Smart Box 4

Instruction Manual

Rev: 20-July-2018

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Introduction:

The Smart Box is designed to interface with progressing cavity pumps. This latest generation Smart Box is versatile, easy to install, and easy to use.

The Smart Box provides simple, direct communication between the plant operators and progressing-cavity pumps. The Smart Box prevents lost production and down time by ensuring that pumps remain within proper operating limits.

NOTE: In order to insure safe, reliable operation, the Onyx Smart Box MUST be used only with a genuine Onyx Isolator Ring.

Only the genuine Onyx Isolator Ring enables this control system to work reliably on viscous fluids, suspended solids, abrasive, corrosive, and volatile liquids.

Connecting the Onyx Smart Box to isolator rings made by other manufacturers compromises safety, reliability, and VOIDS ALL WARRANTIES AND TECHNICAL SUPPORT.

Progressing cavity pumps handle an incredible range of viscous and abrasive fluids; however, they are susceptible to damage from two factors:

1. **High pressure** over the design limit can burst the discharge end of the pump, stall or burn out the motor or break the universal joints.

2. **Run dry** conditions interrupt the flow of liquid the pump needs to dissipate frictional heat, melting the stator.

   Some pumps use the process fluid to cool the stuffing box, so your pump may or may not need an external seal flush system. Refer to the pump manufacturer's instruction sheet to see if your particular pump needs an external seal water flush.

   If an external flush is required but has not been provided, a complete seal water kit is available from Onyx Valve Company. This seal water kit is designed to interface with your pump and the Smart Box. Contact our factory for details.

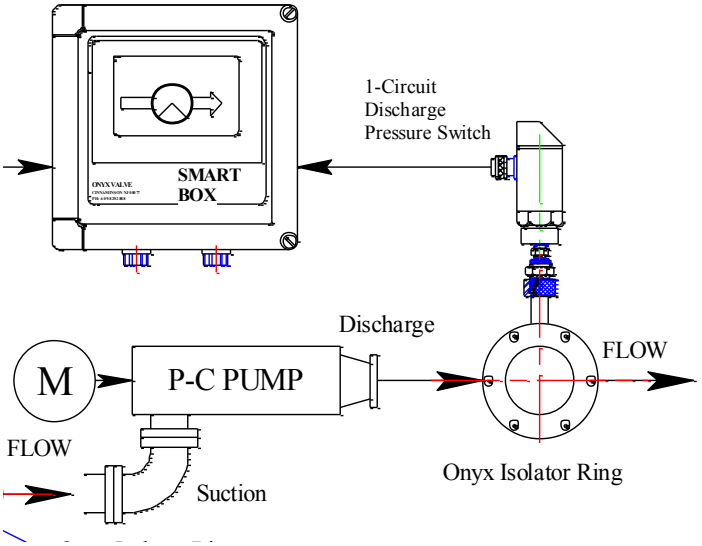
PRINCIPLE OF OPERATION

One switch – or two?

Protecting a pump against **over-pressure i**s simple:

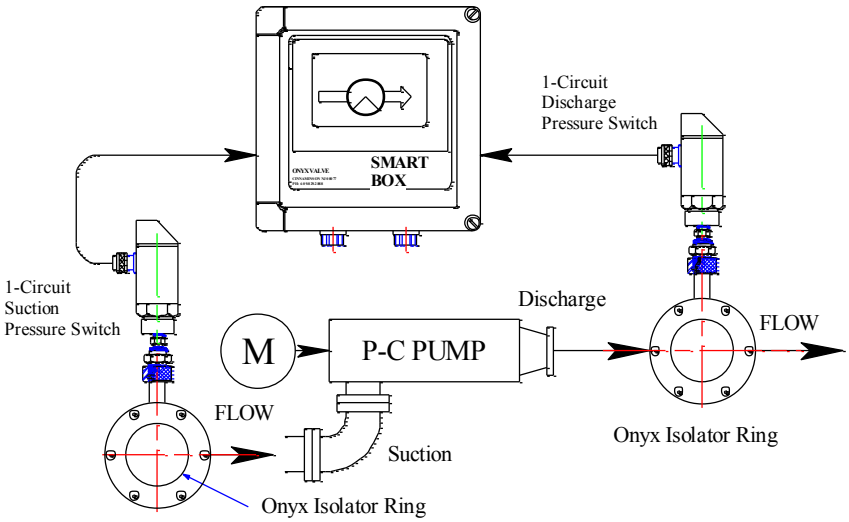
Install a pressure switch in the discharge of the pump as shown here:

If the discharge pressure exceed safe limits the switch signals the Smart box to stop the pump until the excess pressure and been relieved and the RESET button is pressed.

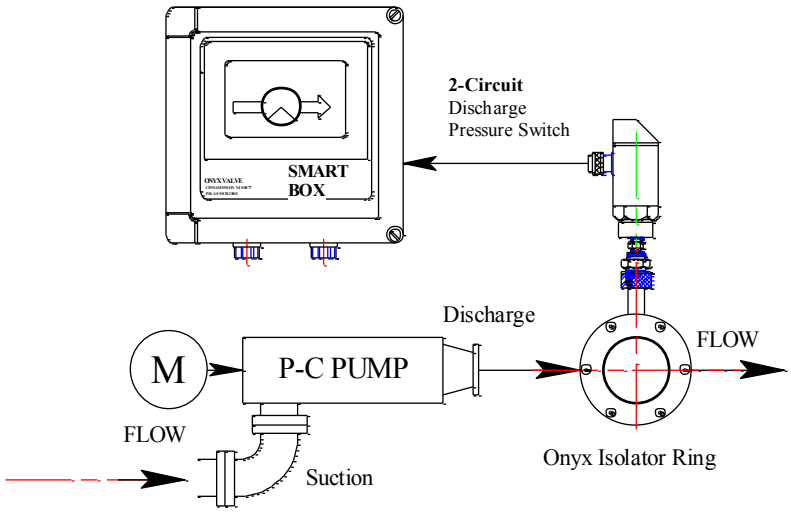


Protecting a pump against a **Run-Dry fault** is a little trickier. There are two ways to accomplish this:

1. The simplest approach: Install **two** separate switches, one in the suction and one in the discharge line.



2. A more economical approach is to install one switch in the discharge:



How can you protect a pump against **BOTH** Over-Pressure and Run Dry with **1** Switch?

Answer: It has to be a 2-stage pressure switch in the discharge.

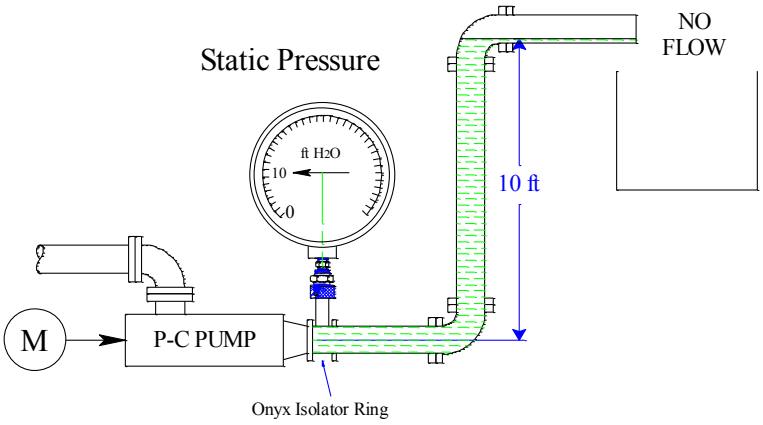
Set the switch in the high circuit to the highest safe operating pressure for the process system. If discharge pressure exceeds the high pressure setting, the Smart Box stops the pump and displays a "High Trip" message. The pump remains stopped until the “Reset" button is pressed.

