



SMARTCAL VALVE POSITIONER

INSTALLATION AND OPERATION MANUAL

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Prepared By: M. Twardowski	Date: 12/17/12	Drafting Work Order: 23135	ECN: 13247
Reviewed By: C. Irwin	Date: 3/14/18	Approved By: T. Paolini	Date: 10/18/18
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Crane Co.

Americas: +1 201 794 7650

Europe, Middle East & Africa: +44 (0) 1892 516 277

Asia Pacific: +65 6869 8909

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1. Introduction

1.1 Product Certification.

<p>IEC Ex FMG 06.0002x Ex ia IIC T4 II 1 G</p>	<p> Ex ia IIC T4 II 1 G FM09 ATEX 0028 II3 DT 75° C </p>	<p> Ex ia IIC T4 CLASS I DIV 1 GROUP A, B, C, D CLASS II DIV 1 GROUP E, F, G NI CLASS I DIV 2 GROUP A, B, C, D</p>
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This product is designed for use in intrinsically safe systems when connected through the correct barriers.

1.2 Description of SmartCal Positioner.

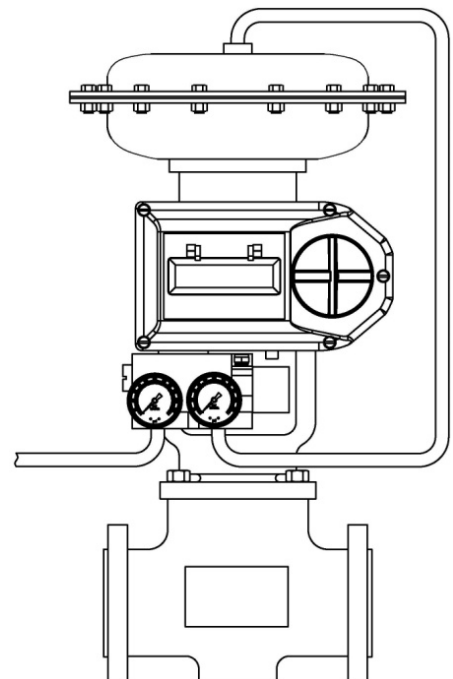
The SmartCal Smart Valve Positioner is an electro-pneumatic servo system that continuously controls the position of a valve based on a 4 to 20 mA input signal. The SmartCal is an instrument that derives its power directly from a control systems current loop. The instrument senses valve position via a non-contact Hall Effect sensor and controls valve position through a current to pressure transducer.

The SmartCal is available in two versions, HART® and non-HART. The non-HART version allows calibration of the instrument through an on board keypad. The HART® version allows calibration and access to on-line diagnostic information via Rosemount 375/475 hand-held terminal or through software.

The positioner has a local liquid crystal display which indicates valve position and set-point in percentage of full span. It also indicates whether the positioner is in calibration mode.

The SmartCal has the capability to monitor operation. If a failure condition occurs, an error message is displayed on the local liquid crystal display.

There are several accessories that can be integrally supplied with the SmartCal. Among these are a 4 to 20 mA analog output, and a set of hermetically sealed non-contact limit switches.



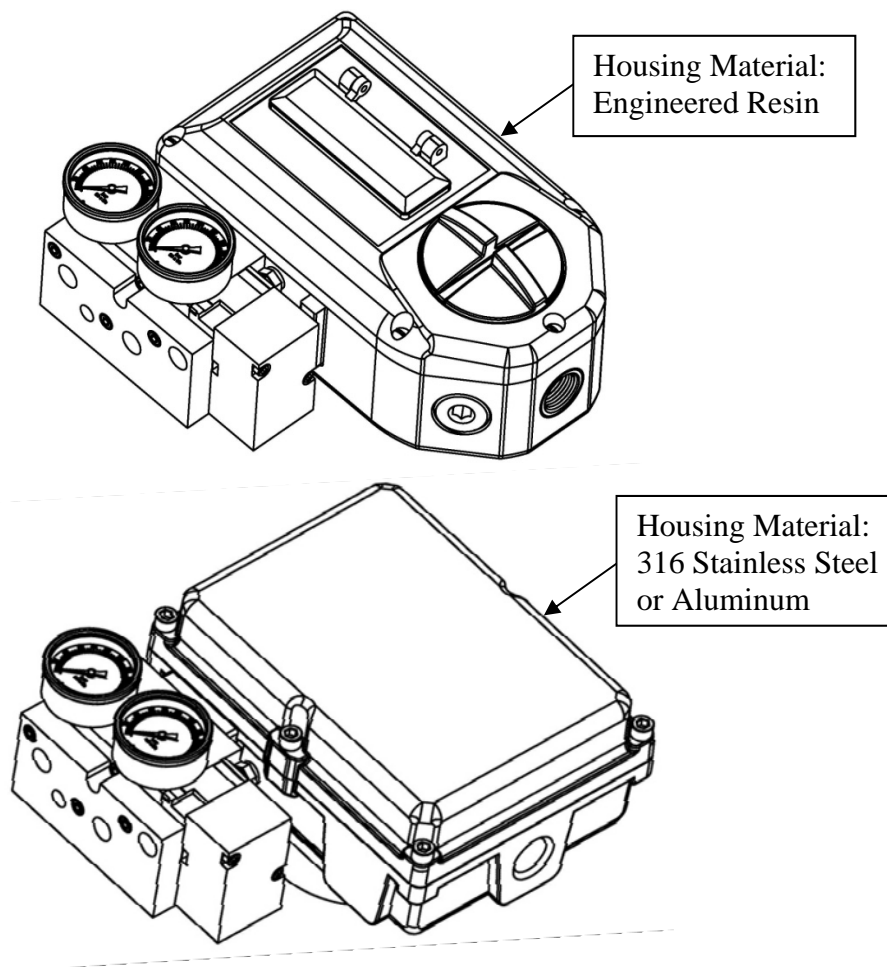
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1.3 Principle of Operation

Unlike conventional positioners, the SmartCal Smart Positioner feeds back valve position without the need for linkages, levers, or rotary and linear seals. Position sensing is performed totally by non-contacting means, permitting use of advanced control strategies where knowledge of valve position is used in predictive and other algorithms. By the integration of multiple components into a singular, cost efficient unit, microprocessor-based intelligence can now be used to implement advanced functions such as early warning diagnostics.

The SmartCal positioner provides intelligence for the control valve through a microprocessor-based diagnostic system utilizing HART® or Foundation Fieldbus protocols. Accurate measurement of valve stem position, input signal, actuator pressure and travel time can be recorded during normal operation, thereby providing information for control valve signature generation.



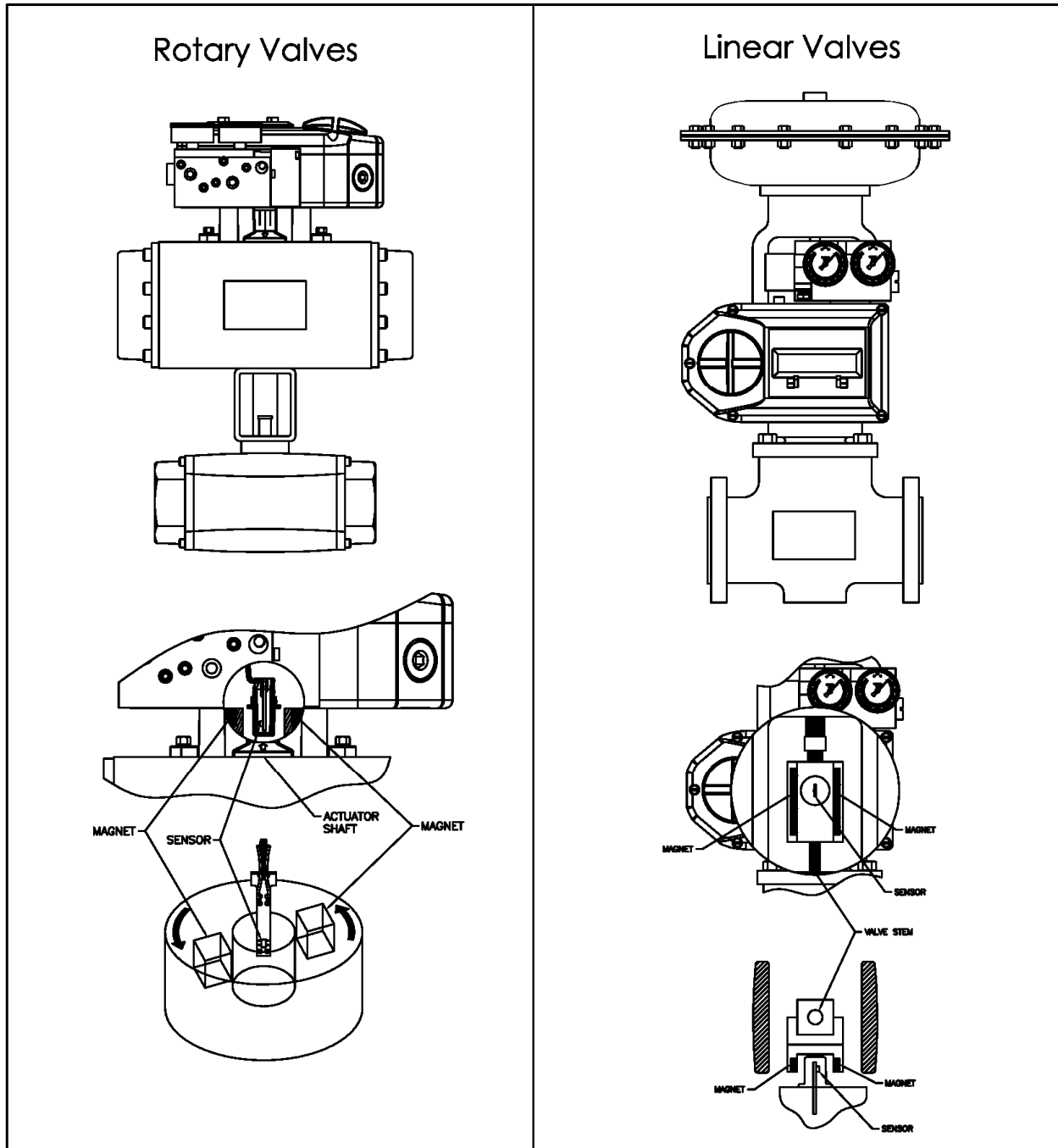
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1.4 Special Features

Non-Contact Position Feedback

To provide consistently accurate performance information, all linkages, levers and connecting rods, from the positioner to the control valve have been eliminated from the design. Valve position sensing is performed totally by non-contact means based upon characterization of magnetic flux strength as a function of position.

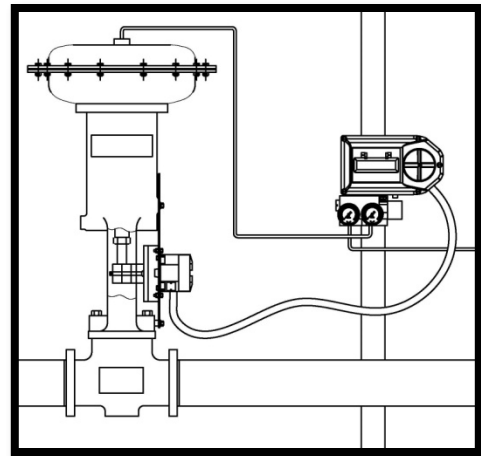


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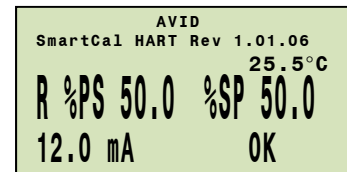
Remote Position Control

Since valve position feedback to the SmartCal positioner is accomplished by non-contact means, the SmartCal has the unique ability to be mounted remotely (up to a distance of 50 feet, optionally 150 feet) from the device it is controlling. The remote position sensor also has the ability to work over a wider temperature range, from -40°C to 125°C (-40°F to 257°F). In the event the control valve is located in a high vibration, high temperature or extremely corrosive environment, the non-contact position feedback feature allows for isolated placement of the positioner.



Local Graphic LCD

The SmartCal positioner is supplied with a digital communication interface (FF, HART®) or a 3-button keypad interface. Both versions are furnished with a graphic LCD, and allow for automated calibration of the positioner. The local LCD provides a multitude of onsite diagnostic information. The LCD shows input current, set-point and current position. The values displayed range from 0.0% to 100.0%. Displayed resolution is in 0.1% increments, however, internal calculations are maintained at higher precision.

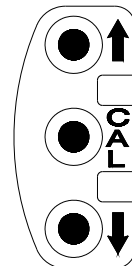


On-Board Sensors

The SmartCal positioner has the capability to monitor its operation. If an error or failure condition occurs, it will be displayed on the local LCD, or if the positioner is supplied with a HART® interface, the error codes will be displayed on a hand held terminal or a PC maintenance station. Note: Error codes are denoted on a label affixed to the LCD flip-up protective cover.

Local Keypad

The positioner is provided with a ruggedized 3-button keypad. The keypad can be used for zero and span adjustments, as well as valve characterization and gain adjustments.



Intelligent Calibration (HART® Protocol)

The SmartCal positioner responds to HART® commands for seeking the “valve closed” position and assigns an instrument signal of 4 mA to this position. The counterpart of the operation for a full open state is implemented next by setting the span value. Action reversal is also configured. Additionally, provisions are made for altering internal servo loop tuning via the HART® link. In this manner, positioner performance may be optimized with a wide combination of valves and actuators.

Negligible Bleed

Designed to consume the least possible amount of control air at steady state, the SmartCal positioner can greatly reduce the air consumption of your process and reduce the demand on instrument air compressors. To increase reliability, the SmartCal employs a patented lapped spool and floating sleeve design. This balanced construction relies on an air bearing which eliminates any metal to metal contact.

2 Ordering

The SmartCal positioner is designed to handle a wide range of control valve applications. Please use the following ordering guide to help choose the SmartCal positioner that best suits the application.

2.1 SmartCal Positioner Ordering Guide

AVID SMARTCAL POSITIONER - PRODUCT DECODING MATRIX	
Base Model	Smart Positioner
SM	Smart Positioner
Application	
G	General Purpose
I	Intrinsically Safe
F	Foundation Fieldbus
Conduit Entry	
1	1/2" NPT
2	M20
Mounting & Remote Options	
D	Direct Modmount Housing
R	Remote Mount Housing (Aluminium MOD3 Type)
S	Remote Mount Housing (316 Stainless Steel N4S Type)
Bracket Type	
D	Modmount Metric
E	Modmount Imperial
J	Modmount Metric & 'J3' Electronics
K	Modmount Imperial & 'J3' Electronics
Switch Options	
0	None fitted
1	One K-Switch
Manifold Options	
B	BSP Ports
N	NPT Ports
X	BSP Ports & Closed Loop Breathing
Y	NPT Ports & Closed Loop Breathing
Flow Type	
0	Standard Flow - 1/4" Ports (Aluminium Manifold)
P	Standard Flow - 1/4" Ports (Aluminium Manifold & Stainless Steel Gauges)
S	Standard Flow - 1/4" Ports (316 Stainless Steel Manifold & Stainless Steel Gauges)
H	High Flow - 3/8" Ports (Aluminium Manifold)
Q	High Flow - 3/8" Ports (Aluminium Manifold & Stainless Steel Gauges)
T	High Flow - 3/8" Ports (316 Stainless Steel Manifold & Stainless Steel Gauges)
Certification	
0	Non Hazardous
A	ATEX
I	IECEX
F	North American
Revision	
R*	Internal Revision Number
SM - I 2 D D 0 B - 0 A R1	= Model Number SM-I2DD0B-0AR1

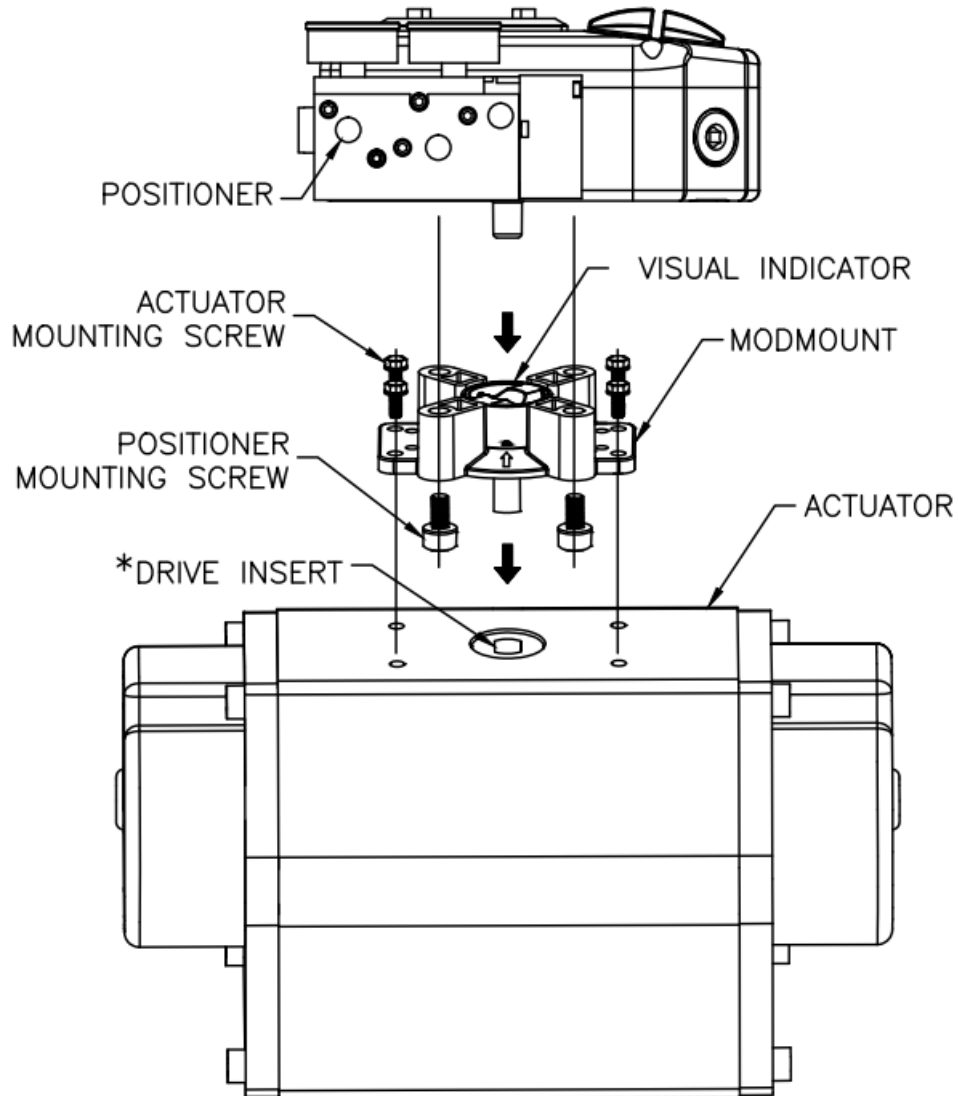
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3 Initial Setup

3.1 Mounting Positioner on a Rotary Actuator

Step 1. Figure 1 shows typical direct mounting of positioner to an actuator. Mount the modmount bracket to positioner using positioner mounting screws.



*NOTE:

1. DRIVE INSERT MUST BE PROVIDED WITH ACTUATOR FOR MODMOUNT INSTALLATIONS.
2. DRIVE INSERT MAY NEED TO BE DISENGAGED AND ROTATED 90° TO ALLOW FOR PROPER MOUNTING.

Figure 3-1

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Step 2. The visual indicator needs to be properly oriented. Use the symbols on the bottom of the indicator to mount as shown in Condition 1 or Condition 2. (see figure 3-2). Condition 1 and Condition 2 show the placement of the indicator with respect to the positioner housing while the actuator is in the fail position.

