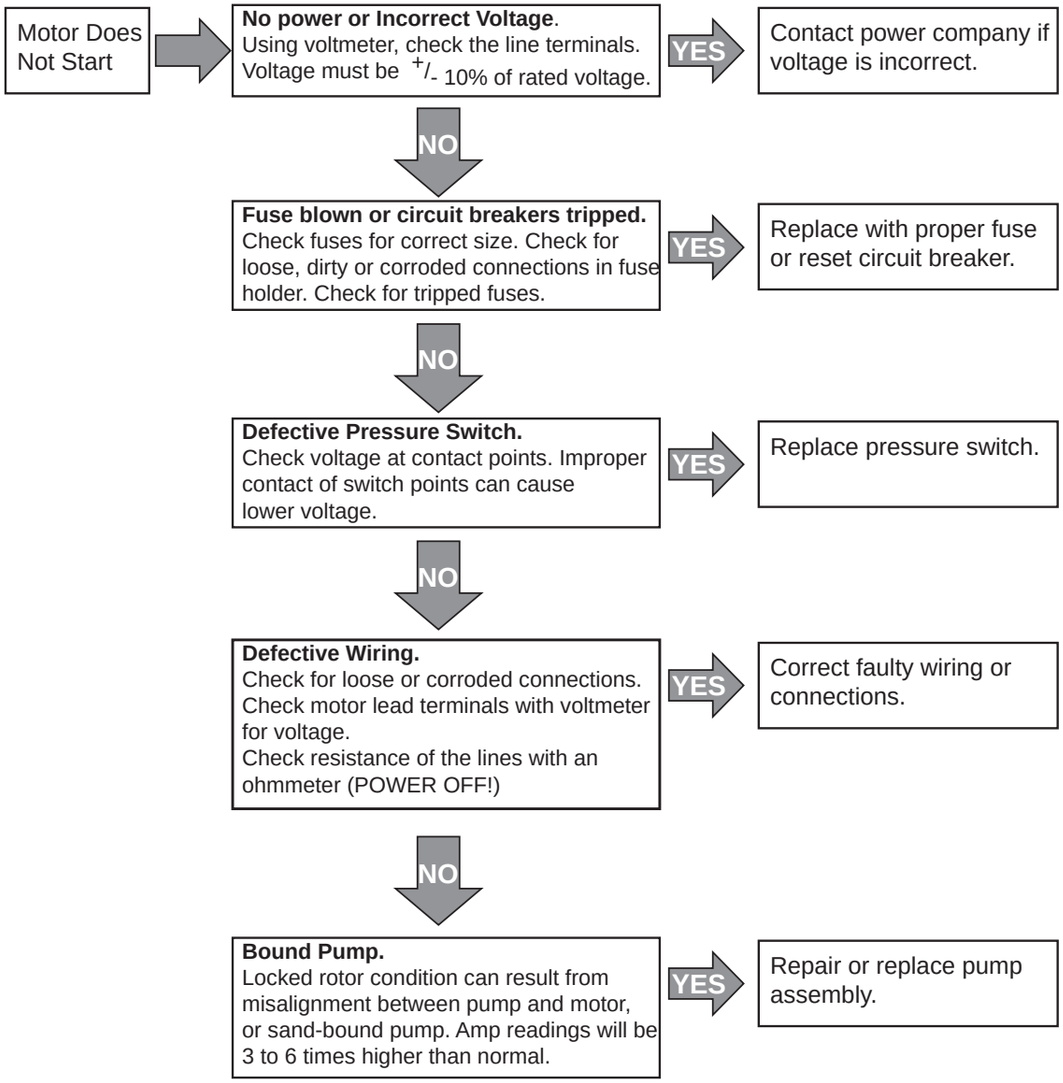
PUMP AND MOTOR PROBLEM ANALYSIS (Continued)

