

APPLICATION NOTE

Level Control Using a VFD, A PID Controller, A REDIFLO4 Pump, And a 4-20 mA Level Sensor

INTRODUCTION

This application note is intended to assist in setting up a constant level control system. It is assumed that the person using this note is trained in the use of Rediflo4 pumps, 4-20 mA sensors, the SI/MP1 VFD Converter and PID loop control. In order to make this application work the Rediflo4 pump end must have a Variable Performance Motor (MS402E), INW part number 3P777 or Grundfos Part number 96022532 attached.

GENERAL OVERVIEW

The VFD Converter has the ability to follow a 4-20 mA signal when it is set up in the auto run mode. Unfortunately the VFD does not have the ability to use the signal directly from a level sensor to achieve constant level control. A PID controller must be between the sensor and the input of the VFD to control the 4-20 ma signal so the pump output will drive the level in the well to the proper set point. When the level is at the set point desired (programmed in the PID), the discharge of the pump will be equal to the recharge of the well. If the recharge rate goes up the level sensor will detect that the water level is rising and the pump needs to pump faster so it will drive the pump at a higher RPM. Likewise if the recharge rate goes down the level sensor will detect a drop in the water level and will need to slow the pump down. Therefore a pump size must be selected that can pump at a flow rate greater than the recharge rate of the well and be able to be throttled back to a pump rate less than or equal to the recharge rate to have set point control. Below is the general requirements of a level control system.

1. The pump must be sized so that it can pump at the recharge rate of the well.
2. The level sensor must be able to provide an accurate level signal to the PID free of pump noise effects at the range of levels desired.
3. The PID controller must be able to provide set point control based on the input signal from the sensor.
4. The VFD must be set up right to provide 4-20 ma automatic control.
5. The system should be tested and checked periodically for accurate operation.

1. SIZING THE PUMP

Grundfos has pump ends from 5 GPM to 25 GPM that work with the same variable performance motor model MS402E. INW can provide pump curves for each of these models and it is assumed that the user of this note can select the right pump end with this motor for his system to be able to provide flow rates in excess of the recharge rate of the well the pump will be installed in. For best control it is recommended that the recharge rate be 50-70% of the full discharge rate of the pump.

2. CHOOSING A LEVEL SENSOR

Choose a level sensor with a range at least as much as the drawdown expected in the well. 1 psi equals 2.31 feet of water. For example if you expect drawdown of the well to be 10 feet, install the sensor at least 10 feet below the static water level plus two or three feet of extra depth if possible. It is important that a sensor be chosen that is designed to be operated near three phase pump motors and that the sensor is properly grounded to avoid inaccurate reading due to electronic and magnetic pump noise. INW's PS9800 and PS98i sensors are designed for this kind of application and are available in 5 psi, 15 psi, 30 psi, 50 psi, 100 psi and 300 psi ranges in absolute and barometrically compensated gage versions.

3. CHOOSING A PID CONTROLLER

Choose a PID controller that can measure and display the output of the sensor in feet of water and if possible, with an inverse scale so that it can display depth to water if desired. Keep in mind as the depth to water increases the sensors output decreases. Choose a PID that can be powered by the AC power being used with the VFD. Choose a PID that is relatively easy to program set points and ramp rates of the control loop. Some PID's will auto tune to allow for easy set point control. Choose a PID that will power and operate the sensor and of course provide the output 4-20 mA control signal that goes to the VFD that drives the RPM's of the pump. Keep in mind that when the input of the VFD sees 4 mA it will operate the pump at the low frequency setting of the VFD and at 20 mA (full scale) will operate the pump at the high frequency setting of the pump.

4. SETTING UP THE VARIABLE SPEED DRIVE (VFD)

In order for the VFD to automatically control the pump from a 4-20 mA control signal the VFD needs to be specially configured as follows: 1. The output from the PID must be wired to pin 5 (4-20 return) and pin 6 (4-20 input) in the auxiliary terminals. 2. A jumper needs to be installed between pins 8 and 11 to activate the automatic run capability of the VFD. 3. The auto reference signal needs to be enabled by enabling the F14 setting (change to 01) of the VFD with the mode buttons inside the front cover of the VFD (see