Step 3. Mount the positioner with Modmount bracket to the actuator. As stated in Step 2 make sure that the positioner is mounted in a fashion that properly orients it with respect to the indicator.

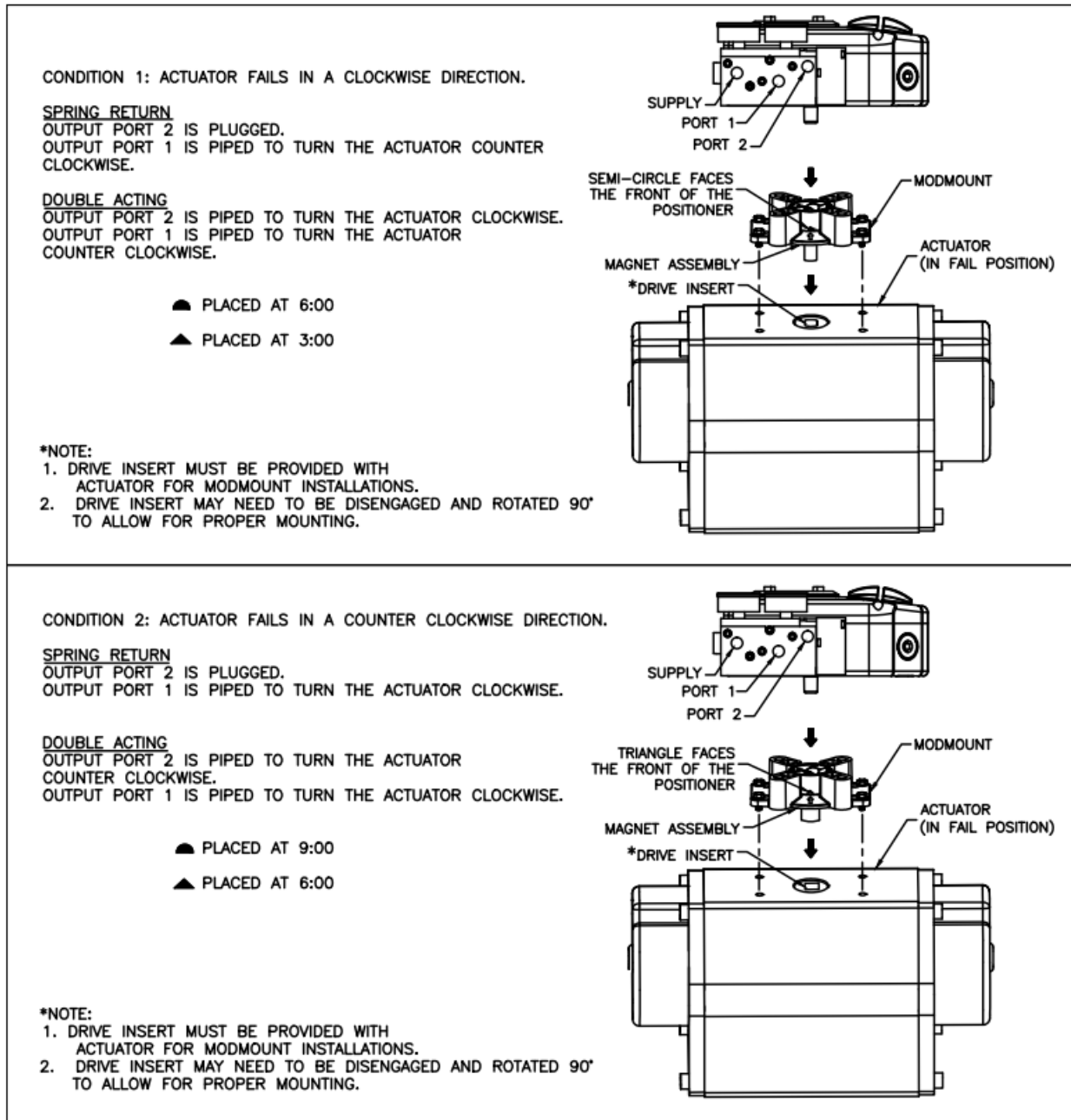


Figure 3-2

3.2 Mounting Remote Positioner on a Rotary Actuator

Step 1. Mount bracket and visual indicator to positioner as described in Section 3.1 Step 1.

Step 2. The visual indicator needs to be properly oriented. Use the symbols on the bottom of the indicator to mount as shown in Condition 1 or Condition 2. (see figure 3-3). Condition 1 and Condition 2 show the placement of the indicator with respect to the positioner housing while the actuator is in the fail position.

Step 3. Mount the positioner with Modmount bracket to the actuator. As stated in Step 2 make sure that the position sensor is mounted in a fashion that properly orients it with respect to the indicator.

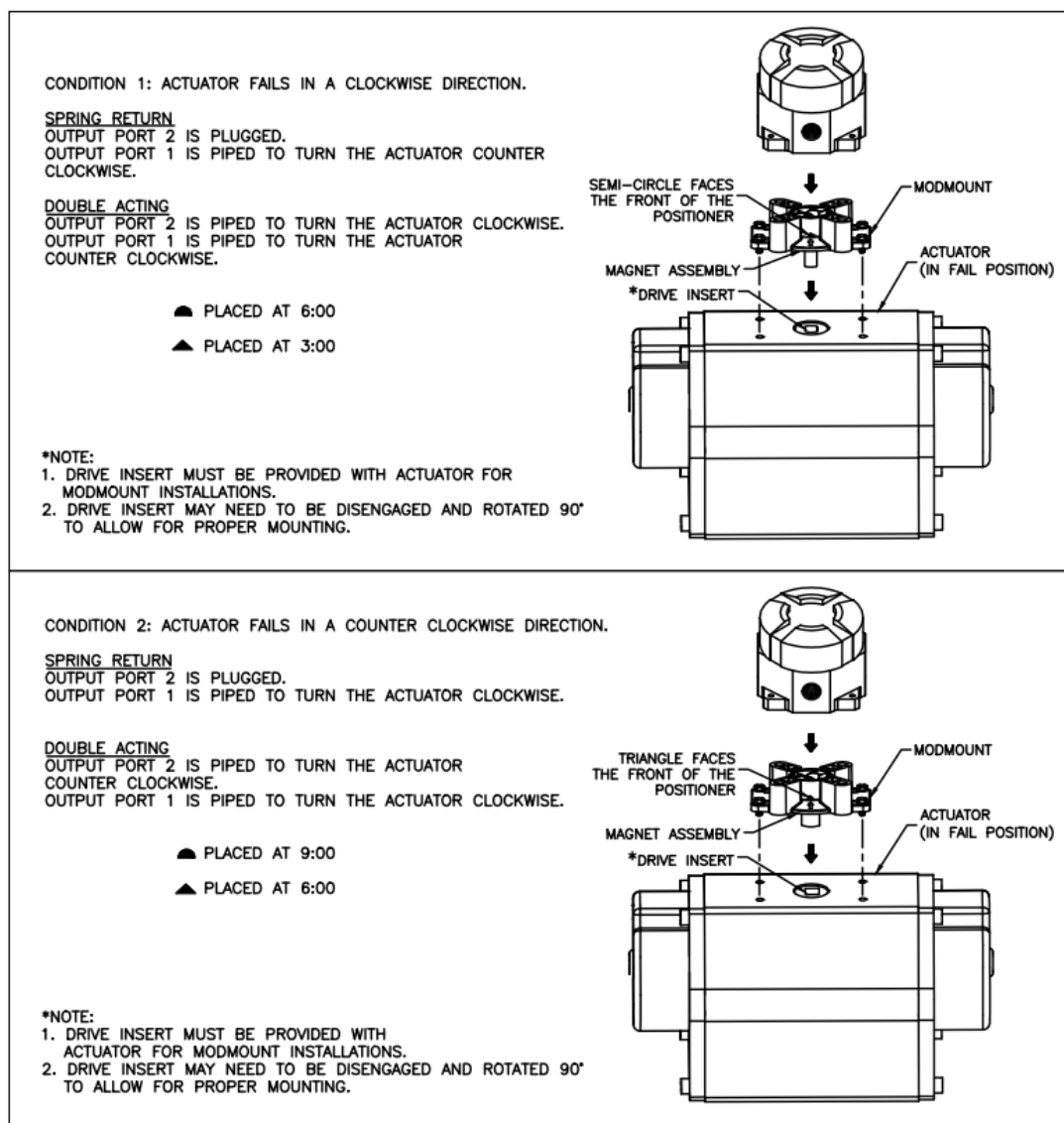


Figure 3-3

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Step 4. Mount positioner at a remote location.

Step 5. Remove the electronic canister cover by unscrewing (2) mounting screws. (Appendix B: Procedure to Remove Electronics Cover and Electronic Canister)

Step 6. If necessary cut remote cable to required length, making sure to cut end opposite female connector. Wire the positioner sensor back to the positioner using the cable provided and replace cover. (See Figure 3-4).

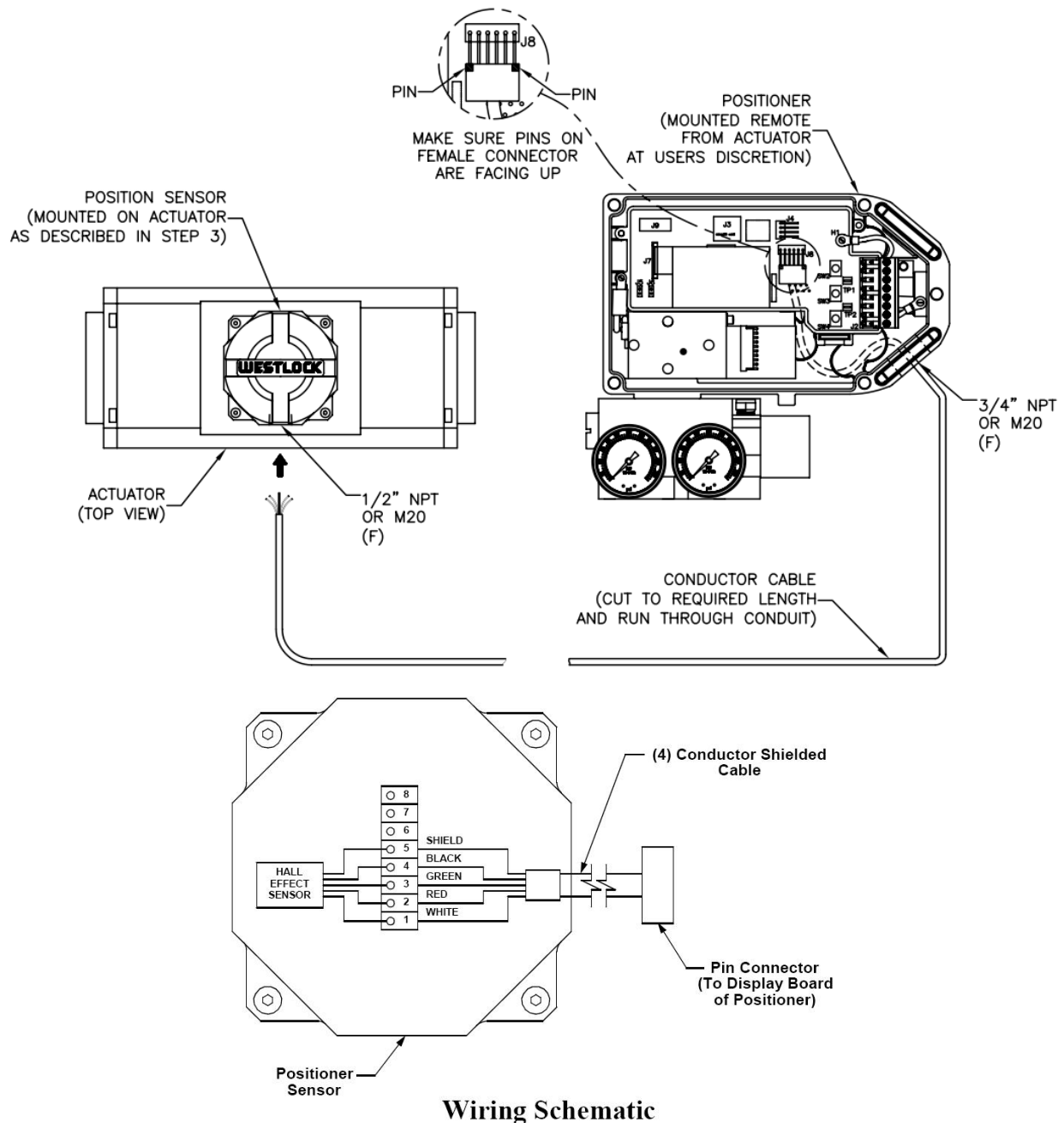


Figure 3-4

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3.3 Mounting Positioner on a Linear Actuator

Step 1. Mount the magnet assembly to the stem of the actuator. A coupler block normally is needed to extend the magnet assembly outside the yoke area and into the sensing range of the magnetic pick-up unit.

Step 2. Fasten the mounting bracket to the actuator.

Step 3. Mount the positioner to the mounting bracket. The positioner should be mounted so the magnetic pick-up unit of the positioner is centered between the limits of the magnetic assembly's stroke. After mounting the positioner, the magnet assembly should be within 1/8" [3.2 mm] from the back of the positioner (1/16" [1.6 mm] is ideal), (See Figure 3-5)

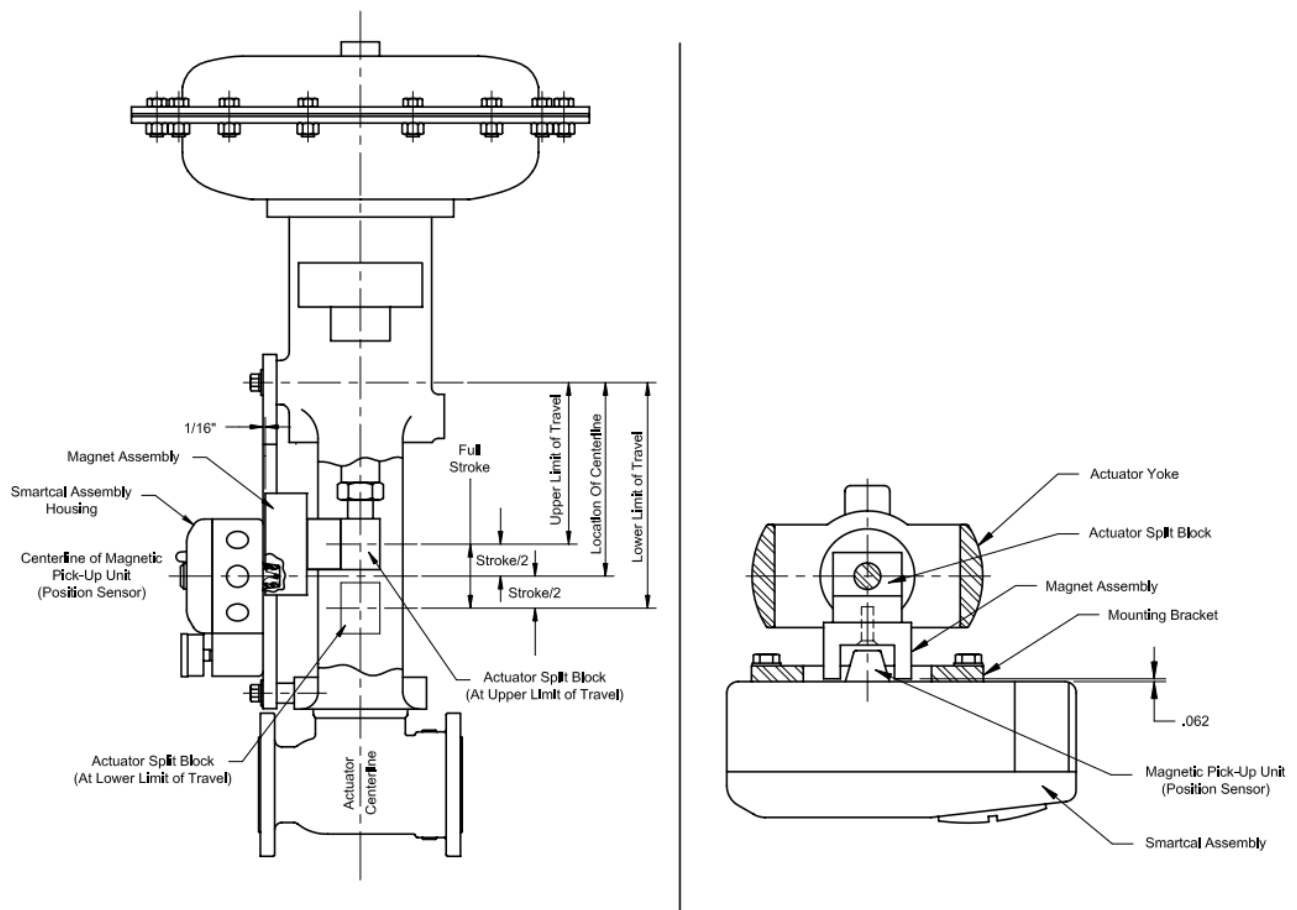


Figure 3-5

Note: For Fisher actuators model 657 & 667 sizes 34 thru 70, a slotted mounting kit design can be supplied. This will allow the user to easily center the positioner sensor between the limits of the magnet assembly's stroke. Other mounting kits are available upon request.

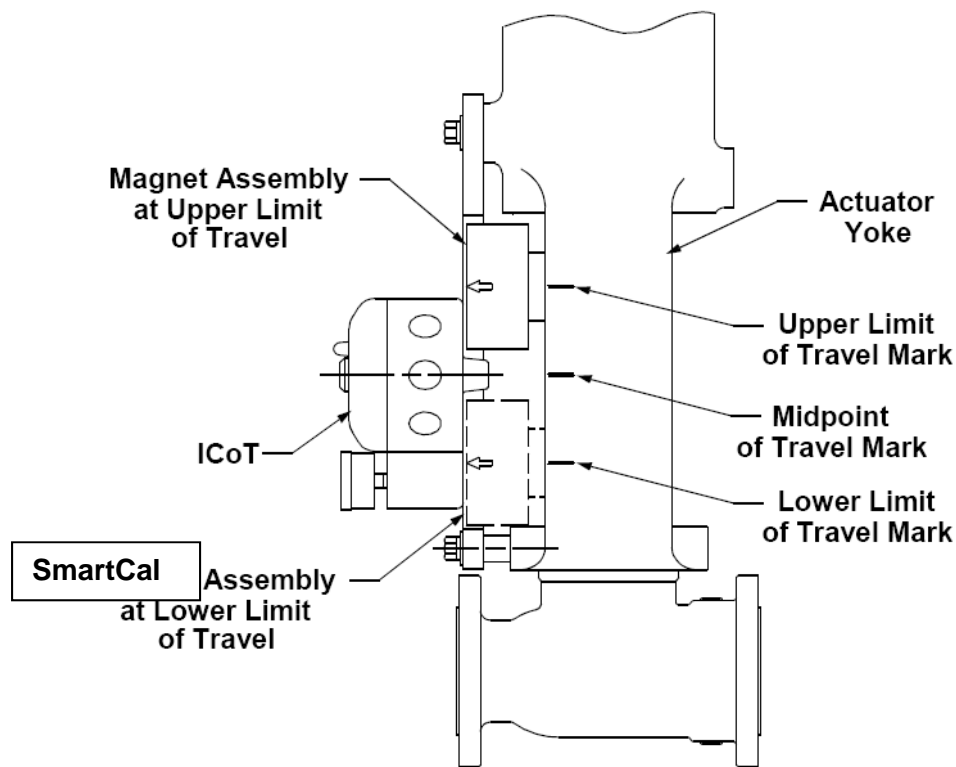


Figure 3-6

To Center the Positioner

1. Stroke the actuator to its upper limit and place a mark on the actuator's yoke that lines up with the red arrow on the magnet assembly.
2. Stroke the actuator to its lower limit and place a mark on the actuator's yoke that lines up with the red arrow on the magnet assembly.
3. Place a third mark on the yoke centered between the upper and lower limit marks.
4. Lastly, mount the positioner to the bracket so that the positioner sensor (nose) of the SmartCal lines up with the midpoint mark. (See Figure 3-6).

