

TopWorx™ T-Series Valve Controllers

Installation, Operation & Maintenance Manual



Emerson™

Emerson is a powerful, global, single source of process improvement technology and expertise. We help major companies optimize their plants and processes to achieve higher quality, greater reliability and faster time to market, while steadily advancing productivity and profitability.

Emerson's technology know-how and application experience enable us to develop products and solutions that deliver the proven performance and reliability our customers expect when looking to build, connect, improve, and maintain their equipment and automation process.

Driven Without Compromise

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Installation on Actuator

Normal and Reverse Acting

Normal acting is full clockwise (CW) when the process valve is closed and counter-clockwise (CCW) when the process valve is open. *Reverse acting* is full CW when the process valve is open and CCW when the process valve is closed.

Indicator dome assemblies are designed to accommodate both **Normal and Reverse Acting units**. When the unit is **Reverse Acting**, the indicator dome assembly will have to be rotated.

The image to the right 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 otherwise specified, your unit will be factory set to operate in this fashion.

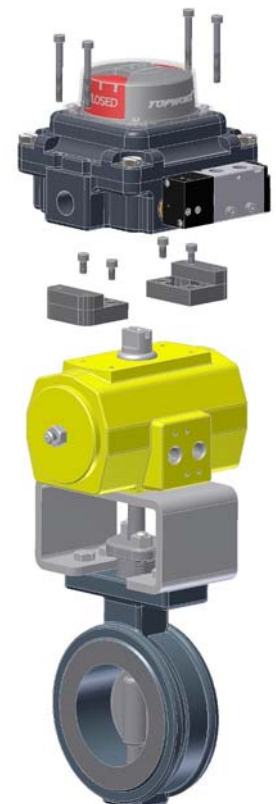
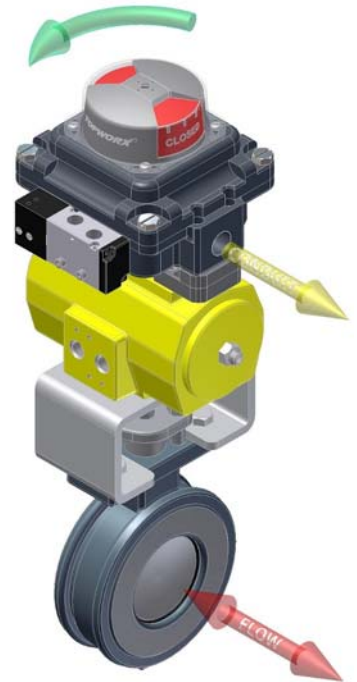
Installation on Actuator

Mounting

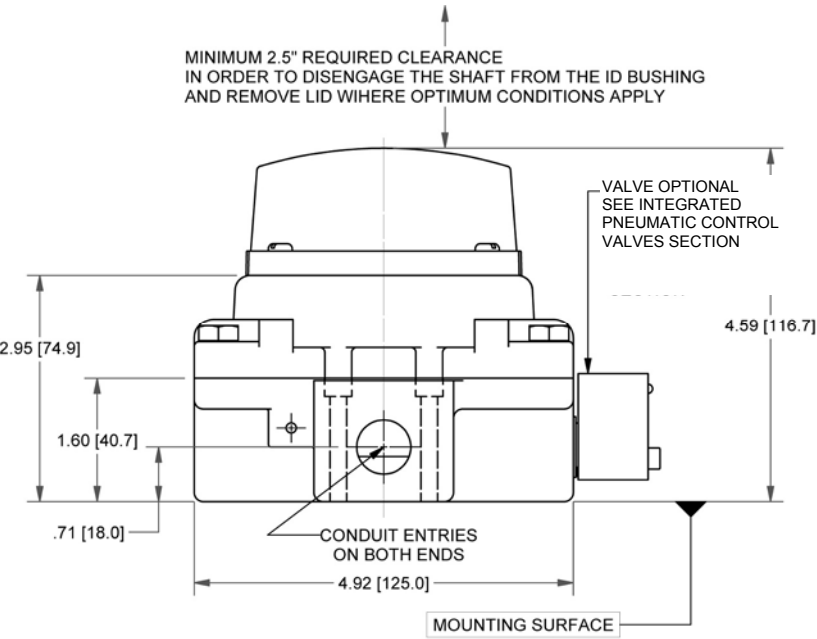
TopWorx™ has numerous mounting bracket kits available to meet your specific application, whether rotary or linear. Consult your local distributor or factory representative for ordering information. The illustration shows a direct Namur mount on a quarter turn valve. Refer to your mounting kit documentation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

Installation Notes

1. Remove the upper housing of the unit to allow access to the target cam assembly.
2. Hold the unit above the mounting surface in the orientation in which you intend to mount. Rotate the shaft to align the tang with the actuator slot. In some cases it may be necessary to rotate the target cam on the shaft to allow assembly. For most units the target cam is secured with a compression spring. Simply grasp the cam, push down, and realign the cam as required. On some units the target cam is secured with a snap ring. On these units the removal of the shaft from the base assembly will be required to change the orientation. Once removed from the base assembly, remove the snap ring securing the target cam and rotate as required.
3. Use caution not to allow undue axial (thrust) load on the shaft.
4. 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. Refer to the Proof Testing section for proper safety function setup.
5. Always use sound mechanical practices when torquing down any hardware or making pneumatic connections. Refer to the Integrated Pneumatic Control Valves section for detailed information on pneumatic connections.
6. This product comes shipped with plastic plugs in the conduit entries 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 outdoors or when installed.
7. 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.

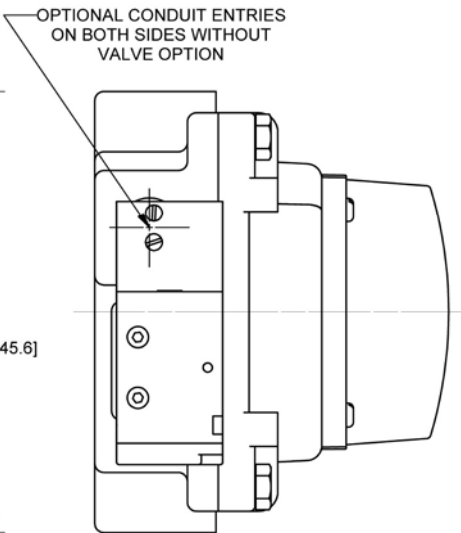
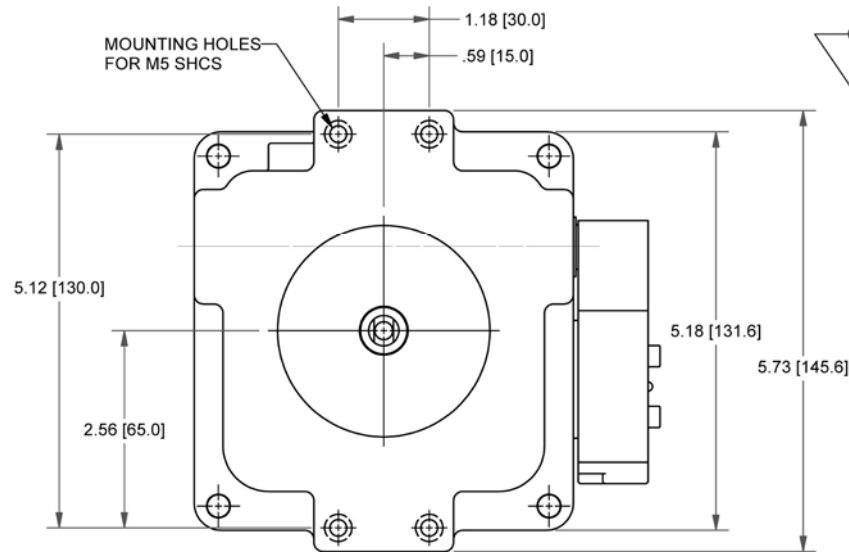


Dimensions and Materials: TopWorx™ TXP

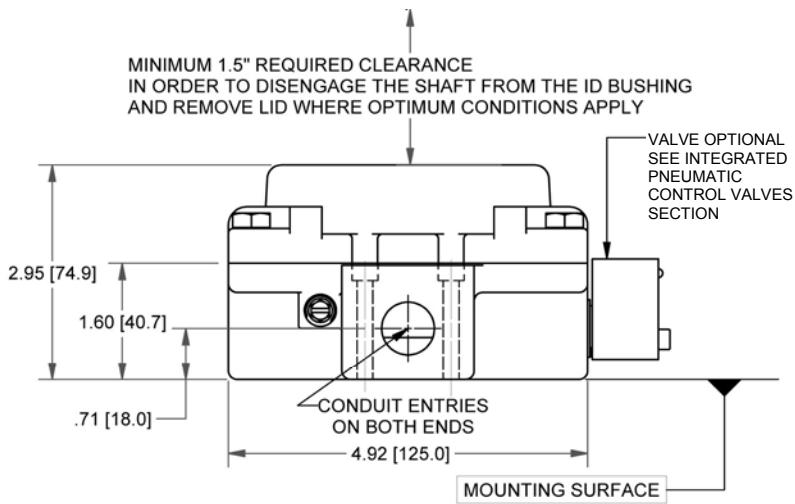


MATERIALS OF CONSTRUCTION	
Enclosure	Cast A360 aluminum with chromate conversion coating inside & out, epoxy coated exterior rated for 1,000 hrs salt spray per ASTM B117
Fasteners	304 Stainless Steel standard 316 Stainless Steel optional
Shaft	304 Stainless Steel standard 316 Stainless Steel optional
Shaft Bushing	ASTM C83600 Bronze
Indicator Dome	Polycarbonate, UV F1 rated
Seals	Silicone/EPDM (Other materials available upon request)

