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

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**Expertise & Innovation To Deliver Proven Results**

Emerson™ is the automation innovator with the depth of expertise and breath of technologies to take on our customers’ toughest challenges and bring predictable success anytime, anywhere.
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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 position 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) improves the SIL (Safety Integrity Level) that the system can achieve through a reduction in the PFD avg (Average Probability of Failure On Demand). 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 included 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 calibration, 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

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<td>0.25A@24VDC w/5V drop 0.25A@120VAC w/5V drop</td>
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<td>800mA@24VDC MAX 250mA@125VAC MAX</td>
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### Suggested Calibration Set-Up:

```
24VDC(+) ← LOAD → COM
24VDC(-) ← NO → 200(4W) to 2500(1/2W)Ohms
```
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 otherwise 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. Notice that the indicator dome has been rotated 90° compared to the unit above.

**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 nameplate will supersede this storage temperature range.

**Mounting Assembly**

**Installation Notes**

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

1. 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.

2. 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.

3. 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.**

4. **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.**
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 internally mounted pilot. The spool valve supply port and work ports are marked as follows:

Highly Recommended
TopWorx™ highly recommends Loclrite 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.

Spool Valve Assembly

* For Explosionproof “1” approval, TopWorx recommends 80 PSI Max Operating Pressure.
Spool Valves and Pilots

SINGLE PILOT ASSEMBLY

- M3 x 16 CHEESE HEAD SCREW
  TORQUE TO 20 IN-oz
- PILOT
  ASCO 302
  MINI PIEZO
  AMISCO 110 VAC
  AMISCO 220 VAC
- SEAL AND PLATE
  (NOT USED WITH MINI PIEZO)
- MANIFOLD
- 10-32 METAL BARB FITTING
  TORQUE TO 60 IN-oz
- 10-32 METAL PLUG
- RED URETHANE TUBING (SUPPLY)
- 10-32 METAL BARB FITTING
  TORQUE TO 60 IN-oz
- ORIFICE TO BE USED IN
  EXPLOSION PROOF APPLICATIONS
- 4-40 x .25" SEM SCREW
  TORQUE TO 100 IN-oz
- BRACKET
- YELLOW URETHANE TUBING (WORK)

DUAL PILOT ASSEMBLY

- M3 x 16 CHEESE HEAD SCREW
  TORQUE TO 20 IN-oz
- PILOT
  ASCO 302
  MINI PIEZO
  AMISCO 110 VAC
  AMISCO 220 VAC
- SEAL AND PLATE
  (NOT USED WITH MINI PIEZO)
- MANIFOLD
- 10-32 METAL BARGED FITTING
  TORQUE TO 60 IN-oz
- Y BARBED KYNAR FITTING
- RED URETHANE TUBING (SUPPLY)
- ORIFICE TO BE USED IN
  EXPLOSION PROOF APPLICATIONS
- 4-40 x .25" SEM SCREW
  TORQUE TO 100 IN-oz
- BRACKET
- YELLOW URETHANE TUBING (WORK)
ESD CONVENTIONAL INSTRUCTION AND OPERATION—Fail Closed Valves

**Operation:** Before operation, the ESD must be calibrated (see Calibration below). After calibration, a Partial Stroke Test (PST) may be performed (see Partial Stroke Test below). The partial stroke time tolerance range can be selected as 20%, 30% or 40% (see Partial Stroke Time Tolerance Range Selection below). A single switch (on board and external) is used to perform the calibration, the partial stroke test and the tolerance range selection. These operations can be initiated from the control room with no need to shut down the entire plant. Non-volatile memory stores the calibration value and the selected tolerance range value allowing for retention, even in the event of loss of power. The LED, both onboard and in the control room, flashes unique visual indicators to signal pass/fail of tests and possible maintenance issues (please see ESD Conventional Flow Chart and Message Table for ESD Conventional for more details).

*Note that the following instructions assume the valve is FAIL CLOSED and the direction of travel from CLOSED to OPEN is CCW.*