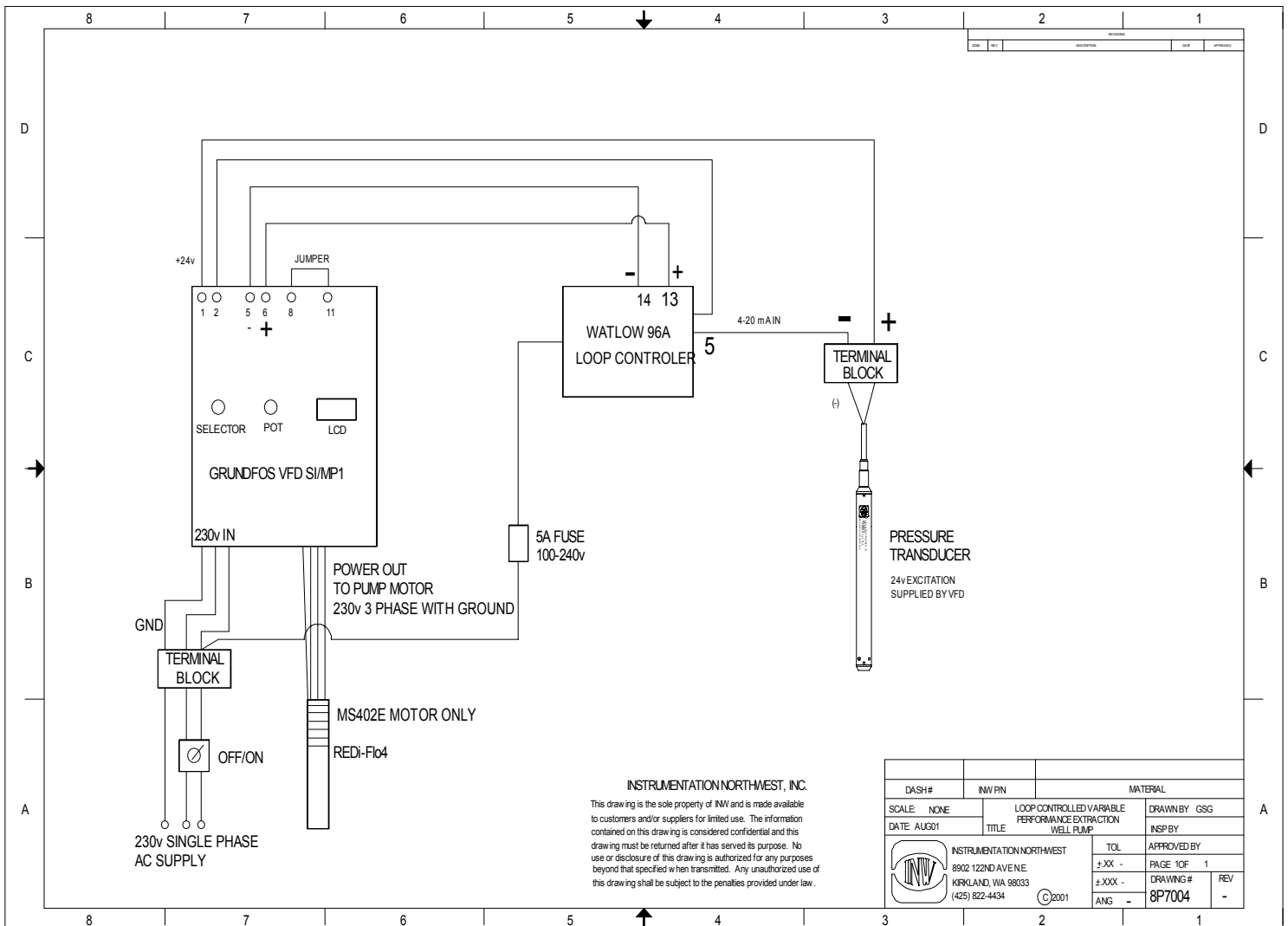
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VFD manual pages 11 to 14.) 4. Optionally you can set the maximum and minimum Output Frequency with the F02 and F03 if a wider or narrower setting is desired. 5. Once the wiring and setting is done the unit the setup is ready to be tested.

5. TESTING THE SYSTEM

1. Install the sensor and insure the PID display is reading the level desired. Lift the sensor up and down manually to insure proper operation of the sensor. Reprogram as necessary. 2. Turn on the pump using the manual control feature of the VFD and insure that the pump works and is able to pump at the rate necessary to get the water level down to the desired set point. Check the sensor is measuring the drawdown accurately unaffected by pump noise. Correct as necessary by proper grounding, making sure sensor cables are not in the same conduit as power cables, or replacing sensor with one designed for rejecting pump noise. You can also record and note pump rates to better fine tune the min/max settings of the VFD if you want more or less max or min pump rates. 3. Allow the well to recharge above the set point in the PID and then turn the VFD to automatic with the front panel rotary switch (RF4A setting). If the system is set right the pump should turn on and draw the water down to the set point holding it there. Adjust the set point up and down to insure that you can change your levels as desired. If the system does not work reprogram the PID as necessary.



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