INSTRUCTION MANUAL
and
DETAILED PRODUCT SPECIFICATION

TRIPLEX PUMP CONTROL SYSTEM

MODEL NUMBER CPC-3

M336 Rev F

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1.0 PURPOSE

This document establishes the performance and design requirements for the Triplex Pump Controller, model CPC-3. This controller is specifically intended for use with the Consilium resistance-tape level sensor. The controller is available in pump down (stardard) or pump up models. For the pump up version the operation of the pump start and stop are reversed. The CPC-3A accepts a powered 4-20mA input where the resistance tape sensor is connected. See the wiring diagram at the end of this manual for the proper way to wire the transmitter.

2.0 APPLICABLE DOCUMENTS

none

3.0 REQUIREMENTS

3.1 GENERAL DESCRIPTION

The Triplex Pump Control System (CPC-3) is a system which automatically controls up to three pumps in pump down type applications. It is intended to be the heart of a triplex pump control system for lift stations, water tanks, and other fluid pumping applications. The CPC-3 is designed to control three pumps. It also provides high and low level alarms and full SCADA support. The CPC-3 is designed to work with the Consilium resistance-tape level sensor and to use float switches as a backup sensors in the event that the primary sensor fails. If backup floats are connected, and a failure is detected in the primary sensor, the CPC-3 will automatically switch to operate on floats. In this way, a control system can be configured which has double redundancy in its sensors.

3.1.1 PUMP CONTROL

The CPC-3 is designed to control up to three pumps using three 15 amp relays. The pumps are operated in a lead/lag/lag2 mode with the turn on and turn off points for each pump individually setable from the front panel. A built-in pump alternator can be enabled or disabled from the front panel. The level is measured by a resistance-tape level sensor. When the level exceeds the lead channel on setpoint the first pump is turned on. Normally this pumps the well level down to the lead channel off setpoint and the pump turns off. If the lead pump cannot handle the flow, the level in the well will continue to rise until it reaches the lag channel on setpoint at which point the lag pump also comes on. If the level continues to rise and reaches the third channel on setpoint, the second lag pump will be called on. If the alternate switch is on, a different pump will be assigned as lead pump each cycle. Each pump has an external disable input which can be connected to fail sensors in the pumps. If a pump is disabled the CPC-3 will automatically call one of the other pumps as the lead pump. A high level alarm and a low level alarm are built in with their setpoints setable from the front panel.

3.1.2 SCADA SYSTEM SUPPORT (Supervisory Control And Data Acquisition)

The CPC-3 is designed to function as a remote terminal in a SCADA system. The CPC-3 has a built-in RS-232 port which is used for SCADA. If the RS-232 port is connected to a telephone or radio modem it will function as a complete SCADA remote terminal when used with a base station system. The base station is simply an MS-DOS computer (IBM compatible) with a telephone or radio modem and a Base Station Software package. This system provides monitoring and control of up to 255 remote stations from a single central base station. The base station can monitor level, all setpoints, all errors and alarms, and pump activity. The base station can be used to change setpoints and disable pumps.

3.2 SYSTEM OPERATION

1. Pump Control

Up to three pumps can be driven by the CPC-3. These pumps are controlled by three pump control channels which have individually setable on and off setpoints. The upper or hi setpoint is the turn on point for the channel and the lower setpoint is the turn off point. To change the setpoints the "SEL" button for that channel is depressed until the "SEL" light comes on. Continue to depress the button and adjust the HI and LO setpoint knobs. Whenever the "SEL" button is depressed the display will show the selected setpoints. Channel 1 is the lead channel and channel 2 is the lag. If the alternator switch is in the off position then channel 1 is assigned to Pump 1, channel 2 to pump 2 and channel 3 is assigned to pump 3. If the alternator is on, then at each cycle the pump to channel assignment will rotate. When a channel is active, the pump control relay assigned to that channel will turn on which in turn activates a motor starter and activates the pump. Whenever a pump is activated there is an 8 second delay before any other pump can be called. This is to prevent more than one pump from starting at the same time. The CPC-3 has three dry contact inputs which are used to disable the pumps. If they are connected to ground then the pump associated with that disable will be disabled and another pump will be called in it's place. These inputs are included for connection to pump fail sensors such as seal leak or over-temp sensors or to the H-O-A switch to disable a pump if the switch in the OFF position.

2. High and Lo Level Alarms.

The CPC-3 has a built-in high and low level alarm which can be set from the front panel. If the level in the well exceeds the high alarm setpoint, the high alarm will be activated. If the level is below the low alarm setpoint, the low alarm will be activated. If either alarm is activated, the alarm relay for that condition will close. Both the high and low alarms are disabled for the first 10 seconds after power up to permit the level sensing system to stabilize.

3.3 REQUIREMENTS

The CPC-3 is composed of two circuit cards, the computer card and the display card. It includes the following functions:

1. Four relays for driving the alarm horn, and the three pumps.
2. Two 115 VAC solid state relays for high and low alarm.
3. A 4-20 mA. current transmitter for level out.
4. A power supply for system power.
5. A control panel for display and setpoint entry.
6. A MC68HC11 microcomputer.
7. An RS-232 serial interface for program loading and SCADA interface.
8. One analog input port for the resistance-tape level sensor.
9. Eight contact inputs for pump disables and floats.

3.3.1 The Pump Controller System has four mechanical relays and two solid state relays which have the following functions:

1. Three for pump control -
   Each of these relays have the following specifications:

Contact rating:	15 amps at 125 VAC
	10 amps at 250 VAC 70 amps inrush
Breakdown voltage:	1,000 Volts RMS
Life:	1,000,000 minimum cycles

2. One relay for the alarm horn output. This relay will close if a low, high or system alarm condition exists. This relay is a 10 amp 125 VAC standard form C relay.