### Wiring Connections:

1. **Terminals 1 and 4:** External power source for switching the internal solenoid valve. Type and voltage level must match type of solenoid selected. Typical is 24VDC.
2. **Terminals 2 and 3:** Pre-wired to the internal solenoid valve. Do not change these connections.
3. **Terminals 5 and 6:** Power for electronics module. 5 MUST be +24VDC and 6 MUST be −24VDC. **You can jumper the power from terminals 1 and 4 where a separate 24VDC supply is not available.**
4. **Terminals 7 and 8:** Connection to external calibration and partial stroke test button (if installed). Can be used to remotely trigger PST and Calibration from a DCS.
5. **Terminals 9 and 11:** Source and return for valve position 1 limit switch. Typically connected to DCS for limit switch sensing. **For bench calibration or use in applications where alternate means of sensing valve position are used, these 2 terminals must still be provided with source and return. The source and return for the electronics module power can be used, but a 2500 Ohm, 1/2W resistor MUST be installed between terminals 6 and 11 to prevent damage to the limit switch contacts from excess current.**
6. **Terminals 10 & 13:** N/C side of Position 1 and 2 limit switch. If the system this unit is implemented on is monitoring the N/C side of the switches, a 2500 ohm, 1/2W resistor will need to wired between terminals 10 and 6, as well terminal 13 and 6 for visual indication. **If the system is monitoring the N/O side, neither of these terminals are used.**
7. **Terminals 12 and 14:** Source and return for valve position 2 limit switch. Typically connected to DCS for limit switch sensing. **For bench calibration or use in applications where alternate means of sensing valve position are used, these 2 terminals must still be provided with source and return. The source and return for the electronics module power can be used, but a 2500 Ohm, 1/2W resistor MUST be installed between terminals 6 and 14 to prevent damage to the limit switch contacts from excess current.**
8. **Terminals 15 and 16:** Pre-wired to the GO™ Switch. Do not change these connections.
9. **Terminals 17, 18 and 19:** External PST status signals:
   - **Terminal 17:** PST status signal. In combination with terminal 18, it forms a dry contact that closes if the PST passes.
   - **Terminal 18:** 24VDC source terminal for diagnostics and status output signal. Wire this to DCS 24VDC output.
   - **Terminal 19:** PST diagnostic signal. When wired to a DCS DC I/O input, will deliver a pulse train after PST completes to report any diagnostic information.
Partial Stroke Time Tolerance Range Selection:

1. The default partial stroke time tolerance range is set to 20%. This value can be selected as 20%, 30% or 40% anytime. The value will be recorded in the EEPROM (memory) of the micro controller.
2. Press and hold the push button for ten to fifteen seconds to set the partial stroke time tolerance range to 20%. If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-1.
3. Press and hold the push button for within fifteen to twenty seconds to set the partial stroke time tolerance range to 30%. If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-2.
4. Press and hold the push button for more than twenty seconds to set the partial stroke time tolerance range to 40%. If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-3.
5. If there is a writing value to memory failure, the LED and diagnostic relay will flash message code 6-6. The Pass/Fail relay will be turned OFF.

Hardware Configuration:

1. Ensure that the valve is in the OPEN position (the green LED should be illuminated.)
2. Refer to Fig. X which shows the correct orientation of the GO™ Switch target and sensor cams for FAIL CLOSED valves.
3. If the unit conforms to this configuration, you may proceed to calibration. If not, complete Hardware Configuration steps 4-7.
4. Lift the target wheel and rotate it such that the magnet is counterclockwise from the GO™ Switch.
5. Loosen and slide the magnet in the target wheel so as to position it approximately one inch from the edge of the GO™ Switch. Tighten to 20 in-oz.
6. Lift up on the upper cam and rotate it such that it is squarely aligned to the front of the electronics module. The green light on the module should come on.
7. Press down on the lower cam and rotate it such that it is 90º counter clockwise from the electronics module.

Calibration:

1. Before performing calibration, make certain the valve is fully open (the green LED should be illuminated,) and the target button is set to the proper partial position. *NOTE: If the valve is not fully open, the test will abort and the LED and diagnostic relay will flash message code 7-7 indicating that the valve is not fully open. The Pass/Fail relay will be turned OFF.*
2. Press and hold the calibration button on board for five to ten seconds.
3. The activation relay will be turned ON to initiate valve closing.
4. The valve will move until the GO™ Switch detects the partial stroke position.
5. The GO™ Switch will send feedback indicating that the pre-determined position is reached.
6. The time required to move the valve from the “fully open position” to the “partially open position” is the partial stroke time of the valve. The acceptable time ranges are from fifty milliseconds to thirty seconds. This “partial stroke calibration time” will be recorded in the EEPROM (memory) of the micro controller. EEPROM will retain the value until your next calibration.
7. If the calibration is successful, the Pass/Fail relay will be turned ON and both the LED and diagnostic relay will flash message code 3-3.
8. After the LED flashes code for three times, both the LED and diagnostic relay will be steady, signifying that the calibration is complete. Reset of the flashing LED and the diagnostic relay may be performed at anytime while the LED is flashing by pressing the calibration button.
Partial Stroke Test:

1. Before performing the Partial Stroke Test (PST), make certain the valve is fully open.
   * NOTE: If the valve is not fully open, the test will abort and the LED and diagnostic relay will flash message code 7-7 indicating that the valve is not fully open. The Pass/Fail relay will be turned OFF.

2. If using the onboard module calibration button, press the button and hold it for more than half a second and less than five seconds. If using the optional external PST button, push firmly once.

3. The activation relay will be turned ON to initiate valve closing.

4. The valve will move until the GO™ Switch detects the partial stroke position.

5. The time required to move the valve to the partial stroke position will be compared against the “partial stroke calibration time” value stored in EEPROM (memory). The acceptable time ranges from ‘(1-tolerance range value) x partial stroke calibration time’ to ‘(1+tolerance range value) x partial stroke calibration time’. For example, if the partial stroke calibration time is 6 seconds and the tolerance range value is 20%, the acceptable PST time ranges are from 4.8 to 7.2 seconds.

