

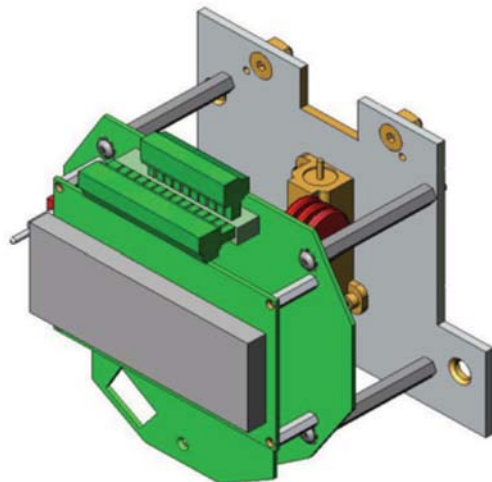
Becker* Digital Natural Gas Positioner (DNGP)

Series 3.5M with Modbus™ Protocol Instruction Manual

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Introduction

The DNGP is designed specifically for the needs of the Natural Gas industry. By using solenoids to control the actuator pressures, the DNGP eliminates the continuous bleed gas produced by I/P transducers and bleeds no gas until the valve is called upon to move. The DNGP can even do this while maintaining a pressure difference across the actuator. Additionally, the discharge can be directed downstream, and the positioner is capable of failing in last position on a loss of signal, DC power or power gas. Reliability and simplicity have been engineered into the DNGP, while features that make the positioner versatile, easy to use, and fail safe, have been retained.

Scope of Manual

This manual provides information on the installation, adjustment, and maintenance of the DNGP-Digital Natural Gas Positioner. For information concerning actuators, valves, and accessories, refer to the instruction manuals provided with the specific product.

Table 1 - DNGP Technical Specifications

Electrical Power Requirements	VIN = 12 to 24 VDC nominal (11-30 VDC) 21 VDC min. for 24 VDC Solenoid, 11 VDC min. for 12 VDC Solenoid 1 to 2 A including DNGP heater and transmitter heater (3 A fuse line recommended)
Over Current Protection	20 Joule, 2000 A surge and lightning transient protection 3 A fuse for Logic module 24 VDC power 50/150 mA PTC resettable fuses for position input signal and transmitter feedback signal
Position Input Signal (Selectable) Standard	4-20 mA (Split Range: 4 mA min. up to 16 mA max. in 1 mA increments), minimum 4 mA band
Transmitter Feedback Signal	Analog Rotary: External or Internal Digital Linear: Internal only; RTU Feedback must be dry
Remote Indicator Dual Function Output	Outputs VIN-1.5V @ 20 mA max. (for example if VIN = 24 VDC, this supplies 22.5 ± 0.5 V) The remote Indicator function can be selected to function as "Solenoid Counter" or "In Standby/Manual". In Counter mode it pulses whenever either solenoid activates. In Standby/Manual mode, it is active whenever the DNGP is in Standby or Manual modes.
Valve Position Feedback Module	Primary: Linear Digital Transmitter Analog Rotary Types Also Available:
Display	80 (4 x 20) character Vacuum Fluorescent Display for: Command Signal, Valve Position Feedback, Solenoid Cycle Count (stored in 10 year non volatile memory), Dead Band value. Incorporates a user navigational menu system.
Input Mode Selection	Manual/Auto/Standby
Electrical Manual Override	Manual pushbutton positioning (must engage Manual Mode with Auto/Manual/Standby Switch)
Communications	DNGP Dashboard PC Interface, Modbus™ communication protocol
Solenoid Bypass	Can be ON or OFF within 1.5% of the end stroke (in full closed and open position).
Loss of Signal Options (Selectable)	Drive to 4 mA position (open or closed valve position) Drive to 20 mA position (open or closed valve position) Lock in last controlled position
Position Input Signal Impedance	120 to 220 Ω
Transmitter Feedback Input Signal Impedance transmitter)	120 to 220 Ω (additional operating voltage required for

Technical Assistance

Only those qualified through training or experience should install, operate, or maintain Becker positioners. Should you have any questions concerning these instructions, you may contact your local GE sales representative, sales office, or manufacturer before proceeding.

GE Energy
Becker Control Valves
Attn: Technical Assistance
1550 Greenleaf Avenue
Elk Grove Village, IL 60007

Toll Free: +1-800-323-8844
Telephone: +1-847-437-5940
Fax: +1-847-437-2549

web: ge.com/energy

Table 1 - DNGP Technical Specifications (continued)

Input Signal Action	Direct or Reverse Acting (selectable by accessing DNGP Menu and Transmitter Switch)
Pneumatic Action	Double Acting or Single Acting
Deadband	Adjustable from 0.1% to 2.0% of full travel
Hysteresis	<2.0% full scale (with rotary position feedback transmitter)
Linearity	<±1.0% full scale (with standard linear digital transmitter)
Repeatability	<±1.0% full scale (with standard linear digital transmitter)
Operating Temperature	-20 °F to 150 °F (-29 °C to 66 °C)
Influence of Temperature on Valve Position	<0.01% per °F (<0.02% per °C)
Steady State Gas Consumption	ZERO - see Table 2.0 for additional information
Recommended Supply Regulator Capacity	100 SCFM at 250 psig (1724 kPa) - Natural Gas 45 SCFM at 100 psig (689 kPa) - Natural Gas 30 SCFM at 60 psig (414 kPa) - Natural Gas
Electrical Classifications	Electrical Enclosure Explosion Proof for Class I Groups C and D ;Class II Groups E, F, G; Class III hazardous locations CSA approved, RoHS compliant Optional ATEX available
Enclosure	Available in explosion proof housing with window or NEMA-4 Poly carbonate enclosure for remote control board mounting
Approximate Weight	15 lb. (5.6 kg); includes standard explosion proof DNGP enclosure and High Pressure 5/3 Solenoid Valve.
Valve Position Limit Switches	Low limit settable from 0 to 45% closed High limit settable from 55 to 100% of open Contacts ratings (maximum) Power: 180 W or 1800 VA Current: 6A Voltage: 150 VDC or 300 VAC (UL 6 A @ 28 DC, VDE 5 A @ 250 VAC).
Digital Control Inputs	Low limit settable from 0 to 45% closed High limit settable from 55 to 100% of open Contacts ratings (maximum) Power: 180 W or 1800 VA Current: 6A Voltage: 150 VDC or 300 VAC (UL 6 A @ 28 VDC, VDE 5 A @ 250 VAC).
Digital Control Inputs	12 to 24 V nominal (11 to 30 V). Digital input current: 3.5 mA at 24 V One input controls Open, one input controls Close, and common Open/ Close return signal.
Maximum Power Supply Gas Pressure	250 psig (1724 kPa) with 5/3 type DNGP Solenoid Valve (Check Maximum Actuator Power Supply Pressure Limitations) 150 psig (1034 kPa) with 3/2 type DNGP Solenoid Valve (Check Maximum Actuator Power Supply Pressure Limitations)
Pneumatic Port Connection	1/4" FNPT standard, larger sizes available for additional capacity
Electrical Conduit Connections	3/4" FNPT standard

Principle of Operation

The solenoid operated electro-pneumatic positioner compares a 4-20 mA signal from a RTU to a 4-20 mA signal from a position transmitter. Depending upon the difference between the two signals, the positioner will energize the open or close solenoid to drive the control valve toward the desired position. If the signals are within an adjustable dead band, neither solenoid will be energized. The solenoid tubing is connected to the valve actuator through a variable orifice. This orifice allows the valve speed to be increased or decreased. The faster the valve speed, the larger the positioner dead band must be to prevent overshoot of the valve position. When the input signal falls within 1.5% of either full open or full closed, and bypass enable is selected, the positioner will continually energize the appropriate solenoid to provide a full pressure differential across the cylinder.

Wire Size Recommendations

Wires of insufficient size will create a voltage drop between the power supply in the control room and the DNGP at the valve site. This voltage drop is created by resistance in the wire carrying power to the DNGP. Smaller diameter wires have more resistance than larger wires and therefore produce a larger voltage drop. Resistance is also function of the length of the wire. From this information, the equation needed to figure the proper wire size is governed by equation (1):

$$(1) \text{ VDROP} = (2 * L * I * R) / 1000$$

Where:

VDROP (Volts) = Voltage drop between the power supply and DNGP

In the case of single acting actuators, the pressure will be full power gas pressure or zero psig. If either the RTU signal or transmitter signal falls below 3.5 mA, the positioner will enter failure mode. In failure mode the positioner will move the valve to fully open, fully close, or hold the current position depending on the user specified failure configuration.

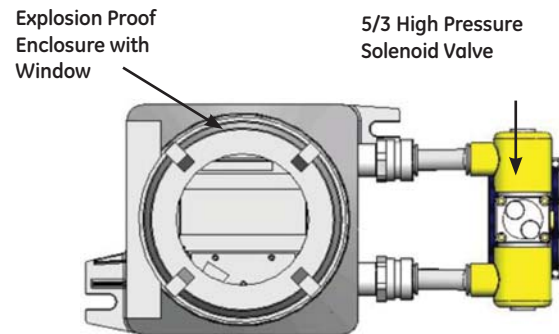


Figure 1 - DNGP EXP Enclosure and High Pressure 5/3 Solenoid Valve

L (Ft.) = Length of wire (one way) between power supply and DNGP

R (Ohm) = Resistance per 1000 ft. of the wire

I (amps.) = DNGP current draw = 1 A

Equation (1) tells us that for longer distances of wire between the power supply and the DNGP, larger sizes of wire are required to keep the voltage drop to a minimum. Voltage drops greater than 4 Volts are not recommended for proper use of the DNGP. The user should note that wire size increases as the gauge of wire decreases. Refer to table 2.0 for all pertinent voltage information.

Table 2 - Wire Size, Wire Resistance, and Voltage Drop Information 1,2,3,4

Wire Size	Resistance per 1000 ft	Length of Wire (one way) for 4 Volts Drop
18 AWG	8.45 Ohms	240 Feet
16 AWG	5.29 Ohms	380 Feet
14 AWG	3.26 Ohms	610 Feet
12 AWG	2.05 Ohms	980 Feet
10 AWG	1.29 Ohms	1550 Feet

1 - Check with wire manufacturer for more accurate resistance data.

2 - Adding multiple DNGP's to a single pair of power wires will increase the voltage drop proportionally.

3 - Voltage drops greater than 4 volts are not recommended.

4 - Actual resistance of wire may differ based on wire characteristics and manufacturer.

Logic Board & Wiring Diagram

The DNGP is equipped with two terminal boards. Terminal board #1 has 10 connections and terminal board #2 has 14 connections. Terminal board #2's connections are associated with the main user interface signals (limit switches, power inputs, position feedback inputs, etc.), while terminal board #1 applies to other interface signals (transmitter position inputs, solenoid inputs, heaters, etc.). A complete logic board layout, and wiring guide for both terminals is given on pages 6 and 7 respectively.

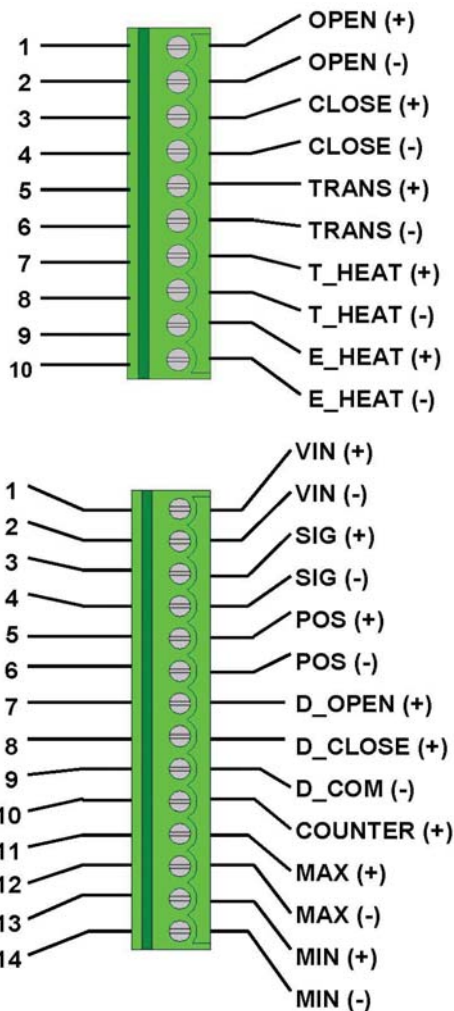


Figure 2 - Terminal Board #1 (10 Pins) & Terminal Board #2 (14 Pins)

Note 1: Check RTU manual for correct polarity before connecting to terminal.
 Note 2: Jumper must be installed between pins 5 & 6 if feedback is not connected.

Jumpers & Fuses

A look at the logic board layout on page 7 shows the location of the jumpers JP1 and JP2. The selection of the jumpers depends on the power of the transmitter. If the transmitter doesn't need external power, select JP1 - 1, 2. If the transmitter needs external power, select JP1 - 2, 3, or remove the jumper. The jumper JP2 functions only as a spare replacement for JP1. There are 4 fuses on the DNGP logic board. The first fuse F1 is 0.1 Amperes, and serves as the PTC fuse for a 4-20 mA signal current loop. F2 is 0.1 Amperes, and serves as the PTC fuse for a 4-20 mA transmitter/ positioner current loop. The fuses F1 and F2 are resettable. F3 is a 3 Ampere fuse for the voltage input power. Finally, F4 is a 3 ampere replacement fuse for F3.

- Open Solenoid Output (+)
- Open Solenoid Output (-)
- Close Solenoid Output (+)
- Close Solenoid Output (-)
- Transmitter Position Input (+); 4-20 mA Current Loop
- Transmitter Position Input (-); 4-20 mA Current Loop
- Transmitter Heater (+) → (Also used as power to Linear Digital Transmitter)
- Transmitter Heater (-)
- Enclosure Heater (+)
- Enclosure Heater (-)
- Power Input (+); 12-24 VDC → (Verify solenoid valve voltage)
- Power Input (-); 12-24 Return
- RTU Position Input (+); 4-20 mA Current Loop
- RTU Position Input (-); 4-20 mA Current Loop
- Position Feedback Input (+); 4-20 mA Current Loop → See Note*
- Position Feedback Input (-); 4-20 mA Current Loop
- Discrete Open Input (+); 12-24 VDC → (Verify solenoid valve voltage)
- Discrete Close Input (+); 12-24 VDC
- Discrete Open/Close Common (-); 12-24 Return
- Pulse Output (+); Referenced VIN Power Ground
- Maximum Limit Switch Output (+)
- Maximum Limit Switch Output (-)
- Minimum Limit Switch Output (+)
- Minimum Limit Switch Output (-)

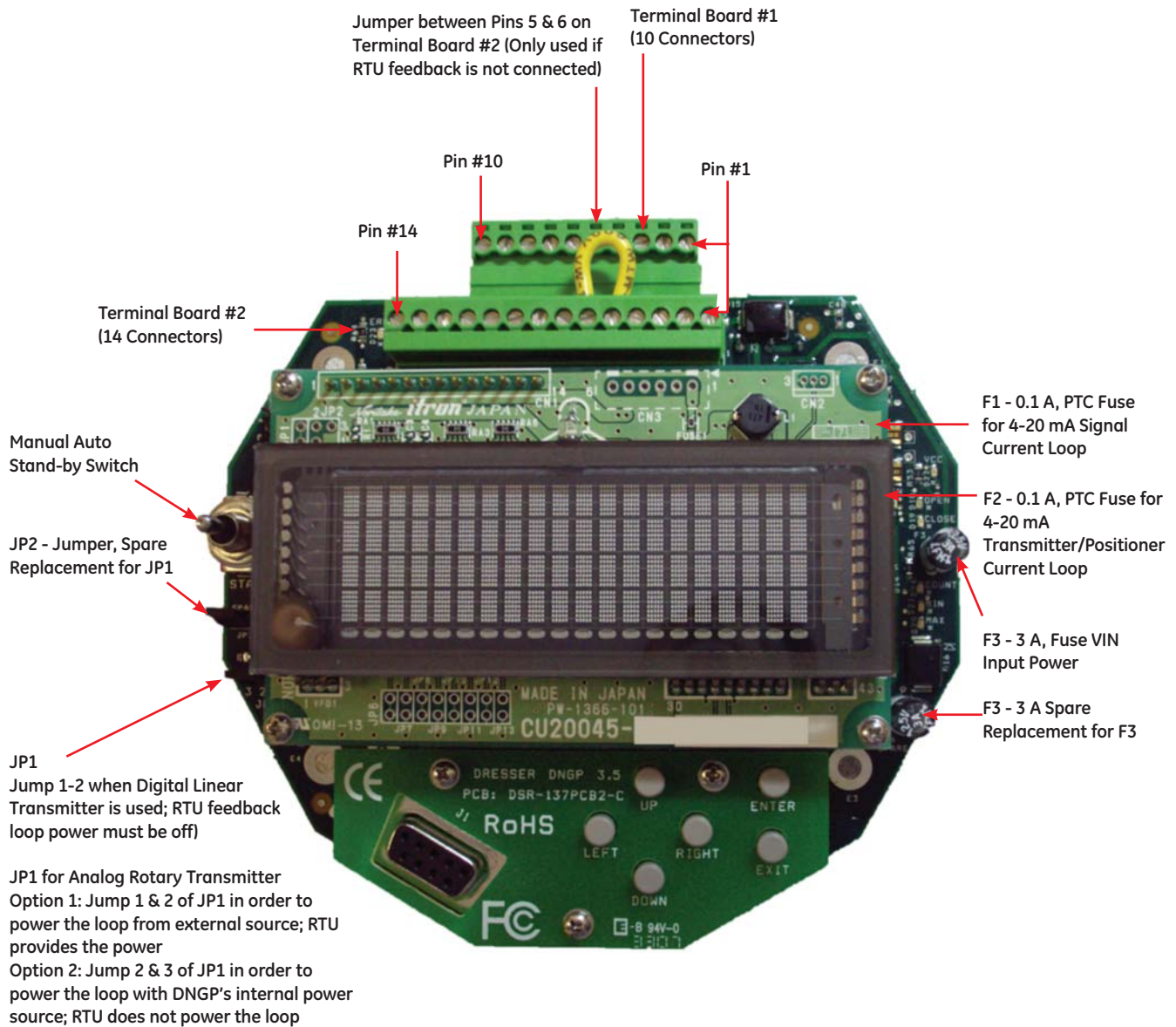


Figure 3 - DNGP Logic Board Layout

Orifice Adjustment

Orifices at each of the cylinder ports (double acting) or flow control valve (single-acting) control the flow of gas into the actuator, and therefore, the speed at which the valve moves.