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

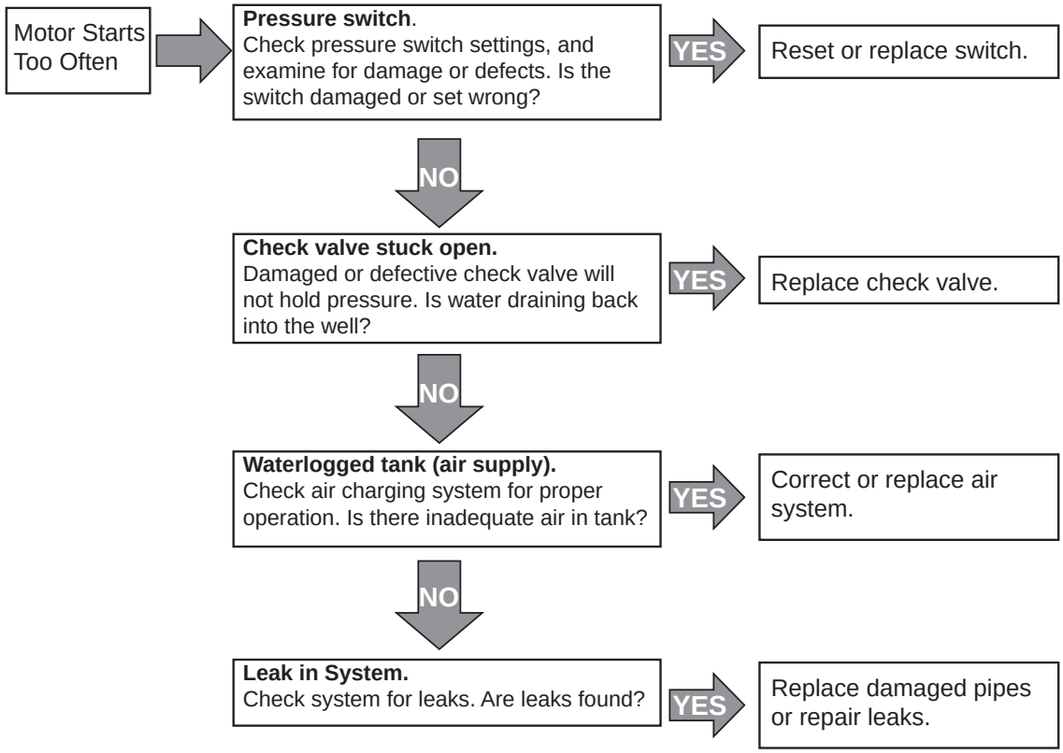
Troubleshooting Flow Chart

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.



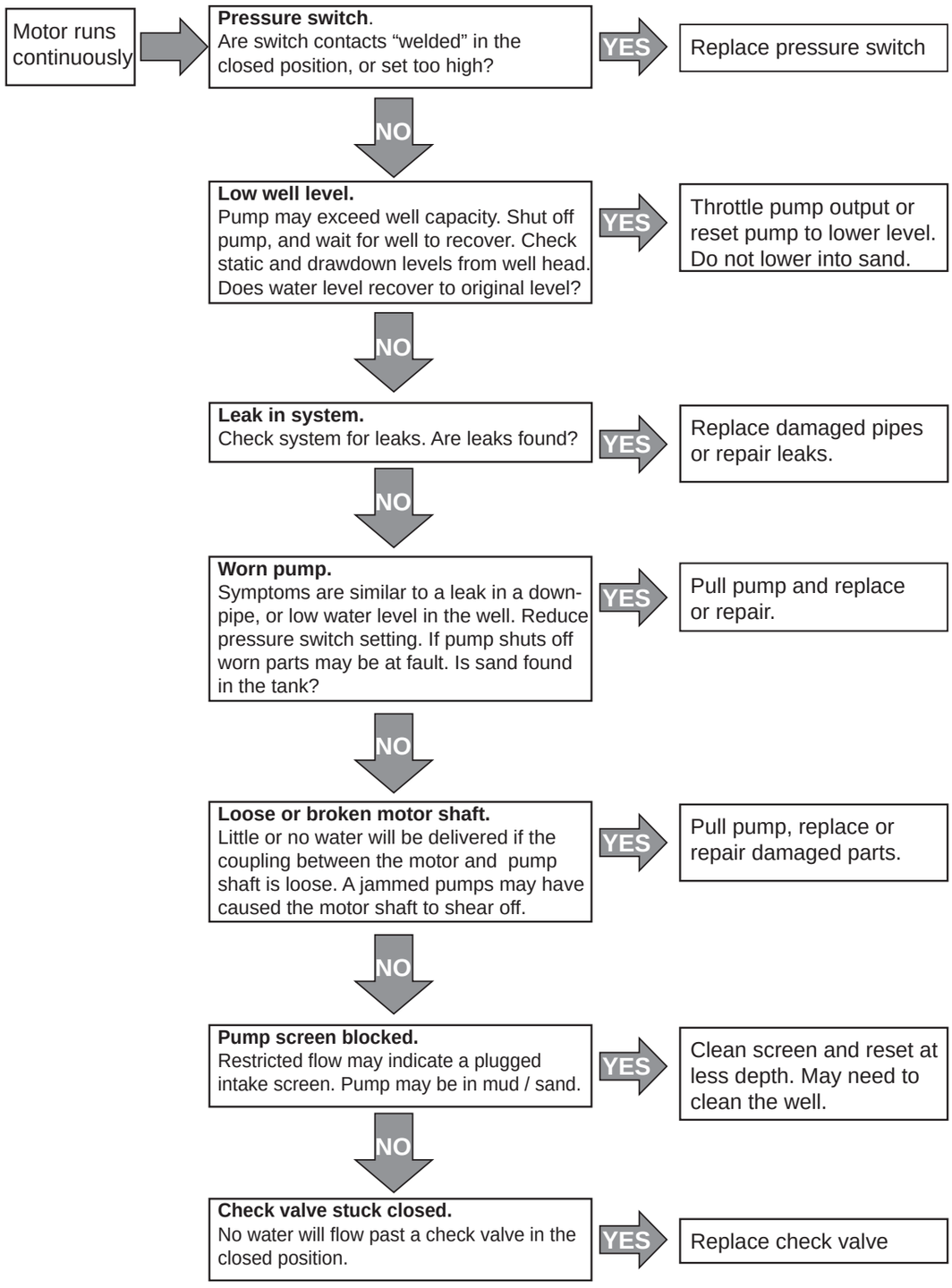
Troubleshooting Flow Chart (Continued)

