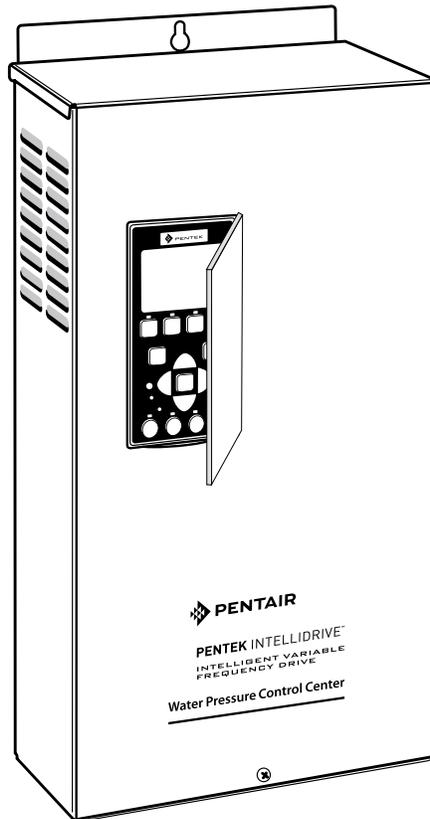


**PENTEK INTELLIDRIVE™**



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## Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during installation, operation, and maintenance of the product. Save this manual for future reference.

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

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

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

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

**NOTICE** addresses practices not related to personal injury.

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

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

The manufacturer cannot anticipate every possible circumstance that might involve a hazard. The warnings in this manual, and the tags and decals affixed to the unit are, therefore, not all-inclusive. If you use a procedure or operating technique that the manufacturer does not specifically recommend, you must satisfy yourself that it is safe for you and others. You must also make sure that the procedure or operating technique that you choose does not render the system unsafe.

## General Safety

Read the Owner's Manual and related documentation carefully before attempting to operate the PENTEK INTELLIDRIVE™. Make sure that you have a full knowledge of the equipment, safety information, and instructions before using this product.

Carefully read and follow all safety instructions in this manual and on the PENTEK INTELLIDRIVE™ (referred to herein as 'VFD').

**▲ WARNING Risk of electric shock.** Can shock, burn or kill. High-voltage electrical shock from the EMI/RFI Filter is possible 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.

- Always hang the VFD box before connecting the wires to it.
- Always make sure your hands are dry before working on the VFD. Perform all operations on the HMI with dry hands.
- Do not reach into or change the cooling fan while power is on to the VFD.
- Do not touch the printed circuit board when power is on to the VFD.

**▲ WARNING Risk of fire** 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 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.

**NOTICE** To avoid damage to the drive or problems with the drive:

- 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.

### California Proposition 65 Warning

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

**Purpose**

The purpose of this document is to help determine some common VFD field issues. This document will give step by step instructions on how to get to the root of problem.

**Document Description**

The symptoms are listed as the problem the customer is describing. The steps that follow will help lead to the root cause. Some problems can be caused by several different things; this is where all steps will need to be followed to find the cause. Others will be found by only going through some of the steps. This document may not cover every possible failure or field issue, but it is intended to show the logical steps taken to get to the root cause and make the corrections needed.

**NOTICE** Please use this document as a learning tool and not an answer to all failures or field issues.

**PENTEK INTELLIDRIVE™ (VFD) Components**

As shown in Figure 1, the VFD system is composed of several integrated devices:

**Drive**

The VFD is specifically designed to operate 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 VFD 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. It will also start when power to the drive is lost.

**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 Figure 2). The LCD display shows a text display of the status of the drive's operation. Other LEDs light up to indicate when certain buttons are pressed or certain events occur.