3.4 Mounting Remote Positioner on a Linear Actuator

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Step 1. Mount the magnet assembly and bracket to the actuator as described in Section 3.3 Step 1.

Step 2. Mount the position sensor housing so that the conduit entry faces away from the diaphragm or cylinder. (See Figure 3-7)

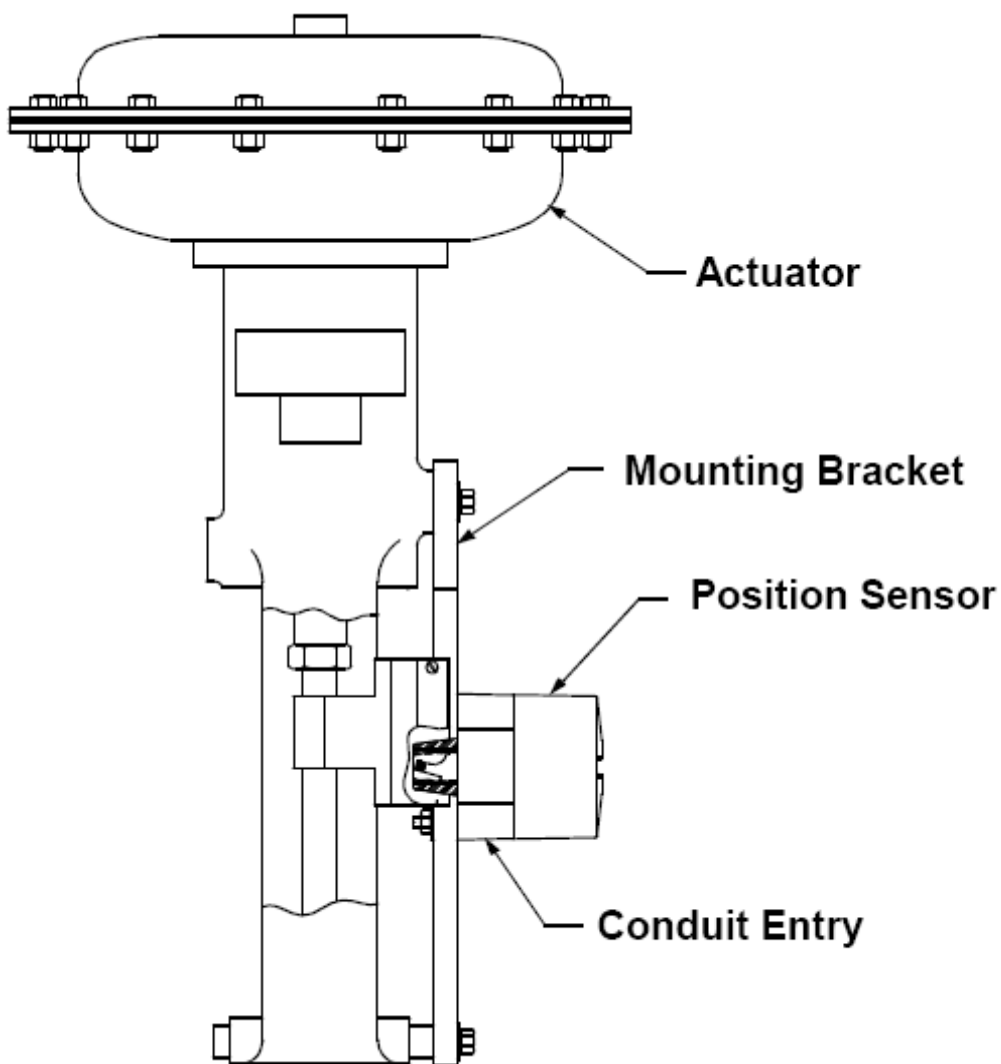


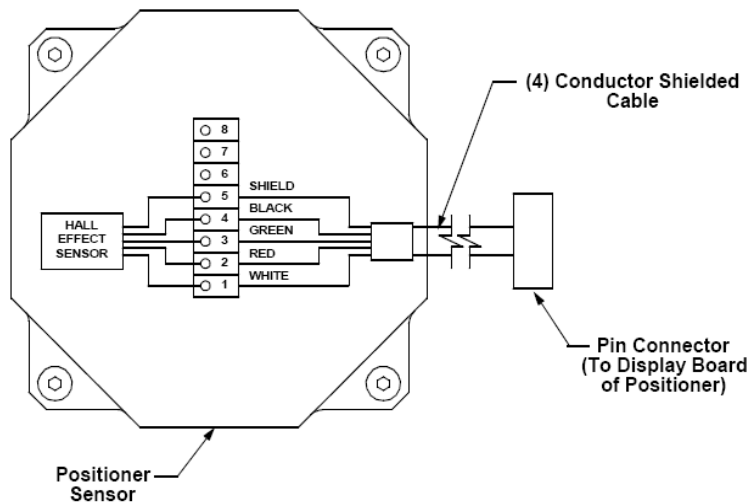
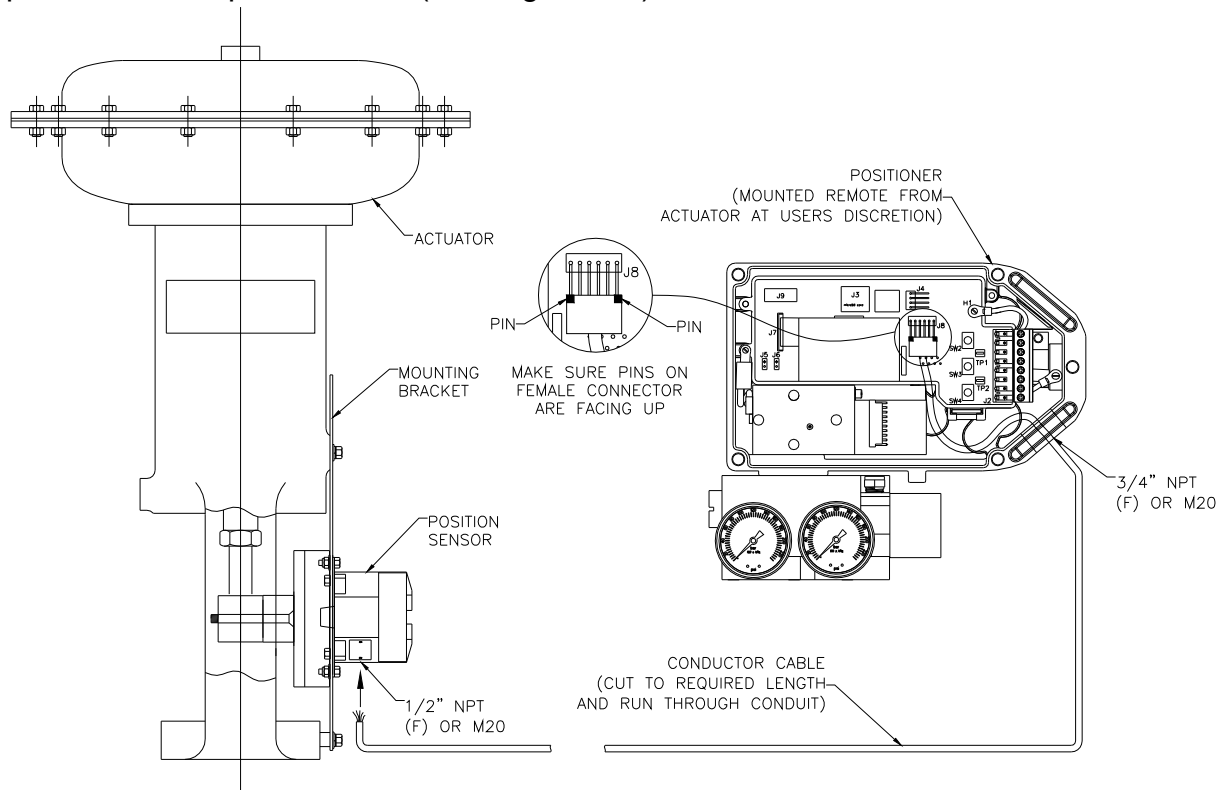
Figure 3-7

Note: For Fisher actuators model 657 & 667 sizes 34 thru 70, a slotted mounting kit design can be supplied to ease the mounting process. This will allow the user to easily center the positioner sensor between the limits of the magnet assembly's stroke. Other mounting kits are available upon request

Step 3. Mount positioner at a remote location,

Step 4. Remove the electronic canister cover by unscrewing (2) mounting screws. (Appendix B: Procedure to Remove Electronics Cover and Electronic Canister)

Step 5. If necessary cut remote cable to required length, making sure to cut end opposite female connector. Wire the positioner sensor back to the positioner using the cable provided and replace cover. (See Figure 3-8).



Wiring Schematic

Figure 3-8

3.5 Pneumatic Connection

Single Acting Actuator (Spring Return):

For single acting actuators Outlet Port 2 is to be plugged. Outlet Port 1 is to be piped to the actuator inlet port that acts against the spring. (increasing set-point signal causes pressure to increase in Outlet Port 1 of the positioner).

Double Acting Actuator (Double Return):

For double acting actuators Outlet Port 2 is piped to drive the actuator towards the fail position. Outlet Port 1 is piped to drive the actuator away from the fail position. (increasing set-point signal causes pressure to increase in Outlet Port 1 of the positioner and pressure to decrease in Outlet Port 2 of the positioner).

Note: Air supply to the positioner must be clean, dry, oil free instrument air per ISA-S7.3. Maximum supply pressure is 120 psi. All pneumatic connections are 1/4" NPT or 1/4 BSP.

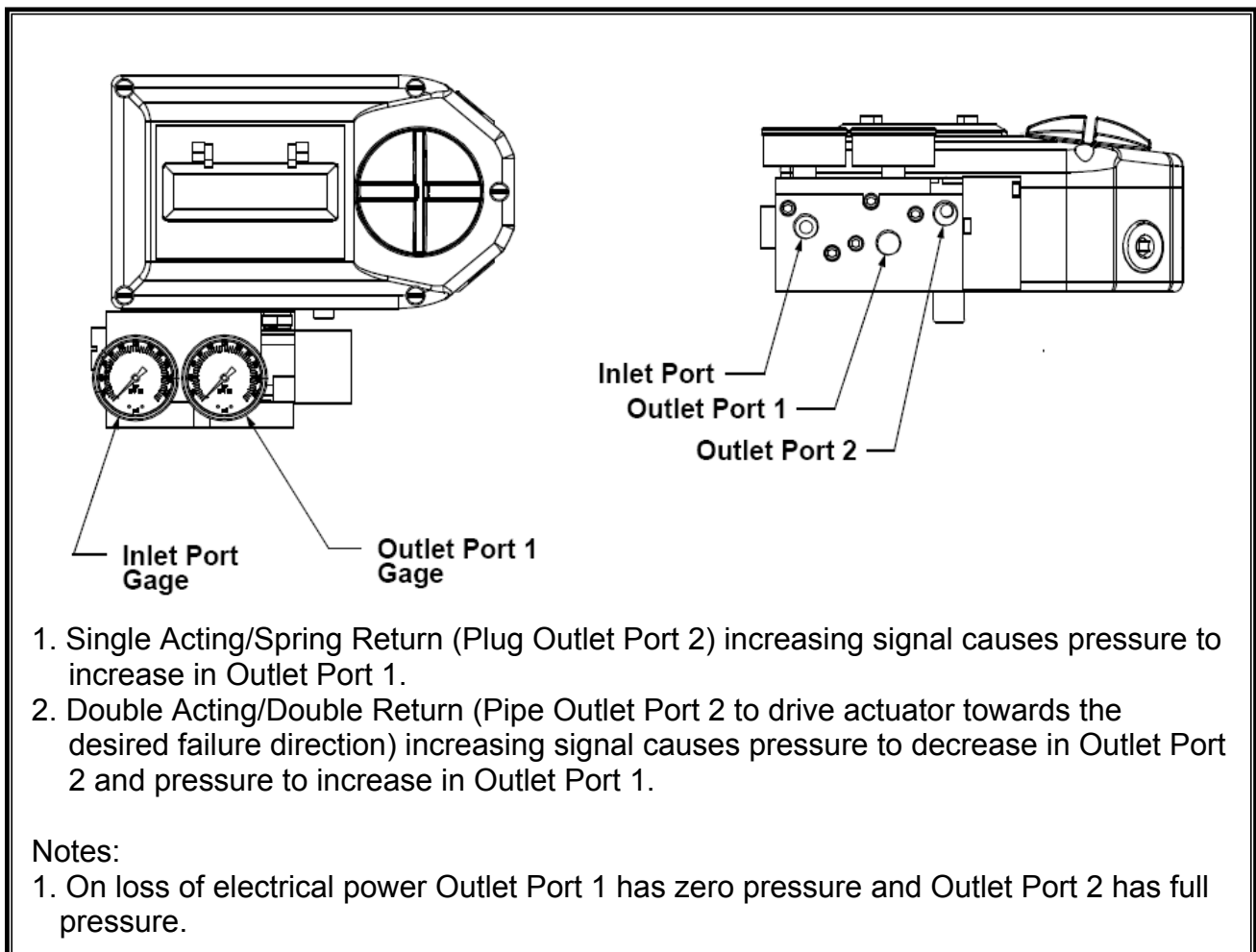


Figure 3-9

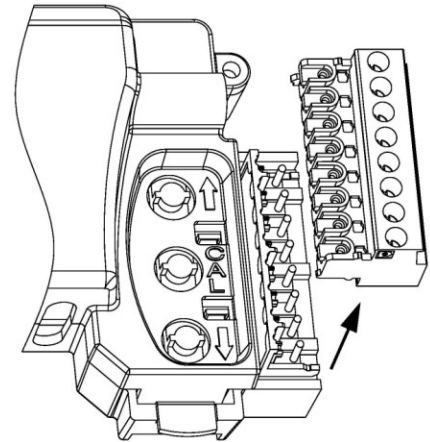
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3.6 Electrical Connection

- A) The certification applies to equipment **without** cable glands. When mounting the enclosure in the hazardous areas, **only** suitably certified cable glands and blanking elements must be used to maintain ingress protection of IP66.
- B) **All** unused cable entries **must** be plugged with suitably certified plugs that can maintain an ingress protection level of IP66.
- C) The positioner, switches, sensors and coils shall be electrically connected suitable to the rated data via a certified isolating interface/zener barrier placed outside the hazardous areas.
- D) For ambient temperatures below -10°C and above $+60^{\circ}\text{C}$, use field wiring suitable for **both** minimum and maximum ambient temperatures.
- E) Electromagnetic compatibility (emissions and susceptibility) is guaranteed only if the unit and all cables are shielded and grounded as illustrated in Appendix F.

1. Remove positioner cover.
2. Locate terminal strip and carefully disconnect (slide off).
3. Connect the 4 to 20 mA loop signal to terminal points marked (+) and (-). See figure 3-10 for a wiring schematic.
4. If the positioner was ordered with an analog output, connect output wiring to terminal points 5 & 6, (polarities shown on figure 3-10). The 4-20mA analog output is of the current sink type therefore it requires a suitable external DC power supply (24VDC nominal).
5. If the positioner was ordered with switches, connect to the switches at terminal points 1 thru 4, as shown in Figure 3-10.
6. After all connections have been made reconnect the terminal strip and replace positioner cover.



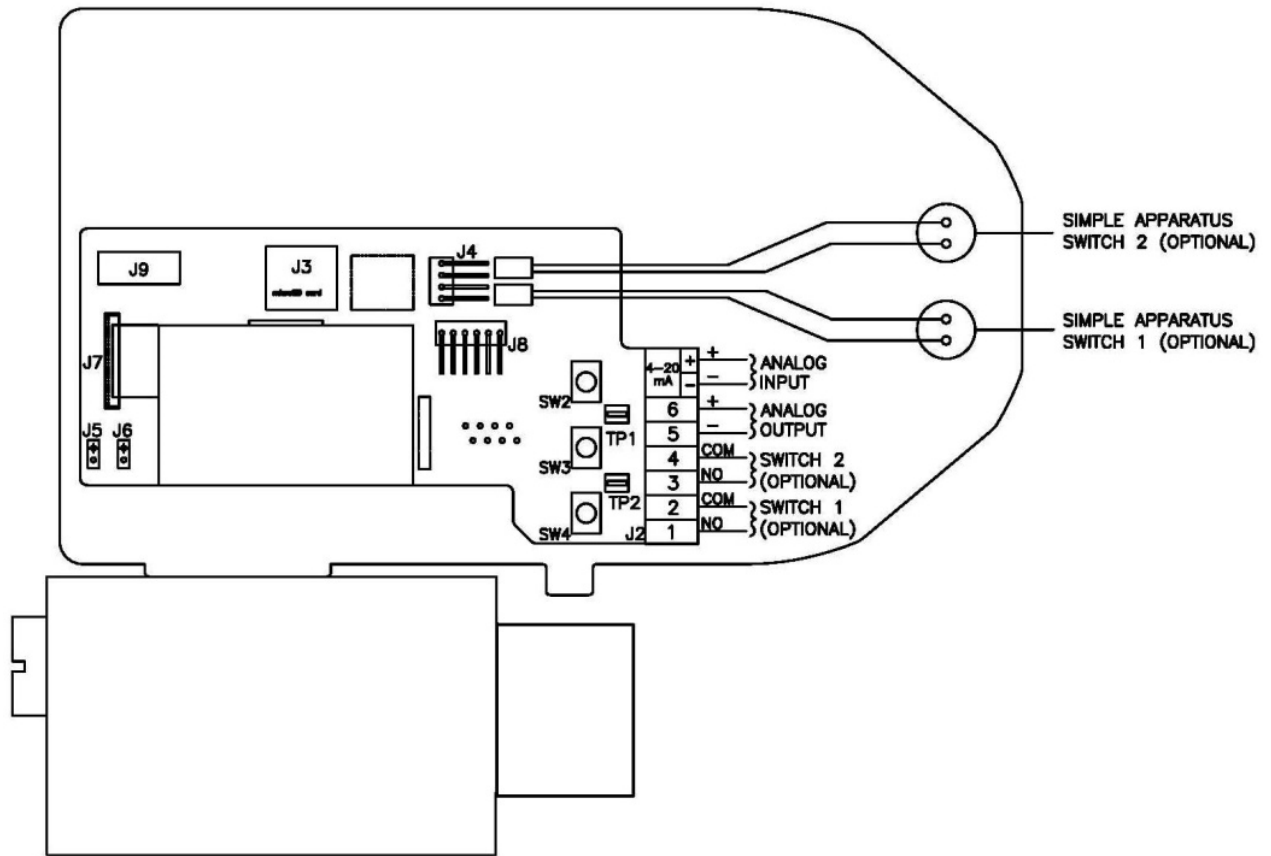


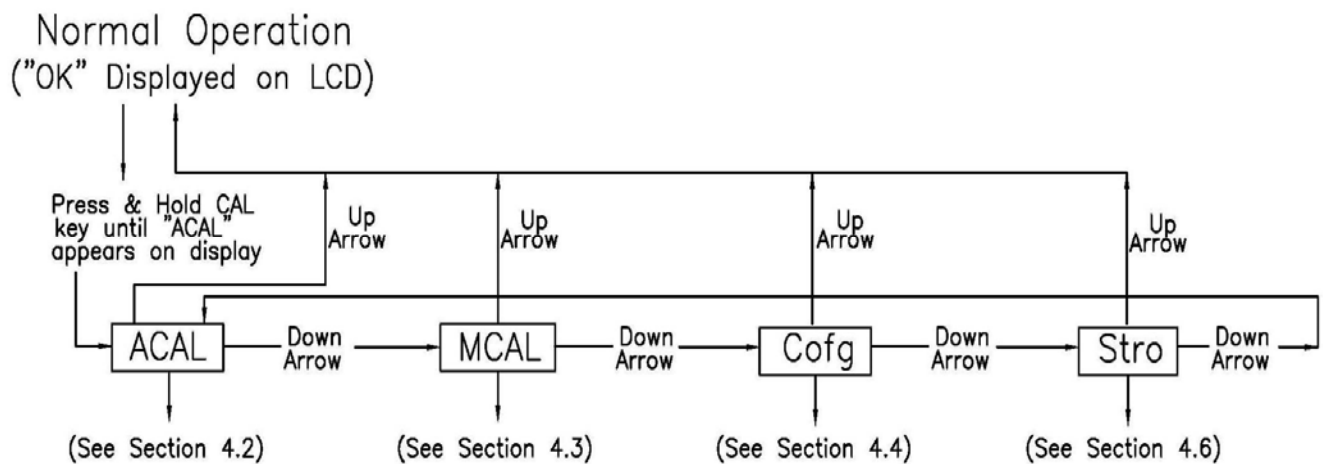
Figure3-10

4 Calibration

The SmartCal positioner has an on-board menu structure that can be accessed by pressing the Cal button. Exit any function by pressing both up and down arrow buttons simultaneously, anytime during calibration.