Initially, both orifices should be set at maximum value. If more precise valve positioning is required for the application, decrease the orifice settings, one or two numbers at a time, and readjust the sensitivity. Because the valve will be moving slower, a smaller dead

Table 3 - Orifice Part Numbers

Orifice Size "Marking"		Part #
Standard (No Mark)	Assembly	25-1559
	Orifice Only	25-1040
Medium "M"	Assembly	25-8162
	Orifice Only	25-8075
Large "L"	Assembly	25-8163
	Orifice Only	25-8076

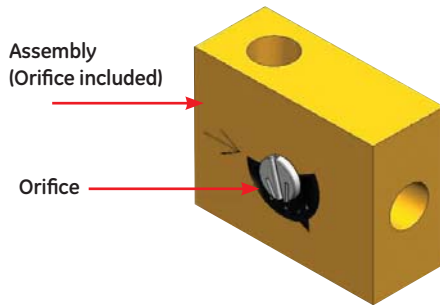


Figure 4 - Variable orifice assembly (standard assembly shown)

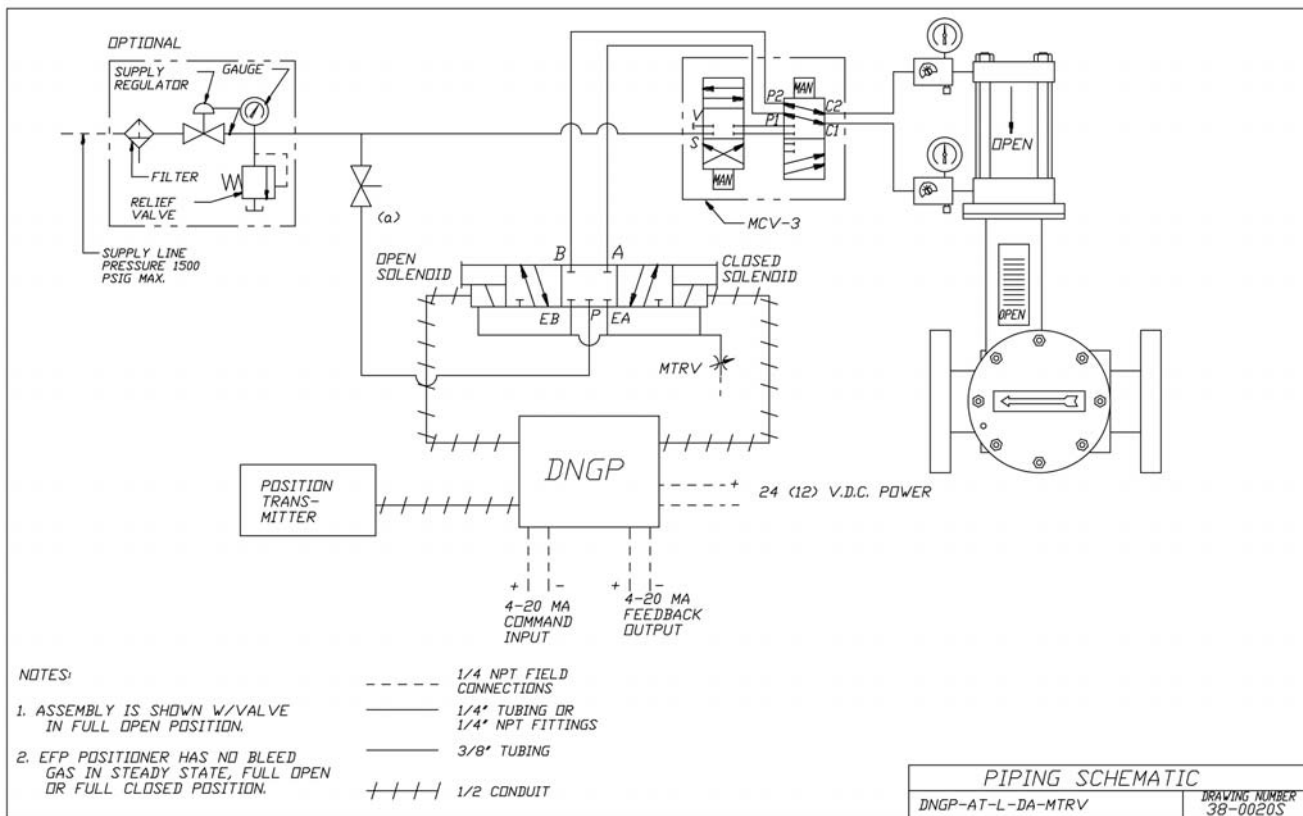


Figure 5 - For 2" & 3" valves an additional backpressure valve (metering valve) is used.

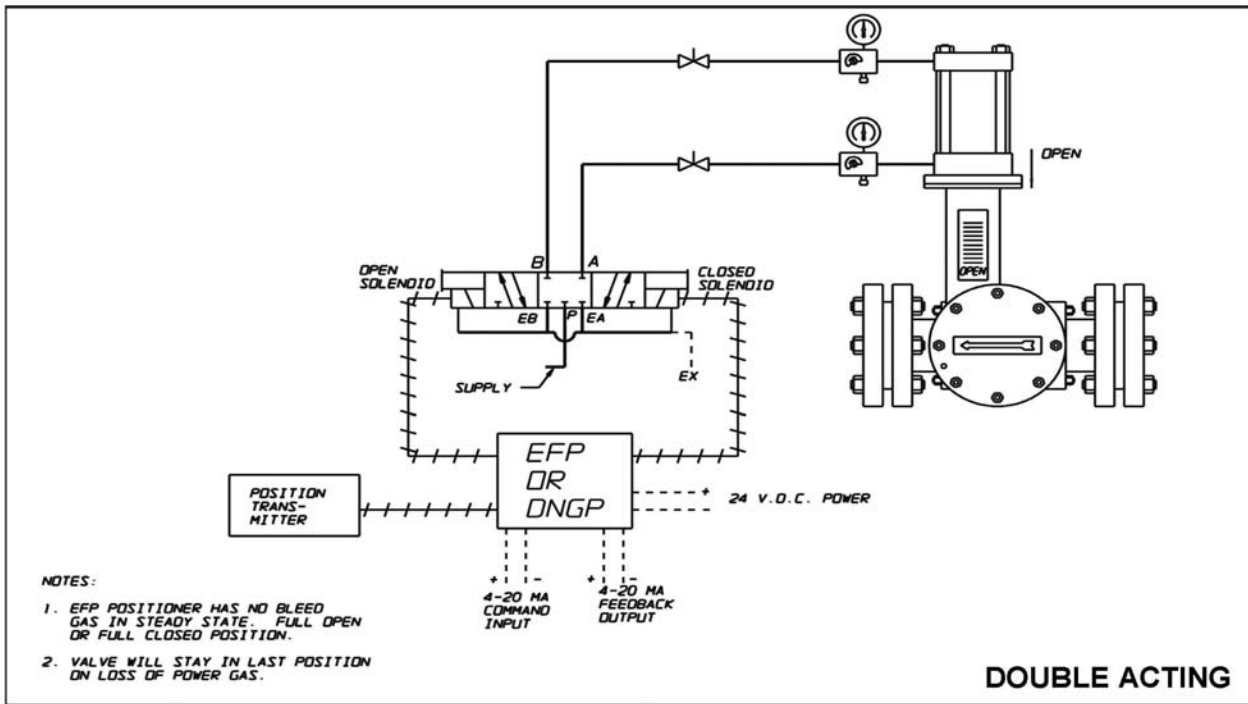


Figure 6 - 4" to 12" valves are used with "M" orifice blocks, 14" & 16" valves are used with "L" orifice blocks

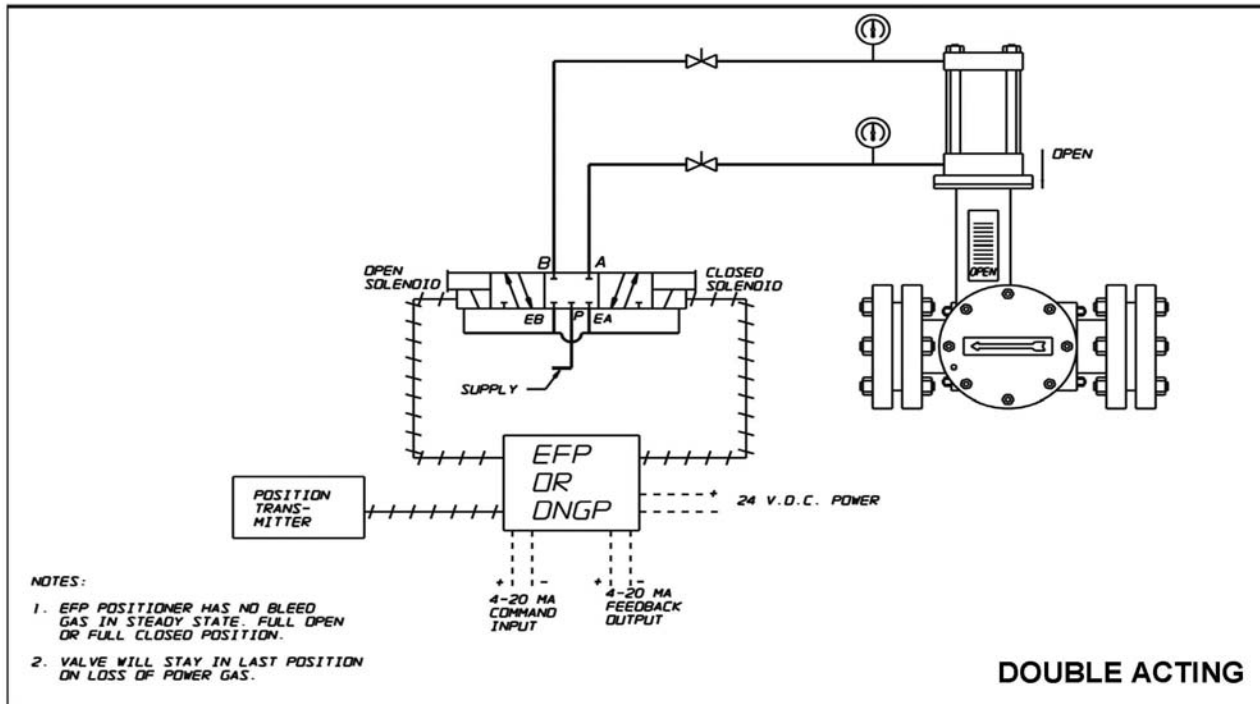


Figure 7 - For valves > 16" no orifices are needed.

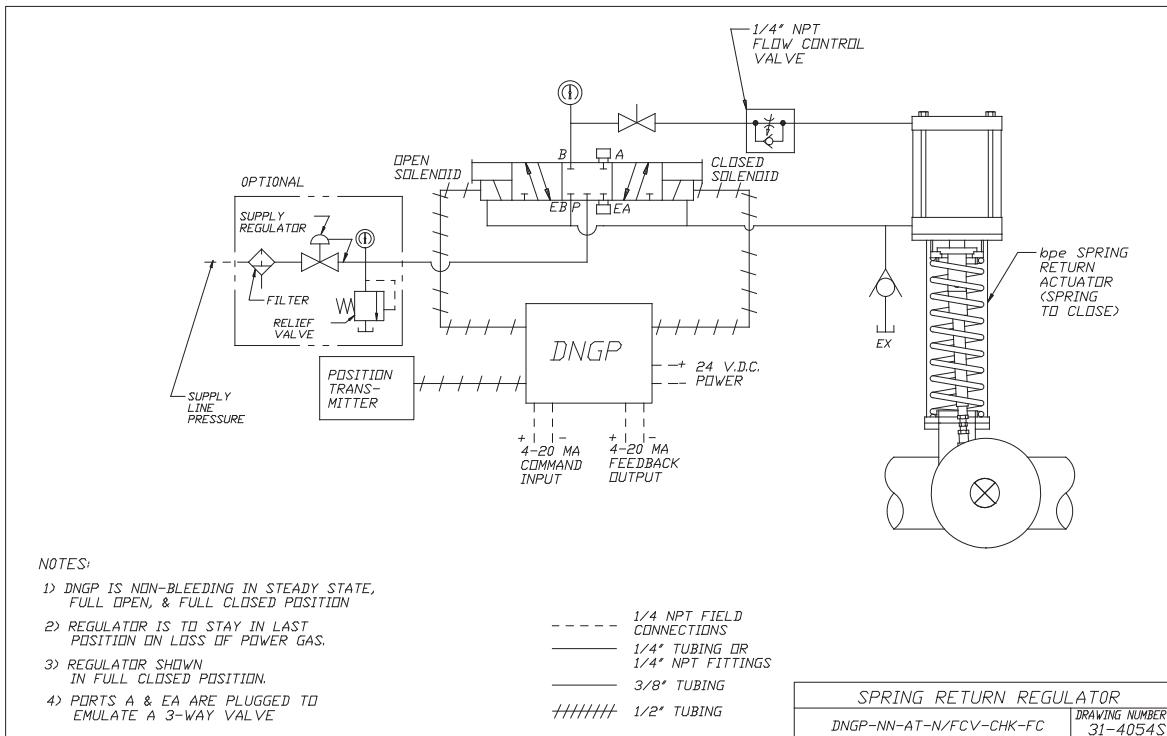


Figure 8 - Single Acting Control Valve, $P_{SUPPLY} \geq 50$ Psig

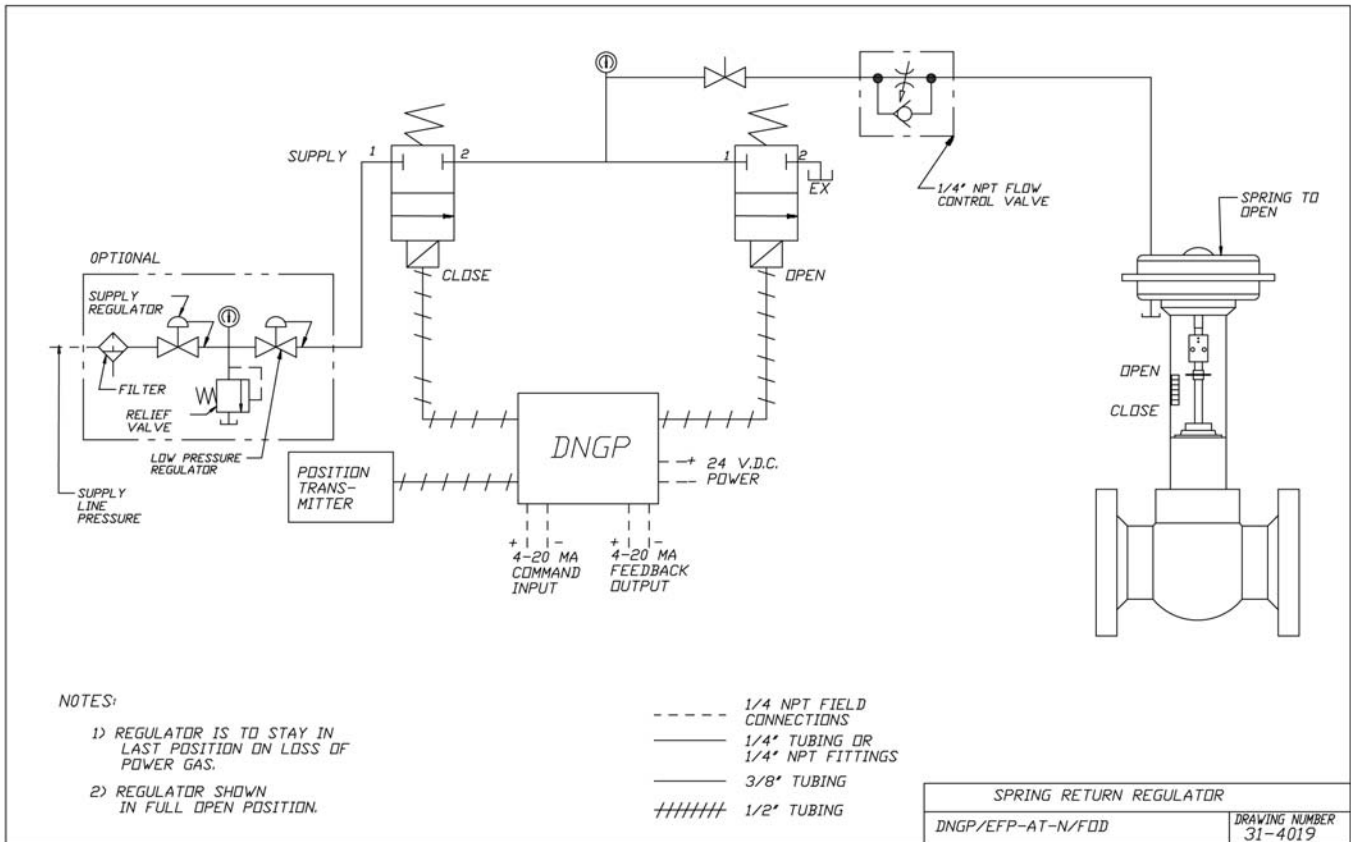


Figure 9 - Single Acting Control Valve, $P_{SUPPLY} \leq 40$ Psig

Electro-Pneumatic Positioner Pressure Control Override*

Conventional flow control with PCO (Pressure Control Override) is accomplished by sending a signal to the positioner from an I/P transducer or pneumatic controller. A HIGH SELECT RELAY determines if the positioner is controlled by the pneumatic controller (pressure control) or the I/P (flow control).

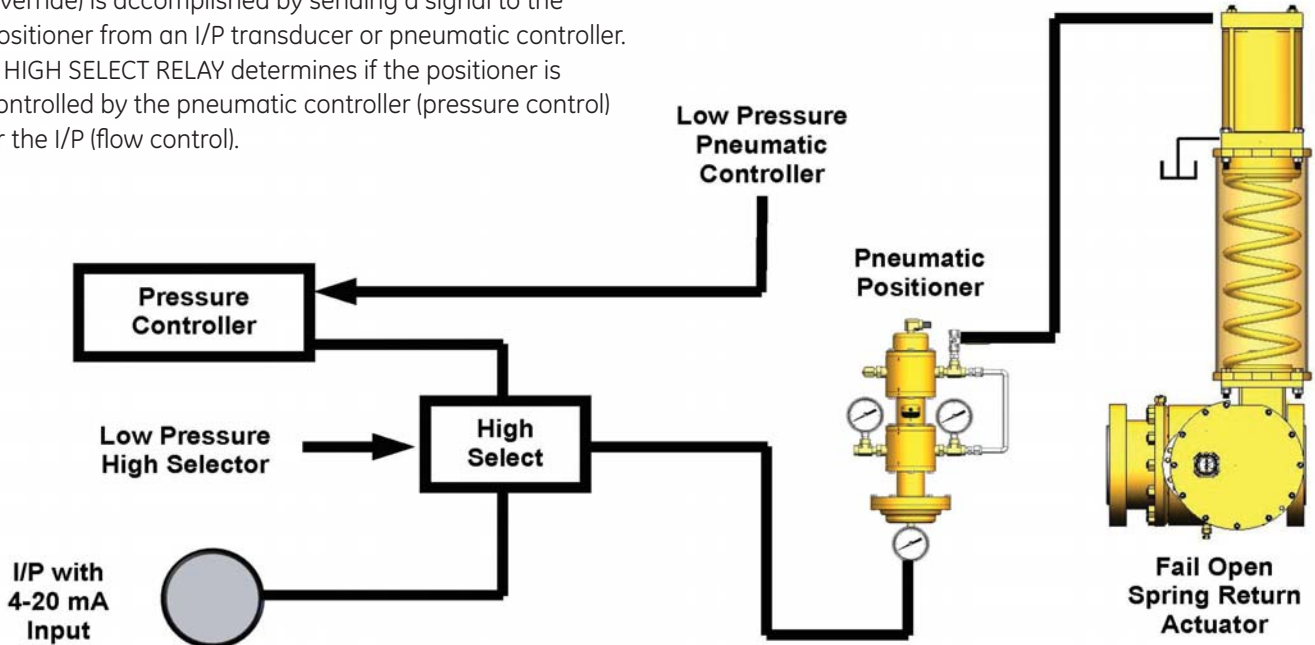


Figure 10 - Conventional Flow Control with Pressure Control Override (PCO)

By exchanging the I/P with an electro-pneumatic positioner, the pneumatic positioner can be eliminated. Using the DNGP for the electro-pneumatic positioner allows the unit to fail open, closed, or in last position on loss of 4-20 mA signal. Becker high pressure VRP pilots and Becker high pressure HIGH/LOW selector relays ideally complement the DNGP electro-pneumatic positioner for high or low pressure override.

*For double acting systems, Becker double acting pilots are used. See the sampling of pneumatic schematics for specific pressure control override applications on the next two pages.