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.



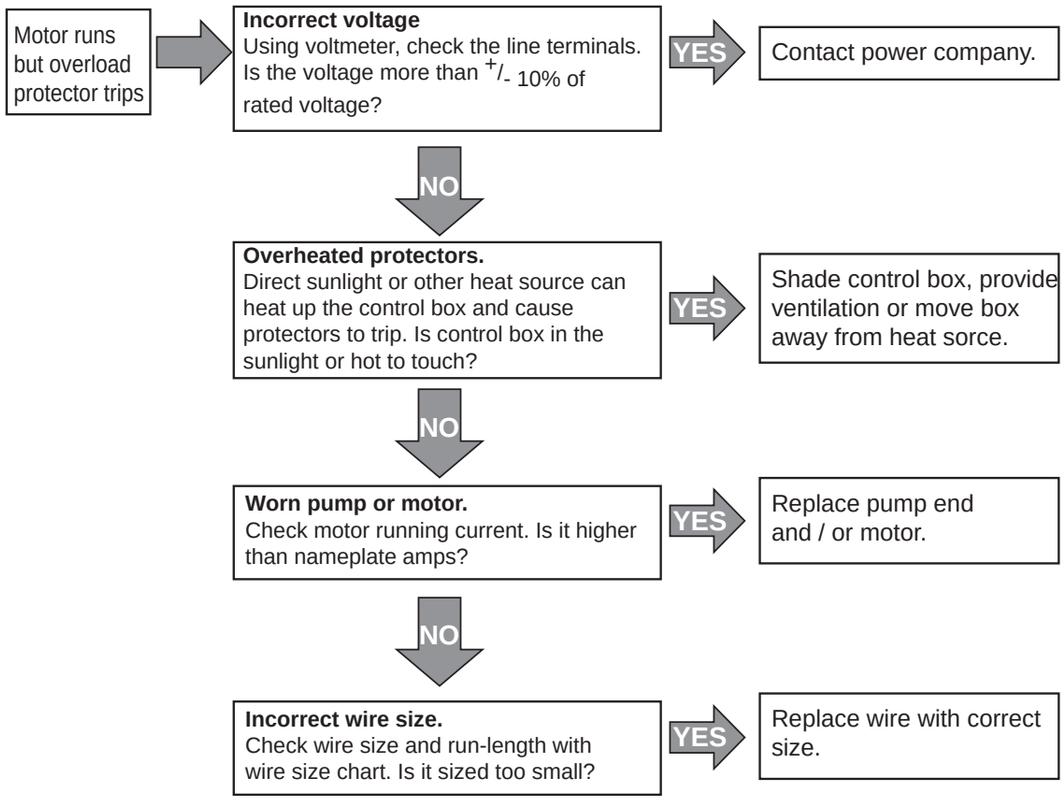
Troubleshooting Flow Chart (Continued)

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.



