TopWorx™ D-Series Valve Controllers

Master Installation, Operation & Maintenance Manual

EMERSON

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Table of Contents

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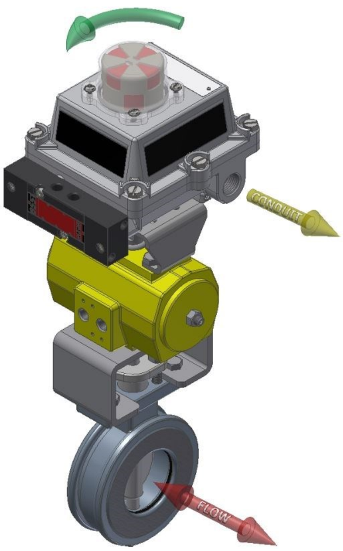
Installation on Actuator

Orientations, Normal and Reverse Acting

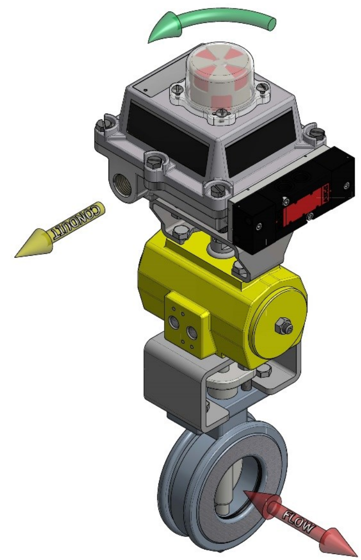
Normal acting is full clockwise when the process valve is closed and counterclockwise when the process valve is open. *Reverse acting* is full clockwise when the process valve is open and counterclockwise when the process valve is closed.

90° indicator dome assemblies are designed to accommodate any mounting arrangement and can be adjusted up to 9° off axis if needed. 45° indicator dome assemblies can only accommodate *normal acting* applications that are *mounted parallel ±9°.* Consult your local distributor or factory representative for 45° *reverse acting* or *mounted perpendicular* applications.



The image to the left shows a TopWorx™ unit *mounted parallel* to the process valve in the closed position. The green arrow at the top shows the "*normal acting*" direction of travel to open the valve. This is the standard orientation and unless other-wise specified, your unit will be factory set to operate in this fashion.

The image to the right shows a TopWorx™ *mounted perpendicular* to the process valve in the closed position. The green arrow at the top shows the "*normal acting*" direction of travel to open the valve.



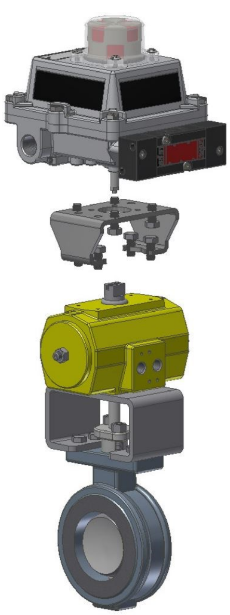
Mounting

TopWorx™ has numerous mounting bracket kits, both rotary and linear, available to meet your specific application. Consult your local distributor or factory representative for ordering information. The illustration below shows a direct NAMUR mount on a quarter turn valve. Refer to your mounting kit documentation for specific mounting instructions.

Storage

Until conduit, conduit covers, and any applicable spool valve port connections are properly installed, the TopWorx™ unit will not support its IP/NEMA rating as the unit ships with temporary covers. Ensure that it is stored in a dry environment with a relative humidity range between 10%-95% and a temperature ranging from -40ºF (-40ºC) to 160ºF (71ºC). Once properly installed, the temperature range listed on the name-plate will supersede this storage temperature range.

Mounting Assembly



Installation Notes

1. Use caution not to allow undue axial (thrust) load on the shaft.

2. Cycle the valve a couple of times prior to final tightening of the mounting kit hardware. This allows the shaft to self-center in the pinion slot, or coupler. Refer to the *dimensions and materials section* of this document for appropriate tightening torque. Please refer to the Proof Testing section for proper safety function set-up.

3. Always use sound mechanical practices when applying torque to any hardware or making pneumatic connections. Refer to the Integrated Pneumatic Control Valves section for detailed information.

4. This product comes shipped with conduit covers in an effort to protect the internal components from debris during shipment and handling. **It is the responsibility of the receiving and/or installing personnel to provide appropriate permanent sealing devices to prevent the intrusion of debris or moisture when stored or installed outdoors.**

5. **It is the responsibility of the installer, or end user, to install this product in accordance with the National Electrical Code (NFPA 70) or any other national or regional code defining proper practices.**

GO™ Switch: Options L2/L4/Z2/Z4

Calibration Procedure

Never perform switch calibration while an area is known to be hazardous.

For intrinsically safe models with L2/L4, the unit must be wired in accordance with the control drawing S-K127 and S-K127A.
For intrinsically safe models with Z2/Z4, the unit must be wired in accordance with the control drawing ES-01743-1 and ES-01744-1.

GO™ Switch calibration may be performed using a Volt-Ohm meter with the Ohm setting across COM and NO. When the switch is active, the meter will read ≤0.5 Ohms, or the Diode setting may be used simply to indicate continuity. If a 120VAC source is used, an appropriately sized resistor must be used in series to limit current to a maximum of 1.5 Amperes when circuit rating is unknown or permanent damage may occur.

For models mounted in perpendicular orientation, the target disk will have to be rotated to realign the target disk to match the desired orientation.

Step 1: Grasp the target disk and gently lift until the target disk disengages the orientation pin in the shaft.
Step 2: Rotate the disk as needed to realign the targets. Use the images provided on the previous page as a reference.
Step 3: Follow steps 1 through 3 for models mounted in Parallel orientation above.

For reverse acting applications (Counterclockwise to close), the switch functions will be transposed. Sw 1 (and Sw 3 if in an L4/Z4 model) be-come open. Sw 2 (and Sw 4 if in an L4/Z4 model) become closed.

The target disk has been designed to accommodate various applications and rotations. If your application is different from those outlined here, please consult the factory for further information.

L2/L4 Specifications 3-1A

Repeatability	.002" (.05 mm)
Response Time	8 milliseconds
Differential	0.020 - .150” (0.5 - 3.8mm)
Operating Temperature	-60° to 221°F (-40° to 105°C)
Contact Material	Silver cadmium oxide, gold flashed
Forms	SPDT, Form C
Ratings	4A@120VAC / 2A@240VAC / 3A@24VDC
Target Material	Magnet
Sensing Range	Approx. 1/10" (2.5 mm)

Z2/Z4 Specifications 3-1B

Repeatability	.002" (.05 mm)
Response Time	8 milliseconds
Differential	0.020 - .150” (0.5 - 3.8mm)
Operating Temperature	-60° to 221°F (-40° to 105°C)
Contact Material	Palladium silver w/sawtooth surface configuration
Forms	DPDT, Form CC
Ratings	4A@120VAC / 2A@240VAC / 3A@24VDC / 0.5A@125VDC
Target Material	Magnet
Sensing Range	Approx. .050 - .080" (1.3 - 2.0 mm)

Continued
GO™ Switch: Options L2/L4/Z2/Z4

Electrical Connections & Wiring 3-1C

Option L2

Switch 1	
Green to GND	Ground
COM (Black)	Terminal 2
NO (Blue)	Terminal 3
NC (Red)	Terminal 1
Switch 3	
Green to GND	Ground
COM (Black)	Terminal 5
NO (Blue)	Terminal 6
NC (Red)	Terminal 4

Option L4

Switch 1		Switch 2	
Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 2	COM (Black)	Terminal 5
NO (Blue)	Terminal 3	NO (Blue)	Terminal 6
NC (Red)	Terminal 1	NC (Red)	Terminal 4
Switch 3		**Switch 4**	
Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 8	COM (Black)	Terminal 11
NO (Blue)	Terminal 9	NO (Blue)	Terminal 12
NC (Red)	Terminal 7	NC (Red)	Terminal 10

Option Z2

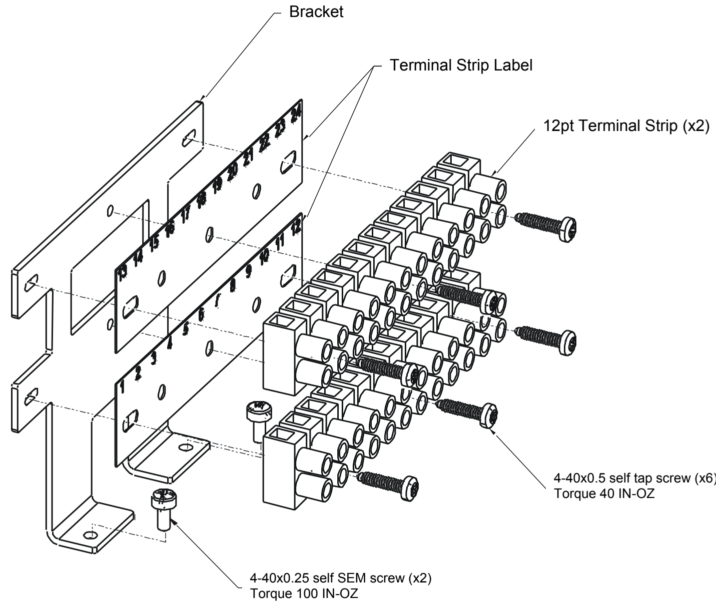
Switch 1			
Green to GND	Ground		
COM (Black)	Terminal 2	COM (Black/White)	Terminal 5
NO (Blue)	Terminal 3	NO (Blue/White)	Terminal 6
NC (Red)	Terminal 1	NC (Red/White)	Terminal 4
Switch 3			
Green to GND	Ground		
COM (Black)	Terminal 8	COM (Black/White)	Terminal 11
NO (Blue)	Terminal 9	NO (Blue/White)	Terminal 12
NC (Red)	Terminal 7	NC (Red/White)	Terminal 10

Option Z4

Switch 1				Switch 2			
Green to GND	Ground	Green to GND	Ground	Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 2	COM (Black/White)	Terminal 5	COM (Black)	Terminal 14	COM (Black/White)	Terminal 17
NO (Blue)	Terminal 3	NO (Blue/White)	Terminal 6	NO (Blue)	Terminal 15	NO (Blue/White)	Terminal 18
NC (Red)	Terminal 1	NC (Red/White)	Terminal 4	NC (Red)	Terminal 13	NC (Red/White)	Terminal 16
Switch 3				**Switch 4**			
Green to GND	Ground	Green to GND	Ground	Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 8	COM (Black/White)	Terminal 11	COM (Black)	Terminal 20	COM (Black/White)	Terminal 23
NO (Blue)	Terminal 9	NO (Blue/White)	Terminal 12	NO (Blue)	Terminal 21	NO (Blue/White)	Terminal 24
NC (Red)	Terminal 7	NC (Red/White)	Terminal 10	NC (Red)	Terminal 19	NC (Red/White)	Terminal 22

*The above terminations are typical and may vary depending on your configuration. Refer to the wiring diagram located on the inside top housing for a wiring diagram specific to your configuration.

Terminal Strip Assembly



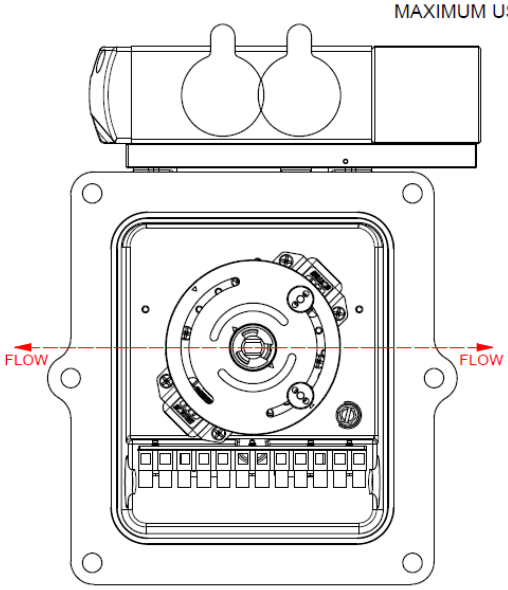
NOTE: *Refer to the wiring diagram on the inside lid of your product to determine actual pin out location.*

Continued
GO™ Switch: Options L2/L4/Z2/Z4

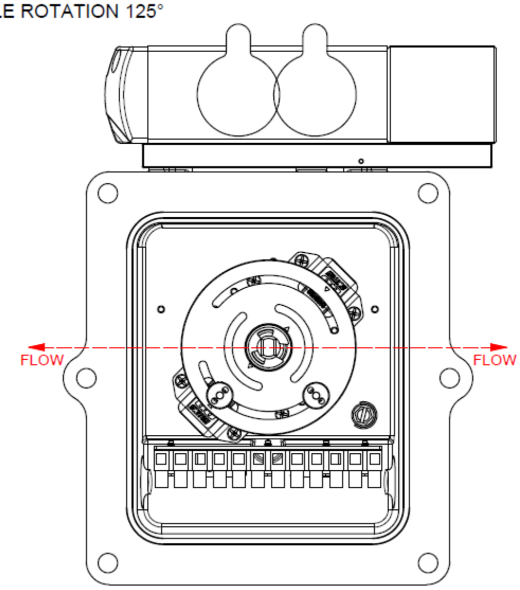
Target Arrangement

All TopWorx™ products are factory set for 90° rotation normal acting on parallel orientation with switch 1 (full clockwise) for the process valve closed position. When changing orientation the target disk will have to be relocated for your application. All target disks are supplied with 4 slots on 90° increments allowing the TopWorx™ unit to be rotated 90°, 180°, or 270° from standard. Loosen target by rotating CCW and slide target to desired position. Once target is properly positioned, tighten target by rotating CW and tighten to 20 in-oz.

TYPICAL L2/Z2 TARGET ARRANGEMENT
MINIMAL USUABLE ROTATION 45°
MAXIMUM USUABLE ROTATION 125°

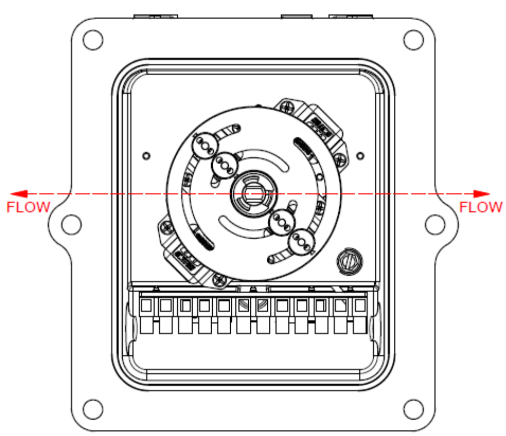


90° PROCESS VALVE OPEN FULL CCW
NORMAL ACTING
PARALLEL ORIENTATION
SW1 FOR PROCESS VALVE CLOSED (NOT MADE)
SW3 FOR PROCESS VALVE OPEN (MADE)

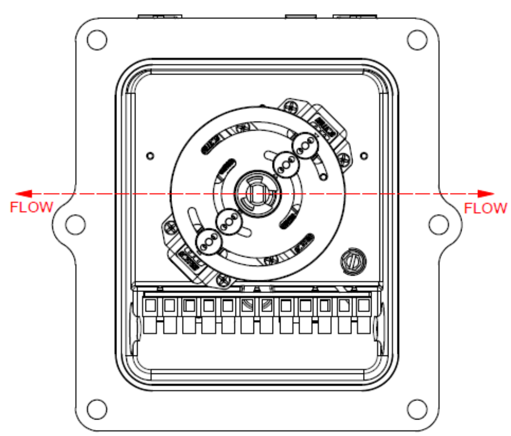


90° PROCESS VALVE CLOSED FULL CW
NORMAL ACTING
PARALLEL ORIENTATION
SW1 FOR PROCESS VALVE CLOSED (MADE)
SW3 FOR PROCESS VALVE OPEN (NOT MADE)

TYPICAL L4/Z4 TARGET ARRANGEMENT



90° PROCESS VALVE OPEN FULL CCW
NORMAL ACTING
PARALLEL ORIENTATION
SW1 FOR PROCESS VALVE CLOSED (NOT MADE)
SW2 FOR PROCESS VALVE OPEN (MADE)
SW3 FOR PROCESS VALVE CLOSED (NOT MADE)
SW4 FOR PROCESS VALVE OPEN (MADE)



90° PROCESS VALVE CLOSED FULL CW
NORMAL ACTING
PARALLEL ORIENTATION
SW1 FOR PROCESS VALVE CLOSED (MADE)
SW2 FOR PROCESS VALVE OPEN (NOT MADE)
SW3 FOR PROCESS VALVE CLOSED (MADE)
SW4 FOR PROCESS VALVE OPEN (NOT MADE)

Mechanical Switches: Options M2/M4/M6/K2/K4/K6/T2 Calibration Procedure

⚠ **Never** perform switch calibration while an area is known to be hazardous. Calibration procedures for DPDT switches are the same as those for SPDT switches.

Calibration may be performed using a Volt-Ohm meter by using the Ohm setting across COM and NO. When the switch is active, the meter will read ≤0.5 Ohms, or the Diode setting may be used to indi-cate continuity.

If a 120Vac source is used, an appropriately sized resistor must be used in series to limit current to a maximum of 15 Amperes when circuit rating is unknown, or permanent damage may occur.

Step 1: With valve in the CLOSED position, disengage the BOTTOM cam from the splined Hub and rotate Clockwise until SW1 activates. Release cam to re-engage splined Hub.

Step 2: Rotate valve to the OPEN position. Disengage the TOP cam from the splined Hub and rotate Counter-clockwise until SW2 activates. Release cam to re-engage the splined Hub.

Step 3: Cycle valve CLOSED and OPEN several times to insure switches will maintain calibration.

For Reverse Acting actuators:
Step 1: With valve in the CLOSED position, disengage the TOP cam from the splined Hub and rotate Counter-clockwise until SW2 activates. Release cam to re-engage the splined Hub.

Step 2: Rotate valve to the OPEN position. Disengage the BOTTOM cam from the splined Hub and rotate Clockwise until SW1 activates. Release cam to re-engage the splined Hub.

Repeat Step 3 above.

**When using the (4) and (6) switch options, use the same calibration steps as above for the switches you determine to indicate OPEN and which indicate CLOSED.*

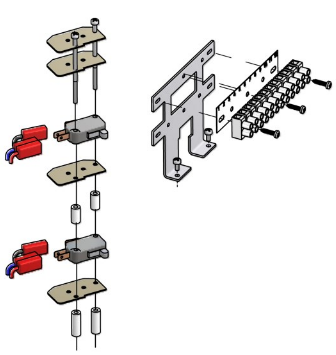
***Switches may also be set at midpoint, or any point, of travel for Dribble Control, or any other logic necessary for the application.*

PRODUCT SPECIFICATIONS	
OPTION M	
Switch Type	Mechanical
Sealed	No
Circuitry	SPDT
Termination	Quick Connect
Rating	15A@125VAC or 250VAC
Conforming to standards	UL: 1054
Contact Resistance	15MΩmax. (initial)
Insulation Resistance	100MΩmin. (at 500V DC)
OPTION K	
Switch Type	Mechanical
Sealed	No
Circuitry	SPDT
Termination	Quick Connect
Rating	0.1A@125VAC MAX
Conforming to standards	UL: 1054

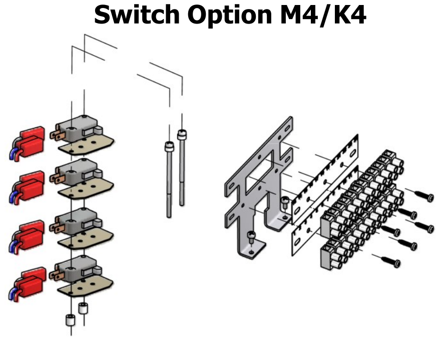
OPTION T	
Switch Type	Mechanical
Sealed	No
Circuitry	DPDT
Termination	Quick Connect
Rating	15A 125V AC or 250V AC
Conforming to standards	UL recognized and CSA certified, meets MIL-S-8805
Contact	Gold or silver
Terminals	End or side

Mechanical Switch Assembly

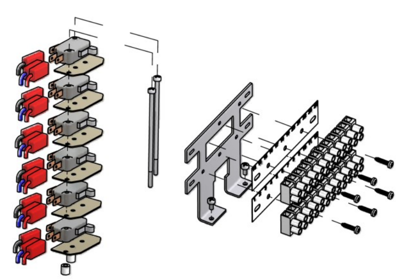
Switch Option M2/K2/T2



Switch Option M4/K4



Switch Option M6/K6



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Mechanical Switches: Options M2/M4/M6/K2/K4/K6/T2

Wiring Diagrams and Charts

Option M/K

Switch#	Connection	Color Code	Terminal#
1	NC	Red	1
	COM	Black	2
	NO	Blue	3
2	NC	Red/White	4
	COM	Black/White	5
	NO	Blue/White	6
3	NC	Yellow	7
	COM	Brown	8
	NO	Orange	9
4	NC	White/Yellow	10
	COM	White/Brown	11
	NO	White/Orange	12
5	NC	White	13
	COM	Gray	14
	NO	Violet	15
6	NC	Pink	16
	COM	White/Gray	17
	NO	White/Violet	18

Option T2

Switch#	Connection	Color Code	Terminal#
1	NC1	Red	1
	COM1	Black	2
	NO1	Blue	3
	NC2	Red/White	4
	COM2	Black/White	5
	NO2	Blue/White	6
2	NC1	Yellow	7
	COM1	Brown	8
	NO1	Orange	9
	NC2	White/Yellow	10
	COM2	White/Brown	11
	NO2	White/Orange	12

⚠ **NOTE:** *Refer to the wiring diagram on the inside lid of your product to determine actual pin out location*

Inductive Sensors: Options E2/E4/E6

Calibration Procedure

Never perform switch calibration while an area is known to be hazardous.

When installing a TopWorx™ product with P&F NAMUR sensors, use of a commercially available switch tester like P&F part# ST0-03 is suggested.

Calibration may be performed using a 24Vdc power supply.
Step 1: With valve in the CLOSED position, disengage the BOTTOM cam from the splined hub and rotate clockwise until SW1 activates. Release cam to re-engage splined hub.

Step 2: Rotate valve to the OPEN position. Disengage the TOP cam from the splined hub and rotate counter-clockwise until SW2 activates. Release cam to re-engage the splined hub.

Step 3: Cycle valve CLOSED and OPEN several times to insure switches will maintain calibration.

For Reverse Acting actuators:
Step 1: With valve in the CLOSED position, disengage the TOP cam from the splined hub and rotate counter-clockwise until SW2 activates. Release cam to re-engage the splined hub.

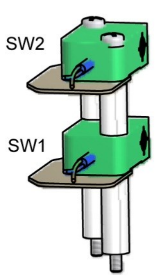
Step 2: Rotate valve to the OPEN position. Disengage the BOTTOM cam from the splined hub and rotate clockwise until SW1 activates. Release cam to re-engage the splined hub.

Repeat Step 3 above.
When using the (4) and (6) switch options, determine which switches are to indicate OPEN and which indicate CLOSED and then use the same calibration steps as above.

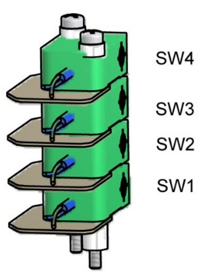
*****Switches may also be set at midpoint, or any point, of travel for Dribble Control, or any other logic necessary for the application.***

P & F NJ2-V3-N Switch Assembly

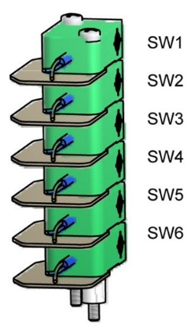
Switch Option E2

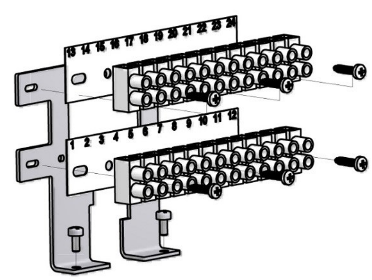


Switch Option E4



Switch Option E6





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Inductive Sensors: Options E2/E4/E6 Product Specifications

PRODUCT SPECIFICATIONS		
General specifications		
Switching element function		NAMUR NC
Rated operating distance	s_n	2 mm
Installation		embeddable
Output polarity		NAMUR
Assured operating distance	s_a	0 ... 1.62 mm
Reduction factor r_{Al}		0.25
Reduction factor r_{Cu}		0.2
Reduction factor r_{V2A}		0.7
Nominal ratings		
Nominal voltage	U_o	8 V
Switching frequency	f	0 ... 1000 Hz
Hysteresis	H	typ. %
Current consumption		
Measuring plate not detected		≥3 mA
Measuring plate detected		≤1 mA
Standard conformity		
EMC in accordance with		IEC / EN 60947-5-2:2004
Standards		DIN EN 60947-5-6 (NAMUR)
Ambient conditions		
Ambient temperature		-25 ... 100 °C (248 ... 373 K)
Mechanical specifications		
Connection type		0.1m, PVC cable
Core cross-section		0.14 mm^2
Housing material		PBT
Sensing face		PBT
Protection degree		IP67
General information		
Use in the hazardous area		see instruction manuals
Category		1G; 2G; 1D

Wiring Chart

LEAD WIRE TERMINATIONS CHART		
SWITCH #	**LEAD COLOR**	**TERMINAL#**
1	BROWN +	1
	BLUE -	2
2	BROWN +	3
	BLUE -	4
3	BROWN +	5
	BLUE -	6
4	BROWN +	7
	BLUE -	8
5	BROWN +	9
	BLUE -	10
6	BROWN +	11
	BLUE -	12

⚠ **NOTE:** *Refer to the wiring diagram on the inside lid of your product to determine actual pin out location*

4-20mA Transmitter: Options LX/MX/KX/EX/TX/ZX/0X

The 2-wire 4-20mA transmitter will generate a nominal 4 – 20mA output for full-range actuation of the valve. The transmitter is capable of generating signals below 4mA and above 20mA if the position sensor indicates an out of range value.

Features:

1) Single push button easy calibration eliminates zero/span calibration interaction in both clockwise and counterclockwise actuator/valve rotation directions.
2) Non-volatile memory of set points (set points remain after loss of power)
3) 4-20mA power connection is not polarity sensitive
4) No internal backlash – direct shaft position feedback
5) No gear wear or mechanical binding
6) Small package size for easier access to limit switch cams. The small packaging allows for additional options that can be mounted in the valve monitoring enclosure
7) Position measurement range from 20º to 320º. Factory set for 20º to 180º operation in counter clockwise rotation to open and 20º to 90º operation in clockwise rotation to open applications.
8) Advanced diagnostics includes detection of dead band, out of range indication and detection of internal memory errors
9) Transmitter PCB is potted and sealed
10) Included with all valve monitoring switching options, incl. DPDT mechanical
11) +/- 1% position linearity for the complete device
12) Selectable +/- 3% over and under travel capability or full linear options set during calibration
13) Hysteresis: 0.5% of full-scale
14) Repeatability: 0.3% of full scale
15) Temperature Range: -40º to 85ºC

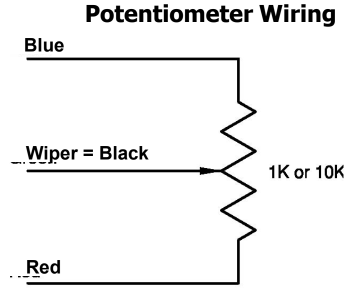
Potentiometer Only Shaft Position Monitoring Description
The potentiometer only version (without the 4-20mA Position Transmitter Module) will generate a ratio metric voltage output based on the excitation voltage and the position of the valve. Standard potentiometer options include 0-1k ohm and 0-10k ohm.