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft-lbs [10.8 N·m] +/- 10%
Indicator Dome Screws	200 in-oz [141 mN·m] +/- 10%
Bottom Mounting Holes	10 ft-lbs [13.6 N·m] +/- 10%

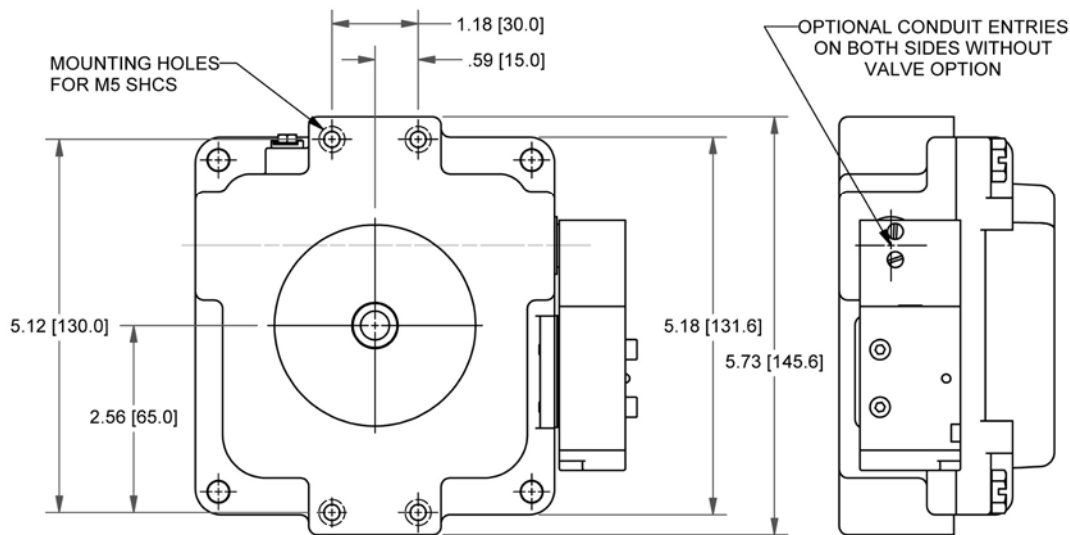


Dimensions and Materials: TopWorx™ TXP Flat Top

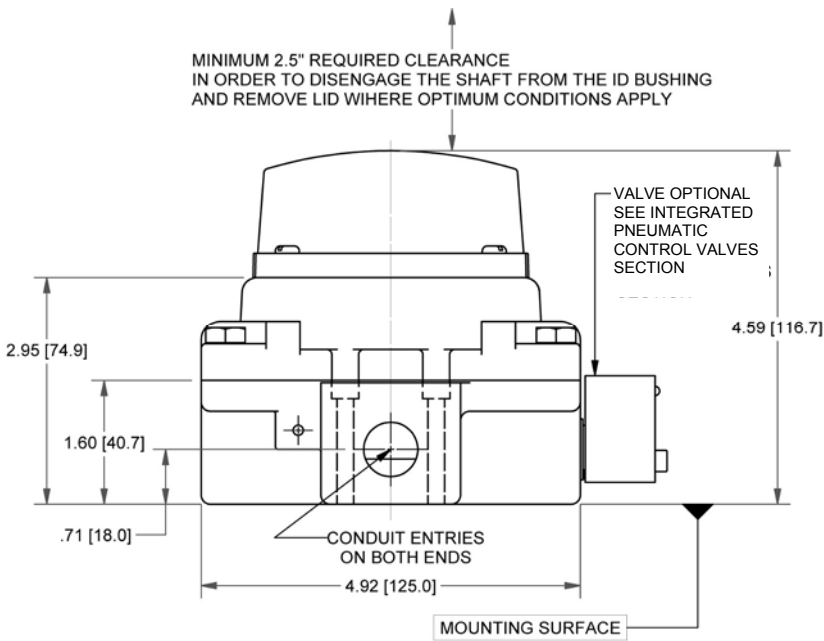


MATERIALS OF CONSTRUCTION	
Enclosure	Cast A360 aluminum with chromate conversion coating inside & out, epoxy coated exterior rated for 1,000 hrs salt spray per ASTM B117
Fasteners	304 Stainless Steel standard 316 Stainless Steel optional
Shaft	304 Stainless Steel standard 316 Stainless Steel optional
Shaft Bushing	ASTM C83600 Bronze
Seals	Silicone/EPDM (Other materials available upon request)

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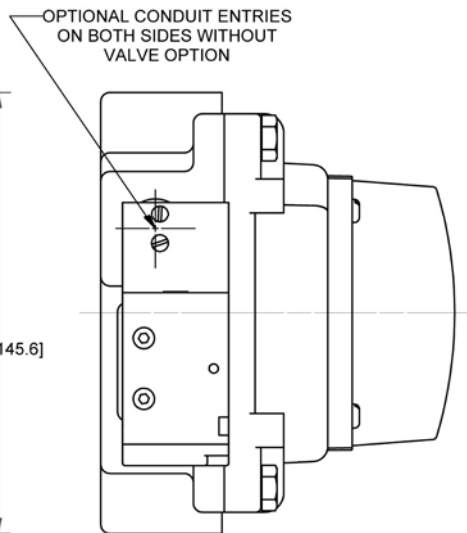
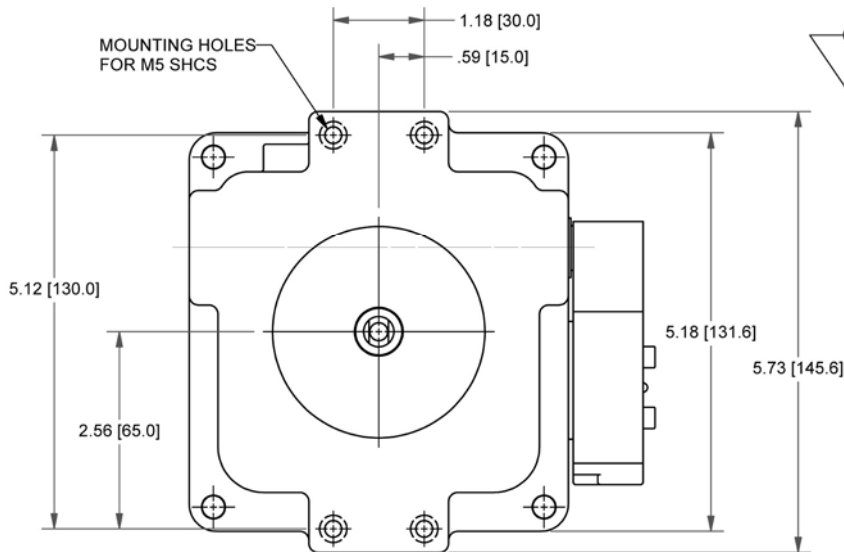


Dimensions and Materials: TopWorx™ TXS

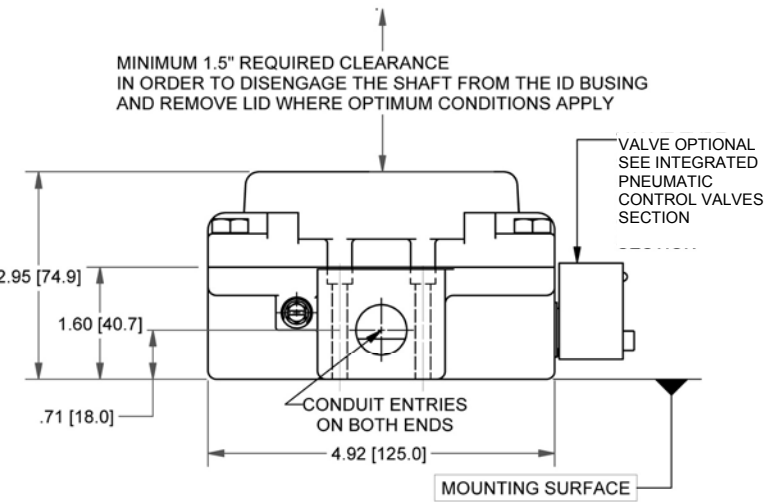


MATERIALS OF CONSTRUCTION	
Enclosure	Stainless steel. 316
Fasteners	304 Stainless Steel standard 316 Stainless Steel optional
Shaft	304 Stainless Steel standard 316 Stainless Steel optional
Shaft Bushing	316 Stainless Steel
Indicator Dome	Same as TXP Dome
Seals	Buna/EPDM (Other materials available upon request)

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft-lbs [10.8 N·m] +/- 10%
Indicator Dome Screws	200 in-oz [i41 m N m] +/- 10%
Bottom Mounting Holes	10 ft-lbs [13.6 N·m] +/- 10%