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 7.7 and Table 7-2 for LED Fault codes.

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

For the PID-1 and PID-6 Series, refer to Section 6.7 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

12.1 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).

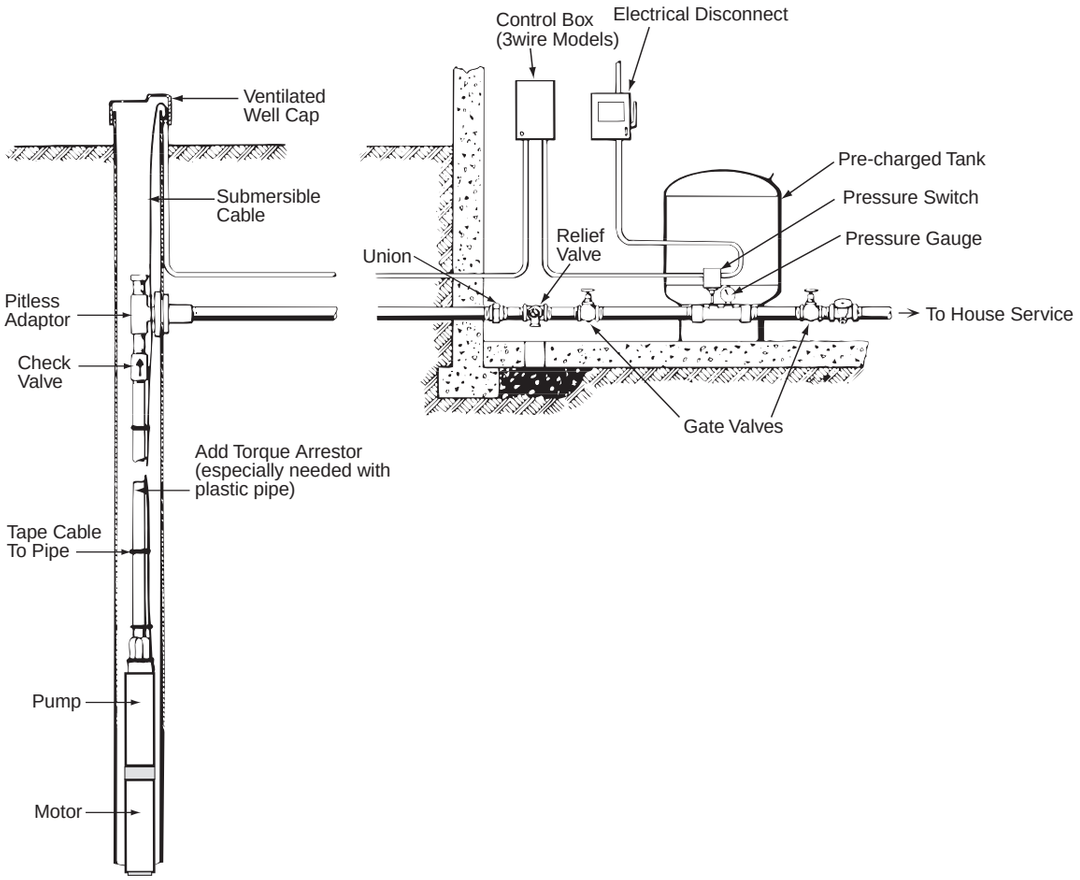
- DO NOT install the check valve midway between the pump and the ground surface. Vibration in the piping will resonate and may damage or destroy the piping or pump. Adjust check valve spacing to avoid a mid-point placement.
- Use only spring type check valves. Swing type valves can cause water hammer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

12.2 CHOOSING A PUMP SYSTEM

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

12.3 SIZING SUBMERSIBLE PUMP, MOTOR, AND TANKS

Sizing a Submersible Pump

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

1. Determine gpm of system and well.
2. Size of well casing and type.
3. Determine service pressure requirements.
4. Determine voltage and phase.
5. Determine discharge pipe size.
6. Calculate friction head loss.
7. Determine total discharge head.
8. Select the submersible pump for the above criteria, and appropriate controls for the pump.
9. Select the proper size tank for minimum one minute pump run time.
10. 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.

