



## **INSTALLATION, OPERATION & MAINTENANCE MANUAL      IOM1026**

**ELECTRO-HYDRAULIC CONTROL SYSTEMS ON DOUBLE ACTING, QUARTER TURN, AND SPRING RETURN ACTUATORS**



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**Appendices**

## 1 Introduction

### 1.1 Company Background

Automation Technology was founded in 1995 as a manufacturer of pneumatic and hydraulic valve actuators. With products in a wide range of applications such as petrochemical, pipelines, refineries, pulp and paper, agriculture, pharmaceutical, municipalities, mining, power plants and marine transportation, ATI has succeeded in becoming a global leader in valve automation technology.

### 1.2 Scope & Purpose of Manual

This manual is intended to assist those who are involved with the installation, operation and maintenance of the ATI Electro-Hydraulic Control Systems on Double Acting, Quarter Turn, and Spring Return Actuators. This manual should be reviewed and thoroughly understood PRIOR to installing, operating or providing maintenance on the device. Refer to separate instruction manuals for details regarding optional accessories and other equipment used with these actuators.

Failure to read and comply with all applicable installation, operation and maintenance instructions may result in bodily injury or equipment damage and will void the Product warranty.

### 1.3 Company Contact

For any questions or clarifications, contact ATI or your nearest ATI Authorized Representative.

Email: [Sales@ATIactuators.com](mailto:Sales@ATIactuators.com)

Web: <http://www.ATIactuators.com/>

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Houston, Texas, USA

Phone: +1 713 934-0171

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ATI Europe – Customer Support

Manchester, United Kingdom

Phone: +44 161 830-2146

## 2 Reference Documents

The following documents are referenced within this publication. These address options and accessories, and one or more of these documents may be required to complete installation, operation or maintenance of the as-built Product.

- Emerson TopWorx IOM ES-01857-1 R17 D-Series IOM
- IOM API 3200 G M420 cal
- IOM ATI 050292-24 operation
- IOM ATI 110585 operation
- IOM ATI 112357 operation
- IOM HPG 3000
- IOM Pressure Switch, BA EDS 4000 ATEX-CSA-IECEx\_ExD\_D\_E 2014-01-08

### 3 Definitions

Term/Abbreviation	Definition
ATI	Automation Technology LLC, the manufacturer of the Product.
cycle	Operating the actuator from full open to full close and back to full open, or from close to open, back to close. When mounted to the valve, this is 2 full stroke operations, one time in each direction.
hydraulic actuator	A hydraulic actuator uses compressed liquid as the power medium to produce mechanical motion.
MAWP	Maximum Allowable Working Pressure, or Maximum Allowable Operating Pressure (MAOP). The maximum design pressure for the Product.
SMAWP	Standard Maximum Allowable Working Pressure, or Standard Maximum Allowable Operating Pressure (MAOP). The standard maximum design pressure for the Product.
Product	Product refers to the Electro-Hydraulic Control System
stroke	Measure of valve openness. Full stroke is the travel distance to move the valve from its full closed to its full open position. In control valve applications, stroke is often described in percentage terms—full closed is 0%, full open is 100%—and stroke is generally proportional to the amount of flow through the pipe.

## 4 Product Description

### 4.1 General Description & Typical Applications

The ATI Electro-Hydraulic Control System is designed to be a 50-5,000 psig hydraulic power (standard is up to 3000 psig) and control source to drive either linear, quarter-turn or multi-turn hydraulic valve actuators.

It includes a 100% duty cycle electric motor, motor starter, hydraulic pump and reservoir, directional control valves and electrical controls. The system permits variable torque or thrust by means of an adjustable pressure switch as well as variable actuator speed by means of flow control valves. Modulating service with a 4-20 control input signal is optional. The 100% duty cycle motor runs only when the system pressure drops below the pressure switch set point. Also, for larger Electro-Hydraulic Controls Systems or for EH Control Systems operating in a high level of hazardous area, a skid is available to mount the hazardous area power unit on with electrical controls placed in an enclosure beside the power unit.