6. If the time required for moving the valve to the Partial Stroke position is outside the acceptable range of the “partial stroke calibration time”, the test will be aborted, indicating valve failure. The Pass/Fail relay will remain OFF and both the LED and diagnostic relay will flash message code 5-5 if the valve has moved. If the valve has not moved, the Pass/Fail relay will remain OFF and both the LED and diagnostic relay will flash code 4-4. CAUTION: Before recalibration, make sure failure type is (see Message Table for ESD Conventional).

7. If the time required is within the acceptable range, the Pass/Fail relay will be turned ON and both the LED and Diagnostic Relay will flash message code 2-2.

8. After the LED flashes code for three times, both the LED and diagnostic relay will be steady, signifying that the Partial Stroke Test is complete.

*Note: Partial Stroke Time Tolerance Range Selection, Calibration or Partial Stroke Test cannot be performed when the LED is flashing. Before re-running the test, please wait for the LED to become steady or clear it by pressing the button.
ESD Calibration/PST Flow Chart—Fail Closed Valves

Apply power

Is memory ok?

No

LED displays memory error

continuous fast flashing
Pass/fail relay state 0

Is device calibrated?

No

Is button pressed and held for

at least 0.5 seconds?

Yes

Begin partial stroke calibration

Set partial stroke time
tolerance range to 20%

Valve opens

Valve opens

Is valve fully open?

Yes

Write uncalibrated status to memory

Is valve fully open?

No

Is button released before

5 seconds?

No

Is stored calibrated value for partial stroke time
within range?

Yes

Valve closes

Is partial stroke position reached?

Yes

Is minimum allowed time (50ms) passed?

No

Valve opens

LED displays partial stroke test complete code 2-2
for all tolerance range
Pass/fail relay state 1

LED displays valve is not calibrated code 1-1
Pass/fail relay state 0

LED displays valve is not
calibrated code 3-3
Pass/fail relay state 0

LED displays

valve closing time failure code 6-6
Pass/fail relay state 0

LED displays

valve has not moved code 4-4
Pass/fail relay state 0

LED displays

valve closing time failure code 7-7
Pass/fail relay state 0

LED displays

valve is not fully open code 5-5
Pass/fail relay state 0

LED displays

writing error code 6-6 Pass/fail relay state 0

Yes

LED displays writing error code 5-5 Pass/fail relay state 0

LED displays range set to 20% complete code 5-1

LED displays range set to 30% complete code 5-2

LED displays range set to 40% complete code 5-3

Is button released?

No

Yes

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Yes

Valve opens

Is button pressed and held for

at least 0.5 seconds?

Yes

Begin partial stroke test

Set partial stroke time
tolerance range to 40%

Is valve fully open?

Yes

Set partial stroke time
tolerance range to 30%

Is valve fully open?

No

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Is button released before

5 seconds?

No

Is device calibrated?

No

Yes

Is device calibrated?

Yes

Is button pressed and held for

at least 0.5 seconds?

Yes

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Yes

Is button released before

5 seconds?

No

Is device calibrated?

No

Yes

Is device calibrated?

Yes

Is stored calibrated value for partial stroke time
within range?

Yes

Valve closes

Is partial stroke position reached?

Yes

Is minimum allowed time (50ms) passed?

No

Valve opens

LED displays valve has not moved code 4-4
Pass/fail relay state 0

LED displays

valve closing time failure code 6-6
Pass/fail relay state 0

LED displays

valve is not fully open code 5-5
Pass/fail relay state 0

LED displays

writing error code 6-6 Pass/fail relay state 0

Yes

LED displays

valve is not calibrated code 1-1
Pass/fail relay state 0

LED displays

calibration complete code 3-3
Pass/fail relay state 0

LED displays

range set to 20% complete code 5-1

LED displays range set to 30% complete code 5-2

LED displays range set to 40% complete code 5-3

Is button released?

No

Yes

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Is button released before

5 seconds?

No

Is device calibrated?

No

Yes

Is device calibrated?

Yes

Is stored calibrated value for partial stroke time
within range?

Yes

Valve closes

Is partial stroke position reached?

Yes

Is minimum allowed time (50ms) passed?

No

Valve opens

LED displays valve has not moved code 4-4
Pass/fail relay state 0

LED displays

valve closing time failure code 6-6
Pass/fail relay state 0

LED displays

valve is not fully open code 5-5
Pass/fail relay state 0

LED displays

writing error code 6-6 Pass/fail relay state 0

Yes

LED displays

valve is not calibrated code 1-1
Pass/fail relay state 0

LED displays

calibration complete code 3-3
Pass/fail relay state 0

LED displays

range set to 20% complete code 5-1

LED displays range set to 30% complete code 5-2

LED displays range set to 40% complete code 5-3

Is button released?

No

Yes

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Is button released before

5 seconds?

No

Is device calibrated?

No

Yes

Is device calibrated?