To determine the Low circuit set-point, it is necessary to understand the difference between static pressure, friction pressure, and total pressure.

Static pressure is caused by elevation differences in the discharge pipe. It is the direct result of the weight of the liquid in the piping system. This pressure is present even when the pump is idle.

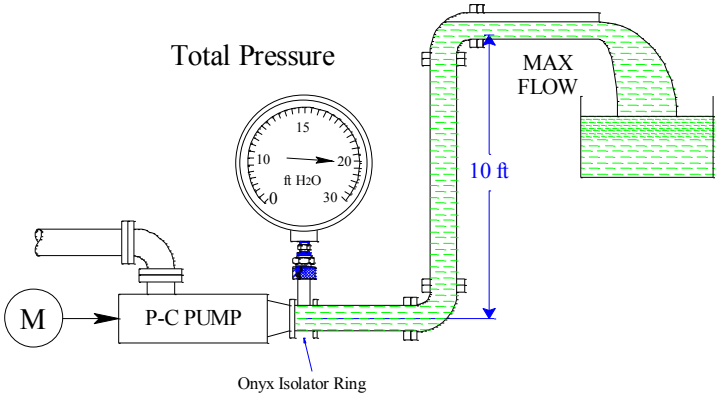
Static pressure is ***not*** influenced by pipe size, number of fittings, or viscosity. It is determined solely by fluid density and the difference in height between the pressure switch and the outlet of the pipe.

In the example shown here, the outlet of the discharge pipe is 10 feet higher than the gauge, so static head is 10 feet.



Friction pressure is caused by the flow of liquid through a pipe and is present only when the pump is primed and running.

It depends on flow rate, size and length of pipe, roughness of the inside of the pipe, number of fittings, and fluid viscosity.



Total pressure = Static Pressure + Friction Pressure.

When the pump is idle the gauge shows static pressure. When the pump is running with flow present the gauge shows total pressure.

In the example, total pressure is 20 feet.

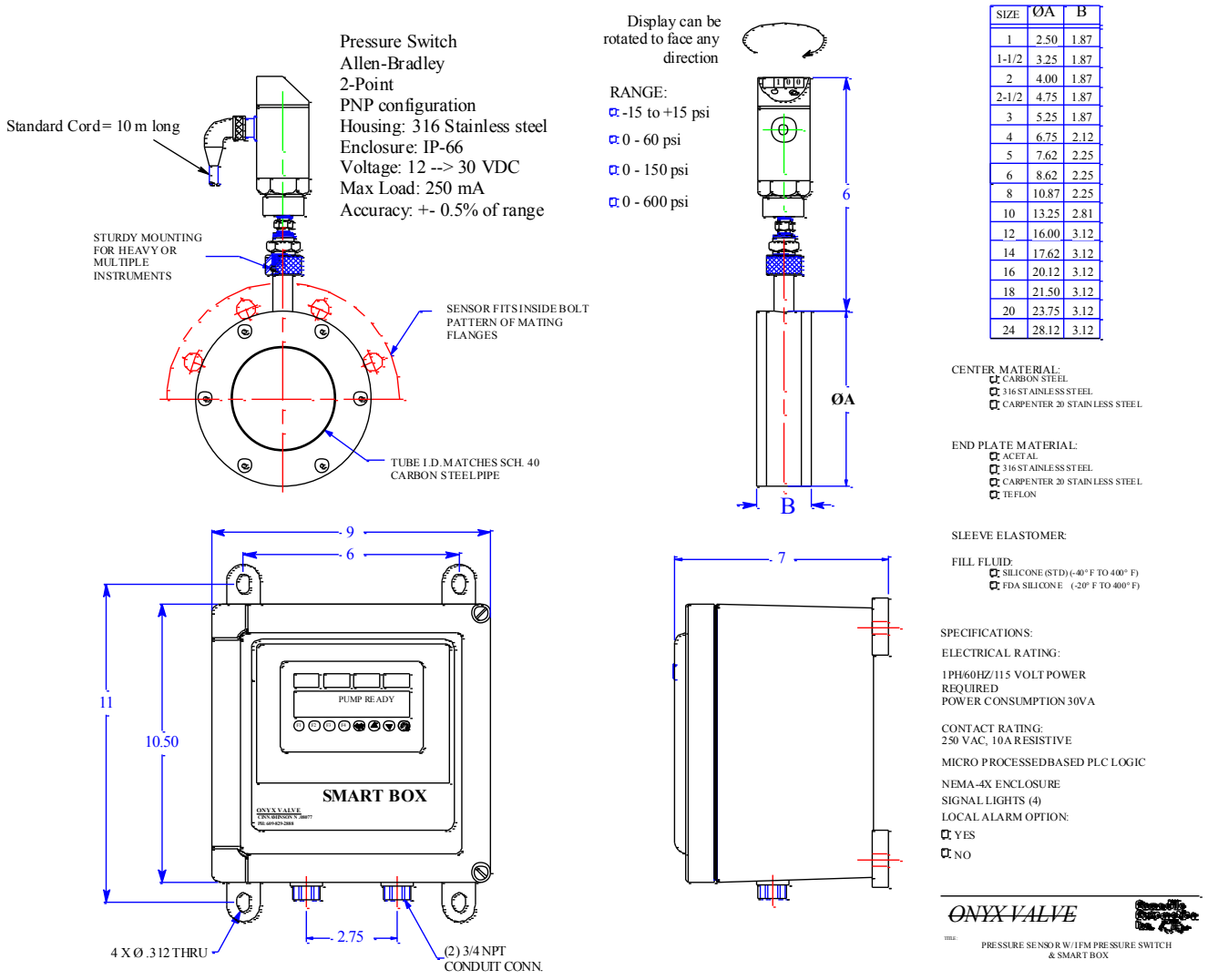
For run dry protection, set the low-pressure switch at the mid-point between the static and total pressure.

In our example the correct setting for the low-pressure switch is 15 feet.

When the pump is running correctly, the low-pressure switch signals that flow is present. If the pump runs dry and flow stops, pressure falls back to the static pressure. This causes the low-pressure switch to signal that flow has stopped.

The Smart Box program allows the pump time to prime. Each time the pump starts, the Smart Box waits 45 seconds before checking for run dry conditions.

After this time-out period, if the pressure falls below the low-pressure setting (which indicates the pump is running dry) the Smart Box stops the pump and displays a "Low Trip" message. The "Low Trip" state remains until the "Reset" button is pressed.