The failure mode is achieved by using a spring-return actuator or by a hydraulic accumulator system with a double-acting actuator. A reservoir float/level switch or pressure sensor can be used as safety devices to shut the system down if there is a leak or line rupture. Also, a 10-micron return oil filtration system with gauge protects and enhances the life of the system. The system can be designed to operate single or multiple actuators and is suitable for small or large volumetric displacement actuators. The unit can be AC-powered, DC-powered or solar-powered. Controls for both local operator control and remote Digital Control System (DCS) operation are standard with selector switches. The control systems can be designed for hazardous areas up to Class 1 Division 1/Zone 1 or Zone 1 with FM, UL, ATEX, or IEC system certification approvals as required.

This power system seamlessly integrates with ATI's proprietary control system to provide a precise electro-hydraulic actuator for control valve applications.

### 4.2 Theory of Product Operation

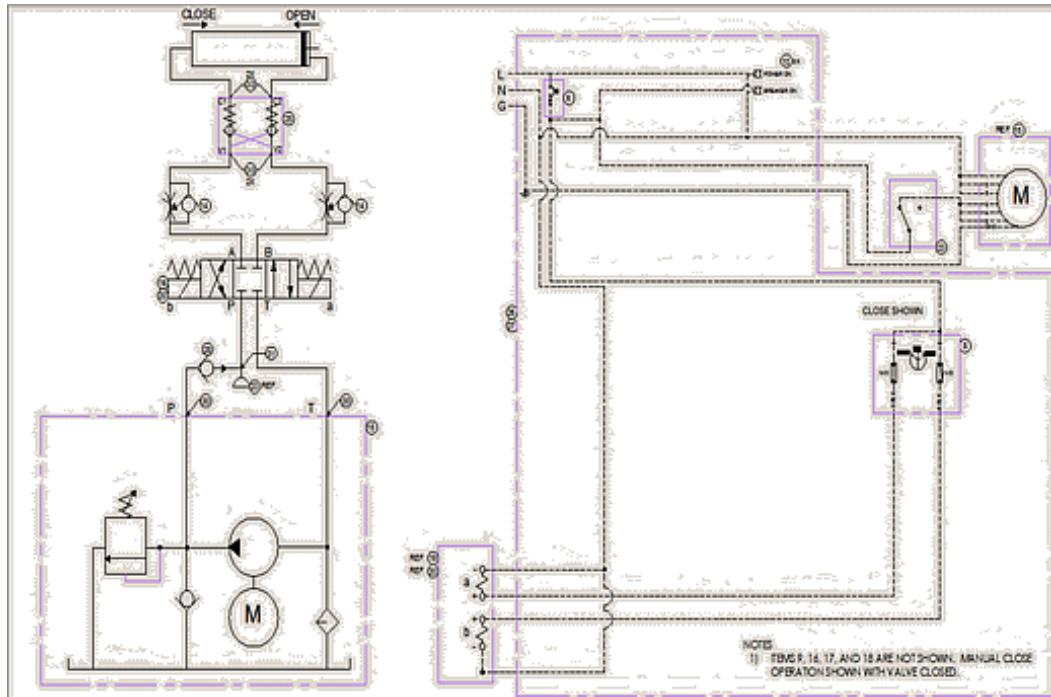
The EH control unit is used to control the actuator position allowing control of the valve position. There are two different operation methodologies, one EH control unit for double acting linear and quarter turn actuators and one EH control unit for single acting SRR (Spring Return Retract) or SRE (Spring Return Exit) actuators.