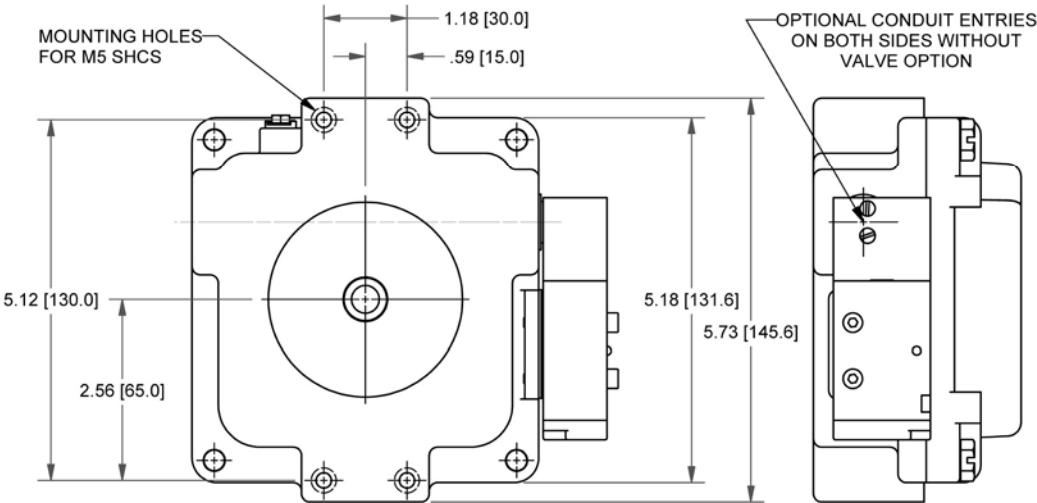


Dimensions and Materials: TopWorx™ TXS Flat Top



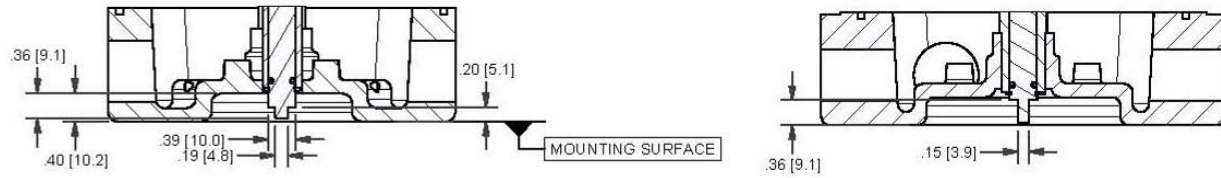
MATERIALS OF CONSTRUCTION	
Enclosure	Stainless steel. 316
Fasteners	304 Stainless Steel standard 316 Stainless Steel optional
Shaft	304 Stainless Steel standard 316 Stainless Steel optional
Shaft Bushing	316 Stainless Steel
Seals	Silicone/EPDM (Other materials available upon request)

Fastener Torque Specifications	
Enclosure Housing Bolts	8 ft-lbs [10.8 N·m] +/- 10%
Bottom Mounting Holes	10 ft-lbs [13.6 N·m] +/- 10%

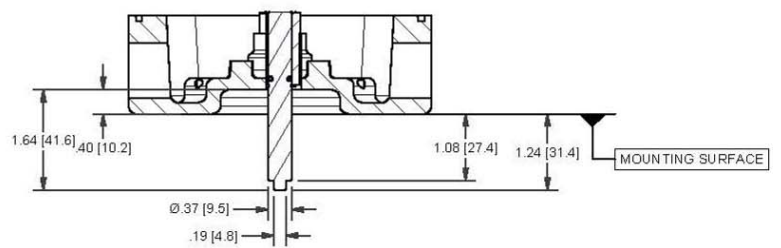
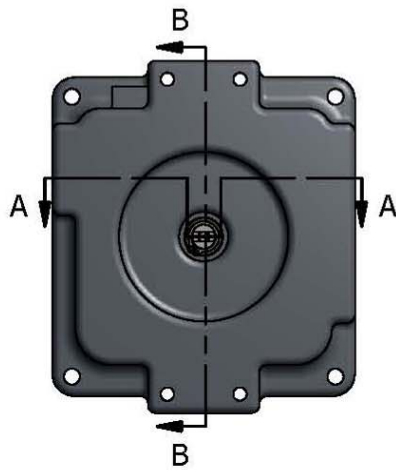


Dimensions and Materials: Shaft Detail

TXP/TXS NAMUR Shaft



TXP/TXS Linear Shaft



Sensors: Basic Function

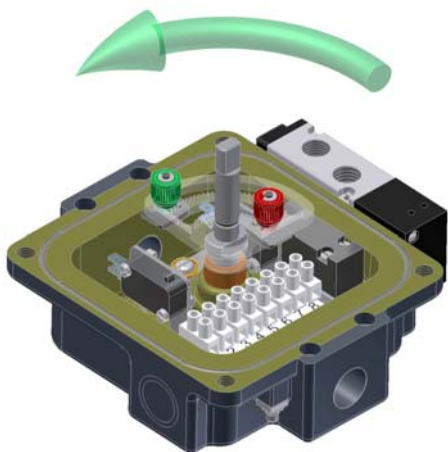
Each T-Series unit is equipped with 2 or 4 adjustable targets with a usable range between 45° and 90°. For *normal acting* applications the targets are color coded red for closed and green for open. The color code would be reversed for *reverse acting* units. After installing the unit on the actuator or valve assembly, the targets must be set.

Normal acting

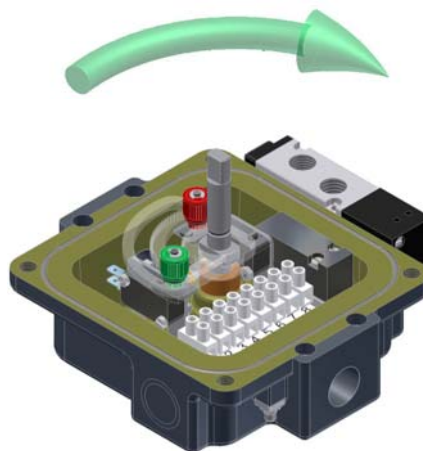
1. Rotate the valve full CW to the closed position.
2. Twist the red target button(s) CW or CCW as required to engage the switch (refer to the specific switch section for testing and confirmation information about your switch type).
3. Rotate the valve full CCW to the open position.
4. Twist the green target button(s) CW or CCW as required to engage the switch (refer to the specific switch section for testing and confirmation information about your switch type).

Reverse acting

1. Rotate the valve full CW to the open position.
2. Twist the red target button(s) CW or CCW as required to engage the switch (refer to the specific switch section for testing and confirmation information about your switch type).
3. Rotate the valve full CCW to the closed position.
4. Twist the green target button(s) CW or CCW as required to engage the switch (refer to the specific switch section for testing and confirmation information about your switch type).



Normal-acting open position
- or -
Reverse-acting closed position

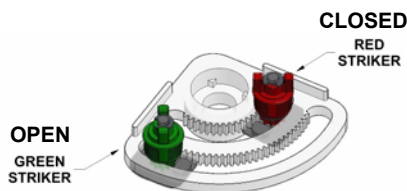


Normal-acting closed position
- or -
Reverse-acting open position

Setting Switches

Unlock the green and red targets. Stroke the actuator open and closed to ensure there is no obstruction in its stroke. Once the actuator is at the desired position, twist the knob on the cam until the switch is made and lock the target. The red knob is for closed and the green knob is for open.

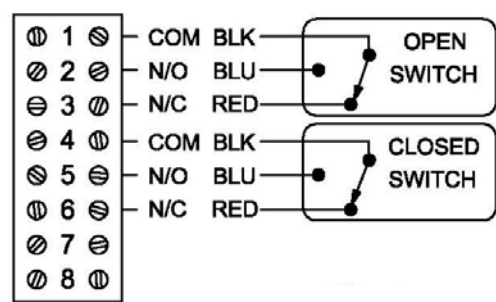
For switching angles less than 45 degrees or more than 90 degrees, consult factory for proper configuration.



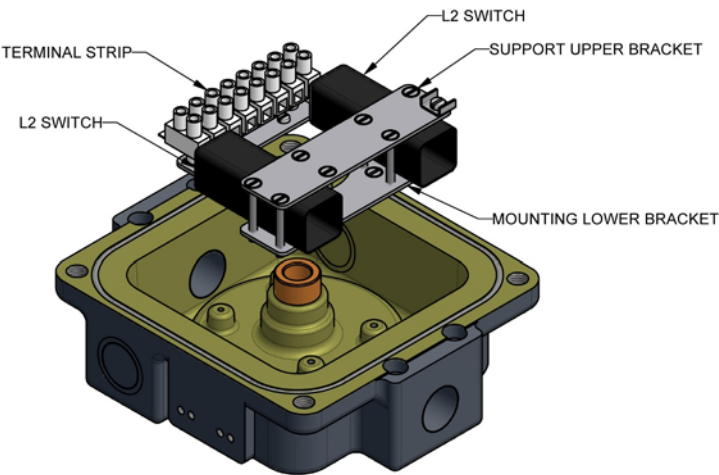
Switch Option L2: GO Switches

GO Switches are dry contact, so they consume no power to operate and have no voltage drop or leakage current.

Wiring Diagram



ES-00631-R2



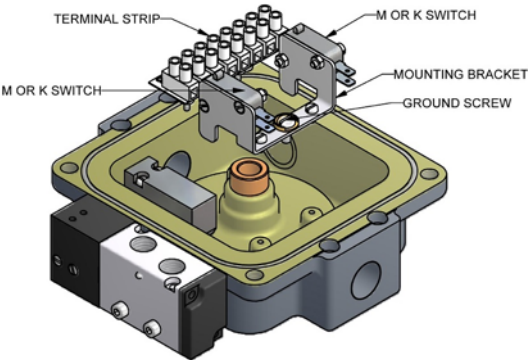
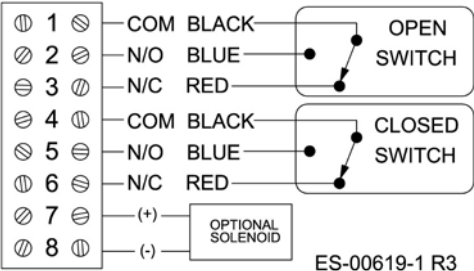
Repeatability	.002" (.05 mm)
Response Time	8 milliseconds
Differential	0.020 to 0.150 (0.5mm to 3.8mm)
Operating Temperature	-76° to 221°F (-60° to 105°C)
Contact Material	Silver cadmium oxide, gold flashed
Forms	SPDT, Form C
Electrical Ratings	4A@120VAC / 3A@24VDC
Target Material	Ferrous metal
Sensing Range	Approx. 1/10" (2.5 mm)
Sensing Range with Target Magnet	3 5/8" (92mm) (max)

Also available from TopWorx™: The TopWorx™ D-Series with DPDT, Stainless Steel GO Switches.
Call Inside Sales or email info.topworx@emerson.com for more details

Switch Option M2/M4 or K2/K4: SPDT Mechanical Switches

When installing units with M or K switches a standard voltage ohm meter may be used to set the target cams by looking for continuity between the N/O and COMMON wires.