Power consumption = ¼ Amp @ 120 VAC / 60~

Wiring

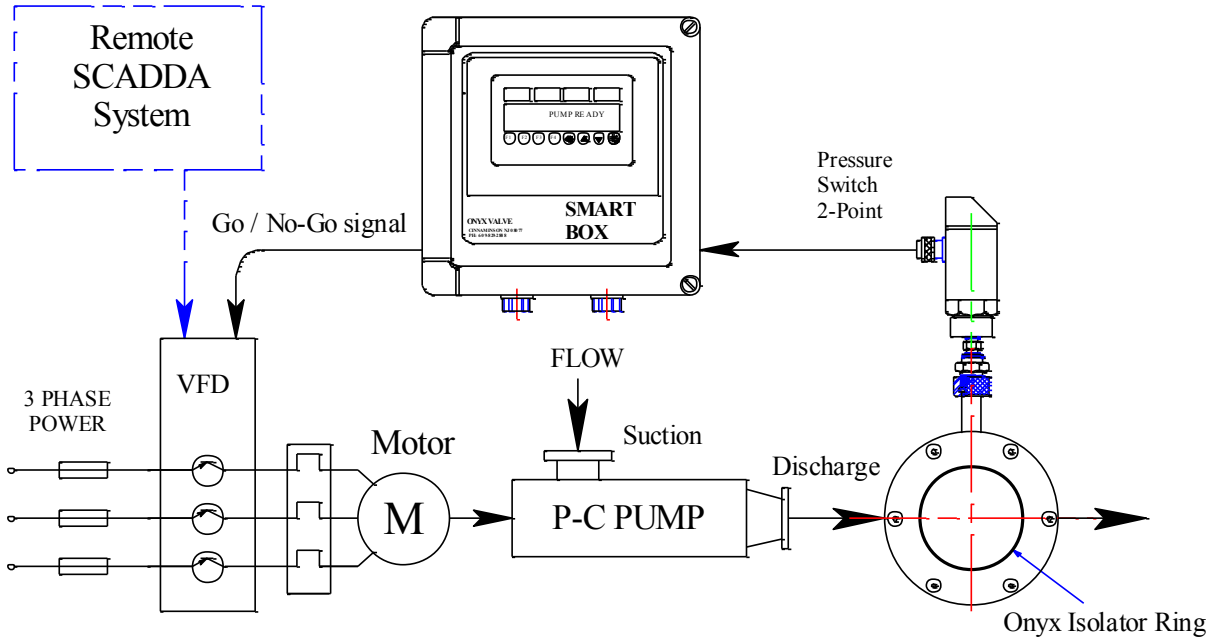
A qualified electrician should perform wiring. All wiring should conform to national and local electrical codes. Disconnect all electric power to this box before wiring or servicing.

How It All Comes Together:

The Smart Box provides a closed-loop system of protection to safeguard the pump.

The elements of the loop include:

1. Progressing Cavity pump
2. Onyx isolator Ring on pump discharge
3. 1 or 2 pressure switches
4. Smart Box
5. A VFD or Motor Starter
6. Motor

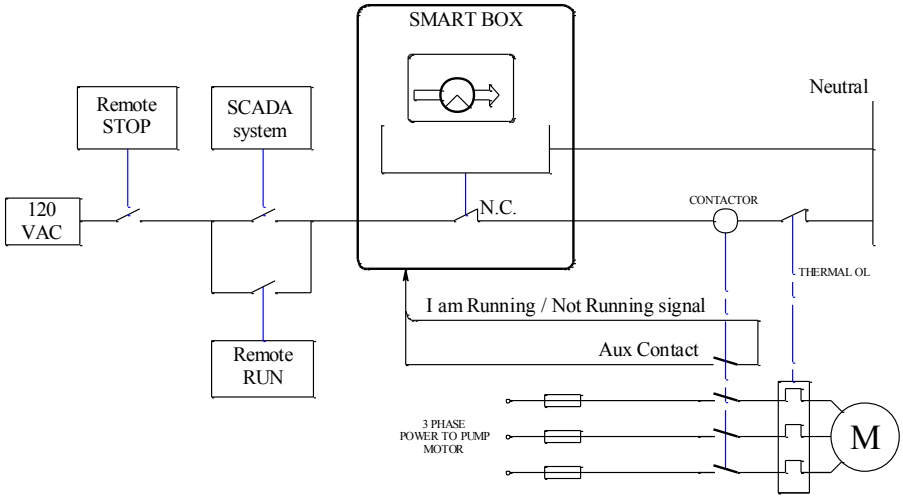


Smart Box General Arrangement
Closing the Loop

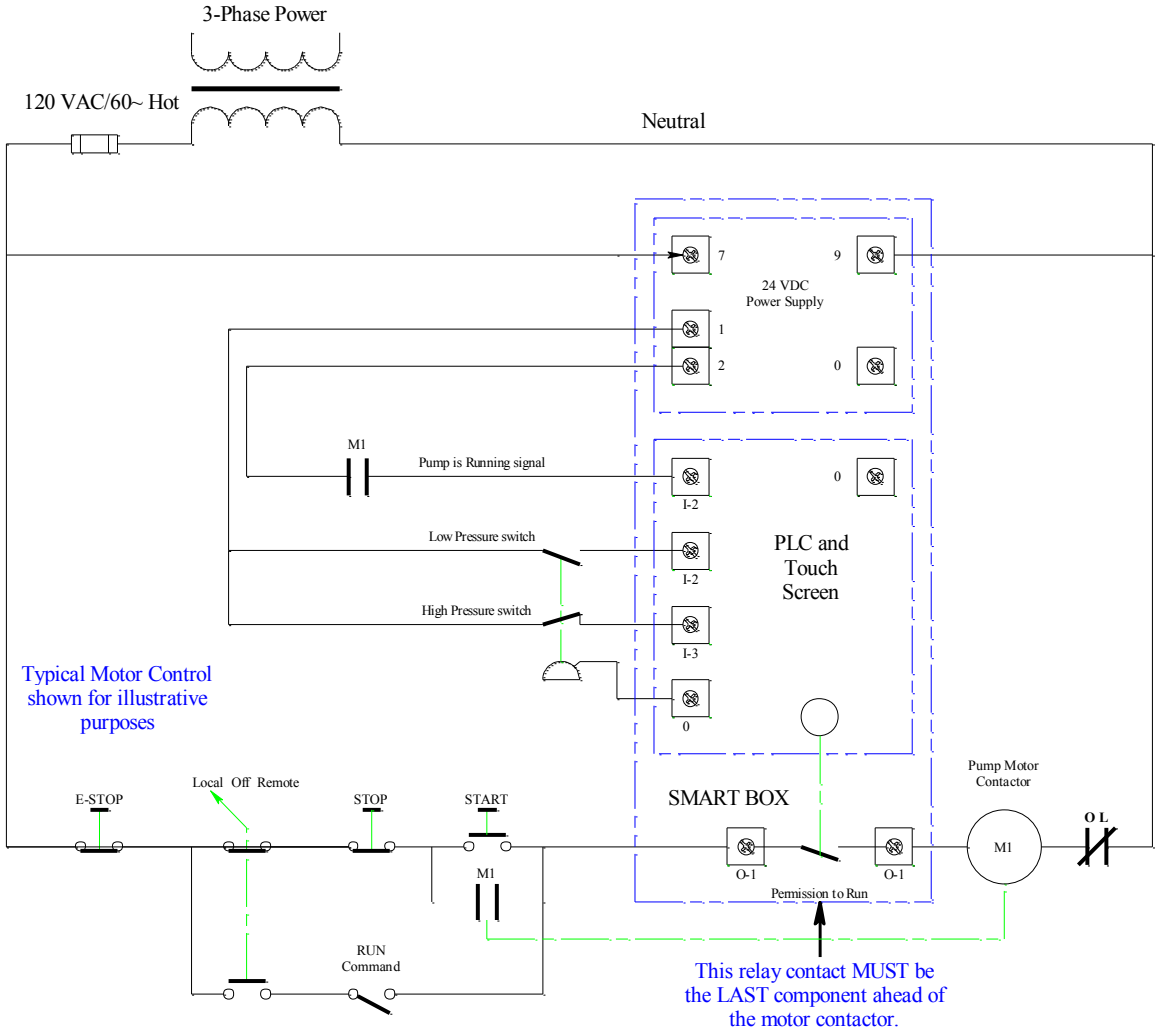
In order to protect the pump properly, the Smart Box needs three things:

1. It has to know the pressure at the pump discharge.
2. It has to know if and when the pump is running
3. It has to have final authority to stop the pump if it detects a malfunction.