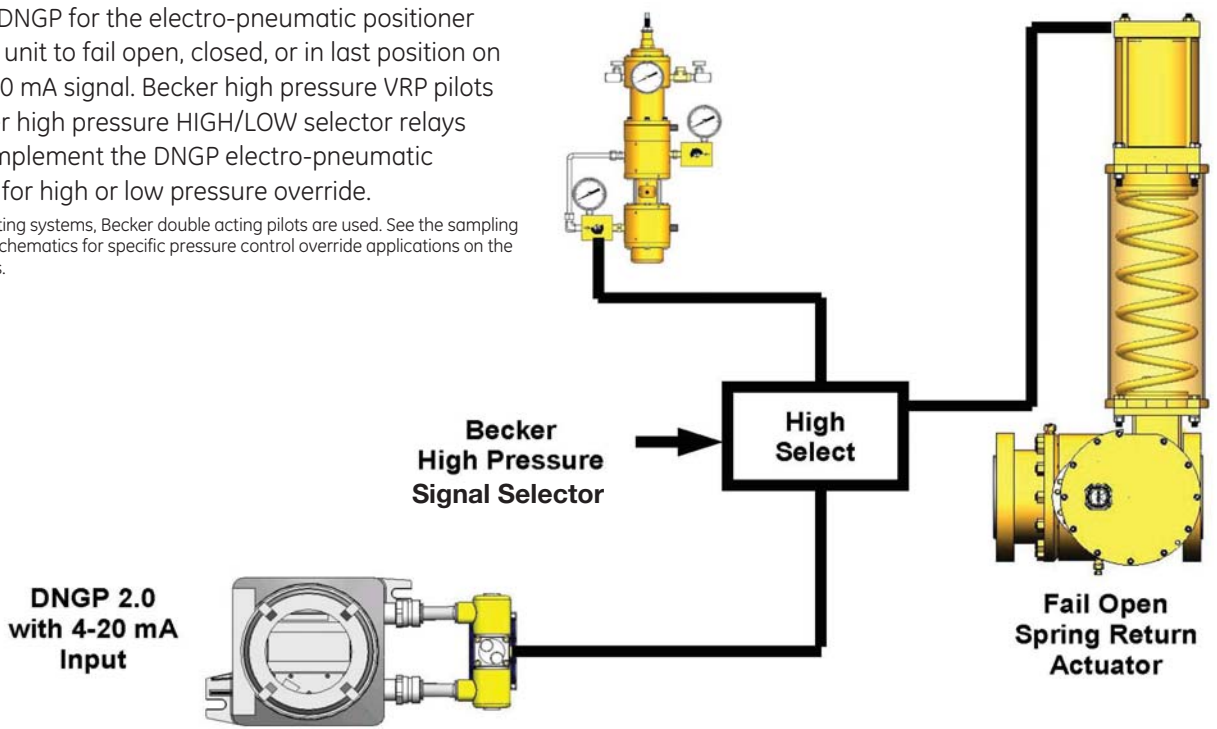


Figure 11 - Flow Control with Electro-Pneumatic Positioner and PCOH High Pressure Override

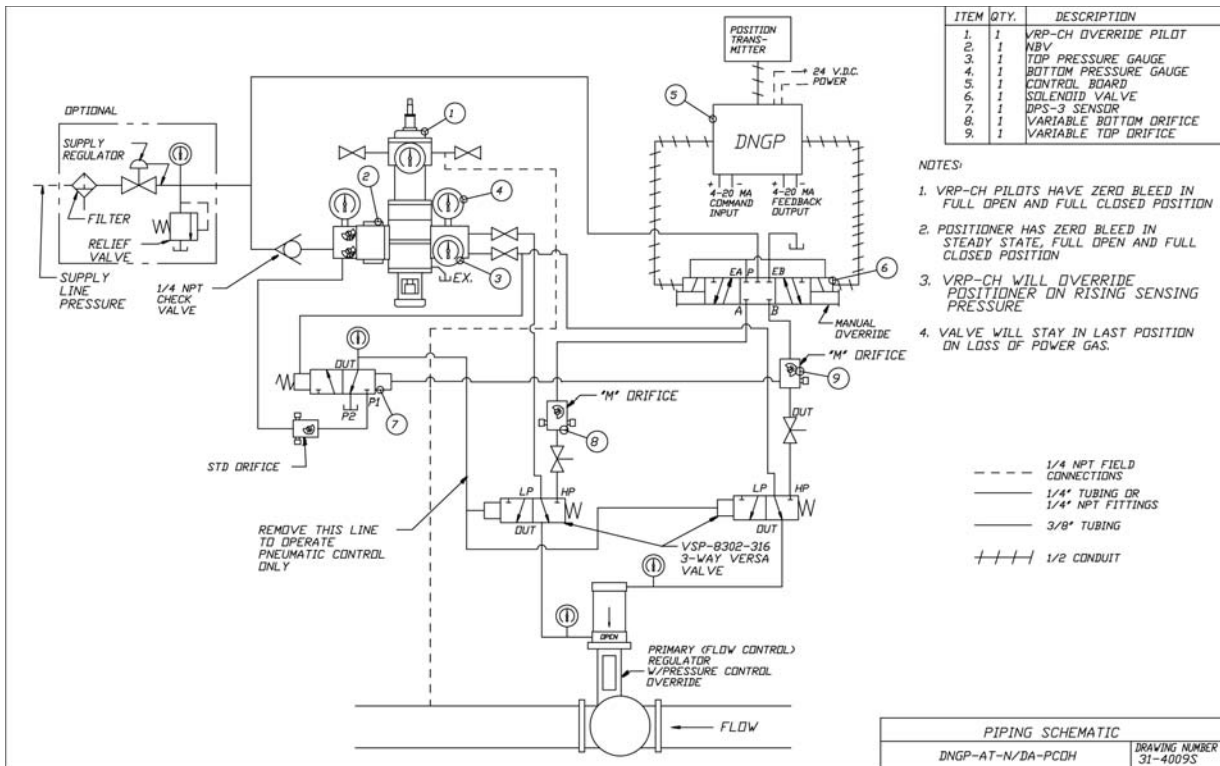


Figure 12 - Double Acting Control Valve with PCO, $P_{SUPPLY} \geq 50$ Psig (High Pressure Override)

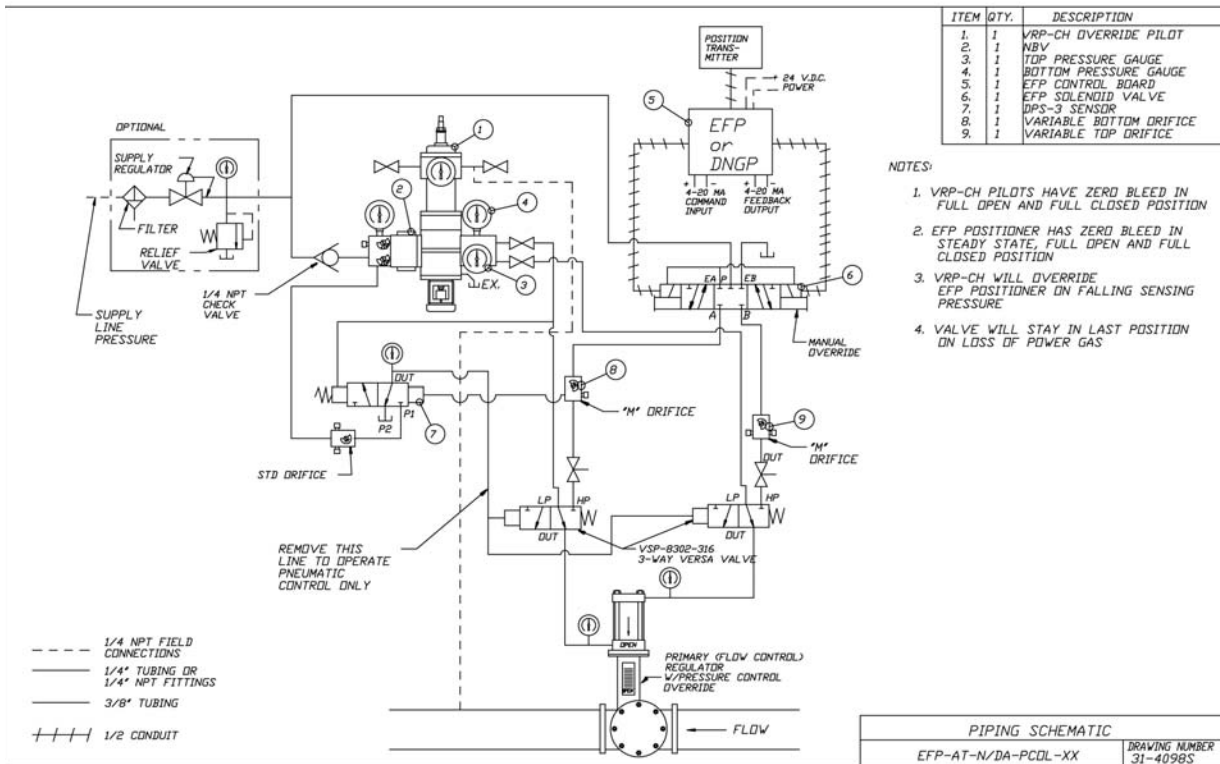


Figure 13 - Double Acting Control Valve with PCO, $P_{SUPPLY} > 50$ Psig (Low Pressure Override)

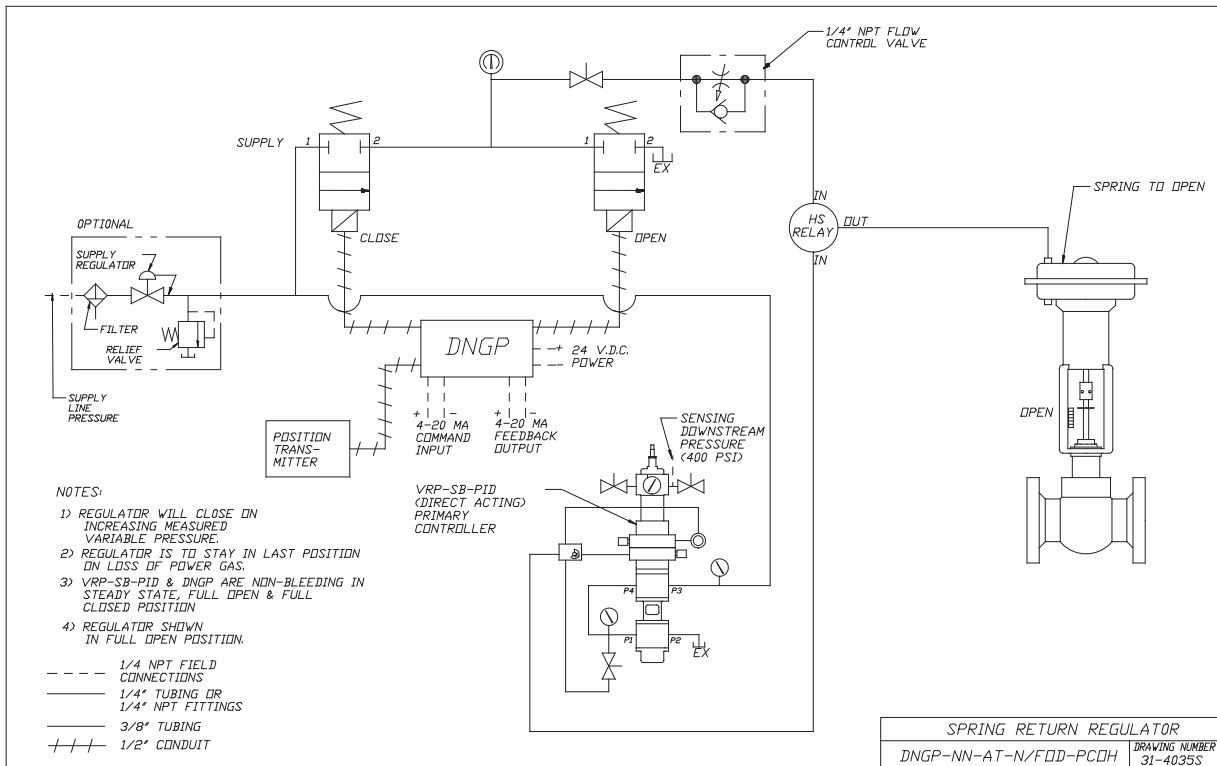


Figure 14 - Single Acting Control Valve with PCO, $P_{SUPPLY} \geq 40$ Psia

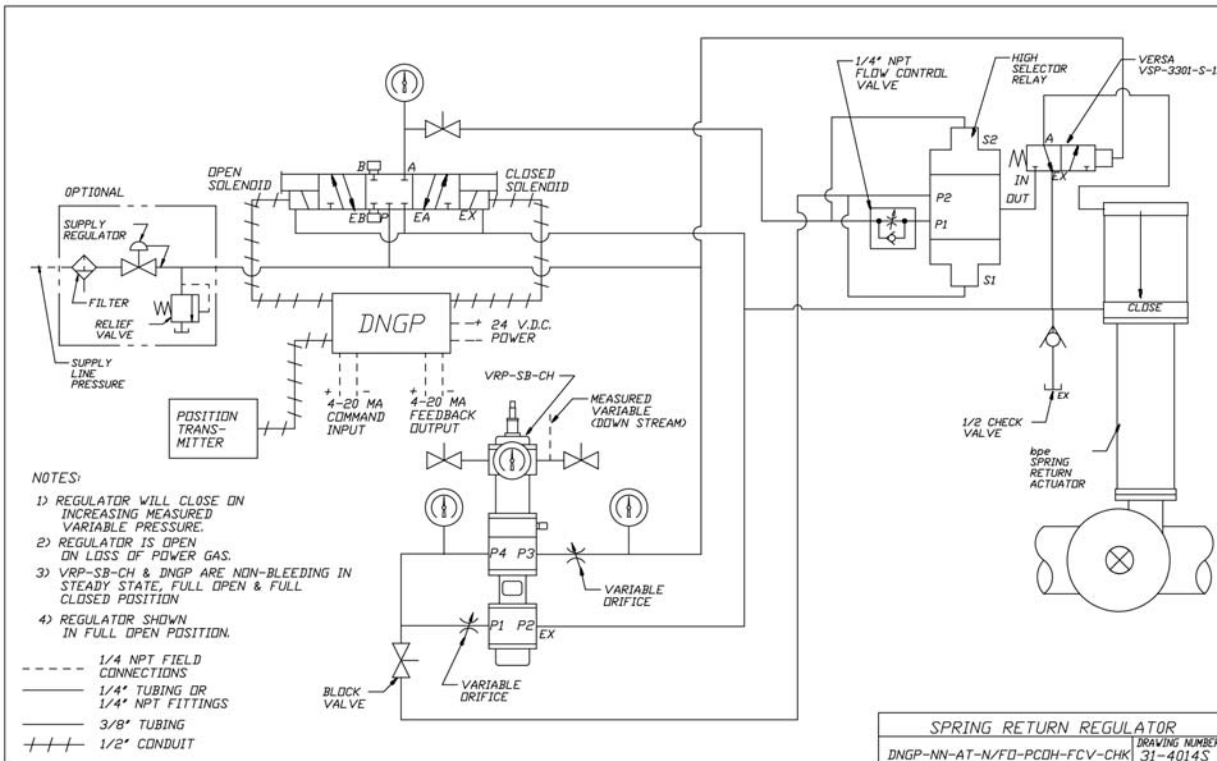


Figure 15 - Single Acting Control Valve with PCO, $P_{SUPPLY} > 50$ Psia

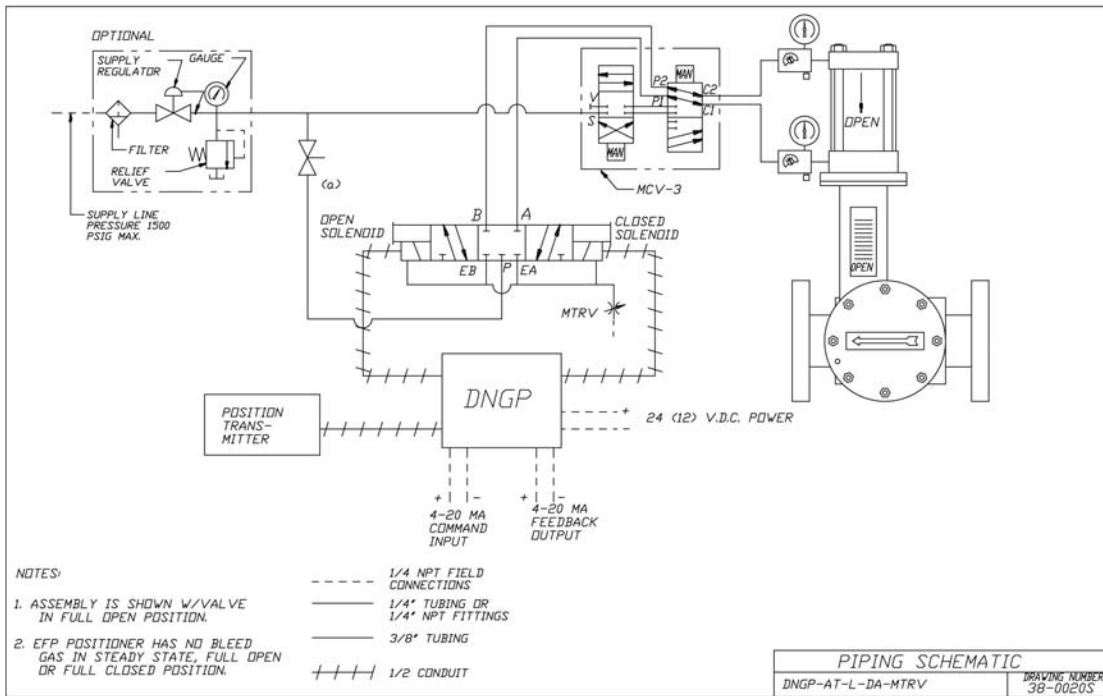


Figure 16 - Rotary Piston Spring To Close Actuator with High Pressure 3/2 solenoid valve P_{SUPPLY} 40 - 150 psig

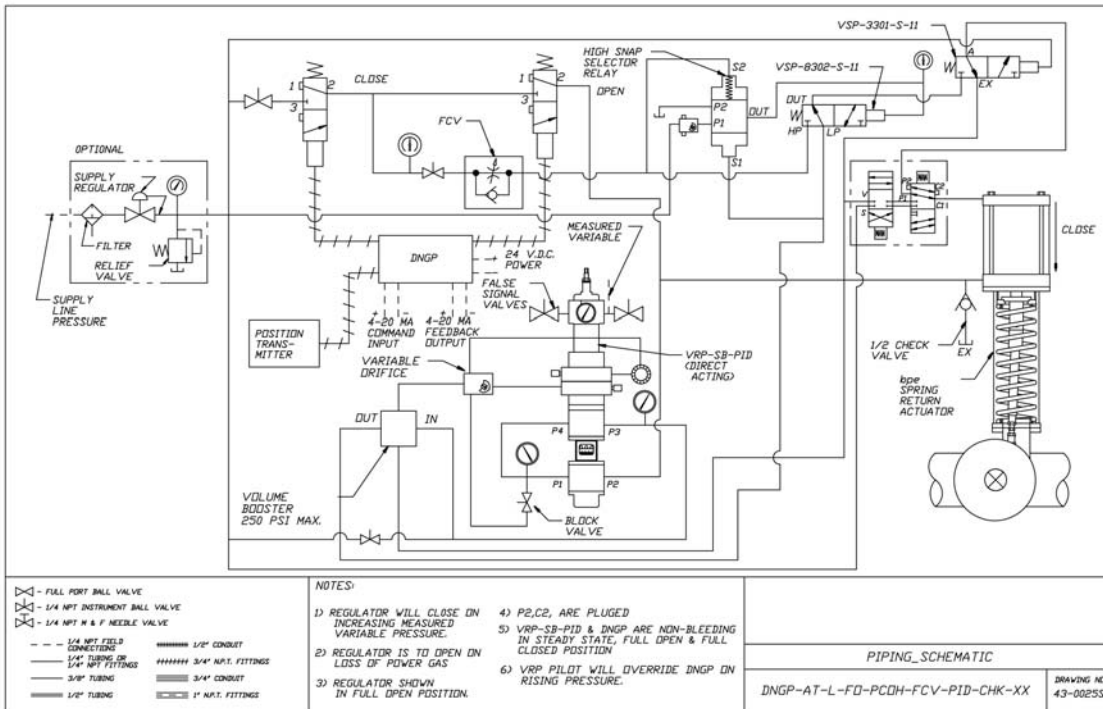


Figure 17 - Rotary Piston Spring To Open Actuator with Pressure Control Override, P_{SUPPLY} 40 - 150 psig