Potentiometer Features
-Hollow shaft mounting requires no gears and has no backlash
-Direct shaft position feedback
-Capable of 4,000,000 lifetime operations
-Better than 0.3° resolution
-Conductive plastic Potentiometric sensor
-for environmental protection
-Temperature Range: -40º to +85ºC

Potentiometer Electrical Data
-Voltage Input Range: 0-35 Volts
-Actual Electrical Travel 340° (dead band of 20°)
-Current Maximum: 3mA
-Recommended operating wiper current is less than or equal to 1 micro amp (recommend using the wiper voltage to drive an operational amplifier working as a voltage follower in which a very small load is applied to the wiper)
-Independent Linearity ±2%
-Resistance Tolerance ±20%

Electrical Data
-Voltage Input Range: 8.5 - 34 Volts DC
-Standard Output Signal: Two wire 4-20mA with out of range indication
-Input Polarity: Bi-Directional

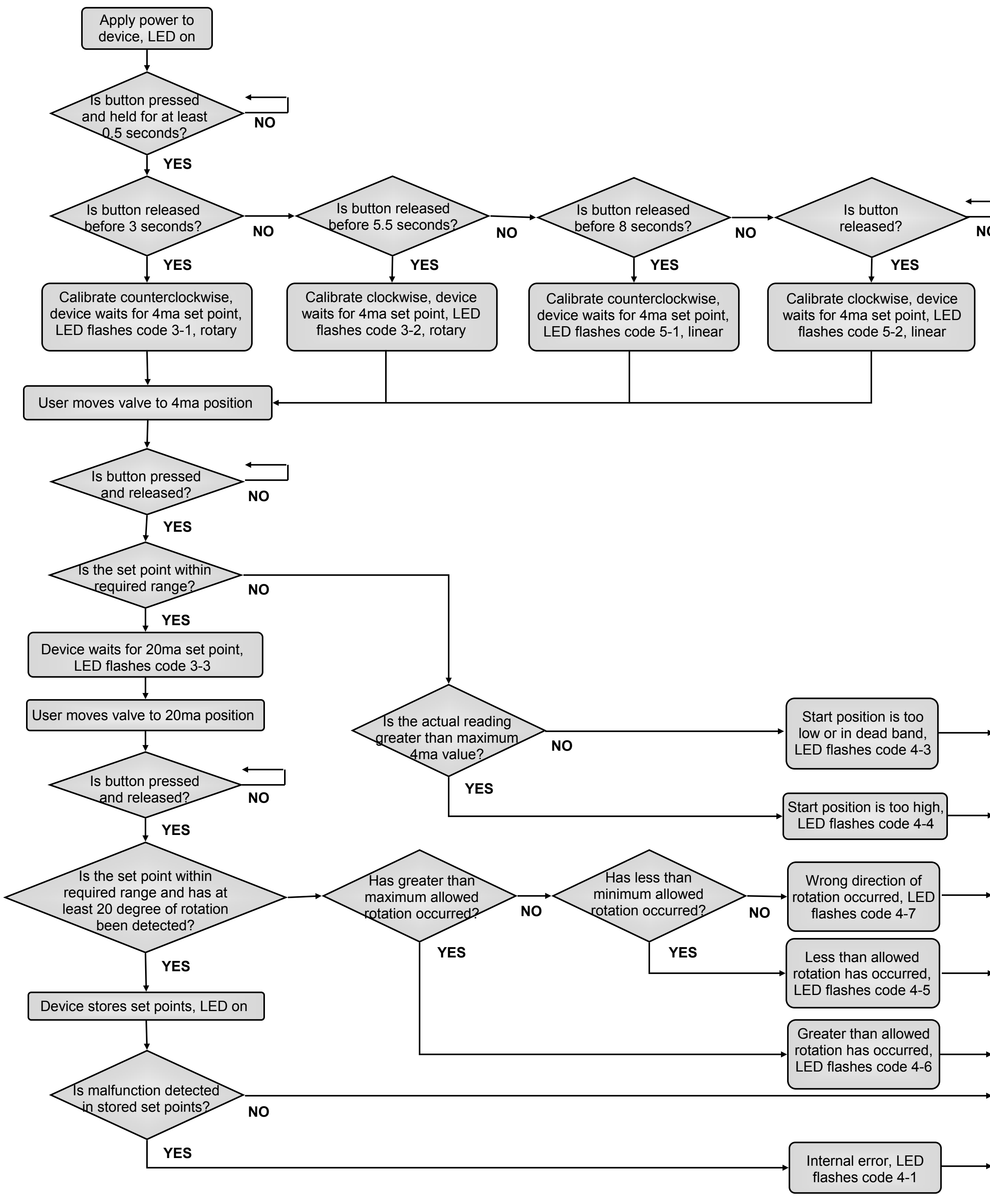
Potentiometer Wiring




NOTE: *Refer to the wiring diagram on the inside lid of your product to determine actual pin out location*

Continued
4-20mA Transmitter: Options LX/MX/KX/EX/TX/ZX/0X

Calibration Flow Chart



Continued
4-20mA Transmitter: Options LX/MX/KX/EX/TX/ZX/0X

Troubleshooting
Error Code and Problem Table

Problem	Probable Cause/Solution
Transmitter Module has no current output	If the LED on the Transmitter Module is not lit - Loose or shorted signal connection (fix connection) - Controller Board not responding (Replace Transmitter Module) If the LED on the Circuit Board is lit - Potentiometer is disengaged from shaft (must be returned for repair) - Defective controller board (Replace Transmitter Module)
Transmitter does not output 4 or 20mA (+/-1%) at desired end of travel	Unit not calibrated (calibrate) Unit is calibrated (recalibrate - if still fails, replace board)
Output is not linear or does not track valve position or rotation	Input signal is not linear - Linkage or drive mechanism is introducing non-linearity - Unit is not calibrated (calibrate)
Error Code 4-3	Start position is too low or in the dead-band position.
Error Code 4-4	Start Position is too high
Error Code 4-5	Start and stop positions are less than 20º, increase valve rotation between start and stop positions to greater than 20º.
Error Code 4-6	Rotation has exceeded the 320º limit. Decrease valve rotation between start and stop positions to less than 320º.
Error Code 4-7	Calibration rotation was in the wrong direction or the potentiometer passed through the dead-band position.
Error Code 4-1	Internal Error has occurred. Recalibrate, if error continues, replace module.

LED Flash Code Diagram

Flash Codes (first count – second count)	Interpretations
0-0	Calibrated
3-1	Counter-Clockwise Calibration, Waiting to calibrate the 4mA position, Rotary Mode
3-2	Clockwise Calibration, Waiting to calibrate the 4mA position, Rotary Mode
3-3	Waiting for 20mA Full Open Setting Button Press
4-1	Calibration Required
4-3	Calibration Start Value is Too Low
4-4	Calibration Start Value is Too High
4-5	End Value is Too Close to Start Value
4-6	Maximum Rotation Exceeded
4-7	Wrong Direction of Rotation
5-1	Counter-Clockwise Calibration, Waiting to calibrate the 4mA position, Linear Mode
5-2	Clockwise Calibration, Waiting to calibrate the 4mA position, Linear Mode

Operation of the 4-20mA Current Position Transmitter
During run mode, the 4-20mA position transmitter will output 4-20mA for valve positions between and including the set points. The module has an optional over or under travel correction if the valve position exceeds the high or low set point by +/-3%. In other words, the output will be 4mA for +/-3% over and under travel on the low end and 20mA for +/-3% over and under travel on the high end. If the valve position ex-ceeds 3% of over travel then values below 4mA or above 20mA will be output. The user selectable other option is to calibrate the device with-out the over and under travel capability. See the calibration procedure in this document for additional information.

Operation of the Stand Alone Potentiometer
The potentiometer only version will generate a ratio metric voltage output based on the excitation voltage and the position of the valve. Standard potentiometer options include 0-1k ohm and 0-10k ohm.

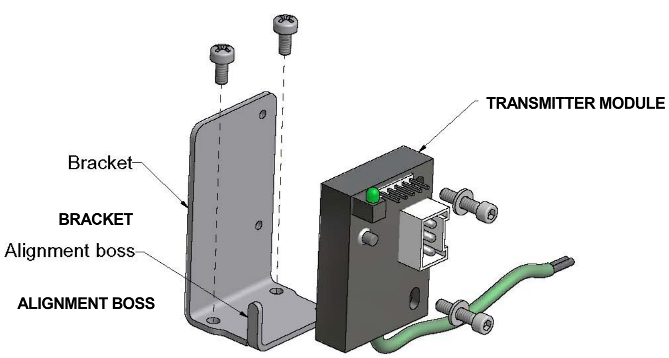
Continued
4-20mA Transmitter: Options LX/MX/KX/EX/TX/ZX/0X
D-Series Replacement Procedure: 4-20mA Position Transmitter

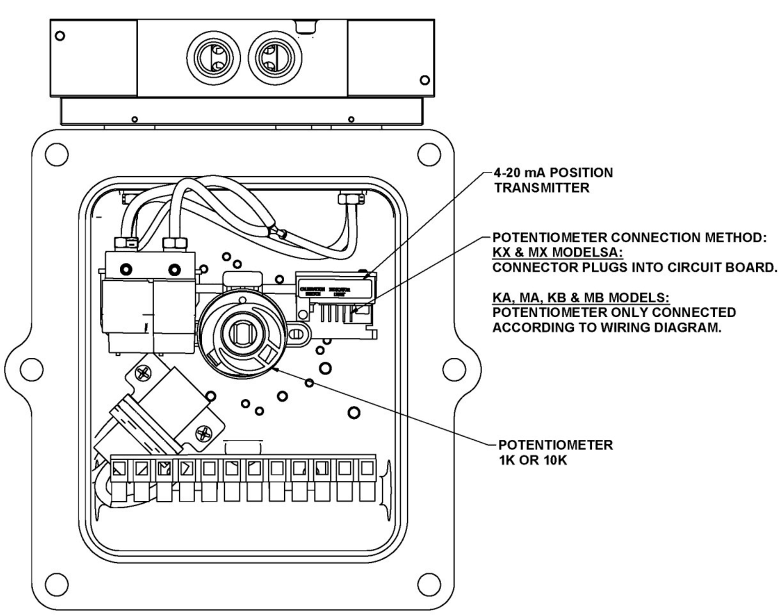
(Use the following installation procedure to replace an existing D-Series in the field)
Typically the 4-20mA Position Transmitter module and potentiometer options are already installed in TopWorx™ valve controller prod-ucts. Use the following installation directions only if you are replacing an existing unit:

1) First remove the valve monitor enclosure from the valve/actuator
2) Install the 4-20mA position transmitter using the supplied or existing mounting bolts (See illustration below)
3) Remove the existing shaft and replace with the new shaft and position sensor kit assembly (See illustration below)
   a) Remove circlip and washer from shaft on bottom of enclosure (outside)
   b) Pull shaft out gently from top side of enclosure
   c) Install lube (from packet) on new shaft just below potentiometer and spread around O-ring seals on shaft
4) The alignment boss on the bracket (indicated in the Illustration below) should hold one of the mounting ears of the sensor in place. Once mounted, verify that no rotary movement of the potentiometer housing is possible
5) If applicable, plug the position sensor cable into the 4-20mA position transmitter keyed header connector
6) Connect the three output wires to the indicated terminal block positions if you are using the potentiometer only option.
7) The module is now ready for calibration/operation
8) Before mounting the DXP to an actuator, make sure the potentiometer alignment marks are aligned as shown in the illustration below with the valve in the closed position.

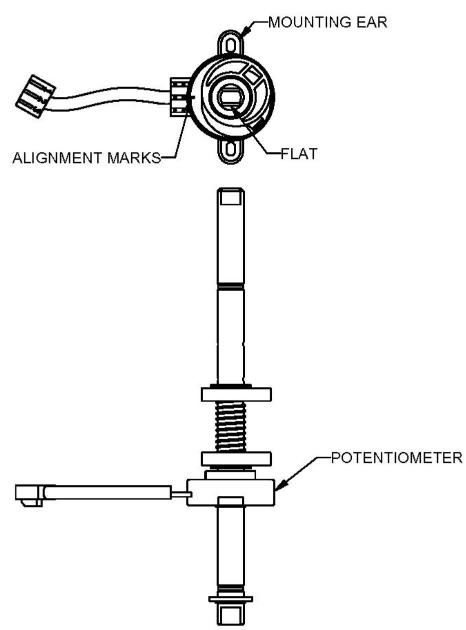
The potentiometer has been factory set for typical valve rotation ranges from 2° to 180° in counter-clockwise rotation applications from the 4mA position to the 20mA position and from valve rotation ranges from 2° to 90° in clockwise rotation applications from the 4mA position to the 20mA position. Please contact TopWorx™ for proper potentiometer set up for ranges greater than specified above.

Module and Bracket





Potentiometer Shaft Assembly

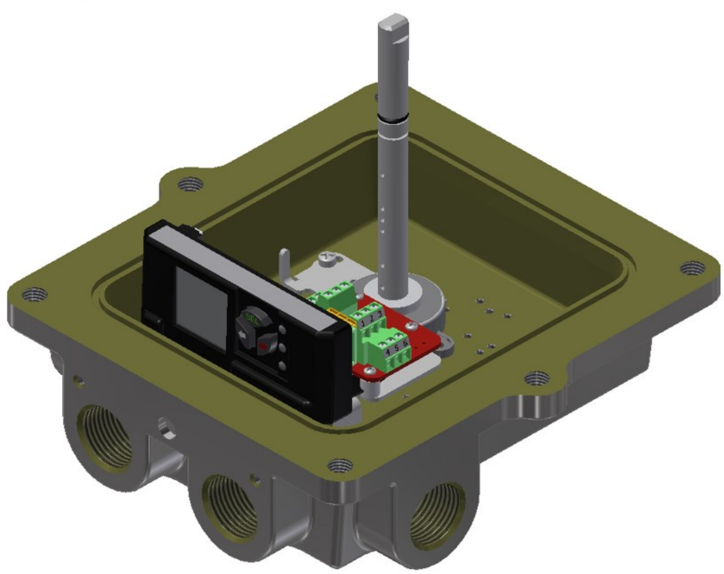


4-20mA Transmitter with HART: Options LH/MH/KH/EH/ZH/0H

Features and Specifications

Description

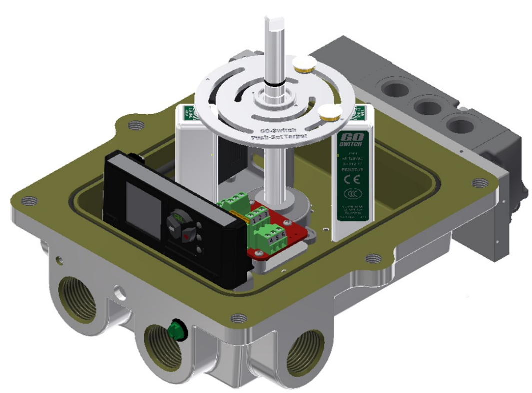
The TopWorx HART 4-20 mA Position Transmitter is a 2-wire high impedance slave transmitter. It is capable of both analog and digital signaling. The transmitter and DD (Device Descriptions) are registered with FieldComm Group™ and supports HART 7. Valve position is sensed directly through a position sensor with hard endpoint detection capability via limit switches.



Features and Specifications

Features:

- -Local user interface via Graphic LCD
- -Selectable endpoint hysteresis ±3 %
- -Internal device temperature monitoring
- -Point to Point and Multi-drop mode
- -Burst mode and Event Notification
- -Supports NE-107 and NE-43
- -Five-point valve position calibration
- -Polarity and overvoltage protection
- -Alarms and counters



Specifications:

Physical Specification	Min.	Typ.	Max.
Device Terminal Voltage	10.0 VDC	24 VDC	39 VDC
Linearity (1/4 Turn)	-	1 % of span	-
Hysteresis	-	0.5 %	-
Repeatability	-	0.5 %	-
Shaft Rotation	20 °	-	180° 1800 (Consult Factory for Additional Shaft Rotation Sensing)
Internal Temperature Sensor Accuracy	-	±2.5 °C	-
Operating Temperature Limits	-40 °C	-	80 °C
Device Resistance and Capacitance	-	Rx: 27.12k ohms, Cx: 6.11nF @ 950 Hz	-
High (H) Alarm NE-43 Current	-	22.3mA	-
Low (L) Alarm NE-43 Current	-	< 3.5mA	-
Multi-Drop Current Draw		4.0mA	
Lift-Off Voltage		10.0V	

For additional device specifications that include commands, please refer to ES-06116-1 HART Instruction Manual Supplement.

Device Information

Wiring Diagram:

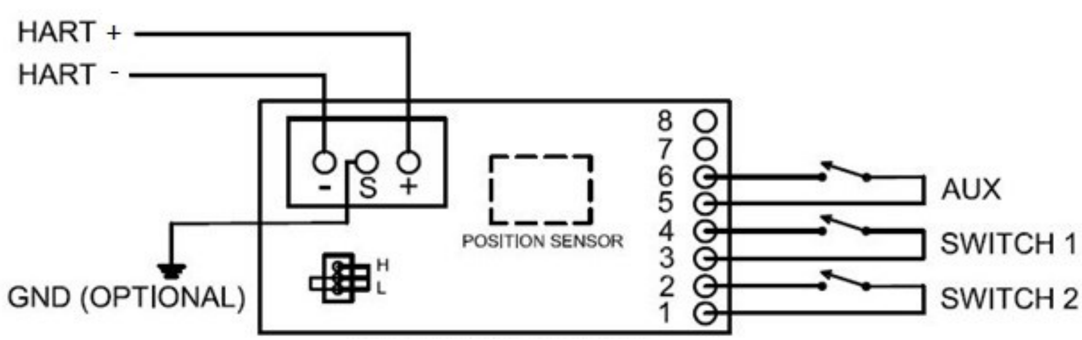


Figure 1: Wiring Diagram

Note: Optional cable shield to be connected on one cable end only. If connected on device side, make sure switchbox housing and grounding strap are properly earth grounded.

High/Low Alarm Jumper:

The TopWorx HART product supports NE-43 which requires the loop current to be driven to a level greater than 21 mA or below 3.5 mA in the event of a device failure. This loop current alarm value is user selectable via a jumper located on the device.

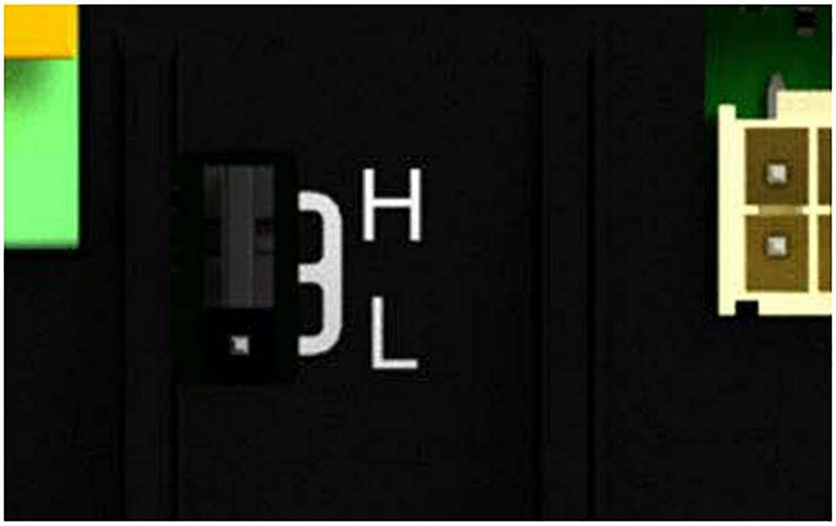


Figure 2: Loop Current Alarm High/Low Selection

Overview:

Manufacturer	TopWorx
Device Type	Transmitter
HART Protocol Revision	Revision 7
Device Description	Revision 1
Burst Mode	Yes
Event Notification	Yes
Dynamic Variables	Yes, 4, SV, TV, QV can be mapped. PV cannot.
Device Variables	Yes, 14

Device Variables:

Table 1: Device Variables

Index	Device Variable	Units	Dynamic Variable Mapping	Description	Range
0	Position	%	Primary Variable	Travel	% of Calibrated Span
1	Limit Switch 1	None	Tertiary Variable	End of Travel 1	1 = Tripped, 0 = Not Tripped
2	Limit Switch 2	None	Quaternary Variable	End of Travel 2	1 = Tripped, 0 = Not Tripped
3	Auxiliary Limit Switch	None	User selectable to SV,TV, or QV	Optional Aux. limit switch	1 = Tripped, 0 = Not Tripped
4	Internal Device Temperature	Celsius	Secondary Variable	Ambient device conditions	-55 to 130
5	Last Close Stroke Time	Milliseconds	User selectable to SV,TV, or QV	Travel time to close the valve	0 to 4294967295
6	Last Open Stroke Time	Milliseconds	User selectable to SV,TV, or QV	Travel time to open the valve	0 to 4294967295
7	Opened Dwell Time	Seconds	User selectable to SV,TV, or QV	Time last spent in the opened position	0 to 4294967295
8	Closed Dwell Time	Seconds	User selectable to SV,TV, or QV	Time last spent in the closed position	0 to 4294967295

9	Cycle Count	None	User selectable to SV,TV, or QV	Counted valve strokes	0 to 9999999
10	Valve State	None	User selectable to SV,TV, or QV	Indicates current valve position	0 = Opened,1 = Closed,2 = Open-ing,3 = Closing,4 = Stopped,5 = Un-known
11	Highest Device Temperature	degC, degF	User selectable to SV,TV, or QV	Highest ambient temperature seen by the device.	-55 to 130
12	Lowest Device Temperature	degC, degF	User selectable to SV,TV, or QV	Lowest ambient temperature seen by the device.	-55 to 130
13	Transition Dwell Time	Millisec-onds	User selectable to SV,TV, or QV	Accumulated time the valve last spent between the open and closed positions.	0 to 4294967295

Field Device Status:

Table 2: Field Device Status

Bit	Status	NE-107	Trigger	UI Code
0	Primary Variable Out of Limits	S	PV has exceeded the sensor limits.	19 – 01
1	Non-Primary Variable Out of Limits	S	Non-PV has exceeded the sensor limits.	19 – 02
2	Loop Current Saturated	S	Set when the loop current output has reached the physical limit.	19 – 04
3	Loop Current Fixed	N	Active during loop test and multi-drop mode.	19 – 08
4	More Status Available	N	Active when any bit in the Additional Field Device Status is set.	19 – 10
5	Cold Start	N	Set at initial device power up or after a device RESET. Cleared after receiving first HART command.	19 – 20
6	Configuration Changed	N	Set when the configuration has been changed by a primary or secondary master. Reset by HART Command 38.	19 – 40
7	Device Malfunction	F	Set or cleared by results of a self-test.	19 – 80

Additional Field Device Status:

Table 3:Additional Field Device Status

Byte	Bit	Status	NE-107	Trigger	UI Code
0	0	Communication Fault	F	Communication with host was unexpectedly lost.	00 – 01
	1	Low Frequency Oscillator Fault	F	Oscillator in the analog module failed to start.	00 – 02
	2	Local Calibration in Progress	S	Complete the calibration method.	00 – 04
	3	Temperature Sensor Failure	S	Reset the device. Contact factory if the alert persists.	00 – 08
	4	Calibration Span Failed	S	Valve travel calibration end set-point failed.	00 – 10
	5	Cycle Count Limit Alert	M	Cycle count exceeded user set alert value.	00 – 20
	6	DAC Trim Required	S	Analog loop current needs to be trimmed.	00 – 40
	7	Valve Calibration Required	S	Valve travel needs to be calibrated into the device.	00 – 80

1	0	Last Close Stroke Time Alert	M	Valve stroke time is greater than the user defined val-ue.	01 – 01
	1	Last Open Stroke Time Alert	M	Valve stroke time is greater than the user defined val-ue.	01 – 02
	2	Closed Dwell Time Alert	M	Valve dwell time is greater than the user defined value.	01 – 04
	3	Open Dwell Time Alert	M	Valve dwell time is greater than the user defined value.	01 – 08
	4	Electrical Hardware Failure	F	Reset the device. Ensure loop power is properly sup-plied.	01 – 10
	5	DAC Output Voltage Out of Range	F	Loop current driver voltage out of range.	01 – 20
	6	Position Sensor Fault	F	Sensor is in the dead band, shorted, or disconnected.	01 – 40
	7	Limit Switch Fault	F	End of travel limit switch is latched.	01 – 80
2	0	Transition Dwell Time Alert	M	Transition dwell time of the valve is greater than the user defined value.	
6	0	Maintenance Required [*Condensed Status*]	M		06 – 01
	1	Device Variable Alert	S		06 – 02
	2	Critical Power Failure	F		06 – 04
	3	Failure [*Condensed Status*]	F		06 – 08
	4	Out of Specification [*Condensed Status*]	S		06 – 10
	5	Function Check [*Condensed Status*]	C		06 – 20
	6	Unused - Returns 0	-	-	06 – 40
	7	Unused - Returns 0	-	-	06 – 80
8	0	Device Variable Simulation Active	C	Device has been placed in simulation mode.	08 – 01
	1	Non-Volatile Memory Defect	F	Memory check failed	08 – 02
	2	Volatile Memory Defect	F	Memory check failed	08 – 04
	3	Watchdog Reset Executed	F	Processor was reset due to failure to kick the watchdog timer.	08 – 08
	4	Power Supply Conditions Out of Range	M	Low board level supply voltage.	08 – 10
	5	Environmental Conditions Out of Range	M	Device temperature exceeded limits of -50 °C to 85 °C.	08 – 20
	6	Electronic Defect	F		08 – 40
	7	Device Configuration Locked	C	Device locked bit is set.	08 – 80
9	0	Status Simulation Active	C		09 – 01
	1	Discrete Variable Simulation Active	C		09 – 02
	2	Event Notification Overflow	C		09 – 04
	3	Unused - Returns 0	-	-	-
	4	Unused - Returns 0	-	-	-
	5	Unused - Returns 0	-	-	-
	6	Unused - Returns 0	-	-	-
	7	Unused - Returns 0		-	-