Wiring Diagram

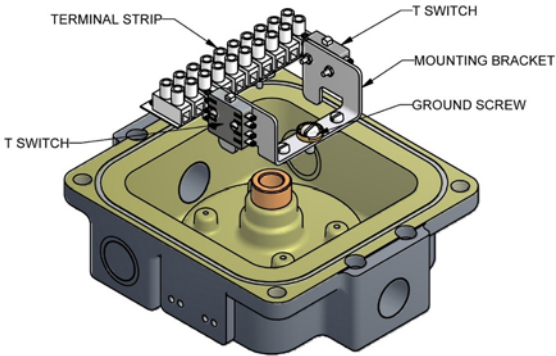
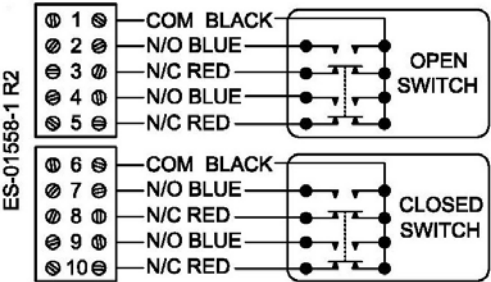


PRODUCT SPECIFICATIONS	
OPTION M	
Switch Type	Mechanical
Sealed	No
Circuitry	SPDT
Termination	Quick Connect
Rating	10A@125VAC or 250VAC
Conforming to standards	UL: 1054
Contact Resistance	15M Ω max. (initial)
Insulation Resistance	100M Ω min. (at 500V DC)
OPTION K	
Switch Type	Mechanical
Sealed	No
Circuitry	SPDT
Termination	Quick Connect
Rating	10A@125VAC or 250VAC
Conforming to standards	UL: 1054

Switch Option T2: DPDT Mechanical Switches

When installing units with T switches a standard voltage ohm meter may be used to set the target cams by looking for continuity between the N/O and COMMON wires.

Wiring Diagram

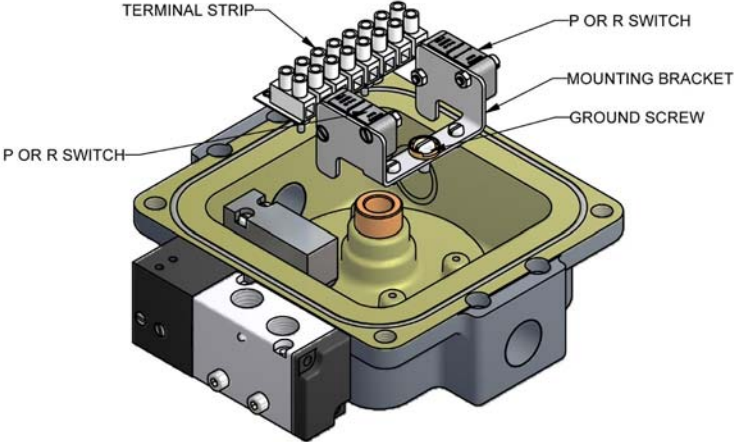
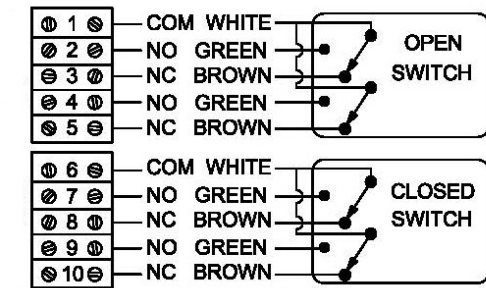
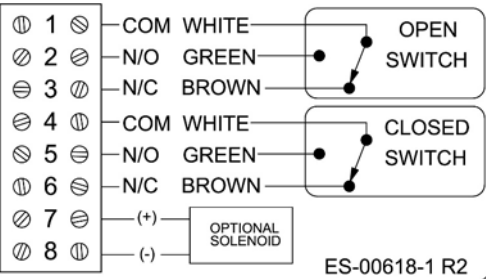


PRODUCT SPECIFICATIONS	
Switch Type	Mechanical
Sealed	No
Circuitry	DPDT
Termination	Quick Connect
Rating	8A 125V AC or 250V AC
Conforming to standards	UL recognized and CSA certified, meets MIL-S-8805
Contact	Silver
Terminals	End Solder

Switch Options P2 or R2/R4: SPDT Reed Proximity Switches

When installing units with P or R switches a standard voltage ohm meter may be used to set the target cams by looking for continuity between the N/O and COMMON wires.

Wiring Diagrams (R2/P2)



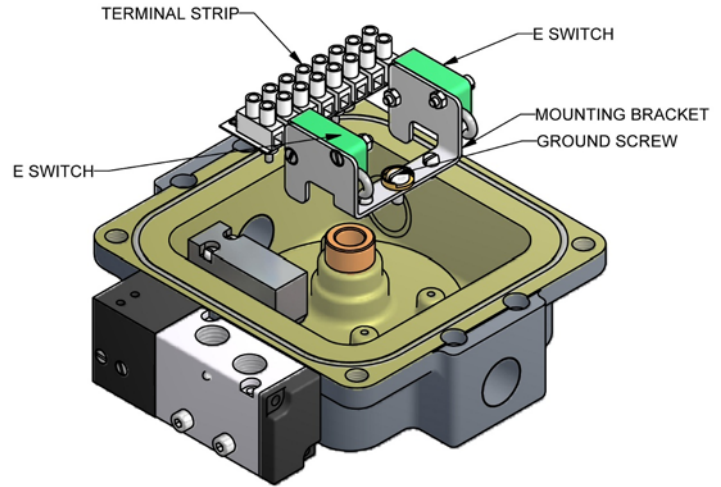
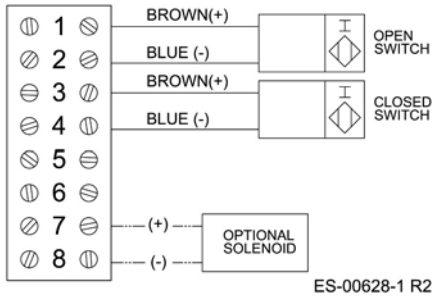
PRODUCT SPECIFICATIONS	
P Option	
Switching Voltage	VDC 120V Max
Carry Current	3 Amp Max
Power Rating	3 - 100 Watt
Contact Material	Tungsten
R Option	
Switching Voltage	DC/AC 30V Max
Carry Current	0.5 Amp Max
Switching Current	0.2 Amp Max
Power Rating	3 Watt
Contact Material	Rhodium

Switch Option E2/E4: Inductive NAMUR Sensors

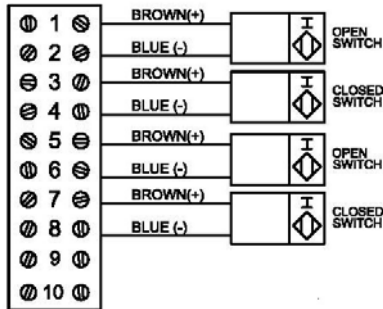
Basic inductive sensors

- 2mm sensing range
- Flush mountable
- NAMUR output
- Intrinsically safe when connected to an approved switch isolator

Wiring Diagram: Switch Option E2



Wiring Diagram: Switch Option E4

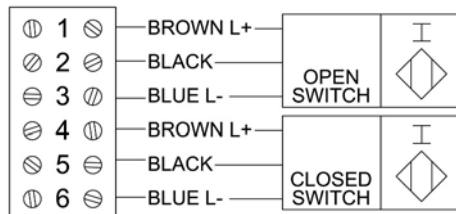


When installing TopWorx™ products with P&F sensors we suggest using a commercially available switch tester like P&F part number: **ST0-03 switch tester**.