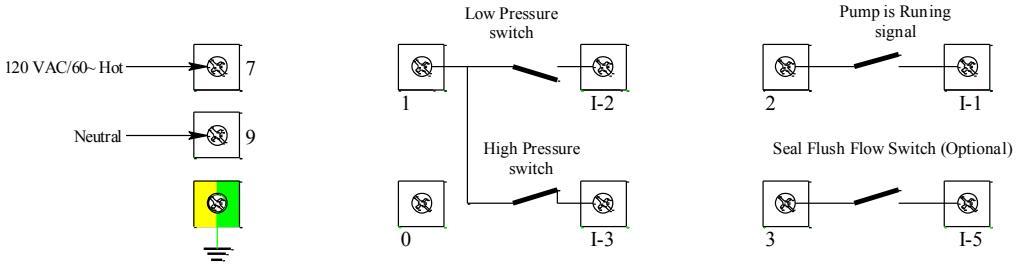
1. **Fixed Speed** pump**:**



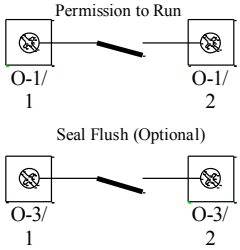
The Smart Box has a permissive contact O-1 that remains closed continuously whether the pump is running or not. This contact stays closed unless there is a problem. If there is a fault in the system, this contact opens until you fix the problem and press RESET on the Smart Box.



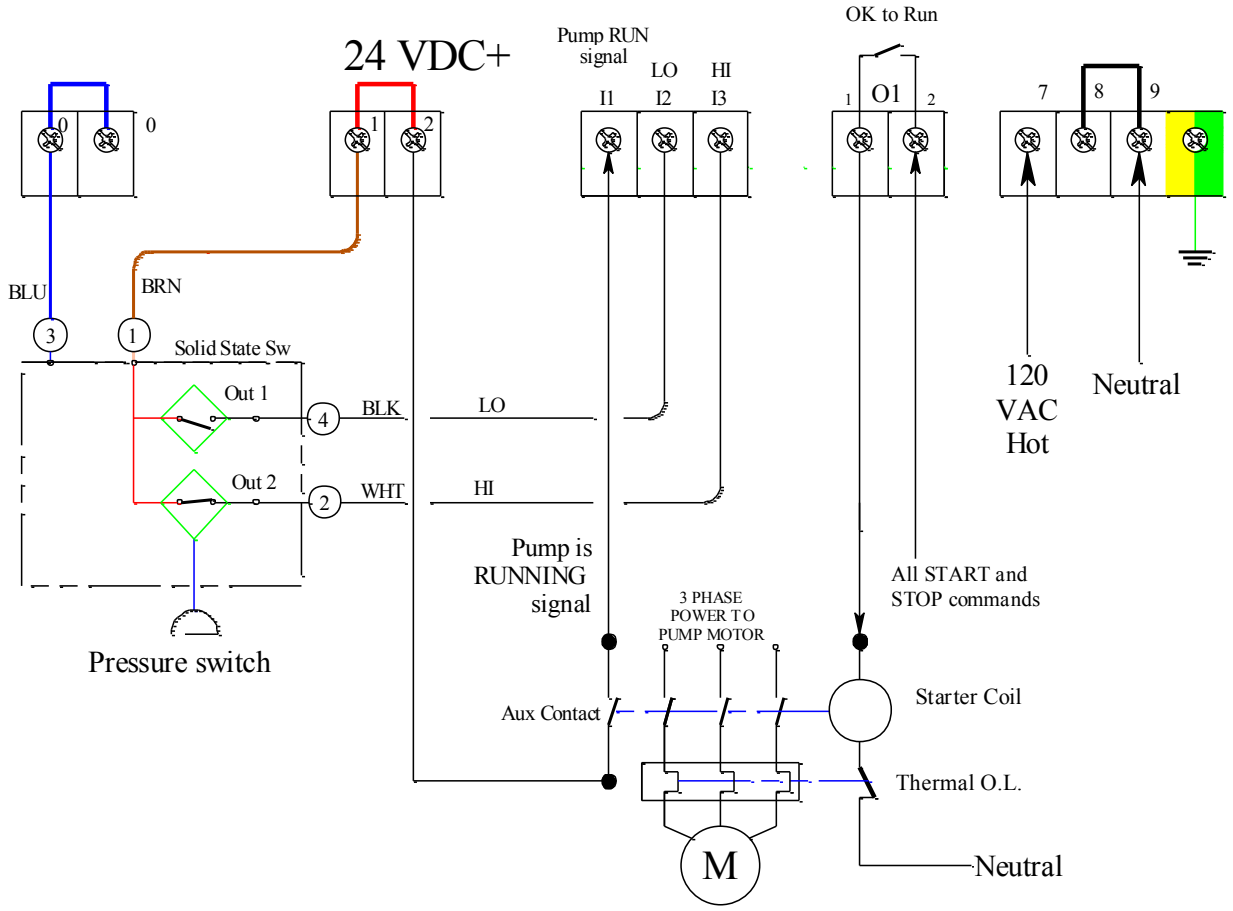
Input connections from the field



Output connections to the field



How you wire it:



It is imperative that the Smart Box is the last link in the chain and that there are no other devices between the Smart Box and the starter coil that can start the pump.

Do you want **Local – Off - Remote** Function?