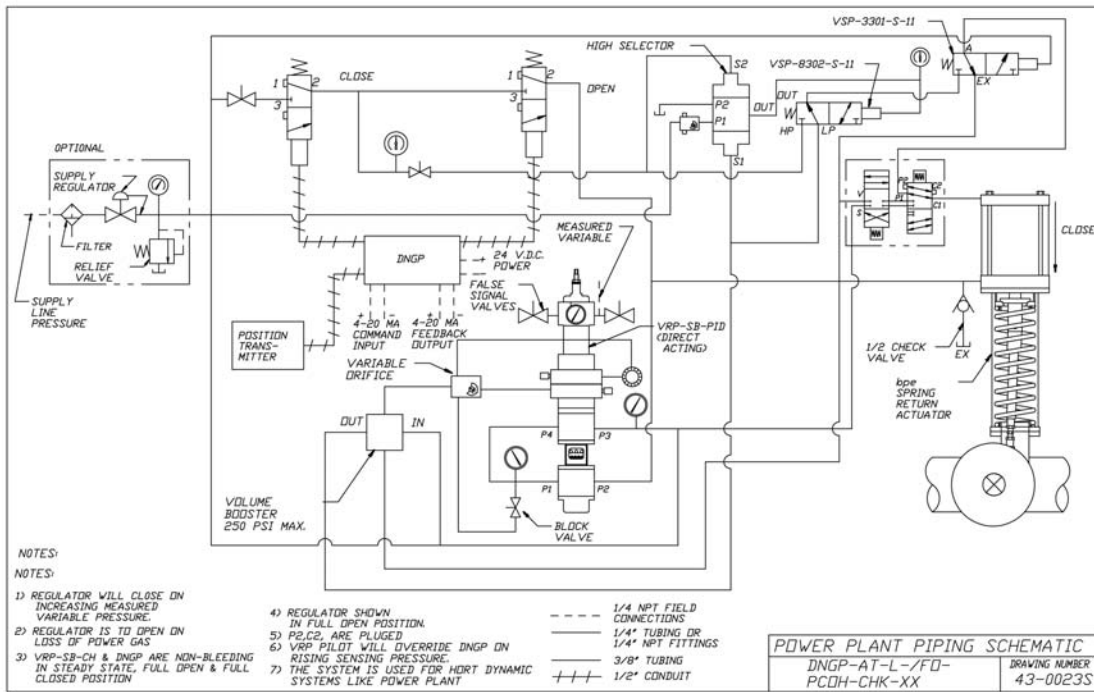


Figure 18 - Rotary Piston Spring Return Actuator with Snap Acting Selector Relay, P_{SUPPLY} 40 - 150 psig
 For Short Dynamic Systems such as Power Plants

Notes:

- 1) REGULATOR WILL CLOSE ON INCREASING MEASURED VARIABLE PRESSURE.
- 2) REGULATOR IS TO OPEN ON LOSS OF POWER GAS
- 3) VRP-SB-CH & DNGP ARE NON-BLEEDING IN STEADY STATE, FULL OPEN & FULL CLOSED POSITION
- 4) REGULATOR SHOWN IN FULL OPEN POSITION.
- 5) P2, P3, ARE PLUGED
- 6) VRP PILOT WILL OVERRIDE DNGP ON RISING SENSING PRESSURE.
- 7) THE SYSTEM IS USED FOR HDRT DYNAMIC SYSTEMS LIKE POWER PLANT

DNGP with Rotary Position Transmitter (Standard)

The Rotary Position Monitor is used in conjunction with the DNGP. This polarity independent, transient protected, transmitter can operate with any voltage from 5 to 38 volts DC. CW and CCW rotation is easily accommodated as well as long cable runs and multiple receivers. It has an easy set up, non-interactive adjustment, and is available in 4-20 mA. For information on installation, calibration, and wiring diagrams please refer to appendix A of this manual. The rotary transmitter incorporates a 1/4% precision potentiometer specifically design for DNGP positioner.

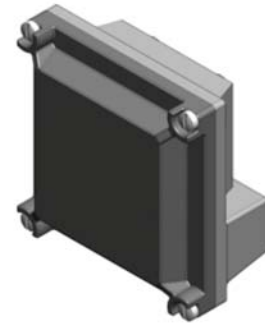


Table 4 - Rotary Transmitter Technical Specifications

Heater Power	12 - 24 Volts DC
Operating Temperature Range	-40 °F to 185 °F
Recommended Power	Loop Power 4-20 mA
Output Signal Range	4 to 20 mA DC
Load Impedance	0-950 Ohms at 24 Volts DC
Output Current Limit	Internally limited to 33 mA
Ambient Temperature	For a 100 °F change in ambient temperature, the maximum zero shift is ±0.3% and the maximum span shift is ±0.4% of span
Rotation Range	45° - 95°
Linearity	±1.0%
Hysteresis	1% of full scale
Repeatability	±0.3% of full scale

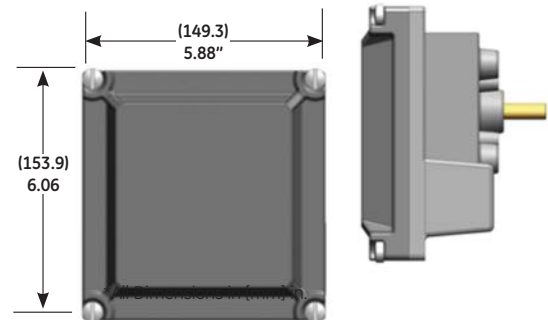


Figure 19 - Overall Dimensions of Rotary Transmitter

Rotary Transmitter 4-20 mA Calibration Procedure

1. Mount the rotary transmitter to the actuator. Set limit switches if supplied per instructions provided with unit.
2. Connect a Loop Power source to terminal points 1 & 2. The multi-meter (set for mA readings) must be connected in series with the terminal one (refer to unit wiring diagram for the standard setup procedure)
3. Stroke the valve to fully clockwise extreme.
4. Depress the main shaft gear disengaging it from its locking position, take extreme care Not to turn the main shaft gear, in order to maintain proper switch settings.
5. With main shaft gear depressed turn the transmitter gear to the fully counterclockwise position, and note the reading (mA) of transmitter. Next, turn the transmitter gear clockwise until the transmitter reading changes no more than 0.5 mA from previous reading. Renegade gears (if equipped with mechanical switches, depress switch plunger to allow gear to engage).
6. Turn the clockwise mA adjustment screw to adjust the transmitter reading to the desired output for this valve position (typically this is 4 mA or 20 mA).
7. Stroke the valve to the fully counter-clockwise extreme.
8. Turn the counter-clockwise mA adjustment screw to adjust the transmitter reading to the desired output for this valve position (opposite of step 6).
9. Stroke the valve between the full clockwise and counter-clockwise positions checking and readjusting the (mA) output as necessary.

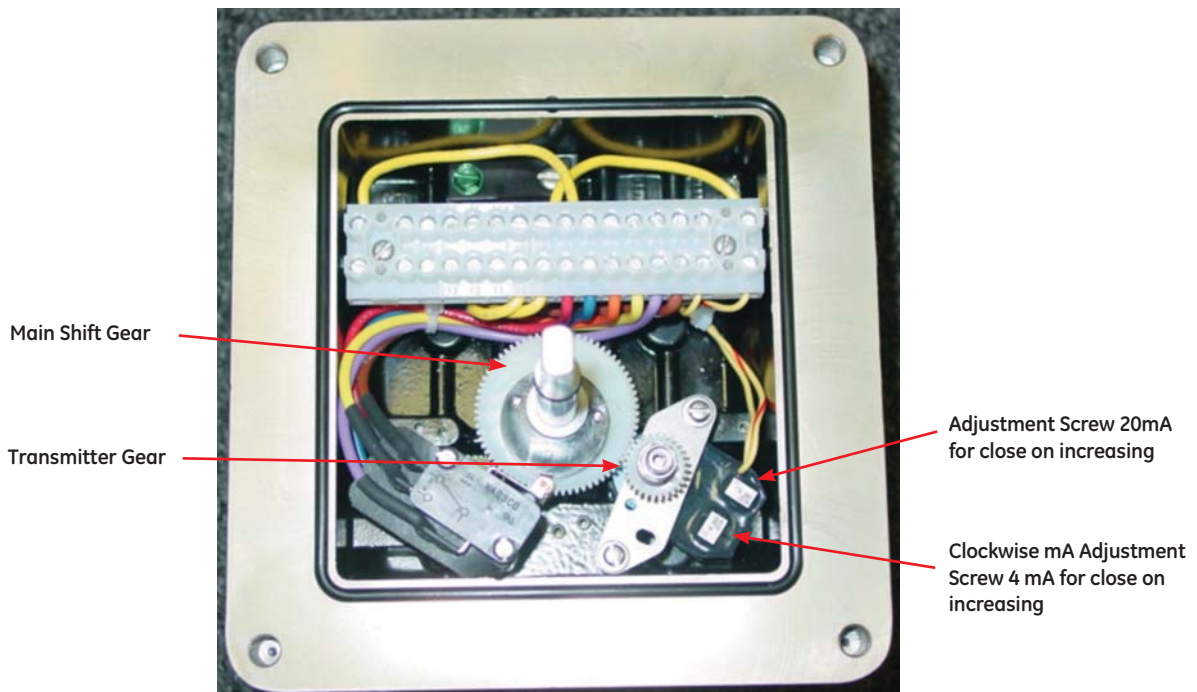


Figure 20 - Components of Rotary Transmitter or Calibration Procedure

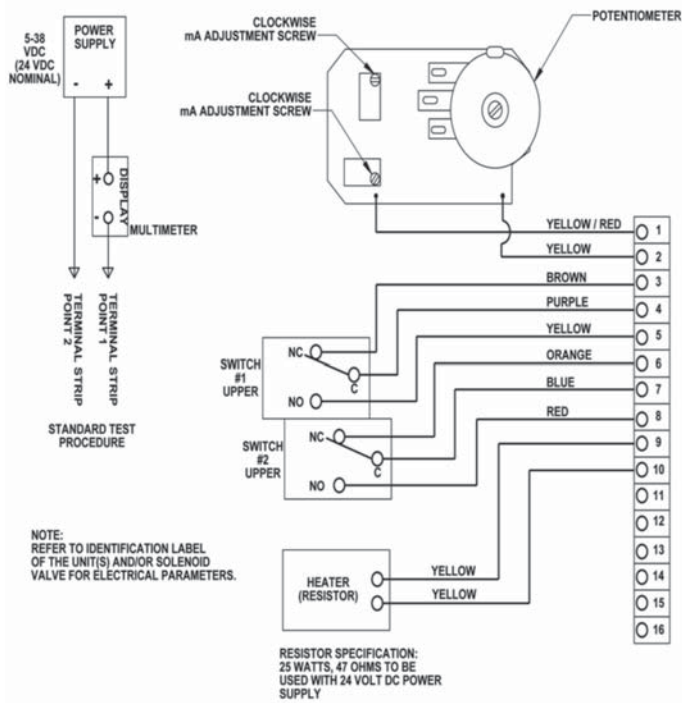


Figure 21- Rotary Transmitter Wiring Diagram

Jumper Settings for DNGP with Rotary Transmitter

Option 1.

Jump 1 & 2 of JP1 in order to power the loop from external source; RTU provides the power.

Option 2.

Jump 2 & 3 of JP1 in order to power the loop with DNGP's internal power source; RTU should not power the loop.

DNGP with Linear Transmitter Assembly (Tail Rod & Standard Configurations)

A linear digital proximity transmitter will be used whenever linear motion is available. These transmitters offer high resolution with a non-contact proximity design. The linear transmitter is available in a tail rod or standard configuration. Figure 22 indicates the major components in a typical tail rod configuration, while in Figure 24 the same concept is used to show the standard configuration.

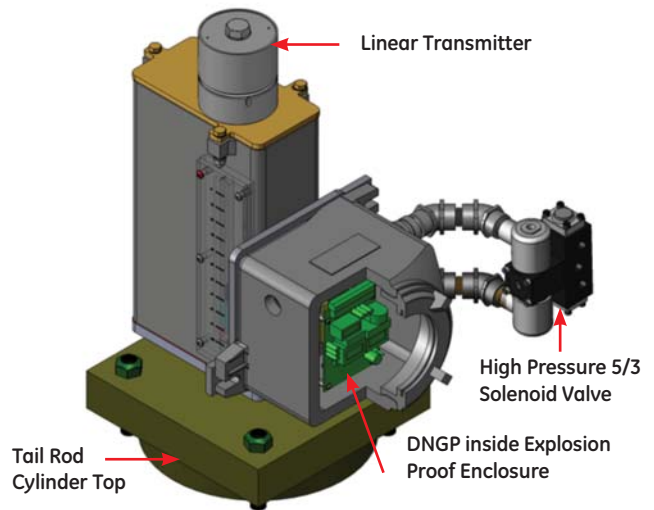


Figure 22 - DNGP and Linear Transmitter Tail Rod Configuration

Table 5 - Tail Rod/Proportional Configuration Part Numbers

Item #	Part #	Description
1	98-3176	10-32 x 1" SHCS
2	98-2529	10-32 Hex Nut
3	31-2013	Bracket
4	98-2782	3/8" ID Lockwasher
5	98-2927	1/4-20 x 2" HHCS
6	98-3269	8-32 x 1/2" SHCS (Alloy)
7	01-8901	Magnet
8	98-3181	7/16 FT Washer (SS)
9	25-8145	Spacer
10	98-3281	7/16-20 x 3" HHCS
11	01-6592	Bushing
12	31-2014	Transmitter Block

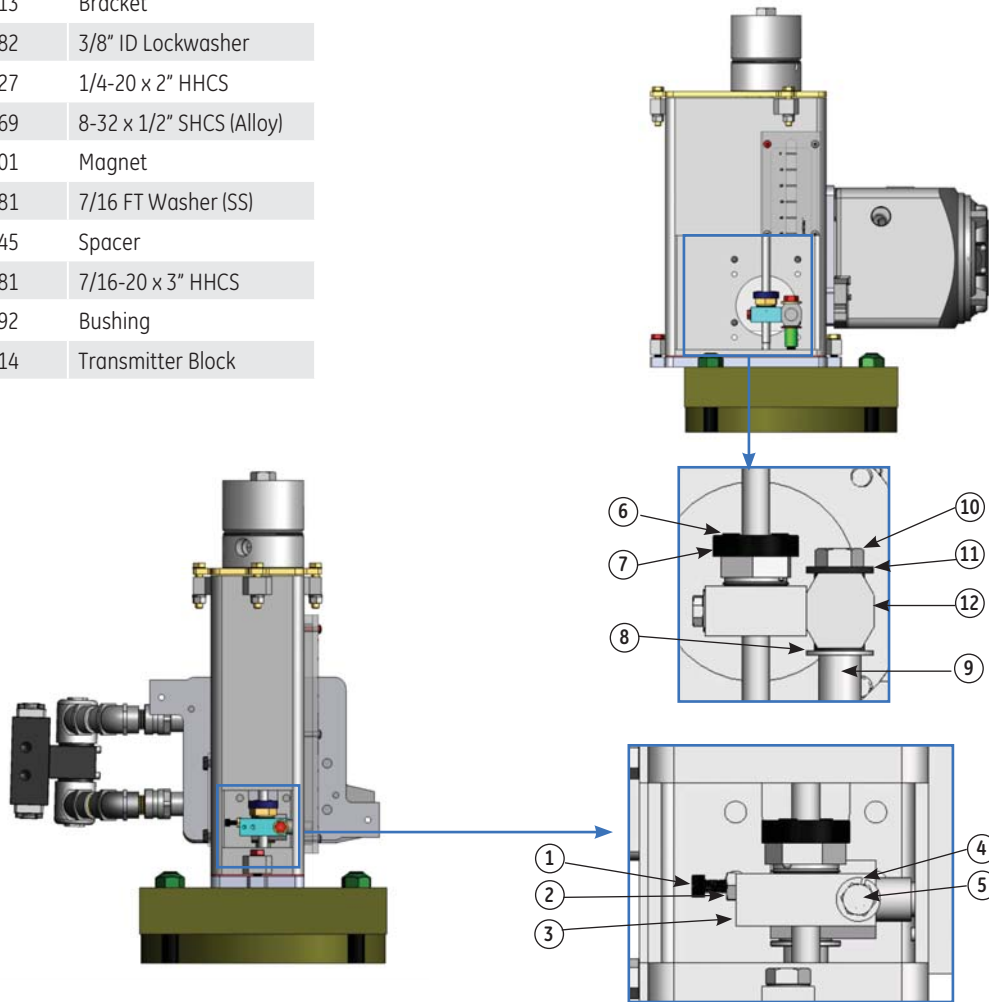


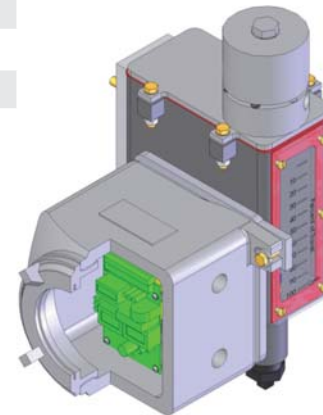
Figure 23 - Detailed View of the Linear Position Transmitter Tail Rod Transducer

Table 6 - Riser Pipe Mount Configuration Part Numbers

Item #	Part #	Description
1	31-2005	Adjusting Bushing
2	98-2614	8-32 x 1/2 SHCS (316)
3	98-2538	8-32 Hex Nut (18.8)
4	31-2004	Adjustment Block Probe
5	01-8901	Magnet
6	98-2579	1/4-20 x 1 HHCS (18.8)
7	98-2777	1/4" Lock Washer
8	98-3171	8-32 x 1/2 SHCS
9	Reference Table 7	Indicator Bar
10	98-2638	1/4-20 x 5/8 SHCS (18.8)

Table 7 - Indicator Bar Part Numbers

Cylinder	Bar Part#
6"	14-3114
8"	14-3130
10"	14-3121
12'	14-3068



NOTES:

1. Lock the screw (2) after any adjustments are completed.
2. Turn the magnet (5) with the adjustment bushing to align 4 or 20 mA.