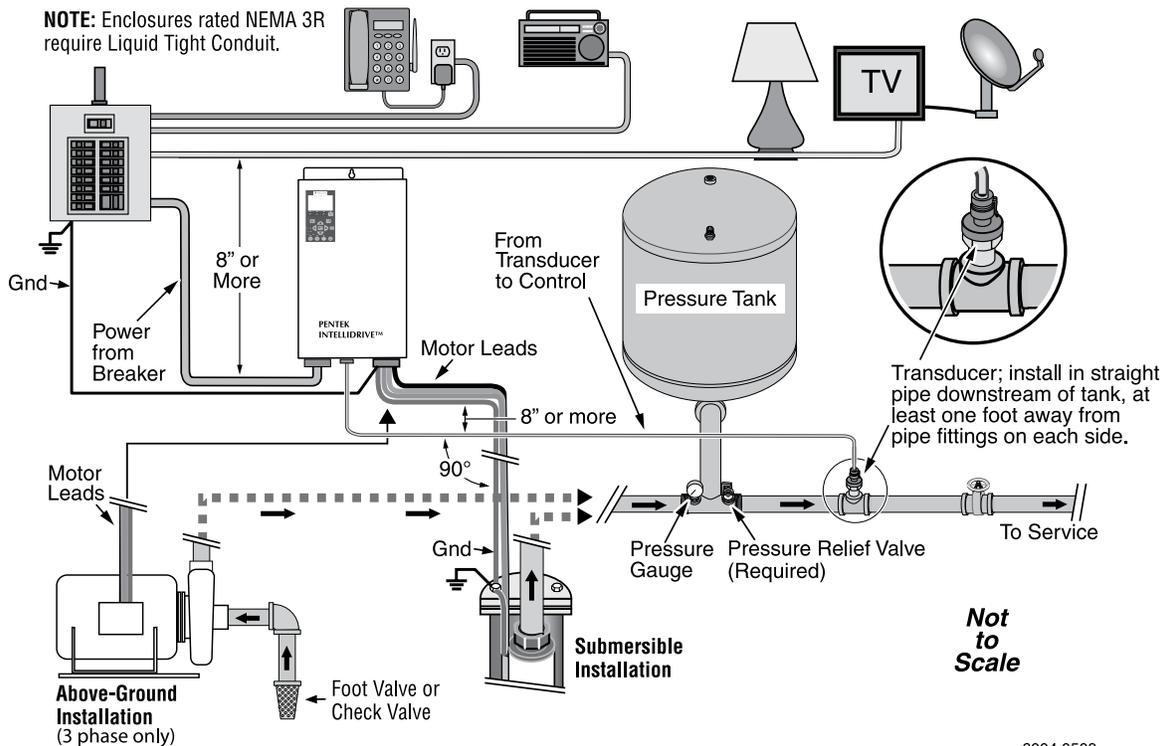
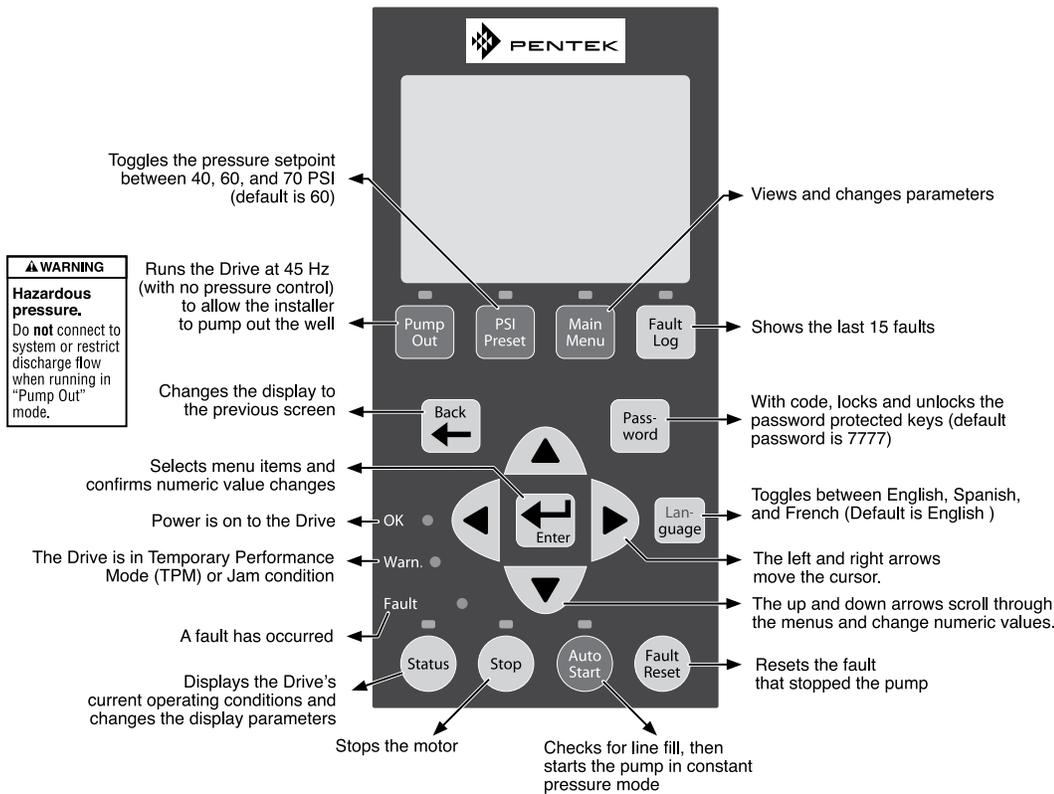