Operation

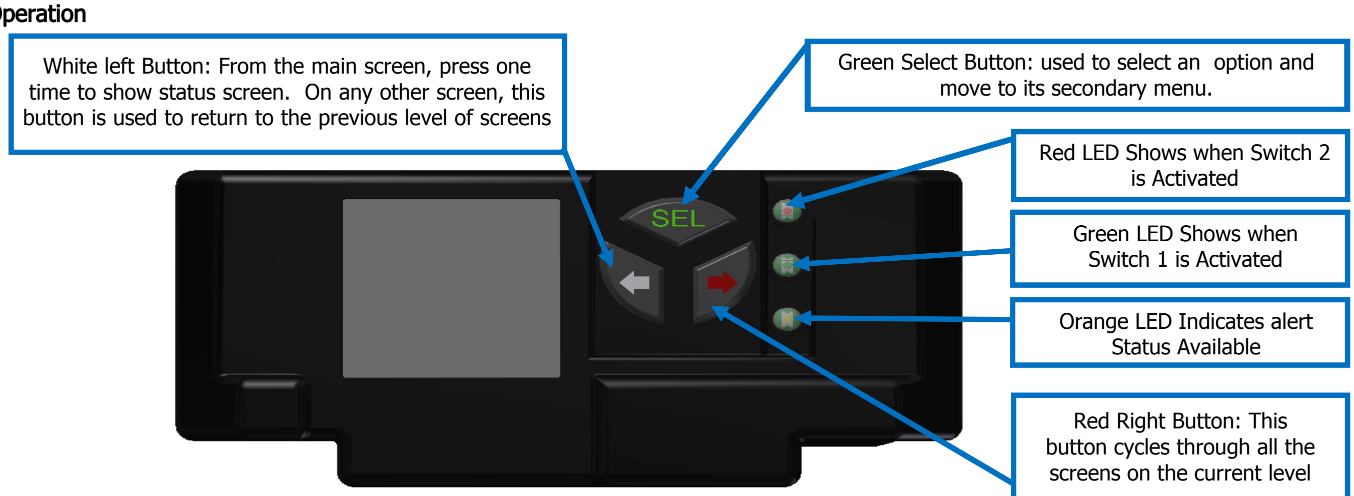


Figure 3: Buttons and Indicator Lights

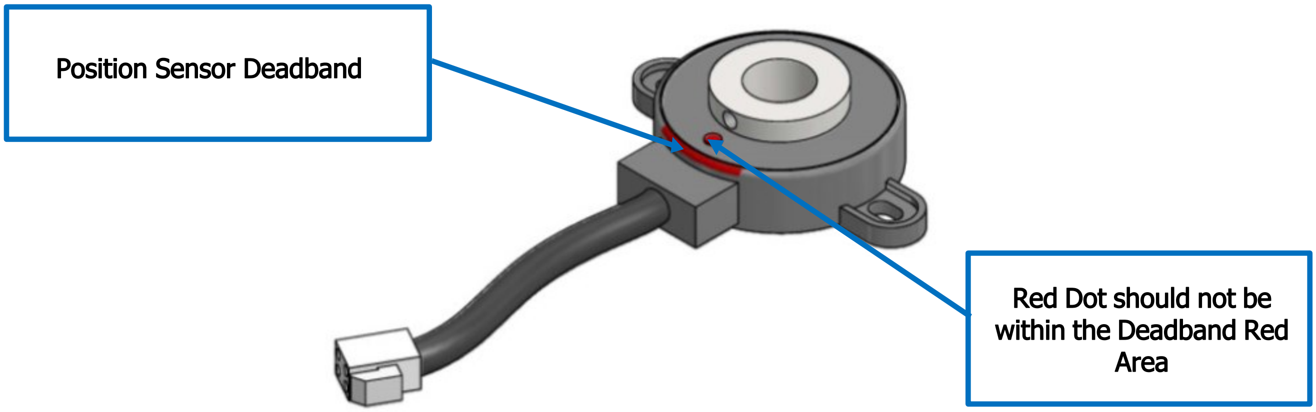


Figure 4: Position Sensor Deadband

Local (at Device) Calibration

Hysteresis Setting: (See Figure 5)

Hysteresis/Valve Mode of the valve endpoint readings can be adjusted to 0% (Linear Mode) or 3% (Rotary Mode). At 3% hysteresis, an over or under travel correction of the valve end points are set within 3%. In other words, the output will be 4mA for 3% range travel from the low-end calibration set point and 20mA for 3% range travel on the high-end calibration set point. If the valve position exceeds 3% of over travel, then values below 4mA or above 20mA will be output. At 0% hysteresis, the position readings at both valve open and closed end points will be exact with no over and under travel correction.

To change the end-point hysteresis (default 3%), press the three times until "HYSTERESIS" is shown. Press the Green Select button. The 0% option is displayed. Press the Green Select button to set the hysteresis to 0%. or press the button to move to the 3% hysteresis screen. Press the Green Select button to set the hysteresis to 3%. A success screen will show the hysteresis (Deadband) setting.

Example: 2-Point Clockwise Local Calibration

To execute 2-point Clockwise valve calibration: From the main screen (Figure 6-1) press the three times on the HART device until "SET VALVE CAL" is shown (Figure 6-2). Press the Green Select button and the device will ask, "ARE YOU SURE?" (if you want to continue with valve calibration) as shown in Figure 6-3. Press the Green Select button to get to the calibration menu. Cycle through the different calibration options by pressing the button. Press the Green Select button to select "2 POINT CW" calibration (Figure 6-4). The device asks "PLACE VALVE AT 0%" (Figure 6-5). Rotate shaft to the desired 0% position and press the Green Select button. Select "STORE 0% AS OPEN?" (Figure 6-6). The screen should now show "PLACE VALVE AT 100%" (Figure 6-7). Rotate the shaft clockwise until shaft is in the 100% or "CLOSED" position. Press the Green Select button again to see "STORE 100% POINT?" (Figure 6-8). After pressing the Green select button, the screen will show "SUCCESS" (Figure 6-9) and then return to the home screen. The output current reading should be 20mA when the target is at 100% (CLOSE). The current reading should be 4ma when the target is at the 0% (OPEN) position. If these are both true, the device is calibrated correctly.

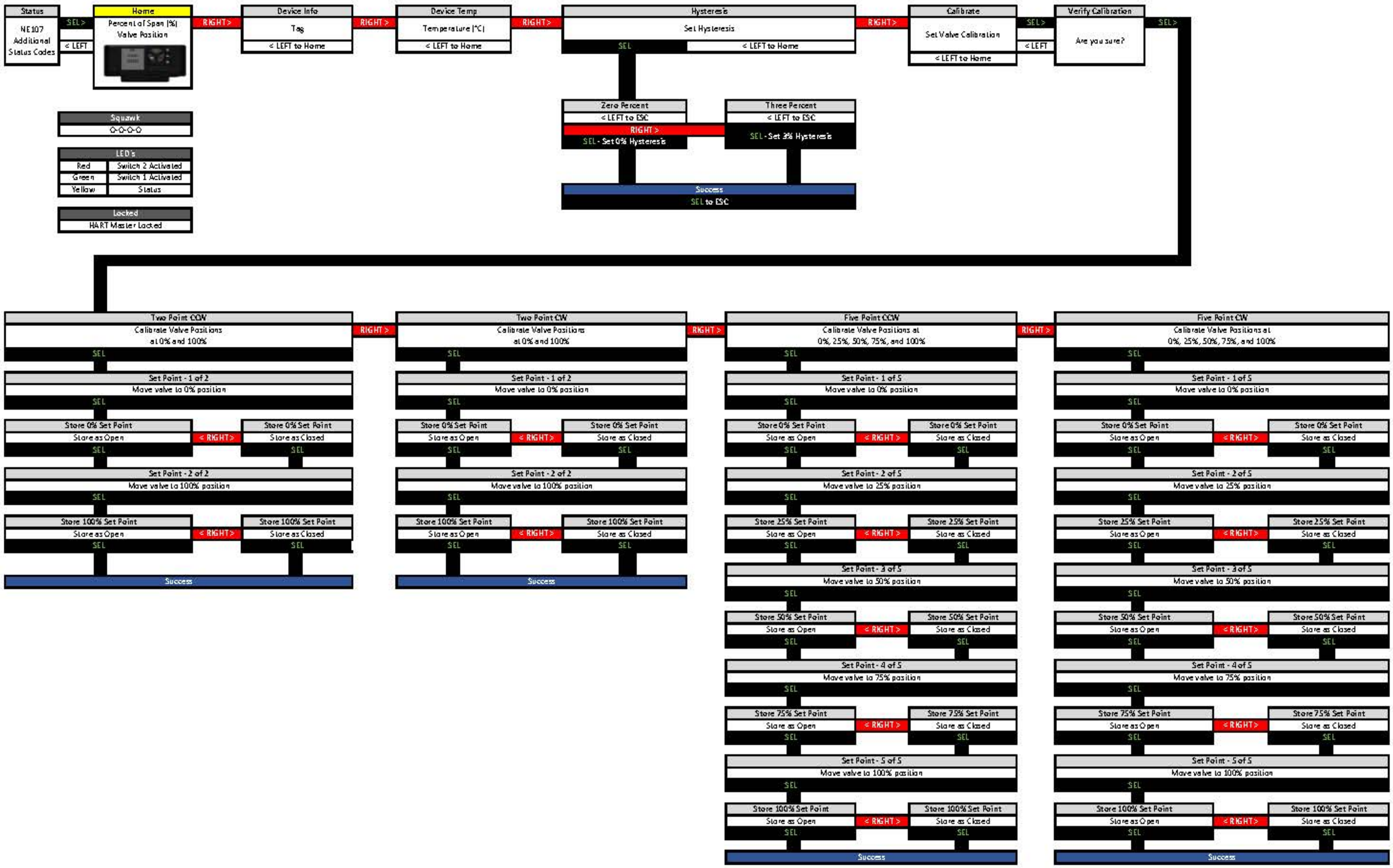


Figure 5: Local User Interface Flow Chart

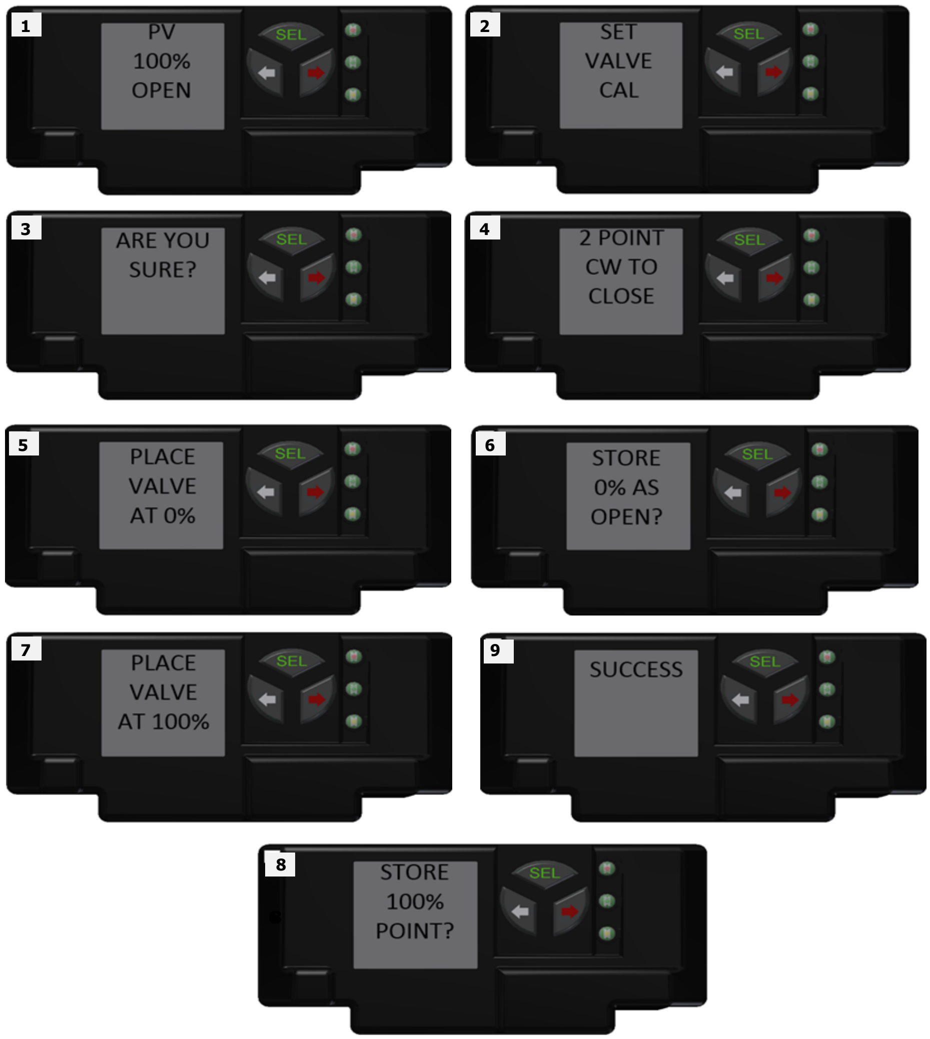


Figure 6.1-6.9: HART CW Calibration Procedure

Example: 5-Point Clockwise Calibration

For additional accuracy, utilize the 5-point calibration. This feature is typically used in conjunction with valve positioners to more accurately align both system's valve position measurement.

To execute 5-point Clockwise valve calibration: From the main screen on the HART Device, press the button four times until "SET VALVE CAL" is shown. Press the Green Select button and the device will ask, "ARE YOU SURE?" (if you want to continue with valve calibration). Press Green Select to get to the calibration menu. Cycle through the different calibration options by pressing the button. Press Green Select to select "5 POINT CW TO CLOSE" calibration. The device asks "PLACE VALVE AT 0%" (Figure 6-5). Rotate shaft to the desired 0% position and press the Green Select. Select "STORE 0% AS OPEN?". The other option is "STORE 0% AS CLOSE". The device will then cycle through the same procedure at 25%, 50%, 75% and then 100% valve rotation. At the 100% location, the screen should now show "PLACE VALVE AT 100%". Rotate the shaft clockwise until shaft is in the 100% or "CLOSED" position. Press the Green Select again to see

"STORE 100% POINT?". After pressing the Green select the screen will show "SUCCESS" and then return to the home screen. The output current reading should be 20ma when the target is at 100% (CLOSE), 16ma at 75%, 12ma at 50%, 8ma at 25% and 4ma at 0% (OPEN). If these are measurements are true, the device is calibrated correctly.

Remote (Not at Device) Calibration/Set-up

Remote calibration/setup can be performed at a maintenance/control system or handheld device. The user has the option of configuring the device either through a guided or manual setup. For example; by executing the calibration method through AMS as shown in **Figure 7.**

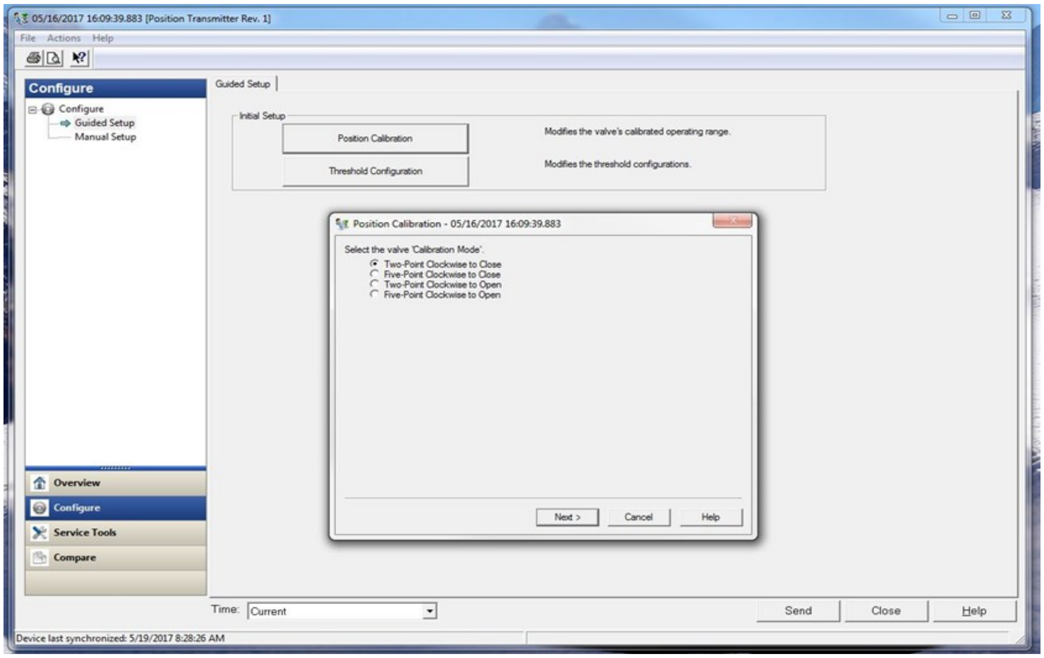


Figure 7: AMS Guided Setup Screen

Another example is setting up threshold configuration of the device as shown in Figure 8: Manual Setup Device Configuration Example . Many features are available utilizing a control system, maintenance system or handheld. For example:

- Device Information
- Device Variable Reading/Setting
- Device Overview
- Alerts
- Device/Alert Simulation
- Position Calibration
- Threshold Configuration for Alerts
- Communication Statistics
- Communication Settings
- Device Location
- Clock/Date Set
- Burst Mode Configurations
- Event Notification
- Variable Mapping
- Polling Addressing/Multidrop setup
- Security – Software Lock
- Trends
- Loop Test
- DAC Trim
- Factory/Processor Reset
- PV Range

Remote calibration/setup can be performed with a HART handheld device.

The handheld device menu is shown in Table 4: Handheld Device Menu

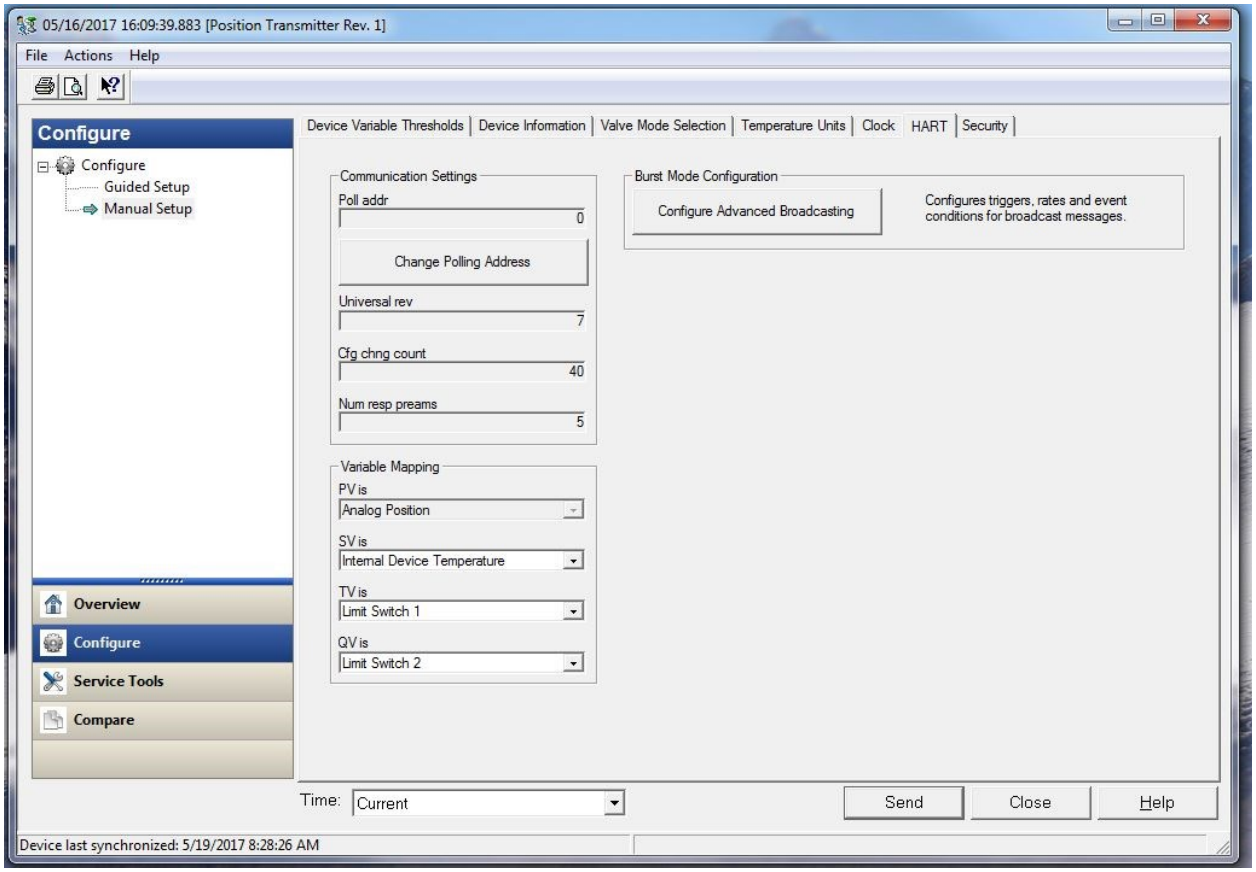


Figure 8: Manual Setup Device Configuration Example

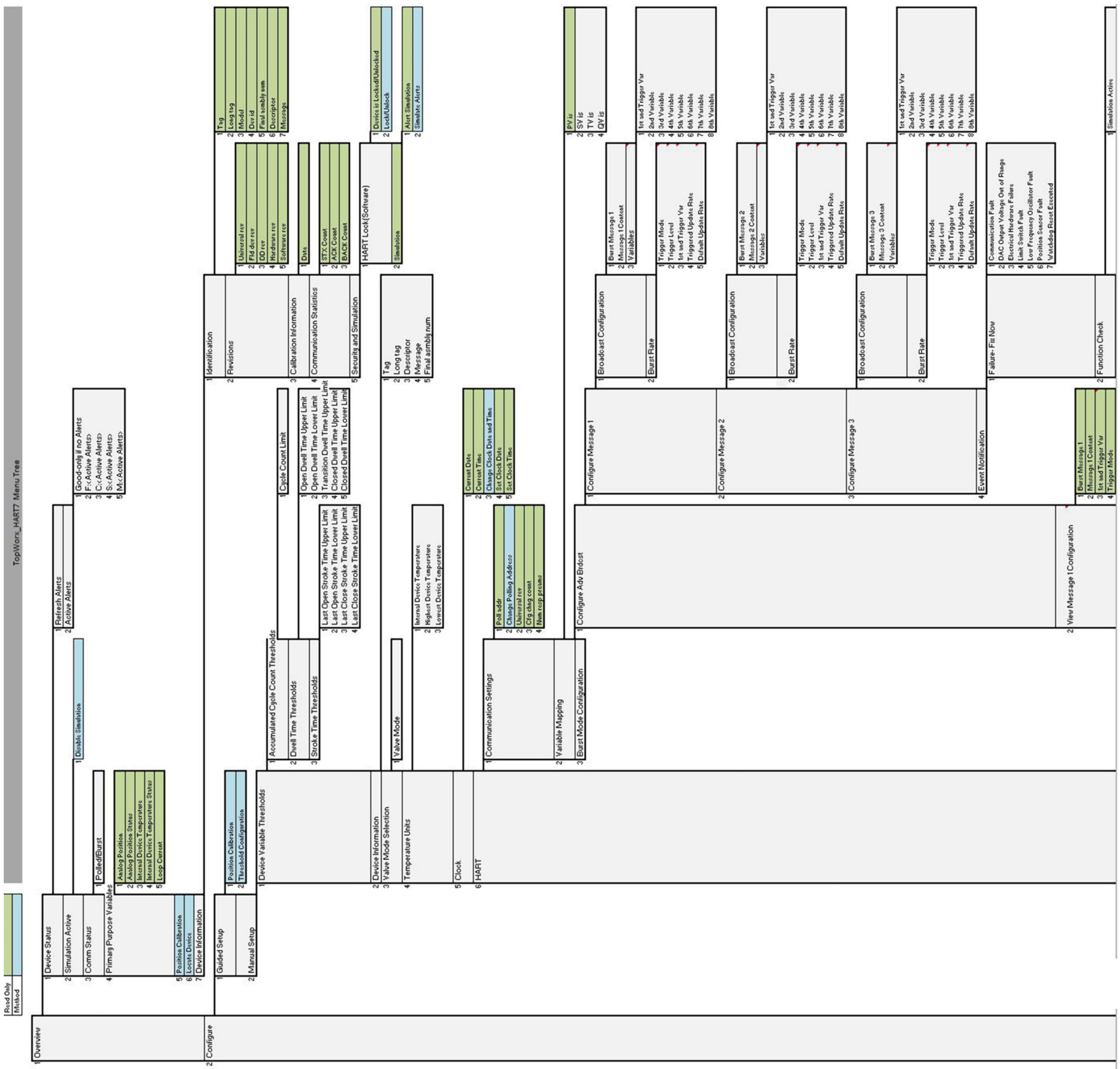
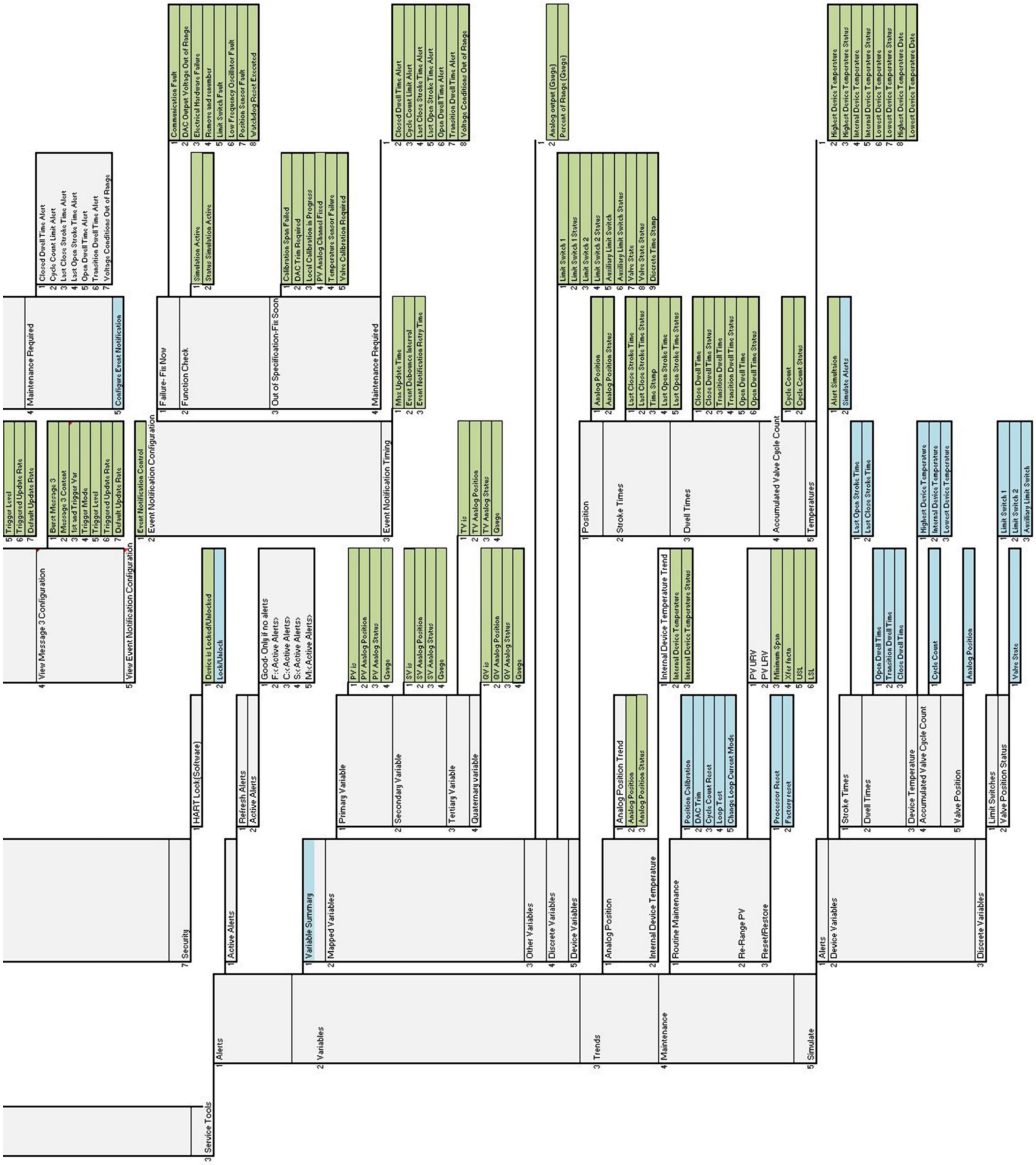