Yes

Is stored calibrated value for partial stroke time
within range?

Yes

Valve closes

Is partial stroke position reached?

Yes

Is minimum allowed time (50ms) passed?

No

Valve opens

LED displays valve has not moved code 4-4
Pass/fail relay state 0

LED displays

valve closing time failure code 6-6
Pass/fail relay state 0

LED displays

valve is not fully open code 5-5
Pass/fail relay state 0

LED displays

writing error code 6-6 Pass/fail relay state 0

Yes

LED displays

valve is not calibrated code 1-1
Pass/fail relay state 0

LED displays

calibration complete code 3-3
Pass/fail relay state 0

LED displays

range set to 20% complete code 5-1

LED displays range set to 30% complete code 5-2

LED displays range set to 40% complete code 5-3

Is button released?

No

Yes

Is button released before

10 seconds?

No

Is button released before

15 seconds?

No

Is button released before

20 seconds?

No

Is button released?

No

Is button released before

5 seconds?

No

Is device calibrated?

No

Yes

Is device calibrated?

Yes

Is stored calibrated value for partial stroke time
within range?

Yes

Valve closes

Is partial stroke position reached?

Yes

Is minimum allowed time (50ms) passed?
ESD CONVENTIONAL INSTRUCTION AND OPERATION—Fail Open Valves

Operation:
For operation, the ESD must be calibrated (see Calibration below). After calibration, a partial stroke test may be performed (see Partial Stroke Test below). The partial stroke time tolerance range can be selected as 20%, 30% or 40% (see Partial Stroke Time Tolerance Range Selection below). A single switch (on board and external) is used to perform the calibration, the partial stroke test and the tolerance range selection. These operations can be initiated from the control room with no need to shut down the entire plant. Non-volatile memory stores the calibration value and the selected tolerance range value allowing for retention, even in the event of loss of power. The LED, both onboard and in the control room, flashes unique visual indicators to signal pass/fail of tests and possible maintenance issues (please see ESD Conventional Flow Chart and Message Table for ESD Conventional on pg.#15 for more details).

*Note that the following instructions assume the valve is FAIL OPEN and the direction of travel from CLOSED to OPEN is CCW.*

![Diagram of ESD Conventional Instructions and Operation](image)

Fail Open

**Wiring Connections:**
1. Terminals 1 and 4: External power source for switching the internal solenoid valve. Type and voltage level must match type of solenoid selected. Typical is 24VDC.
2. Terminals 2 and 3: Pre-wired to the internal solenoid valve. Do not change these connections.
3. Terminals 5 and 6: Power for electronics module. 5 MUST be +24VDC and 6 MUST be -24VDC. **You can jumper the power from terminals 1 and 4 where a separate 24VDC supply is not available.**
4. Terminals 7 and 8: Connection to external calibration and Partial stroke test button (if installed) can be used to remotely trigger PST and Calibration from a DCS.
5. Terminals 9 and 11: Source and return for valve Position 2 limit switch. Typically connected to DCS for limit switch sensing. **For bench calibration or use in applications where alternate means of sensing valve position are used these 2 terminals must still be provided with source and return.** The source and return for the electronics module power can be used, but a 2500 Ohm, 1/2W resistor MUST be installed between terminals 6 and 11 to prevent damage to the reed switch contacts from excess current.
6. Terminals 10 & 13: N/C side of Position 1 and 2 limit switch. If the system this unit is implemented on is monitoring the N/C side of the switches, a 2500 ohm, 1/2W resistor will need to be wired between terminals 10 and 6, as well terminal 13 and 6 for visual indication. **If the system is monitoring the N/O side, neither of these terminals are used.**
7. Terminals 12 and 14: Source and return for valve Position 1 limit switch. Typically connected to DCS for limit switch sensing. **For bench calibration or use in applications where alternate means of sensing valve position are used these 2 terminals must still be provided with source and return.** The source and return for the electronics module power can be used, but a 2500 Ohm, 1/2W resistor MUST be installed between terminals 6 and 14 to prevent damage to the reed switch contacts from excess current.
8. Terminals 15 and 16: Pre-wired to the GO™ Switch. Do not change these connections.
9. Terminals 17, 18 and 19: External PST status signals:
   A. Terminal 17: PST status signal. In combination with terminal 18, it forms a dry contact that closes if the PST passes.
   B. Terminal 18: Source terminal for status and diagnostic signal output. Should be wired to DCS as source.
   C. Terminal 19: PST diagnostic signal. In combination with terminal 18, delivers a pulse train illustrated on page #16.
Partial Stroke Time Tolerance Range Selection:
1. The default partial stroke time tolerance range is set to 20%. This value can be selected as 20%, 30% or 40% anytime.
   The value will be recorded in the EEPROM (memory) of the micro controller.
2. Press and hold the push button for ten to fifteen seconds to set the partial stroke time tolerance range to 20%.
   If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-1.
3. Press and hold the push button for within fifteen to twenty seconds to set the partial stroke time tolerance range to 30%.
   If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-2.
4. Press and hold the push button for more than twenty seconds to set the partial stroke time tolerance range to 40%. If the value is saved to memory successfully, the LED and diagnostic relay will flash message code 5-3.
5. If there is a writing value to memory failure, the LED and diagnostic relay will flash message code 6-6. The Pass/Fail relay will be turned OFF.