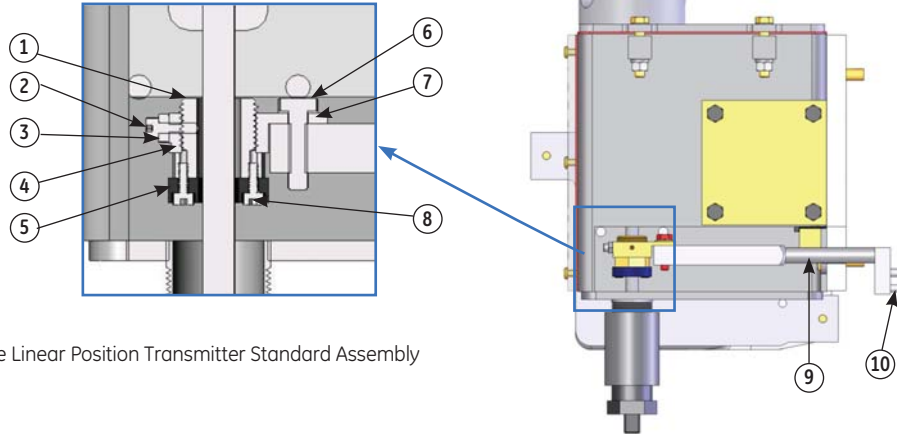


Figure 24- Detailed View of the Linear Position Transmitter Standard Assembly

WARNING: This Model Was Discontinued in 2007

Table 8 - Reversible Fixed Range Linear Position Transmitter Specifications

Measured Parameter	Specification	Analog Output
Repeatability (Resolution + Hysteresis)	Voltage-Output Versions	0.5 mV or 5 μ m (whichever is greater)
	Current-Output Versions	1 μ A or 5 μ m (whichever is greater)
Sampling Rate	For stroke lengths \leq 2000 mm	1 kHz
	For stroke lengths $>$ 2000 mm	500 Hz
Non-linearity	For stroke lengths \leq 500 mm	\pm 100 μ m
	For stroke lengths $>$ 500 mm	\pm 0.02% of full-scale
Pressure Rating (Rod)	Up to 600 bar	
Operating Temperature	-40°F to +185°F	
Supply Voltage	+24 VDC \pm 20%	
Humidity	$<$ 90% non-condensing	

WARNING: This model was discontinued in 2007

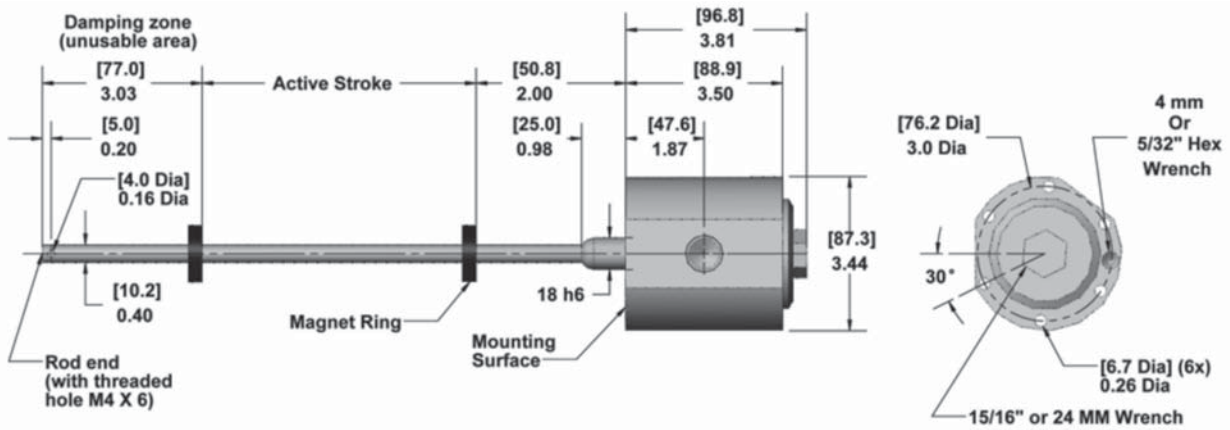


Figure 24 - Linear Transmitter Overall Dimensions

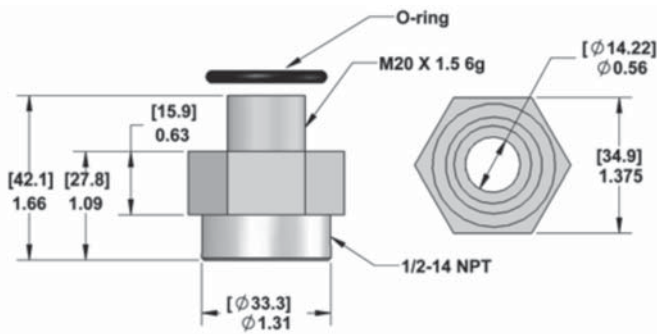


Figure 25 - Linear Transmitter Adapter Flange

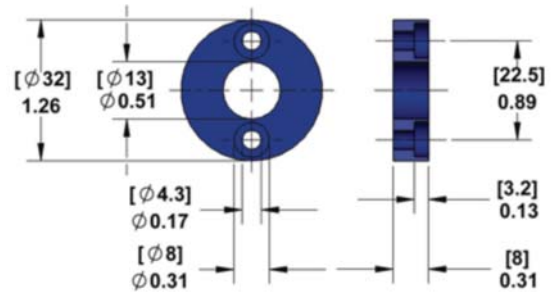


Figure 26 - Linear Transmitter Magnet

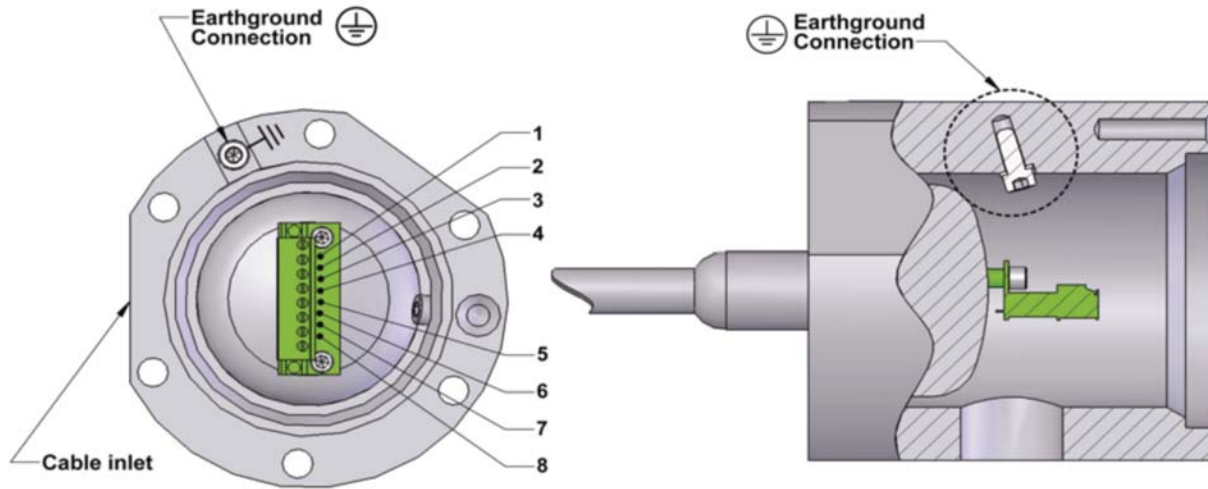


Figure 27 - Reversible Linear Transmitter Connector

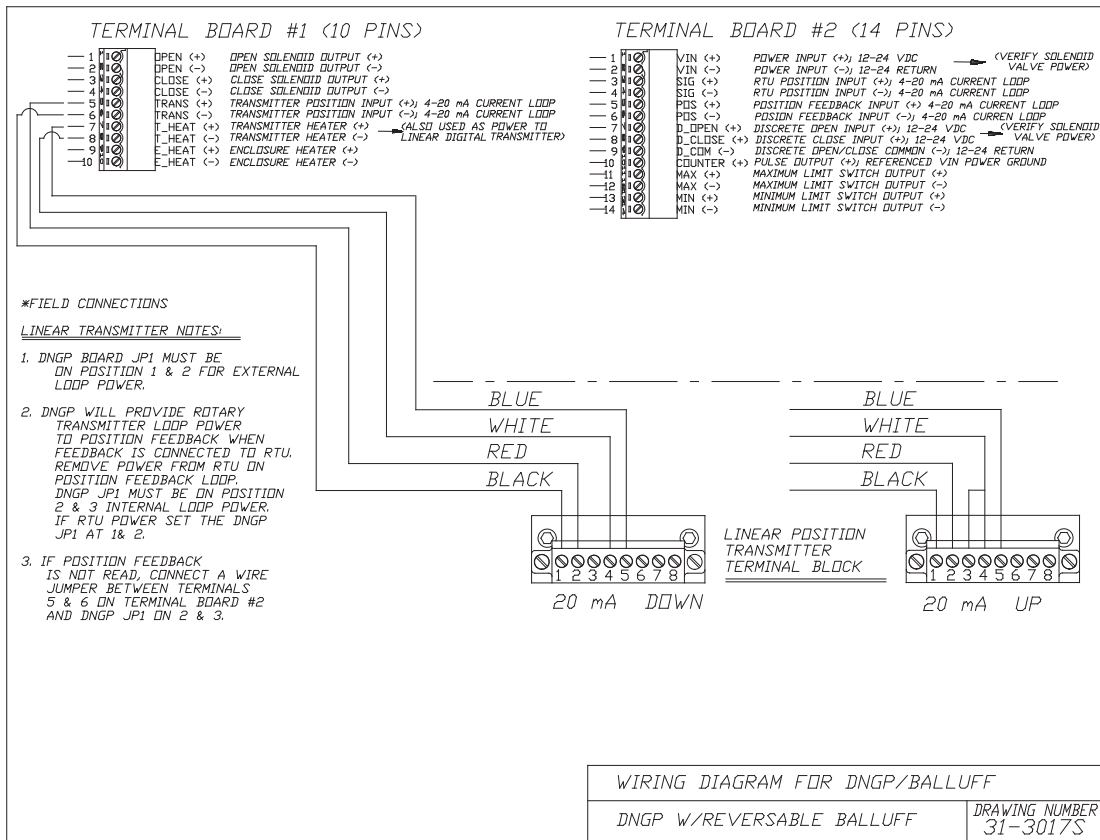


Figure 28 - Linear Transmitter Wiring Diagram

Table 9 - Programmable Linear Position Transmitter Specifications (Supplied 2006 and later)

Measured Parameter	Specification	Analog Output
Repeatability (Resolution + Hysteresis)	Voltage-Output Versions	0.5 mV or 5 μ m (whichever is greater)
	Current-Output Versions	1 μ A or 5 μ m (whichever is greater)
Sampling Rate	For stroke lengths \leq 2000 mm	1 kHz
	For stroke lengths $>$ 2000 mm	500 Hz
Non-linearity	For stroke lengths \leq 500 mm	\pm 100 μ m
	For stroke lengths $>$ 500 mm	\pm 0.02% of full-scale
Pressure Rating (Rod)	Up to 600 bar	
Operating Temperature	-40°F to +185°F	
Supply Voltage	+24 VDC \pm 20%	
Humidity	<90% non-condensing	

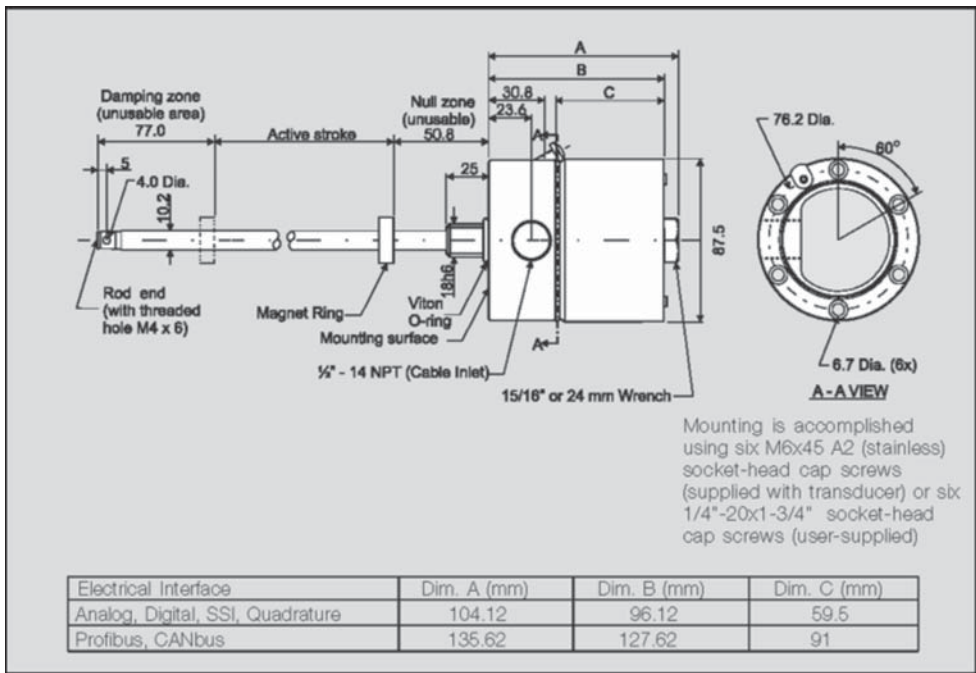


Figure 29 - Linear Transmitter Overall Dimensions

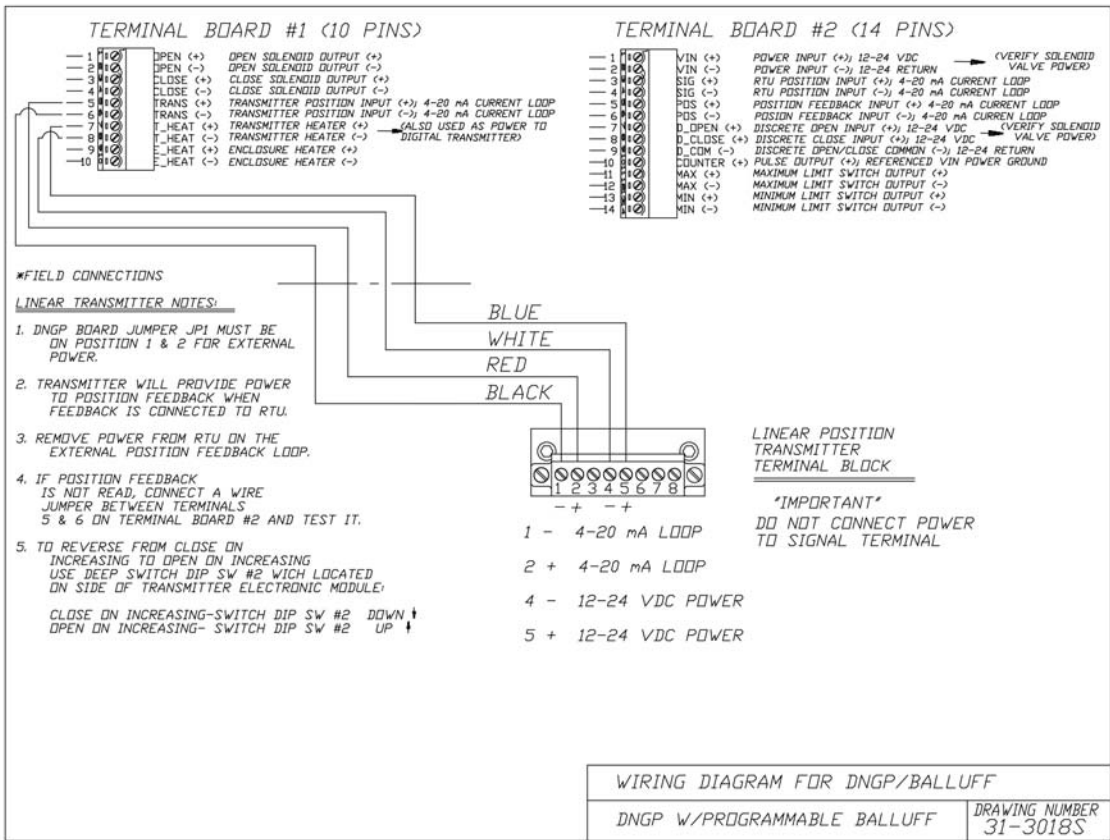


Figure 30 - Programmable Linear Transmitter Wiring Diagram

Replacing the Electronic Module of the Programmable Linear Transmitter

Step 1: Turn off the power and remove the 4 connecting wires.

Step 2: Remove the two retaining screws with a 3mm hex wrench.

Step 3: Remove the Electronic Module from the housing and shaft.

Step 4: The new transmitter Module can be either 20 mA Down or 20mA Up depending on the position of Dip Switch #2 (See Fig. 32)

To Program the transmitter to the 20mA Down mode (the 20mA signal will be generated at the end of the shaft) : Dip Switch #2 is "down" or "off"

To Program the transmitter to the 20mA Up mode (the 20mA signal will be generated close to the body) : Dip Switch #2 is "up" or "on"

Step 5: Insert the new Electronic Module back on the transmitter housing, connect the 4 wires and turn the power to "On".

Step 6: Insert the two screws with hex wrench, connect the wires and power the unit.

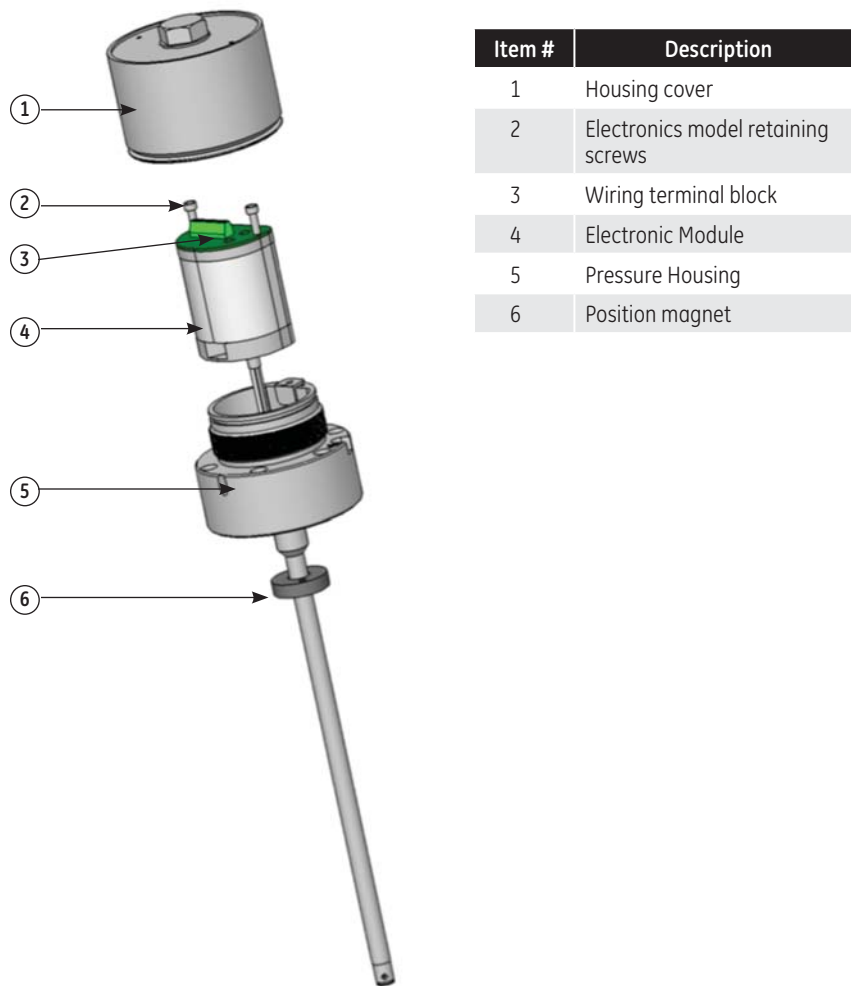
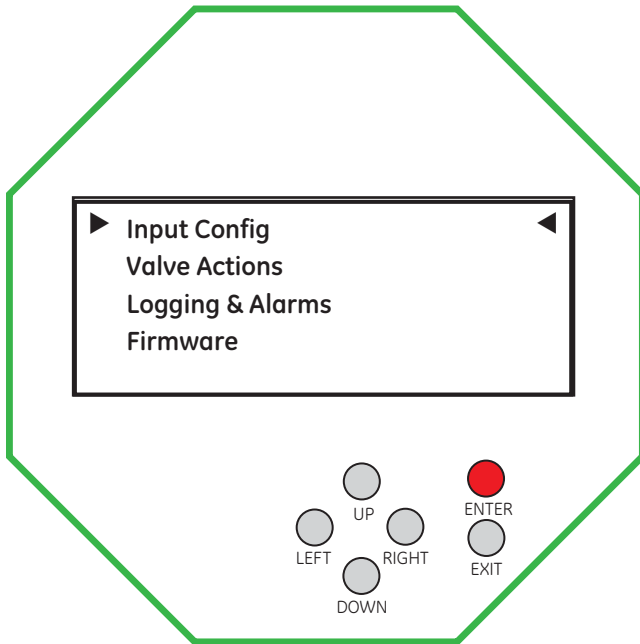


Figure 31 - Linear Transmitter (Supplies 07/01/2006 and later)

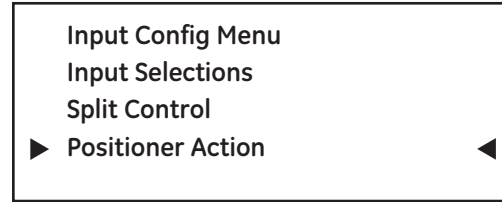
Configuring the DNGP Positioner Action

In order to change your valve from Close on Increase to Open on Increase and vice versa, access the DNGP valve state menu and the linear position transmitter as the following:

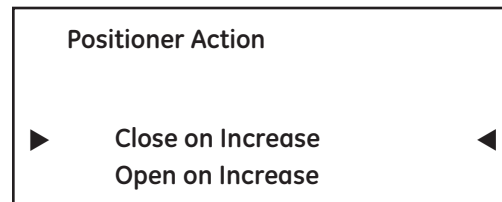
Step 1. Hit the ENTER button and go to the “Input Configuration Menu”.