Table 4: Manual Setup Device Configuration Example


3 Service Tools
1 Alerts
1 Active Alerts
1 Refresh Alerts
2 Active Alerts
1 Good- Only if no alerts
2 F:<Active Alerts>
3 C:<Active Alerts>
4 S:<Active Alerts>
5 M:<Active Alerts>
7 Security
1 HART Lock (Software)
1 Device is Locked/Unlocked
2 Lock/Unlock
4 View Message 3 Configuration
5 Trigger Level
6 Triggered Update Rate
7 Default Update Rate
1 Burst Message 3
2 Message 3 Content
3 1st and Trigger Var
4 Trigger Mode
5 Trigger Level
6 Triggered Update Rate
7 Default Update Rate
5 View Event Notification Configuration
1 Event Notification Control
2 Event Notification Configuration
1 Failure- Fix Now
1 Communication Fault
2 DAC Output Voltage Out of Range
3 Electrical Hardware Failure
4 Remove and renumber
5 Limit Switch Fault
6 Low Frequency Oscillator Fault
7 Position Sensor Fault
8 Watchdog Reset Executed
2 Function Check
1 Simulation Active
2 Status Simulation Active
3 Out of Specification-Fix Soon
1 Calibration Span Failed
2 DAC Trim Required
3 Local Calibration in Progress
4 PV Analog Channel Fixed
4 Temperature Sensor Failure
5 Valve Calibration Required
4 Maintenance Required
1 Closed Dwell Time Alert
2 Cycle Count Limit Alert
3 Last Close Stroke Time Alert
4 Last Open Stroke Time Alert
5 Open Dwell Time Alert
6 Transition Dwell Time Alert
7 Voltage Conditions Out of Range
3 Event Notification Timing
1 Max Update Time
2 Event Debounce Interval
3 Event Notification Retry Time
4 Maintenance Required
1 Closed Dwell Time Alert
2 Cycle Count Limit Alert
3 Last Close Stroke Time Alert
4 Last Open Stroke Time Alert
5 Open Dwell Time Alert
6 Transition Dwell Time Alert
7 Voltage Conditions Out of Range
5 Configure Event Notification
2 Variables
1 Variable Summary
2 Mapped Variables
1 Primary Variable
1 PV is
2 PV Analog Position
3 PV Analog States
4 Gauge
2 Secondary Variable
1 SV is
2 SV Analog Position
3 SV Analog States
4 Gauge
3 Tertiary Variable
1 TV is
2 TV Analog Position
3 TV Analog States
4 Gauge
4 Quaternary variable
1 QV is
2 QV Analog Position
3 QV Analog States
4 Gauge
3 Other Variables
1
2 Analog output (Gauge)
Percent of Range (Gauge)
4 Discrete Variables
1 Limit Switch 1
2 Limit Switch 1 States
3 Limit Switch 2
4 Limit Switch 2 States
5 Auxiliary Limit Switch
6 Auxiliary Limit Switch States
7 Valve State
8 Valve State States
9 Discrete Time Stamp
5 Device Variables
1 Position
1 Analog Position
2 Analog Position States
2 Stroke Times
1 Last Close Stroke Time
2 Last Close Stroke Time States
3 Time Stamp
4 Last Open Stroke Time
5 Last Open Stroke Time States
3 Dwell Times
1 Close Dwell Time
2 Close Dwell Time States
3 Transition Dwell Time
4 Transition Dwell Time States
5 Open Dwell Time
6 Open Dwell Time States
4 Accumulated Valve Cycle Count
1 Cycle Count
2 Cycle Count States
5 Temperatures
1
2 Highest Device Temperature
3 Highest Device Temperature States
4 Internal Device Temperature
5 Internal Device Temperature States
6 Lowest Device Temperature
7 Lowest Device Temperature States
8 Highest Device Temperature Date
Lowest Device Temperature Date
3 Trends
1 Analog Position
1 Analog Position Trend
2 Analog Position
3 Analog Position States
2 Internal Device Temperature
1 Internal Device Temperature Trend
2 Internal Device Temperature
3 Internal Device Temperature States
4 Maintenance
1 Routine Maintenance
1 Position Calibration
2 DAC Trim
3 Cycle Count Reset
4 Loop Test
5 Change Loop Current Mode
2 Re-Range PV
1 PV URV
2 PV LRV
3 Minimum Span
4 Xfer fnctn
5 USL
6 LSL
3 Reset/Restore
1 Processor Reset
2 Factory reset
5 Simulate
1 Alerts
1 Alert Simulation
2 Simulate Alerts
2 Device Variables
1 Stroke Times
1 Last Open Stroke Time
2 Last Close Stroke Time
2 Dwell Times
1 Open Dwell Time
2 Transition Dwell Time
3 Close Dwell Time
3 Device Temperature
1 Highest Device Temperature
2 Internal Device Temperature
3 Lowest Device Temperature
4 Accumulated Valve Cycle Count
1 Cycle Count
5 Valve Position
1 Analog Position
3 Discrete Variables
1 Limit Switches
1 Limit Switch 1
2 Limit Switch 2
3 Auxiliary Limit Switch
2 Valve Position Status
1 Valve State

Alerts

If the status indicator LED(Orange) is flashing, then the device has an alert. From the home screen on the HART device, press the White Left button once to get to the status screen. The status of the device will be indicated. Each status code is accompanied with brief de-scription. For additional information on the status code and recommended action, refer to Table 5: Status Codes

Figure 9: Status Screen

Alerts are also available remotely at the control system or handheld device. An example is shown Figure 10:

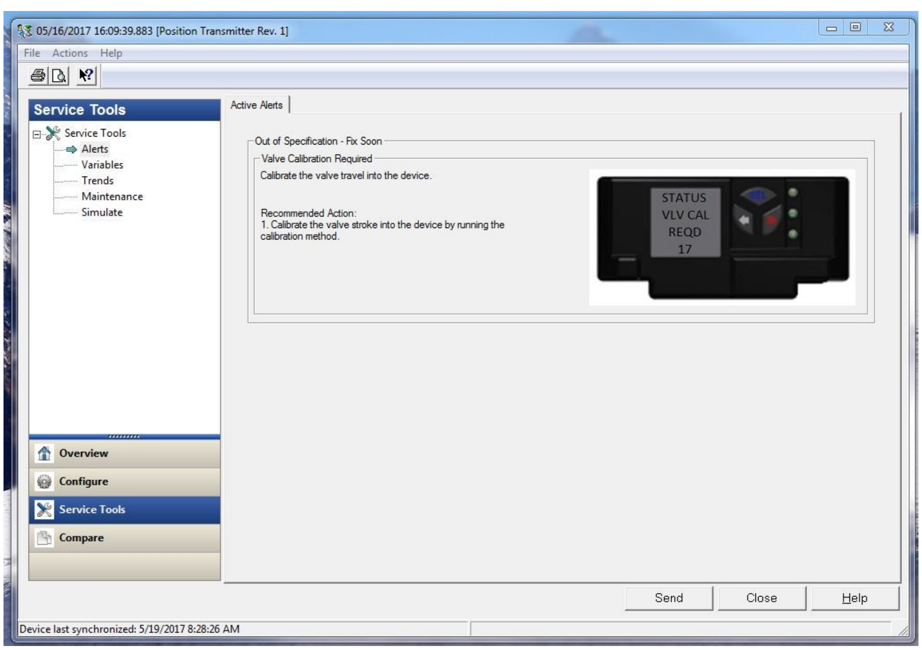


Figure 10: AMS Active Alert Example Screen

Table 5: Status Codes

Displayed Status at Device					
Status Code	**Text - Line 2**	**Text - Line 3**	**Status Description**	**Alert Description**	**Recommended Action**
260	PRI VAR	OUT LIM	Primary Variable Out of Limits	The Primary Variable is beyond its operating limit.	Check the valve for over travel. Recal-ibrate the device.
261	NP VAR	OUT LIM	Non-Primary Variable Out of Limits	A Device Variable not mapped to the Primary Variable is beyond its operating limits.	Check the device variable limit settings.
262	LOOP I	SATUR8D	Loop Current Saturat-ed	The loop current has reached its maximum or minimum value and cannot increase or decrease any further.	Check the valve for over travel. Verify the position sensor is connected and not in the deadband.
263	LOOP I	FIXED	Loop Current Fixed	The device is in multi-drop mode or the loop current is set to a fixed level and is not responding to pro-cess inputs.	If analog loop current signaling is desired disable multidrop mode.
264	MORE	STATUS	More Status Available	More status is available via Com-mand 48 - Read Additional Status	Automatically reset once the Host issues HART Command 48 - Read Additional Device Status.
265	COLD	START	Cold Start	Power has been cycled or a Device Reset has occurred.	Automatically reset once the host issues the first command to the de-vice.
266	CONFIG	CHANGE D	Configuration Changed	An operation changed the devices configuration.	Automatically reset for the specific host which issued Command 38 - Reset Configuration Changed Bit.
267	DEVICE	MALFUNC	Device Malfunction	The device detected a serious error or failure that compromises device operation.	Reset the device. Request the device to run a self-test if possible. Contact the factory if the condition persists.
10	COMM	FAULT	Communication Fault	A device peripheral bus communi-cation fault has occurred.	Reset the device. Contact factory if the alert persist.
11	LFO	FAULT	Low Frequency Oscil-lator Fault	The low frequency clock source failed to start.	Reset the device. Contact factory if the alert persist.
12	CAL IN	PROGRES	Local Calibration in Progress	Valve position may not reflect ac-tual value during calibration.	Complete the calibration method.
13	TMP SNS	FAULT	Temperature Sensor Failure	The device temperature sensor has failed.	Reset the device. Contact factory if the alert persist.
14	CALSPAN	FAILED	Calibration Span Failed	Valve stroke is too small or calibra-tion is bad.	Stroke must be greater than 20 De-grees. Recalibrate the valve span.
15	CYC CNT	LIMIT	Cycle Count Limit Alert	Cycle Count Limit has been exceeded.	Valve maintenance is recommended. Readjust or reset the upper cycle count limit parameter.
16	DA TRIM	REQD	DAC Trim Required	DAC trim is required to ensure accurate loop current output.	Execute the DAC trim method to trim the loop current to the proper value against a calibrated current meter.
17	VLV CAL	REQD	Valve Calibration Required	Calibrate the valve travel into the device.	Calibrate the valve stroke into the device by running the calibration method.

Displayed Status at Device					
Status Code	**Text - Line 2**	**Text - Line 3**	**Status Description**	**Alert Description**	**Recommended Action**
20	**CLS STR**	**TIME**	**Last Close Stroke Time Alert**	**Set when the stroke time is outside the range set by the upper and lower limit ranges.**	**Valve maintenance is recommended. Adjust the limits according to the valves stroke time.**
21	OPN STR	TIME	Last Open Stroke Time Alert	Set when the stroke time is outside the range set by the upper and lower limit ranges.	Valve maintenance is recommended. Adjust the limits according to the valves stroke time.
22	CL DWEL	TIME	Closed Dwell Time Alert	Set when the stroke time is outside the range set by the upper and lower limit ranges.	Stroke/Partially stroke the valve to reset the timer, clear the counter manually, increase the limit.
23	OP DWEL	TIME	Open Dwell Time Alert	Set when the stroke time is outside the range set by the upper and lower limit ranges.	Stroke/Partially stroke the valve to reset the timer, clear the counter manually, increase the limit.
24	ELECTRIC	HDWARE	Electrical Hardware Failure	Set when an electrical component on the device failed.	Reset the device. Ensure loop power is properly supplied.
25	DAC OUT	RANGE	DAC Output Voltage Out of Range	The loop transistor drive voltage is higher than expected.	Reset the device. Ensure loop power is properly supplied.
26	POSITN	SENSOR	Position Sensor Fault	The device detected an issue with the position sensor.	Check the wiring connections for the positions sensor / potentiometer.
27	LIM SW	FAULT	Limit Switch Fault	The device detected an issue with the limit switch.	Check the wiring connections for each limit switch.
30	TRANST N	DWEL TM	Transition Dwell Time Alert	Set when the transition dwell time exceeds the upper limit parameter.	Valve maintenance is recommended. Adjust the limits according to the transition dwell time.
70	MAINT	REQD	Maintenance Re-quired [*Condensed Status*]	This bit is set to indicate that the field device or valve requires maintenance.	Check the additional device status bits for details.
71	DEVICE	VARIABL	Device Variable Alert	This bit is set if any of the device variables are in an alert state.	Check that the process inputs have not exceed the device senor limits.
72	CRITICL	PWR FLT	Critical Power Failure	This bit is reserved for devices that operate from stored power and is not implemented in this device.	This bit will not ever be set.
73	FAILURE	STATUS	Failure [*Condensed Status*]	Signal invalid due to malfunction in the device or sensor.	Check the additional device status bits for details.
74	OUT OF	SPEC	Out of Specification [*Condensed Status*]	Permissible ambient or process conditions exceeded or the meas-uring uncertainty of sensors is probably greater than expected.	Check the additional device status bits for details.

Displayed Status at Device					
Status Code	**Text - Line 2**	**Text - Line 3**	**Status Description**	**Alert Description**	**Recommended Action**
75	FUNCT	CHECK	Function Check [*Condensed Status*]	Signal temporarily invalid due to on-going work on the device.	Check the additional device status bits for details.
90	VAR SIM	ACTIVE	Device Variable Simulation Active	Device variables are being simu-lated.	Disable Device Variable Simulation mode.
91	NV MEM	DEFECT	Non-Volatile Memory De-fect	FRAM Uncorrectable bit Error.	Reset the device. Contact the facto-ry if the problem persists.
92	VOL MEM	DEFECT	Volatile Memory Defect	RAM/Code overwrite Error. Micro-processor Stack Overflow.	Reset the device. Contact the facto-ry if the problem persists.
93	WDT RST	EXECD	Watchdog Reset Executed	Code execution has exceeded the WDT timer limit.	Reset the device.
94	PWR SUP	RANGE	Power Supply Conditions Out of Range	Regulated power supply voltage is out of range.	Verify the bus voltage is in range.
95	ENVI-RON	RANGE	Environmental Conditions Out of Range	Internal Temperature outside -40 to 80 C	Ensure the environmental condi-tions are appropriate for the
96	ELECTR	DEFECT	Electronics Defect	Internal electronics failure.	Contact the factory.
97	CONFIG	LOCKED	Device Configuration Locked	The device is locked by the host.	Unlock the device.
100	SIMUL	ACTIVE	Status Simulation Active	Status alerts are being simulated.	Disable Status Simulation mode.
101	VAR SIM	ACTIVE	Discrete Variable Simula-tion Active	Discrete variables are being simulated.	Disable Discrete Variable Simulation mode.
102	EVENT	OVER-FLO	Event Notification Over-flow	Event notification buffers have overflowed.	The device buffers 3 unacknowl-edged events. Ensure the host acknowledges the events in a timely manner.

Certifications:

HART DEVICE ONLY:

Ex ia IIC Ga
Tamb = -40ºC to +80ºC
Device Entity Parameters:

Input		Simple apparatus Inputs	
Ui	28 V	Ui	0
Ii	100 mA		
Pi	0.7 W		
Ci	11 nF	Ci	22.993 µF
Li	14 µH	Li	14 µH
		Uo	7.71 V
		Io	100 mA
		Po	0.7 W
		Co	0.993 µF
		Lo	3541 µH

D2-FF Discrete Valve Controller Description & Specification

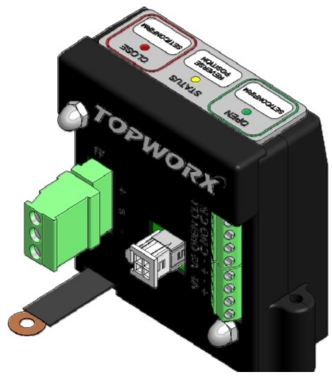
The TopWorx™ D2-FF Discrete Valve Controller combines position sensing and monitoring with FOUNDATION Fieldbus communications and pilot valve output drivers. It in-corporates the following features:

FOUNDATION Fieldbus digital communication:

- Link active scheduler capability/Link Master (LAS)
- Pre-instantiated** blocks include Resource Block (RB), Transducer Block (TB), Analog Input (AI) Function Block, Discrete Output (DO) Function Block, 2 Dis-crete Input (DI) Function Block, Proportional, Integral, and Derivative (PID) Function Block
- Function block instantiation, live download, auto commission/replacement
- Fast function block execution time: DI: 15ms, AI: 15ms, DO: 20ms, PID: 20ms
- Easy integration into AMS and DeltaV systems
- Device Dashboards powered by enhanced Electronic Device Description Language (EDDL)

Position sensing/monitoring

- Optional GO switches for open/close status
- Optional potentiometer for position percent-age indication, can be used for any rotation range between 20 and 320 degrees. End position offsets are adjustable.



Control and monitor inputs and outputs

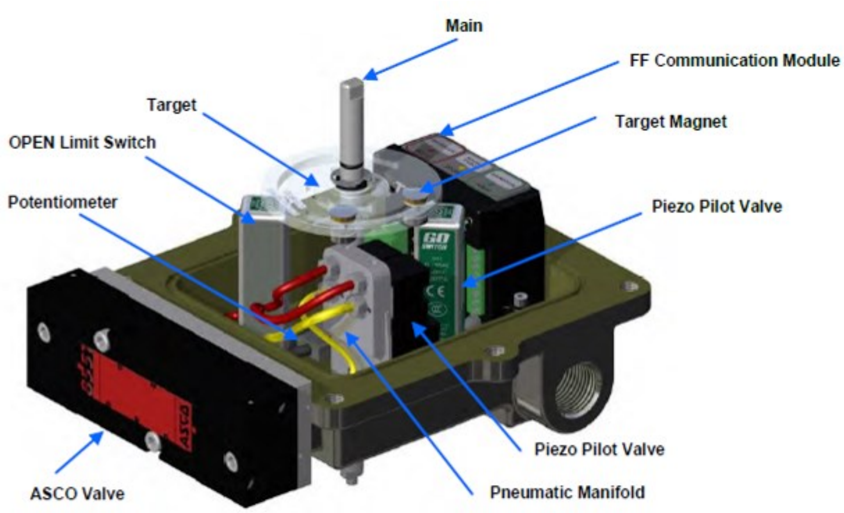
- Supports single/double and normal/reverse acting actuators
- Local LEDs for visual indication
- Local push buttons for calibration
- Remote configuration from control system or field communicator
- Stroke valve method
- Cycle count monitoring
- Open/close time monitoring
- Temperature monitoring
- Open/short circuit protection
- Integrated field diagnostics
- Embedded NAMUR NE 107 diagnostics

Intrinsically Safe Input Parameters: Bus Connector pins 1 to 3			
I.S. Parameters		**FISCO Parameters**	
Ui	30V	Ui	17.5V
Ii	380mA	Ii	380mA
Pi	1.5W	Pi	5.32W
Ci	5nF	Ci	5nF
Li	10µH	Li	10µH

Electrical Specifications	
Current Consumption	17.65mA nominal
Max. Applied Voltage	35VDC
Operating Voltage	9-32VDC
Fieldbus Specifications	
Topology	Point to Point Bus with Spurs Daisy Chain Tree
Cable	Twisted Pair
Bus Length	1900m (max)
Transmission Speed	31.25 kbit/s
Intrinsically Safe	Yes
Function Block Execution Times	DI 15ms AI 15ms DO 20ms PID 20ms

**Pre-instantiated blocks are the pre-installed factory default function blocks. Instantiation is the capability to add blocks to and delete blocks from FF devices on the link. Up to 15 additional copies of each function block can be added to a device (except the transducer and resource blocks). Not an available feature in some DSC systems.

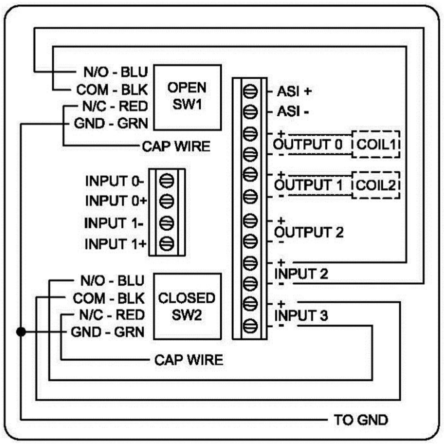
D2-FF Assembly: "Inside the Box"

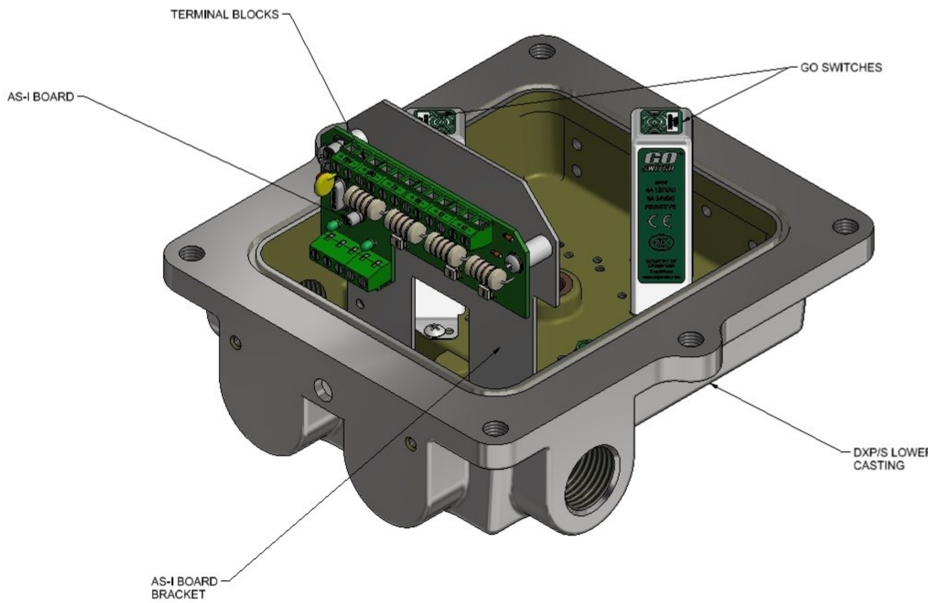


For more information concerning the TopWorx™ D2-FF Discrete Valve Controller visit us online at **http://www.topworx.com** and go to the download documents section or call 502-969-8000 and reference # ES-02512-1.