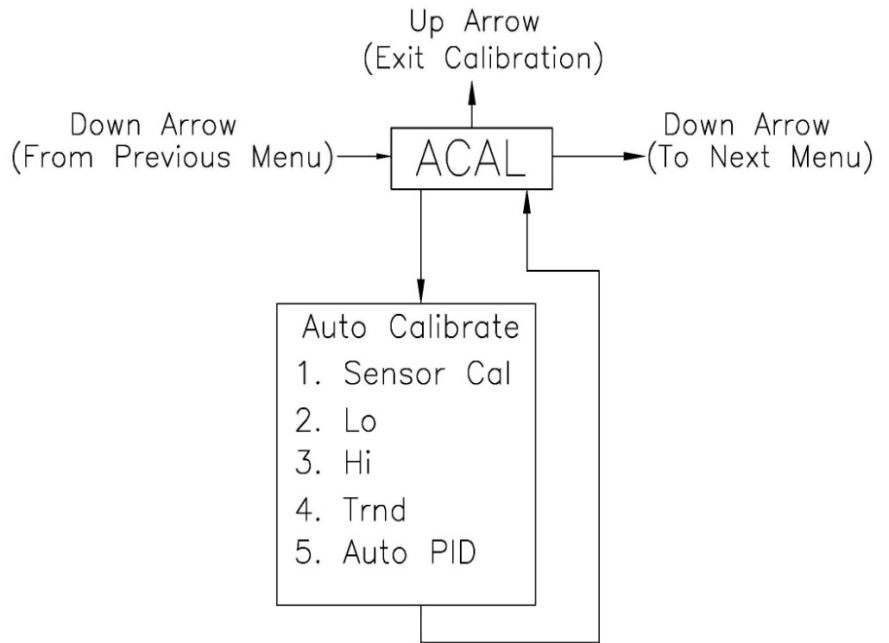
4.1 Enter Calibration (Menu Level)

Enter the calibration menu by pushing the CAL button. **ACAL** (Auto Cal Menu) is the first of four menus. By pressing the CAL button again you enter go to a lower level menu or start a routine. Pushing the down arrow button you can cycle through the menus. The remaining three menus are **MCAL** (Manual Cal Menu), **Cofg** (Configuration Menu), **Stro** (Manual Position Override Menu). Pushing the up arrow you exit the menu or go to an upper level menu. The menu level is shown below.



4.2 Automatic Calibration

The Automatic Calibration (ACAL) performs several self-adjustments, as well as a zero calibration, a span calibration, and tunes the positioner's PID gain settings. From the normal operation screen, press the CAL button until ACAL is shown on the display (the ACAL routine is shown to the right). Press and hold the CAL button until it starts the automatic calibration, of which the first step in the sequence is the Sensor Calibration.



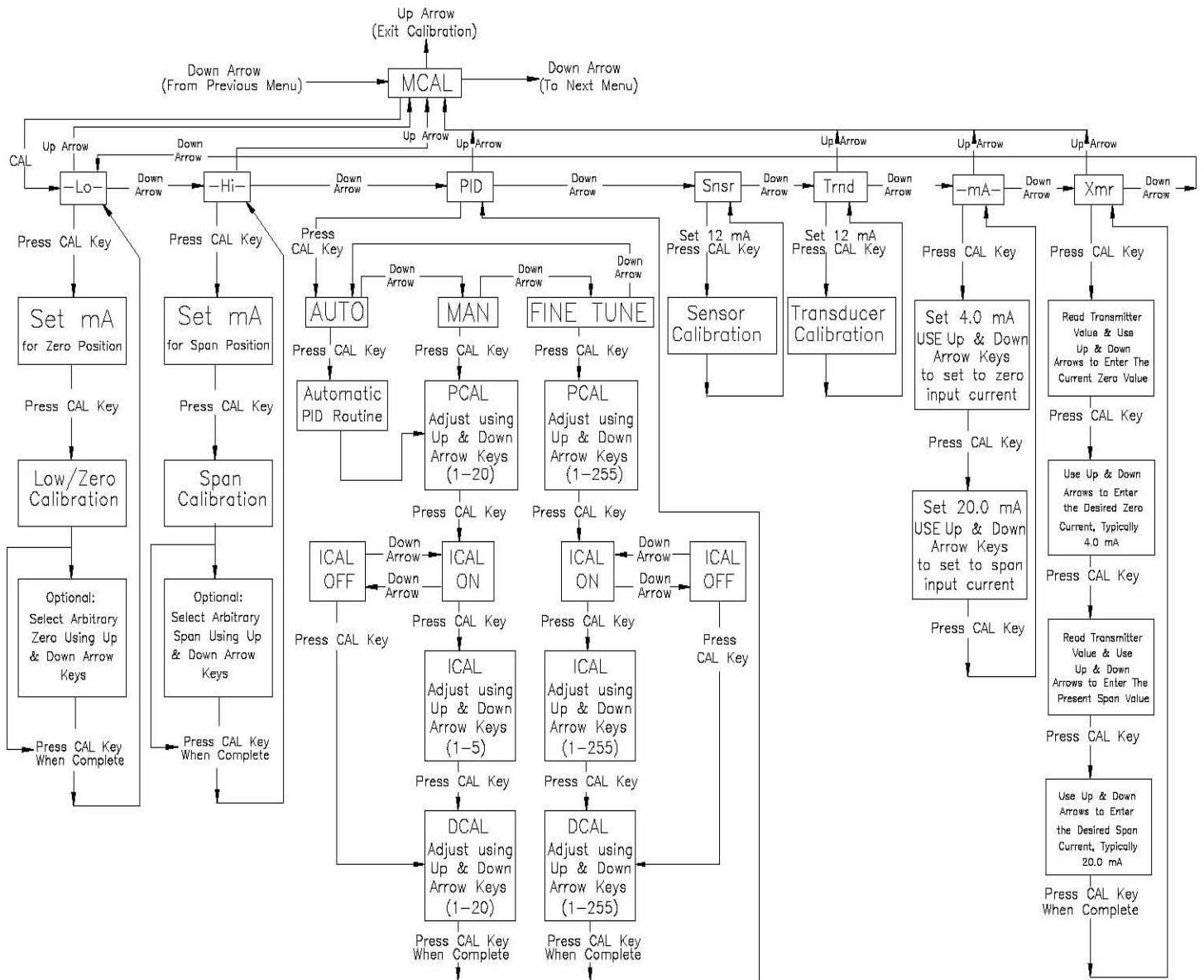
SPECIAL NOTE Flow Capacity:

SmartCal standard flow design is suitable for actuator swept volumes of a minimum 40 inch³ (0.65 liters) to a maximum of 600 inch³ (9.80 liters) for proper Auto Calibration functionality. It should also be noted that this is to be used as a general guideline only. The actuator/ valve package dynamics would dictate the success of the Auto calibration routine and could be compromised by the following: instrument air supply, volume capacity, actuator sizing, tubing size and actuator/valve health.

SmartCal Optional High Flow design is suitable for actuator swept volumes of a minimum 200 inch³ (3.2 liters) to a maximum of 1000 inch³ (16.30 liters) for proper Auto Calibration functionality. It should also be noted that this is to be used as a general guideline only. The actuator/ valve package dynamics would dictate the success of the Auto calibration routine and could be compromised by the following: instrument air supply volume capacity, actuator sizing, tubing size and actuator/valve health.

4.3 Proceed to Exiting Calibration or Perform Advanced Calibration

After the completion of an Automatic Calibration (ACAL) the calibration of the positioner is complete. The Automatic Calibration that was performed in Section 3 is adequate for most applications. If no advanced calibration is required proceed to Section 5 to exit calibration. If the user requires using the advanced settings to fine tune the positioner he may proceed with the remainder of this step and perform adjustments and calibrations in the Manual Calibration Menu (MCAL). From the menu level press the down arrow button until MCAL is shown on the display (MCAL Routine shown below).



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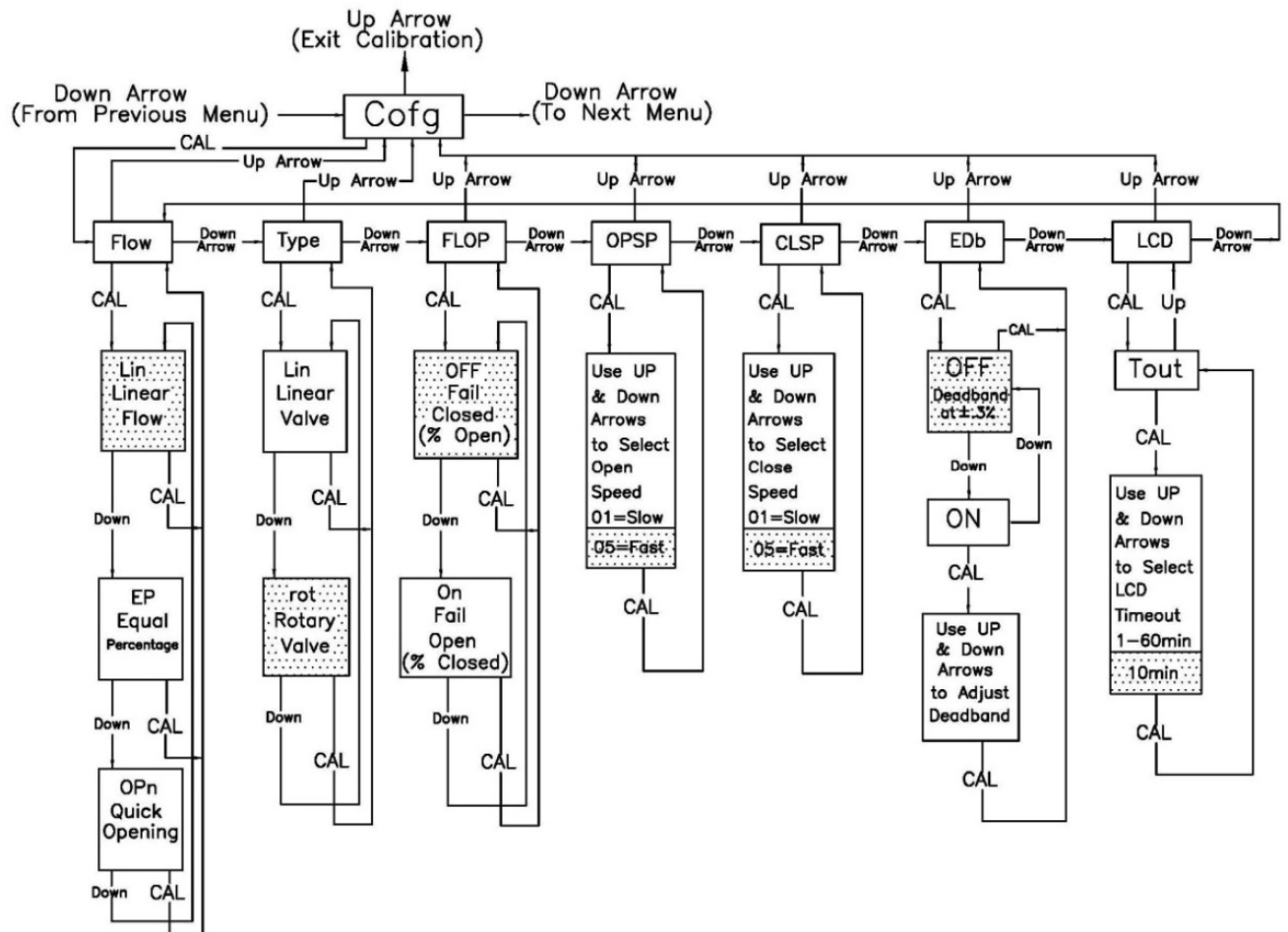
4.4 Exiting Calibration

To exit calibration mode and return to normal operation use the **up arrow** key as follows:

- If the positioner is at **Menu level** in the calibration, as determined by LCD displaying a Menu name only (**MCAL**, etc.), press the **up arrow** key once to exit **CAL** mode.
- If the positioner is at **function level** in the calibration, as determined by LCD displaying a function and Menu name only (**MCAL Lo**, etc.), press the **up arrow** key once to enter the Menu level and once more to exit **CAL** mode.
- If the positioner is performing any calibration function (e.g., **ACAL Trnd**), press up and down key simultaneously to abort the current operation and go to the normal operation screen.
- When the calibration mode is exited the Menu and function names will no longer be displayed by the LCD. The LCD will be displayed "OK".

4.5 Configure the Positioners Parameters

From the menu level press the down arrow button until the Cofg (Configuration Menu) is shown on the display (Configuration Routine Shown Below). Enter this menu and change any of the parameters, if other than the factory settings are needed. The factory settings are highlighted.

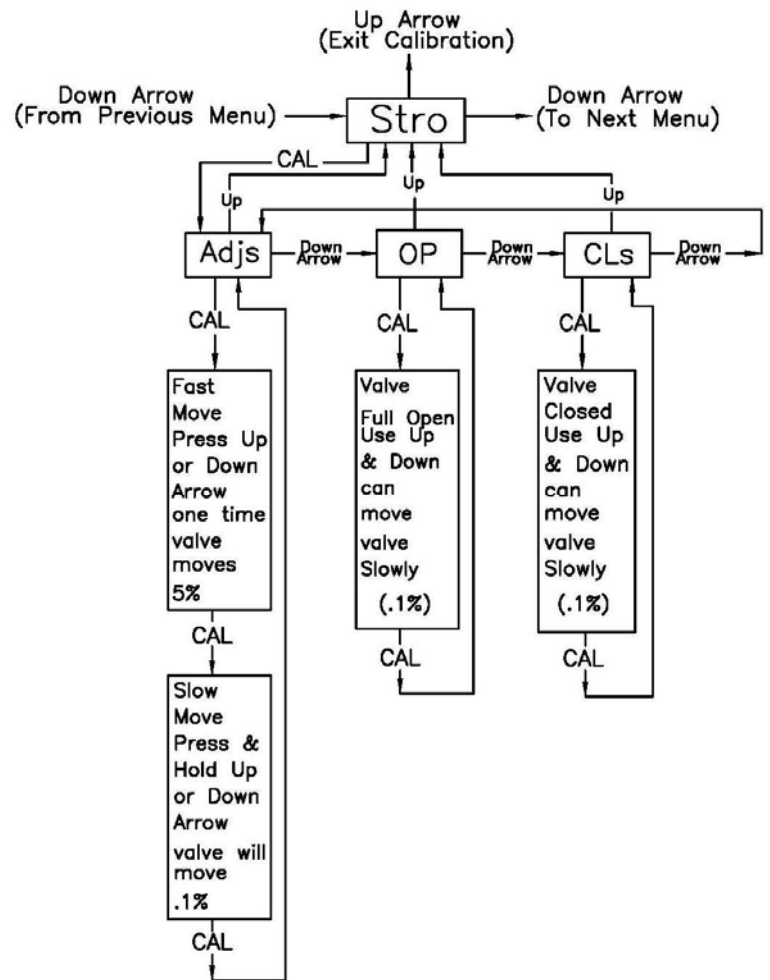


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4.6 Manual Override of Input Signal (Via On-Board Keypad)

The positioner has a feature which allows the operator to override the analog set-point signal and change valve position from the keypad. This is done from the **Stro (Manual Override-Stroke Menu)**. Enter calibration as described in section 4.1 and use the down arrow button to cycle to the **Stro** menu. Enter this menu and control the position of the valve as shown below.



4.7 Description of Menus

The calibration functions of the positioner are organized into the following four menus:

Menus

- Menu 1: **ACAL (Automatic Calibration)**
- Menu 2: **MCAL (Manual Calibration)**
- Menu 3: **Cofg (Configuration)**
- Menu 4: **Stro (Manual Override of Input Signal)**

Menu descriptions are as follows:

Menu 1: ACAL (Automatic Calibration)

Entering this menu allows you to initiate an approximately seven minute self-calibration function. The positioner will automatically enter digital control mode and perform a shallow (**input current independent**) calibration in the following sequence:

Function

1. **-Snsr-** Sensor Calibration
2. **-Lo-** Low (Zero) Calibration
3. **-Hi-** High (Span) Calibration
4. **-Trnd-** Transducer Calibration
5. **-Auto-** Automatic PID Tuning

Menu 2: MCAL (Manual Calibration)

Entering this menu allows you access to the following four calibration functions via the keypad:

1. **-Lo-** Low (Zero) Calibration
2. **-Hi-** High (Span) Calibration
3. **-PID-** Proportional, Integral and Derivative Gain Adjustment
4. **-Snsr-** Sensor Calibration
5. **-Trnd-** Transducer Calibration
6. **-mA-** Milliampere Calibration
7. **-Xmr-** Transmitter Calibration

Menu 3: Cofg (Configuration)

Entering this menu allows you access to the following five configuration functions via the keypad:

1. **-Flow-** Positioner Output Flow Characteristics
2. **-Type-** Positioner Recognition of Magnetic Feedback, Rotary or Linear
3. **-Flop-** Positioner Fail Position, Open or Closed
4. **-OPSP-** Positioner Opening Speed Adjustment
5. **-CLSP-** Positioner Opening Speed Adjustment
6. **-EDb -** Positioner Operating Dead-band Adjustment
7. **-LCD-** LCD Menu Timeout Adjustment

These functions allow display, speed and valve characteristic changes from standard factory settings.

Menu 4: Stro (Manual Override of Input Signal)

Entering this menu allows you access to the following three stroking functions via the keypad:

1. **-Adjs-** Adjustment of Positioner to Any Position Using Keypad Arrows
2. **-OP-** Open, Sets the Valve to the Full Open Position
3. **-CLs-** Close, Sets the Valve to the Full Closed Position

These functions set the positioner to digital control mode (**input current independent**) and therefore allow override of the control signal.

4.8 Description of Functions

LO This function serves to set the fail position of the actuator/valve. Initially during this calibration the valve is driven to the fail position (hard stop). The user will notice full pressure to Outlet Port 2 and zero pressure to Outlet Port 1. After a short period of time pressure will increase in Outlet Port 1 and the valve will be driven to the fully energized position and then back to the fail position. At this point the user has the option to select the hard stop as low (zero) position or to select an arbitrary position as low (zero) position.