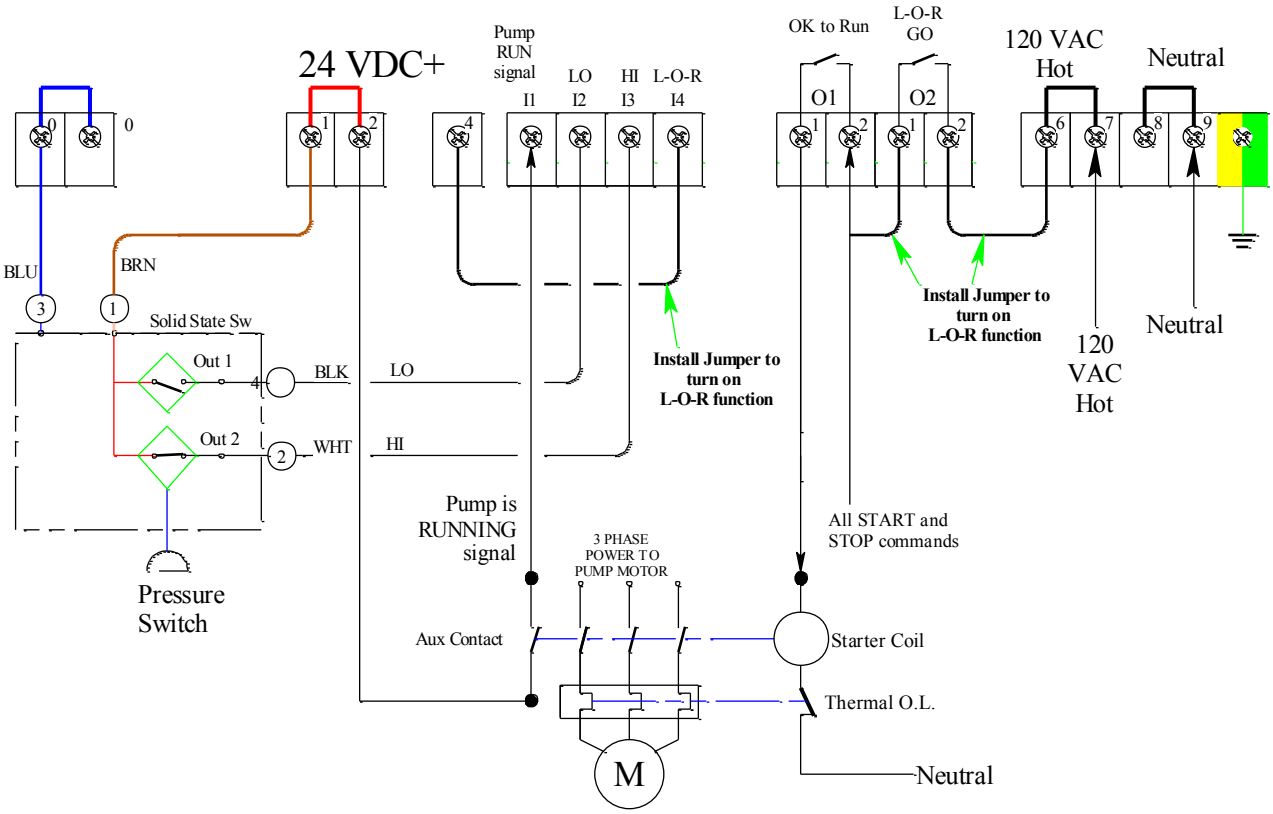
You do not need a separate H-O-A (Hand - Off – Auto) switch.

The Smart box is pre-programmed to perform the Local-Off - Remote function.

Same operation as above except that now when you turn on the Smart Box a set of START and STOP buttons will appear in the screen.

How to activate the L-O-R function:

1. Add a jumper between terminal #4 and I-4 as shown below.
2. Add a jumper between O-1/2 and O-2/1 as shown below.
3. If your motor starter coil is 120 VAC, add a jumper between terminals # 6 and O-2/2 as shown below. WARNING: If your starter coil is not 120 VAC, then skip this step.

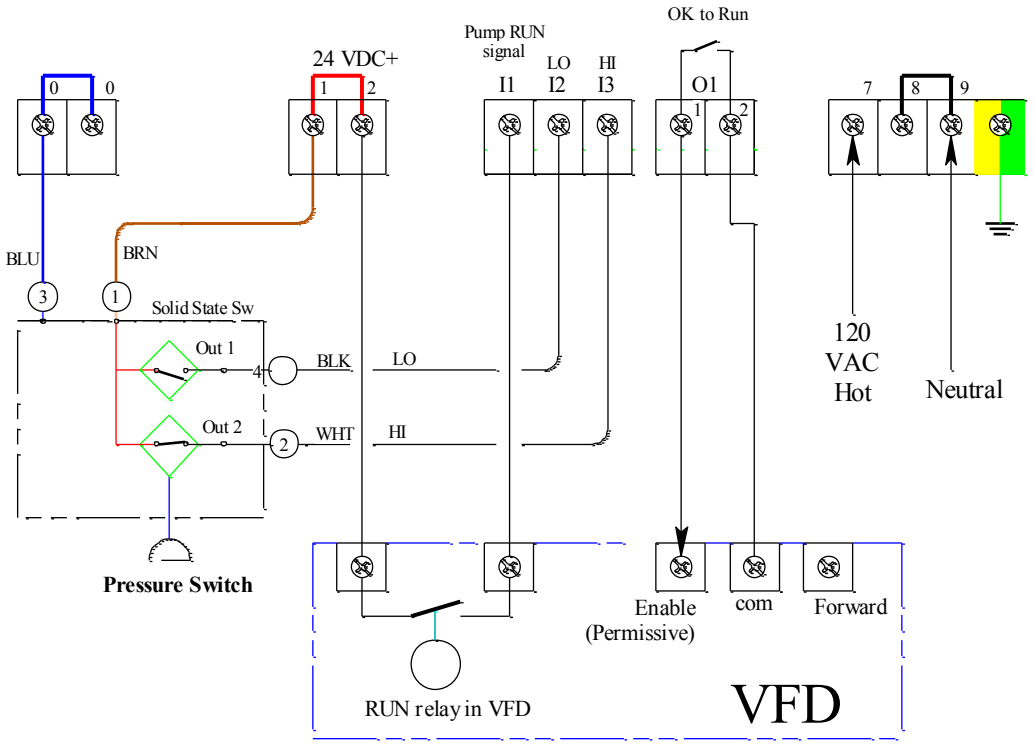


It is imperative that the Smart Box is the last link in the chain and that there are no other devices between the Smart Box and the starter coil that can start the pump.

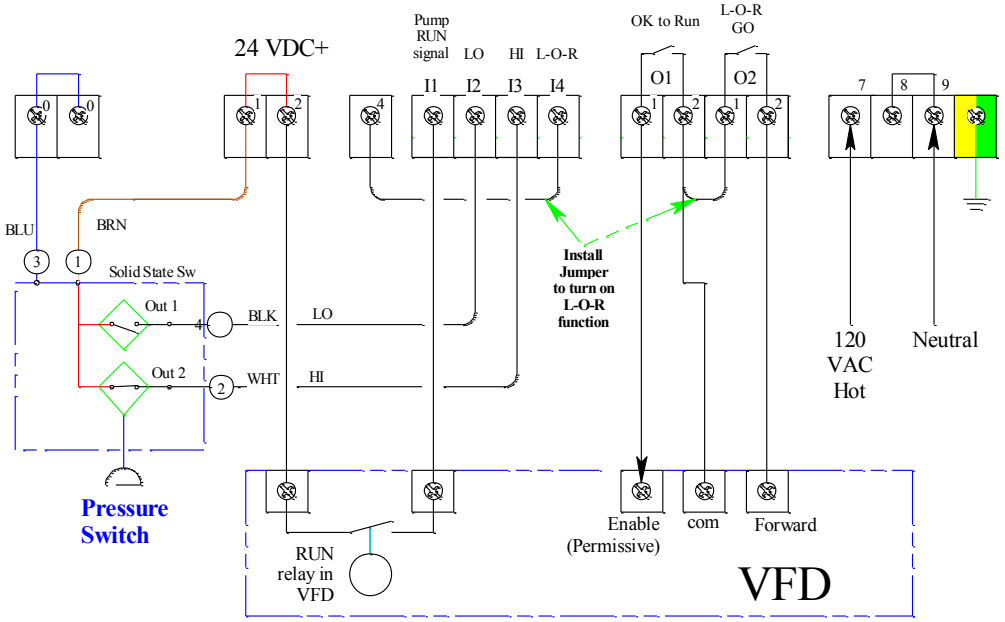
2. Variable Speed pump with VFD

In this arrangement the Smart Box is connected to the “ENABLE” terminals inside the VFD. Sometimes these are labeled “PERMISSIVE”.