Bus Option AS: ASi with GO Switches and optional pilot(s)

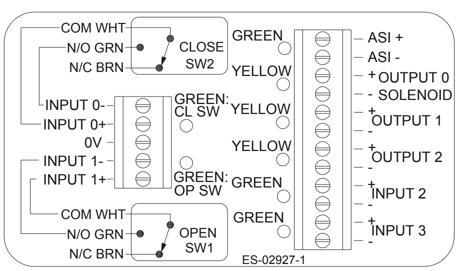
Wiring Diagram:

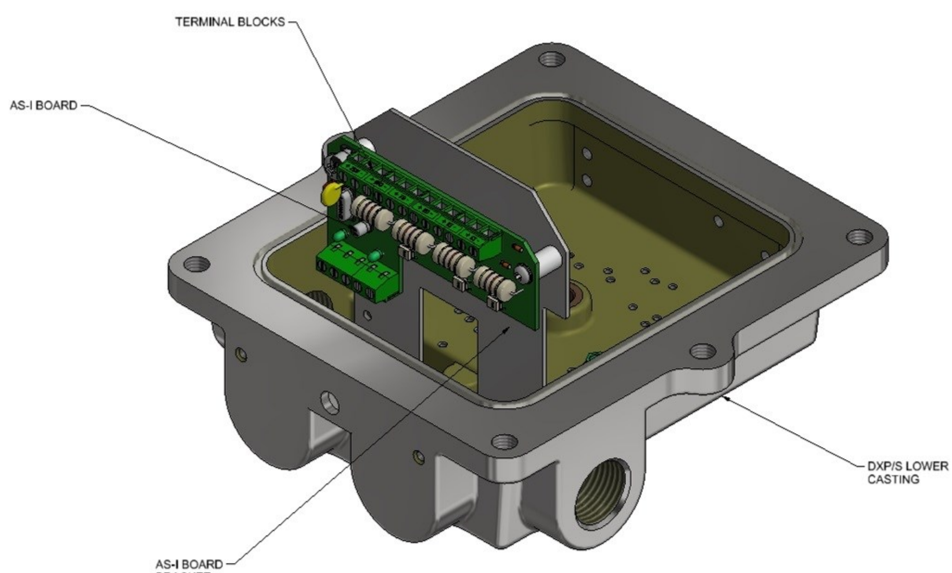




Bus Option A0: ASi without switches and pilots

Wiring Diagram:



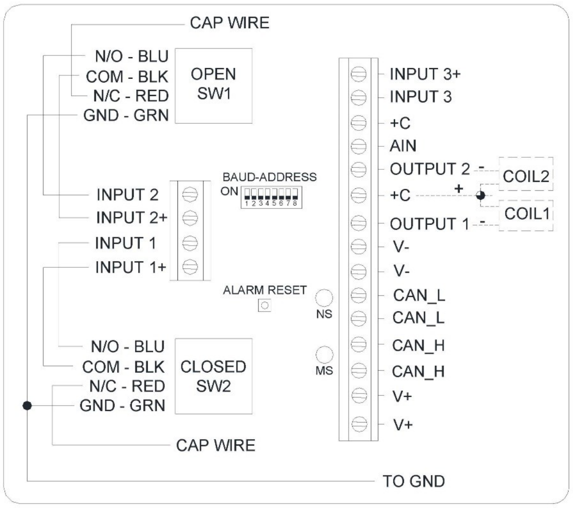


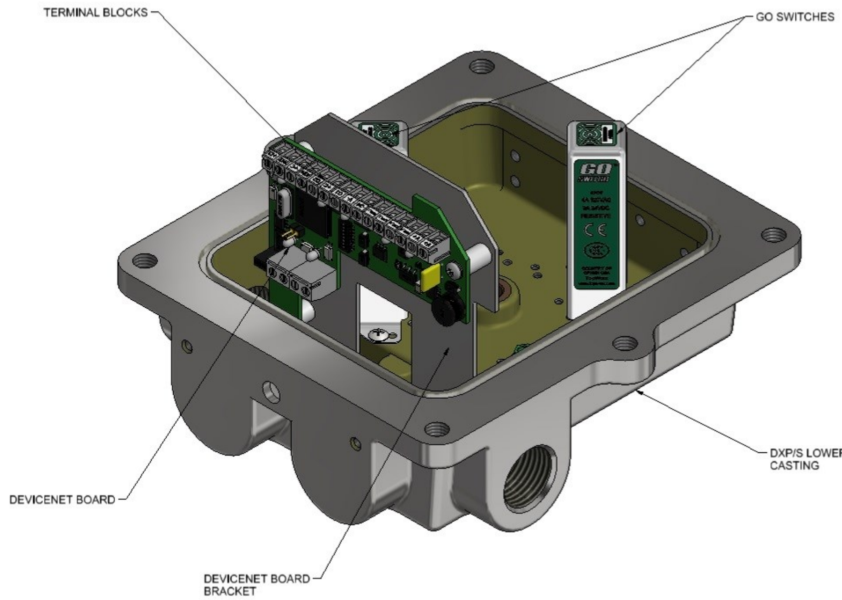
Bus Options AS/A0: ASi — continued —

Openess	800+ products, 150 Vendors
Type of Network	Sensor Bus
Physical Media	2-wire cable (flat or round)
Network Topology	Bus, Ring, Tree, Star
Maximum Devices	
v3.0	62 nodes (or 496 I/O pionts)
Maximum Devices	
Maximum Distance	100 meters
Maximum Distance with repeaters (max. of 2 repeaters can be used)	300 meters
Communication Methods	
Transmission Properties	5 mSec latency max. on fully loaded segment
Primary Usage	• Master/Slave with cyclic polling • Manchester Bit Encoding implemented via Alternating Pulse Modulation (APM)
Power & Communications on same pair	• Limited to 200 mA per device power consumption (29.5V DC to 31.6V DC) • Requires AS-i specific power supply on communications bus for de-coding
Device Power Supply	• Devices can be supplied from bus (<200 mA) • Additional power can be supplied by AS-i power bus cable having multiple power supplies (required for higher power outputs) • Supply shall be powered by a limited-voltage power supply
Wiring Types	
Round:	Normal 2 wire cable. #16AWG (1.5mm)
Flat:	2 wire flat AS-i cable (1.5mm conductors) Yellow for communications / Black for additional power
Grounding aspects	Ungrounded communications bus
Shielding	Unshielded wire
Terminators	No terminators required
Device Addressing	Automatic when connected one at a time to the segment or with Handheld Addressing Unit
Governing Body	ATO (AS-i Trade Organization)
Website	www.as-interface.com
Electromagnetic Compatibility	EN 61326-1:2006, EN 61000-4-2:1995 inc. A2:2001, EN 61000-4-3:2002, EN 61000-4-4:2004 inc. A1:2010, EN 61000-4-6:2009, EN 61000-4-8:1993 inc. A1:2001, EN 55011:2009 inc. A1:2010

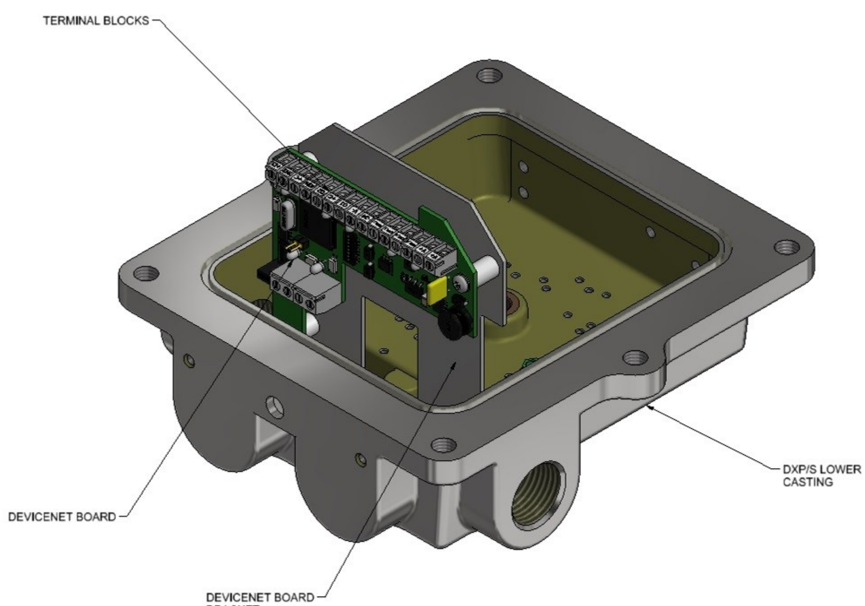
AS-i Bit Settings	**Data bit**	**Bit**	**Function**	**Input**	**Output**
		DO	Output O1	NA	Solenoid coil 1
		D1	Output O2	NA	Solenoid coil2
		D2	Input 12	Open Limit Green	NA
		D3	Input 13	Closed Limit Red	NA
	Parameter bit	**Bit**	**Function**	**Input**	**Output**
		P0	Not used	Extended ID code 1	0
		P1	Not used	IO Code	B
		P2	Not used	Extended ID code 2	E
		P3	Not used	ID code	A
		Watchdog	On	Profile: S-B.A.0	Two Inputs/Two Outputs

Bus Options DN: DeviceNet with GO Switches and Optional Pilot Valve(s)





Bus Options D0: DeviceNet without switches



Bus Options DN/D0: DeviceNet — continued —

Description: Remote multiplexer, compatible with ODVA's DeviceNet protocol for discrete I/O. This is a product family which supports three (3) discrete inputs, two (2) discrete outputs, and 1 analog ***10-bit*** input.

DeviceNet Device Profile: General Purpose Discrete I/O, Class 7 with objects:
- Identity (Class 1)
- Message Router (Class 2)
- DeviceNet (Class 3)
- Assembly (Class 4) ------- 5 instances
- Connection (Class 5)
- Parameter (Class F_{hex}) –- 10 instances
- Valve (Class $6E_{hex}$)
- Alarm (Class $6F_{hex}$) – 5 instances
- Alarm Group (Class 70_{hex}) -- 2 instances

DeviceNet Conformance: Designed to conform to the ODVA DeviceNet Specification Volume I, Version 2.0 and Volume II, Version

Communications: 2.0. Predefined Master/Slave Connection Set, Group 2 Only Server

DeviceNet I/O Protocols: Polled I/O
Change-of-state (COS), Cyclic

Status Indicators:
Module Status(MS): green/red bi-color LED
Network Status(NS): green/red bi-color LED

I/O Electrical specifications

Ratings	Min	Typical	Max	Units	Comments
Input Power					
Device Power	11	24	25	Vdc	per DeviceNet spec.
Discrete Inputs					
Inputs	11	24	25	Vdc	
Open, Close Outputs					
Max voltage			25	Vdc	
Output current	0	0.02	0.5	A	Each output simultaneously
Surge current			4	A peak	
Turn-on time		10*	40**	ms	*Resistive load
Turn-off time		10*	40**	ms	**Function of solenoid

Standard Conformity

Electromagnetic Compatibility	EN 61326-1:2006, EN 61000-4-2:2009, EN 61000-4-3:2006 inc. A2:2010, EN 61000-4-4:2004 inc. A1:2010, EN 61000-4-5:2006, EN 61000-4-6:2009, EN 61000-4-8:2010, EN 55011:2009 inc. A1:2010, EN 55014-1:2006

Module Status (MS)

LED State	Module Status	Meaning
OFF	No power	There is no power though DeviceNet.
Green	Device operational	Operating normally.
Flashing Green	Device in standby	Needs commissioning.
Flashing Red	Minor fault	Recoverable fault.
Red	Unrecoverable fault	May need replacement.
Flashing Red/Green	Device self-testing	In self-test mode.

Network Status (NS)

LED State	Module Status	Meaning
OFF	No power/Not on-line	Has no power or has not completed the Dup_MAC_ID test.
Flashing Green	On-line, not connected	On-line but is not allotted to a Master.
Green	On-line	Operating normally.
Flashing Red	Connection time-out	One or more I/O connections are timed out.
Red	Critical link failure	Detected an error which makes it incapable of communicating on the link. (Bus off or Duplicate MAC ID.)

Bus Options DN/D0: DeviceNet — continued —

How to Install and Establish DeviceNet Communications

1. Make sure that the DeviceNet network is terminated properly.
2. Set the baud rate and address of the device if different from default (see next section on how to address and set baud rate).
3. Make sure that there is power on the DeviceNet network and that it is plugged into a Master device.
4. Connect the DeviceNet wires into the device.
5. In autobaud mode (default), the device Module Status LED (labeled MS) will continue to blink until the device recognizes valid traffic on the DeviceNet link and syncs to a specific baud rate.
6. In fixed baud rate mode, the device will undergo its initialization sequence, flashing both LEDs. After approximately 4 seconds, the Module Status LED (labeled "MS") will go on solid green and the Network LED will flash green.
7. The green Network Status LED (labeled "NS") will go on solid once the Master recognizes the unit on the link and allocates the connection (commissions it).
8. The device is now operating on the network.

How to Configure the DeviceNet Node Address and Baud Rate

1. The address and baud rate are pre-set to 63 and 125k baud at the factory.
2. The user may change these values via dip switch reconfiguration at any time (see the following tables)
3. A change to the baud rate will NOT take effect until the device is reset with either a RESET command or a power cycle.
4. A change to the address will be saved internally and will cause the unit to immediately undergo a soft reset. Upon restart the new address will be active, along with the new baud rate, if previously changed.

Address Selection

Node Address	ADDRESS Switch Position					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
	Switch Position Values					
	32	16	8	4	2	1
0	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
. . .						
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

Baud Rate Selection

DeviceNet Baud Rate	DIP Switch Position	
	SW 7	SW 8
125k	OFF	OFF
250k	OFF	ON
500k	ON	OFF
Autobaud	ON	ON

How to Read Discrete Input Data – DeviceNet

1. Plug the DeviceNet connector into the device. This powers the unit electronics.
2. Allocate a Poll Connection to the device from the client.
3. Perform a poll command to the device from the client. The device returns 2 bytes of data using Assembly Instance 1 (default).
4. The discrete input channel values will be available in the first 2 bits of data in the 1st byte returned. The bits are defined as:

Table 1 Poll Response (Input Data) Assembly Instance 1

Byte	Bit Positions							
	7	6	5	4	3	2	1	0
1	Reset Switch State	Auxiliary Input State	Calibrate Close Switch State	Calibrate Open Switch State	Close Output State	Open Output State	Close Limit Switch State	Open Limit Switch State
2	0	0	0	0	0	Cycle Count Alarm	Close Timeout Alarm	Open Timeout Alarm

Bus Options DN/D0: DeviceNet — continued

— Table 2 Poll Response (Input Data) Assembly Instance 2

	Bit Positions							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	Reset Switch State	Auxiliary Input State	Calibrate Close Switch State	Calibrate Open Switch State	Close Output State	Close Output State	Close Limit Switch State	Open Limit Switch State
2	Analog Input Overcurrent	Analog Input Undercurrent	0	0	Analog Input Alarm	Cycle Count Alarm	Close Timeout Alarm	Open Timeout Alarm
3	Analog Input LSB (bits 0-7)							
4	0	0	0	0	0	0	Analog Input MSB (bits 8 and 9)	

Using Assembly instance 3 (Parameter 10), the cycle open and close times are added on to the poll bytes as shown below:

Table 3 Poll Response Assembly Instance 3

Byte	Description
1	Input Status Bits
2	Alarm Bits
3	AI LSB
4	AI MSB
5	LS Byte of Last Open Time
6	MS Byte of Last Open Time
7	LS Byte of Last Close Time
8	MS Byte of Last Close Time

Using Assembly instance 4, the cycle count is added on to the poll bytes as shown below:

Table 4 Poll Response Assembly Instance 4

Byte	Description
1	Input Status Bits
2	Alarm Bits
3	AI LSB
4	AI MSB
5	LS Byte of Last Cycle Count
6	MLS Byte of Last Cycle Count
7	MMS Byte of Last Cycle Count
8	MS Byte of Last Cycle Count

Assembly instance 5 incorporates all data, as shown:

Table 5 Poll Response Assembly Instance 5

Byte	Description
1	Input Status Bits
2	Alarm Bits
3	AI LSB
4	AI MSB
5	LS Byte of Last Open Time
6	MS Byte of Last Open Time
7	LS Byte of Last Close Time
8	MS Byte of Last Close Time
9	LS Byte of Last Cycle Count
10	MLS Byte of Last Cycle Count
11	MMS Byte of Last Cycle Count
12	MS Byte of Last Cycle Count

Bus Options DN/D0: DeviceNet — continued —

How to Energize and De-energize Valve Solenoids

1. Reconnect the device and allocate a Poll Connection to the device from the client.
2. Issue a Poll command from the client with a data value of 00, 01, or 02. Each of the two possible outputs will be turned ON or OFF, as defined by a corresponding bit value of 1 or 0. Note that having both open and close bit set is an illegal state and will be ignored by the controller.

Table 6 Poll Request (Output Data)

	Bit Positions							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	0	0	0	Reset Cycle Count	Enable Cal Mode	Reset Alarms	Output 2	Output 1

Setting the Reset Alarms bit to 1 clears the Open and Close Time counters and resets all active alarm notification bits. As long as this bit is set, the alarms will be inactive.

The Enable Cal Mode bit is set to 1 to allow calibration of the limit switches sense positions. When the device is commanded into Cal Mode, normal operation of the outputs is disabled. The Closed and Open limit switches can then set active, which will cause the associated input LEDs to be activated, along with activating the corresponding Input 1 or Input 2 status bits.

The Reset Cycle Count bit is set to 1 to clear the cycle counter.

Parameters

The TopWorx device is software-configured for several parameters. Table 7 defines the legal values and the default values for the I/O configuration selections available.

Table 7 Configuration Parameters (Class 15)

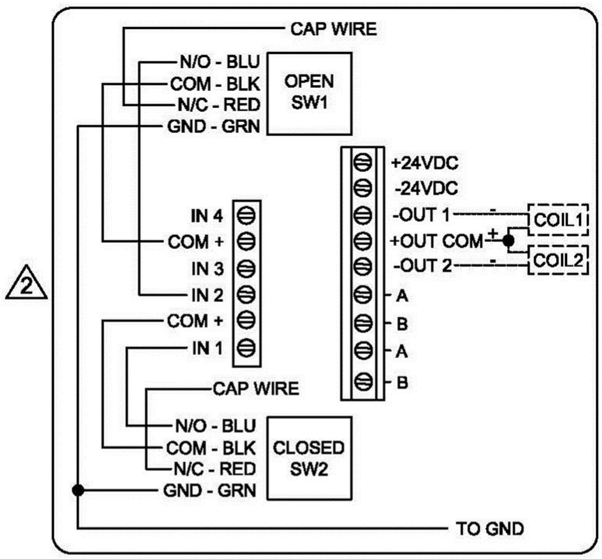
Instance	Parameter Name	Values	Default Setting	Default Value	Description
1	Max Open Time	0 to 65535 (0-655.35 sec.)	Disabled	0	Maximum allowed time for valve to open before triggering alarm (in 10's of milliseconds)
2	Max Close Time	0 to 65535 (0-655.35 sec.)	Disabled	0	Maximum allowed time for valve to close before triggering alarm (in 10's of milliseconds)
3	Cycle Count Limit	0 to 4294967295	Disabled	0	Maximum number of valve cycles before triggering alarm
4	Analog High Limit	0 to 1024	Disabled	1024	Highest analog value before triggering alarm
5	Analog Low Limit	0 to 1024	Disabled	0	Lowest analog value before triggering alarm
6	DeviceNet Fault Action	0 or 1	Use Fault Value	0	0 = Use Fault Value 1 = Hold last State
7	DeviceNet Fault Value	0 or 1	OFF	0	0 = OFF 1 = OPEN 2 = CLOSE 3 = No Change
8	DeviceNet Idle Action	0 or 1	Use Fault Value	0	0 = Use Fault Value 1 = Hold Last State
9	DeviceNet Idle Value	0 or 1	OFF	0	0 = OFF 1 = OPEN 2 = CLOSE 3 = No Change
10	Assembly configuration	0 or 4	Standard Assembly	1	See Table 1 through Table 5

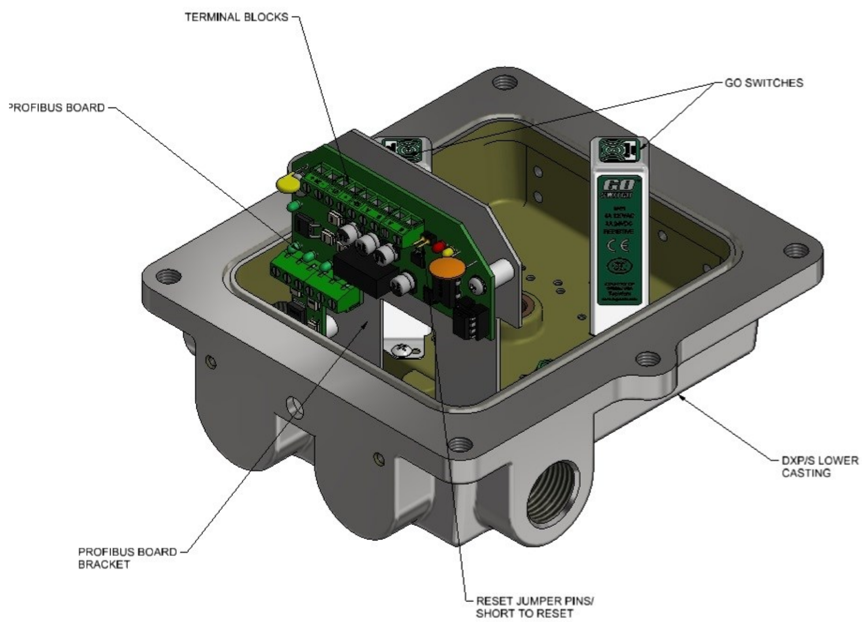
Bus Options DN/D0: DeviceNet — continued —

Definitions of these parameters are as follows:

1. **Max Open Time**: Maximum allowed time in 10's of milliseconds for valve to open before triggering alarm.
2. **Max Close Time**: Maximum allowed time in 10's of milliseconds for valve to close before triggering alarm.
3. **Cycle Count Limit**: Maximum number of valve cycles before triggering alarm.
4. ***Analog High Limit**: Highest analog value before triggering alarm.
5. ***Analog Low Limit**: Lowest analog value before triggering alarm.
6. **Output Fault Action**: Selection to determine whether each output will hold its last state or assume the value identified in the next parameter upon a device fault.
7. **Output Fault Value**: The value each output will assume after a Fault if Fault Value is selected above (hold last state is not se-lected).
8. **Output Idle Action**: Selection to determine whether each output will hold its last state or assume the value identified in the next parameter if an Idle Command is issued by the Master.
9. **Output Idle Value**: The value each output will assume upon an Idle Command if Idle Value is selected above (hold last state is not selected).
10. **Assembly Configuration**: This determines what data is returned in the poll response.

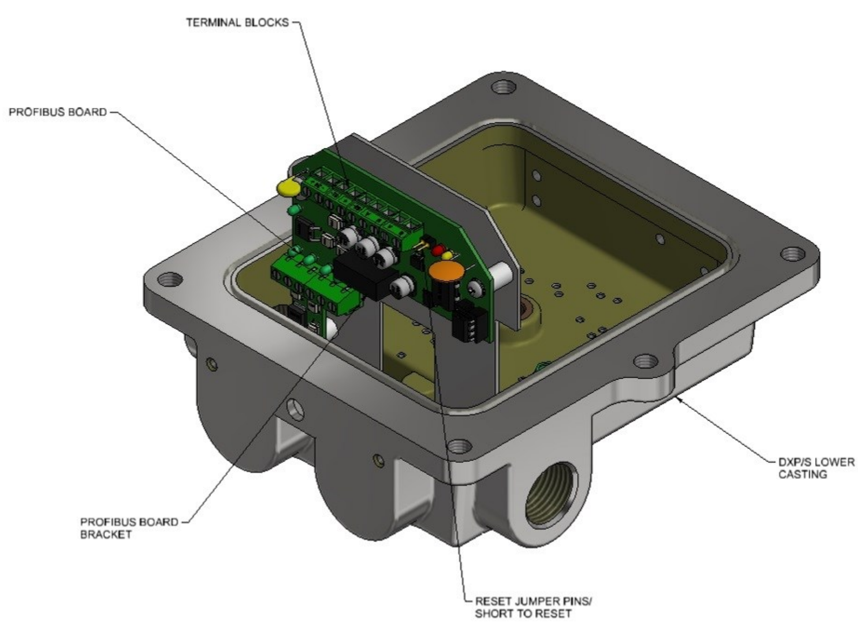
Bus Options PB: Profibus with GO Switches and Optional Pilot Valve(s)





Utilize the jumper across the two RESET pins shown above ONLY when a reset is required.

Bus Options P0: Profibus Without Switches



Utilize the jumper across the two RESET pins shown above ONLY when a reset is required.

Bus Options PM/PB: Profibus protocol — continued —

Type of Network	Device Bus
Physical Media	Twisted pair, fiber
Network Topology	Bus, Ring, Star
Maximum Devices	max. 126 stations on one bus (maximum of 244 bytes input and output data possible for each slave)
Maximum Distance	
DP	93.75Kbps and less - 1200 meters 500Kbps - 400 meters 1.5Mbps - 200 meters 12Mbps - 100 meters
Maximum Distance with repeaters (max. of 9 repeaters can be used)	9,500 meters with repeaters
Communication Methods	Per-to-peer, multicast or cyclic master-slave (uses token passing sequence)
Primary Usage	Used for Discrete and Analog for PLC, Variable Speed Drives, Remote I/O communications
Power & Communications	Power is supplied separately from communications bus (can be supplied on a parallel power bus)
Device Power Supply	Devices are powered separately from communications bus. A 5A fuse must be placed in series with the input power terminals.
Wiring Types	Shielded twisted pair #22 AWG
Device Addressing	Handheld/Software only
Governing Body	PROFIBUS International (PI)
Website	www.profibus.com
Electromagnetic Compatibility	EN 61326-1:2006, EN 61000-4-2:1995 inc. A2:2001, EN 61000-4-3:2002, EN 61000-4-4:2004 inc. A1:2010, EN 61000-4-6:2009, EN 61000-4-8:1993 inc. A1:2001, EN 55011:2009 inc. A1:2010

NOTE: In order to meet EMC requirements the Profibus communication cabling must be encased by conduit and properly grounded to the device housing."

Technical Data

Power requirements	
PROFIDP 4I20	24 VDC +-10% Max I = 350 mA maximum (solenoids/activated)

Profibus info	
ID	09ED HEX
GSD file	TWIS09ED.GSD
Transmission Speed	12Mbaud (max)

Line Parameters	**Line Tyoe A**	**Line Type B**
Impedence	135 to 165	100 to 130
Capacitance per unit length (pF/m)	<30	<60
Loop resistance (V/km)	110	- - -
Core diameter (mm)	0.64	>0.53
Core cross section (mm^2)	>0.34	>0.22

Recommended Line Lengths							
Transmission rate (kBaud)	9.6	19.2	93.75	187.5	500	1200	1500
Line Tyoe A	1200	1200	1200	1000	400	200	100
Line Type B	1200	1200	1200	600	200	-	-

Software Parameters

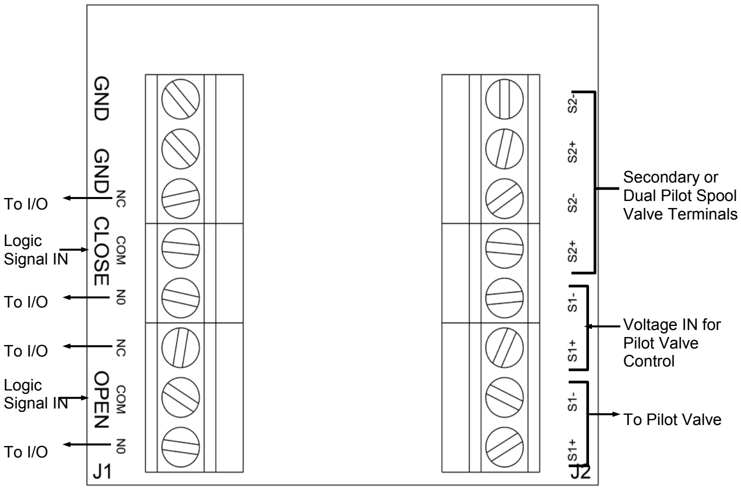
Output Byte 1		**Fail Closed**	**Fail Open**	**Dual Coil**
Bits				
7	n/a	n/a	n/a	n/a
6	n/a	n/a	n/a	n/a
5	n/a	n/a	n/a	n/a
4	n/a	n/a	n/a	n/a
3	n/a	n/a	n/a	n/a
2	n/a	n/a	n/a	n/a
1	Output 2	n/a	n/a	High Closed
0	Output 1	High Open	High Closed	High Open
		Low Closed	Low Open	

Intput Byte 1		
Bits		
7	n/a	n/a
6	n/a	n/a
5	n/a	n/a
4	n/a	n/a
3	SPARE	Input 4
2	SPARE	Input 3
1	High Closed	Input 2
0	High Open	Input 1

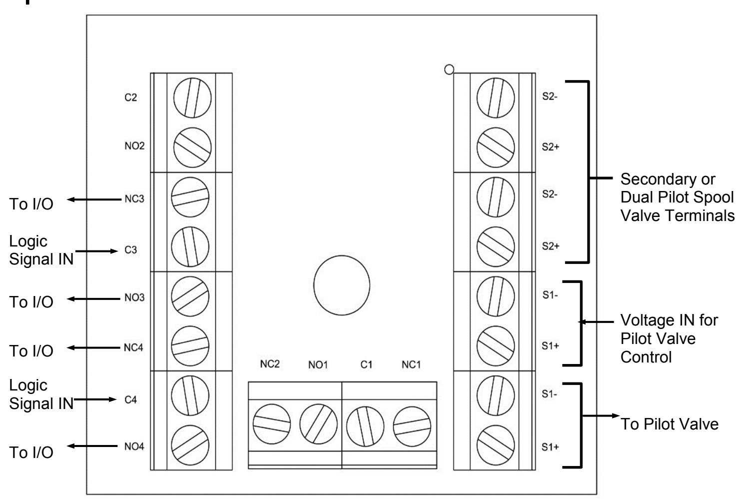
Diagnostic Byte 1	
Bits	
7	n/a
6	n/a
5	n/a
4	n/a
3	n/a
2	Hard Wired high
1	Hard Wired high
0	Hard Wired high

Reed Switch Sensor Communication Module (SCM) Calibration: Options R2/R4

Option R2: SCM



Option R4: SCM



Electrical Ratings	
SCM R2/R4	200mA@120VAC (25W MAX)

NOTE: *Refer to the wiring diagram on the inside lid of your product to determine wiring configuration and actual pin out location.*
***Install per control drawing #ES-01743-1*

Calibration

Never perform limit switch calibration while an area is known to be hazardous.