Hardware Configuration:
1. Ensure that the valve is in the CLOSED position (the green LED should be illuminated).
2. Refer to Fig. X which shows the correct orientation of the GO™ Switch target and sensor cams for FAIL OPEN valves.
3. If the unit conforms to this configuration, you may proceed to calibration. If not, complete Hardware Configuration steps 4-7.
4. Lift the target wheel and rotate it such that the magnet is counterclockwise from the GO™ Switch.
5. Loosen and slide the magnet in the target wheel so as to position it approximately one inch from the edge of the GO™ Switch. Tighten to 20in-oz.
6. Lift up on the upper cam and rotate it such that it is squarely aligned to the front of the electronics module. The green light on the module should come on.
7. Press down on the lower cam and rotate it such that it is 90º counter clockwise from the electronics module.

Calibration:
1. Before performing calibration, make certain the valve is fully closed (the green LED should be illuminated,) and the target button is set to the proper partial position. *NOTE: If the valve is not fully closed, the test will abort and the LED and diagnostic relay will flash message code 7-7 indicating that the valve is not fully closed. The Pass/Fail relay will be turned OFF.
2. Press and hold the calibration button on board for five to ten seconds.
3. The activation relay will be turned ON to initiate valve closing.
4. The valve will move until the GO™ Switch detects the partial stroke position.
5. The GO™ Switch will send feedback indicating that the pre-determined position is reached.
6. The time required to move the valve from the “fully closed position” to the “partially closed position” is the partial stroke time of the valve. The acceptable time ranges are from fifty milliseconds to thirty seconds. This “partial stroke calibration time” will be recorded in the EEPROM (memory) of the micro controller. EEPROM will retain the value until your next calibration.
7. If the calibration is successful, the Pass/Fail relay will be turned ON and both the LED and diagnostic relay will flash message code 3-3.
8. After the LED flashes code for three times, both the LED and diagnostic relay will be steady, signifying that the calibration is complete. Reset of the flashing LED and the diagnostic relay may be performed at anytime while the LED is flashing by pressing the calibration button.
Partial Stroke Test:

1. Before performing the Partial Stroke Test (PST), make certain the valve is fully closed.
   "NOTE: If the valve is not fully closed, the test will abort and the LED and diagnostic relay will flash message code 7-7 indicating that the valve is not fully closed. The Pass/Fail relay will be turned OFF.

2. If using the onboard module calibration button, press the button and hold it for more than half a second and less than five seconds. If using the optional external PST button, push firmly once.

3. The activation relay will be turned ON to initiate valve closing.

4. The valve will move until the GO™ Switch detects the partial stroke position.

5. The time required to move the valve to the partial stroke position will be compared against the "partial stroke calibration time" value stored in EEPROM (memory). The acceptable time ranges from "(1-tolerance range value) x partial stroke calibration time" to "(1+tolerance range value) x partial stroke calibration time". For example, if the partial stroke calibration time is 6 seconds and the tolerance range value is 20%, the acceptable PST time ranges are from 4.8 to 7.2 seconds.

6. If the time required for moving the valve to the Partial Stroke position is outside the acceptable range of the "partial stroke calibration time", the test will be aborted, indicating valve failure. The Pass/Fail relay will remain OFF and both the LED and diagnostic relay will flash message code 5-5 if the valve has moved. If the valve has not moved, the Pass/Fail relay will remain OFF and both the LED and diagnostic relay will flash code 4-4. CAUTION: Before recalibration, make sure failure type is addressed (see table pg.#16).

7. If the time required is within the acceptable range, the Pass/Fail relay will be turned ON and both the LED and Diagnostic Relay will flash message code 2-2.

8. After the LED flashes code for three times, both the LED and diagnostic relay will be steady, signifying that the Partial Stroke Test is complete.

*Note: Partial Stroke Time Tolerance Range Selection, Calibration or Partial Stroke Test cannot be performed when the LED is flashing. Before re-running the test, please wait for the LED to become steady or clear it by pressing the button.
Apply power

Is memory ok?

No: LED displays memory error
   continuous fast flashing
   Pass/fail relay state 0

Yes: Is device calibrated?

No: Is button pressed and held for
    at least 0.5 seconds?

Yes: 

Is button released before
   5 seconds?

No: 

Yes: 

Begin partial stroke test

Is valve fully closed?

No: 

Yes: 

Is device calibrated?

No: 

Yes: 

Is stored calibrated value for partial stroke time
    within range?

Yes: 

Is partial stroke position reached?

No: 

Is minimum allowed time (50ms) passed?

No: 

Value closes

Yes: 

Is writing tolerance range value to memory
    successful?