HI This function serves to set the fully energized (full travel) position of the actuator/valve. Initially during this calibration the valve is driven to the fully

energized (full travel) position (hard stop). The user will notice full pressure to Outlet Port 1 and zero pressure to Outlet Port 2. At this point the user has the option to either select the hard stop as the high (span) position, or to select an arbitrary position as the high (span) position.

PID The PID function allows the user to modify the PID settings of the positioner so the user can optimize the dynamic response of the positioner **regarding the** speed of response, overshoot and **steady-state** error by varying the appropriate gain settings. This function is often used to fine tune the PID values obtained from the automatic calibration function (**ACAL**). The PID entry allows the user to modify the tuning parameters in three different ways:

1. **Auto PID:** this option triggers the Auto PID procedure. It will override the positioner control and will modulate the valve in order to automatically find out the best P, I and D parameters.

2. **Manual PID:** the **Manual Proportional (PCAL)** and **Derivative (DCAL)** gain settings can be varied incrementally on a scale from 1-20. The **Integral (ICAL)** gain setting can be varied incrementally on a scale from 1-5. The Manual PID values are actually index representations of the Fine Tune settings that are reported through the HART communication.

3. **Fine Tuning:** the **Fine Tune Proportional (PCAL)**, **Derivative (DCAL)** and **Integral (ICAL)** gain settings can be varied incrementally on a scale from 1-255. The fine tuning values are directly related to the actual time constant values (T_i or T_d) and the Proportional gain value (K_c). The proportional gain (K_c) has a direct effect in the system response time. So, as higher the K_c as faster is the response time. The drawback of increasing the value of the K_c is the higher overshoot and settling time. Sometimes the valve's position control becomes instable, oscillating forever around the set point. The integrative term (T_i) affect the dynamic response of the position control by damping the positioner response according to the T_i value. So as lower the value of T_i as less damped is the dynamic response. This means that as lower the T_i as more oscillations are observed before the stabilization of the position and vice-versa. However, as higher the T_i as higher will be the settling time. Regarding the Derivative term (T_d), as greater is its value as greater will be the derivative effect. Different from the proportional gain and integrative term, the derivative term is not proportional to the error but the variation of the position. The effect of T_d is to decrease the overshoot and the control reacts against the variation of the position. The drawback is that as higher the T_d as unstable can be the control system.

Snsr The sensor calibration is a self-adjustment that sets the positioner's Hall-Effect circuitry. This is automatically done during the **ACAL (Automatic Calibration)** routine. The sensor calibration also shows up under the **MCAL** menu. This calibration only needs to be performed under the **MCAL** routine when the

positioner is set-up on a new application and only if the **ACAL** routine is not performed.

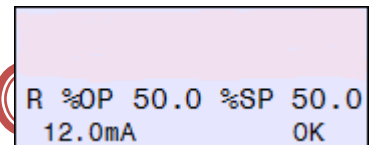
Trnd The purpose of this function is to calibrate the positioner's pressure transducer. It should be performed only after a manual sensor calibration.

mA This routine calibrates the positioner's electronics to recognizing input current. This is done using 4.0 mA and 20.0 mA as reference points. If exactly 4.0 mA or 20.0 mA cannot be given as inputs, the user can adjust the positioner's values to the input using the arrow buttons.

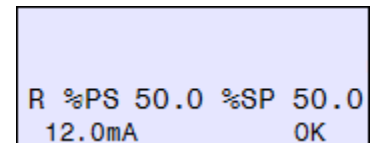
Xmr This routine calibrates the positioner's optional 4-20mA position transmitter. The transmitter calibration does not require the user to change the input current, although it does require the user to be able to read the transmitter's value in mA. For each, the zero and span, the user is first prompted to enter the value that the transmitter is presently at. This is done by using the up and down arrow buttons. The user is then prompted to enter the desired transmitter output (typically 4.0 mA for zero and 20.0 mA for span). The positioner then calculates the difference between the present and the desired output currents (for zero and span) and uses the differential to adjust the transmitter accordingly.

Flow This function allows for the setting of the flow characteristic of the positioner (not to be confused with the flow characteristic of the valve). The options are **Lin (Linear)**, **EP (Equal Percentage)** and **Opn (Quick Opening)**. A **Lin (Linear)** positioner characteristic duplicates the inherent characteristic of the valve and is the most often used setting.

Type This function configures the positioner for the type of valve. The options are **R (Rotary)** and **L (Linear)**. This setting needs to be done in order to configure the positioner to recognize the type of magnetic feedback being given to the positioner. This setting is shown on the left side of the LCD.



FLOP This function allows the user to configure the positioner to match the failure method of the valve/actuator. The options are "off" or "on". The "off" option is for fail closed applications and the "on" option is for fail open application. When "off" is chosen the LCD will read 0% at the **zero (Lo Calibration)** and 100% at the **span (Hi Calibration)**. When "on" is chosen the LCD will read 100% at the **zero (Lo Calibration)** and 0% at the **span (Hi Calibration)**.



OPSP This function allows for the setting of the opening speed of the actuator/valve. The range is 1 thru 5. Setting 5 is the fastest opening speed and setting 1 is the slowest opening speed.

Setting	Approx.% Dynamic Speed
5	100%
4	80%
3	60%
2	40%
1	20%

CLSP This function allows for the setting of the closing speed of the actuator/valve. The range is 1 thru 5. Setting 5 is the fastest closing speed and setting 1 is the slowest closing speed.

Setting	Approx.% Dynamic Speed
5	100%
4	80%
3	60%
2	40%
1	20%

EDb This feature configures the positioner’s operating dead-band. The configuration options are “**off**” and “**on**”. The positioner is factory set as “**off**”. When the dead-band feature is “**off**” it operates with nominal value of $\pm 0.3\%$ of full scale for dead-band. When the feature is turned “**on**”, the dead-band can be set using the up and down arrow buttons to a value from 1 to 20. The value 1 (**lowest dead-band when turned “on”**) has a dead-band range of 1%, which is equivalent to a dead-band of $\pm 0.5\%$. The value 20 (**highest dead-band value**) has a range of 20%, which is equivalent to a dead-band of $\pm 10\%$.

LCD This feature configures LCD menu timeout. The range is 1 to 60 minutes. It measures the amount of time there is no activity on the keypad and returns the system to the main screen after the configured timeout. The default value is 10 minutes.

Adjs This function allows for the adjustment of the positioner to any position via the keypad. This function places the positioner in digital control mode (**input current independent**) and therefore allows override of the control signal. Within this function there are **Fast** and **Slow move** modes. In **Fast move** mode the valve is opened or closed in 5% increments via the keypad. In **Slow move** mode the valve is opened or closed slowly via the keypad.

OP This function sets the valve to the fully energized position via the keypad (**Outlet Port 1 = Supply psi & Outlet Port 2 = 0 psi**). This function places the positioner in digital control mode (**input current independent**) and therefore allows override of the control signal.

CLs This function sets the valve to the fully de-energized position via the keypad (**Outlet Port 1 = 0 psi & Outlet Port 2 = Supply psi**). This function places the positioner in digital control mode (**input current independent**) and therefore allows override of the control signal.

5 Trouble Shooting

5.1 Preliminary Checks

Before operating the positioner check the following:

5.1.1. Voltage

The positioner requires a 4-20 mA current source, with a minimum voltage of 9VDC at its terminals, over-current protected up to 35VDC.

Current range: 3.2mA to 22mA, accordingly to the following table (NAMUR NE43):

Loop Current [mA]	Electronics	Spool valve	HART comm
$0.0 \leq I < 3.2$	OFF	OFF	OFF
$3.2 \leq I < 3.5$	ON	OFF	OFF
$3.5 \leq I < 3.8$	ON	OFF	ON
$3.8 \leq I \leq 20.5$	ON	ON	ON
$I > 20.5$	ON	ON	ON

5.1.2. Electrical Connection

Check the polarity of the 4-20 mA loop current loop. The SmartCal terminal strip visually designates the positive and negative terminal points for connection with a "+" and "-", respectively.

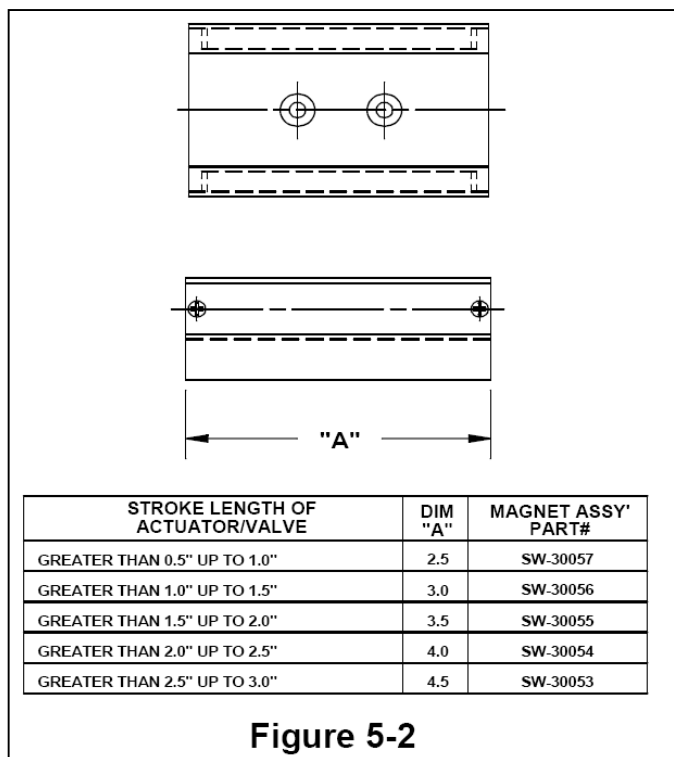
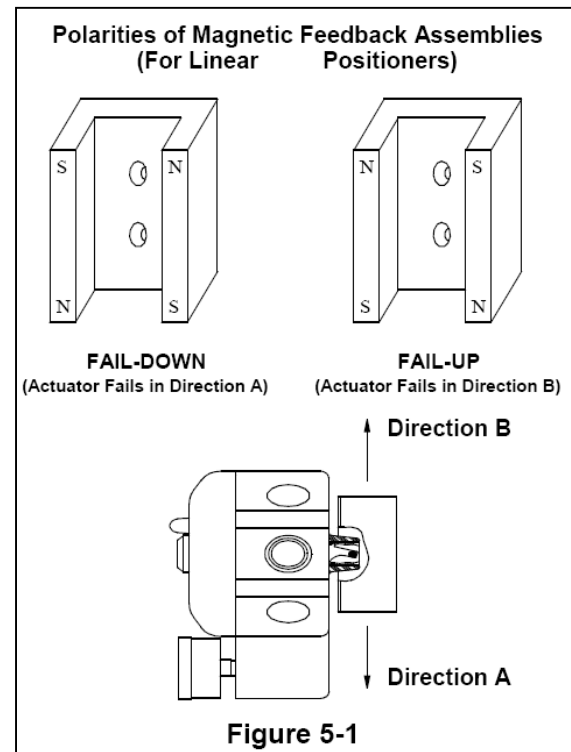
5.1.3. Pneumatic Connection

Single Acting: Output port 1 should be piped to drive the actuator away from the valves fail position. Output port 2 should be plugged. (See Section 3.3)

Double Acting: Output port 1 should be piped to drive the actuator away from the valves fail position. Output port 2 should be piped to drive the actuator towards the valves fail position. (See Section 3.3)

5.1.4. Magnetic Position Feedback

Rotary Positioner: The magnetic beacon should be set in the proper orientation, based on the direction of failure. (See Section 3.1)



Linear Positioner: The magnetic assembly supplied with the positioner should correspond to the stroke length and failure direction of the actuator. To make sure you have the appropriate magnet assembly, check the part. The stroke length and failure direction should be printed on the part. On the older SmartCal the magnet assembly is not printed with this information, although there should be a serial number. Contact the factory with the serial number to verify that it is correctly matched to the actuator. (See Figure 5-1 & Figure 5-2).

5.1.5. Supply Pressure

The supply pressure should be regulated appropriately with regard to the actuator. If there is question as to the proper supply pressure, the actuator manufacturer should be contacted.

5.1.6. Positioner Pressure Rating

If the supply pressure is above 40 PSI a high pressure SmartCal positioner must be used. If the supply pressure is below 40 PSI a low pressure SmartCal positioner must be used.

(See Ordering Guide - Section 2.1)

5.2 FAQ's

Listed here are some FAQ's encountered with the SmartCal positioner.

5.2.1. The LCD remains blank even after power is applied to the positioner.

- Check if loop current polarity matches positioner input.
- The positioner should be given a minimum current of 3.2mA and at least 9VDC @ 20mA. The voltage across the positioner can be checked by removing the cover and connecting a voltmeter across TP1 and TP2 on the display board.

5.2.2. The positioner has power but the position as shown on the LCD does not match the actual position of the actuator/ valve.

- May need to be calibrated. Perform a manual step by step calibration or a full automatic calibration (see sections 4.7 and 4.8).
- Beacon may be incorrectly oriented.
- Check if it is properly configured as linear or rotary (see section 4.8 function "Type").
- The flow characteristic during calibration was set to equal percentage or quick opening, not linear. If linear is desired enter calibration and make this change (See Calibration Instructions section 4.1 & 4.2).

5.2.3. The positioner is properly set-up, and air is applied to the positioner. When powering up the positioner, the actuator goes into a state of constant oscillation.

- Check for air leaks and if assembly is tightly coupled: tubing, actuator, bracket, cables etc.
- The gain settings are probably too high for the actuator/valve assembly. If not done yet, perform a full automatic calibration (see section 4.7).
- If full auto cal has not given good results, perform a manual auto PID (see section 4.8, function “PID”).
- If manual PID has not given good results, try to manually fine tune the PID. Enter the calibration mode and reduce the **PCAL** value until oscillation ceases.
- Try also to increase the **ICAL** setting until oscillation ceases.
- Try to adjust **PCAL**, **ICAL** and **DCAL** settings one at a time, until the dynamics response is satisfactory.

5.2.4. After removing power to the positioner there is full pressure to output port 1 and zero pressure to output port 2.

- On loss of power the positioner fails full air pressure to output port 2. If this does not happen the positioner is damaged. Contact factory.

5.2.5. An Err 6 (Calibration Error) is returned during a Lo or Hi Calibration.

- In the case of a rotary application, the beacon may be incorrectly oriented or the actuator may not have enough rotation. The positioner requires the actuator to stroke a minimum of 45 degrees.
- In the case of a linear application, the feedback magnet assembly needs to be ordered specific to the stroke of the actuator and the fail direction of the actuator. (See figure 5-1 & 5-2).

5.2.6. An Err 5 (Integrator Overflow) message is shown on the display.

- This message indicates a deviation between position and set-point. This error message does not clear itself after the problem ceases, therefore, try clearing the message.
- If the Err 5 returns, make sure all the preliminary checks, as described earlier in this section, have been made. If still the cause for the Err 5 cannot be diagnosed, call the factory for help.

6 Technical Specifications

Input

Set-point: 4-20 mA, two wire, Namur NE43
Normal Operation: $3.8 \leq I \leq 20.5$ mA
Fail Condition: $I \leq 3.6$ or $I \geq 21.0$ mA
Minimum current w/o reset: 3.2mA
Voltage: 9 to 35 VDC
Over-current protection: < 70mA, 40VDC
Impedance: 450 Ohms @ 20mA

Pressure: 15 - 45 psi (Low)
40 - 120 psi (High)

Instrumentation air quality must be according to ISA-7.3 "Air Quality Standards for Pneumatic Instruments"

Output

Flow Rate: 16.2 scfm @ 90 psi
Pressure: 0 to 120 psi (High)
Actuator: Single Acting or
Double Acting

Optional position transmitter:
4-20 mA, two wire, Namur NE43
Normal Operation: $3.8 \leq I \leq 20.5$ mA
Fail Condition: $I \leq 3.6$ or $I \geq 21.0$ mA
selectable by switch
Maximum voltage: 35VDC
Maximum load impedance: 1 KOhm

Performance

Resolution: $\pm 0.2\%$ Full Travel
Linearity: $\pm 0.5\%$ Full Scale (Rotary)
 $\pm 1.0\%$ Full Scale (Linear)
Hysteresis: $\pm 0.2\%$ Full Scale
Repeatability: $\pm 0.2\%$ Full Scale

Operating Temp: -40°C to 85°C
(-40°F to 167°F)

LCD readable: -20°C to 70°C
(-40°F to 158°F)

Remote Hall sensor: -40°C to 125°C
(-40°F to 257°F)

Thermal Coefficient: $\pm 2\%$ / 100°C

Air Consumption: 0.08 scfm @ 90 psi

Stroke: 0.25 to 24 inches (Linear)
45 to 95 degrees (Rotary)

Position Feedback: Magnetic (Non-Contact)

Diagnostics: HART Protocol, Software Utilizing HART Protocol

Enclosure

Material: Engineered Resin,
Aluminum, Stainless Steel

IP Rating: IP 66

Weight: 3.3 Kg / 7.2 Pounds (resin, standard flow manifold)

Air Connections: 1/4" NPT or 1/4" BSP
(STD Flow)
3/8" NPT or BSP
(High Flow)

Conduit Connection: M20
(Standard)
1/2" NPT (Optional)

EMC (Electromagnetic Compatibility)

IEC 61000-6-4: 2007 "Emission standard for industrial environments".