Step 2. Select the “Positioner Action” option.



Step 3. Choose the desired “Positioner Action” mode. Hit ENTER. Press the EXIT button twice to go back to the main screen.



Calibrating the Linear Position Transmitter

Step 1: Open and close the valve manually using the pneumatic controller such as Becker MCV; check the FDBK reading at the DNGP. When the valve moves and the DNGP reads around 4mA at one extremity and around 20mA at the other extremity, you are ready to calibrate.

Note: In order to change the direction of the 4-20mA signal, adjust the Dip Switch #2 located on the electronic module. When Dip Switch #2 is “down” or “off”, the 20mA signal will be generated at the end of the shaft. The reverse is true when the switch is on the “on” position.

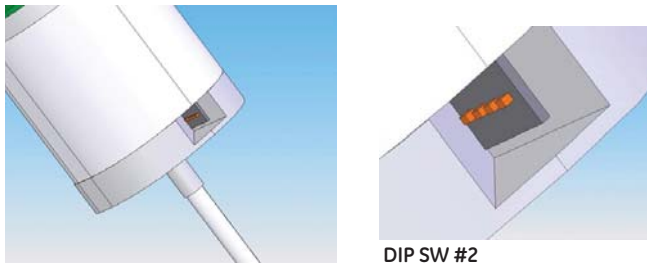


Figure 32 - Linear Transmitter Dip Switch Location

Step 2: Insert the Analog Programming Tool

Step 3: Set the Transmitter to the Program Mode.

Press the Blue button and hold for 4 sec

Press the Blue and Gray button and hold for 4 sec

Press the Blue button and hold for 4 sec

Step 4: Move the valve to the Top Position (The Position Magnet will be close to the transmitter body).

Press the Blue button and hold for 4 sec

Step 5: Move the Valve to the Bottom Position (The Position Magnet will be close to the end of the shaft).

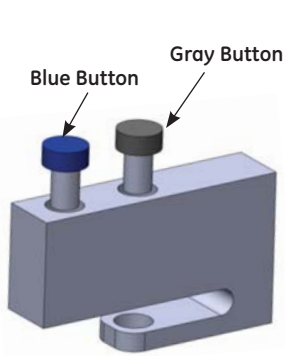
Press the Grey button and hold for 4 sec

Step 6: Release the transmitter from the Program Mode.

Press the Blue and Gray button and hold for 6 sec

Press the Blue button and hold for 1 sec

Step 7: Remove the analog programming tool from the transmitter



Part Number 01-8902

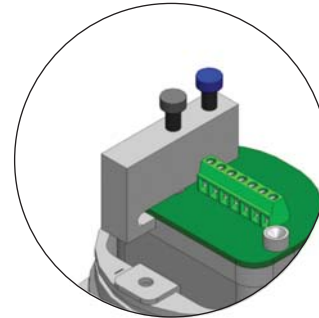


Figure 33 - Linear Transmitter Assembly with Programming Tool

Transmitter Parts

Stk.	Complete Transmitter Assembly with Electronic Module	Electronic Module
4"	01-8975	01-8980
6"	01-8976	01-8981
8"	01-8977	01-8982
12"	01-8978	01-8983

DNGP Accessories: High Pressure 5/3 Solenoid

The high pressure 5/3 solenoid is used for DNGP applications where $P_{SUPPLY} \geq 40$ psig. The 5/3 is a threaded body, double solenoid, 3 position valve with a spring centered, closed center spool. All ports are blocked when both solenoids are de-energized. Also, looking from the two hole side (below), the flow pattern is such that when the solenoid on the left is energized, air flow comes from the cylinder port on the left. This solenoid can be converted from external to internal pilot operation and vice versa to allow a greater pilot pressure range.

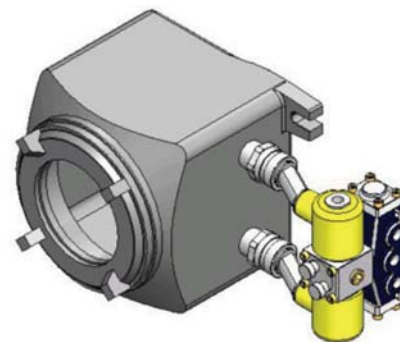
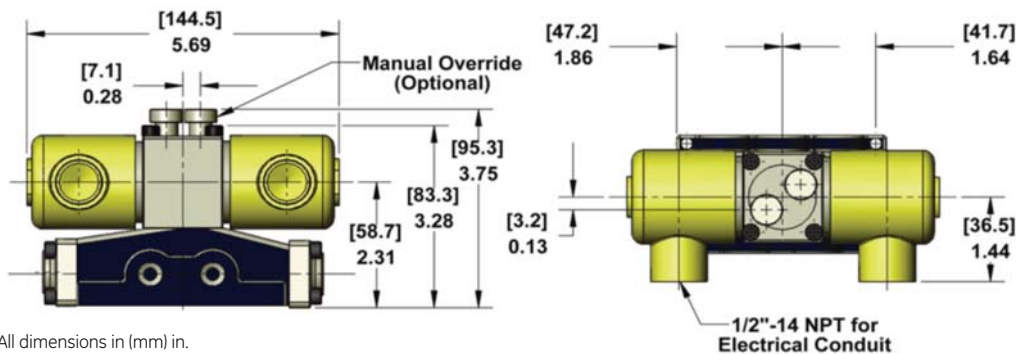


Figure 34 - DNGP with 5/3 solenoid attached



All dimensions in (mm) in.

Figure 35 - High Pressure 5/3 Solenoid Overall Dimensions

Table 10 - High Pressure 5/3 Solenoid Specifications

Pressure Ratings*	For Internal Pilot Operation: 160 psi line pressure max., 50 psi line pressure min For External Pilot Operation: 160 psi line pressure max., for pilot 50 psi line pressure min. - 250 psi max.
Weight	2.5 lbs (1.1 kg)
Fluid Media	Air, vacuum, and gases compatible with aluminum and Buna-N or Viton rubber
Coil Voltage & Frequency	24 VDC, 12 VDC
Inrush Current	0.58 amps
Holding Current	0.58 amps
Power Consumption	11 Watts
Conduit Connections	1/2"-14 NPT Electrical Conduit Connections (2) For wiring convenience conduit boss able to rotate 240°, and 24" wire leads may be pulled from the conduit to the nearest box

NOTE: Solenoid valves may be used on vacuum or pressures below or above the stated limits, up to 250 psi, however, the pilot pressure range MUST be 50 psi - 160 psi.

External/Internal Pilot Conversion & Valve Maintenance Instructions

Pilot Conversion:

For line pressure more than 160 psi, the solenoid valve must be re-assembled to accept an external source of air pressure within this range for shifting the spool. This will allow the main ports to work at any pressure from vacuum to 250 psi.

1. Remove 4 screws holding the solenoid structure to the main valve body and remove the entire solenoid assembly (leave the gasket as is).
2. Rotate the solenoid assembly 180°, and then remount to the body.
3. Take careful note of the 1/8" NPT external pilot port that was either on the top or side of the solenoid structure. It should now be nearest to 3-porthole side of the main body.
4. Connect a source of external pilot pressure to the 1/8" NPT port, 50 psi - 160 psi, to the pilot port

Gas Line Filter:

For the longest life and best results, use an air line filter installed no further than 10 feet from the valve. The filter should be rated at 25 µm or finer.

Valve Seals:

Some oils may swell the rubber seals in valves and cylinders, and may cause binding. To determine if the seals are swelled in AAA valves:

1. Remove one O-ring from the body and slip it over the spool.
2. Measure the clearance between the O-ring and spool. If the clearance between the O-ring and spool is 0.005 in. or more all around, the ring is swelled from its original shape (the paper these instructions are printed on is approximately 0.005 in. thick and can be used as a gauge).

A small amount of swelling will not usually impair valve performance, and sometimes the valve will perform reliably with as much as 1/32 in. clearance all around.

O-rings:

WARNING
Use Factory Designed O-Rings ONLY

The 5/3 solenoid valve uses 6, 3/4" I.D. x 15/16" O.D., Buna-N A O-rings. To replace these O-rings:

1. Remove the old O-rings using a sharp tool such as a pick or scribe.
2. Use an air hose (and solvent if necessary), to thoroughly clean out the grooves in the body.
3. Use a pair of tweezers* with an angle point, starting ring in groove in one side and working around.
4. Lightly grease the spool and body bore before assembly, using only valve grease, Moly Disulphide, or O-ring grease.

NOTE: If tweezers are not available, slip the spool into the bore, as a guide, to just below a groove, and work the ring into the groove with a small rod.

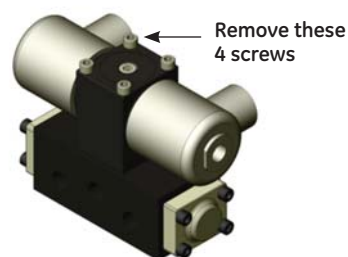


Figure 36 - High Pressure 5/3 Solenoid Valve

DNGP Accessories: Low Pressure 2/2 Solenoid Valve for Power Gas < 40 psig

For Valves with Spring and Diaphragm Actuators (See Figure 14 for Pipeline Schematic)

Two Low Pressure 2/2 solenoid valves are used in single-acting DNGP applications when the $P_{SUPPLY} < 40$ psig. When the solenoid is energized the core is drawn into the solenoid base sub-assembly. When the solenoid is de-energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.

Each solenoid is equipped with a valve that operates Normally Closed, in other words, the valve is closed when solenoid is de-energized; open when energized.

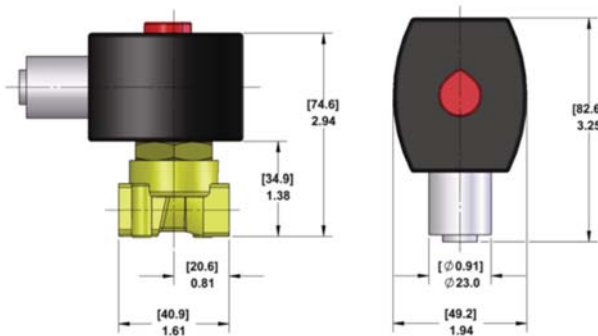


Figure 37 - Low Pressure 2/2 Solenoid Valve Overall Dimensions

High Pressure 3/2 Solenoid Valve for Power Gas 40 - 150 psig

For Spring Return T-Ball Control Valves (See Figs.16 & 17 for Pipeline Schematic)

Two High Pressure 3/2 Solenoid Valves are used in DNGP applications with P_{SUPPLY} from 40 to 150 psig. When the solenoid is energized the core is drawn into the solenoid base sub-assembly. When the solenoid is de-energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction. Each solenoid is equipped with a valve that operates Normally Closed, in other words, the valve is closed when solenoid is de-energized; open when energized.

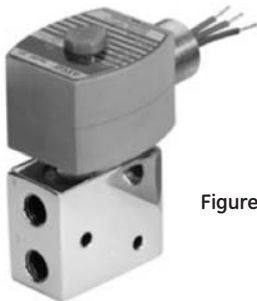


Figure 38 - High Pressure 3/2 Solenoid Valve (40 - 150 psig)

Table 11 - Low Pressure 2/2 Solenoid Valve Specifications

Enclosure Types	7 - (A, B, C, &D) Explosion proof Class I, Division 1, Groups (A, B, C & D) 9 - (E, F, & G) - Dust - Ignition proof Class II, Division 1, Groups (E, F, & G)
Operating Temperature	Max. Ambient Temperature: (150°F) 66°C Min. Ambient Temperature: (-20°F) -29°C These temperatures only indicate maximum application temperatures for field wiring rated at (90°C) 194°F. To prevent fire and explosion do not install solenoid and/or valve where ignition temperatures of hazardous atmosphere is less than 165°C (329 °F)
Valve Pressure Ratings	Inlet Port (Marked with a 1): 40 psi Outlet Port (Marked with a 2): 40 psi
Insulation Class	F
Power Rating	11.6 Watts
Conduit Connections	1-1/2" NPT Conduit Connection Conduit can be rotated 360°

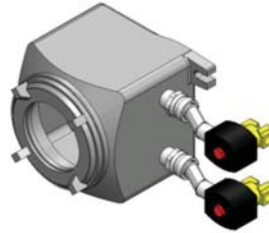


Figure 39 - DNGP with 2/2 solenoid valves

Table 12 - High Pressure 3/2 Solenoid Valve Specifications

Enclosure Types	7 - (A, B, C, &D) Explosion proof Class I, Division 1, Groups (A, B, C & D) 9 - (E, F, & G) - Dust - Ignition proof Class II, Division 1, Groups (E, F, & G)
Operating Temperature	Max. Ambient Temperature: (150°F) 66°C Min. Ambient Temperature: (-20°F) -29°C These temperatures only indicate maximum application temperatures for field wiring rated at (90°C) 194°F. To prevent fire and explosion do not install solenoid and/or valve where ignition temperatures of hazardous atmosphere is less than 165°C (329 °F)
Valve Pressure Ratings	Inlet Port (Marked with a 1): 150 psi Outlet Port (Marked with a 2): 150 psi
Insulation Class	F
Power Rating	11.6 Watts
Conduit Connections	1-1/2" NPT Conduit Connection Conduit can be rotated 360°

2/2 and 3/2 Solenoid Valve Maintenance & Troubleshooting Instructions

WARNING

To prevent the possibility of personal injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and

Cleaning:

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventative Maintenance:

1. Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
2. While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
3. Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

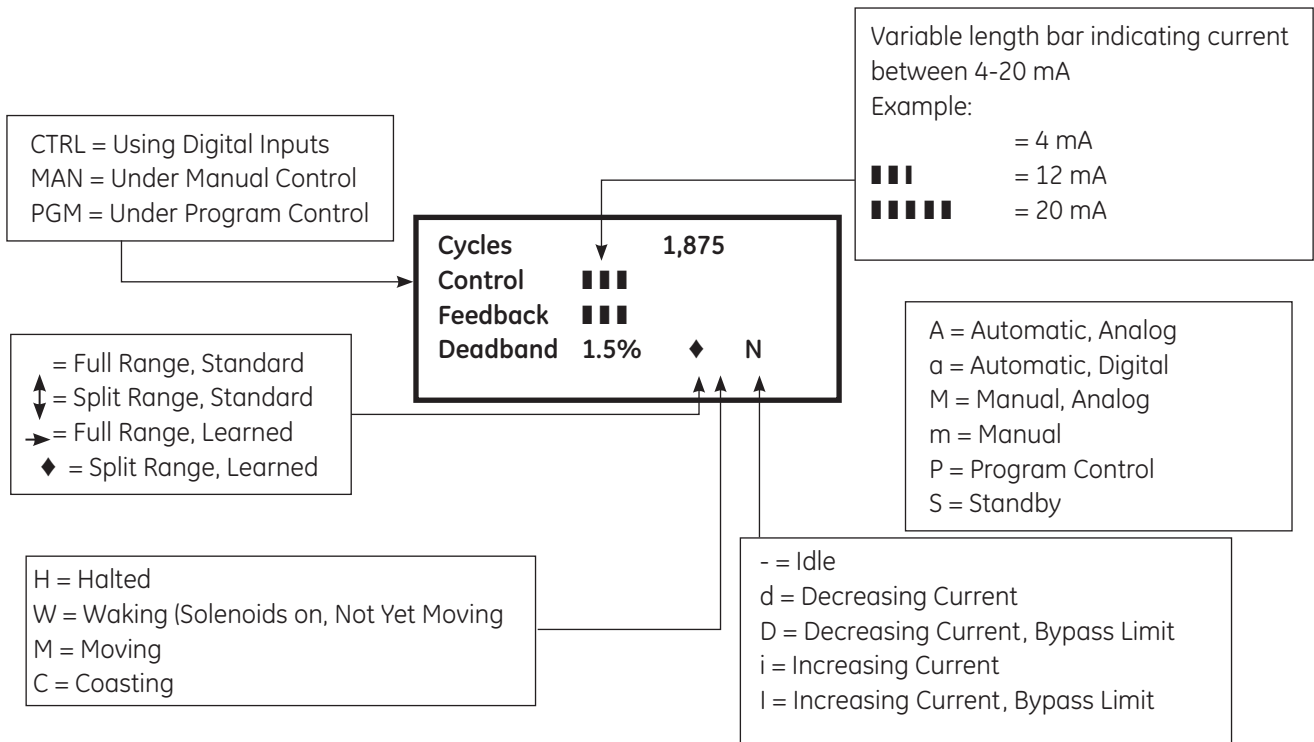
Causes of Improper Operation:

1. **Faulty Control Circuit**
Check the electrical system by energizing the solenoid. A metallic click signifies that the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown fuses, open - circuited or grounded solenoid, broken lead wires or splice connections.
2. **Burned - Out Solenoid**
Check for open - circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
3. **Low Voltage**
Check voltage across the solenoid leads. Voltage must be at least 85% or rated voltage

Run Time Screen

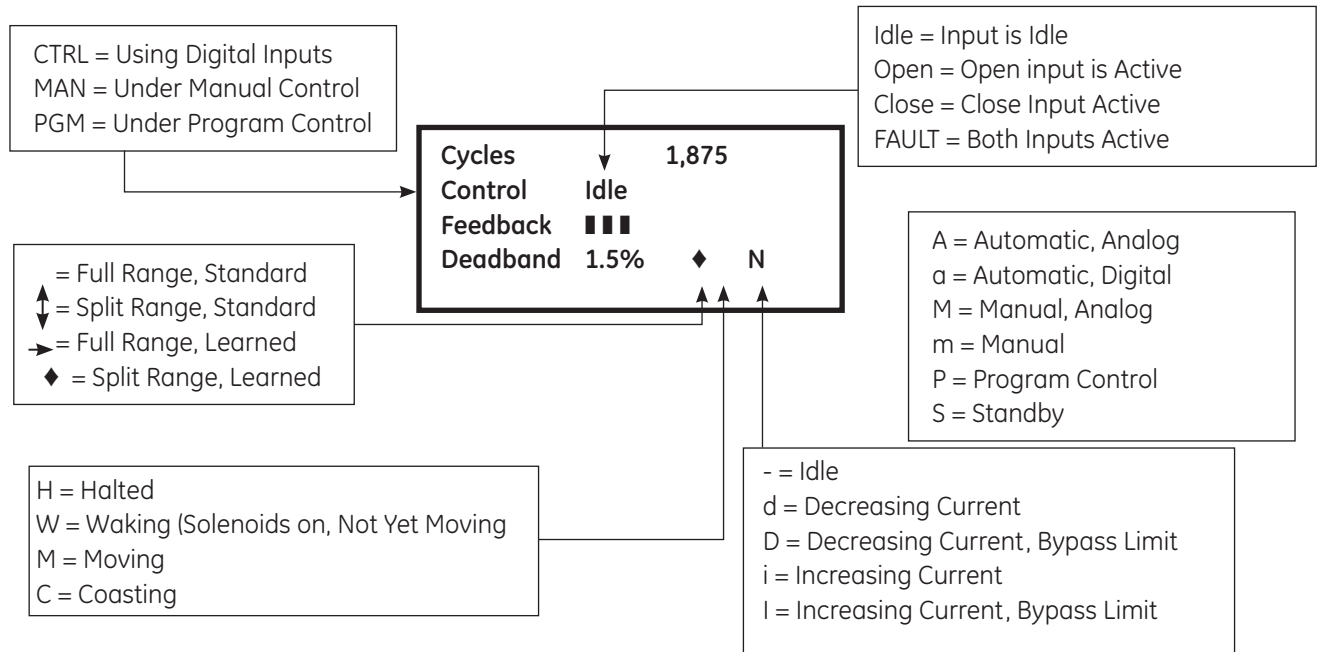
1. Current Loop Mode

The Run-Time Screen contains all the real-time feedback data for the DNGP. The diagram below shows a screenshot of a DNGP Run-Time Screen. The boxes accompanying the diagram show all possible feedback symbols and their meanings. In Current Loop Mode the DNGP accepts the standard 4-20 mA input and energizes the solenoid to stroke the valve to the desired position. In this mode pressing the RIGHT button will increase the input current signal and manually move the valve (the direction will depend on what positioner action is selected). Pressing the LEFT button will decrease the input current signal and manually move the valve. Pressing the UP and DOWN buttons increase and decrease the deadband respectively to adjust the sensitivity of the positioner. Pressing the ENTER button will take you to the Top Level Setup Screen (to be further explained in another section).