No: 

Yes: 

Is writing status value to memory
    successful?

No: 

Yes: 

Is maximum allowed time (30s) passed?

No: 

Is calibrated time passed?

Yes: 

Valve closes

Yes: 

LED displays writing error code 6-6 Pass/ fail relay state 0

No: 

LED displays range set to 40% complete code 5-3

Is button released before
   10 seconds?

No: 

Yes: 

Begin partial stroke calibration

Set partial stroke time
   tolerance range to 20%

Is valve fully closed?

No: 

Yes: 

Write uncalibrated status to memory

Is writing status value to memory
   successful?

No: 

Yes: 

Is writing tolerance range value to memory
    successful?

No: 

Yes: 

LED displays range set to 30% complete code 5-2

Is button released before
   20 seconds?

No: 

Yes: 

Set partial stroke time
   tolerance range to 30%

Is button released before
   25 seconds?

No: 

Yes: 

LED displays range set to 20% complete code 5-1

Is button released?

No: 

Yes: 

LED displays partial stroke test complete code 2-2
   for all tolerance range Pass/fail relay state 1

Is button released before
   10 seconds?

No: 

Yes: 

Begin partial stroke test

Is valve fully closed?

No: 

Valve closes

Yes: 

Is device calibrated?

No: 

Yes: 

Is button pressed and held for
   at least 0.5 seconds?

Yes: 

Is button released before
   5 seconds?

No: 

Yes: 

Begin partial stroke test

Is valve fully closed?

No: 

Yes: 

Is device calibrated?

No: 

Yes: 

Is stored calibrated value for partial stroke time
    within range?

Yes: 

Is partial stroke position reached?

No: 

Is minimum allowed time (50ms) passed?

No: 

Valve closes

Yes: 

Is writing tolerance range value to memory
    successful?

No: 

Yes: 

LED displays writing error code 6-6 Pass/ fail relay state 0

Is button released before
   10 seconds?

No: 

Yes: 

LED displays range set to 40% complete code 5-3

Is minimum allowed time
   (50ms) passed?

No: 

Yes: 

LED displays writing error code 6-6 Pass/ fail relay state 0

Is maximum allowed time
   (30s) passed?

No: 

Yes: 

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?

No: 

Yes: 

LED displays range set to 30% complete code 5-2

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?

No: 

Yes: 

LED displays range set to 20% complete code 5-1

Is maximum allowed time
   (30s) passed?

No: 

Yes: 

LED displays range set to 30% complete code 5-2

LED displays writing error code 6-6 Pass/ fail relay state 0

Is minimum allowed
   time (50ms) passed?

No: 

Yes: 

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?

No: 

Yes: 

LED displays range set to 20% complete code 5-1

LED displays partial stroke test complete code 3-3 Pass/ fail relay state 1

Is minimum allowed
   time (50ms) passed?

No: 

Yes: 

LED displays range set to 30% complete code 5-2

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?

No: 

Yes: 

LED displays range set to 40% complete code 5-3

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?

No: 

Yes: 

LED displays range set to 20% complete code 5-1

LED displays writing error code 6-6 Pass/ fail relay state 0

Is writing tolerance
   range value to memory
   successful?
### Message Table for ESD Conventional

<table>
<thead>
<tr>
<th>LED Status Flash Code</th>
<th>Diagnostic Relay Message</th>
<th>Problem Cause / Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid ON</td>
<td>Unit operating correctly</td>
<td>No action required</td>
</tr>
<tr>
<td>1 - 1</td>
<td>Device not calibrated</td>
<td>Need to perform the calibration procedure before the partial stroke test</td>
</tr>
<tr>
<td>2 - 2</td>
<td>Partial stroke test passed with-in tolerance range</td>
<td>No action required</td>
</tr>
<tr>
<td>3 - 3</td>
<td>Calibration completed</td>
<td>No action required</td>
</tr>
<tr>
<td>4 - 4</td>
<td>Valve has not moved during partial stroke test</td>
<td>Possible causes include: 1) The valve is stuck 2) The shaft is broken</td>
</tr>
<tr>
<td>5 - 1</td>
<td>Partial stroke time tolerance range is set to 20%</td>
<td>No action required</td>
</tr>
<tr>
<td>5 - 2</td>
<td>Partial stroke time tolerance range is set to 30%</td>
<td>No action required</td>
</tr>
<tr>
<td>5 - 3</td>
<td>Partial stroke time tolerance range is set to 40%</td>
<td>No action required</td>
</tr>
<tr>
<td>5 - 5</td>
<td>Partial stroke test failed</td>
<td>The valve did not reach the partial stroke position within the allotted time. Possible causes include: 1) The valve is stuck or sluggish 2) The GO™ Switch target for the partial stroke position is set incorrectly 3) The shaft is broken</td>
</tr>
<tr>
<td>6 - 6</td>
<td>Module memory error</td>
<td>Contact factory</td>
</tr>
<tr>
<td>7 - 7</td>
<td>Valve is not fully at the required open or closed position</td>
<td>Unit cannot calibrate or run a partial stroke test without the valve starting in the required open or closed position. Check the following: 1) Air supply to actuator 2) Solenoid is powered 3) Cam setting for fail open or fail closed valves as required</td>
</tr>
<tr>
<td>Continuous fast flashing</td>
<td>Hardware failure</td>
<td>Contact factory</td>
</tr>
</tbody>
</table>