3. The two solid state relays are for high and low alarm outputs. These relays are for alternating current (AC) only and will not work on direct current (DC). They have the following specifications:

Continuous output voltage:	12 to 280 volts AC. 50 to 60 Hz.
Continuous output current:	.02 to 3 amps
Isolation:	4,000 volts RMS optically isolated
Peak blocking voltage:	+/- 600 volts zero voltage switching

3.3.2 The System has a 4-20 milliamp current loop output for transmitting level. It is a non-isolated transmitter with a total compliance of 10 volts DC

3.3.3 The system has eight input pins for connection to external pump disable switches and float switches. These are intended for contact closures and are active when shorted to ground. They are transient protected and pulled up to 5 Volts DC through a 4700 ohm resistor. They have the following functions:

1. Disable Pump 1
2. Disable Pump 2
3. Disable Pump 3
4. High alarm float switch input

5. Lag Lag float switch input
6. Lag float switch input
7. Lead float switch input
8. Pumps off float switch input

3.3.4 Input Power: The system is designed to operate with an external 12 Volt transformer.

Input Voltage: 12 VAC + 50% - 10%
Input Current: 1 amps max.

Input power is transient protected and current limited. Transient protection is a metal oxide varistor. The power system regulated.

3.3.5 The system has one RS-232 serial interface for connection to a telephone or radio modem if SCADA is used.

3.3.6 The CPC-3 System is controlled by a Motorola MC68HC711E9 microcontroller. All programs and setpoints are stored in non-volatile memory so that no information can be lost during a power loss.

3.3.7 The control module display card includes a 40 segment LED bargraph display which is used to display well level. It also contains all the controls and displays required to enter or check setpoints and monitor system status.

3.3.8 FRONT PANEL CONTROLS

Figure 1 is a view of the front panel of the CPC-3. The front panel includes all of the displays and controls required to set up and operate the system.

3.3.9 BARGRAPH DISPLAY

The system includes a 40 segment LED bargraph display which is used for well level and setpoints.

3.3.10 ALTERNATE SWITCH

The alternate switch determines if the pumps will be alternated or not.

3.3.11 CHANNEL 1, 2 AND 3

Each pump is controlled by a pump channel. Which pump is connected to a channel is determined by the state of the alternator. The P1, P2 and P3 lamps will illuminate if the associated pump is on. The CH1, CH2 and CH3 lamps will illuminate if the associated channel is on. To display the setpoints for a channel, depress the SEL switch for that channel and the bargraph will display the setpoints. Each channel has two setpoints - an upper or pump on point and a lower or pump off point. To adjust the setpoints for a channel depress the SEL switch for several seconds until the SEL lamp illuminates. Then use the

SETPOINTS knobs to adjust the setpoints. When the select button is released, the setting will be stored in the computer non-volatile memory and the system will return to normal mode. Note that the system will not allow the lower setpoint to be higher than the upper.

3.3.13 HI AND LO ALARMS

The system includes a high and low level alarm. If the level is below the LO setpoint then the low alarm will be activated and the LO lamp will be illuminated. If the level is above the HI setpoint then the HI alarm will be activated and the HI alarm lamp will be illuminated. These setpoints can be displayed and adjusted just like the channels using the SEL switch and lamp.

3.3.14 TEST

Test mode can be entered by depressing the TEST button until the TEST lamp illuminates (do not release the test button). In this mode the TEST Knob is substituted for the sensor input as long as the button is depressed and can be used for testing pump function. To exit this mode release the TEST button.

3.3.15 SENSOR STATUS AND ERRORS

The system has three lamps for indicating sensor status and system errors.

1. Primary: This lamp will illuminate if the CPC-3 is receiving a signal from the resistance-tape sensor and the system is not in FLOAT mode. Normally the controller runs on the resistance-tape input but if it drops below zero percent then the controller will assume that the transducer has failed and switch to FLOAT mode. If the level increases to the point where all of the floats are closed (under water) and the controller is not already calling for all pumps then it will also switch to FLOAT mode. When in FLOAT mode the Primary lamp will go out and the FLOAT lamp will illuminate. Once the high float has cleared the RESET button will return the controller to NORMAL mode and the Primary lamp will illuminate.

2. FLOATS: The floats sensor lamp will illuminate when the system is in FLOAT mode. The system will not enter FLOAT mode if the floats are out of order.

3. SYS ERR: The system error lamp will illuminate when a system error condition exists. If the primary sensor fails (loss of input) and the floats are out of order a system error condition exists. Under this condition the controller cannot find a working sensor to operate on. Then system error will clear if either the external sensor or the floats return to normal.

3.4 CONNECTOR PIN DEFINITIONS

The back of the CPC-3 has three connectors (J1, J2, and J3).

3.4.1 CONNECTOR J1

PIN NO.	FUNCTION
1	GROUND (level sensor - input)
2	LEVEL SENSOR INPUT +
3	DISABLE PUMP 1 disable pump 1 if shorted to ground
4	DISABLE PUMP 2 disable pump 2 if shorted to ground
5	DISABLE PUMP 3 disable pump 3 if shorted to ground
6	PUMPS OFF FLOAT SWITCH
7	LEAD PUMP FLOAT SWITCH
8	LAG PUMP FLOAT SWITCH
9	LAG LAG FLOAT SWITCH
10	LEVEL OUTPUT + (4-20 mA current loop out +)
11	GROUND (4-20 mA current loop out -)
12	HIGH ALARM FLOAT SWITCH
13	GROUND
14	not used
15	not used
16	GROUND

3.4.2 CONNECTOR J2

PIN NO.	FUNCTION
1	12 Volt AC power input
2	12 Volt AC power input
3	GROUND
4	High and Low relay common
5	High alarm relay output (normally open) contact
6	Low alarm relay output (normally open) contact
7	Alarm horn normally open contact
8	Alarm horn common contact
9	Alarm horn normally closed contact
10	System error discrete output (shorts to ground if error)
11	On floats discrete output (shorts to ground if on floats)
12	+12 VOLTS DC output

Note: The system error and on floats discrete outputs are 0.5 amp open drain field effect transistor outputs suitable for small 12 volt lamps or discrete inputs to remote terminal units. Do not use with voltages greater than 12 volts, any AC voltages or with loads which draw more than 0.5 amps.