Figure 1: Overall Layout – Typical VFD installation

## Keypad Nomenclature and functions



**▲ WARNING**  
**EMI/RFI Filter**

**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.

Figure 2: Keypad functions

## Symptoms

### Over Pressurizing System

Additional descriptions: Display pressure is much lower than the gauge reading, Pressure relief valve open, display pressure does not match gauge.

1. Is this a new install?
  - a. If no then how long has it been installed for? If it is 2 – 3 months, this is a strong indication that it is an ungrounded system, but follow the steps to determine for sure (The VFD will work for 2 – 3 months without showing any problems like this, based on field data collected in the past).
2. Press Auto Start.
  - a. Does the display pressure match the gauge after Stop is pressed?
  - b. YES: Step 4.
  - c. NO: Go to Step 3.
3. Stop the drive.
  - a. Does the display pressure match the gauge?
  - b. YES: Go to Step 5b (**NOTICE** seems like ground issue).
  - c. NO: Go to Step 5 to verify, but note it seems like the transducer Sensor values have been changed (Step 5a).

4. What is the setpoint?
  - a. Verify, not just by memory, but by looking at the Internal Setpoint or pressing Enter while running in Auto Start. The setpoint may be too high and it is important to verify this parameter..

**Solved:** Pressure setpoint was too high (If not then go to next step).

5. What does the display show?
  - a. Stop the drive.
    - i. Go to Sensor Menu.
    - ii. Verify the Sensor min value = 0
    - iii. Verify the Sensor max value = 100
      1. If either of these are changed then it will change the pressure scale and the drive will not measure pressure properly. (Only change the Max Sensor value is using a transducer with a different max pressure than 100 psi).
      2. If they are not changed then go to Step 5b.

**Solved:** Transducer scaling was changed (If not then go to next step).

- b. Is the display pressure much lower than the gauge pressure when pump is running?
  - i. Then check for bad or ungrounded electrical system (see Appendix A: Ungrounded Electrical System Test).
  - ii. If the system is not grounded then either a new ground wire should be connected from the electrical panel or the existing ground wire problem needs to be corrected.

**Solved:** Improper ground.

### Open Transducer Fault(s)

1. Press the stop button.
2. Check AI+ and AI- transducer connections (pull on them to make sure they are not loose.
  - a. If loose then reconnect them.
  - b. Press Auto Start and verify there are no Open Transducer faults.

**Solved:** Loose connection (If not then go to next step).

- c. If not loose then check the connection at the transducer.
- d. If not connected then reconnect.
- e. Press Auto Start and verify there are no Open Transducer faults.

**Solved:** No connection (If not then go to next step).

- f. If the transducer was connected then follow procedure for Appendix B: Transducer Linearity Test.
- g. If it fails test then it is a bad transducer.

**Solved:** Bad Transducer (If not then go to next step).

- h. If it passes then check for bad or ungrounded electrical system (see Appendix A: Ungrounded Electrical System Test.)
- i. If the system is not grounded then either a new ground wire should be connected from the electrical panel or the existing ground wire problem needs to be corrected.

**Solved:** Improper ground.

### Does Not Go to Sleep

1. Run in Auto Start with all valves are closed.
2. Watch the screen, verify the pressure reading and the drive is boosting after approx 1 min.
  - a. If the pressure is dropping with the frequency (during the Wake Delay part of the boosting process), then check the following.
    - i. Check for leaks in the system.