The Smart ox needs to know when the pump is running so you must dedicate one of the RUN relays in the VFD to the Smart Box. Wire the RUN signal directly to Smart box terminals #2 and I-1.

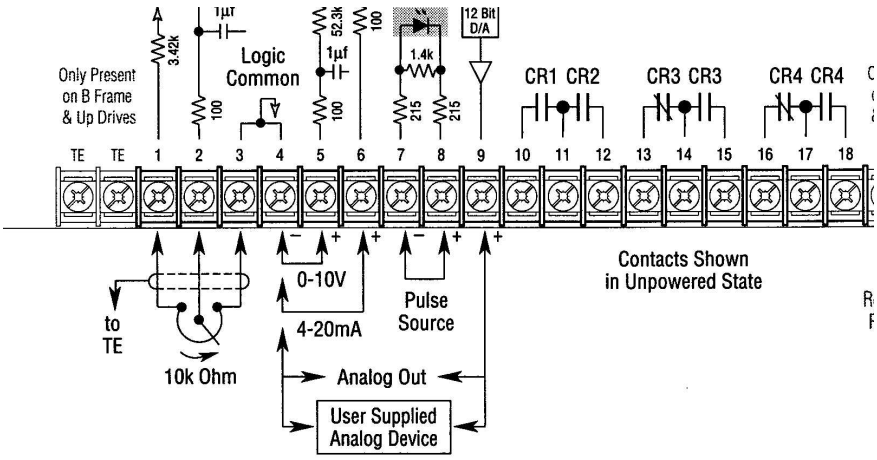


Do you want to add the Local – Off - Remote Function? Simply add a jumper between terminal #4 and I-4 and a jumper between O-1/2 and O-2/1. You also need to connect O-2/2 to your “Forward Run” terminal in the VFD.



Notes on the VFD:

The first thing you have to do prior to wiring a VFD to the Smart Box is to identify the critical interface terminals in the VFD. By way of example, we will use the Allen Bradley model 1336 VFD.

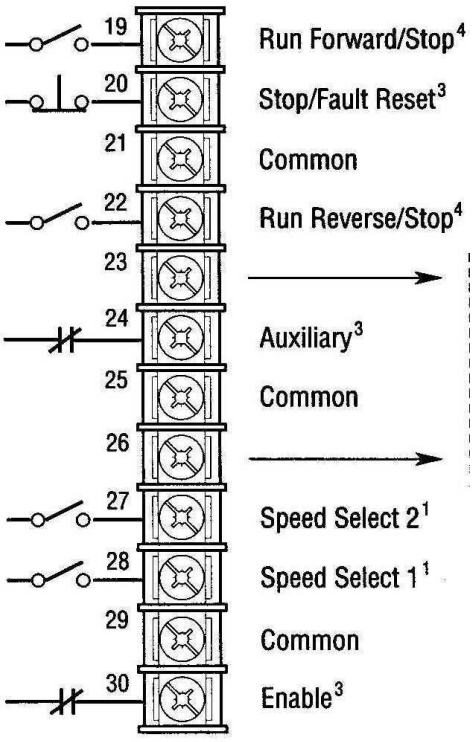


Terminal board # TB-2 is shown at the right.

The A-B drive has (4) programmable relays labeled CR-1 to CR-4. The Smart Box needs one Normally Open "**RUN**" relay. You can use any available relay for this purpose so long as it is N.O. and is programmed to energize whenever the pump motor is running.

In our example we used CR-1 as the run relay. Connect terminal #10 in the A-B drive to Smart Box terminal #2. Connect terminal #11 in the A-B drive to terminal I-1 in the Smart Box.

The second step is to identify the relevant terminals on the input side of the VFD. Terminal board TB-3 in the A-B drive is shown at the right.



First, we need a "**COMMON**", so we could use either terminal #21, 25, or 29. Connect A-B terminal #21 to Smart Box terminal # O-1/1.

Next, we need an "**ENABLE**" terminal, which would be #30 in the example A-B drive. Connect A-B terminal #30 to Smart box terminal #O-1/2

Finally, if you elect to activate the L-O-R function, then you need a "**Run Forward/Stop**" terminal, which is #19 in our example. Connect A-B terminal #19 to Smart Box terminal #O-2.

Important note: Just because A-B used these numbers in their 1336 VFD does NOT imply that any other drive will have the same terminal numbering system. It is up to the system engineer to determine the corresponding terminal numbers for whatever brand and model drive they specified. If in doubt call or e-mail the Onyx factory for assistance. Don't guess at it if you are uncertain or you could wind up smoking the VFD and the Smart Box.

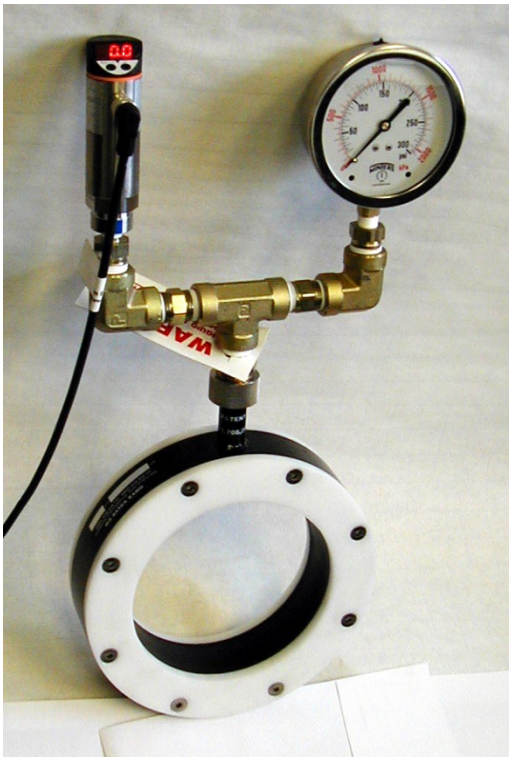
Solid State Pressure Switches

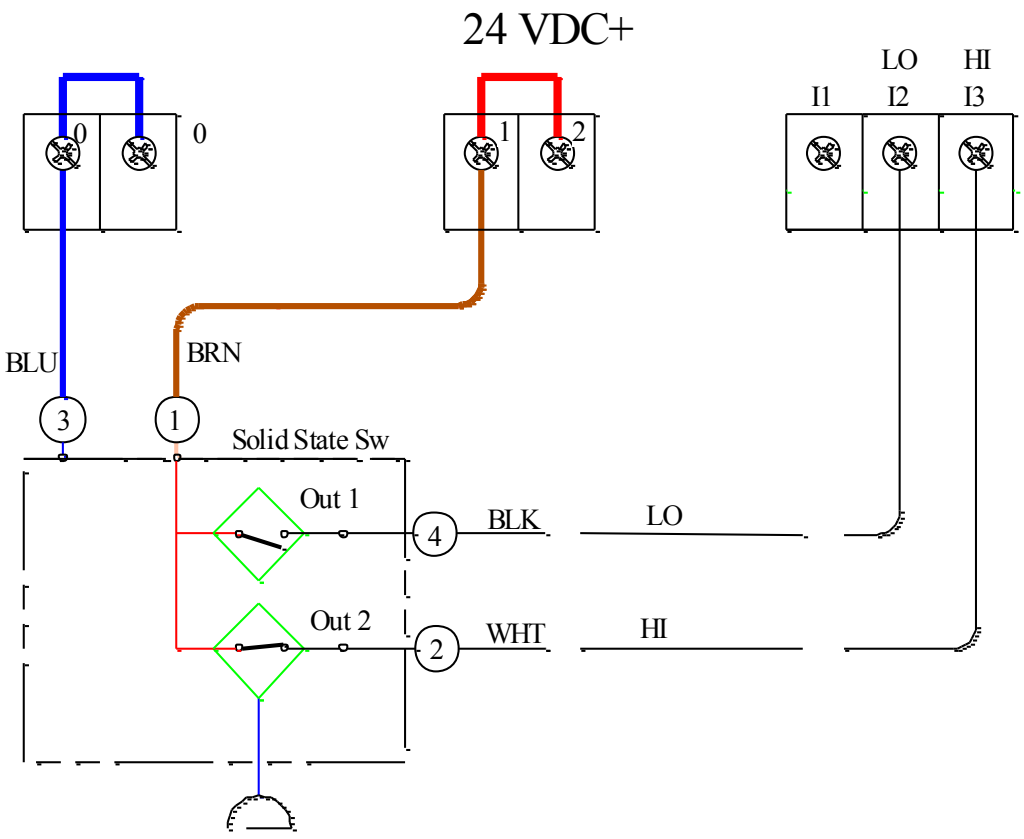
Solid state pressure switches are more accurate than their mechanical counterparts and are easier to set up and configure during start up.