3.4.3 CONNECTOR J3

PIN NO.	FUNCTION
2	RECEIVE LINE
3	TRANSMIT LINE
5	GROUND
7	REQUEST TO SEND
8	CLEAR TO SEND
9	MODE CONTROL (ground to call program loader)

3.5 SYSTEM SETUP AND CALIBRATION

Two methods can be used to setup the controller and calibrate the system. One uses the resistance-tape level sensor only and the other uses a simulated resistance.

3.5.1 The following procedure is to setup the controller and calibrate the system using the sensor and level in the tank.

1. Turn power to the controller off.
2. Depress the RESET and ALARM SEL buttons and hold them while power is turned back on.
3. Release the two buttons. The system is now in the setup mode. The setup mode is used to set the remote terminal address if the controller is used in a telemetry system. The CPC-3 SETUP PANEL drawing shows the functions of the lights and switches in this mode.
4. ADDRESS SETUP. This operation is only required if the controller is used to communicate using the RS-232 port to a central monitoring station. If this is not the case then skip this operation. After entering the setup mode depress the CH 3 SEL button to enter the address setup mode. The lamps will now show the current address in BCD format. To interpret this number simply add up the value of all lamps that are lit. Use the RESET (up) and ALARM SEL (down) buttons to adjust the address to the desired number.
5. Once the address is correct, or if the address setup is not required, depress the TEST (end) button and wait until the controller bargraph display shows a level.
6. Release the TEST button and adjust the LO setpoint knob fully counter clockwise. Adjust the HI setpoint knob fully clockwise.
7. Remove the sensor probe from the water. There are two potentiometer adjustment screws available through a slot on the top of the controller. Adjust both of these fully counter clockwise (20 turns each). Remove the sensor probe from the water. The level sensor

calibration is done using the small adjustment potentiometers on the top of the controller. It is done with the sensor completely out of the water.

8. Adjust one of the potentiometers on the top of the controller clockwise until the level on the bargraph reaches a non zero reading. If, after 20 turns, the display has not reached a non zero then switch to the other potentiometer and continue adjusting until the level display reaches just above zero.

9. Adjust the potentiometer on the top until the level on the bargraph just reaches zero.

10. OFFSET ADJUSTMENT. This adjustment is to enter a value for the distance between the bottom of the probe and the bottom of the wet well. Use the LO knob to adjust the bargraph display to read the distance between the bottom of the active area of the probe and the bottom of the well.

11. Install the sensor back in the well and raise the level to the highest practical level which is within the measurement range.

12. SCALE ADJUSTMENT. This adjustment is used to select the level which will be full scale for the controller. Adjust the HI knob until the bargraph reading is correct for the current level in the well.

13. SAVE THE CALIBRATION. To save the settings in non-volatile memory, depress the CH 3 SEL button and hold until the CH 3 SEL lamp comes on. Release the button. The controller will now save the settings and return to normal mode. This will take a few seconds.

Note: The calibration procedure will corrupt the CH 3 setpoints so be sure to program these after the sensor calibration is completed.

3.5.2 Calibration of the CPC-3 using the simulated resistance method.

1. Calculate the following (see diagram at bottom of following page):

   a. R_{100} = (100% distance in feet - .59) x RG + 56Ω
   R_{100} is the Resistance to the 100% point

   b. R_0 = (0% distance in feet - .59) x RG + 56Ω
   R_0 is the Resistance to the 0% point

2. Turn the power off to the controller.

3. Press and hold the RESET & ALARM SEL buttons while power is turned back on.

4. Depress and hold the Test button until the controller bargraph display shows a level.

5. Release the TEST button and adjust the LO setpoint knob fully counter clockwise. Adjust the HI setpoint knob fully clockwise.

6. There are two potentiometer adjustment screws available through a slot on the top of the controller. Adjust both of these fully counter clockwise (20 turns each). Input the R_0 value across terminals 1 & 2 on J1.

7. Adjust one of the potentiometers on the top of the controller clockwise until the level on the bargraph reaches a non zero reading. If, after 20 turns, the display has not reached a non zero then switch to the other potentiometer and continue adjusting until the level display reaches just above zero.

8. Adjust the potentiometer on the top until the level on the bargraph just reaches zero.

9. To save the settings in non-volatile memory, depress the CH 3 SEL button and hold until the CH 3 SEL lamp comes on. Release the button. The controller will now save the settings and return to normal mode. This will take a few seconds.

Note: The calibration procedure will corrupt the CH 3 setpoints so be sure to program these after the sensor calibration is completed.