**Solved:** Leaking system (If not then go to next step).

- ii. If no leaks then check the tank is not water-logged.

**Solved:** Water-logged tank (If not then go to next step).

- j. If no water-logged tank then check the grounding (see Appendix A: Ungrounded Electrical System Test).

**Solved:** Improper ground.

### Open Lead Fault

1. Remove the power to the drive.
  - a. After the drive has been powered down, pull on each motor wire connection in the drive to verify all connections are tight.
    - i. If any are loose, tighten them and then run the drive in Auto Start – if no Open Lead failure then it is solved.

**Solved:** Loose motor wires (If not then go to next step).

2. Run the drive in Auto Start.
3. Close all faucets and try to make the drive go to Sleep.
  - a. Watch the screen Amps and frequency.
  - b. During the boost process or any time the drive is running at 30Hz (lowest speed) do the amps drop to 1.0 Amps or close to that value?
    - i. If they do then it is a false reading do to the low horsepower of the pump (usually found on 1/2 HP).
    - ii. Press the Stop button and change the Min Frequency to 35 Hz.
    - iii. Press Auto Start with all faucets/valves closed, verify the new Min Frequency does not allow the amps to go it the 1.0 or close to it.

**Solved:** False reading due to low HP pump (If not then go to next step).

4. If not false reading then perform Appendix C: Motor Voltage Test.

**Solved:** No output voltage - Internal drive damage.

### Display Pressure Does Not Match the Gauge

1. Check the Sensor Menu parameters are correct.
  - a. Min pressure = 0
  - b. Max Pressure = 100
  - c. If they are different then change them back to the default values and press Auto Start. These are the pressure scaling parameters that tell the drive the pressure the transducer is sensing. The only time they need to be changed is if a different transducer is used with the drive (with a different max pressure value).

**Solved:** Sensor Values Changed (If not then go to next step).

2. Press Auto Start and watch the drive display pressure and the pressure gauge.
  - a. Watch them while the drive is running the pump.
    - i. If different then press the Stop button and continue to watch the display pressure and the gauge pressure.
    - ii. If the values match when the drive is not running, the pump most likely has a grounding problem.
    - iii. You can also see Appendix A: Ungrounded Electrical System Test.
    - iv. Correct the grounding problem.

**Solved:** Improper ground.

### Drive Builds Pressure At 30Hz

1. Run the drive in Auto Start.
2. Watch the Frequency and the pressure when there is no water usage.
  - a. If at 30 Hz the pressure is increasing this indicates the pump is over sized for the application. The pump should not build pressure at 30 Hz..
  - b. A new pump needs to be installed (correct HP for the application).

**Solved:** Over sized Pump (If cannot change the pump due to different static levels at different times then go to next step).

3. If the problem is that the well static water level changes and the pump is sized for the worst case and there is no way they can go smaller in HP, then the following may help.
  - a. Lower the Boost Delay time to 30 seconds (this will start the boost process in 30 seconds).
  - b. Lower the Wake Delay time to 3 seconds (this will decrease the Boost process).
    - i. Total time to go to Sleep will now = 48 seconds (30s Boost Delay + 15 Boost + 3 Wake Delay).

### No Display/Pump Not Running

1. Verify power is applied to the drive (breaker on).
  - a. Should be able to hear a relay click right after power is applied.
  - b. Use voltmeter (set to AC) to measure the voltage at the input terminals (can measure right at the screw on the terminals). Should be between 190 and 265V. If it is then.....

**Most likely a power surge, but can check further.....**

2. With the cover off power down the drive.
  - a. The fan should run for a short period of time. If it does not then.....

**Most likely a power surge, but can check further.....**

3. Check input and output ohm values, see Appendix D: Input & Output Ohm Test. If it does not pass then it is.....

**Solved:** Power surge, drive is in operable.

### Faults On Dry Run When Running Open Discharge

Additional descriptions: Dry run faults when using on tank filling applications.