### Electrical Ratings

<table>
<thead>
<tr>
<th>Current/Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open/Closed Indication</strong></td>
</tr>
<tr>
<td>0.25A@24VDC w/5V drop</td>
</tr>
<tr>
<td>0.25A@120VAC w/5V drop</td>
</tr>
<tr>
<td><strong>Module Voltage</strong></td>
</tr>
<tr>
<td>18-28VDC</td>
</tr>
<tr>
<td><strong>Module Current</strong></td>
</tr>
<tr>
<td>50mA (MAX)</td>
</tr>
<tr>
<td><strong>Pilot Current (Standard)</strong></td>
</tr>
<tr>
<td>20mA</td>
</tr>
<tr>
<td><strong>PST Feedback Relays</strong></td>
</tr>
<tr>
<td>800mA@24VDC MAX</td>
</tr>
<tr>
<td>250mA@125VAC MAX</td>
</tr>
<tr>
<td><strong>Pilot MAX Valve Rating</strong></td>
</tr>
<tr>
<td>800mA@24VDC MAX</td>
</tr>
<tr>
<td>250mA@125VAC MAX</td>
</tr>
</tbody>
</table>

### Diagnostic Relay and Pass/Fail Relay Outputs:
The diagnostic relay outputs the status flash code as shown in the Message Table Above.

**DIAGNOSTIC RELAY TIMING CHART**

**EXAMPLE OF A 2-2 RESPONSE**

The Pulse Train will repeat 3 times. In order to use this diagnostic relay output, control logic should count the number of positive transitions in order to get the message number. Clear the count register in the logic when you see a logic low (open) for more than one second. The Pulse Train can be reset anytime by activating the Calibration Switch or the PST/Calibration Activation Input.
Suggested Calibration Set-Up:

24VDC(+) → COM

LOAD

24VDC(-) → NO

W

200(4W) to 2500(1/2W)Ohms

**Same for both open indication and closed indication output.**

Pass/Fail Relay:
The Pass/Fail Relay indicates whether the PST passed or failed. In this example the relay is closed (high) from the last successful Partial Stroke Test.

When the Partial stroke test button is pressed for less than 5 seconds the test begins and the Pass/Fail Relay opens (low). The Pass/Fail Relay closes again once the unit passes a Partial Stroke Test.

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 7 bar.

Preventative Maintenance
TopWorx™ 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.

Personal preforming maintenance and testing on the product shall be competent to do so.

Hardware Fault Tolerance: HFT = 0
Device Type: Type A
Systematic Capability: SC3 - SIL3 Capable
Useful Life: 10 years

The proof test procedure should verify the ESD valve controller allows the ESD valve to function 100% on command, and that any failures related to the valve, actuator or partial stroke test function are revealed. The partial stroke test should be preformed monthly.
Dimensions and Materials: TopWorx™ DXP
Cast aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.

<table>
<thead>
<tr>
<th>MATERIALS OF CONSTRUCTION</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enclosure</strong></td>
<td>Cast A360 aluminum with dichromate conversion coating inside &amp; out, epoxy coated exterior rated for 250 hrs. salt spray per ASTM B117</td>
</tr>
<tr>
<td><strong>Fasteners</strong></td>
<td>304 Stainless Steel standard, 316 Stainless Steel optional</td>
</tr>
<tr>
<td><strong>Shaft</strong></td>
<td>304 Stainless Steel standard, 316 Stainless Steel optional</td>
</tr>
<tr>
<td><strong>Shaft Bushing</strong></td>
<td>Oilite Bronze</td>
</tr>
<tr>
<td><strong>Indicator Dome</strong></td>
<td>Polycarbonate, UV F1 rated</td>
</tr>
<tr>
<td><strong>Seals</strong></td>
<td>O-ring seals available in: Buna, Silicone</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fastener Torque Specifications</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enclosure Housing Bolts</strong></td>
<td>8 ft.-lbs [10.8 N·m] +/-10%</td>
</tr>
<tr>
<td><strong>Indicator Dome Screws</strong></td>
<td>320 in.-oz. [2.3 N·m] +/-10%</td>
</tr>
<tr>
<td><strong>Bottom Mounting Holes</strong></td>
<td>10 ft.-lbs [13.6 N·m] +/-10%</td>
</tr>
</tbody>
</table>
Dimensions and Materials: TopWorx™ DXP - Flameproof Ex d IIC
Cast aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.