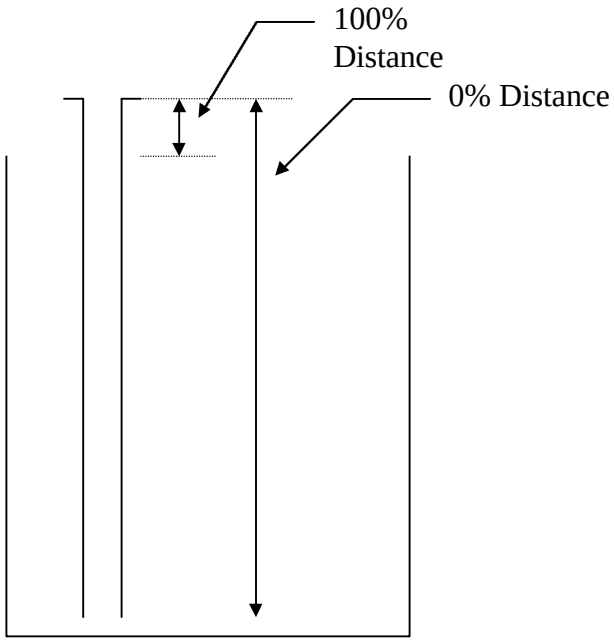

Diagram 1

TRIPLEX PUMP CONTROLLER MODEL CPC-3

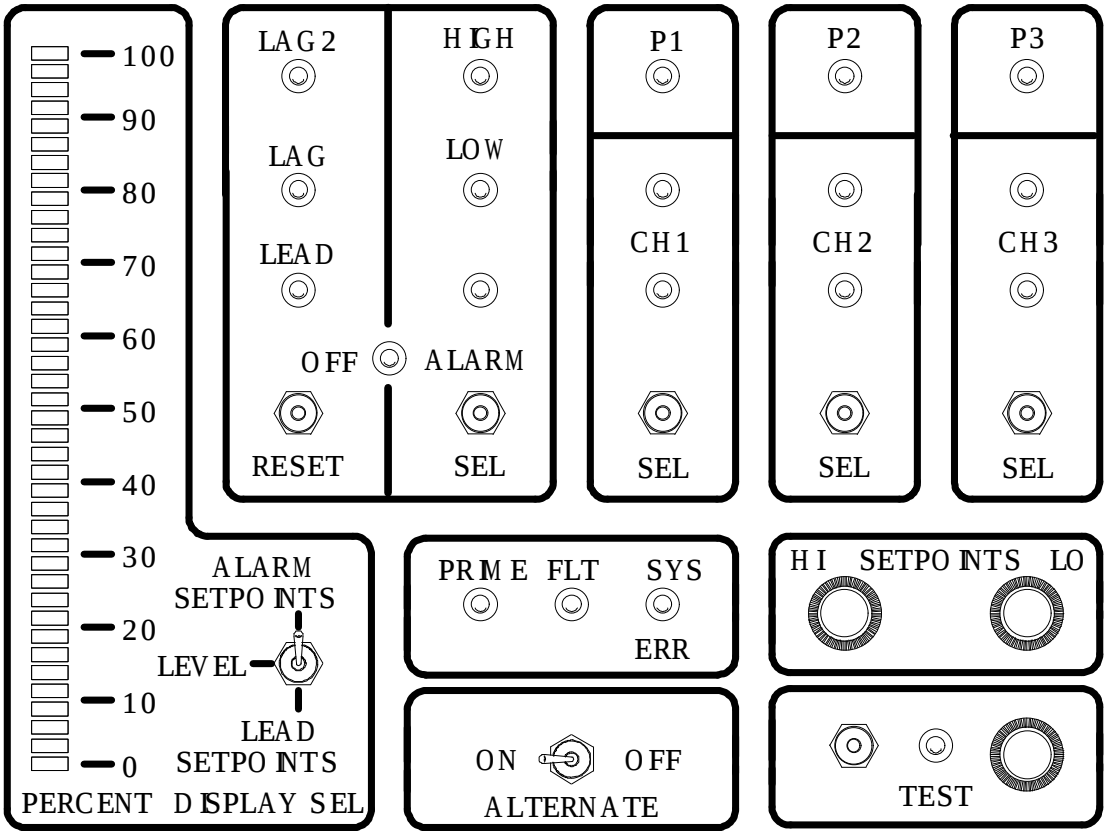