IEC 61000-6-2: 2005 "Immunity for industrial environments"

7 Error codes and LCD messages

7.1 *Error codes that are backward compatible to previous versions of the SmartCal positioner*

Err 3 (Error 3)	Low Input Pressure
Err 5 (Error 5)	Integrator Overflow – Actual position does not match set-point
Err 6 (Error 6)	Calibration Error - Positioner could not successfully perform calibration
ALR (Alert 3)	<p>Valve position is not being maintained within the dead-band range. The dead-band range (EDb) is set from the configuration menu during calibration (Section 4). The EDb must be set to other than zero (0) to enable the Alert 3 message. Additionally, check the following items:</p> <ul style="list-style-type: none">• Hall sensor connector and cable, especially if remote• Pressure supply stability• Actuator and tubing leaks• Magnet assembly in correct position and tight• Set-point stability• Flow turbulence• Sources of electromagnetic noise too close to the sensor or to the positioner cables, like AC cables for motors, inverters etc

7.2 LCD error messages

The SmartCal positioner has built-in diagnostics that allow the user to identify and resolve most of the common installation and operation problems. The following table lists the available messages, their meaning and recommended solutions:

Message	Meaning	Solution
Valve position unstable	Position is unstable or oscillating too much during calibration	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Pressure supply stability • Actuator and tubing leaks • Magnet assembly in correct position and tightly coupled • Set-point stability • Actuator/Valve assembly integrity • Sources of electromagnetic noise too close to the sensor or to the positioner cables, like AC cables for motors, inverters etc • Perform a full auto CAL • Call factory for additional support
HALL sensor rail error	Position error during PID calibration	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Pressure supply stability • Actuator and tubing leaks • Perform a full auto CAL • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
PID gain error	PID calibration was not able to find proper gain values and control the valve position	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Pressure supply stability • Actuator and tubing leaks • Actuator/Valve assembly integrity • Perform a full auto CAL • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
Transducer PWM error	During calibration an error occurred with the PWM signal that control the spool-valve driver	<p>Check:</p> <ul style="list-style-type: none"> • Cable between the inner canister and the pneumatic transducer assembly is tightly connected • Cable and connector between the transducer board and the spool-valve coil • Perform a full auto CAL • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry the calibration • Call factory for additional support

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Message	Meaning	Solution
Input pressure unstable	Pressure was unstable during calibration	Check: <ul style="list-style-type: none"> • Pressure supply stability • Actuator and tubing leaks • Manifold and transducer assembly are tightly coupled to the enclosure and there are no leaks • Check if the cable between the inner canister and the pneumatic transducer assembly is tightly connected • Actuator/Valve assembly integrity • Perform a full auto CAL • Call factory for additional support
HALL span too small	Hall sensor used to read position is unstable	Check: <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly: <ul style="list-style-type: none"> ○ For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). ○ For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7) • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry the calibration • Grounding issues, cable shield is properly grounded; positioner ground is properly connected to a clean ground reference. • Sources of electromagnetic noise too close to the sensor or to the positioner cables, like AC cables for motors, inverters etc • Try to replace the Hall sensor and/or the magnet • Call factory for additional support
A2D span too small	One or more of the analog variables (position, pressure or loop current) does not have enough span to calibrate accordingly	Check: <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly: <ul style="list-style-type: none"> ○ For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). ○ For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7) • Set-point stability, current generator, grounding issues, cable shield is grounded properly, cables entry ground is properly connected to a clean ground reference. • Pressure supply stability, actuator and tubing leaks • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Grounding issues, cable shield is properly grounded; positioner ground is properly connected to a clean ground reference. • Sources of electromagnetic noise too close to the sensor or to the positioner cables, like AC cables for motors, inverters etc • Call factory for additional support

Message	Meaning	Solution
Comp range error	An unknown error has occurred during calibration	<p>Check:</p> <ul style="list-style-type: none"> • Remove power for at least 1 minute and retry • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
Valve stuck	Problems in the movement detection during calibration	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly. <ul style="list-style-type: none"> ○ For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). ○ For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7) • Pressure supply stability • Actuator and tubing leaks • Manifold and transducer assembly are tightly coupled to the enclosure and there are no leaks • Check if the cable between the inner canister and the pneumatic transducer assembly is tightly connected • Actuator/Valve assembly integrity • Try to repeat a full auto CAL • Call factory for additional support
Not possible to set down gain	The calibration of the position sensor could not find a proper gain to work with the current Hall sensor and magnet assembly	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly is in correct position. <ul style="list-style-type: none"> ○ For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). ○ For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7). Check if the proper fail-down or fail-up magnet is being used (figure 5.1) • Try to repeat a full auto CAL • Try to replace the Hall sensor and/or the magnet • Remove power for at least 1 minute and retry • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
Not possible to set up gain		
Wrong delta value	An unknown error has occurred during calibration	<p>Check:</p> <ul style="list-style-type: none"> • Remove power for at least 1 minute and retry • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support

Message	Meaning	Solution
PWM overflow	During calibration an error occurred with the PWM signal that control the spool-valve driver and the position is not following the control signal	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly is in correct position. <ul style="list-style-type: none"> ○ For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). ○ For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7). Check if the proper fail-down or fail-up magnet is being used (figure 5.1) • Check if the cable between the inner canister and the pneumatic transducer assembly is tightly connected • Check the cable and connector between the transducer board and the spool-valve coil. • Try to replace the Hall sensor and/or the magnet • Remove power for at least 1 minute and retry • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
HALL sensor out of range	(SEN, LO, HI, T) Hall sensor used to read position is unstable	<p>Check:</p> <ul style="list-style-type: none"> • Hall sensor connector and cable, especially if remote (see Figure 3-4, connector J8) • Magnet assembly. For rotary magnets check if it is not rotated 90 degrees (see figures 3.2, 3.3 and 3.4). For linear magnets, check if the magnet assembly center is matching the actuator mid position (see figures 3.5, 3.6 and 3.7) • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry the calibration • Grounding issues, cable shield is grounded properly, positioner ground is properly connected to a clean ground reference. • Sources of electromagnetic noise too close to the sensor or to the positioner cables, like AC cables for motors, inverters etc • Try to replace the Hall sensor and/or the magnet • Call factory for additional support
mA input A/D is not in linear range	An invalid loop current is applied during set-point calibration	<p>Check:</p> <ul style="list-style-type: none"> • Check if the current generator is set at the proper value (between 3.8mA and 20.5mA) • Check the set-point value on the LCD and adjust the current generator accordingly • Make sure the minimum loop current span is at least 1.6mA • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support
Illegal calibration code	An unknown error has occurred during calibration	<p>Check:</p> <ul style="list-style-type: none"> • Remove power for at least 1 minute and retry • Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL • Call factory for additional support

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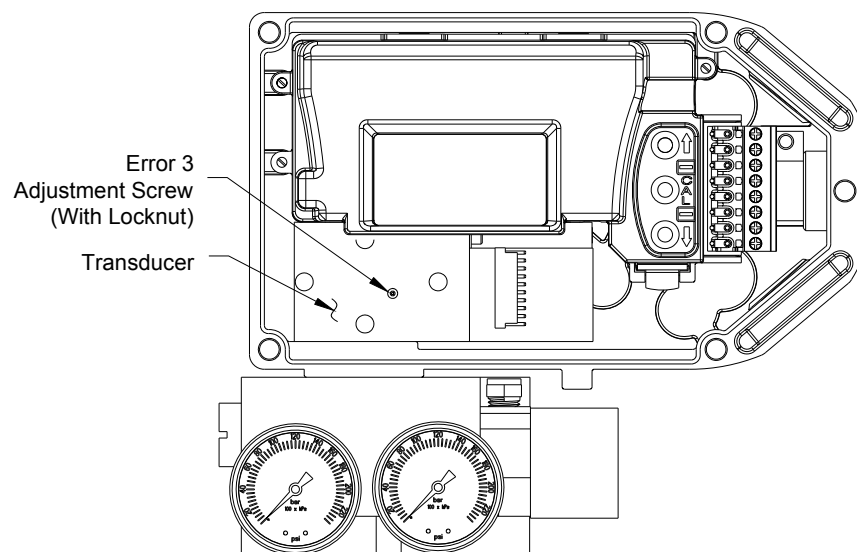
Message	Meaning	Solution
Too few bytes received	An unknown error has occurred during calibration	Check: <ul style="list-style-type: none"> Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL Call factory for additional support
Current is not 12mA	The current operation needs the loop current set to 12mA	Check: <ul style="list-style-type: none"> Check if the loop current is set at 12mA Remove power for at least 1 minute and retry Recalibrate the loop current input (see 4.8 item "mA") Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL Call factory for additional support
Generic error	An unknown error has occurred during calibration	Check: <ul style="list-style-type: none"> Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL Call factory for additional support
Service not implemented	An unknown service was request via HART communication	Check: <ul style="list-style-type: none"> Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and retry a full auto CAL Call factory for additional support
Other service running	A service request via HART communication was refused because another service is running	Check: <ul style="list-style-type: none"> Wait for 1 minute maximum for the service to finish Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and a full auto CAL Call factory for additional support
Failure mA. Not enough power	Device requires a minimum of 3.8mA to operate properly.	Check: <ul style="list-style-type: none"> Check if the loop current is set at least at 3.8mA Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and a full auto CAL Call factory for additional support
Unknown error code	An unknown error has occurred during calibration	Check: <ul style="list-style-type: none"> Remove power for at least 1 minute and retry Remove power for at least 1 minute, perform a factory default (see Appendix I) and a full auto CAL Call factory for additional support

Appendix A

Procedure to Adjust the Error 3 Setting (or Low input pressure)

Note: The error 3 message threshold is pre-set from the factory. For a low pressure positioner it is set to 15 psi and for a high pressure positioner it is set at 55 psi. If these settings come out of calibration or if it is necessary to change these settings, the following instructions can be followed.

1. Before adjusting the Error 3 threshold setting the positioner must be mounted and set-up. See section 3 of this manual.
2. To adjust the setting of the Error 3 threshold message to indicate low input pressure, there is an adjustment screw located on the top of the pneumatic transducer (see figure below).
3. To set the Error 3 threshold for an explicit pressure value, loosen the lock nut on the adjustment screw and **gently** turn the screw clockwise as far as it will go. Do not force the screw past its limit or diaphragm assembly may be damaged.
4. Regulate the supply pressure to the pressure you would like to set as a low input pressure flag.
5. Turn the adjustment screw slowly counter-clockwise to the point where the Err 3 message appears on the LCD.
6. Set this point by tightening the lock nut. Be careful not to affect the adjustment screw setting.
7. Re-regulate the supply air to the normal operating pressure.



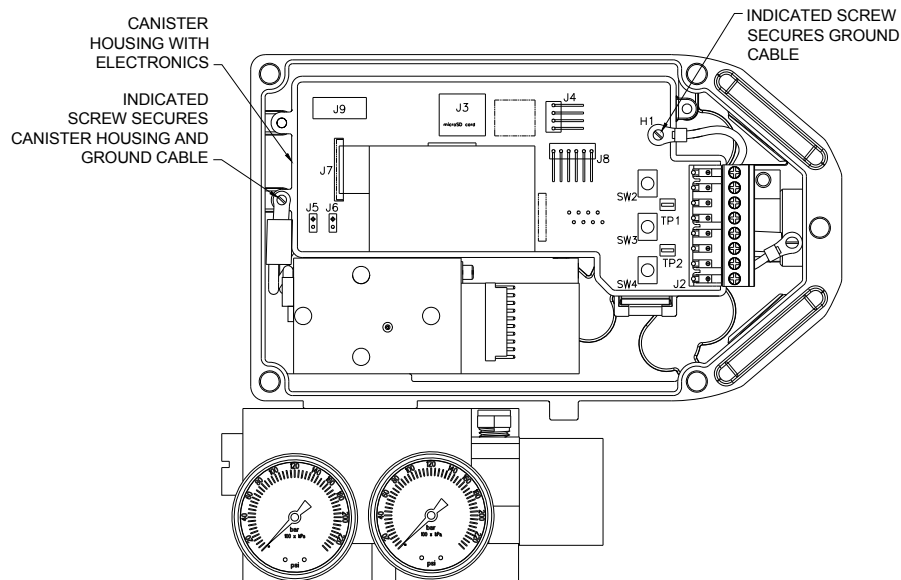
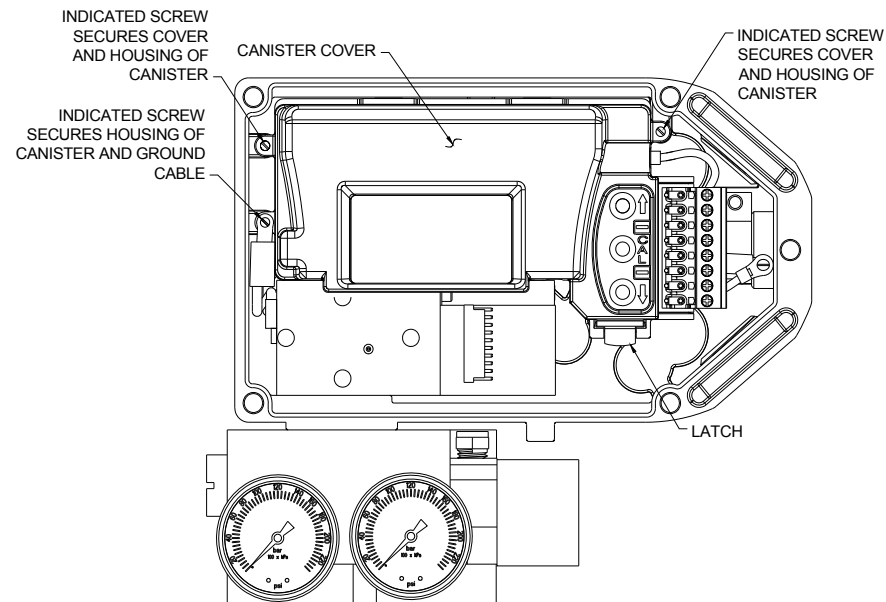
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Appendix B

Procedure to Remove Electronics Cover and Electronic Canister

1. Remove the two screws that secure the inner canister cover, unlock the latch by pulling it up and remove the canister cover (see figures below).
2. Disconnect all connectors from electronics canister; make sure to note connector locations. Remove the screw that secures canister housing and ground cable. Remove the screw that secures ground cable (see figures below).
3. Remove the canister with electronics from SmartCal enclosure.



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Appendix C

Setting the Transmitter Output Fail current.

The SmartCal positioner conforms to Namur NE43 with an operating input current of 3.8 mA to 20.5 mA. Input currents between 3.2mA and 3.6mA and above 21.0 mA are considered outside the control range and are a current input failure.

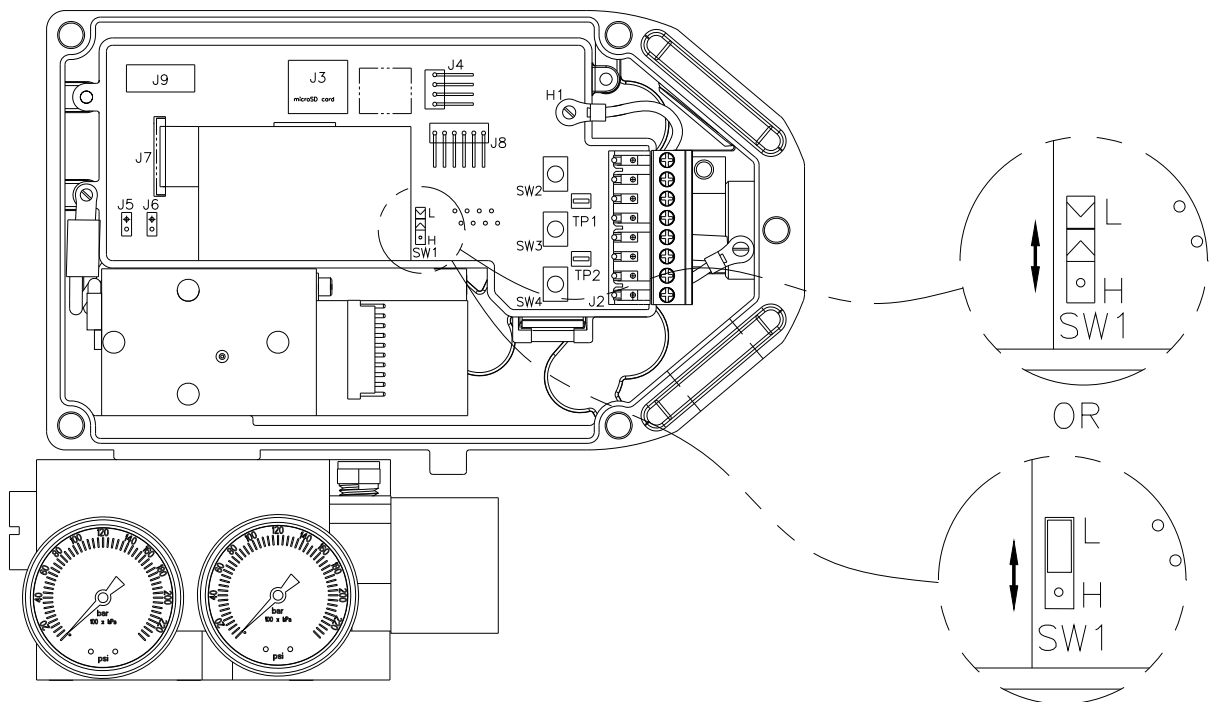
- When the input current is out of range the LCD will display a Failure message and the transmitter output (if so equipped) will go to pre-determined current to indicate the failed state.
- Another event that causes the transmitter output current to go to a fail state is whenever the onboard microcontroller gets reset by the internal or external watchdog circuits.
- A third event that causes the transmitter output to go to the fail current is whenever the input current is removed or below 3.2mA.

The transmitter output fail current can be configured to go to 3.4mA or 21.1 mA by the user. To set the desired value:

Step 1: Remove the enclosure cover. Follow appendix B to remove the electronics cover.

Step 2: For 3.4 mA (Low current) slide the yellow switch (or move the jumper) up towards **L** marking on the printed circuit board. Note this is the default factory position. For 22.0 mA (High current) transmitter output slide the yellow switch (or move the jumper) down towards **H** marking on the LCD printed circuit board.

Step 3: Replace electronic canister cover and enclosure cover.



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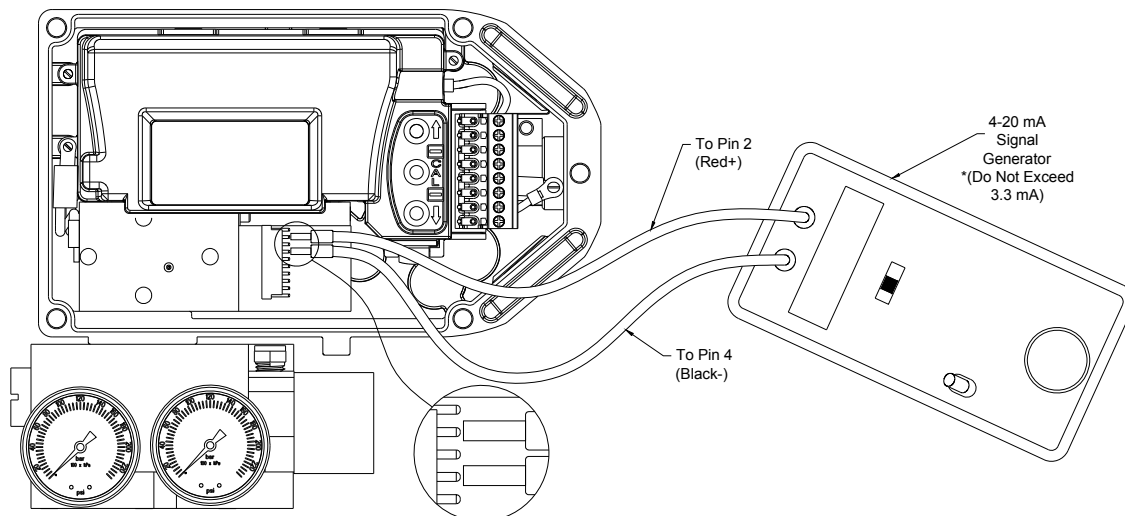
Appendix D

Procedure to Check Transducer Operation

This procedure should only be used for trouble shooting

This procedure requires a 4-20mA current generator.

1. Mount the positioner and connect the pneumatics as described in section 3 of this manual.
2. Remove the cable that connects the inner canister to the pneumatic transducer assembly. The electronic canister does not need to be removed.
3. Locate Pin 2 & Pin 4 on transducer pin connector (see figure below).
 - a. **Ref.:** Pin 1 is furthest from the pressure gages, Pin 10 is nearest to the to the pressure gages.
4. Connect positive lead of the current generator to Pin 2 and negative lead to Pin 4.
 - a. **Note:** make sure power on the current generator is turned off before connecting it to the pins. Make sure the two leads are not shorting by both coming in contact with Pin 3.
5. Turn the 4-20 mA generator on.
 - a. **Note:** the transducer operates between 0 and 3.3 mA. Therefore, make sure when turning on the current generator the current is turned down within this range. Applying a current greater than 3.3 mA can permanently damage the transducer.
6. Apply enough air supply to the positioner.
7. The transducer consists of a spool that will channel air between the two output ports of the positioner. As the current is raised air is removed from Output Port 2 and applied to Output Port 1 of the positioner.
8. To check the operation of the positioner, raise and lower the current between 0 and 4 mA. This should allow you to fully open and fully close the actuator. You should also be able to control the position of the actuator by slowly adjusting the current supply at an intermediary (idle) current somewhere between 0 and 3.3 mA.