First, be sure you have an air supply connected, and the appropriate spool valve to actuator connections. Set the air supply betweeen 30 and 80psi.

Step 1
For standard explosion-proof units: Using a 24VDC regulated power supply, connect (+) to COM and (-) to NO terminals. Limit curent to the internal limit switches below maximum current ratings.

Caution: *Many power supplies do not have current limiting; therefore, ALWAYS use a load resistor with a value of 200 to 2500 Ohms in series with the COM or NO legs of the circuit or damage may occur.*

Step 2
With the valve in the CLOSED position, disengage the lower cam from the splined Hub and rotate clockwise until the Red LED lights. Release the cam to re-engage the splined Hub, making sure it is seated on the splines. This sets the CLOSED limit switch.

Step 3
Cycle the valve to the OPEN position using the attached control equipment.

Step 4
While the valve is in the OPEN position, disengage the upper cam from the splined Hub and rotate the upper cam counter-clockwise until the Green LED lights. Release the cam to re-engage the splined Hub, making sure to seat the cam on the splines. This sets the OPEN limit switch.

Step 5
Cycle valve several times to insure limit switches maintain calibration. Check that the target assembly is secure to the actuator pinion, and all air connections are tight.

NOTE: *Continuity may be verified using a continuity light or by using an Ohmmeter in series with the NO connection.*

ESD Theory of Operation

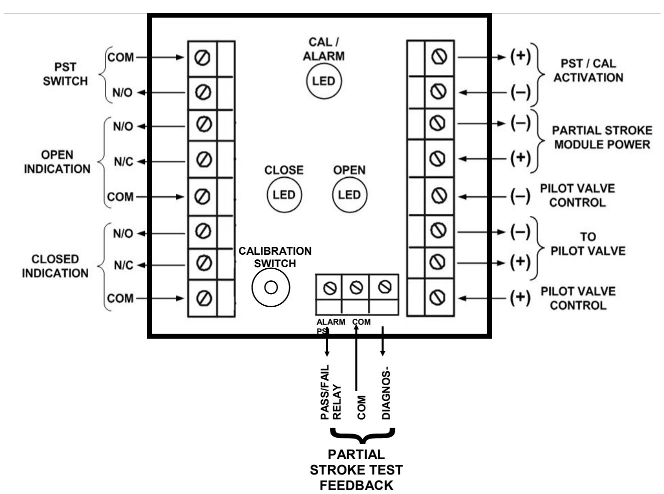
The purpose of the TopWorx™ Emergency Shut-Down (ESD) model is to partially stroke a valve that maintains a full open or full closed posi-tion for an extended period of time while offering an ESD function. A partial stroke test (PST) verifies functionality of critical valves that must be in their fail position during an emergency. Increasing the frequency of partial stroke testing (i.e. reducing the proof test interval) im-proves the SIL (Safety Integrity Level) that the system can achieve through a reduction in the PFD avg (Average Probability of Failure On De-mand). These partial stroke tests can be performed without shutting down or disrupting the process. In an emergency, the ESD function overrides partial stroke testing and the valve moves to its fail position.

This ESD unit incorporates a sensor communication module (SCM-ESD) to perform the partial stroke test, verify its status, and output that status back to the user. In combination with the SCM, the ESD unit uses either the optional TopWorx™ pilot and spool valve or a customer-supplied solenoid valve to drive the actuator during both normal operation and partial stroke testing. A TopWorx™ GO™ Switch is includ-ed for partial stroke confirmation and two (2) limit switches built into the SCM confirm open and close position.

Once the unit is installed, the SCM-ESD must be calibrated for that specific valve, actuator, and solenoid exhaust settings. During calibra-tion, the unit records the time to partially stroke the valve. All future PST times are compared to this original value for determining the test status. To pass a PST, the time must be within +/-20%, 30%, or 40% of the stored calibration value. This PST time tolerance can be changed prior to calibration.

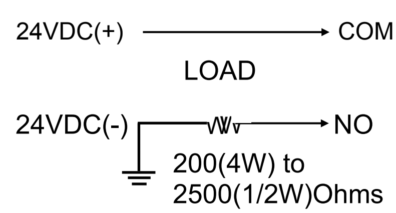
The partial stroke test is initiated via an optional partial stroke test button with a lockable cover, the calibration button on the top of the SCM, or a pulsed DO from the PLC. Upon issuing a PST command, the SMC-ESD begins a timer while switching a relay to de-energize the pilot/ solenoid. The valve moves from its normal position toward its fail position until the GO™ Switch is made. Once made, the SCM energizes the pilot/solenoid and the valve moves to its normal position while outputting the PST status.

Option ES: SCM



Electrical Ratings	
	Current/Voltage
Open/Closed Indication	0.25A@24VDC w/5V drop 0.25A@120VAC w/5V drop
Module Voltage	18-28VDC
Module Current	50mA (MAX)
Pilot Current (Standard)	20mA
PST Feedback Relays	800mA@24VDC MAX 250mA@125VAC MAX
Pilot MAX Valve Rating	800mA@24VDC MAX 250mA@125VAC MAX

Suggested Calibration Set-Up:



For More Information

To download more information concerning the TopWorx™ D-Series ESD Valve Controller, including a copy of the **Sira Functional Safety Assessment Report** visit us online at
http://www.topworx.com
or call 502-969-8000 and reference # ES-00936-1.

The manufacturer may use the mark:

Revision 3.0 March 31, 2017
Surveillance Audit Due
April 1, 2020

ANSI Accredited Program
ISO/IEC 17065
PRODUCT CERTIFICATION BODY
#1004

Certificate / Certificat
Zertifikat / 合格証

EPM 1308108 C001

exida hereby confirms that the:

D-ESD Valve Controller

Topworx, Inc.
Louisville, KY - USA

Has been assessed per the relevant requirements of:

IEC 61508 : 2010 Parts 1-7

and meets requirements providing a level of integrity to:

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type A, Route 2_H Device

PFD_{AVG} and Architecture Constraints must be verified for each application

Safety Function:
The Valve Controller will move the associated actuator and valve to the designed safe position per the final element design within the specified safety time.

Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.

Evaluating Assessor

Certifying Assessor

Certificate / Certificat / Zertifikat / 合格証

EPM 1308108 C001

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type A, Route 2_H Device

PFD_{AVG} and Architecture Constraints must be verified for each application

D-ESD Valve Controller

Systematic Capability:

The Product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.
A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than stated.

Random Capability:

The SIL limit imposed by the Architectural Constraints must be met for each element. This Device meets *exida* criteria for Route 2_H.

This certificate covers the following Model Designations:

Model Designation	Description
DXP/S-ESXXXXXXXXYX	Integrated Solenoid
DXP/S-ESXXXXXXXXYXZZZZ	Integrated Solenoid

IEC 61508 Failure Rates in FIT[1]

Application	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
Single Acting Actuator	0	284	0	217
Single Acting Actuator w/PVST[2]	281	3	201	16

[1] FIT = 1 failure / 10^9 hours
[2] PVST = Partial Valve Stroke Test

SIL Verification:

The Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) must be verified via a calculation of PFD_{AVG} considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

The following documents are a mandatory part of certification:

Assessment Report: EPM 13/08-108 R002 V3 R1

Safety Manual: ES-05481-1

80 N Main St
Sellersville, PA 18960

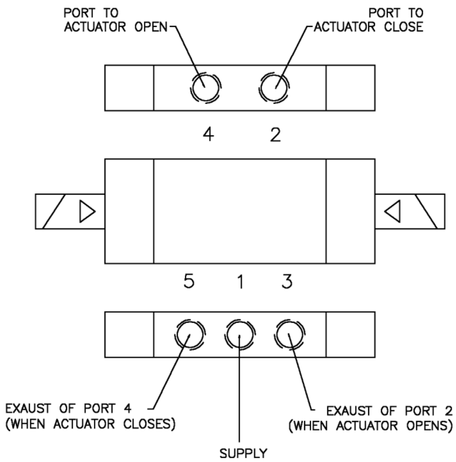
T-061, V2R1

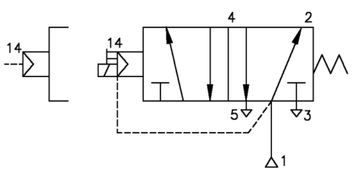
Pneumatic Hookup Procedures

Prior to connecting the supply air to the spool valve, flush the system to remove any debris or contaminates. Galvanized pipe can easily flake and contaminate the system and therefore is not recommended. A 40 micron point of use filter at every device is recommended.

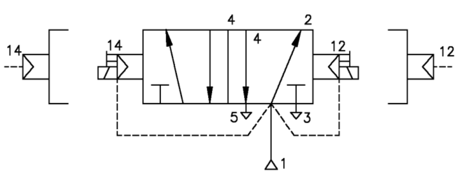
4-Way Spool Valves

The TopWorx™ spool valve is a 5 port, 4-way valve driven by an inter-nally mounted pilot. The spool valve supply port and work ports are marked as follows:

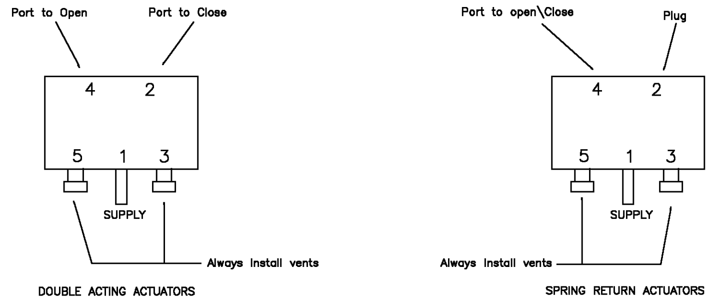




FAIL CLOSED



FAIL LAST POSITION



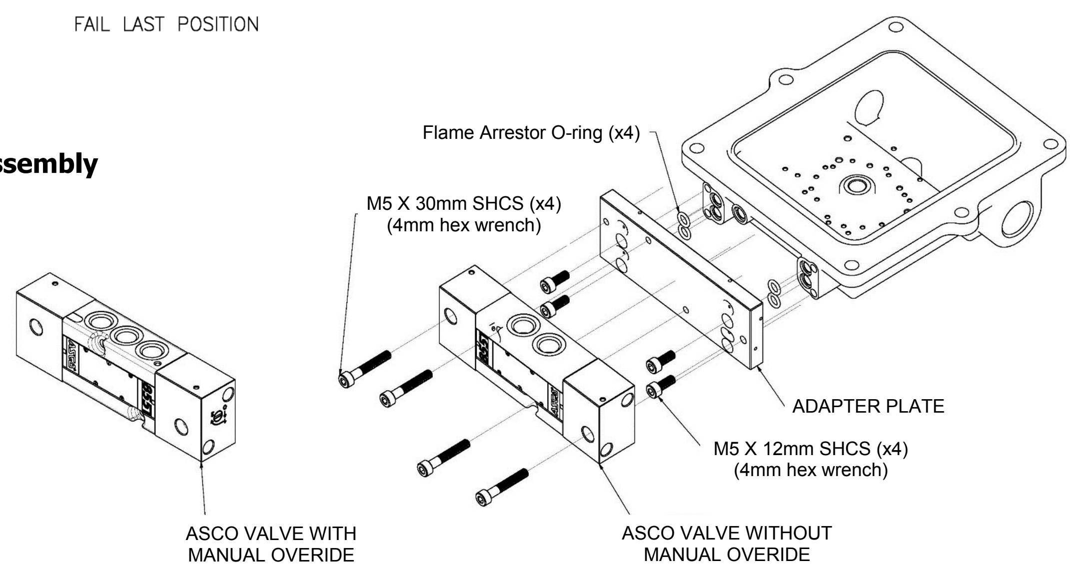
Highly Recommended

TopWorx™ highly recommends Locktite 567 brand thread sealant. Do not use a hard setting pipe compound. If Teflon thread seal tape is used, start the wrap on the second thread from the leading thread of the fitting. This will prevent tape shreds from contaminating the spool valve seals.

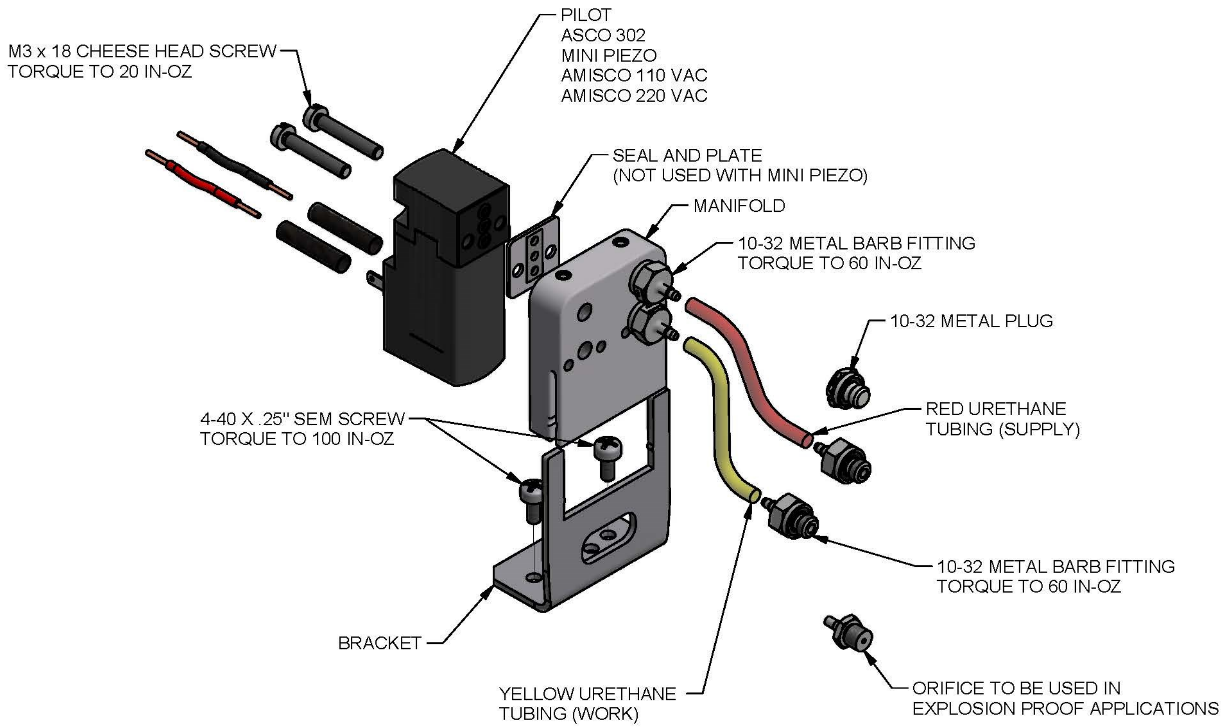
Breathers (AL-M31) should be installed in the exhaust ports to keep debris from falling into the spool valve and damaging the seals. This must be addressed prior to installation, or storage.

VALVE SPECIFICATIONS	
ITEM	PERFORMANCE
MEDIA	AIR
MEDIA TEMPERATURE	MIN: -40°C (-40°F); MAX: 60°C (140°F)
OPERATIONAL AMBIENT TEMPERATURE	MIN: -40°C (-40°F); MAX: 60°C (140°F)
INLET/SYSTEM PRESSURE	MIN: 45 PSI (3.1 BAR); MAX: 145 PSI (10 BAR)
OPERATIONAL PRESSURE DIFFERENTIAL	MIN: 45 PSI (3.1 BAR); MAX: 145 PSI (10 BAR)
SAFE WORKING PRESSURE	150 PSI (10.3 BAR)
FLOW / Cv (Kv)	Cv=0.86 (Kv=0.74)
BODY PORT CONNECTIONS	1/4" NPT
ALLOWABLE LEAKAGE	EXTERNAL: 2 SCCM; INTERNAL: 10 CC/MIN MAX FOR -15°C TO 60°C. 3300 CC/MIN MAX FOR -40°C TO -15°C.
OPTIMAL DESIGN LIFE	500,000 CYCLES
MATERIAL IN CONTACT W/ FLUID	BODY: ALUMINIUM (BLACK ANODIZED) AND STAINLESS STEEL 316L; INTERNAL: STAINLESS STEEL, LT NITRILE, PTFE, ACETAL.

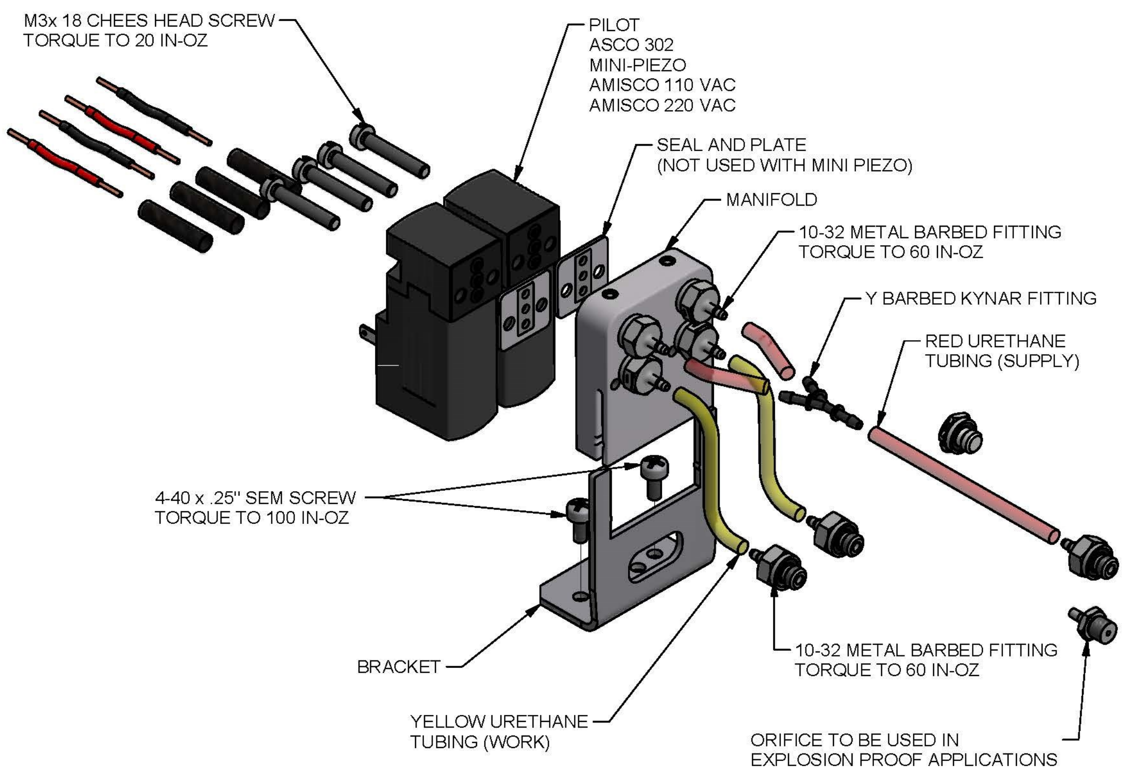
Spool Valve Assembly



SINGLE PILOT ASSEMBLY



DUAL PILOT ASSEMBLY



Installation & Maintenance Instructions SPECIAL 8551 AND 8553 PAD

MOUNTED, AIR OPERATED, SPRING RETURN AND DUAL PILOT, OFFERED IN ALUMINIUM AND STAINLESS STEEL CONSTRUCTIONS, WITH AND WITHOUT MANUAL OVERRIDE (MO), DESIGNED FOR 45 PSI TO 145 PSI (3 BAR TO 10 BAR) FOR TOPWORX CONTROLLER

⚠ **WARNING: To prevent the possibility of death, serious injury or property damage, the Spool Valve and Pilot Valve must be installed and serviced only by a qualified service technician avoiding the following hazards:**

- **Pressure hazard. Depressurize valve and vent hazardous or combustible fluid to a safe area before inspection or removal of the valve from service.**
- **Electrical hazard. Turn off all electrical power to Pilot Valve.**
- **Risk of electric shock – More than one disconnect switch may be required to de-energize the device for servicing.**
- **Explosion, fire or toxic gas hazards. Extinguish all open flames and avoid any type of sparking or ignition during leakage testing.**

DESCRIPTION

X551 and X553 are based off ASCO's standard 8551 and 8553 series spring return, dual pilot, with and without manual operator valves.

Stainless Steel version: Body and End Cap are offered in SS 316L material. Aluminum version: Body and End Cap are Black Anodized.
Pipe connection for 551: 1/4'" NPT
Pipe connection for 553: 1/2'" NPT
All valves are configured for internal pilot pressure supply. Pilot pressure supply is from Pilot Valve mounted inside the TopWorx Indicator Box as shown in Figure 1 (a).

Versions isolated from atmosphere: The internal parts of the valve are isolated from the outside atmosphere in order to provide protection in aggressive environments. All the exhaust ports of the spool valve are pipable, providing better environmental protection, particularly recommended for sensitive areas such as clean rooms and applications in the pharmaceutical or food processing industries. It is necessary to connect pipes or fittings to the exhaust ports to protect the internal parts of the spool valve if used outside or in harsh environments (dusts, liquids etc.).

SPECIAL CONDITIONS FOR SAFE USE

- Do not connect the pressure supply to the exhaust port 3. The "environmentally protected" construction is not adapted for NO function. Contact us for functions available in specific versions. Connect pipes for the required functions in accordance with this documentation and the port markings on the product.
- Make sure no foreign matter enters the circuit to prevent blocking the valve function. Restrict the use of sealing tape or sealing matter to a minimum.

These valves are intended for use with clean and dry air. Recommended minimum filtration: 50 micron.

- The dew point of the fluid used must be at least –10°C (18°F) below the minimum temperature to which the fluid may be exposed.
- When using lubricated air, the lubricant must be compatible with the elastomers used. Instrument air in compliance with ANSI/ ISA standard S7.3 (1975) exceeds the necessary requirements and is, therefore, an acceptable fluid for these valves

⚠ **If not connected, all exhaust ports must be protected with Stainless Steel Exhaust Protectors. Connect these Exhaust Protectors to ports 3 and 5 of the valves. When used outside, or stored for longer periods of time, and/or where exposed to harsh environments (dusts, liquids etc.), Exhaust Protectors must be used. The reliability of the valve cannot be guaranteed if an exhaust protection other than that supplied is used. Refer "Exhaust Restriction" section.**

- Storage conditions: protected from exposure to weather; storage temperature: -40 C to +70°C, Relative humidity: 95%.
- The Valve must be kept in its original packaging as long as it is left unused. The protective covers must not be removed from the connection ports and solenoid operators.
- Ambient temperature: -40°C to +60°C. The maximum temperature of the fluid does not exceed the ambient temperature.
- **After storage at low temperature, the spool valves must gradually be brought to operating temperature prior to pressurization.**
- The Valves are intended to be operated within the technical characteristics specified on the nameplate.
- Changes to the products may only be made after consulting the manufacturer or his representative.
- **These solenoid spool valves are designed to operate with filtered air.**
- Spool Valve Rating: 45 psi to 150 psi (3 Bar to 10 Bar).
- -40C version of Pilot Valve Pressure Rating: 30 psi to 116 psi (2 Bar to 8 Bar).
- Ensure that Pressure supply to the Pilot valve shall be 45 psi to116 psi (3 Bar to 8 Bar) as minimum 45 psi (3 Bar) pressure is required for Spool valve to operate and maximum limit of Pilot Valve is 116 psi (8 Bar).

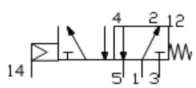
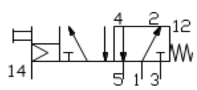
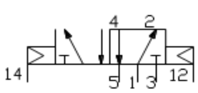
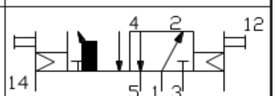
⚠ **Caution:**

Installation of a Valve

Check Nameplate for correct catalog number, pressure and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and maintenance to be performed by qualified personnel only.

Future Service Considerations

- Provision should be made for performing seat leakage, external leakage and operational tests on the valve with a non-hazardous, non-combustible fluid.
- When assembling this product to a pilot to **ATEX 2014/34/EU,** take the least favorable category, maximum working pressure and temperature into account. Compliance with the Essential Health and Safety Requirements has been assured by compliance with the European Standards EN 13463-1. The mounting position for he pilots as shown in figure 1 (a).

	Valve Operation (X551 and X553	
	Without Manual Operator	**With Manual Operator**
Spring Return Air Operated		
Dual Pilot Air Operated		

ASSEMBLY

- **ASSEMBLY OF 551 VERSIONS:** 551 series valves are directly mounted on Indicator Box. Spring Return valves are mounted with the help of 3 screws and Dual Pilot valves are mounted with the help of 4 screws as shown in figure 1 (a) & 1 (b). Mounting screws are not provided with valve. TopWorx Indicator Box shown in the pictures are only for illustration purpose.