1. The dry run fault is triggered by 10 psi or lower for 15 seconds.
2. Determine the application, why the dry run fault is occurring.
  - a. Usually occurs with tank filling applications, If so there are 2 ways around this.
    - i. When operating in Auto Start (constant pressure mode) then a valve of some sort will need to be placed by the transducer to provide some backpressure on the transducer (above 10 psi). Requires use of a float switch and setting the External Input to Run Enable to start and stop the pump.
    - ii. Operate the drive in Pump Out (constant speed mode), set the speed desired. Requires use of a float switch and setting the External Input to Run Enable. Pump Out mode ignores the pressure and the user will lose all pressure related faults (including dry run).
3. All other Dry Run faults caused not by filling tanks can be adjusted in the Dry Run menu to fault sooner, later, restart sooner, restart later, or never restart after the first Dry Run Fault.

**Solved:** Add valve or use in Pump Out.

### Pipe Break Fault

1. Pipe break fault caused from operating the pump for 24 hours without ever stopping (Sleeping).
  - a. Usually caused from irrigation or using on a geo-thermal pump (heat pump).
  - b. These types of applications require the Pipe Break parameters to adjusted.
    - i. Either extend the Days with No Sleep parameter under the Pipe Break menu or Disable the Pipe Break parameter under the Pipe Break menu.

**Solved:** Pipe Break parameters needed adjusted (If not then go to next step).

2. If not that then check all faucets and valves for leaks.

**Solved:** Leak in system.

## Hard Fault

Background: Hard Fault is caused by any fault displayed for 30 minutes or any combination of self resetting faults that occur with 30 minutes.

1. If there is a Hard Fault displayed on the screen; check the Fault Log.
  - a. The Fault Log will show The Hard Fault (most recent fault displayed 1st).
2. Press the down arrow to display the fault that occurred previous to the Hard Fault.
  - a. The fault that occurred just previous to the Hard Fault caused the Hard Fault.

**Solved:** Correct the fault that caused the Hard Fault.

## All Hard Faults In The Fault Log

Background: Hard Fault is caused by any fault displayed for 30 minutes or any combination of self resettable that occur with 30 minutes. The 1st software release had a bug; where the Hard Fault displayed for 30 minutes caused another Hard Fault and so on, until the entire Fault Log is full of Hard Faults. This was fixed in version 1.02.000.

1. Usually caused by Pipe Break fault (but cannot see due to all Hard Faults in the Fault Log).
2. Verify the application.
  - a. If the pump is used for long run times (24 hours or more) such as irrigation or heat pump and house water combination.
    - i. These are indications that it is a Pipe Break fault due to the 24hr default setting of the Pipe Break fault.
  - b. If used on long run times then either increase the pipe break time (days with no sleep) or disable the Pipe Break fault.
    - i. Determine if it is better to increase the time or disable.

**Solved:** Old software, pipe break fault due to long run times.

- c. If no long run times then the only option is to try to witness the first fault that causes the Hard Fault.
  - i. Determine when the fault usually occurs ask other questions about the system to help with the diagnosis.
  - ii. Have someone there to witness the fault and analyze from there.

## Pressure Fluctuates (Unstable)

Background: If the pressure is unstable it usually has to do with the PID Control or something in the system changed.

1. If the drive has been installed for some time (not a brand new install) then most likely there has been a change in the system.
  - a. Check for any leaks.
  - b. Check for additional water usage (different from the day of the install).
    - i. Hoses, irrigation, new plumbing, etc.
  - c. May require adjusting the PID Control parameters (see Appendix E: Adjusting the PID Control Parameters).

**Solved:** System changed.

2. If it is a new install and the pressure is unstable then the PID Control parameters need to be adjusted (see Appendix E: Adjusting the PID Control Parameters).

**Solved:** PID Control parameters needed to be adjusted.

## Cannot Build Pressure

1. Check the correct amps are entered for the motor.

**Solved:** Incorrect Amps entered (If not then go to next step).

2. If correct amps are entered then verify the correct motor type is entered.
  - a. 2-wire, 3-wire, sub, above ground.

**Solved:** Incorrect motor entered (If not then go to next step).

3. If correct motor is entered and still have the problem and the motor is a 3 phase or a 3 wire then verify the correct rotation, by switching any 2 motor wires at the drive..