2. Digital Mode

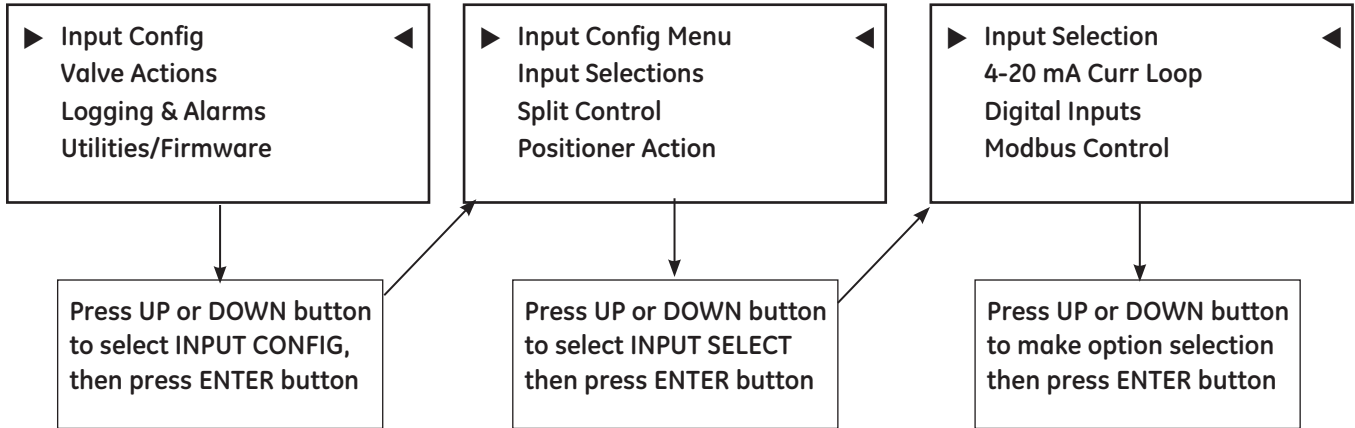
As opposed to the Current Loop Mode, the DNGP also has Digital Mode. In navigating the Run-Time Screen the only noticeable difference is the display of the Top Variable Feedback Bar. In this case there is no bar, only the current active input is displayed. All button commands have the same function as in Current Loop Mode.



Input Configuration Menu

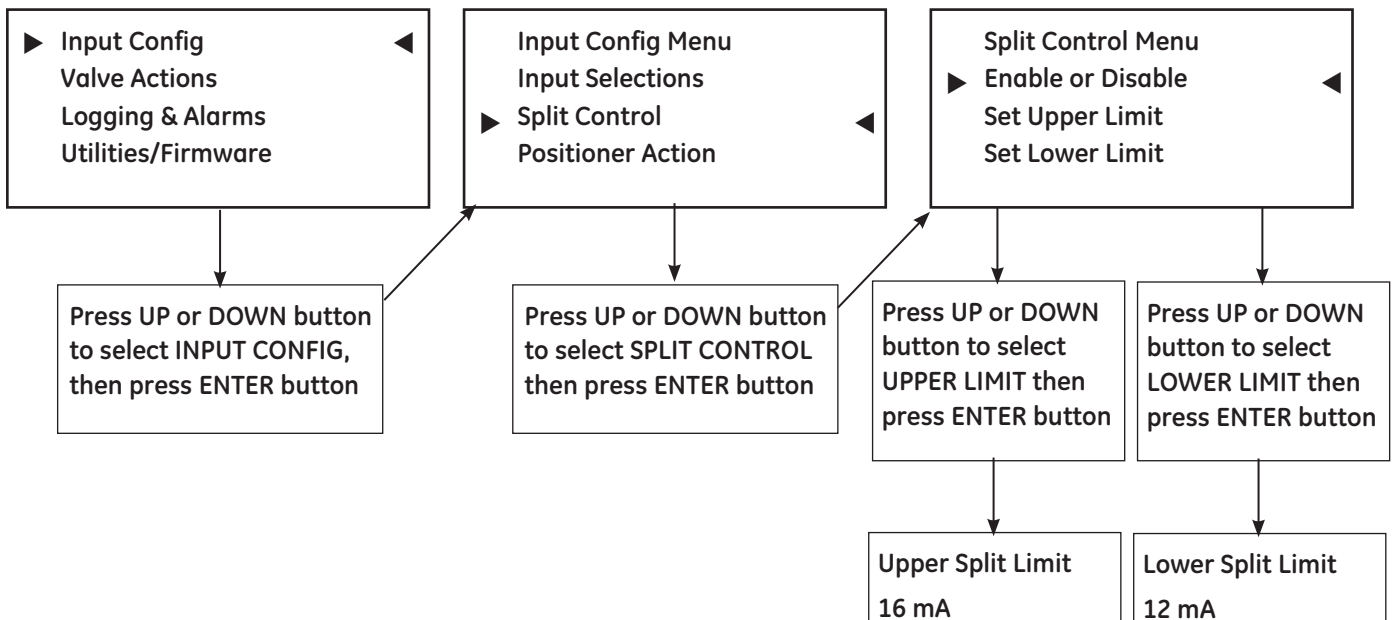
1. Input Select

It is sometimes desirable to change the input of the DNGP from standard 4-20 mA to user defined digital inputs, or Modbus Control. This can be accomplished through the INPUT CONFIGURATION MENU using the INPUT SELECT option. The diagram below, and on the following pages, show the actual process needed to configure the inputs of the DNGP when already operating from the TOP LEVEL SETUP SCREEN



2. Split Control

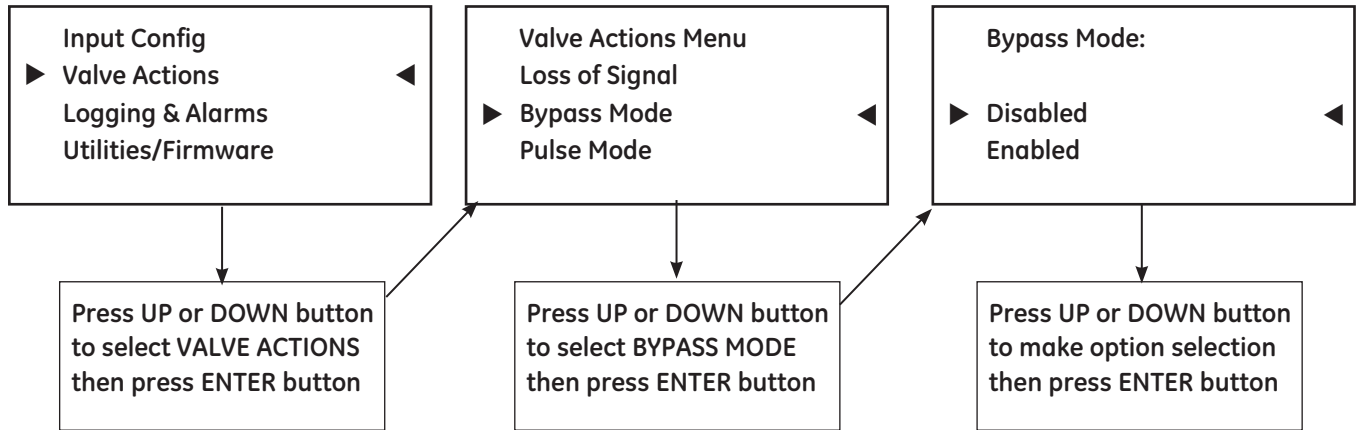
In some applications, split range control is needed instead of the standard 4-20 mA range. The DNGP can be accomplish this feat through the INPUT CONFIGURATION MENU using the SPLIT CONTROL option. The DNGP has the option to enable or disable the split control feature or set the upper and lower split limits with 4 mA minimum range in 1 mA increments.



Valve Actions Menu

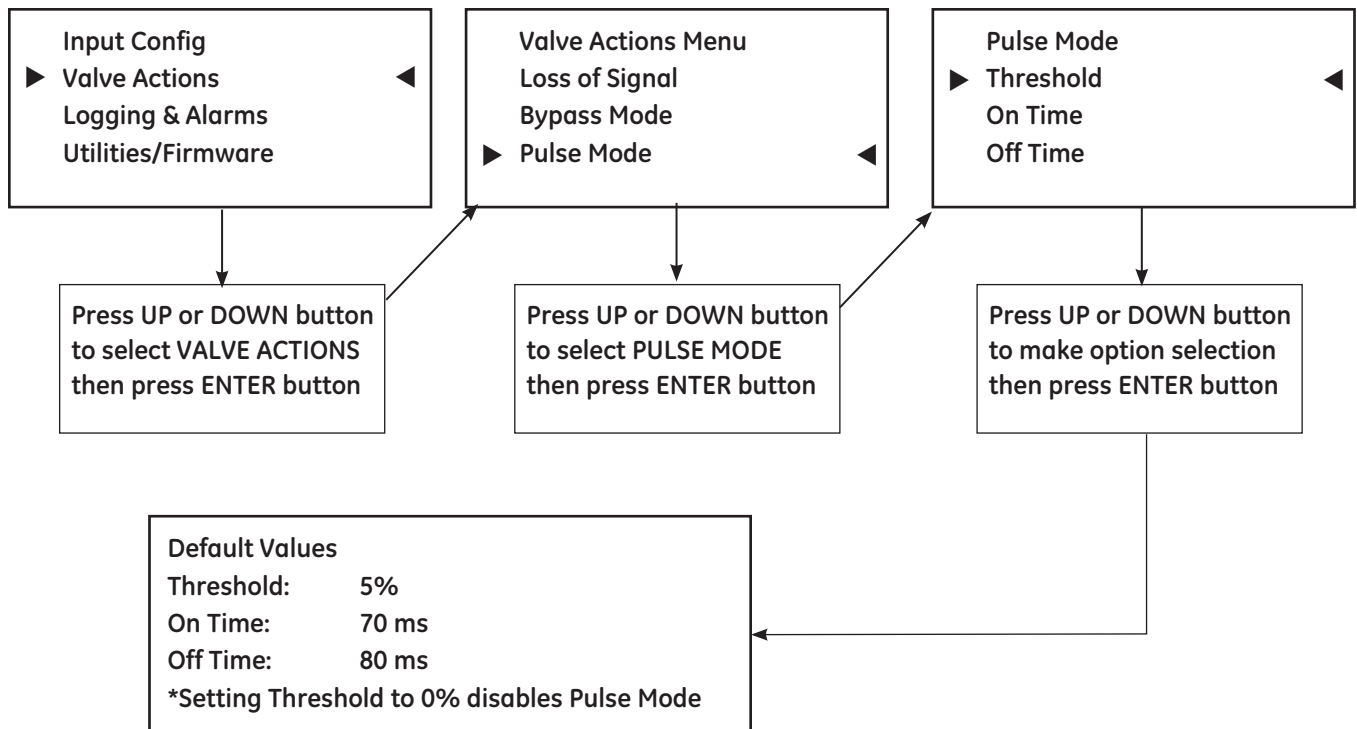
1. Bypass Mode

In some cases a valve may need the solenoid on or off when in a full closed or full open position. The DNGP has the ability to energize (turn on) or de-energize (turn off) the solenoid using the bypass mode.



2. Pulse Mode

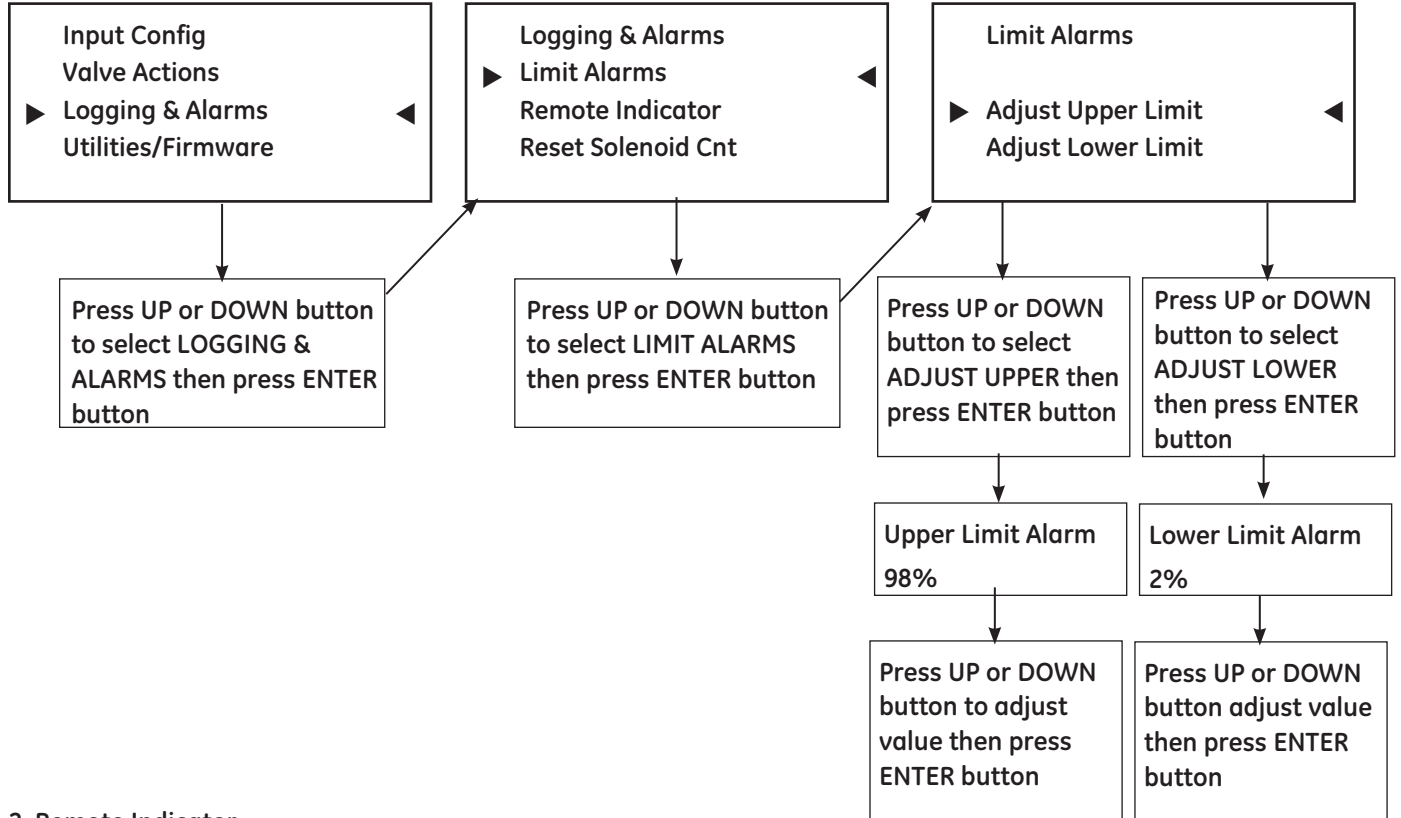
Pulse Mode is used for underdamped dynamic systems such as compressor recycle valve application.



Logging and Alarms Menu

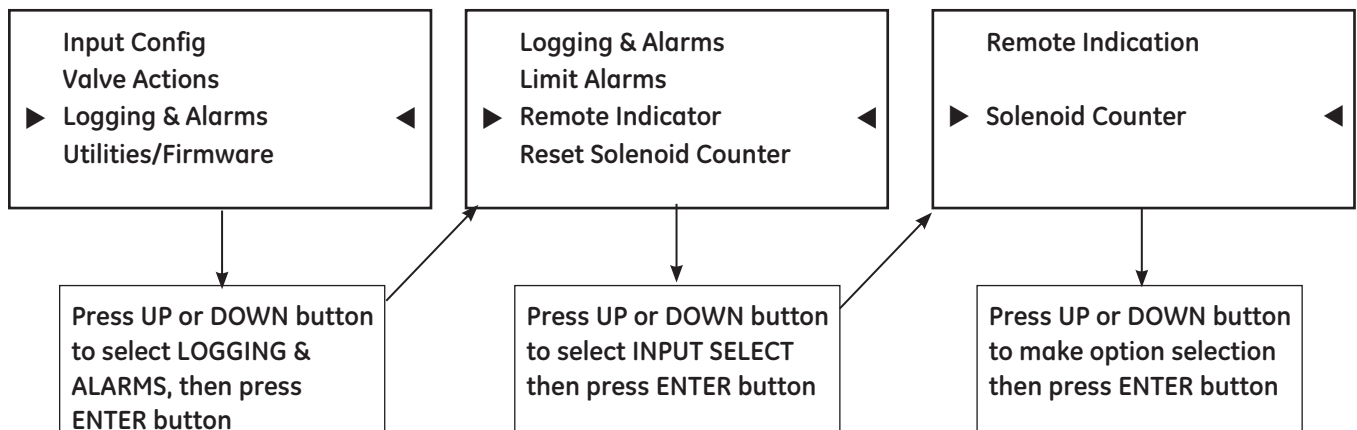
1. Limit Alarms

In some applications the valve may need to stay inside a specific prescribed region of operation. For this situation the DNGP can be configured to give alarms when these limits are reached. To set the upper and lower limit alarms follow the procedure given below.