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Figure 1

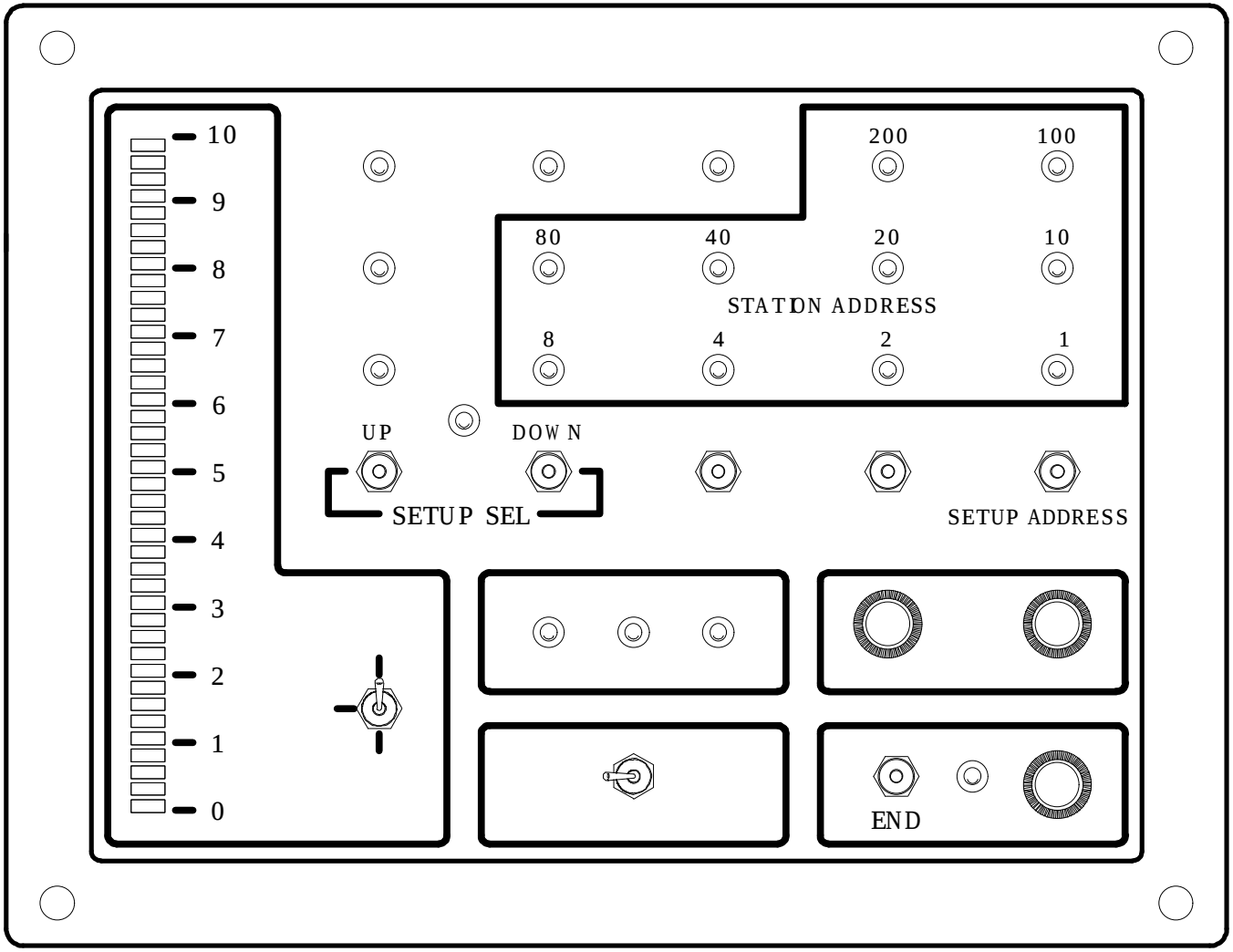


FIG. 2 PUMP CONTROLLER SETUP PANEL