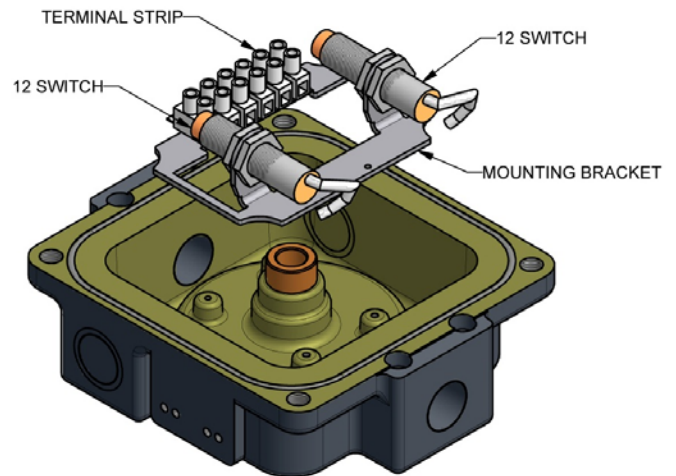
PRODUCT SPECIFICATIONS		
General specifications		
Switching element function		NAMUR NC
Rated operating distance	S _n	2 mm
Installation		embeddable
Output polarity		NAMUR
Assured operating distance	S _a	0 ... 1.62 mm
Reduction factor r _{AI}		0.25
Reduction factor r _{CU}		0.2
Reduction factor r _{V2A}		0.7
Nominal ratings		
Nominal voltage	U ₀	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 Core cross-section		130 mm, PVC cable 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

Switch Option 12: Inductive Sensors

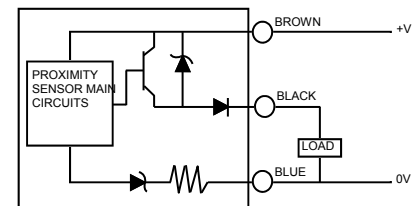
Wiring Diagram



ES-00629-1 R2



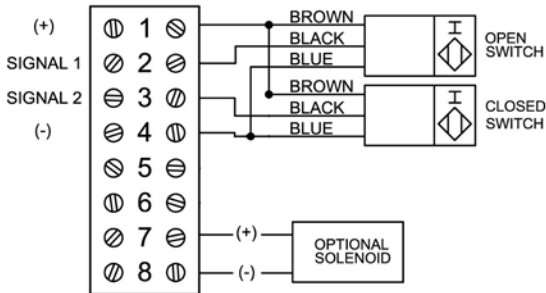
PRODUCT SPECIFICATIONS	
Item	Standard
Switch Option 1 - M12 body	5mm sensing
Differential travel	10% max. of sensing distance
Power supply voltage (operating voltage range)	12 ~ 24 VDC. Ripple (p~p): 10% max. (10 ~ 30 VDC)
Current consumption (DC 3-wire)	10 mA max.
Output type	PNP
Control output	200 mA max. (32 VDC max.) [see Note 1]
Residual voltage	1.0 V max. (under load current of 200 mA with cable length of 2m)
Operation mode (with sensing object approaching)	N/O
Protection circuit	Output reverse polarity protection, Power source circuit reverse polarity protection, Surge suppressor, Short-circuit protection
Ambient air temperature	Operating: -40°C to 70°C, Storage: -40°C to 85°C (with no icing or condensation)
Temperature influence (See note 1 below)	±10% max. of sensing distance at 23°C within temperature range of -25°C to 70°C ±15% max. of sensing distance at 23°C within temperature range of -40°C to 70°C
Ambient humidity	Operating: 35% to 95%, Storage: 35% to 95%
Voltage influence	±1% max. of sensing distance in rated voltage range ±15%
Insulation resistance	50 MΩ min. (at 500 VDC) between current carry parts and case
Dielectric strength	1,000 VAC at 50/60 Hz for 1 min between current carry parts and case
Vibration resistance	10 to 55 Hz, 1.5mm double amplitude for 2 hours each in X, Y and Z directions
Shock resistance	1,000 m/s ² , 10 times each in X, Y and Z directions
Standards and listings	IEC60529: IP66, Degree of protection EN60947-5-2: EMC



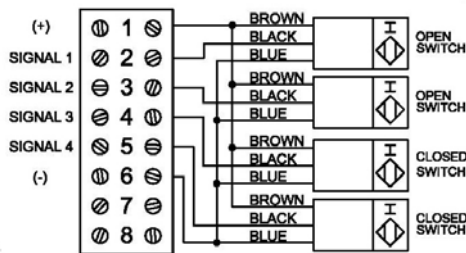
Note 1: When using any model at an ambient temperature between -40°C and -25°C and a power voltage between 30 and 32 VDC, use a load current of 100 mA max.,

Switch Option 42/44 or 52/54: Inductive Sensors

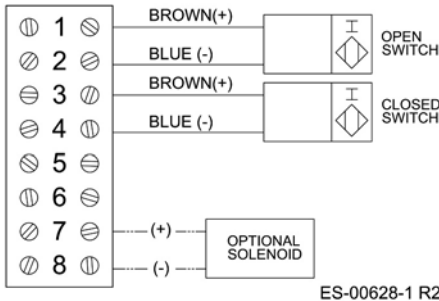
42 Wiring Diagram



44 Wiring Diagram



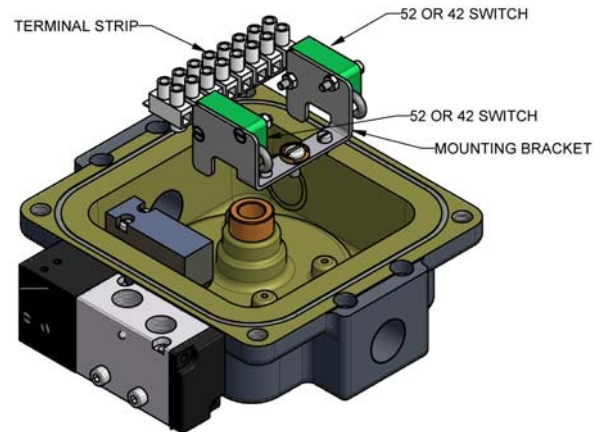
52 Wiring Diagram



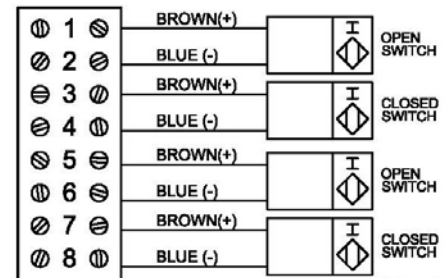
ES-00628-1 R2

Switch Option 42/44

SUPPLY VOLTAGE	10-30 VDC
LOAD CURRENT (IL)	100 mA max.
LEAKAGE CURRENT (OFFSTATE)	0.05 mA typ., 0.1 µA at 25°C
OUTPUT	PNP normally open
VOLTAGE DROP AT IL (MAX.)	≤ 3 V
HYSTERESIS	—
SHORT CIRCUIT AND OVERLOAD PROTECTION	Yes
REVERSE POLARITY	Yes
FACE MATERIAL	PBT
STANDARDS	EN 60947-5-2
PROTECTION DEGREE	IP67
AMBIENT TEMPERATURE	-14 °F to +158 °F (-25.6 °C to +70 °C)



54 Wiring Diagram

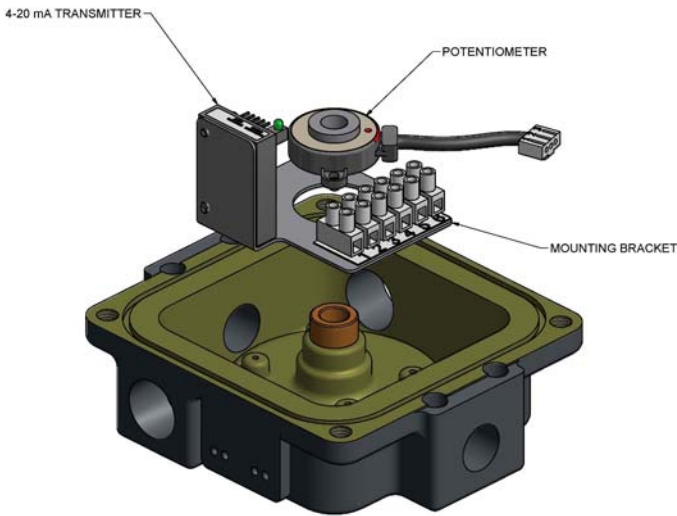
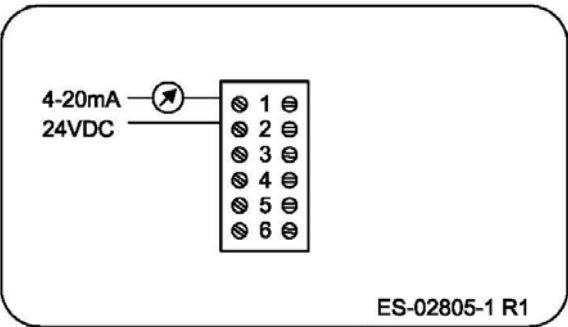


Switch Option 52/54

SUPPLY VOLTAGE	5-60 VDC
LOAD CURRENT (IL)	100 mA max.
LEAKAGE CURRENT (OFFSTATE)	0.05 mA typ., 0.1 µA at 25°C
OUTPUT	2 Wire DC normally open
VOLTAGE DROP AT IL (MAX.)	≤ 5 VDC
HYSTERESIS	Typ. 0.2mm
SHORT CIRCUIT AND OVERLOAD PROTECTION	No
REVERSE POLARITY	Yes
FACE MATERIAL	Crastin
STANDARDS	IEC / EN 60947-5-2:2004
ENVIRONMENTAL PROTECTION	IP67
AMBIENT TEMPERATURE	-14°F to +185°F (-25.6 °C to +85 °C)