**Solved:** 3 phase motor running backwards.

## Ground Fault

1. If there is a Ground Fault displayed, the motor wire insulation may be damaged.

- a. Test the motor wire insulation using a megohmmeter (see Appendix F: Insulation Breakdown Test).

**Solved:** Damaged motor wire(s).

## Appendix A: Ungrounded Electrical System Test

### Using an ohmmeter/voltmeter

1. Set it to volts.
2. Place one probe on the ground lug or inside frame of the drive (non-painted surface).
3. Place the other on the building ground (ie. pipe, conduit, ground bar in the electrical panel, etc.).
4. Run the drive (press Auto Start).
5. With the drive operating the motor, the voltage between two points should be around 1 V or less.
6. Any voltage above 1 volt indicates the drive is not grounded properly.
  - a. Typically you will see around 40 volts when there is no ground.

### Using a Non-contact voltage tester

1. After Auto Start is pressed touch the tip of the tester to the sheet metal on the drive (not by the wires).
2. If the tester lights up (and beeps depending on the brand used) then there is voltage on the body of the drive, which is due to a bad ground or ungrounded drive (Figure 3).
3. If it does not light up (or beep) then voltage is not present and the drive is properly grounded (Figure 4).



Figure 3. Easy ground check: Ungrounded



Figure 4. Easy ground check: Grounded

Appendix B: Transducer Linearity Test

Using an Ammeter or Multimeter (set to Amps)

1. Disconnect the RED transducer wire connected to the drive.
2. Place a new wire in that terminal (both ends should be stripped).
3. Using the meter.
  - a. Connect one lead to the new wire coming out of the transducer terminal (Figure 5).
  - b. Connect the other lead to the RED transducer wire (that was removed from the terminal).
  - c. Set the meter to mA (milliamps).
  - d. Press the yellow button to change to DC.
  - e. Plug the red meter lead into the mA slot (on the meter).
4. Using the drive set the pressure to 0, 20, 30, 40, 50, 60, 70, 80, 90 or as high as possible without damaging anything (it is not permitted to set pressure to 10 PSI).
5. The meter will give a mA reading at every pressure.
  - a. The 4-20mA, 0-100psi transducer that comes with the drive should measure as shown in Table I.
  - b. These readings show the transducer is linear if 4 mA is the lowest amp reading and is equal to 0 psi; 20 mA is the highest reading and is equal to 100 psi.

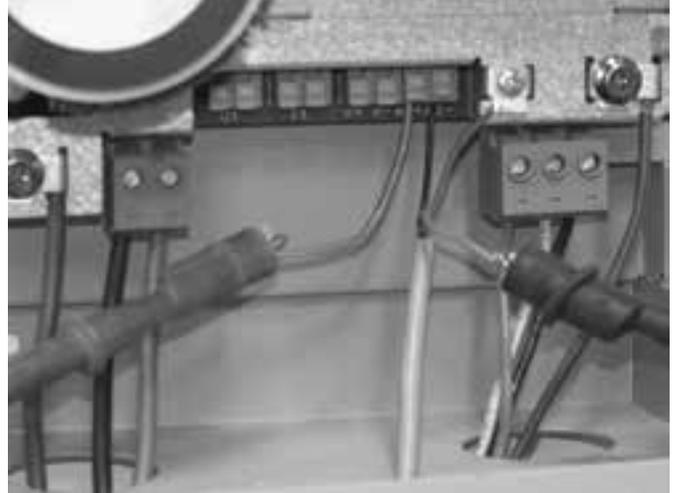


Figure 5. Transducer measurement connections

Table I. Transducer Current to PSI Scale

Pressure Setting (PSI)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.00
Theoretical Current mA	4.0	5.6	7.2	8.8	10.4	12.0	13.6	15.2	16.8	18.4	20.0

NOTICE The actual mA measurement may be slightly different then theoretical (see Figures 6-14).



Figure 6. 0 PSI measurement



Figure 8. 30 PSI measurement



Figure 7. 20 PSI measurement



Figure 9. 40 PSI measurement



Figure 10. 50 PSI measurement



Figure 12. 70 PSI measurement



Figure 11. 60 PSI measurement



Figure 13. 80 PSI measurement



Figure 14. 90 PSI measurement

**Appendix C: Motor Voltage Test**

Using a voltmeter (need to have a low pass filter) ie. Fluke 87 V or equivalent (see Figure 15.)