**MATERIALS OF CONSTRUCTION**

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</tr>
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<td>O-ring seals available in: Buna, Silicone</td>
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**Fastener Torque Specifications**

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<tr>
<td>Bottom Mounting Holes</td>
<td>10 ft.-lbs [13.6 N·m] +/-10%</td>
</tr>
</tbody>
</table>
Dimensions and Materials: TopWorx™ DXS
Cast aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.

**MATERIALS OF CONSTRUCTION**

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>Cast 316 Stainless Steel</td>
</tr>
</tbody>
</table>
| Fasteners       | 304 Stainless Steel standard  
316 Stainless Steel optional |
| Shaft           | 304 Stainless Steel standard  
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**

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<th>Torque Specification</th>
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<tr>
<td>Enclosure Housing Bolts</td>
<td>8 ft.-lbs [10.8 N·m] +/-10%</td>
</tr>
<tr>
<td>Indicator Dome Screws</td>
<td>320 in.-oz. [2.3 N·m] +/-10%</td>
</tr>
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</tr>
</tbody>
</table>
Dimensions and Materials: TopWorx™ DXR
Cast aluminum bracket is recommended for installation with SS 8553 valve in vibrating environment.

### Fastener Torque Specifications

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<tr>
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<th>Fastener Type</th>
<th>Torque Specifications</th>
</tr>
</thead>
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<td></td>
</tr>
<tr>
<td>Indicator Dome Screws</td>
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<td></td>
</tr>
<tr>
<td>Bottom Mounting Holes</td>
<td>8 ft.-lbf [10.8 N·m] +/-10%</td>
<td></td>
</tr>
</tbody>
</table>

### Materials of Construction

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>Valox™ 364</td>
</tr>
<tr>
<td>Fasteners</td>
<td>304 Stainless Steel standard</td>
</tr>
<tr>
<td></td>
<td>316 Stainless Steel optional</td>
</tr>
<tr>
<td>Shaft</td>
<td>304 Stainless Steel standard</td>
</tr>
<tr>
<td></td>
<td>316 Stainless Steel optional</td>
</tr>
<tr>
<td>Shaft Bushing</td>
<td>Delrin™ 500P white</td>
</tr>
<tr>
<td>Indicator Dome</td>
<td>Polycarbonate, UV F1 rated</td>
</tr>
<tr>
<td>Seals</td>
<td>Silicone</td>
</tr>
</tbody>
</table>

MINIMUM 2 1/2” RECOMMENDED CLEARANCE
IN ORDER TO DISENGAGE THE SHAFT FROM THE ID BUSHING AND REMOVE LID WHERE OPTIMUM CONDITIONS APPLY
Interior and Indicator Assemblies

Interior Assembly

ENCLOSURE
DXF TROPICALIZED ALUMINUM
DXS 316 STAINLESS STEEL

TARGET WHEEL
TARGET MAGNET
CAM TARGET
UPPER CAM
LOWER CAM

24 VDC PILOT

MODEL 35 GO SWITCH TO SET PARTIAL STROKE POSITION

VALVE
ANODIZED ALUMINUM
3/16 STAINLESS STEEL
0.86 Cv 1/4" NPT PORTS
3.7 Cv 1/2" NPT PORTS

ESD MODULE CONTAINS (2) REED RELAYS FOR FULL OPEN/CLOSED INDICATION PLUS ESD TIMER CIRCUIT

PAD LOCK PROVIDED BY END USER

OPTIONAL EXTERNAL PUSH PIEZOElectric SWITCH WITH LOCKING SHIELD FOR INITIATING THE PARTIAL STROKE PROCEDURE
Certifications & Approvals

Ex ia IIC T* Gb; Ex tb IIC T* Db
Ex ib IIC T* GB; Ex tb IIC 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.T508.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.T508.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 IIC T* Db
IECEx SIR 09.0086X / Sira 09ATEX3209X (DXR)

Ex nA nC IIC T* Gc; Ex tb IIC 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.
Certificate / Zertifikat
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.

Page 1 of 2
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

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:

<table>
<thead>
<tr>
<th>Model Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXP/S-ESXXXXXXXXXYX</td>
<td>Integrated Solenoid</td>
</tr>
<tr>
<td>DXP/S-ESXXXXXXXXYYZZZ</td>
<td>Integrated Solenoid</td>
</tr>
</tbody>
</table>

IEC 61508 Failure Rates in FIT$^1$

<table>
<thead>
<tr>
<th>Application</th>
<th>$\lambda_{SD}$</th>
<th>$\lambda_{SU}$</th>
<th>$\lambda_{AD}$</th>
<th>$\lambda_{DU}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Acting Actuator</td>
<td>0</td>
<td>284</td>
<td>0</td>
<td>217</td>
</tr>
<tr>
<td>Single Acting Actuator w/PVST$^2$</td>
<td>281</td>
<td>3</td>
<td>201</td>
<td>16</td>
</tr>
</tbody>
</table>

$^1$ 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
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 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 temperature classes T3, T4, 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 applicable 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 10.0bar.

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 10.0 bar.
3. For ambient temperatures above 110°C, 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 value of 10.85Nm (8 ft./lbs) minimum.
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