Switch Option 0X: 4-20mA Position Transmitter

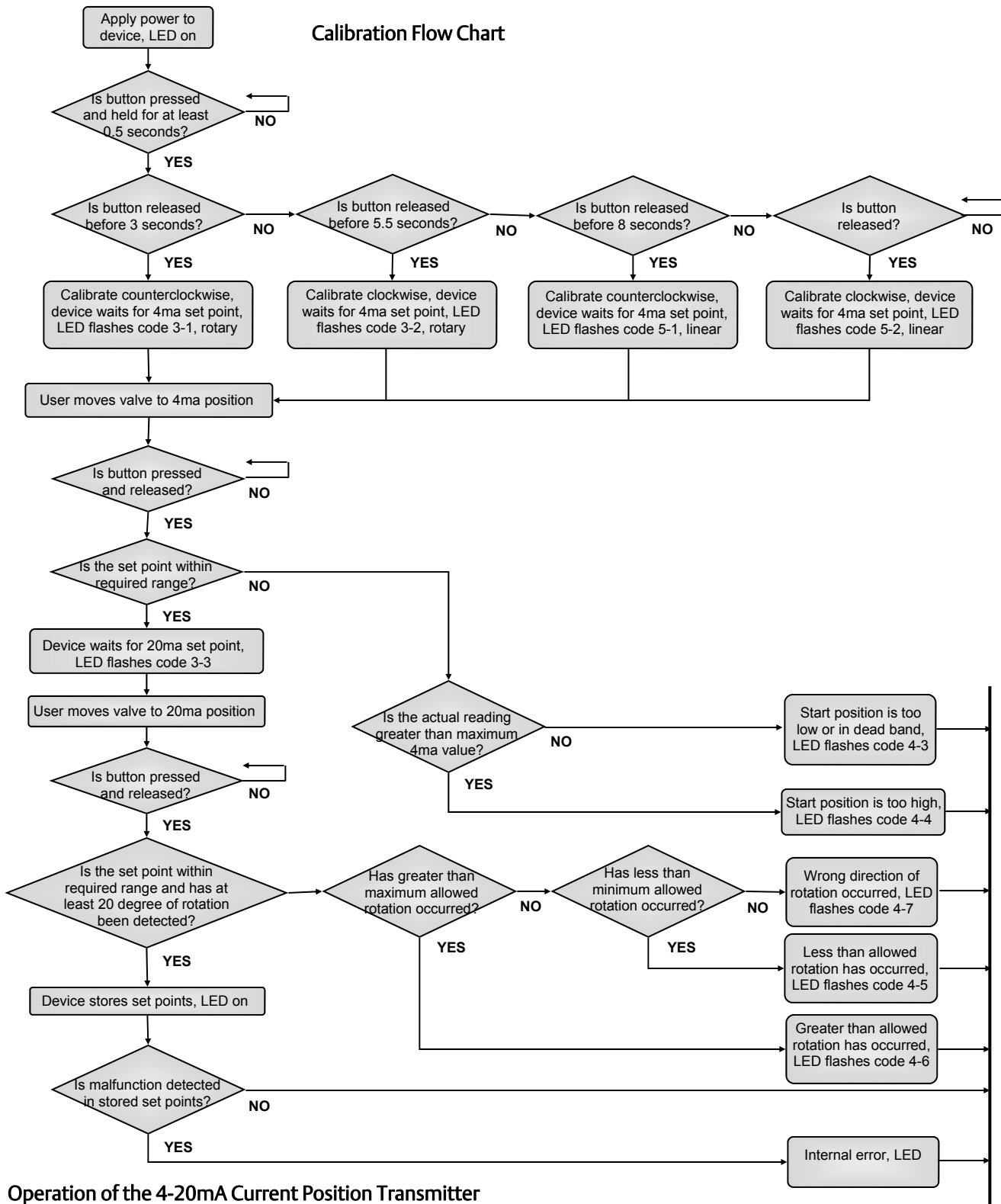
Wiring Diagram



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
Primary Usage	The 2-wire 4-20mA transmitter will generate a nominal 4 – 20mA output for full-range actuation of the valve. The generating signals below 4mA and above 20mA if the position sensor indicates an out of range value.
Rotation	Any rotation range between 20 and 320 degrees. Factory set for 20 to 180 degree operation in counter clockwise rotation to open and 20 to 90 degree operation in clockwise rotation to open applications.
Modes	Optional linear and rotary modes
Linearity	+/- 1%*
Repeatability	0.3%*
Hysteresis	0.5%*
Temperature	-40 to 85C

*Indicated linearity, repeatability and hysteresis is for the device only. Installed specifications will depend on the total mechanical and electrical system's capability.

Switch Option 0X: 4-20mA Position Transmitter



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. In rotary mode, 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 exceeds 3% of over travel then values below 4mA or above 20mA will be output. The other user-selectable option is to calibrate the device without the over and under travel capability (Linear Mode.) See the calibration flow chart in this document for additional information.

Switch Option 0X: 4-20mA Position Transmitter

Troubleshooting Error Code and Problem Table

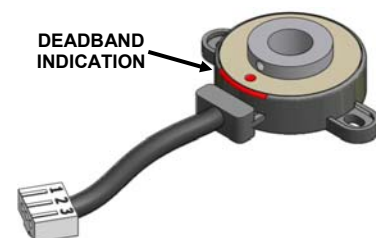
Problem	Probable Cause/Solution
Transmitter Module has no current output	If the LED on the Transmitter Module is not lit <ul style="list-style-type: none"> - Loose or shorted signal connection (fix connection) - Controller Board not responding (Replace Transmitter Module) If the LED on the Circuit Board is lit <ul style="list-style-type: none"> - 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 <ul style="list-style-type: none"> - 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 20°, increase valve rotation between start and stop positions to greater than 20°.
Error Code 4-6	Rotation has exceeded the 320° limit. Decrease valve rotation between start and stop positions to less than 320°.
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

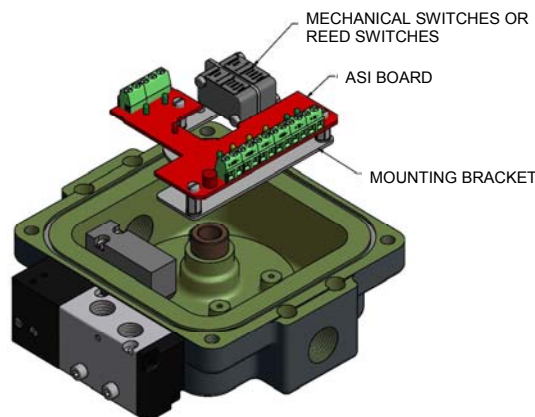
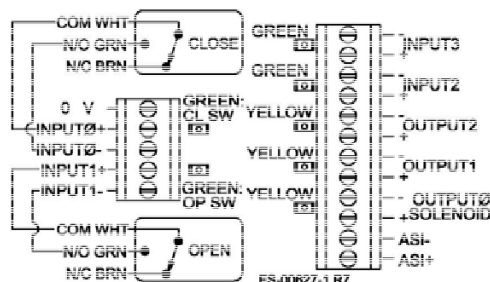


During calibration, make sure the potentiometer is not rotating through its deadband area. The red dot located on the potentiometer should not rotate through the area marked with red during the full rotation of the valve. If it does, reposition the shaft.



Bus Option AS/AM: AS-i protocol

Wiring Diagram



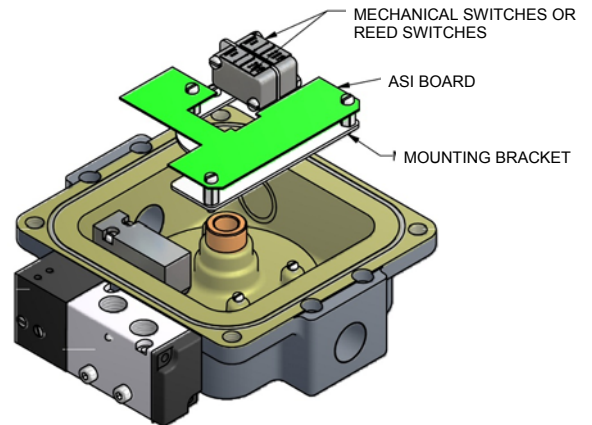
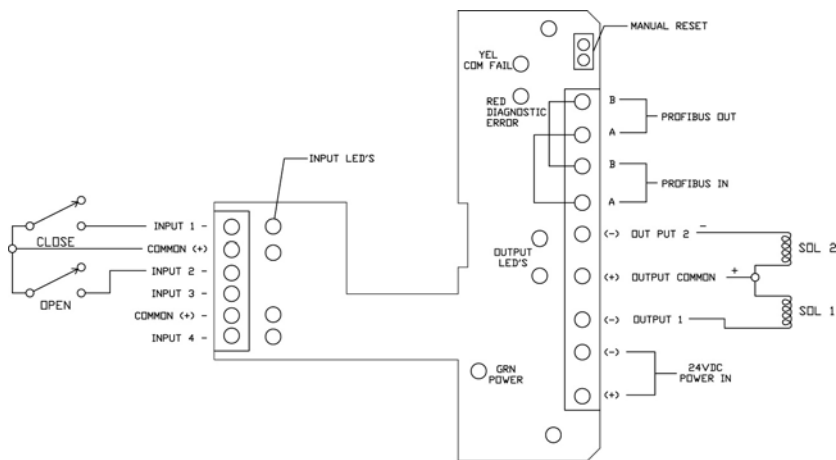
Openness	800+ products, 150 Vendors
Type of Network	Sensor Bus
Physical Media	2-wire cable (flat or round)
Network Topology	Bus, Ring, Tree, Star
Maximum Devices	
v2.0	31 nodes (or 248 I/O points)
v2.1	62 nodes (or 434 I/O points)
Maximum Distance	
Maximum Distance	100 meters
Maximum Distance with repeaters (max. of 2 repeaters can be used)	300 meters
Communication Methods	
Transmission Properties	5 mSec latency max. on fully loaded segment
Primary usage	<ul style="list-style-type: none"> • Master/Slave with cyclic polling • Manchester Bit Encoding implemented via Alternating Pulse Modulation (APM)
v2.0	Discrete Signals
v2.1	Discrete Signals (supports 12 bit analog signals accessed over 5 cycles)
Power & Communications on same pair	<ul style="list-style-type: none"> • Limited to 200mA per device power consumption • Requires AS-i specific power supply on communications bus for de-coupling
Device Power Supply	<ul style="list-style-type: none"> • Devices can be supplied from bus (<200mA) • 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

AS-I Bit-Settings

Data bit	Bit	Function	Input	Output
	D0	Input I1 / Output O1	Closed limit Red	Solenoid switch 1
	D1	Input I2 / Output O2	Open Limit Green	Solenoid switch 2
	D2	Input I3 / Output O3	N/A	Solenoid switch 3
	D3	Input I4	Fault signal (optional)	N/A
Parameter bit	Bit	Function	Configuration Code	
	P0	not used	Extended ID code 1	7
	P1	not used	IO code	7
	P2	not used	Extended ID code 2	E
	P3	not used	Parameter	8
	Watchdog	on	ID code	A

Bus Option PB/PM: Profibus Protocol

PB/PM Wiring Diagram



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
Max Distance with repeater (max. of 9 repeaters can be used)	9,500 meters with repeaters
Communication Methods	Peer-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 and 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 maximum 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)
Web Site	www.profibus.com

(Continued next page.)