The Onyx Smart Box-4 is designed to interface directly with the IFM #PN-769X or the Allen Bradley 836 series solid state switch.

The Smart Box-4 comes standard with an internal power supply to drive the pressure switch.

The pressure switch cable has 4 wires inside, each with a different color. Wire the switch into the circuit as shown in the diagram below.

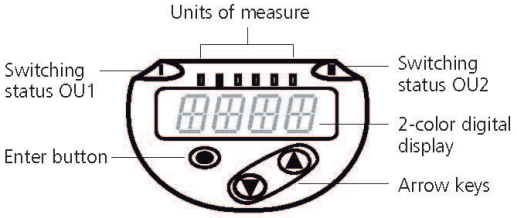




Pressure switch

Notes on the IFM Solid State Pressure Switch:

PN7 Series Pressure Sensor
Programming Menu Guide



Programming Mode

1	Press Enter [⬬] to access parameter selection menu
2	Press Up / Down [▲] [▼] Arrow until desired menu item is displayed. (See Pressure Sensor Menu Items) SP1
3	Press Enter [⬬] to display the current setting.
4	To change the setting, press and hold the up [▲] or down [▼] arrow for 1 second until the flashing value is continuously incremented. After this time, the switch point may be increased continuously (by holding down the up or down arrow) or incremented (by pressing and releasing the arrows repeatedly) until the desired value is reached.
5	Press Enter [⬬] once to save the desired value.
6	The desired value is set. If no button is pressed for 30 seconds, the sensor returns to the operating mode.
7	Repeat these steps to set other values as required.

Pressure Sensor Menu Items

Program uni (Display units) first to avoid programming errors.

SP1 is the Low Pressure Set Point.
rP1 is the low ***reset*** point. Set this to SP1 + 1 psi.

SP2 is your High Pressure Limit.
rP2 is the high ***reset*** point. Set this to SP2 – 1 psi.

- SP1 Setpoint 1
- rP1 Resetpoint 1
- SP2 Setpoint 2
- rP2 Resetpoint 2
- EF Enhanced functions – Press Enter [⬬], then Up [▲] or Down [▼] arrows to scroll through the Enhanced Function options. (See detailed instructions for complete listing of EF menu.)
  - rES Restore factory settings
  - ou1 Output 1, ou2 Output 2
    - Hno Hysteresis mode: normally open — Set "Ou1" to **Hno**
    - Hnc Hysteresis mode: normally closed
    - Fno Field mode: normally open — Set "Ou 2" to **HnC**
    - Fnc Field mode: normally closed
  - dS1, dr1, dS2, dr2 Delay time for switching outputs — Set to: **0**
  - uni Select units (options vary depending on range of sensor): inHg, bar/mbar, psi, kPa, MPa, inH$_2$O
  - P-n
    - PnP, nPn PNP output, NPN output ← Set to: **PnP**
  - coLr Display color
    - rlou Display color changes to red when OU1 switches
    - Glou Display color changes to green when OU1 switches
  - diS Display options
    - d1, d2, d3 Display updated 50, 200, or 600 mSec
    - rd1, rd2, rd3 Same as above with display rotated 180°
    - OFF Display deactivated

For additional information, please see the operating instructions.

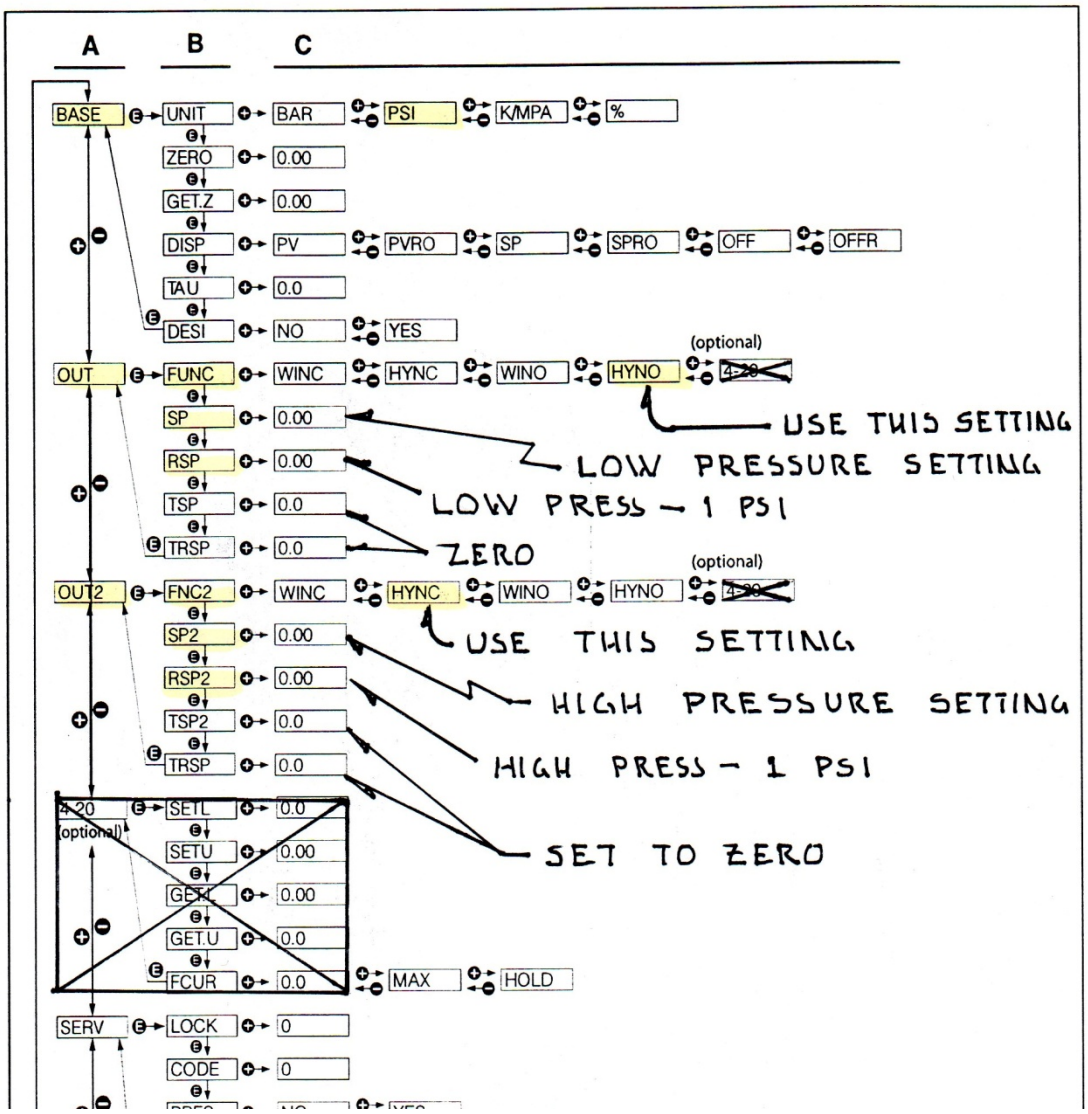
ifm efector inc.
800-441-8246
ifm.com/us
email: cs.us@ifm.com