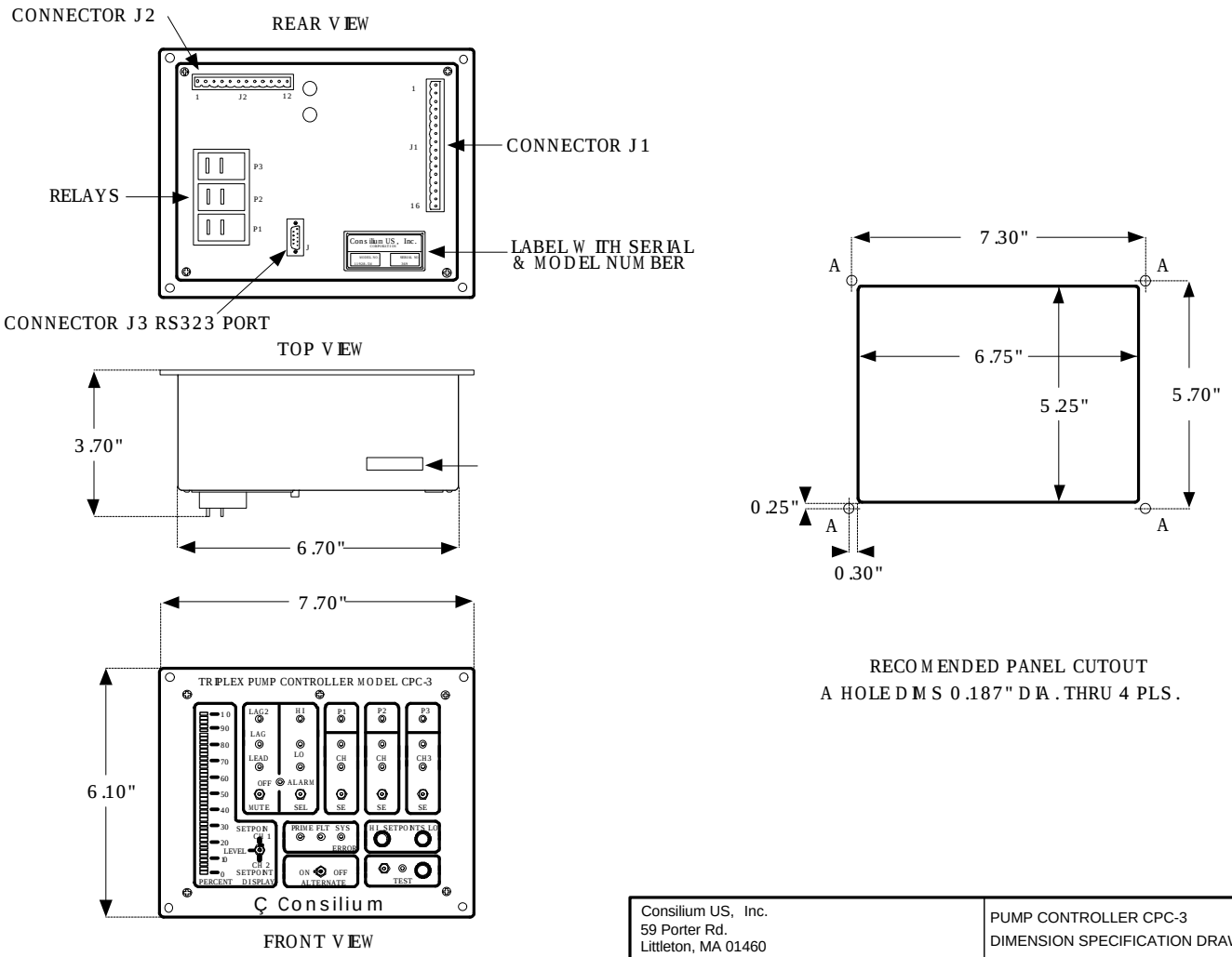
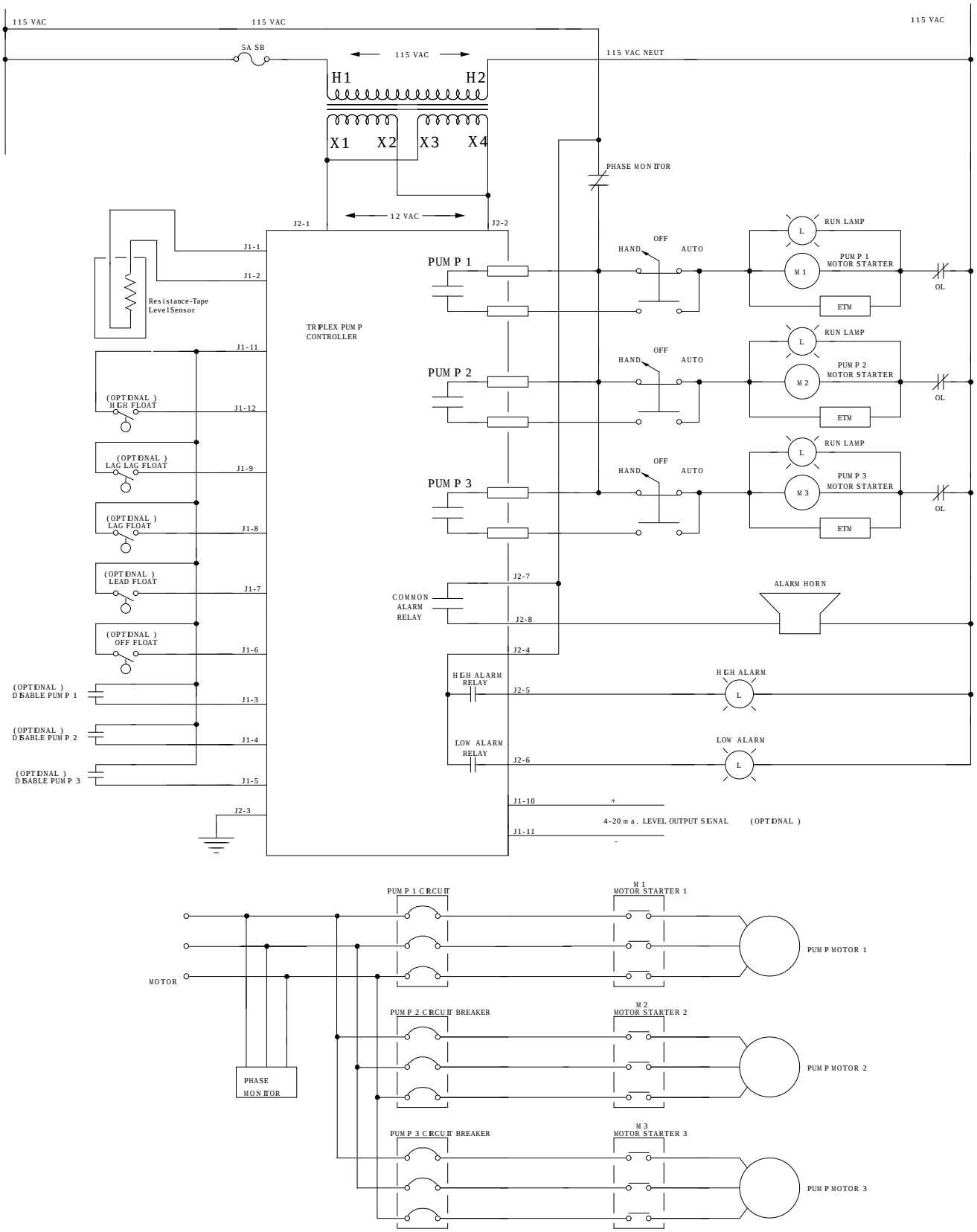
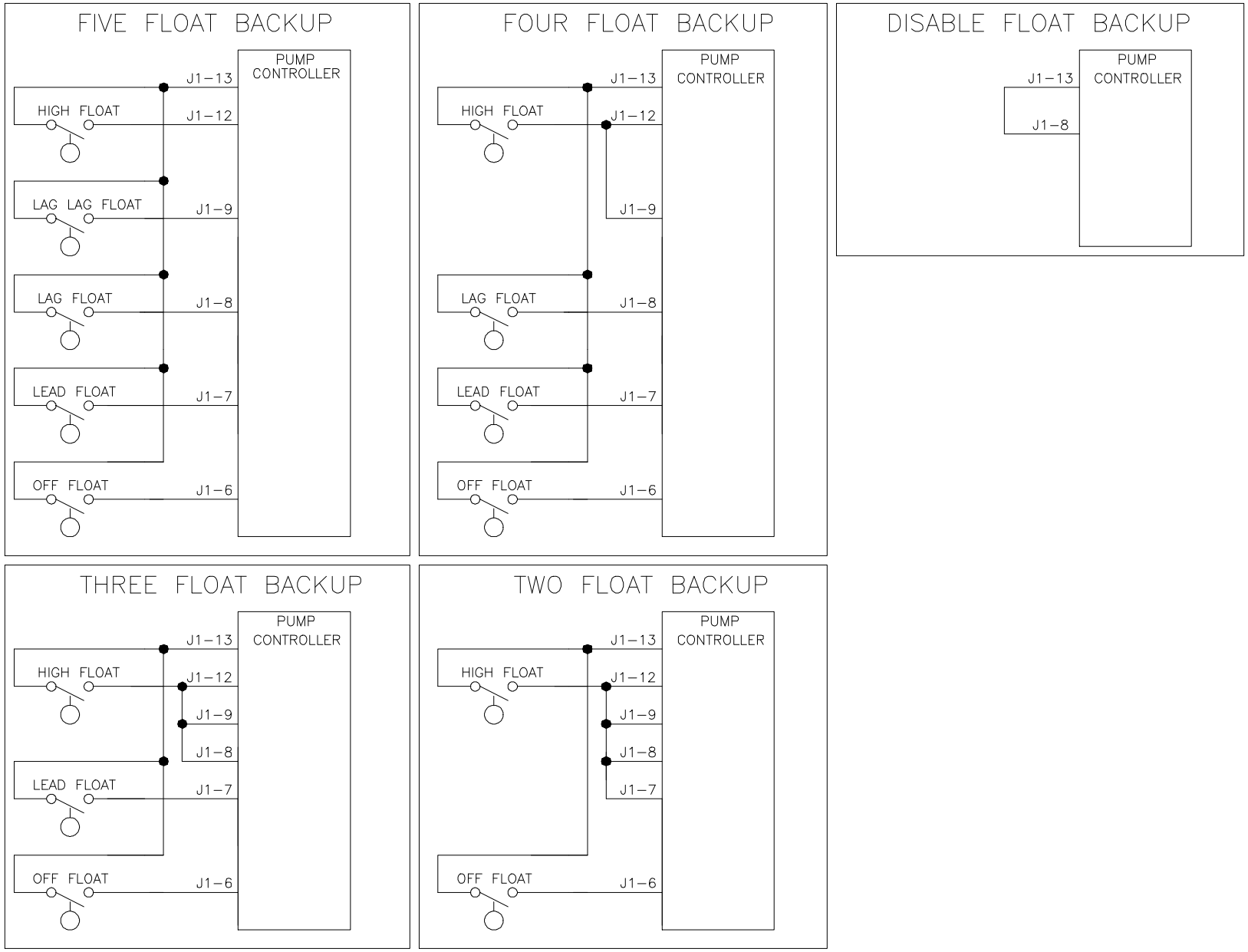