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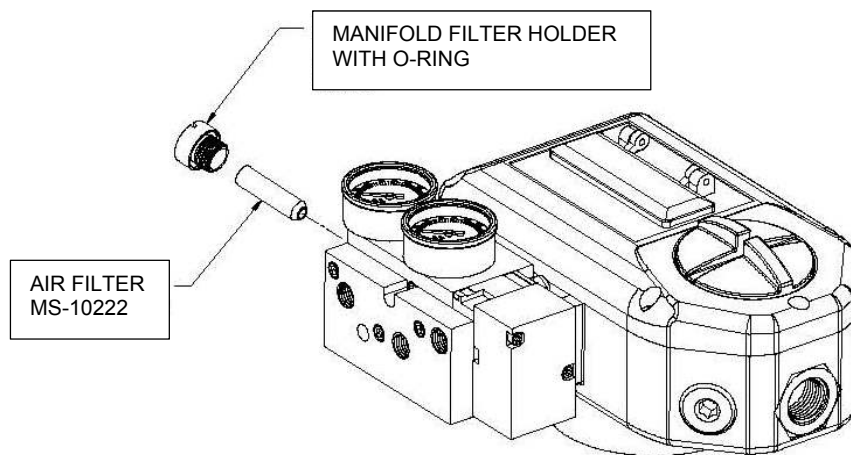
Appendix E

General Maintenance Standard Flow

The positioner's onboard filter should be replaced regularly or whenever it gets clogged. See diagram below for location of the filter. **Note:** the following instructions are for Standard Flow. For High Flow please contact the factory.

Important: The positioner's onboard filter is not a substitute for normal instrument air preparation. Supply air to the positioner should conform to ISA Standard S7.3 - Quality for Instrument Air.

Important: The filter's original color is chalk white. If the filter is discolored, its replacement should be performed more often. A discolored filter may also indicate the need for an evaluation of the air-supply quality. A filter/regulator with a 5 micron or better element, just prior to the positioner, is therefore recommended.



Spool valve cleaning

In favorable conditions (i.e. high quality supply air, healthy actuator) there will be minimal if any maintenance necessary on the spool valve. If unfavorable conditions exist (i.e. poor supply air quality or if lubrication and sediment from the actuator is being exhausted through the spool valve) it may become necessary to clean the spool valve to avoid operational failures due to valve sticking and to maintain optimum positioner performance.

To clean the spool valve, the spool piece needs to be removed (see following diagram). Prior to removing the spool, make sure the positioner is out of service and all air pressure has been bled-off the positioner and the actuator. The spool piece and sleeve can be cleaned using any non-chlorinated cleaning solvent (such as Stoddard solution or volatile mineral spirits). To clean the spool, use a clean lint free cloth. To clean the I.D. of the sleeve a polyester lint free clean room swab is

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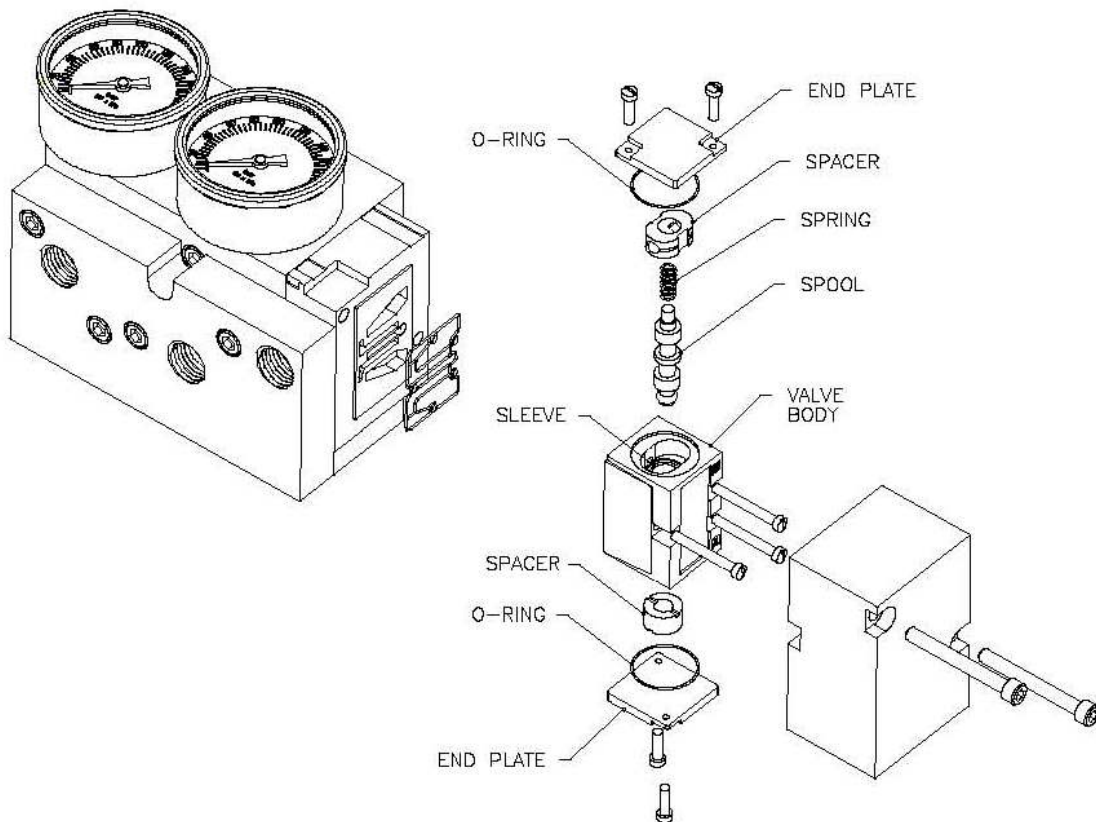
recommended. These items can be obtained from most industrial supply companies or catalogs.

Important: do not use an abrasive cleaner on the spool or sleeve. Never buff the spool or sleeve or use crocus cloth, and never attempt to remove the sharp edges from the spool lands. These practices will permanently damage the spool assembly and will affect the fit and action of the spool sleeve assembly.

Important: the spool and sleeve assembly are sold as a precision matched set. Spools are not interchangeable. To prevent mix-ups it is recommended that only one assembly be cleaned at a time. In case mix-up happen contact factory for additional support.

Important: after cleaning, gently insert the spool into the sleeve. Insert straight with a slight rotating motion. Do not cock the spool. Make sure the spool spins and moves freely. After the spool valve is cleaned and reassembled the positioner should recalibrated using the auto CAL function.

SPOOL/VALVE ASSY
PR-30034

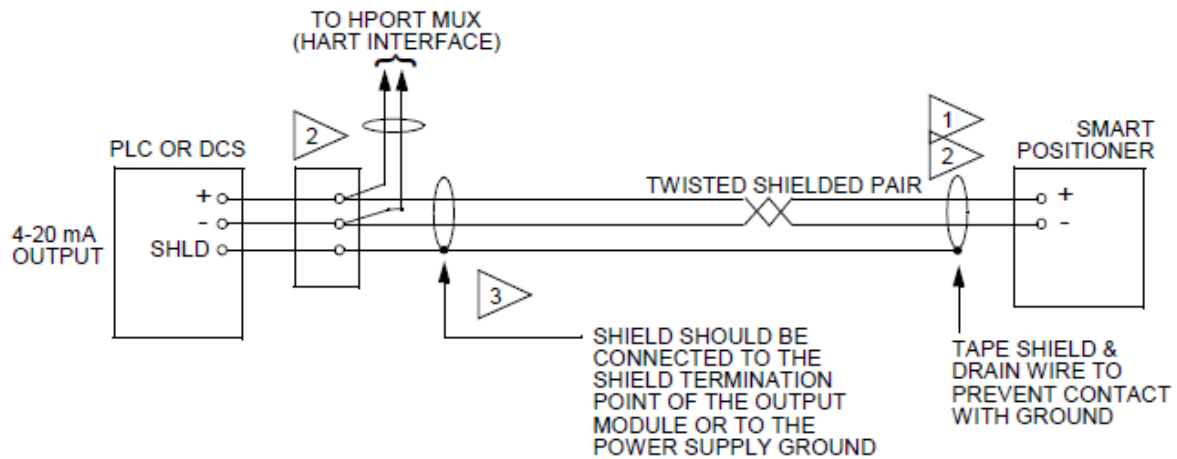


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Appendix F

Grounding Schematic



- 1 CONNECTION FROM DCS OR PLC TO POSITIONER IS 20 GAUGE SHIELDED TWISTED PAIR (BELDEN 8762 OR EQUIVALENT). MAXIMUM DISTANCE IS 5000 FEET.
 - 2 CONNECTION FROM HART MULTIPLEXER TO POSITIONER IS 20 GAUGE SHIELDED TWISTED PAIR (BELDEN 8762 OR EQUIVALENT). MAXIMUM DISTANCE FROM HART MULTIPLEXER TO POSITIONER IS 6000 FEET.
 - 3 SHIELD SHALL BE CONNECTED TO GROUND AT ONE POINT ONLY IN ORDER TO AVOID GROUND LOOPS AND NOISE INTERFERENCE.
4. THE FOLLOWING TABLE, PER IEEE STD 518-1982, INDICATES THE MINIMUM DISTANCE BETWEEN CABLE TRAYS AND CONDUITS CONTAINING LEVEL 1 (THIS INCLUDES 4-20 mA SIGNALS) AND 120 VAC OR 480 VAC, IN ORDER TO MINIMIZE ELECTRICAL NOISE INTERFERENCE.

RACEWAY	480 VAC	120 VAC
TRAY	26"	6"
TRAY-CONDUIT	18"	4"
CONDUIT	12"	3"

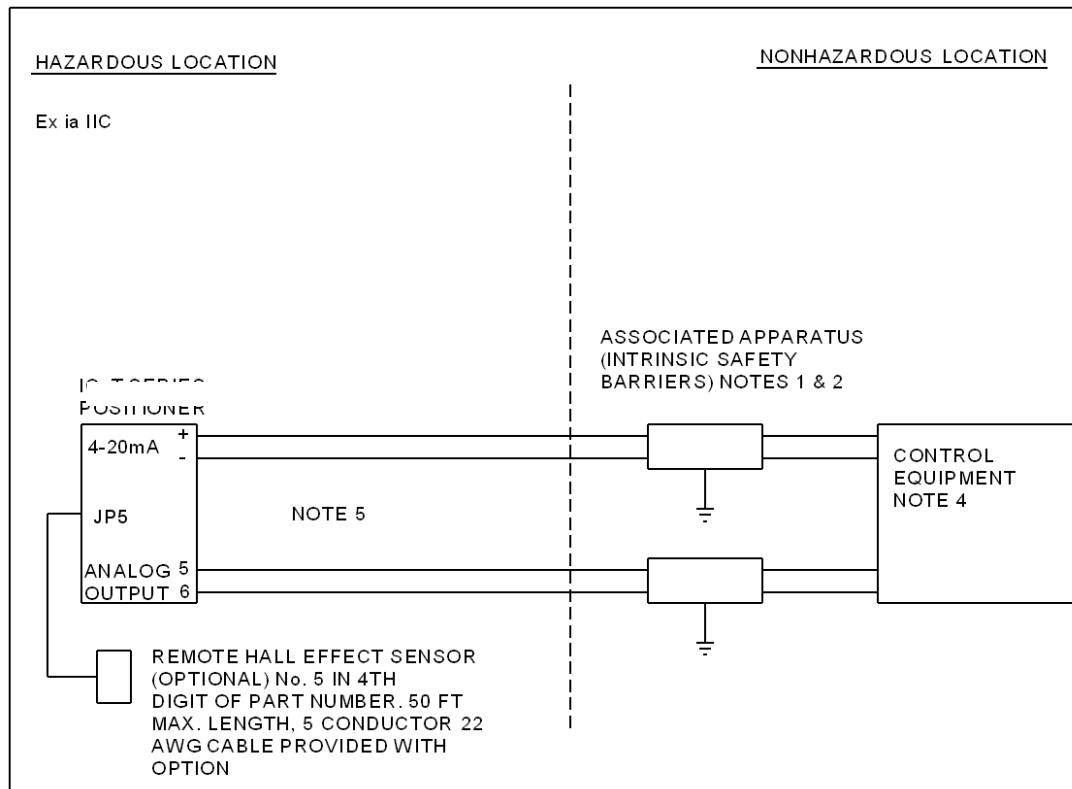
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Appendix G

Control Schematic for Wiring of Intrinsically safe SmartCal for ATEX & IECEX

(Sheet 1 of 2)



Entity parameters for each field wiring terminal pair of SmartCal:

$V_{max} = 30V$ $I_{max} = 100mA$ $P_i = 0.75 \text{ Watt}$
 $C_i = 0 \text{ pF}$ $L_i = 17.25 \text{ uH}$

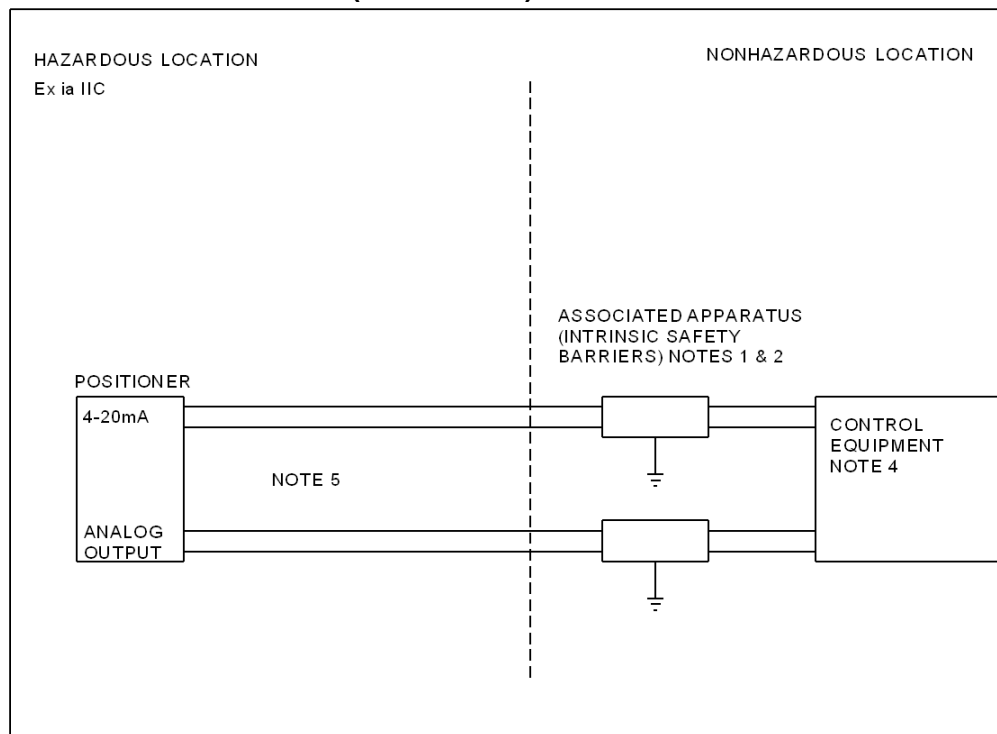
1. ATEX Entity approved associated apparatus used in an approved configuration, such that:
 - A. SmartCal $V_{max} \geq V_{oc}$ and V_t of associated apparatus.
 - B. SmartCal $I_{max} \geq I_{sc}$ and I_t of associated apparatus.
 - C. C_i of SmartCal cable capacitance $\leq C_a$ of associated apparatus.
2. Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
3. Control equipment connected to associated apparatus must not use or generate more than 250V.
4. To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
5. Where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
6. Installation should be in accordance with EN 60079 and / or the local / national electrical codes of practice.

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Control Schematic for Wiring of Intrinsically safe SmartCal for ATEX & IECEx

(Sheet 2 of 2)



Entity parameters for each field wiring terminal pair of SmartCal:

$V_{max} = 30V$ $I_{max} = 100mA$ $P_i = 0.75 \text{ Watt}$
 $C_i = 0 \text{ pF}$ $L_i = 17.25 \text{ uH}$

ATEX Notes:

- Barrier must be a ATEX certified, single channel grounded shunt-diode zener barrier or single channel isolating barrier or one dual channel or two single channel barriers may be used where both channels have been certified for use together with combined entity parameters.

The following conditions must be satisfied:

$$V_{oc} \text{ or } V_o \leq V_{max} \text{ or } U_i$$

$$C_a > C_i + C_{cable}$$

$$I_{sc} \text{ or } I_o \leq I_{max} \text{ or } I_i$$

$$L_a > L_i + L_{cable}$$

- Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
- Control equipment connected to associated apparatus must not use or generate more than 250V.
- To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
- Where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
- Installation should be in accordance with EN 60079 and / or the local / national electrical codes of practice.

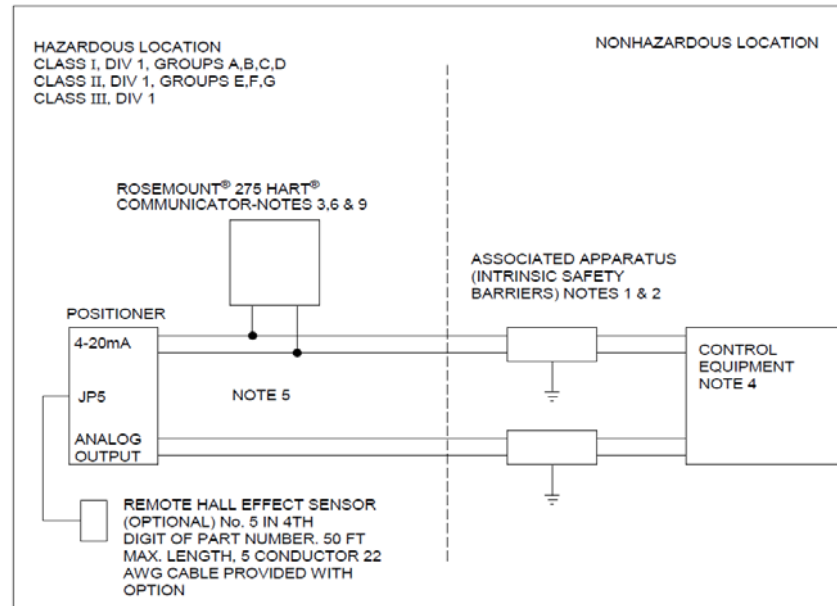
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Appendix H

Control Schematic for Wiring of Intrinsically safe SmartCal (WD-10836) for US & CANADA

(Sheet 1 of 4)



Entity parameters for each field wiring terminal pair of SmartCal:

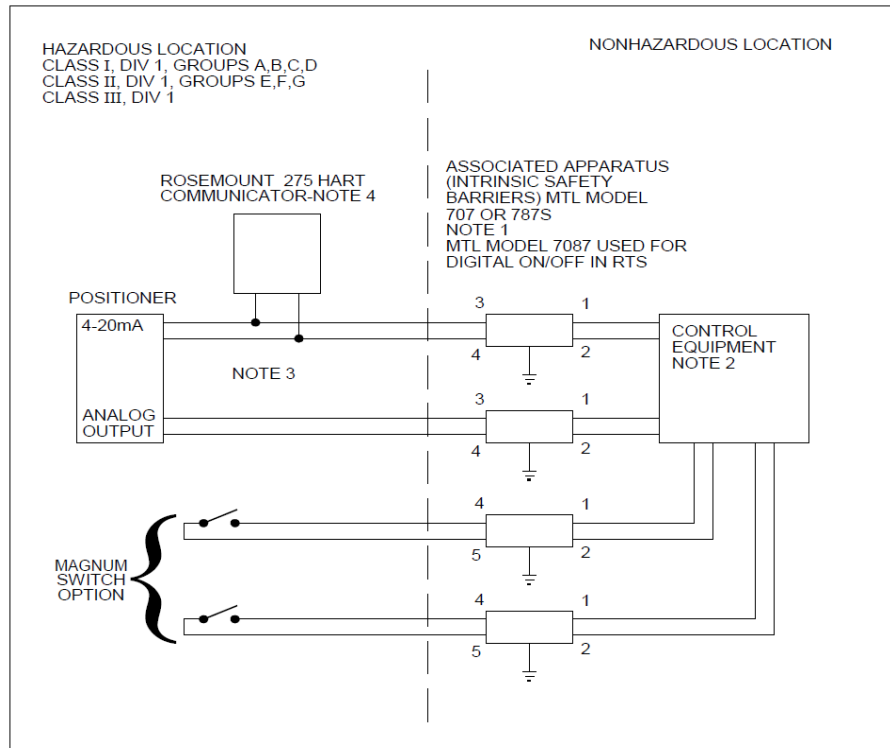
$$\begin{aligned} V_{\max} &= 30V & I_{\max} &= 100mA & P_i &= 0.75 \text{ Watt} \\ C_i &= 0 \text{ pF} & L_i &= 17.25 \text{ uH} \end{aligned}$$

1. FMRC Entity approved associated apparatus used in an approved configuration, such that:
 - A. SmartCal $V_{\max} \geq V_{oc}$ and V_t of associated apparatus.
 - B. SmartCal $I_{\max} \geq I_{sc}$ and I_t of associated apparatus.
 - C. C_i of SmartCal + C_i of ROSEMOUNT® 475 HART® COMMUNICATOR (if used) + cable capacitance $\leq C_a$ of associated apparatus.
 - D. In cases where the ROSEMOUNT® 475 HART® COMMUNICATOR is not connected between the associated apparatus and the SmartCal, L_i of SmartCal + cable inductance $\leq L_a$ of associated apparatus.
 - E. In cases where the ROSEMOUNT® 475 HART® COMMUNICATOR is connected between the associated apparatus and the SmartCal, cable inductance should be determined in accordance with ROSEMOUNT® installation drawing 00475-0081.
2. Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
3. In cases where the ROSEMOUNT® 475 HART® COMMUNICATOR is connected between the associated apparatus and the SmartCal. ROSEMOUNT® installation drawing 00475-0081 must be followed when installing this equipment.
4. Control equipment connected to associated apparatus must not use or generate more than 250V.
5. To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
6. ROSEMOUNT® 475 HART® COMMUNICATOR is NOT FMRC approved for use in Class II and III Hazardous Locations.
7. For Class II and III locations where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
8. Installation should be in accordance with ANSI/ISA RP12.6 and the National Electrical Code (ANSI/NFPA 70).