### 4.3 Double Acting EH Control Units

The EH control unit works in the following general way for DA actuators:

- The single-direction power unit pressures one side of the actuator or the other depending if an open or close signal is sent from the controller/positioner or manual open/close selector switch to the directional solenoid valve.
- The pressure switch will send an "ON" 24VDC signal to a motor contactor, which will allow 120/230VAC Power or 24VDC Power to be sent to the AC or DC motor, respectively, whenever pressure gets below a back-switch point pressure. The motor will turn off after the pump output pressure is above the rising pressure set point of the pressure switch.
- The controller/positioner or manual open/close selector switch will send an "open" or "close" signal to a directional solenoid valve that pressurizes one side of the actuator or the other. As an option, at end of travel, the "open" or "close" signal may be terminated by an opened relay (if limit switch is included as an option). For basic EH control units, there is no limit switch transducer, and the pressure switch at the outlet of the power unit will prevent over pressurization of the actuator.
- Typically, the reservoir is self-contained, in that the reservoir is part of the HPU and is attached to the pump supplying hydraulic fluid to the pump.

**Figure 1: Double Acting Linear Actuator in the closed position without Positioner**

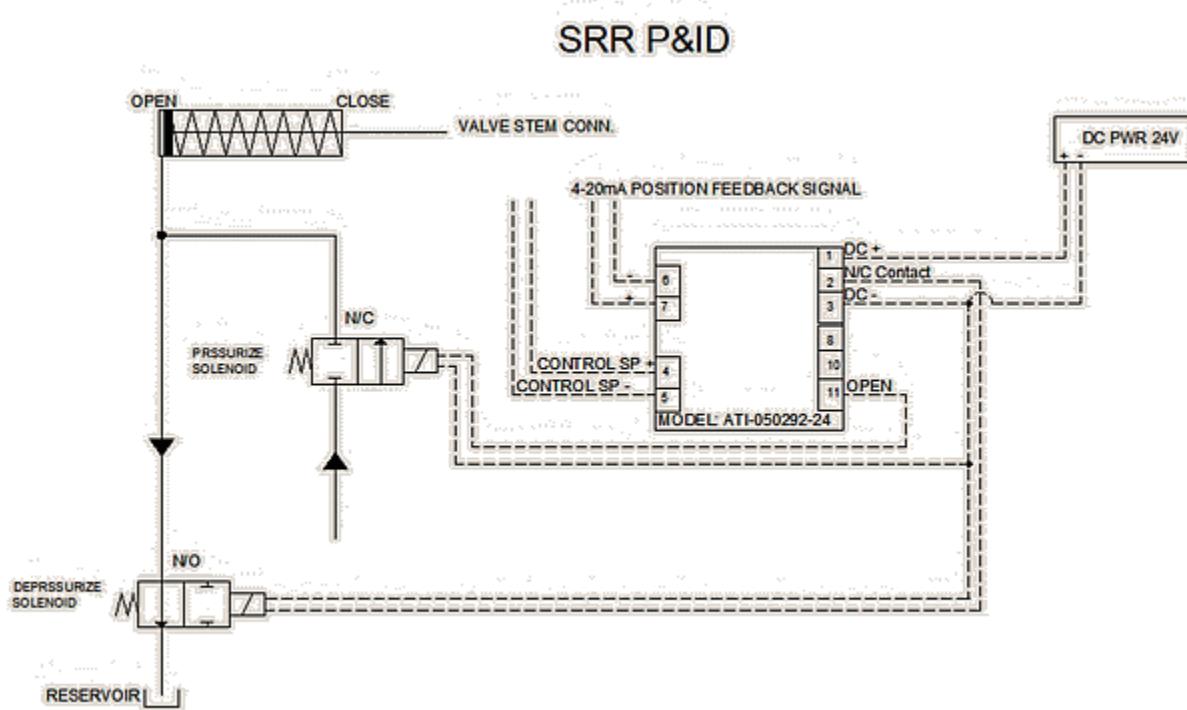


#### 4.4 Single Acting EH Control Units

The EH control unit works the following basic way for SRE and SRR actuators:

- The power unit pressurizes **only** one side of the actuator as an open or close signal is sent from the controller/positioner or manual open/close selector switch to the two-position Normally Closed and Normally Open solenoid valve. The EH control unit depressurizes the actuator to allow the spring in the spring-return actuator to reverse direction.
- The pressure switch will send an “ON” 24VDC signal to a motor contactor, which will allow 120/230VAC Power or 24VDC Power to be sent to the AC or DC motor, respectively, whenever pressure of the accumulator or actuator (without accumulator) gets below the back-switch point pressure. The motor will turn off after the output pump pressure is above the rising pressure set point of the pressure switch.
- The controller/positioner or manual open/close selector switch will send an “open” or “close” signal to a directional solenoid valve that pressurizes one side of the actuator or the other. As an option, at end of travel, the “open” or “close” signal may be terminated by an opened relay (if limit switch is included as an option). For basic EH control units, there is no limit switch transducer, and the pressure switch at the outlet of the power unit will prevent over pressurization of the actuator.
- Typically, the reservoir is self-contained, in that the reservoir is part of the HPU and is attached to the pump supplying hydraulic fluid to the pump.

**Figure 2: A SRR actuator with Positioner (hydraulic cylinder shown opened)**



#### 4.5 Product Specifications

<b>4.5.1 Operating Pressure</b>	<p>The working pressure range for a standard ATI Electro-Hydraulic Control Systems is as follows:</p> <p>MINIMUM: 300 psig (20.7 bar)      STANDARD MAXIMUM (SMAWP): 3000 psig (207 bar)</p> <p>The minimum pressure may be lower than 300 psig, but backpressure in control circuits is likely to make this impractical. Consult ATI for supply pressure above the Standard Maximum limits.</p>				
<b>4.5.2 Temperature Limits</b>	<p><b>Operating Temperature</b></p> <table border="1" data-bbox="644 1474 1395 1573"> <thead> <tr> <th data-bbox="644 1474 1003 1510">Control System</th><th data-bbox="1003 1474 1395 1510">Operating Temperature*</th></tr> </thead> <tbody> <tr> <td data-bbox="644 1531 1003 1573"><b>standard</b></td><td data-bbox="1003 1531 1395 1573">-4°F to +122°F (-20°C to +50°C)</td></tr> </tbody> </table> <p>Consult ATI for alternate temperature requirements.</p>	Control System	Operating Temperature*	<b>standard</b>	-4°F to +122°F (-20°C to +50°C)
Control System	Operating Temperature*				
<b>standard</b>	-4°F to +122°F (-20°C to +50°C)				
<b>4.5.3 Duty Cycle &amp; Cycle Speed</b>	<p>The Product is capable of intermittent duty and continuous modulation when operated within recommended temperature limits with properly filtered fluid. The stroke speed is controlled by the control circuit for hydraulic fluid supply and typically varies between 30 seconds to 3 minutes depending if an accumulator is used.</p> <p>Consult ATI for cycle speeds faster than 0.5 second per inch of travel.</p>				

4.5.4 Fluid Type	<p>The Product is designed and constructed of heavy duty materials for operation in hydraulic systems using petroleum-based fluids. Optional materials of construction are available for operation with other fluids.</p> <p>Refer to section 0 for more information.</p>
4.5.5 Service Life	<p>ATI Electro-Hydraulic Control System can be operated with petroleum-based hydraulic fluids for up to 5 years without maintenance. In harsh environments and safety critical applications, more frequent maintenance intervals and a proper fluid monitoring program should be considered to ensure reliable Product performance. With regular maintenance and monitoring of the hydraulic fluid, the service life for this actuator will extend well beyond 5 years.</p>
4.5.6 Lubrication	<p>For normal duty, the actuator is self-lubricated for the life of the Product.</p> <p>The hydraulic fluid should be filtered and monitored for cleanliness to a contamination threshold of 20/18/15 per ISO 4406 (NAS 9). Lower contamination thresholds are recommended to maximize service life: For operating pressures to 2000 psig, it is recommended to maintain fluid to a cleanliness level better than 17/15/12 (NAS 6). For operating pressure to 3000 psig, maintain fluid to a cleanliness level better than 16/14/11 (NAS 5).</p> <p>Refer to section 0 for additional information.</p>
4.5.7 Lifting Point Load Ratings	<p>Typical free standing enclosures are fitted with heavy duty Type 316 lifting bolts. Consult with enclosure manufacture on lifting load ranges or if lifting from ATI actuator consult with ATI IOM 1025.</p>
4.5.8 Pressure Connections	<p>Typical Electro-Hydraulic manifold connections are <math>\frac{1}{4}</math>" NPT ports.</p>
4.5.9 Warranty	<p>Complete warranty terms and conditions are included in section 11 of this manual.</p> <p>ATI EH control systems, if handled, installed, used, and maintained according to this manual, are guaranteed to be without defects in material and workmanship. The warranty period is two (2) years after the date of factory shipment. Refer to Product nameplate for serial number to confirm date of shipment. The warranty does not cover accessory components installed by others or materials that are installed inappropriately, used inappropriately, or modified or repaired without approval by ATI.</p> <p><b>NON-WARRANTY CLAUSE:</b> Contents of this publication are periodically checked for compliance with the associated Products, and corrections are made as necessary for subsequent publications. ATI also modifies the Product in this publication (within limits of Optional Certifications) to meet special requirements for specific customer orders. Therefore, ATI cannot exclude the possibility of discrepancies between this publication and the Product and special documentation that is prepared for a particular shipment, and ATI does not accept liability for discrepancies between information in this publication and the Product.</p>