1. Remove the cover of the drive.
2. Press Auto Start (or Pump Out).
3. Using the a volt meter.
  - a. Set the meter to AC volts (~V).
  - b. Turn on the low pass filter (press the yellow button, the “Lo” symbol will appear on the screen; see Figure 15).
  - c. Place one lead on of the screws on the output terminal (could also put short wires coming out of the terminals with the motor wires still connected and then clamp on to the wires, see Figure 16 and 17).
  - d. Place the other lead on another output terminal (see Figure 16 and 17).
  - e. Use the chart to verify the voltages are correct at the different frequencies.
  - f. Repeat this at the 3 voltage measurement combinations.
    - i. R-Y, Y-B, R-B.
  - g. If there is no voltage measured then the drive is damaged and needs to be returned.

**NOTICE** The voltage is not exactly 230V all the time - it varies as the frequency varies; this is known as Volt/Hz.

**NOTICE** 3-wire voltage will all be different and 3 phase voltages will all be the same.

**NOTICE** If you do not use a Fluke 87 V with the low pass filter turned on, or equivalent, your voltage measurements will be higher than the actual voltage (See Figures 18 & 19).

**Table 2. Output Voltage Scale**

	60 Hz			45 Hz			30 Hz		
	(volts)			(volts)			(volts)		
Measure	B-Y	R-Y	R-B	B-Y	R-Y	R-B	B-Y	R-Y	R-B
<b>2 wire</b>	240	N/A	N/A	154	N/A	N/A	90	N/A	N/A
<b>3 wire</b>	190	260	N/A	170	260	N/A	125	200	N/A
<b>3 phase</b>	220	220	220	160	160	160	90	90	90

**NOTICE** These voltages are approximate. The table is to be used as a reference only.

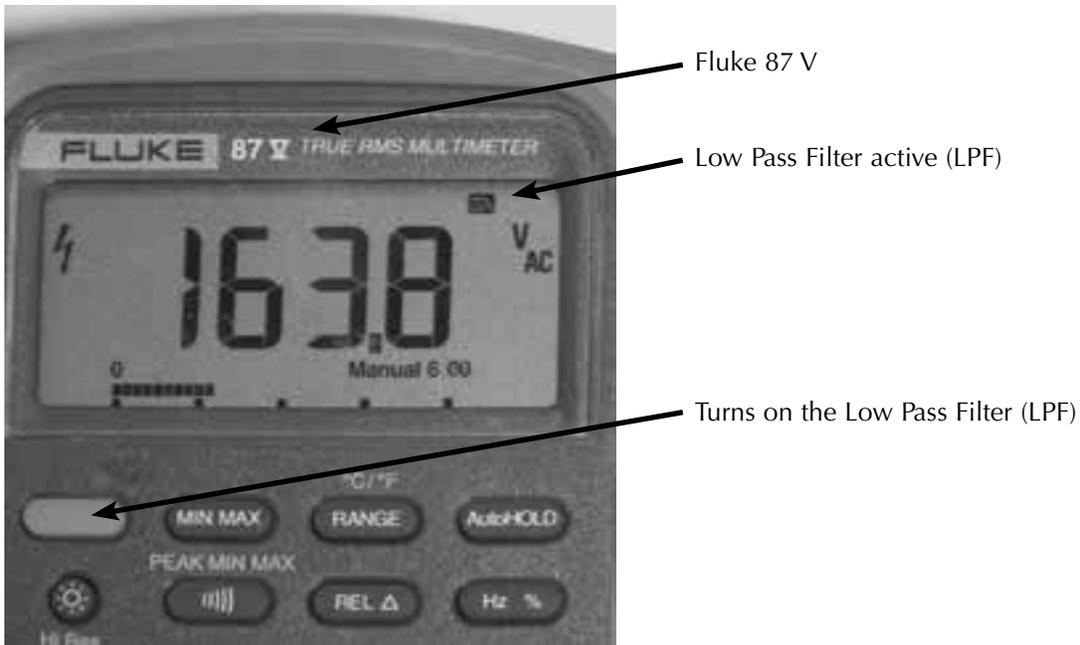


Figure 15. Fluke 87 V



Figure 16. Output voltage measurement



Figure 17. Output voltage measurement close up



**Figure 18. 45Hz voltage measurement w/ LPF**



**Figure 19. 45Hz voltage measurement w/out LPF**

This shows the difference when using the low pass filter. The voltage is much higher without the LPF active.