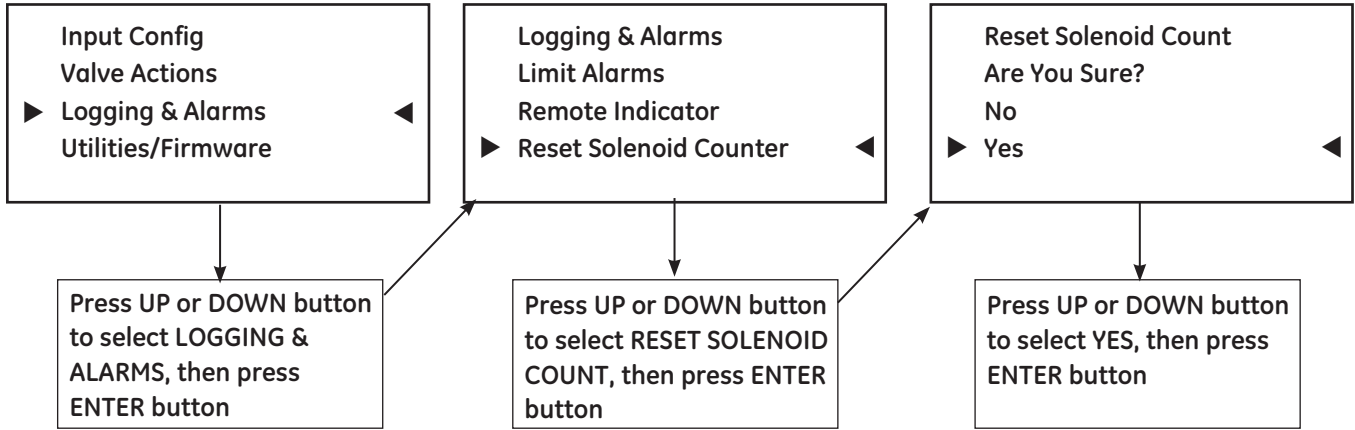
2. Remote Indicator

The DNGP remote indicator function can be selected to function in solenoid counter mode, or standby/manual mode. In counter mode the indicator pulses whenever either solenoid activates. In standby/manual mode, the indicator is active whenever the DNGP is in standby or manual modes.



3. Reset Solenoid Counter

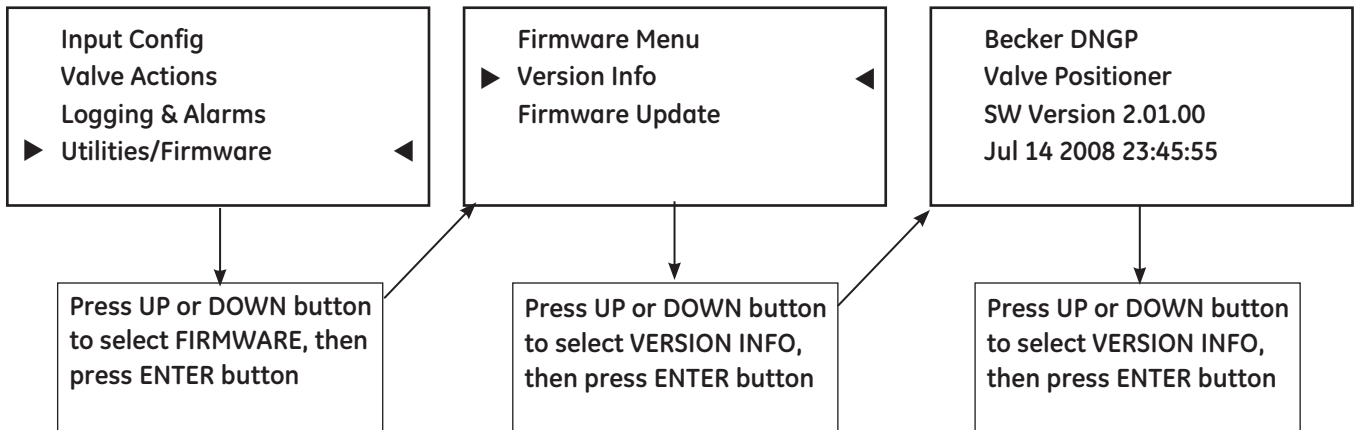
The user can reset the solenoid counter of the DNGP for various reasons (count the number of cycles from a zero reference, etc). This is accomplished through the RESET SOLENOID COUNTER function on the LOGGING AND ALARMS MENU.



Firmware Menu

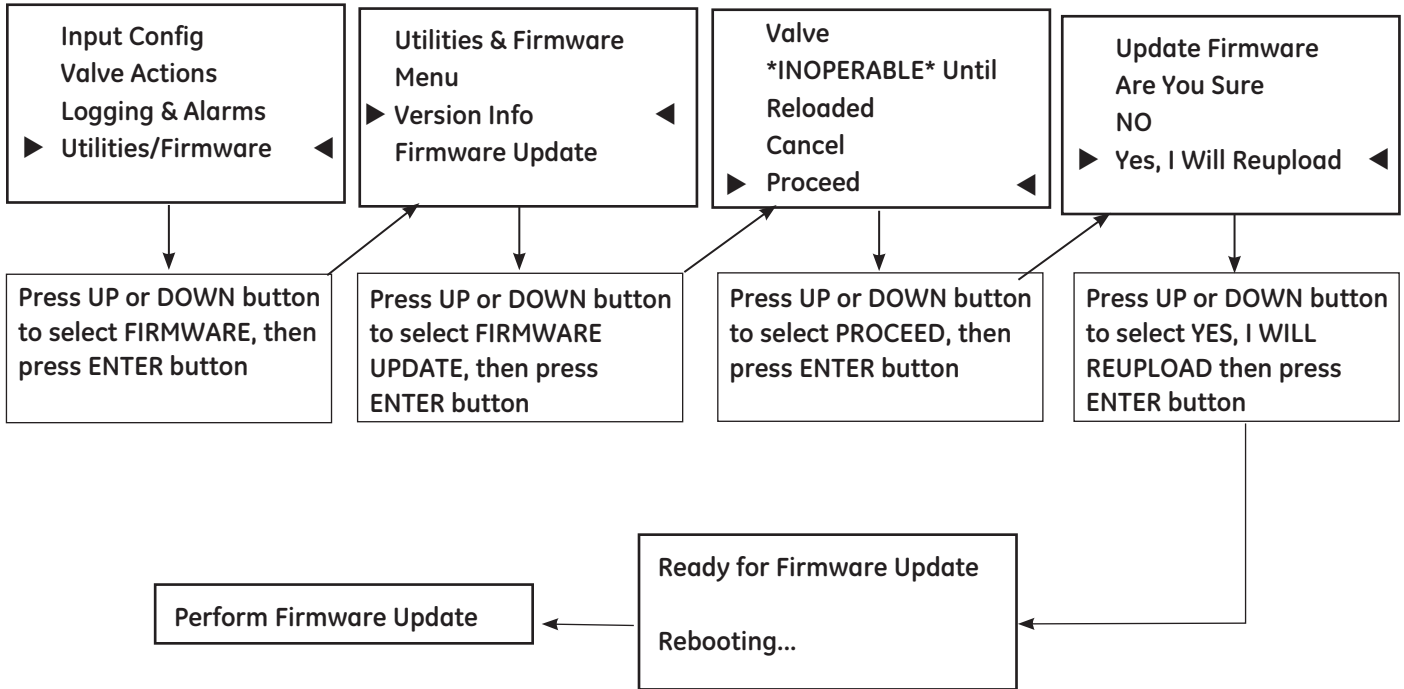
1. Version Info

The DNGP is a dynamic software tool that undergoes constant changes and improvements as time goes on. Using the FIRMWARE MENU the user is able to find out information about the current version they are using. It is important to keep up to date with the most current version of the software to ensure any added features or bug fixes are implemented.



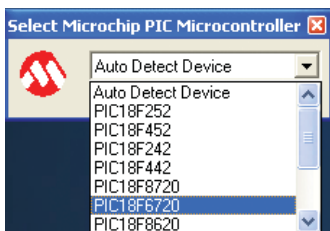
2. Firmware Update

Occasionally the firmware of the DNGP may need rebooting, or updating. During this time the valve is inoperable. The new version is available from the Becker website. When the process is complete the currently installed version will be displayed on the screen. See the Upgrading DNGP Firmware section for additional instructions on FIRMWARE installation.

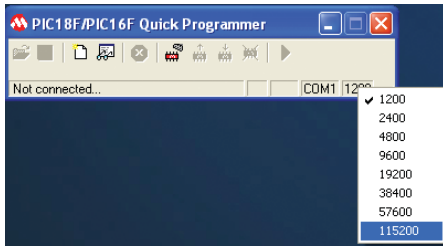


Upgrading DNGP Firmware

- Using the menus on the DNGP, go to FIRMWARE -> FIRMWARE UPDATE and proceed with the update. The unit should reboot, and the ERROR LED should come on. The HEARTBEAT LED will blink slowly.
- Make sure that the P1618QP APPLICATION is installed. If not, it can be installed using the supplied P1618QP zip file. If Windows asks about keeping any files, be sure to answer YES.
- Connect the DNGP 3.5 device to be upgraded to PC via a 9-pin straight through serial cable.
- Launch the P1618QP application.
- You will be prompted to Select Microchip PIC Microcontroller. Choose PIC18F6720 from the dropdown menu then click on the SELECT button.

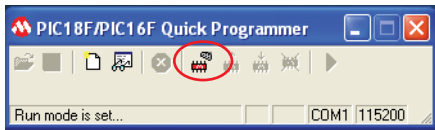


6. Next, change the Baud Rate. Right click on the bottom right box, and then select 115200. If any problems occur while downloading, try 57600 instead.

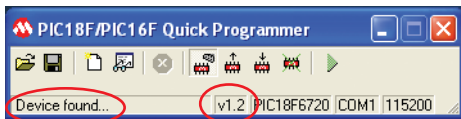


7. Go over to the box where the serial port is shown as COM1. Right click on this, and select the appropriate COM PORT for where you have plugged your cable in.

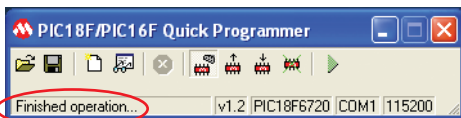
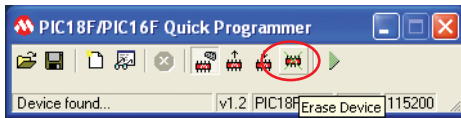
8. Click on the CONNECT TO DEVICE icon.



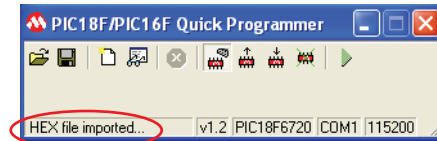
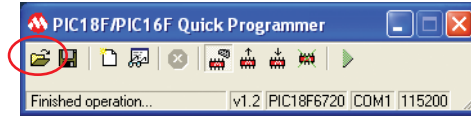
9. In the left most box in the bottom of the PIC18F/PIC16F QUICK PROGRAMMER BOX, you should see DEVICE FOUND... You should also see that the box to the right of DEVICE FOUND... will be filled in with a version number, such as V1.2. If not, please re-check your cabling, com port selection, or try a slower Baud Rate, and click on CONNECT TO DEVICE again. Make sure the button is down.



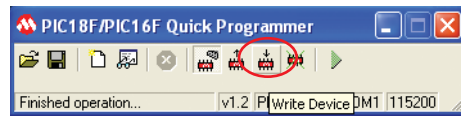
10. Click on the ERASE DEVICE icon. You will see ERASING: and a progress count in the lower left box. This takes about 2 minutes. Wait until you see the FINISHED OPERATION... message.



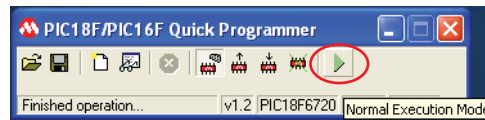
11. It will bring up Open HEX File window. Browse to the hex file to download, e.g. Dngp_download.version.dd MMM_YYYY.hex. Open file and in a few seconds it will display HEX File Imported.



12. Click on the WRITE DEVICE icon. You will see WRITING: and a progress count in the lower left box. This takes about 3 minutes. Wait until you see the FINISHED OPERATION... message.



13. Click on the NORMAL EXECUTION MODE icon.



A box will pop up, asking if you wish to continue. Click YES

14. The newly upgraded unit should start up on its own. Go to the FIRMWARE -> VERSION INFO menu and check that the unit is showing new software.

Troubleshooting for Firmware Upgrade

If any problems occur during software download, cold restart the DNGP by the following steps.

Step 1: Turn the DNGP power off.

Step 2: Press and hold the UP, DOWN and ENTER buttons.

Step 3: Apply power to the DNGP. Alarm light will be on and the D17 led will be flashing.

Table 12 - DNGP Alarm and Fault Handling

Condition	Response/Action
Loss of Control Signal 1 (Current Loop) in 4-20 mA Input Mode.	<p>Displays "CTRL: Fault"</p> <p>Check the RTU output</p> <p>Check wires # 1 and 2 on Terminal Board 2</p>
Loss of Feedback Signal	<p>Display "FDBK: Fault"</p> <p>Disconnect any other wires from #5 & 6 on TB 2 and jump # 5 & 6 instead</p> <p>Checks the SCADA for Internal power or external power</p> <p>Check the DNGP board JP1 for external or internal power: At JP1, Jump 1, 2 for external power, and 2, 3 for internal power (see page 16)</p>
If Digital Input Activated	<p>Display "CTRL: Idle"</p> <p>If the Open and Close signal are present at the same time the display shows CTRL: Fault Disconnect the wires to the TB2 # 7 open command, and 8 close commands, if this clears the Display to Idle check the switches, DI on SCADA should be open</p>
Limit alarm ON minimum or maximum	<p>If valve not fully Close or Open check the settings at Logging and Alarms/ Limit Alarms =Adjust the alarm Upper Limit 55% to 100% and the Lower Limit 0% to 45%</p>
Controller display a flashing alarm screen, Error Light ON normal operation continues even though this screen is being displayed.	<p>Indicates that the valve is not responding to signal</p> <p>Check Valve Position must be same position as the DNGP Input Config Menu/Position Action = Close on Increase or Open on increase</p> <p>If the valve is going to be on the close position most of the time close the valve and check the CTRL: and FDBK: values must be within .16ma if not adjust the VP pot or magnet for the linear position transmitter.</p>
DNGP doesn't move on change of signal CTRL: and FDBK shows some mA signal	<p>Minimum pressure for solenoid operation in 60 psi</p> <p>Check the Air pressure block valve, the Standby/Manual Switch should be on Auto, The MCV3L should be on Auto, and the solenoid manual on Auto if available</p>
Cycling of DNGP	<p>Perform a Leak test on unit; check the Dead band on display move up if necessary (see page 48)</p>
3 Amp Fuse protects the board not the Solenoids	<p>For 24VDC the impedance should be 58-65 Ohms; for 12VDC 14-17 Ohms</p>
Increased or Sudden Cycling of Positioner	<p>Perform leak test on unit (See Below)</p>
3A Fuse on Logic Board Blown	<p>Perform measurement of voltage power supply 12-24 VDC. Maximum allowed voltage is 30 VDC. If supply voltage exceeds 24 V the fuse will protect the board, not the solenoids.</p> <p>Measure the impedance of solenoid coils. For 24 VDC: If below 58-65 Ohms, the solenoid is shorted. For 12 VDC: If below 14-17 Ohms, the solenoid is shorted. Change the solenoid coils. See spare parts list below for coil part number.</p>

Table 13 - DNGP Spare Parts List

Condition	Response/Action
High Pressure 5/3 Solenoid Valve - Complete Assembly	20-4500
High Pressure 5/3 Solenoid Valve Body	20-4506
High Pressure 5/3 Solenoid Coil - 24 VDC	20-4509
High Pressure 5/3 Solenoid Coil - 12 VDC	20-4518
Low Pressure 2/2 Solenoid Valve - 24 VDC (less than 40 psig)	20-4202
High Pressure 3/2 Solenoid Valve - 24 VDC (40 to 150 psig)	20-4221
3 Amp Replacement Fuse (Input Power)	31-9002
DNGP Control Board (includes display board and terminals)	31-0016

DNGP Leak Test Procedure

1. Switch DNGP to standby from auto. Observe feedback mA indicator. If position of the valve changes follow continue to step #2.
2. Move MCV to manual to close block valve or close cylinder block valves.
3. Check cylinder for decaying or equalizing pressure.
 - a) If cylinder pressure is decaying, check and repair leaks at fittings.
 - b) If cylinder pressure is equalizing, rebuild cylinder.
4. Check for external leak at gasket, NPT instrumentation ports.
 - a) If leak is found, tighten bolts or fittings.
 - b) If no leak is found, rebuild solenoid valve with O-ring kit by replacing lower valve body. See spare parts list Table 12 for part numbers.

Certifications and Approvals

Part/Component	Certification
DNGP Logic Board	RoHS Compliant Tested per FCC Part 15.07 EN 61000-6-2, EN 61000-6-4
DNGP Enclosure	Class I, Groups B,C,D Class II, Groups E,F,G CSA C22.2 No. 25 & 30 Optional ATEX Available DEMKO 03 ATEX 0303070U II G D EEx d IIB + H2
Linear Position Transmitter	SIRA 05 ATEX M334 II 2 G EEX d IIC T6 Class I, Division 1, Groups A, B, C, and D Class II/III, Groups E, F, and G Enclosure Type 4X/6P
Rotary Position Transmitter	Class I, Group C and D Class II, Groups E, F and G
High Pressure 5/3 Solenoid Valve	Class I, Group C and D Class II, Groups E, F and G
2/2 and 3/2 Solenoid Valves	Class I, Div 1, Group A, B, C, & D Class II, Div 1, Groups E, F and G Nema Enclosure Types 3, 3S, 4, 4X, 6, 6P, 7, & 9 Optional ATEX Available LCIE 00ATEX 6008 X II G D EEx d IIC T6

Software Release Information

Version	Release Date	Feature
3.01.00	Aug 28 2011	*Modbus protocol added
2.02.00	Nov 7 2008	* Fault Alarm is disabled at 4 & 20mA positions within 1.5% of feedback signal
2.01.00	Jul 14 2008	* Pulse control mode added to menu * Pulse Mode replaces Learn Mode
2.00.P6	Feb 18 2008	* Enable Pulse Mode (not added to menu)
2.00.05	May 12 2005	* Initial firmware release

5. Warranty

5.1 Seller warrants that Products shall be delivered free from defects in material, workmanship and title and that Services shall be performed in a competent, diligent manner in accordance with any mutually agreed specifications.

5.2 The warranty for Products shall expire one (1) year from first use or eighteen (18) months from delivery, whichever occurs first, except that software is warranted for ninety (90) days from delivery. The warranty for Services shall expire one (1) year after performance of the Service, except that software-related Services are warranted for ninety (90) days.

5.3 If Products or Services do not meet the above warranties, Buyer shall promptly notify Seller in writing prior to expiration of the warranty period. Seller shall (i) at its option, repair or replace defective Products and (ii) re-perform defective Services. If despite Seller's reasonable efforts, a non-conforming Product cannot be repaired or replaced, or non-conforming Services cannot be re-performed, Seller shall refund or credit monies paid by Buyer for such non-conforming Products and Services. Warranty repair, replacement or re-performance by Seller shall not extend or renew the applicable warranty period. Buyer shall obtain Seller's agreement on the specifications of any tests it plans to conduct to determine whether a non-conformance exists.

5.4 Buyer shall bear the costs of access for Seller's remedial warranty efforts (including removal and replacement of systems, structures or other parts of Buyer's facility), de-installation, decontamination, re-installation and transportation of defective Products to Seller and back to Buyer.

5.5 The warranties and remedies are conditioned upon (a) proper storage, installation, use, operation, and maintenance of Products, (b) Buyer keeping accurate and complete records of operation and maintenance during the warranty period and providing Seller access to those records, and (c) modification or repair of Products or Services only as authorized by Seller in writing. Failure to meet any such conditions renders the warranty null and void. Seller is not responsible for normal wear and tear.

5.6 This Article 5 provides the exclusive remedies for all claims based on failure of or defect in Products or Services, regardless of when the failure or defect arises, and whether a claim, however described, is based on contract, warranty, indemnity, tort/extra-contractual liability (including negligence), strict liability or otherwise. The warranties provided in this Article 5 are exclusive and are in lieu of all other warranties, conditions and guarantees whether written, oral, implied or statutory. NO IMPLIED OR STATUTORY WARRANTY, OR WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE APPLIES.

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