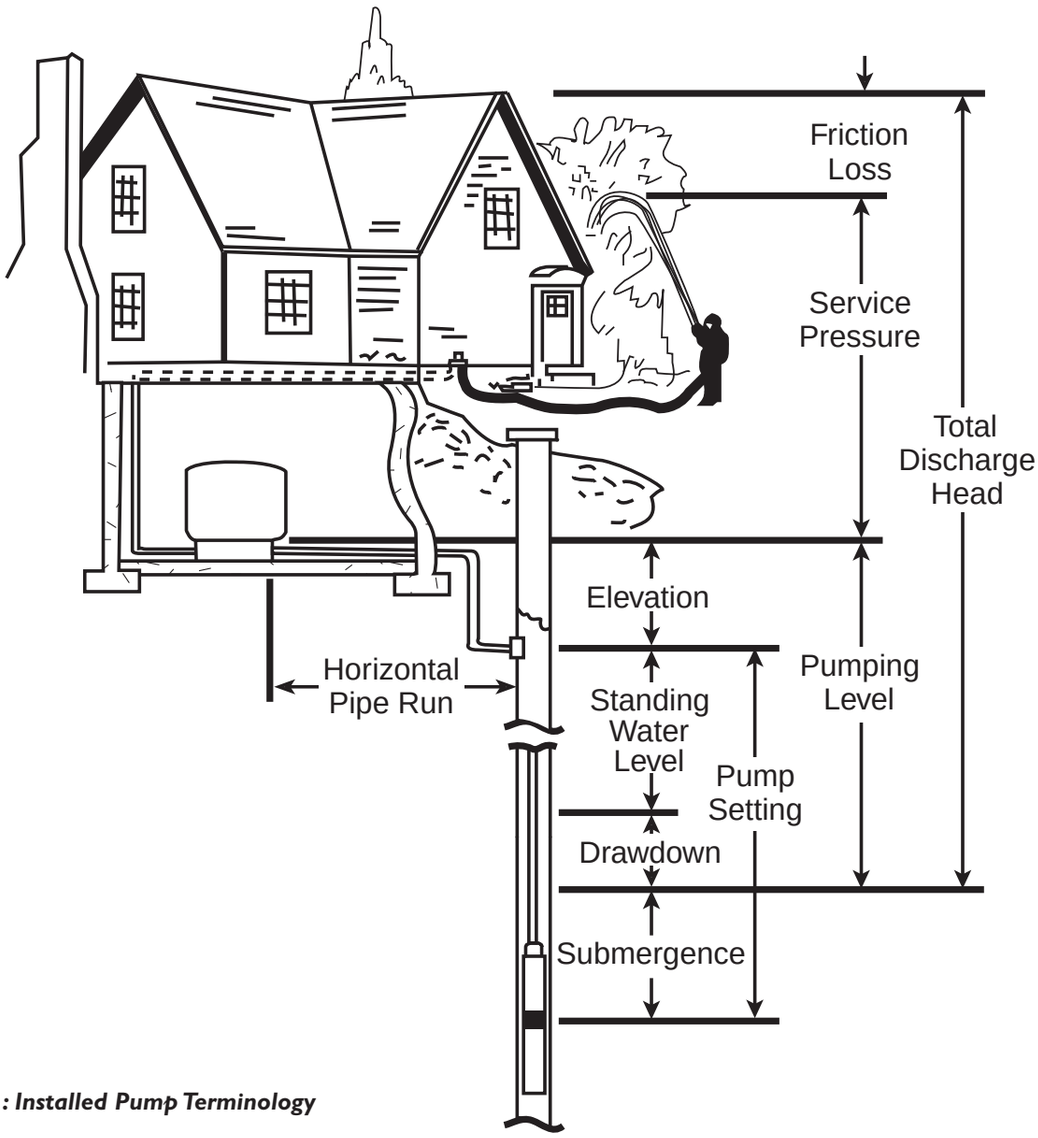


Figure 12-1: Installed Pump Terminology

12.4 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 12-1 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 12-1: Average Water Requirements

AVERAGE WATER REQUIREMENTS FOR GENERAL SERVICE AROUND THE HOME AND FARM

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

AVERAGE AMOUNT OF WATER REQUIRED BY VARIOUS HOME AND YARD FIXTURES

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

AVERAGE FLOW RATE REQUIREMENTS BY VARIOUS FIXTURES

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

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

EXAMPLE

Assume we want 16 GPM at 60 PSI from a pump 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