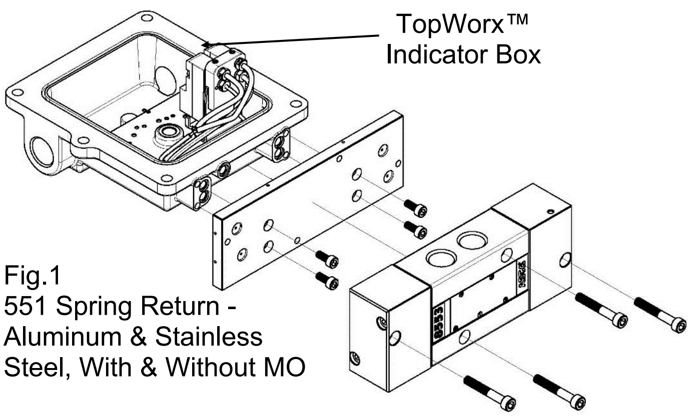


Fig.1
551 Spring Return -
Aluminum & Stainless
Steel, With & Without MO

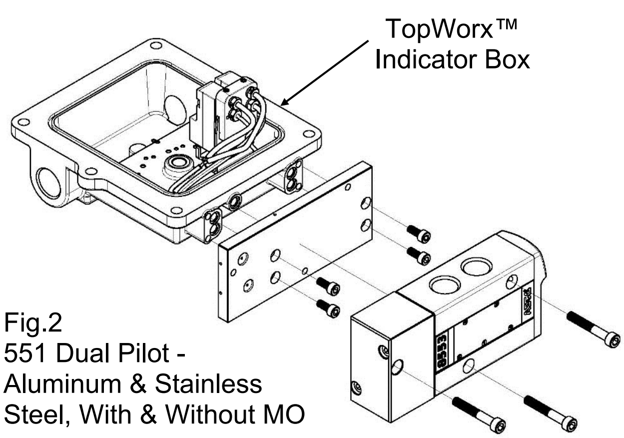


Fig.2
551 Dual Pilot -
Aluminum & Stainless
Steel, With & Without MO

ASSEMBLY OF 553 VERSIONS:

Steps to assemble 553 series valve:

1. Interface Plate Assembly will be mounted on Indicator Box with the help of 3 screws for Spring Return versions and 4 Screws for Dual Pilot versions.
2. Spool Valve is mounted on the Interface Plate Assembly. Three screws are used to mount the Spring Return versions and 4 Screws to mount the Dual Pilot versions as shown in figure 2 (a) & 2 (b).
3. Interface Plate Assembly: TopWorx to manufacture Interface Plate, and Sub-assembly of Plate, O Ring, and Ball plug

Fig.3
553 Spring Return -
Aluminum & Stainless
Steel, With & Without MO

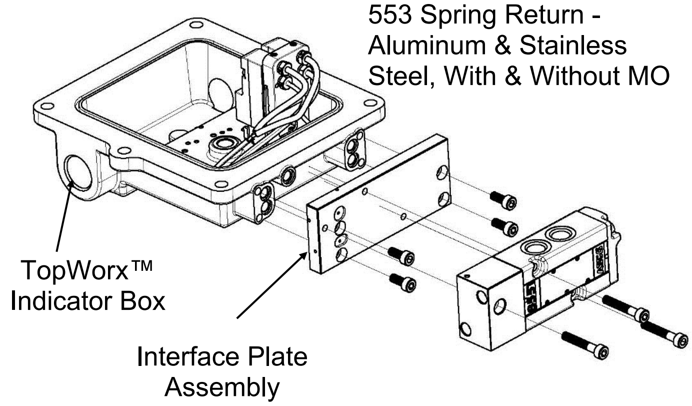
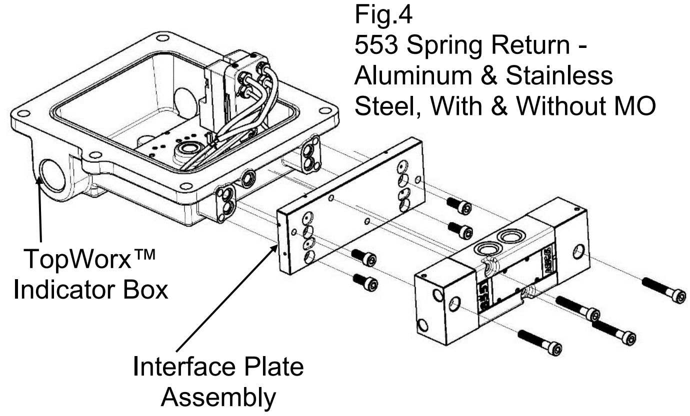


Fig.4
553 Spring Return -
Aluminum & Stainless
Steel, With & Without MO

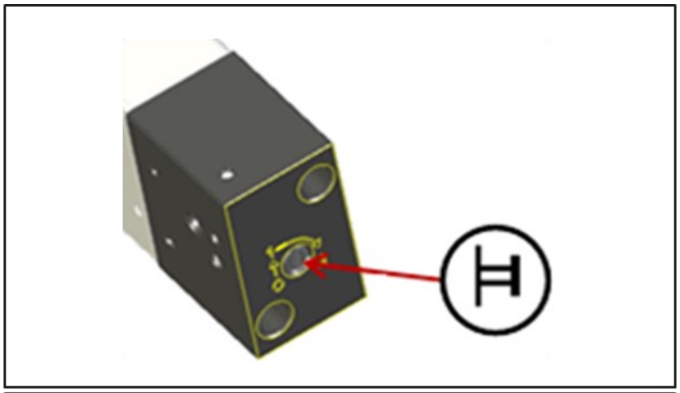


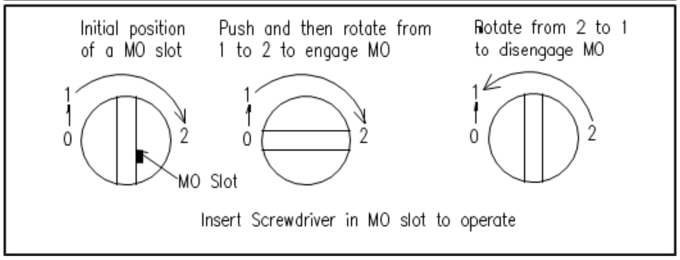
Manual Override

The MO is indicated with symbol ( ) in Figure 3. MO provides manual operation when desired or during an electrical power outage. Refer to figure 4 for MO Operation. To engage valve manually, insert a screwdriver into arrow slot, push the MO forward till it stops and then rotate it as far as possible to “2”. Valve will now be in the same position as when the solenoid is energized. To disengage MO, rotate arrow slot as far as possible to “0”.

Please note that MO is mechanical type. For Spring Return Valves, MO will return to it’s original position due to Valve Spring force. For Dual Pilot Valves, MO returns to it’s original position when other side of the valve is energized.

⚠ **Prior to putting into operation, make sure the manual override is returned to its Disengaged position "0" to prevent the risk of personal injury or damage to equipment.**





General recommendations for pneumatic connection:

Connect piping or tubing to valve according to markings on valve body. Refer to flow diagrams in OPERATION section. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

⚠ **Caution: To avoid damage to the valve body, DO NOT OVERTIGHTEN PIPE CONNECTIONS. If PTFE tape, paste, spray or similar lubricant is used, use extra care when tightening due to reduced friction.**

• **Threaded ¼ and ½ port versions:**

Connection of the Spool Valve: Connect pipes as indicated on the label: pressure nlet at port 1. Pressure outlet at ports 2 and 4. The exhausts are channeled through the valve to ports 3 and 5.

EXHAUST RESTRICTION

Valve function: The Exhausts are channeled through the valve to ports 3 and 5. The Exhaust Speed can be controlled by using adjustable Exhaust Reducers. Caution: Do not seal off the Exhaust as this will prevent the Valve from shifting. For best results, do not restrict flow through the Exhaust below Cv 0.10 (ø2 mm). If Exhaust is fully restricted, then the Valve will not shift.

EXHAUST PROTECTOR

Depending on the versions (551 or 553),
Stainless steel exhaust protectors can be used.
1/4" NPT Part# PS-01236-1
1/2" NPT Part# PS-01237-1

MAINTENANCE

⚠ Prior to maintenance work or putting into operation, power off, depressurize and vent the valve to prevent the risk of personal injury or damage to equipment.

Cleaning

Maintenance of the valves depends on the operating conditions. They must be cleaned at regular intervals. During servicing, the components must be checked for excessive wear. The components must be cleaned when a slowing down of the cycle is noticed even though the pilot pressure is correct or if any unusual noise or a leak is detected.

Sound emission

The exact determination of the sound level can only be carried out by the user having the valve installed in his system. The emission of sound depends on the application, fluid and type of equipment used.

Preventive maintenance

- Prepare and follow routine inspection schedule based on the media, environment and frequency of use.
- Keep the medium flowing through the valve as free from dirt and foreign material as possible. Depending on medium and service conditions, clean valve strainer or filter as required to keep the valve free of contamination. In the extreme case, contamination will cause faulty valve operation and the valve may fail to shift.
- Operate the valve at least once a month to check its function.
- If problems arise during maintenance or in case of doubt, please contact us or one of our authorized representatives.

Troubleshooting

Incorrect outlet pressure: Check the pressure on the supply side of the valve; it must correspond to the values indicated on the nameplate.

⚠ **Caution: Observe the minimum pilot pressure value 3 Bar. To avoid personal injury or damage to equipment, check that the valve operates correctly before putting it back into operation.**

Troubleshooting

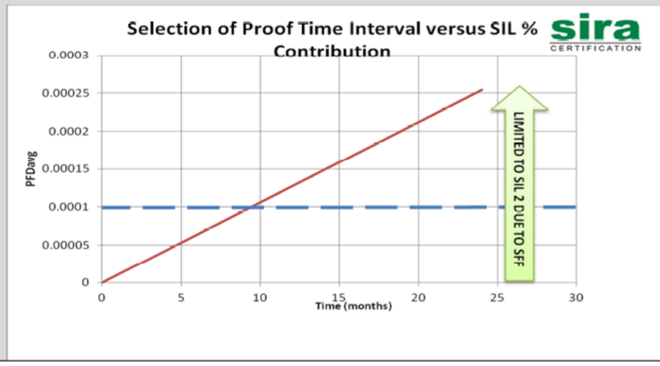
Replace the entire valve.

Continued-Proof Testing for D-Series TopWorx™

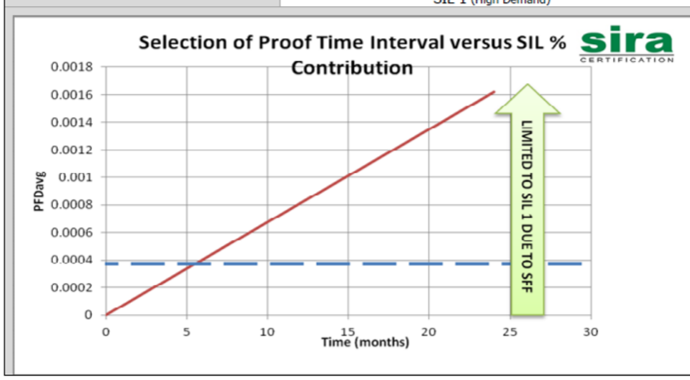
Sira Test & Certification Ltd has conducted a Failure Mode, Effect and Diagnostic Analysis (FMEDA) of the D-Series Discrete Valve Controller against the requirements of IEC61508-2.

Report Summary

D-Series Discrete Valve Controller			
Safety Function: *"TO CLOSE OFF (RELIEVE) PNEUMATIC PRESSURE TO THE SPOOL VALVE"*			
Architectural constraints:	Type A HFT=0 SFF 87.39%	Proof Test Interval =8760Hrs MTTR = 8 Hrs	SIL2
Random hardware failures:	$\lambda_{DD} = 0$ $\lambda_{DU} = 2.90E-08$	$\lambda_{SD} = 0$ $\lambda_{SU} = 8.40E-08$	
Probability of failure on demand:	PFD_{AVG}=1.27E-04 (Low Demand Mode)		SIL3
Average Frequency of Dangerous failure on safety function:	PFH = 2.90E-08 (High Demand Mode)		SIL3
Hardware safety integrity compliance	Route 1_H		
Systematic safety integrity compliance	Route 1_S		
Systematic Capability	SC 3 (See report R56A24114B)		
Overall SIL-capability achieved	SIL 2 (Low Demand) SIL 2 (High Demand)		



D-Series Discrete Valve Controller			
Safety Function: *"TO OPEN (ADMIT) PNEUMATIC PRESSURE TO THE SPOOL VALVE"*			
Architectural constraints:	Type A HFT=0 SFF 31.36%	Proof Test Interval =8760Hrs MTTR = 8 Hrs	SIL1
Random hardware failures:	$\lambda_{DD} = 0$ $\lambda_{DU} = 1.85E-07$	$\lambda_{SD} = 0$ $\lambda_{SU} = 7.04E-08$	
Probability of failure on demand:	PFD_{AVG}=8.10E-04 (Low Demand Mode)		SIL3
Average Frequency of Dangerous failure on safety function:	PFH = 1.85E-07 (High Demand Mode)		SIL2
Hardware safety integrity compliance	Route 1_H		
Systematic safety integrity compliance	Route 1_S		
Systematic Capability	SC 3 (See report R56A24114B)		
Overall SIL-capability achieved	SIL 1 (Low Demand) SIL 1 (High Demand)		

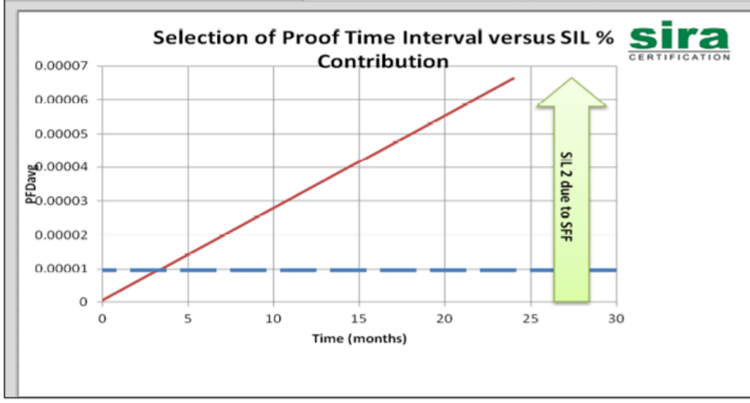


For More Information

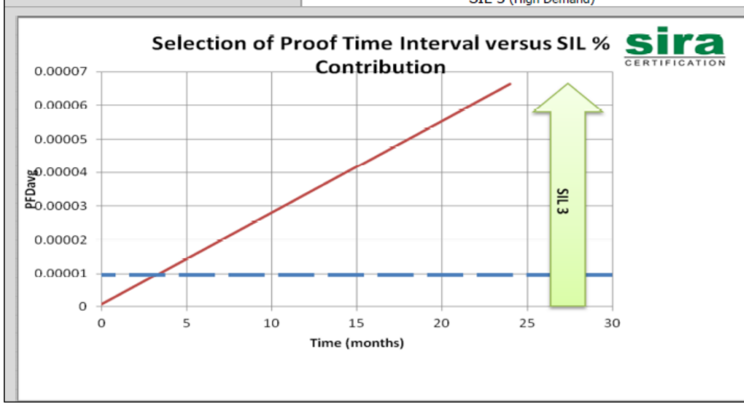
To download more information concerning the TopWorx™ D-Series Valve Controller, including a copy of the Sira Functional Safety Assessment Report visit us online at **http://www.topworx.com** Or call 502-969-8000

Continued-Proof Testing for D-Series TopWorx™

D-Series Switchboxes used as Indicators			
Safety Function: *"TO PROVIDE AN INDICATION OF THE MONITORED VALVE POSITION"*			
Architectural constraints:	Type A HFT=0 SFF=89%	Proof Test Interval =8760Hrs MTTR = 8 Hrs	SIL2
Random hardware failures:	λ_{DD} = 6.74E-08 λ_{DU} = 7.50E-09	λ_{SD} = 0.00E-00 λ_{SU} = 0.00E-00	
Probability of failure on demand:	PFD_{AVG}=3.34E-05 (Low Demand Mode)		SIL4
Average Frequency of Dangerous failure on safety function:	PFH = 7.50E-09 (High Demand Mode)		SIL4
Hardware safety integrity compliance	Route 1_H		
Systematic safety integrity compliance	Route 1_S		
Systematic Capability	SC 3 (See report R56A24114B)		
Overall SIL-capability achieved	SIL 2 (Low Demand) SIL 2 (High Demand)		

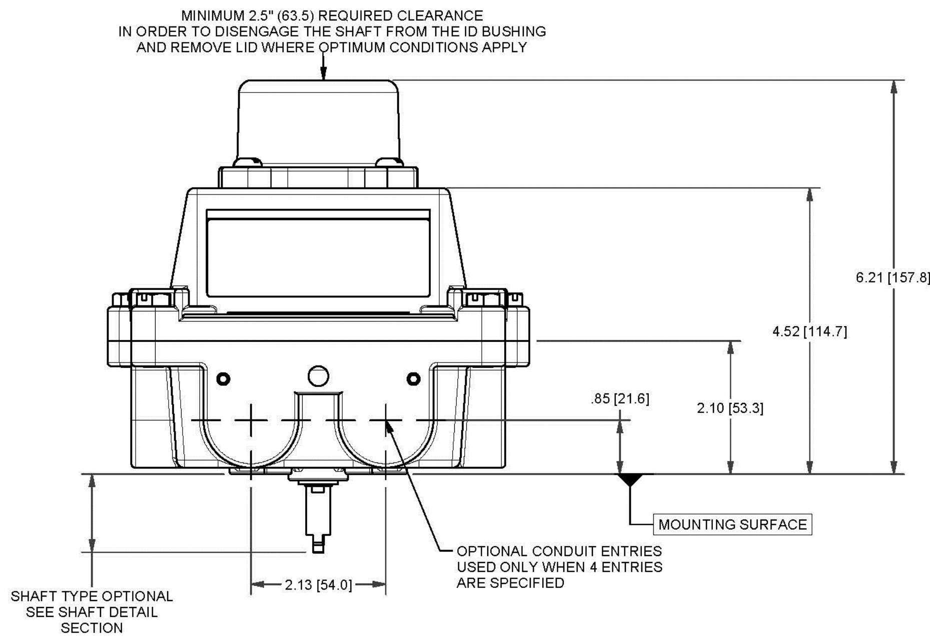


D-Series Indicator using GO switches (Z series, L series and 35 series)			
Safety Function: *"TO PROVIDE AN INDICATION OF THE MONITORED VALVE POSITION"*			
Architectural constraints:	Type A HFT=0 SFF=91%	Proof Test Interval =8760Hrs MTTR = 8 Hrs	SIL3
Random hardware failures:	λ_{DD} = 7.07E-08 λ_{DU} = 7.50E-09	λ_{SD} = 0.00E-00 λ_{SU} = 0.00E-00	
Probability of failure on demand:	PFD_{AVG}=3.35E-05 (Low Demand Mode)		SIL4
Average Frequency of Dangerous failure on safety function:	PFH = 7.50E-09 (High Demand Mode)		SIL4
Hardware safety integrity compliance	Route 1_H		
Systematic safety integrity compliance	Route 1_S		
Systematic Capability	SC 3 (See report R56A24114B)		
Overall SIL-capability achieved	SIL 3 (Low Demand) SIL 3 (High Demand)		



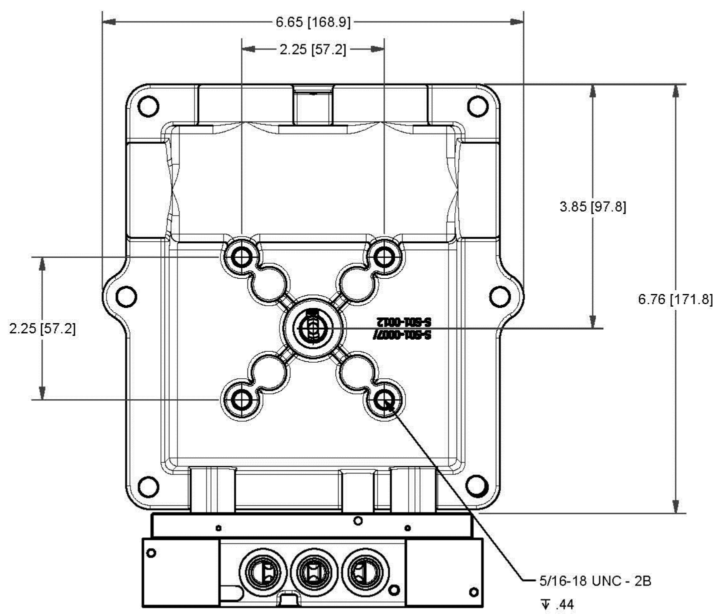
Dimensions and Materials: TopWorx™ DXP

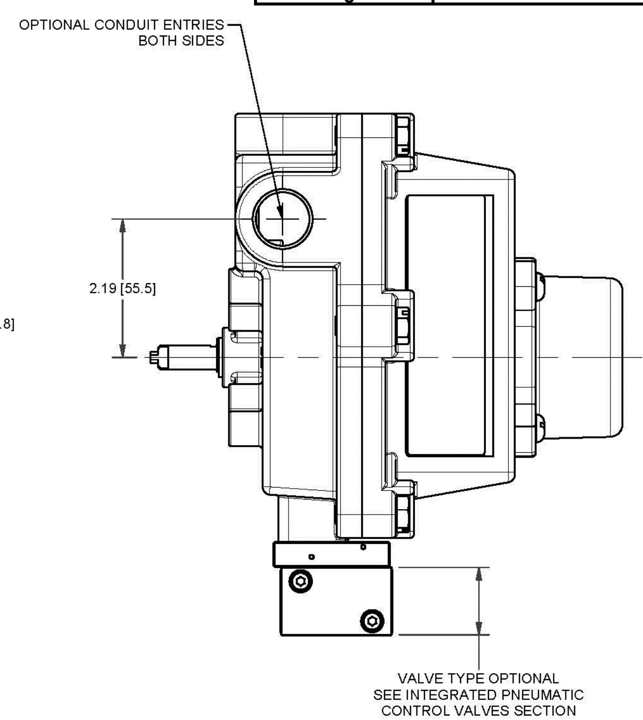
Casted aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.



MATERIALS OF CONSTRUCTION	
Enclosure	Cast A360 aluminum with dichromate conversion coating inside & out, epoxy coated exterior rated for 250 hrs. salt spray per ASTM B117
Fasteners	316 Stainless Steel optional
Shaft	316 Stainless Steel optional
Shaft Bushing	Oilite Bronze
Indicator Dome	Polycarbonate, UV F1 rated
Seals	O-ring seals available in: Buna, & Silicone

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft.-lbs [10.8 N·m] +/-10%
Indicator Dome Screws	320 in-oz. [2.3 N·m] +/-10%
Bottom Mounting Holes	10 ft.-lbs [13.6 N·m] +/-10%

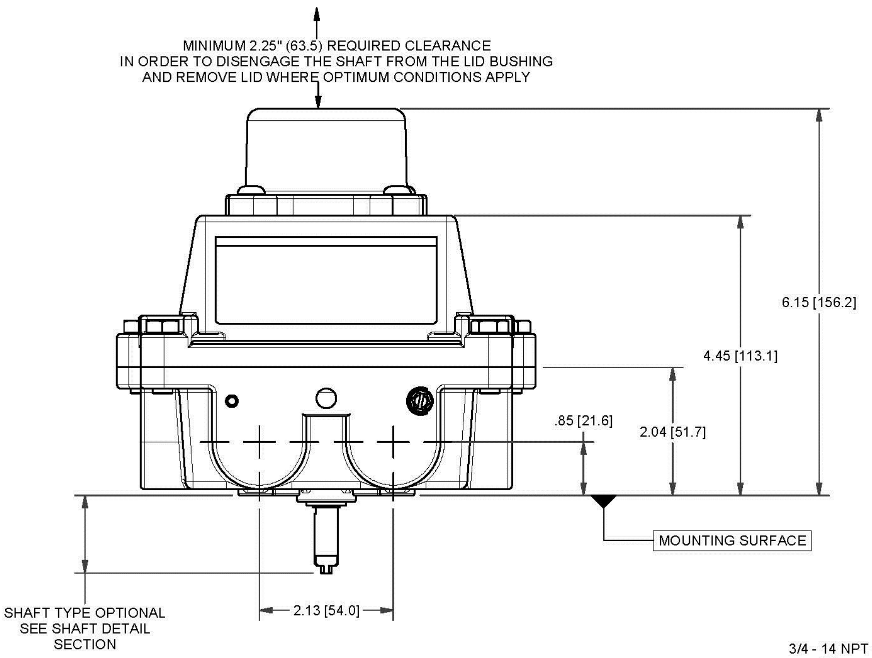




NOTE: REPLACE ENCLOSURE BOLTS WITH ONLY THOSE PROVIDED FROM THE MANUFACTURER !

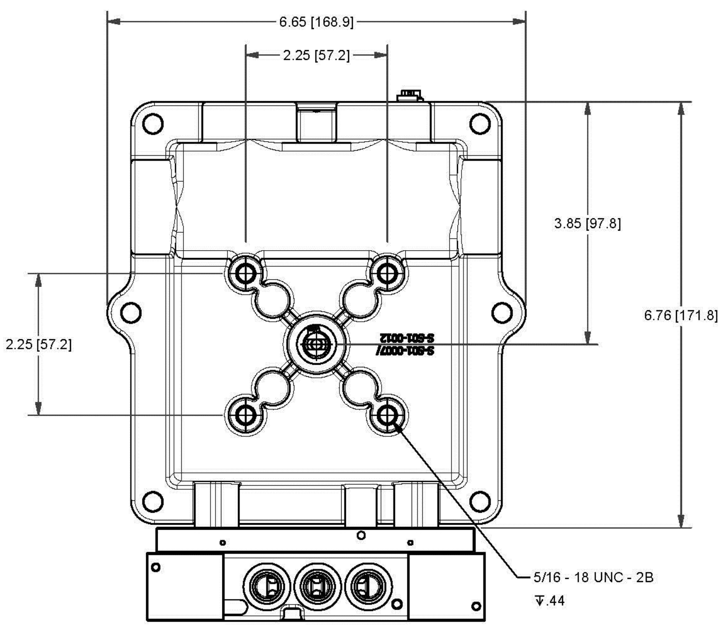
Dimensions and Materials: TopWorx™ DXP - Flameproof Ex d IIC

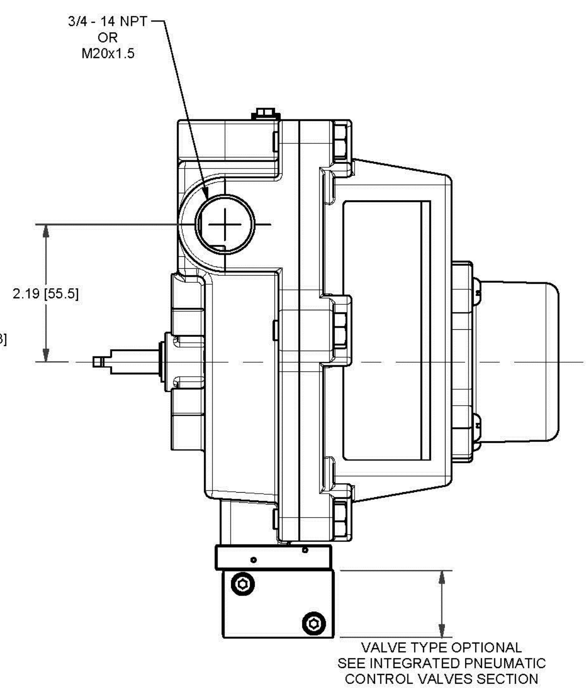
Casted aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.