**Figure 20. 3 phase 30Hz voltage measurement**



**Figure 21. 3 phase 45Hz voltage measurement**



**Figure 22. 3 phase 60Hz voltage measurement**

These are real measurements taken on a 3 phase VFD at 30, 45, and 60Hz. All with the Fluke 87 V, with the low pass filter active. These measurements match those in Table 2.

## Appendix D: Input And Output Ohm Test

Using an Ohmmeter

1. Turn the power off.
2. Remove the input and motor wires.
3. Remove the cover of the drive.
4. Using the a volt meter.
  - a. Set the meter to Ohms ( $\Omega$ ).
  - b. Connect short wires at the output terminals.
  - c. Clamp one lead on to one of the wires (Figure 23).
  - d. Clamp the other lead on to another wire.
  - e. The repeat this over the 3 measurement combinations.
    - i. R-Y, Y-B, R-B.
  - f. All resistance values should be equal.
  - g. If an measurements shows an OL (over load): that indicates the phase to phase measurement is open and the power module damaged; the drive will need to be returned.
  - h. If the are not measurements are not equal then there is some internal damage to the power module and the drive will need to be returned.
    - i. If the output measurement are all equal then the output is ok.
5. Repeat on the input terminals (there is only one measurement (L1-L2).
  - a. This should be somewhere between 5 and 6 M ohms (Meg Ohms) ( $M\Omega$ ).
  - b. If the readings are correct then the drive input is ok.
  - c. If it is open it will show OL and it is damaged; it will need to be sent back for analysis.

**NOTICE** The input measurement is not as accurate and sometimes is not read clearly.



Figure 23. Output ohm measurement

## Appendix E: Adjusting The PID Control Parameters

This is only done if the pressure is unstable and the drive cannot maintain constant pressure. Adjusting these parameters will greatly affect how the drive reacts to the system pressure changes. If adjusted improperly they can make the pressure unstable or make the instability worse.

1. If the pressure is unstable first start by pressing the Stop button.
2. Go to the PID Control menu.
3. Arrow down to Integral Time.
4. Change the value to 1500.
5. Press Auto Start.
6. Check to see if drive is holding constant pressure.
  - a. If it is holding constant pressure, then no other changes are needed.
  - b. If the pressure was more stable, then go to the Step 7.
  - c. If there was no change, then change the number back to 500 and go to Step 9.
7. If the pressure was more stable when the Integral Time was set to 1500; now change it to 2500.
8. Check to see if drive is holding constant pressure.
  - a. If it is holding constant pressure, then no other changes are needed.
  - b. If the pressure is still not constant then change the Integral Time back to 500 and go to Step 9.
9. Use the up arrow, go to Proportional Gain and change the value to 500.
  - a. If it is holding constant pressure then no other changes are needed.
  - b. If the pressure was more stable, but still not constant then repeat Step 7 and 8 if needed (a combination of the P and the I value may be needed in some cases).

**NOTICE** The values shown above are examples and can be different in application.....use your logical judgment.

## Appendix F: Insulation Breakdown Test

- Use a megohmmeter to measure insulation breakdown (leakage current) at high voltage levels.
- A megohmmeter tests beyond the capabilities of an ohmmeter.
- Example: Fluke 1550B megohmmeter
- How to test:
  1. Start at the drive.
  2. Remove the motor and ground wires from the terminals.
  3. Test from each motor wire to ground.
  4. 50 megohms or higher = good insulation.
  5. If the measurement is lower than 50 megohms, repeat test at the well head (remove the wire nuts and test down to the motor.)
    - i. This will indicate if the damaged insulation is in the wires down the well or under ground.
  6. Locate the insulation damage and replace the wire (may require pulling the pump out of the well).