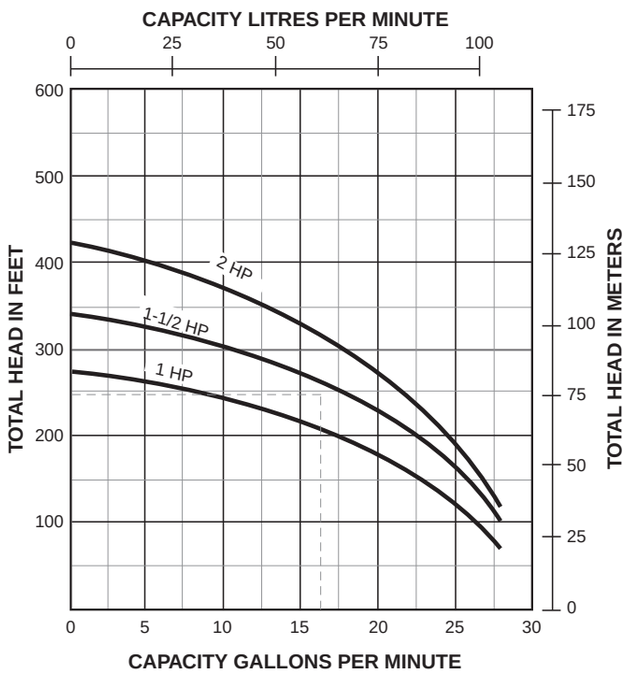
- In the friction loss charts, find the loss of head for 173 feet of 1 1/4" pipe at 16 gpm. (3.96 per 100') = 3.96 x 1.73 = 6.8 (round to 7.0)

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.



12.5 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 12-2: Drawdown Volume Multiplier (Approximate)

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

Tank sizing for Variable Frequency Drives

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

12.6 RECORD OF INSTALLATION

Outside Power:

Transformer 1 _____ KVA

Transformer 2 _____ KVA

Transformer 3 _____ KVA

Cables

From Service Entrance to Pump Control:

Size _____ AWG/MCM

Length _____ ft.

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

Check appropriate boxes

☐ Copper ☐ Aluminum

☐ Jacketed ☐ Individual Conductors

From Pump Control to Motor:

Size _____ AWG/MCM

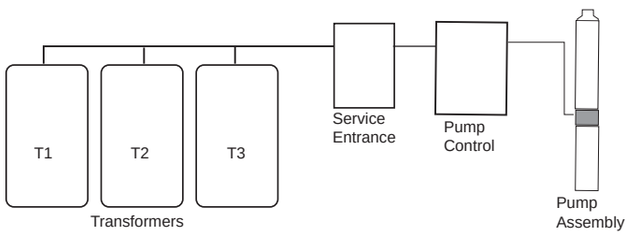
Length _____ ft.

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

Check appropriate boxes

☐ Copper ☐ Aluminum

☐ Jacketed ☐ Individual Conductors



Pump Motor Control Panel

Manufacturer / Model _____

Circuit Protection:

☐ Circuit Breaker: _____ Amps

☐ Fuse _____ Amps

☐ Std. _____ ☐ Delay _____

Starter

Manufacturer _____ Size _____

Type

☐ Autotransformer

☐ Full Voltage

☐ Other _____

Time to full voltage _____ sec.

Heaters

Manufacturer _____

Qty: _____ Amp setting _____

Installation Data

Controls grounded to:

☐ Motor ☐ Well Head

☐ Power Supply ☐ Buried Rod

Grounding wire size _____ AWG / MCM

Date _____

Location _____

Motor serial number

_____

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 +	——%	——%	——%

Record of Installation

Installer _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

E-mail _____

Who to contact? _____

Owner _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

E-mail _____

Who to contact? _____

Installation

Well Identification _____

Water Temperature _____

Date Installed _____

Signature _____

Pump Information

Model _____

GPM _____ @ft. TDH

PSI _____

Date code _____

Motor Nameplate Information

Manufacture _____

Model _____

HP _____

Voltage _____

Phase _____

Max Amps _____

Date code _____

Serial Number _____

VFD (Variable Frequency Drive) Information

Drive Manufacture _____

Model Number _____

☐ Input Filters _____

☐ Output Filters _____