## 5 Safety Warnings

THIS MANUAL COVERS GENERAL INSTRUCTIONS AND DOES NOT CLAIM TO ADDRESS ALL SAFETY FACTORS ASSOCIATED WITH ATI PRODUCTS OR THE ACCESSORIES THAT MAY BE MOUNTED TO ATI PRODUCTS. FOLLOWING THESE INSTRUCTIONS AND GUIDELINES WILL HELP IN PREVENTING PERSONAL INJURY, PROPERTY DAMAGE, AND DAMAGE TO THE PRODUCT.

ACTUATORS AND VALVES COME INTO CONTACT WITH CAUSTIC GASES AND FLUIDS IN MANY APPLICATIONS. AS A RESULT, ALL TOXIC OR FLAMMABLE FUMES MUST BE VENTED AND LIQUIDS MOVED TO A SAFE LOCATION TO ENSURE SAFETY.

FOR GENERAL SAFETY REQUIREMENTS AND RISK ASSESSMENTS OF HYDRAULIC POWER SYSTEMS, REFER TO BS EN 982, ISO 4413, AND ISO 12100.

### 5.1 Personnel Requirements

DO NOT INSTALL, OPERATE, OR MAINTAIN AN ATI PRODUCT UNLESS TRAINED AND QUALIFIED IN PRODUCT AND ACCESSORY INSTALLATION, OPERATION AND MAINTENANCE.

PROPER INSTALLATION OF THE PRODUCT IS CRITICAL TO PERFORMANCE AND SAFETY. DUE TO THE MANY VARIATIONS OF ACTUATORS, VALVES, AND RELATED CONTROLS, THE GENERAL INSTRUCTIONS IN THIS MANUAL MAY NOT ADDRESS SPECIFIC ISSUES AT A PARTICULAR INSTALLATION. EACH TECHNICIAN FOLLOWING THESE INSTRUCTIONS MUST BE COMPETENT, TRAINED, AND HAVE A WORKING KNOWLEDGE OF VALVES, VALVE ACTUATORS, ACTUATOR CONTROLS, AND THE SPECIFIC APPLICATION FOR THE INTENDED PRODUCT(S).

IT IS THE RESPONSIBILITY OF THE USER TO ENSURE PROPER SAFETY. ALWAYS TAKE NECESSARY PRECAUTIONS AND UTILIZE PROPER PERSONAL PROTECTIVE EQUIPMENT (PPE) WHEN DEALING WITH COMPRESSED GAS, PRESSURIZED HYDRAULIC FLUID, PINCH POINTS, AND ELECTRICITY. IT IS THE USER'S RESPONSIBILITY TO UTILIZE APPROPRIATE PROTECTION AGAINST HEARING DAMAGE WHEN WORKING NEAR THE ACTUATOR AND CONTROLS.