Switch Option PB/PM: Profibus Protocol (Continued)
 Technical Data

Power requirements	
PROFIDP 4I20 V1.2	24VDC +- 10% Max I = 530mA (solenoid/s activated) Idle I = 24mA

Line Parameters	Line Type A	Line Type B
Impedance	135 to 165	100 to 130
Capacitance per unit length (pF / m)	<30	<60
Loop resistance (Ω / km)	110	---
Core Diameter (mm)	0.64	>0.53
Core cross section (mm2)	>0.34	>0.22

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

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

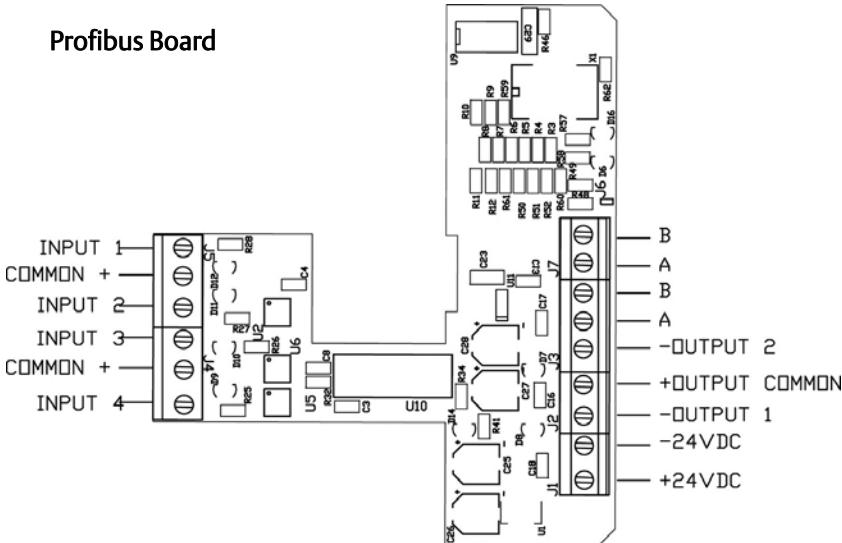
Software Parameters

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	

INPUT 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

Profibus Board

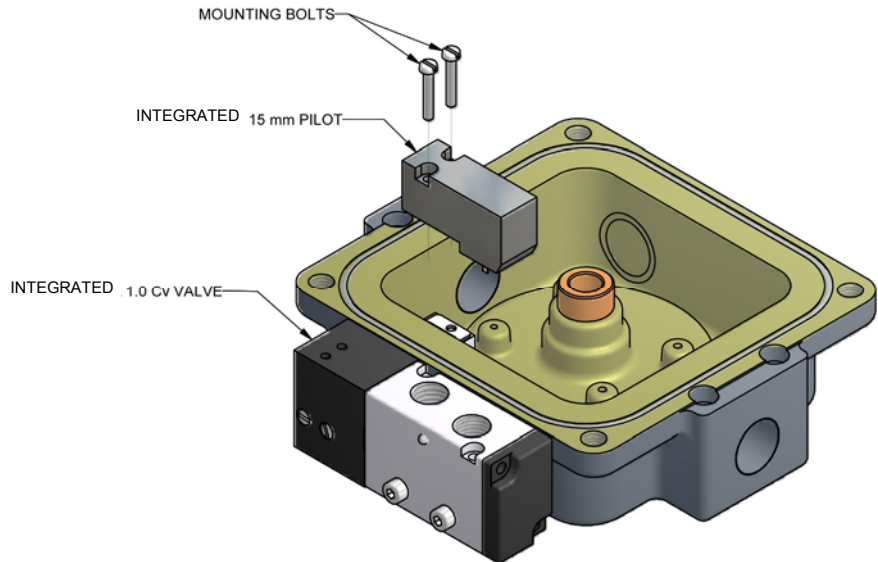


Integrated Pneumatic Pilots

The 15 mm pilot valve has been designed and developed by TopWorx™ as a logical evolution of the traditional product range manufactured for the pneumatic market. The 15 mm solenoid valve is designed for those applications, more and more common on the actual market, where besides high performances in terms of pressure and flow, minimum dimension, very low power consumption and high reliability even at high cycling rates are specified.

All the 15mm pilot valves feature:

- Heat-resistant bobbin molded with 30% glass-filled polyester (PBT)
- Class H 200°C copper wire according to IEC 317-8
- Encapsulation with specially designed, high-quality, glass-filled polyamide (PA66)
- Stainless steel guiding tube
- Plunger and core made of magnetic stainless steel specially designed for solenoid applications



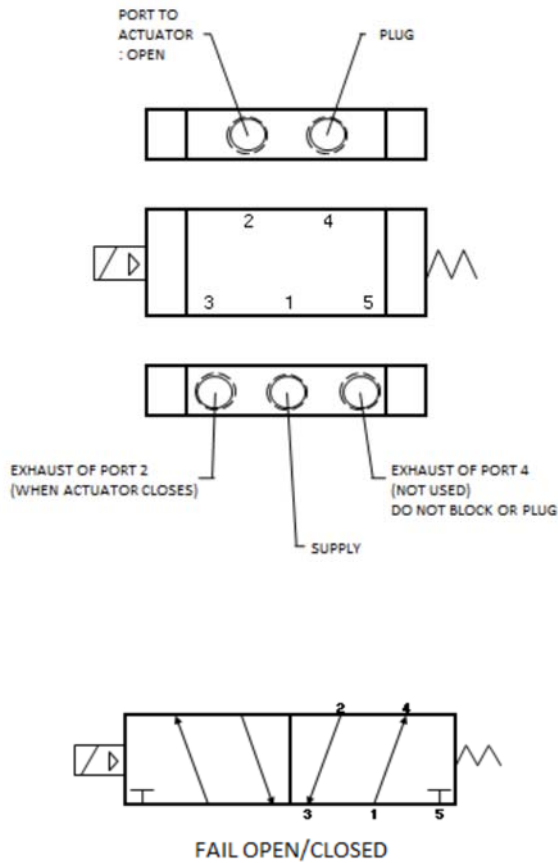
Contact factory for technical pilot valve information

Integrated Pneumatic Control Valve Hookup Procedures

Prior to connecting the supply air to the spool valve, flush the system to remove any debris or contaminants. 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.

2-Way Spool Valves

The TopWorx™ open/closed spool valve is a 5 port, 2-way valve driven by an internally mounted pilot valve. The spool valve supply port and work ports are marked as follows:



Highly Recommended

TopWorx™ highly recommends Loctite 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-M30) should be installed in the exhaust ports, when NPT threads are used, to keep debris from falling into the spool valve and damaging the seals. This must be addressed prior to installation, or storage.

A flow control may be used in Port 3, but should NEVER BE USED in Port 5. Any blockage or restriction may cause an internal pressure build-up inside the enclosure and pose a safety issue.

Spool Valve Specifications	
Medium	Dried, filtered air (40 micron)
Max Operating Pressure	100psi (0.7 MPa) (6.89Bar)
Min. Operating Pressure	30psi (0.21 MPa) (2.06Bar)
Ambient Temperature Range	Refer to Product Nameplate Marking
Flow Coefficient	1.0Cv
Protection Degree	Type 4, 4X, IP67
Port Size	1/4" NPT or BSP for 1.0Cv valve
Valve Body	Available in Hardcoat Anodized Aluminum TF061 or 304 Stainless Steel or 316 Stainless Steel
Valve Seals	Buna-N/EPDM

Maintenance

No maintenance is required. The bearing's internal diameter should be checked after 1 million cycles for wear. Require dimension should be between 10.00 to 10.05mm. In the event of wear, return the unit to the manufacturer for replacement. Switch setting can be checked periodically.

Aggressive substances: e.g. acidic liquids or gases that may attack metals or solvents that may affect polymeric materials. If the equipment is likely to come into contact with aggressive substances, then it is the responsibility of the user to take suitable precautions that prevent it from being adversely affected, thus ensuring that the type of protection provided by the equipment is not compromised.

Suitable precautions: e.g. regular checks as part of routine inspections or establishing from the material's datasheets that it is resistant to specific chemicals. If in doubt, contact TopWorx™ for assistance.

Area Classifications

Explosion Proof Protection Method

Explosion proof protection is accomplished by using long flange and bearing surfaces with small clearances that do not allow flames from explosions to escape the enclosure. In the event that the flange surface or bearing areas become damaged, the protection method will fail and allow potentially explosive vapor to ignite. Gaps between flanged surfaces, once torqued, should not exceed .0015" [.038mm].