5/2016
Lit No.: U50416e

Sett ing the Allen Bradley 836 E switch:

4.1.2 Structure of the programming menu

The chart below illustrates the structure of the programming menu.

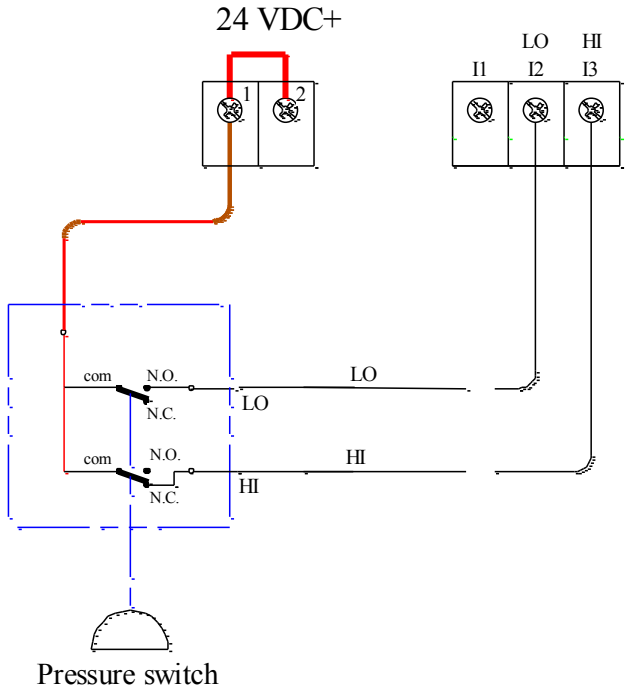


Programming the Allen Bradley # 836E switch

1. Set the UNITS to “PSI”
2. Set OUT → FUNC to “HYNO” (High, Normally Open)
3. Set OUT → SP to the low pressure threshold for your pump.
4. Set OUT → RSP to the low pressure threshold minus 1 psi.
5. Set OUT2 → FUNC to “HYNC” (High Switch, Normally Closed)
6. Set OUT2 → SP to the maximum safe pressure for your pump.
7. Set OUT2 → RSP to the maximum safe pressure minus 1 psi.

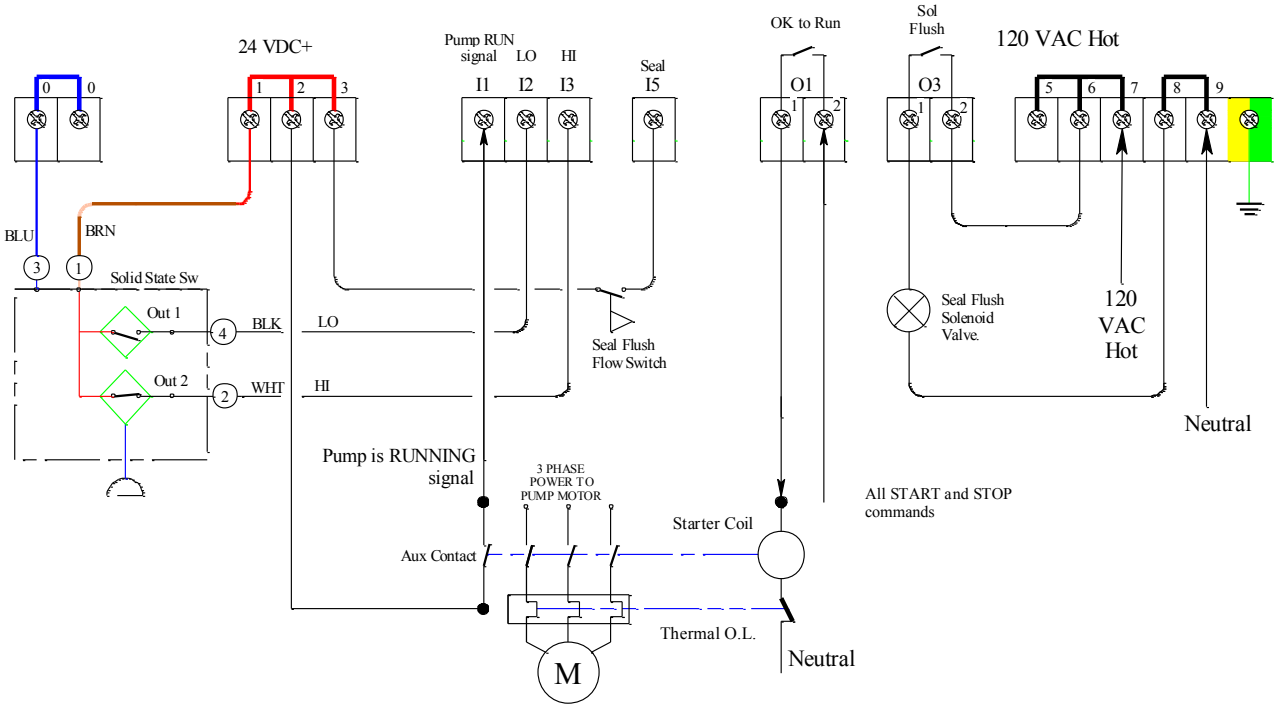
Mechanical Pressure Switches

If you prefer mechanical switches, they are compatible with e Smart Box-4 as well.

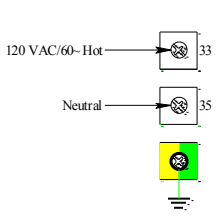


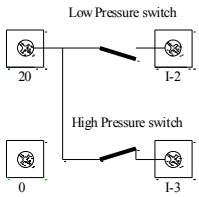
Seal Water Control

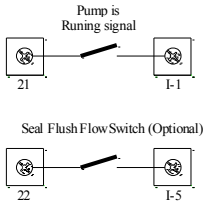
If your pump requires an external water quench for the mechanical seal or packing box and you want to control it with the Smart box, wire it as shown below. The solenoid valve coil voltage must be 110/120 VAC. Wire the solenoid valve at terminals #8 and O-3/1. Install a jumper between #6 and O-3/2 as shown. Wire the flow switch between terminals #3 and #I-5. If you don't have a flow switch, install a jumper across these two terminals.



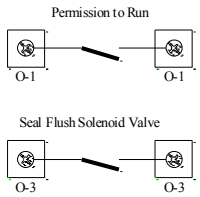
Input connections from the field







Output connections to the field



Questions? Need help? Contact:

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