MATERIALS OF CONSTRUCTION	
Enclosure	Cast A360 aluminum with dichromate conversion coating inside & out, epoxy coated exterior rated for 250 hrs. salt spray per ASTM B117
Fasteners	316 Stainless Steel optional
Shaft	316 Stainless Steel optional
Shaft Bushing	Oilite Bronze
Indicator Dome	Polycarbonate, UV F1 rated
Seals	O-ring seals available in: Buna, & Silicone

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft.-lbs [10.8 N·m] +/-10%
Indicator Dome Screws	320 in-oz [2.3 N·m] +/-10%
Bottom Mounting Holes	10 ft-lbs [13.6 N·m] +/-10%

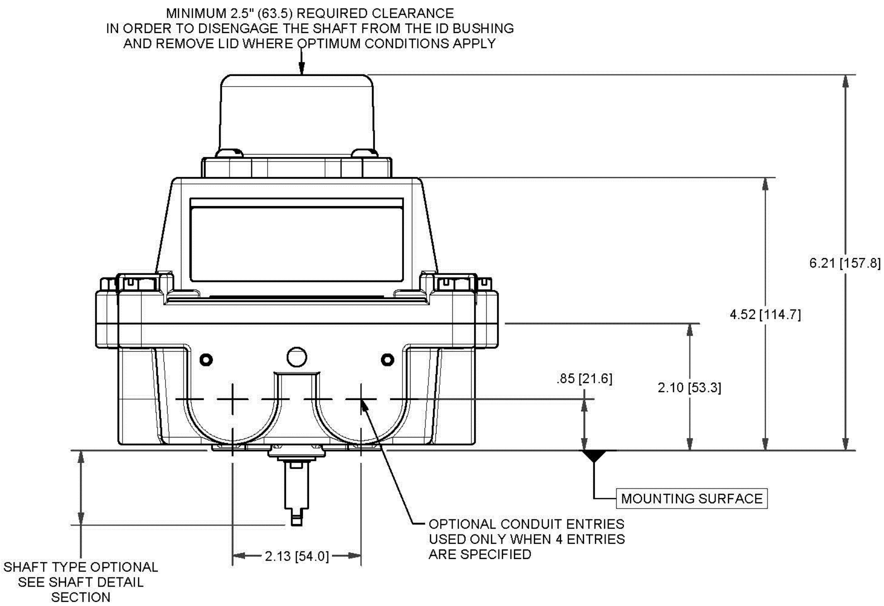




NOTE: REPLACE ENCLOSURE BOLTS WITH ONLY THOSE PROVIDED FROM THE MANUFACTURER !

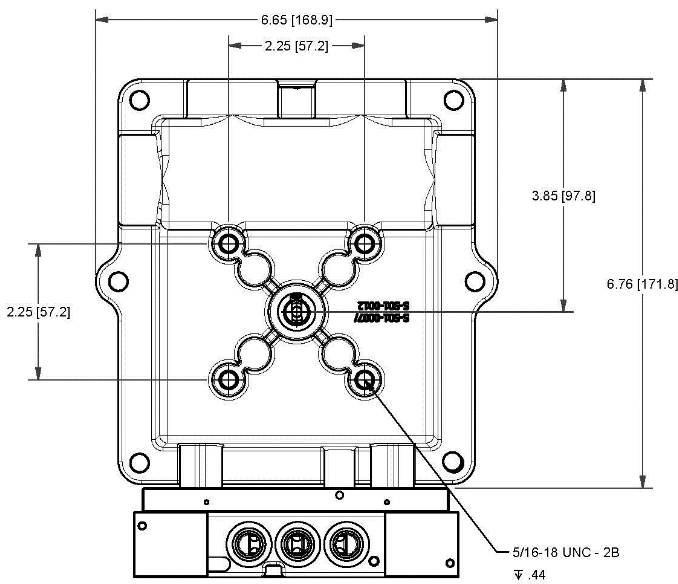
Dimensions and Materials: TopWorx™ DXS

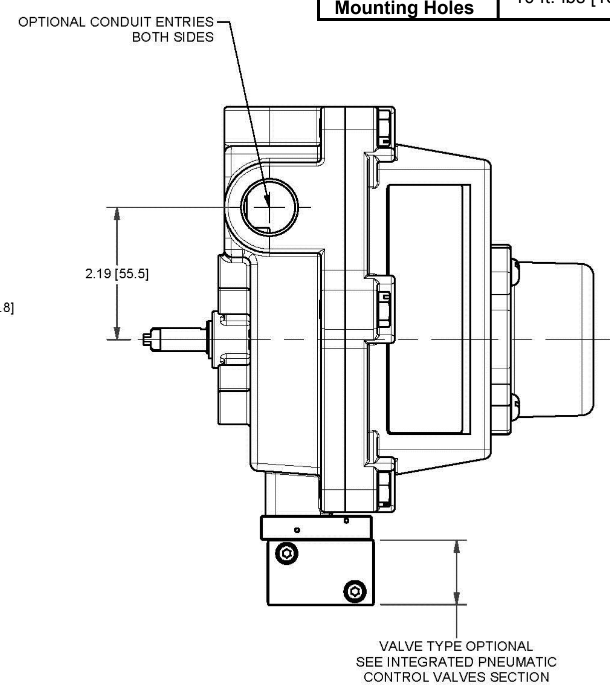
Casted aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.



MATERIALS OF CONSTRUCTION	
Enclosure	Cast 316 Stainless Steel
Fasteners	316 Stainless Steel optional
Shaft	316 Stainless Steel optional
Shaft Bushing	N/A
Indicator Dome	Polycarbonate, UV F1 rated
Seals	O-ring seals available in: Buna & Silicone,

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft.-lbs [10.8 N·m] +/-10%
Indicator Dome Screws	320 in-oz. [2.3 N·m] +/-10%
Bottom Mounting Holes	10 ft.-lbs [13.6 N·m] +/-10%





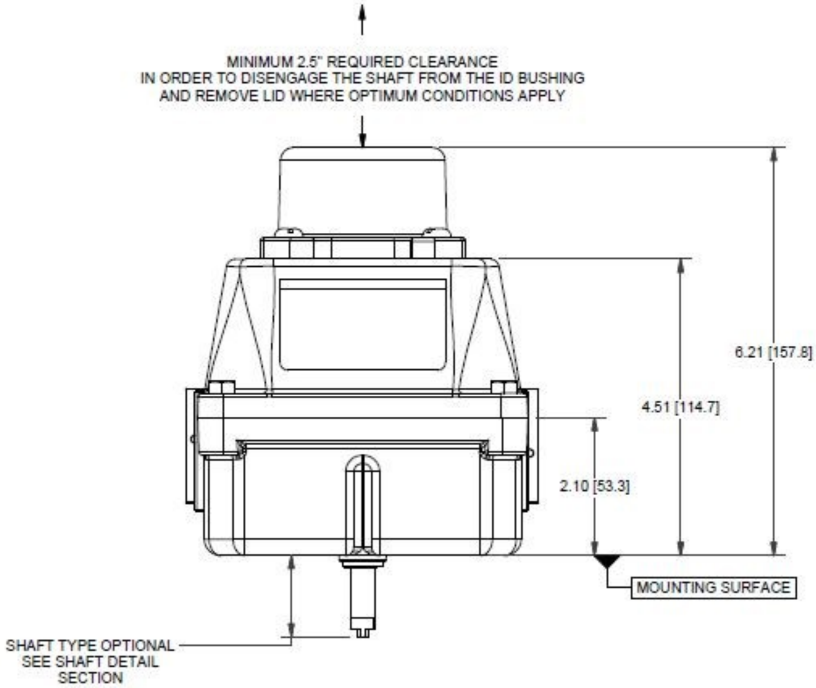
NOTE: REPLACE ENCLOSURE BOLTS WITH ONLY THOSE PROVIDED FROM THE MANUFACTURER !

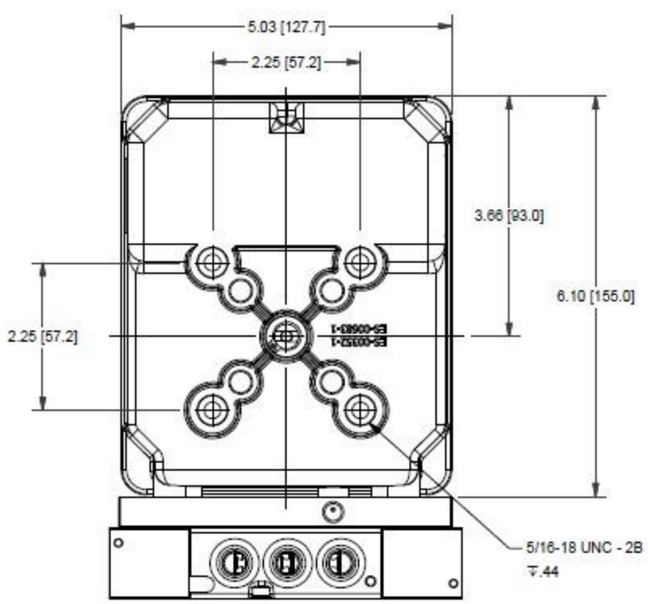
Dimensions and Materials: TopWorx™ DXR

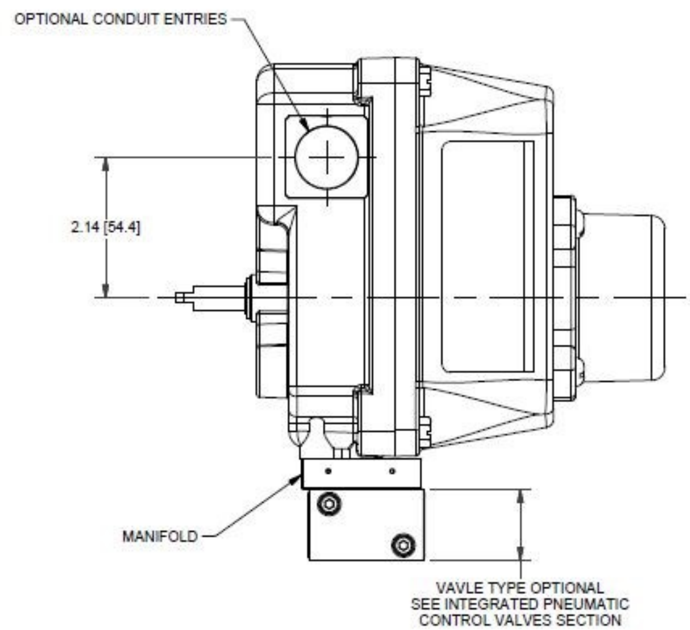
Casted aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.

MATERIALS OF CONSTRUCTION	
Enclosure	Valox™ 364
Fasteners	304 Stainless Steel standard 316 Stainless Steel optional
Shaft	316 Stainless Steel optional
Shaft Bushing	Delrin™ 500P white
Indicator Dome	Polycarbonate, UV F1 rated
Seals	Silicone

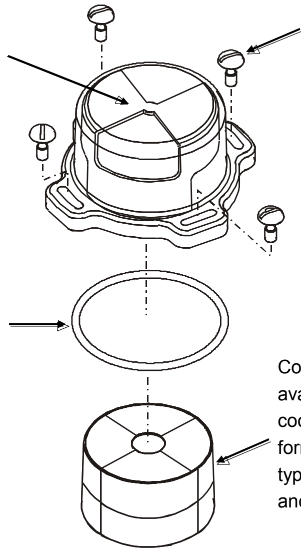
Fastener Torque Specifications	
Enclosure Housing Bolts	20 in-lbs [2.3 N·m] +/-10%
Indicator Dome Screws	20 in-oz. [2.3 N·m] +/-10%
Bottom Mounting Holes	8 ft.-lbs [10.8 N·m] +/-10%



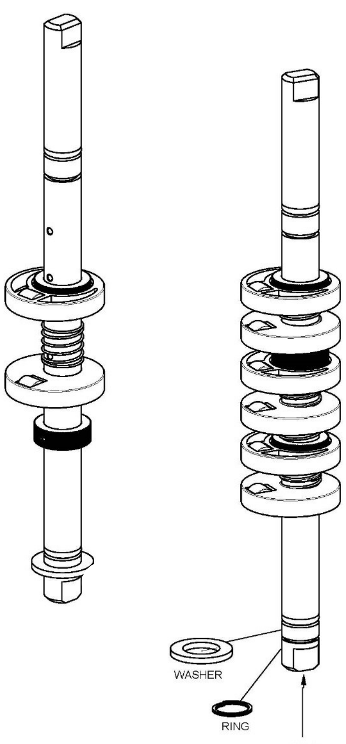


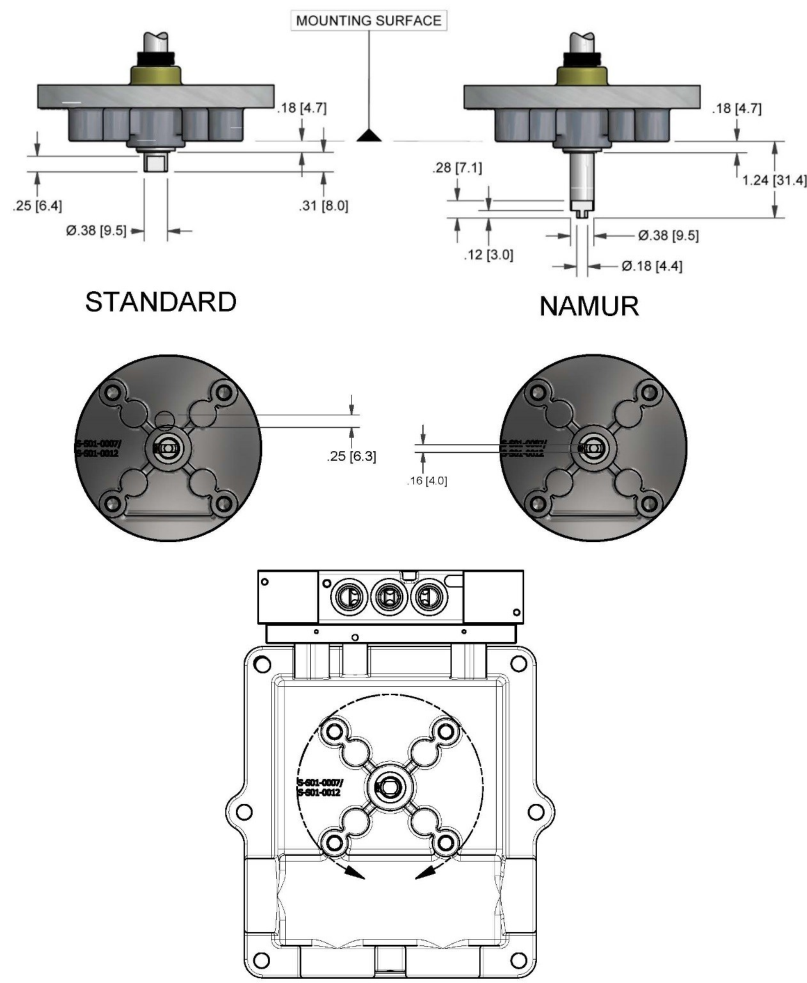


Indicator Assembly



Cam/Shaft Assemblies





TopWorx™ D-Series Certifications

PESO

Ex ia IIC T* Gb; Ex tb IIIC T* Db
Ex ib IIC T* GB; Ex tb IIIC T* Db
IECEx SIR 14.0078X / Sira 14ATEX2241X
IECEx BAS 11.0022X / Baseefa 11ATEX0035X (FF)
USL/CNL Class I, Div 1, GrABCD
UL File E125326
EAC RU C-US.ГБ08.B.02500
NEPSI GYJ13.1297X
InMetro NCC12.1260X, NCC12.0767X
PESO P347552

Ex d IIC T* Gb or Ex d IIB+H2 T* Gb; Ex tb IIC T* Db
IECEx SIR 07.0093X / Sira 07ATEX1273X
USL/CNL Class I, Div 1, GrCD; Class II, Div 1, GrEFG
UL File E125326
EAC RU C-US.ГБ08.B.02500
KOSHA 13-AV4BO-0003X & 14-AV4BO-0073X
NEPSI GYJ13.1295X
InMetro NCC 12.1138X
PESO P353049

Ex e MB IIC T* Gb; Ex tb IIIC T* Db
IECEx SIR 09.0088X / Sira 09ATEX3209X (DXR)

Ex nA nC IIC T* Gc; Ex tb IIIC T* Dc
IECEx BAS 11.0023X / Baseefa 11ATEX0036X (FF)
USL/CNL Class I, Div 2, GrABCD; Class II, Div 2, GrFG
UL File E125326

USL/CNL General Purpose
UL File E359150

Environmental Ratings: Type 4, 4X; IP 66/67

Conformance to Directives: ATEX 2014/34/EU, EMC 2004/108/EC, LVD 2006/95/EC

*Operating and Ambient temperature ratings vary depending on bus/sensor option(s), reference certificate for specific markings available.

Consult factory for certification questions or to request a custom product.

Safe Use
User instructions (in compliance with ATEX 2014/34/EU Directive, Annex II, 1.0.6)

Instructions for safe selection, installation, use, maintenance and repair

1) The equipment may be used in zones 0, 1 or 2.
2) The equipment may be used in the presence of flammable gases and vapors with apparatus groups IIC or IIB or IIA and with tempera-ture classes T1 or T2 or T3 or T4 or T5 or T6.
3) The equipment is certified for use in ambient temperatures in the range of -50°C to +60°C and should not be used outside this range. ***(NOTE: Ambient temperature range may change according to protection method)***
4) The equipment is to be installed by suitably trained personnel in accordance with the applicable code of practice (typically IEC 60079-14)
5) Under certain extreme circumstances, the plastic cover over the valve position indicator may generate an ignition-capable level of electrostatic charge. Therefore, particularly in the event of an installation in zone 0, the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge, e.g. wind-blown dust, etc. Additionally the equipment shall only be cleaned with a damp cloth.
6) Periodic inspection of the equipment and system should be performed by suitably trained personnel in accordance with the applica-ble code of practice (typically IEC 60079-17) to ensure it is maintained in a satisfactory condition.
7) The equipment does not require assembly or dismantling.
8) The equipment is not intended to be repaired by the user. Repair of the equipment is to be carried out by the manufacturer, or their approved agents, in accordance with the applicable code of practice.

Special Conditions of Safe Use (All installations)

Clean only with a damp cloth to prevent possibility of electrostatic discharge.

For Explosion Proof installations, the internal ground connection shall be used and the external ground connection, if supplied in addition, is supplemental bonding allowed where local authorities permit, or is required.

When installing with a third party listed nipple-mount solenoid, it is the responsibility of the installer to provide fittings, and apparatus, suitable for the area classification in accordance with the National Electrical Code.

All cable entry devices or conduit stopping boxes shall be certified according to protection type and suitable for the conditions of use and correctly installed.

The IIC enclosures are excluded from use in carbon disulphide atmospheres.

The air pressure to the valve block, when fitted, shall not exceed 150 PSI.

Special Conditions or Safe Use (Flameproof Installations)

1. The IIC enclosures are excluded from use in carbon disulphide atmospheres.
2. The air pressure to the valve block, when fitted, shall not exceed 150 PSI.
3. For ambient temperatures above 110ºC, the degrees of ingress protection IP66 and IP67 are not endorsed.
4. The slotted hexagonal head cover screws are not of standard form; they shall only be replaced with identical screws sourced from the equipment manufacturer.
5. The hexagonal head cover screws are to be replaced only with stainless steel 304, grade A2-70 or A4-80 screws to ISO 35061.
6. Cover fasteners are to be tightened to a torque valve of 10.85Nm (8 ft./lbs) minimum.

Continued

Special Conditions or Safe Use Continued (Intrinsically Safe Installations)

The D-Series Intrinsically Safe TopWorx™ may contain one or more devices covered by the following certificates:
The installer shall confirm which certified sub-assemblies are contained within the equipment and ensure compliance with the appropriate certificate (with particular reference to input parameters)

Number	Description
PTB 99ATEX2219X plus supplement 1	Pepperl & Fuchs slot-type initiators, types SJ… & SC...
PTB 00ATEX2032X plus Supplements 1 & 2	Pepperl & Fuchs cuboidal inductive sensors, type NJ...
PTB 00ATEX2048X plus Supplements 1, 2 & 3	Pepperl & Fuchs cylindrical inductive sensors, types NC… & NJ...
PTB 00ATEX2049X plus Supplement 1	Pepperl & Fuchs SN sensors, type NJ...
KEMA 02ATEX1090X plus Amendment 1	Turk two-wire proximity sensors type …-….-.Y1.-…../….
PTB 01ATEX2191	IFM inductive proximity switch type NE****, NF****, NG****, NI****, NN****, NT****, NS****
LCIE 02ATEX6122X	Crouzet electro-valve type 81519xxx
Sira 12ATEX2192U	4-20 mA Transmitter Module

1. The 4-20 mA loop circuit and the various additional sub-assemblies (switches, sensors and valves) shall be treated as separate intrinsically safe circuits.

2. The DXR (resin) enclosure shall only be installed where there is a low risk of mechanical damage.

3. The switchbox may contain simple switches, which shall have a maximum input power (Pi) of 1.3 W for T4 or 0.7 W for T6 from an intrin-sically safe supply.

4. For a T4 temperature class, the switchbox may contain simple switch and resistor arrangements, which shall have a maximum input power (Pi) of 0.7 W from an intrinsically safe supply. These are not permitted for a T6 temperature class.

5. For a T6 temperature class, the input parameters to sensors covered by PTB 99ATEX2219X, PTB 00ATEX2032X, PTB 00ATEX2048X or PTB 00ATEX2049X shall be limited to Ui = 16V, Ii = 25mA, Pi = 64mW.

6. For a T6 temperature class, the Turck proximity sensors listed in certificates KEMA 02ATEX1090X shall have the maximum input parame-ters as follows:
   - Type AX & GX: Ui = 15V, Ii = 20mA, Pi = 200mW
   - All other sensors: Ui = 15V, Ii = 60mA, Pi = 130W

7. When the equipment incorporates a 4-20 mA Transmitter Module (Sira 12ATEX2192U), the manufacturer may apply the marking "II 1G' or 'II 2 D' or 'II 2 GD'. A T6 temperature class is not permitted with this Module fitted. The ambient temperature is limited to a maximum range of -40ºC to +53ºC, but this range may be reduced, depending on the enclosure and gasket type, as well as the internal sub-assemblies fitted. Additionally, the output from the 4-20mA Transmitter Module shall only be connected to a Novotechnic WAL30 po-tentiometer

Preventative Maintenance

The TopWorx™ DXP/DXS Switchbox is designed to operate for one million cycles without servicing. Call the factory when you are approaching this milestone for a preventative maintenance kit and instructions.

TopWorx™ D-Series Replacement Part Number List

35 Series GO™ Switches	
35-13319M	Option L2/L4 - SPDT
7Z-23528M	Option Z2/Z4 - DPDT Stainless Steel
Switch / Module Replacement Kits	
AV-FFD2-1	Foundation Fieldbus module replacement (with piezo pilots)
AV-FFD2-2	Foundation Fieldbus module replacement (without piezo pilots)
AV-AS1-1	AS-Interface module
AV-DN1-1	DeviceNet module
AV-MSW1	(M) SPDT mechanical switch replacement
AV-E1	(E) P+F NJ2-V3-N sensor replacement
AV-TSW1	(T) DPDT mechanical switch replacement
AV-420TBD	4-20mA transmitter replacement assembly w/ potentiometer
Indicator / Dome Replacement Kits	
AV-GB002	90º, Green/Open, Red/Closed, Buna O-Ring
AV-YB002	90º, Yellow/Open, Black/Closed, Buna O-Ring
AV-BB002	90º, Black/Open, Yellow/Closed, Buna O-Ring
AV-4B002	45º, Green/Open, Red/Closed, Buna O-Ring
Shaft Replacement Kits Mechanical Switches (M2 or T2)	
AV-SSB201	Standard shaft Buna-N O-Rings & (2) cam Assembly w/ Hardware
AV-NSB201	NAMUR Shaft Buna-N O-Rings & (2) cam Assembly w/ Hardware
Shaft Replacement Kits GO™ Switches (L2 - Manufactured after July 1, 2007)	
AV-SSB205	Standard shaft Buna-N O-Rings & (2) Target Assembly w/ Hardware
AV-SNB205	NAMUR shaft Buna-N O-Rings & (2) Target Assembly w/ Hardware
Shaft Replacement Kits SCMs with Reed Switches (R2)	
AV-NSB203	NAMUR Shaft Buna-N O-Rings & (2) cam Assembly w/ Hardware
AV-SSB203	Standard Shaft Buna-N O-Rings & (2) cam Assembly w/ Hardware

Consult Factory

To order replacement parts or for information concerning parts or spool valve options not listed call

TopWorx™ at 502-969-8000

TopWorx™ D-Series Replacement Part Number List Continued

Pilot Replacement Kits	
AV-A24PRK	24vdc pilot
AV-A110PRK	110vac pilot
AV-A220PRK	220 VAC pilot
AV-S15MPMRK	Piezo pilot
Spool Valve Replacement Assemblies	
AV-AB1A20	ASCO 8551 Spool Valve, Fail Open/Closed, Aluminum
AV-AB1620	ASCO 8551 Spool Valve, Fail Open/Closed, SST
AV-AV2A20	ASCO 8551 Spool Valve, Fail Last, Aluminum
AV-AB2620	ASCO 8551 Spool Valve, Fail Last, SST
AV-AB1A30	ASCO 8553 Spool Valve, Fail Open/Closed, Aluminum
AV-AB1630	ASCO 8553 Spool Valve, Fail Open/Closed, SST
AV-AB2A30	ASCO 8553 Spool Valve, Fail Last, Aluminum
AV-AB2630	ASCO 8533 Spool Valve, Fail Last, SST

* If you are needing a replacement for a TopWorx™ switchbox with a non-ASCO spool valve, please consult the factory for a kit number.

Recommended Operating Temperatures

No Approvals (DXP/DXS) *DXR Enclosure limited to -40°C to 80°C*			
Option	**Switch Description**	**Switchbox (NO Integrated Solenoid)**	**Switchbox (WITH Integrated Solenoid)**
L	35 GO™ Switch SPDT	-60°C to +105°C	Consult Factory
Z	35 GO™ Switch DPDT	-60°C to +105°C	Consult Factory
M	Mechanical switch - SPDT	-40 to +85°C	Consult Factory
K	Mech. switch w/Au contact	-40 to +85°C	Consult Factory
T	Mechanical switch DPDT	-40 to +85°C	Consult Factory
R	Reed Switch SPDT	-40 to +80°C	Consult Factory
E	PEPPERL+FUCHS NJ2-V3-N	-25° to 100°C	Consult Factory
_X	4-20mA Transmitter	-40 to +80°C	Consult Factory
_H	4-20 Xmitter with HART	-40 to +80°C	Consult Factory
AS	Asi	-40 to +80°C	Consult Factory
DN	DeviceNet	-40 to +80°C	Consult Factory
PB	Profibus	-40 to +80°C	Consult Factory
FF	Foundation Fieldbus	-40 to +80°C	Consult Factory
FL	Foundation Fieldbus w/GO	-40 to +80°C	Consult Factory
FP	FF w/GO and potentiometer	-40 to +80°C	Consult Factory
ES	ESD/PST	-40 to +80°C	Consult Factory

GLOBAL SUPPORT OFFICES

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