Intrinsically Safe Protection Method

For installation parameters, refer to the product nameplate.

Non-Incendive Protection Method

Non incendive units are designed with circuitry in which any arc or thermal effect produced, under intended operating conditions of the equipment, is not capable of igniting the flammable gas, vapor or dust-air mixtures.

Certifications & Approvals

TopWorx™ is proud to be certified for use in the following markets:



ATEX – European Union



IEC – Europe and other World Areas, including Australia & New Zealand



US and Canada



Brazil



Russia



China

PESO

India



Korea

TopWorx™ products carry a wide range of certification markings:

Class I, Div 1 – Intrinsically Safe and Explosion-proof

Class I, Div 2 – Non-incendive

Class III – Dust Ignition Proof

Ex ia IIC – Zone0/Zone1 – Intrinsically Safe

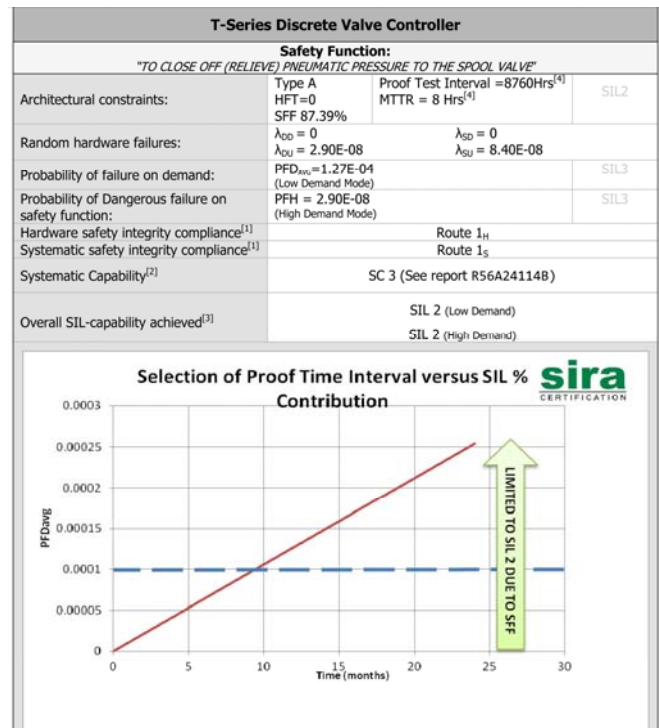
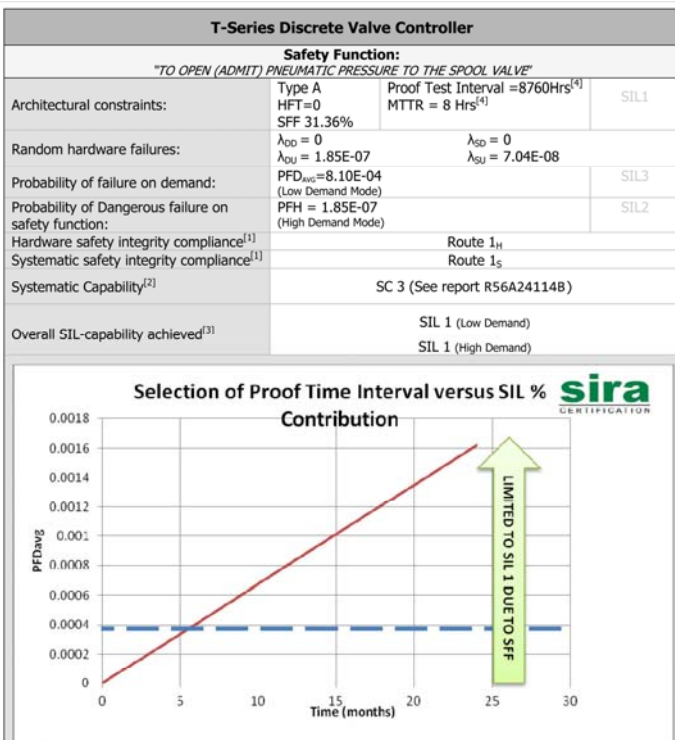
Ex d IIC & IIB+H2 – Zone1 – Flameproof

Ex nAnC IIC – Zone2 – Non-arcing/Non-sparking

Consult factory for copies of our certifications, which will include all product specifications such as ambient temperature ranges, gas/dust group coverage, intrinsic safety parameters and special conditions for safe use.

Proof Testing

Sira Test & certification Ltd has conducted a Failure Mode, Effect and Diagnostic Analysis (FMEDA) of the T-Series Discrete Valve Controller against the requirements of IEC61508-2. The SIL ratings described below are only applicable to products manufactured in the U.S.A.



^[1] These are new parameters used in IEC61508 Part 2 Sections 7.4.2 & 7.4.4.

^[2] This is a new measurable scale for the systematic safety integrity level; refer to IEC61508 Part 4 Section 3.5.9.

^[3] This is determined by the lowest SIL indicated by each of the parameters given above.

^[4] These figures are used only for demonstration purposes.

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^[3] This is determined by the lowest SIL indicated by each of the parameters given above.

^[4] These figures are used only for demonstration purposes.

T-Series Safety Functions

The safety functions of the T-Series Discrete Valve Controller are defined as:

- To relieve pneumatic pressure to the spool valve by de-energizing the solenoid valve allowing the actuator to perform its safety function.
- To admit pneumatic pressure to the spool valve by energizing the solenoid valve allowing the actuator to perform its safety function.

The actuator and valve may be configured to fail safe in a normally open (N/O) or normally closed (N/C) configuration depending on the process under control. The T-Series Discrete Valve Controller requires an air supply in some form which must be assessed by the end user to ensure the required SIL is achieved. E.g. If the T-Series Discrete Valve Controller is configured with the safety function to admit pneumatic pressure to the actuator in order for it to revert to its fail safe state then a failure of the air supply will be dangerous failure (see Tables on pages 29 and 30).

Hardware Functional Description

The T-Series Discrete Valve Controller implements the safety functions as a sub-system as defined according to IEC 61508-2 clause 7.4.2.11 Note 1. Furthermore, with reference to IEC 61508-2 clause 7.4.4.1.2/3, the full assembly can be classified as a "Type A" sub-system. A complete functional block diagram of the T-Series Discrete Valve Controller can be shown in the Tables on pages 29 and 30.

No fault (normal) conditions

- a) Under normal operating conditions the T-Series Discrete Valve Controller will maintain the Normally Open (N/O actuator / valve in the closed position or the Normally Closed (N/C) actuator / valve in the open position.
- b) The bus networking device may relay valve positional data to the operator during normal operating conditions but this device is not responsible for implementing the safety function.

Self diagnosed fault conditions

The T-Series Discrete Valve Controller does not have any online fault diagnostics, however if the T-Series Discrete Valve Controller develops a fault which reverts the valve to its fail safe state then the sensor module will acknowledge this change in the valve position through the integrated shaft which is coupled to the valve. The bus networking device can then notify the operator of a valve position change without being requested. This kind of failure is a safe detectable failure (λ_{SD}) and is considered as such in the FMEDA. If the T-Series Discrete Valve Controller develop a fault which latches the valve in its current, potentially dangerous, state then this form of failure will only be acknowledged during proof test, PVST or when a demand is placed on the element. The bus networking device can only notify the operator of no valve movement after failure event has occurred and therefore this kind of failure is a dangerous undetectable failure (λ_{DD}) and is considered as such in the FMEDA.

The utilization of the PVST by the T-Series Discrete Valve Controller will reveal any covert undetected dangerous failures and therefore increase the availability of the device. The use of PVST as a diagnostic tool will enable the following actions:

- Detect the valve position
- Detect valve movement
- Measure the time to travel from open to partial stroke position

It should be realized that the electronics in the T-Series Discrete Valve Controller are performing positional feedback to the PLC and operator which is not considered online diagnostics. Diagnostic coverage is assessed in the FMEDA according to utilizing PVST to reveal covert undetected dangerous failures. This diagnostic coverage is only applicable at the point of PVST and not for normal operations.

Please visit our website to download a copy of the Sira Functional Safety Assessment Report for the T-Series Discrete Valve Controller at <http://www.topworx.com/downloads/data.html>.

Safe Use

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 in type of explosion protection 'd', 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 7bar.

Preventative Maintenance

The TopWorx™ products are 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.

Special Conditions of Safe Use (Flameproof Installations)

- The slotted hexagonal head cover screws are not of standard form; they shall only be replaced with identical screws sourced from the equipment manufacturer.
- The hexagonal head cover screws are to be replaced only with stainless steel 304, grade A2-70, or 316 grade A4-80 to ISO 35061.
- Cover fasteners are to be tightened to a torque value of 10.85Nm (8 ft/lbs) minimum.

Special Conditions For Safe Use (Intrinsic Safety)

- The 4-20mA loop circuit and the various additional sub-assemblies (switches, sensors, valves, etc.) shall be treated as separate intrinsically safe circuits.
- The entity parameters for simple switches that are not covered by a certificate are $U_i = 30\text{ V}$, $I_i = 200\text{ mA}$ and $P_i = 0.72\text{ W/switch (T4)}$ or $P_i = 0.34\text{ W/switch (T6)}$. The entity parameters of certified devices fitted shall be obtained from the applicable certificate.

Recommended Operating Temperatures

No Approvals (TXP/TXS)			
Option	Switch Description	Switchbox (NO Integrated Solenoid)	Switchbox (WITH Integrated Solenoid)
L	35 GO™ Switch SPDT	-60 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
P	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
AS	Asi	-40 to +80°C	Consult Factory
PB	Profibus	-40 to +80°C	Consult Factory

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