CONNECTOR J2
REAR VIEW
CONNECTOR J1
RELAYS
LABEL WITH SERIAL & MODEL NUMBER
CONNECTOR J3 RS323 PORT
TOP VIEW
3.70"
6.70"
7.70"
6.10"
TRIPLEX PUMP CONTROLLER MODEL CPC-3
FRONT VIEW
7.30"
6.75"
5.25"
5.70"
0.25"
0.30"
RECOMENDED PANEL CUTOUT
A HOLE DIMS 0.187" DIA. THRU 4 PLS.
Consilium US, Inc.
59 Porter Rd.
Littleton, MA 01460
PUMP CONTROLLER CPC-3
DIMENSION SPECIFICATION DRAWING
CAD HOLTZMAN TEH SCALE N/A DRAWING
DEV BRITTIAN SHEET 1 1 12169A
ENGR PARKER

Figure 3



TRIPLEX CONTROLLER SYSTEM WIRING



TRIPLEX PUMP CONTROLLER
BACKUP FLOAT CONFIGURATIONS

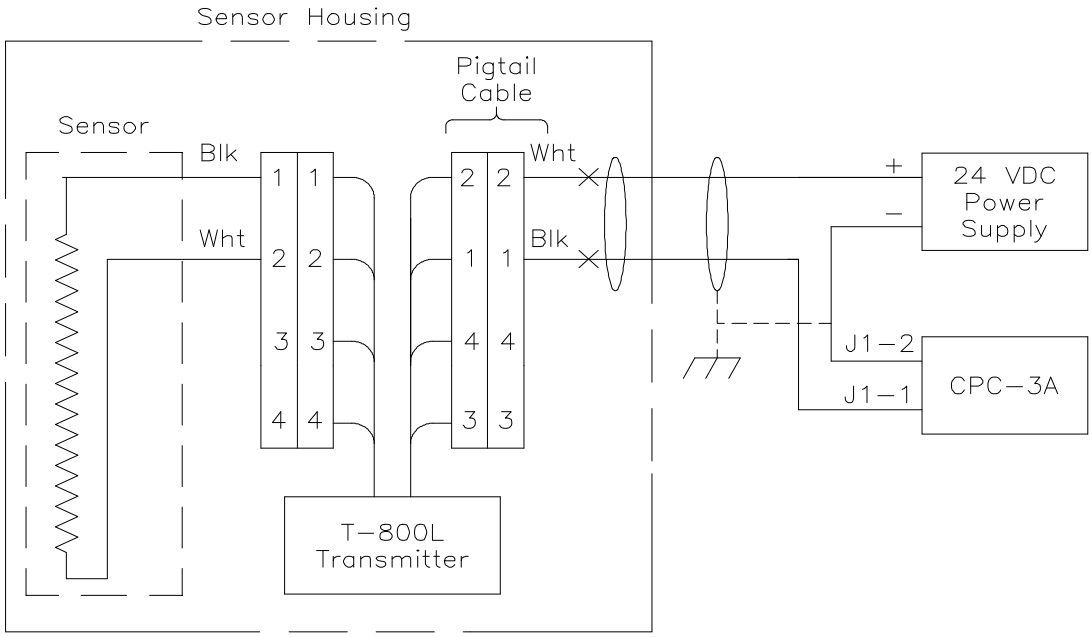


Figure 6

Wiring of Loop powered transmitter to the CPC-3A

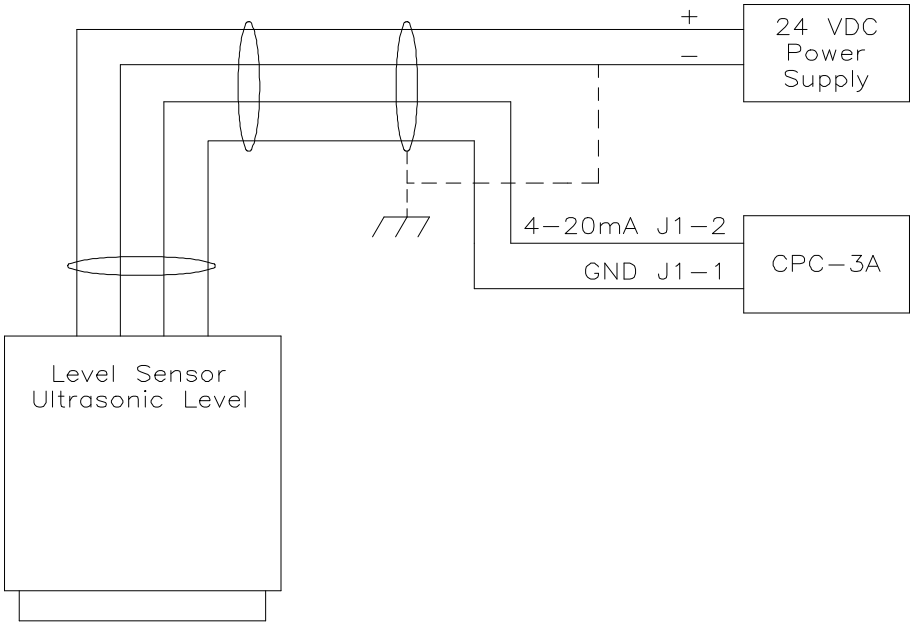


Figure 7

Wiring of 4 - wire device to the CPC-3A

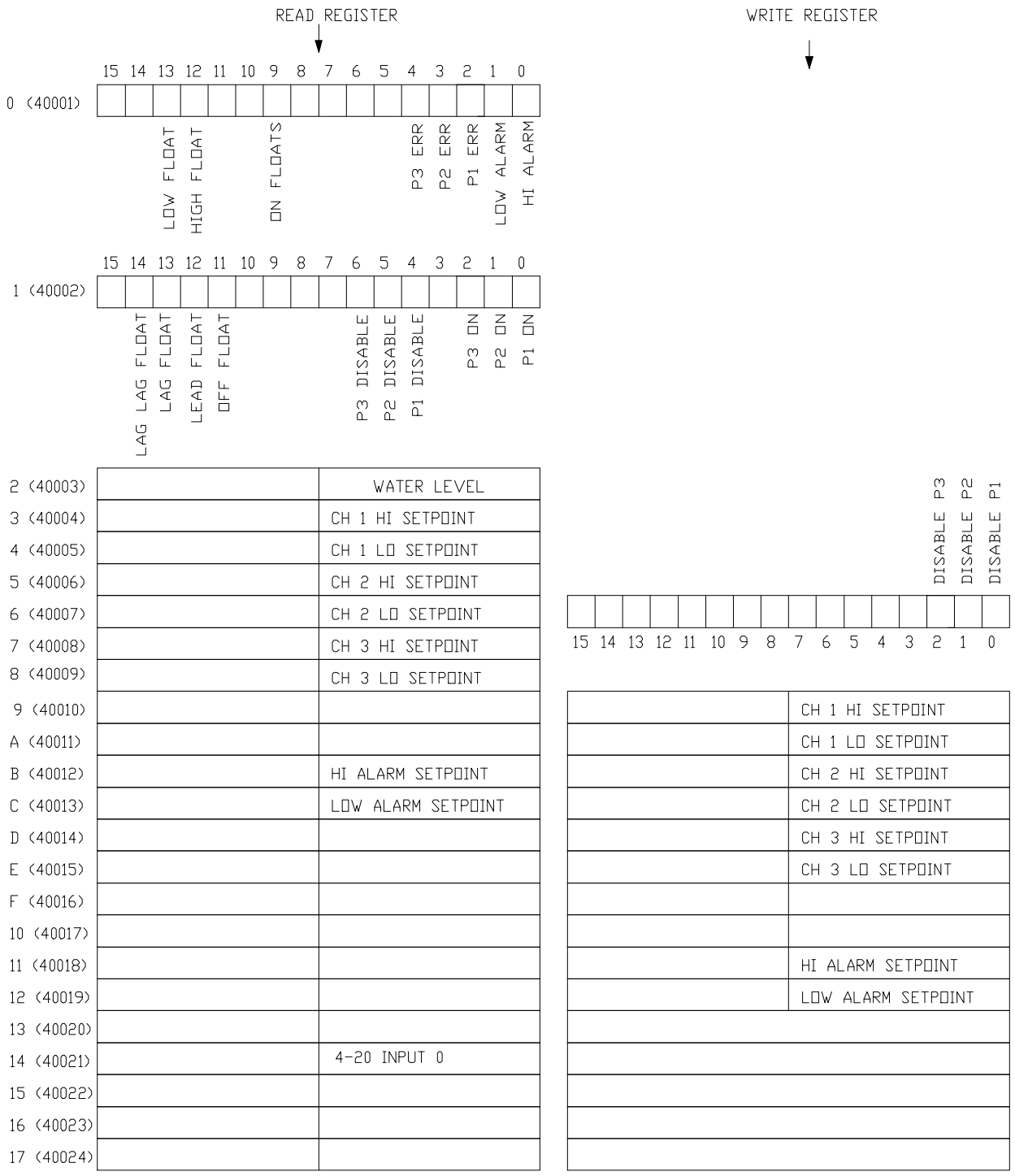


Figure 8

Specification for SCADA connection with CPC-3