### 5.2 Potential Hazards

The Product has been designed in accordance with best practices for operational reliability, but as an industrial machine, it bears the risk of hazards if handled or operated improperly. Only trained, qualified personnel should work on or near the Product.

Some potential risks from installation include rigging & lifting. Risks during maintenance and operations include stored energy hazards, pinch points, overpressure conditions, and ignition hazards.

#### Rigging & Lifting

The Product includes a provision for lifting, refer to section 4.5.7 and order documentation. This provision does not address all possible assemblies that will include the additional weight of the valve and related controls. The user must ensure that the package weight including this Product does not exceed the rated limit of these lifting points. For cases where this limit is exceeded, the actuator and valve or other equipment must be rigged and lifted separately. Refer to rigging instructions in section 6.1 for lifting recommendations.

Before rigging, ensure the crane/hoist/rigging hardware lifting capacity can safely accommodate the desired load. Dropping the Product and any attached accessories or the attached valve may cause personal injury and/or equipment damage. For all mounting procedures, use adequately rated chain(s) & sling(s) with an adequately rated hoist or crane to lift and maneuver the Product. Use caution during lifting and handling to prevent uncontrolled movement or sudden shock loads.

#### Overpressure

The pressure of the system is regulated by a pressure switch on the outlet of the pump pre-set during assembly to the correct operating pressure of the actuator and pump. For pressure switch programming instructions refer to section 9.4.

## Ignition Hazard in Hazardous Areas

Units can be designed for up to Class I Division 1, Class I Zone 1, or Zone 1. If the EH Control system is designed for any hazardous area, **DO NOT OPEN THE ELECTRICAL ENCLOSURE WHEN HAZARDOUS FLAMMABLE GAS IS PRESENT AS THIS MAY CAUSE AN EXPLOSION. EVEN WITH ELECTRICAL COMPONENTS DEENERGIZED, CAPACITORS IN THE ELECTRICAL COMPONENTS WILL STILL HAVE STORED ENERGY.**

## 6 Handling and Storage

### 6.1 Receiving the Product

Proper care and precautions should be taken when unloading and handling the EH control system, especially when rigging and lifting. Ensure that the valve is not connected to the actuator.

### 6.2 Storage and Preservation

ATI Products leave the factory in excellent working condition and with an excellent finish (these conditions are guaranteed by individual inspection certificates). To maintain these characteristics until the Product is installed, it is necessary to take appropriate measures during the storage period.

## 7 Installation Instructions

### 8 Preparation for Start-up

Review Product Description and Theory of Product Operation in Section 4.

#### 8.1 Hydraulic Connections

Connect the C1 and C2 ports from the EH control system to the correct actuator ports according to the P&ID using hose or tubing with appropriate pressure rating (3000 psi or greater). Typical EH control system connections are  $\frac{1}{4}$ " NPT. Connection must be sized appropriately to ensure necessary flow rate of fluid to the actuator. Piping must be suitably fastened so as not to cause excessive stress or cause the threaded connections to loosen if the system undergoes strong vibrations.

**IMPORTANT:** Every precaution must be taken to ensure that any solid or liquid contaminants that may be present in hydraulic fill lines and pipework are removed before connection and pressurization, to avoid possible damages or other loss of performance to the Product. Connections should be made by qualified staff using pipes and connections appropriate for system specifications.

The inside of pipes and connecting elements must be cleaned before use. The ends of the tubes must be de-burred and cleaned. Pipes should be washed with suitable substances and purged with air or nitrogen, then flushed using an appropriate hydraulic flushing procedure.

#### 8.2 Electrical Connections

For electrical connections, use components (cable glands, cables, hoses, conduits, wire) that meet the requirements and codes applicable to site specifications (ingress protection and/or hazardous area protection). If conduits are used, it is advisable to carry out the connection to the electrical enclosures by inserting flexible conduit so as not to cause anomalous stress on the housing cable entries.