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Control Schematic for Wiring of Intrinsically safe SmartCal (WD-10836) for US & CANADA (Sheet 2 of 4)



1. Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
2. Control equipment connected to associated apparatus must not use or generate more than 250V.
3. To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
4. ROSEMOUNT® 475 HART® COMMUNICATOR is NOT FMRC approved for use in Class II and III Hazardous Locations.
5. For Class II and III locations where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
6. Installation should be in accordance with ANSI/ISA RP12.6 and the National Electrical Code (ANSI/NFPA 70).

MAXIMUM FIELD WIRING CAPACITANCE AND INDUCTANCE

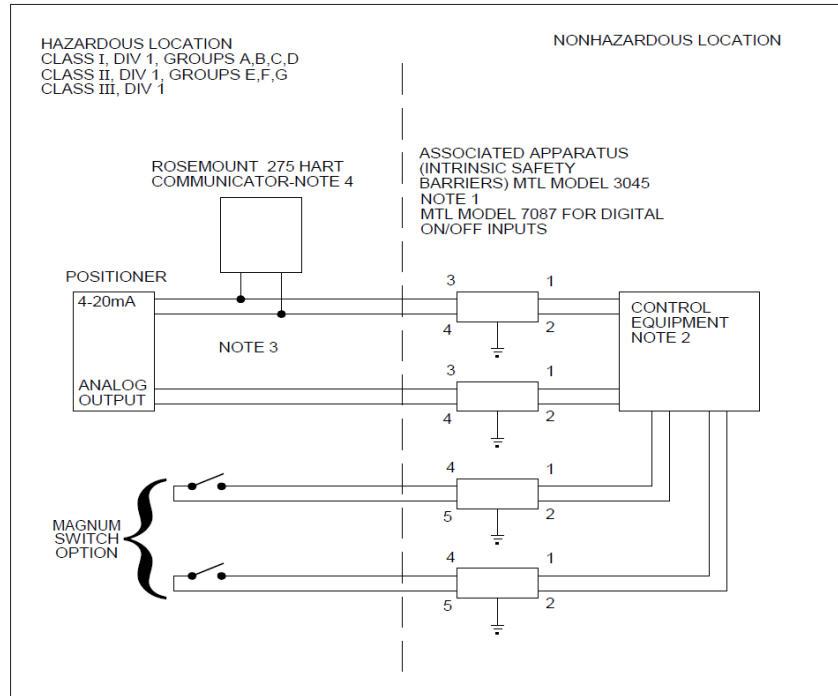
HAZARDOUS LOCATION & CONFIGURATION	MAXIMUM ALLOWABLE FIELD WIRING CAPACITANCE	MAXIMUM ALLOWABLE FIELD WIRING INDUCTANCE
GP A OR B LOCATION W/ COMMUNICATOR	30nF	4.0mH
GP C,D,E,F,G LOCATION W/ COMMUNICATOR	230nF	16mH
GP A OR B LOCATION W/OUT COMMUNICATOR*	100nF	4.0mH
GP C,D,E,F,G LOCATION W/OUT COMMUNICATOR*	300nF	16mH

* ROSEMOUNT® 475 HART® COMMUNICATOR not used or used only on the INPUT side of associated apparatus.

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Control Schematic for Wiring of Intrinsically safe SmartCal (WD-10836) for US & CANADA (Sheet 3 of 4)



1. Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
2. Control equipment connected to associated apparatus must not use or generate more than 250V.
3. To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
4. ROSEMOUNT® 475 HART® COMMUNICATOR is NOT FMRC approved for use in Class II and III Hazardous Locations.
5. For Class II and III locations where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
6. Installation should be in accordance with ANSI/ISA RP12.6 and the National Electrical Code (ANSI/NFPA 70).

MAXIMUM FIELD WIRING CAPACITANCE AND INDUCTANCE

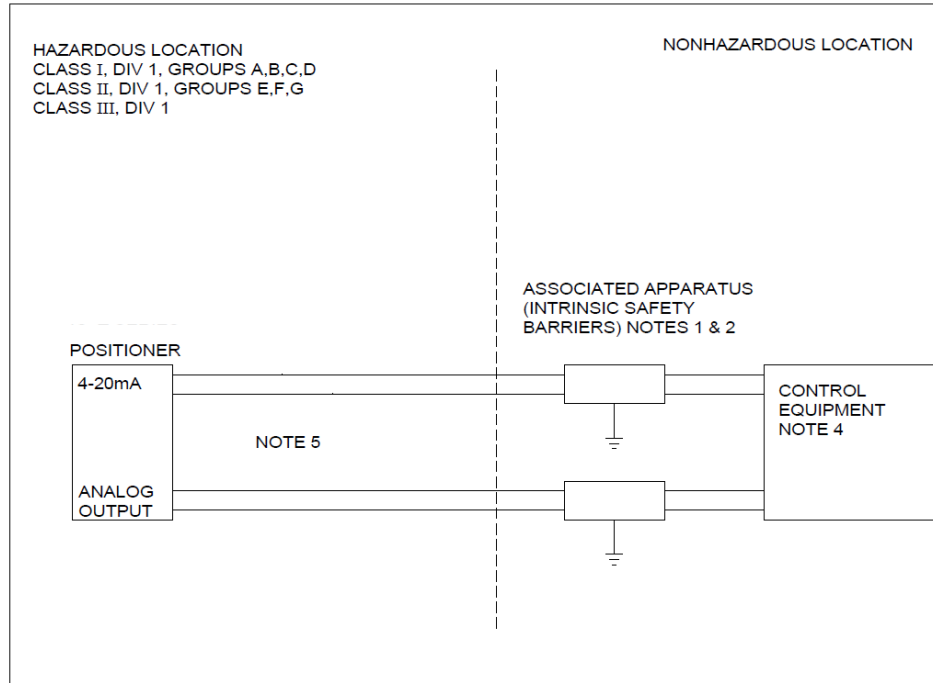
HAZARDOUS LOCATION & CONFIGURATION	MAXIMUM ALLOWABLE FIELD WIRING CAPACITANCE	MAXIMUM ALLOWABLE FIELD WIRING INDUCTANCE
GP A OR B LOCATION W/ COMMUNICATOR	30nF	4.0mH
GP C,D,E,F,G LOCATION W/ COMMUNICATOR	230nF	16mH
GP A OR B LOCATION W/OUT COMMUNICATOR*	100nF	4.0mH
GP C,D,E,F,G LOCATION W/OUT COMMUNICATOR*	300nF	16mH

* ROSEMOUNT® 475 HART® COMMUNICATOR not used or used only on the INPUT side of associated apparatus.

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Control Schematic for Wiring of Intrinsically safe SmartCal (WD-10836) for US & CANADA (Sheet 4 of 4)



Entity parameters for each field wiring terminal pair of SmartCal:

$V_{max} = 30V$ $I_{max} = 100mA$ $P_i = 0.75 \text{ Watt}$

$C_i = 0 \text{ pF}$ $L_i = 17.25 \text{ uH}$

CSA Notes:

1. Barrier must be a CSA certified, single channel grounded shunt-diode zener barrier or single channel isolating barrier or one dual channel or two single channel barriers may be used where both channels have been certified for use together with combined entity parameters.

The following conditions must be satisfied:

$$V_{oc} \text{ or } V_o \leq V_{max} \text{ or } U_i \quad C_a > C_i + C_{\text{Cable}}$$

$$I_{sc} \text{ or } I_o \leq I_{max} \text{ or } I_i \quad L_a > L_i + L_{\text{Cable}}$$

2. Associated apparatus manufacturer's installation drawing must be followed when installing this equipment.
3. Control equipment connected to associated apparatus must not use or generate more than 250V.
4. To maintain intrinsic safety, each field wiring pair (4-20 mA and Analog Output) must be run in separate cables or separate shields connected to intrinsically safe (Associated Apparatus) ground.
5. ROSEMOUNT® 475 HART® COMMUNICATOR is NOT FMRC approved for use in Class II and III Hazardous Locations.
6. For Class II and III locations where rigid metal conduit is not used, seal SmartCal cable entries against dust and fibers using an appropriate NRTL listed cable gland fitting.
7. Installation should be in accordance with ANSI/ISA RP12.6 and the National Electrical Code (ANSI/NFPA 70).
8. Install in accordance with Canadian Electrical Code Part 1.

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Appendix I

Procedure to Reset the Non-Volatile Memory to Factory Settings

The SmartCal positioner is a digital device. Its operation relies on data that is stored in the positioner's non-volatile memory. Calibration and configuration data that has been established during the positioner's calibration is stored in this memory. Under abnormal conditions this stored information can become corrupted. If this occurs it is necessary to reset the memory and re-calibrate the positioner.

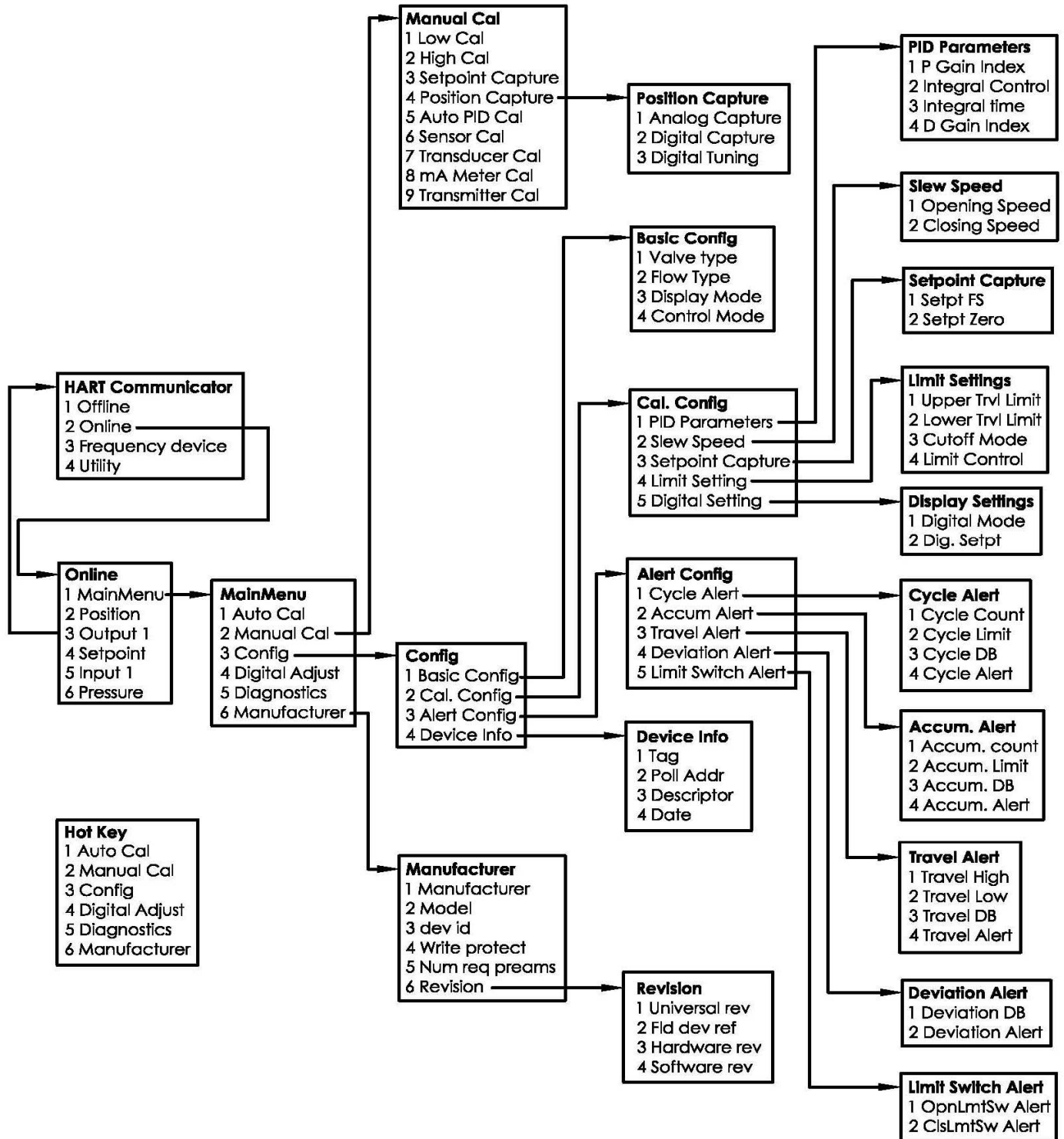
1. Remove power from the positioner. This can be done by removing the plug-in style terminal strip.
2. Press and hold the CAL button while replacing the terminal strip (returning power). The LCD will show "Starting Up..." for several seconds while holding down the CAL button.
3. Continue to hold the CAL button until the LCD shows "Factory Default Initialization. No?" When this statement appears release the CAL button and use the down arrow to select "Yes" or press once more to select "All". Then press the CAL button to begin the factory default procedure.
 - a. "Yes" option resets all non-volatile data to default with exception of the position transmitter calibration data.
 - b. "All" option resets all non-volatile memory contents including all factory and user calibration data.
4. After a few seconds you will be prompted to enter 4.0 mA to calibrate the loop current input. Change the current input to the positioner to exactly 4.0 mA and press the CAL button. If your zero position signal is other than exactly 4.0 mA then use the Up/Down arrow buttons to adjust the value shown on the positioner's LCD to match the zero position mA and press the CAL button.
5. You will then be prompted to enter 20 mA. Change the current input to the positioner to exactly 20.0 mA and press the CAL button. If your full-scale position signal is other than exactly 20.0 mA then use the Up/Down arrow buttons to adjust the value shown on the positioner's LCD to match the full-scale position mA and press the CAL button.
6. The positioner will automatically return to normal operating mode.

It is recommended then to follow the normal calibration procedure as described in the manual section 4.7.

Appendix J

HART® Communicator Menu Flow Chart

SmartCal Digital Valve Controller



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Appendix K

DD and DTM for configuration and control system integration

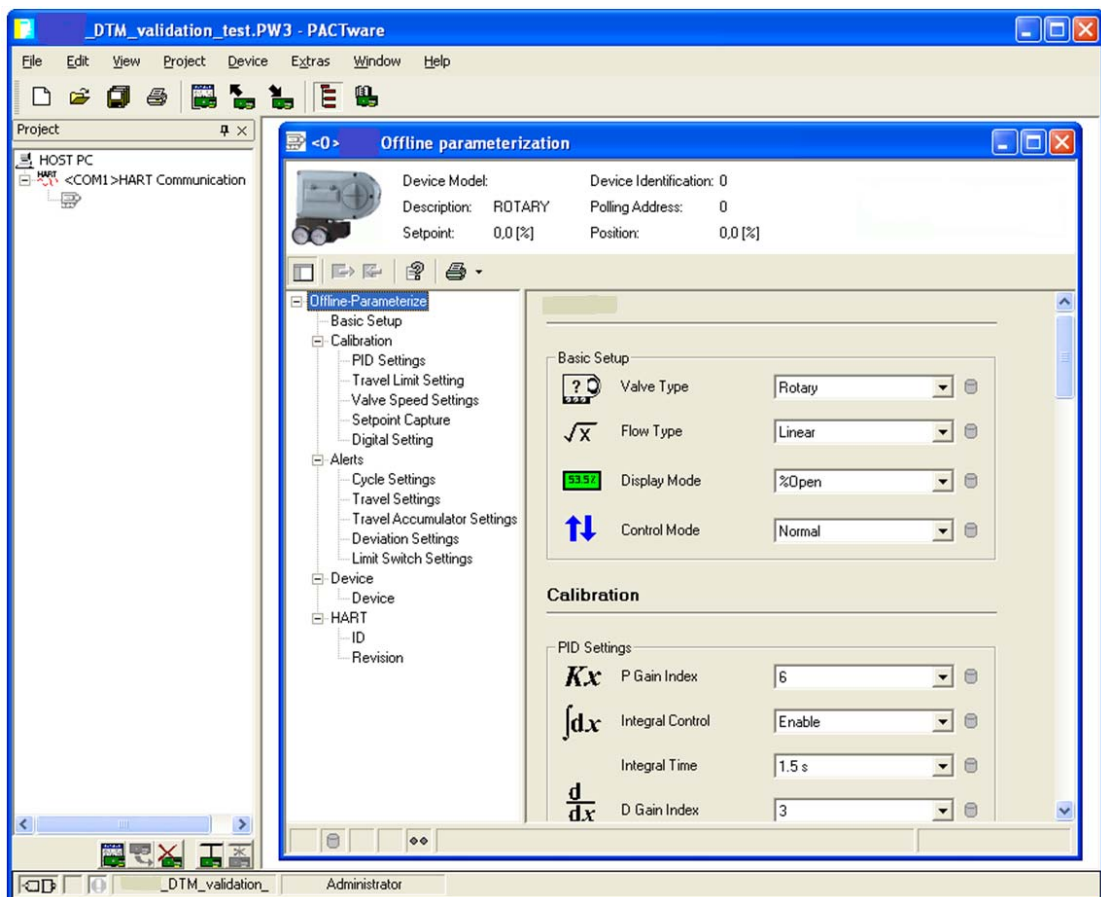
The SmartCal positioner can be fully integrated into most of the configuration tools, control systems and asset management systems in the market. Crane Co. provides DD files and DTM for this integration.

- DD files can be downloaded from:

<http://www.hartcommproduct.com/inventory2/index.php?action=viewprod&num=1104>

- FDT certified DTM, compatible with FDT 1.2, contact www.avid.com.

Crane Co. also provides the FDT Pactware 3.0 that can be used in conjunction with the DTM to perform configuration and diagnostics. Contact us for more information. Visit also www.fdtgroup.org.



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