For EH control systems, there are three-hole cable entries on the side of the enclosure. From top to bottom respectively, cable entries include incoming DCS control/signal wiring, Incoming Power, and outgoing position transducer wiring. The incoming DCS control/signal wiring will contain the control set-point wiring if positioner is included and outgoing signal wiring. The second cable entry is for the incoming power and must be wired to the power terminal blocks. The third cable hole entry is for the outgoing position transducer cable wiring for the position transducer mounted onto the actuator. For more information on cabling and wiring to the EH control system, refer to the wiring schematic.

Replace the plastic plugs of the unused enclosure entries with metal plugs, to guarantee weatherproof tightness and to comply with the hazardous area code requirements (as applicable).

After connections are complete, check that the feed voltage value of each component is correct and that controls and signals work properly.

### **8.3 Oil Fill**

Ensure the hydraulic fluid meets the specification for the system and the specific construction for the cylinder. Refer to sections 4.5.4, 4.5.6 and 0 for more information. If the wrong oil is used, seals or internal surfaces of the actuator or pump can be damaged, resulting in system leaks and loss of function.

Hydraulic cylinders may stroke erratically due to entrapped air. Cylinders must be stroked several times to purge this air from all internal cavities. Before attempting air purge, ensure the system is not pressurized. During the air purge operation, direct any air bleed in a safe direction.

### **8.4 Start-up**

Prior to start-up in a hazardous area, ensure that the Product and all accessories are certified for the risk of ignition hazard at the site.

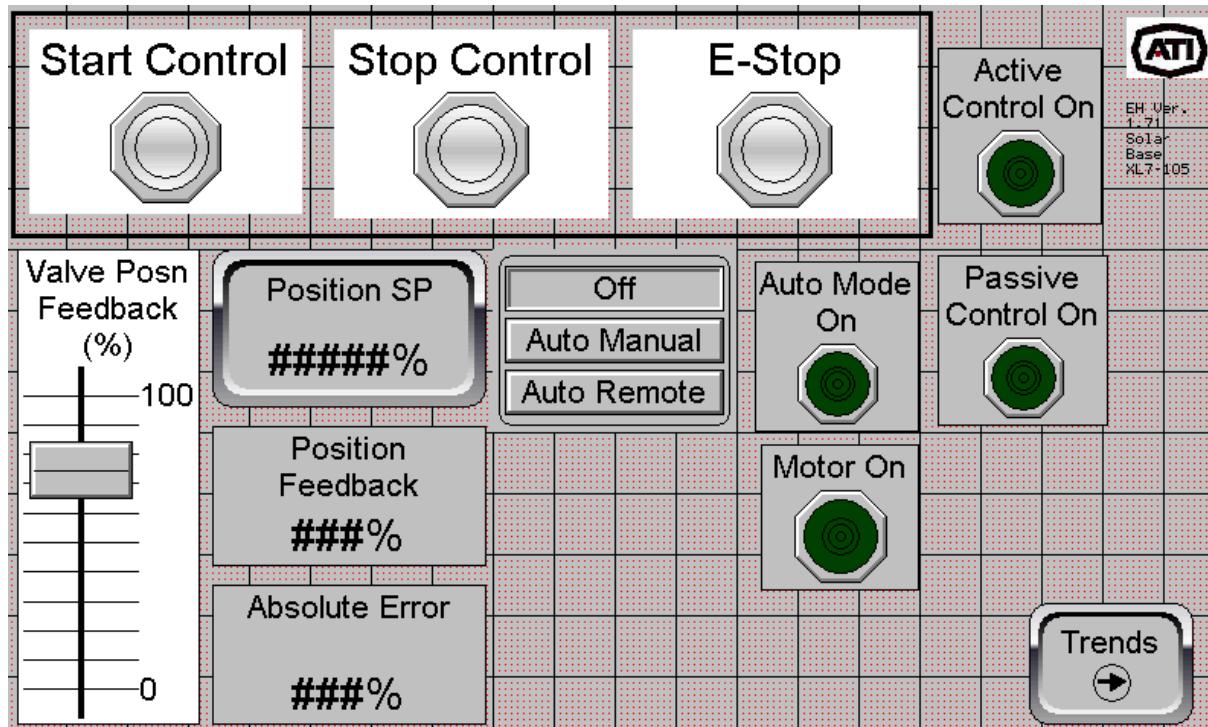
During start-up, ensure that all accessories are properly connected and calibrated for use, as follows:

1. Secure enclosure or skid onto a stable base and connect power and control/signal wiring to the proper terminals according to the wiring and enclosure cable & port hole drawing
2. Connect tubing between valve manifold output ports (EHM direct mounted unit) or enclosure port holes (Free-standing EHM unit) and actuator port holes according to the P&ID and enclosure cable & port hole drawing
3. Pre-charge the bladder accumulator to correct manufacturers pre-charge pressure according to P&ID using the Hydac pre-charge unit FPO210F3K (ATI P/N 212001). Refer to [IOM FPO210manual.pdf](#) for proper pre-charging procedure.
4. Check that the actuator controls work properly (remote control, local control, emergency controls).
5. Check that the required remote signals (valve position, supply pressure, etc.) are correct.
6. Check that the setting of the actuator control unit components, (pressure regulator, pressure switches, flow control valves, etc.) meet site requirements.
7. Check that the pressure and quality of the fluid supply (contamination threshold and dehydration) are as prescribed. Check that the feed voltage values of the electric components (solenoid valve coils, micro-switches, pressure switches, etc.) are as prescribed. Before start-up for operation under maximum design pressure, clean or replace all filtering elements.
8. Prime system by first filling the reservoir 90% full then use the hand pump to stroke the actuator open and close 10 times with electrical power off, or with selector switch in manual mode use the power unit to charge the accumulator and then stroke the actuator to prime the system (ensuring stroking is slow when using the power unit to prime the system while air is in the hydraulic actuator). Regulate the flow rate as necessary using flow control valves as shown in the P&ID.

**WARNING: For 24 VDC solar powered EH control units, ENSURE BATTERIES ARE PROPERLY CHARGED BEFORE STARTING 24 VDC SOLAR POWERED POWER UNIT MOTOR.**

9. Check that there are no leaks in hydraulic connections. After oil heats to its working temperature, check that all joints and connections are tight.
10. Calibrate the position transducer if needed; in manual selector switch mode with electrical power on, calibrate the position transducer at the 4-mA closed position and the 20-mA open position referring to [MP1054 Calibration & Limit Switch instructions for 4-20 mA DXP Position transducer.pdf](#) as needed.

11. If a PLC is used (if not go to step 15), test the **Passive Control** functionality of the EHM system, wire the powered 4-20 mA control set-point signal into the PLC according to the wiring schematic and place the Auto/Manual Selector switch in Auto. Once the system is in Auto, then the **Auto Mode On** and **Passive Control On** indicator lights will be illuminated (as long as the Control Set-point signal is powered) as shown in Figure 3.



*Figure 3: Main Controls Screen*

**Passive Control** occurs when the Digital Control System (DCS) sends a 4-20 mA control set-point to the PLC remotely. Passive Control will resume by default when the PLC reboots or **Active Control** is not on, and Auto/Manual selector switch is in Auto (Auto Mode) and there is no **E-Stop** button pushed and the Control Set-point signal is not lost. Note, Auto Remote will be selected when Passive Control is on.

If needed, test Passive Control by changing the DCS control set-point signal sequentially to 4, 8, 12, 16, and 20 mA (0%, 25%, 50%, 75% and 100% valve position) ensuring feedback position matches set-point position within  $\pm 1\%$ . Give the control system a few seconds to respond when making a valve position change.

12. Ensure **Active Control** (with **Auto Mode On**) is functioning by pushing the **Start Control** button on as shown in Figure 3, when this occurs then the **Active Control On** indicator light will be illuminated. The operator can control the valve locally or remotely via the PLC HMI when Active Control is on.

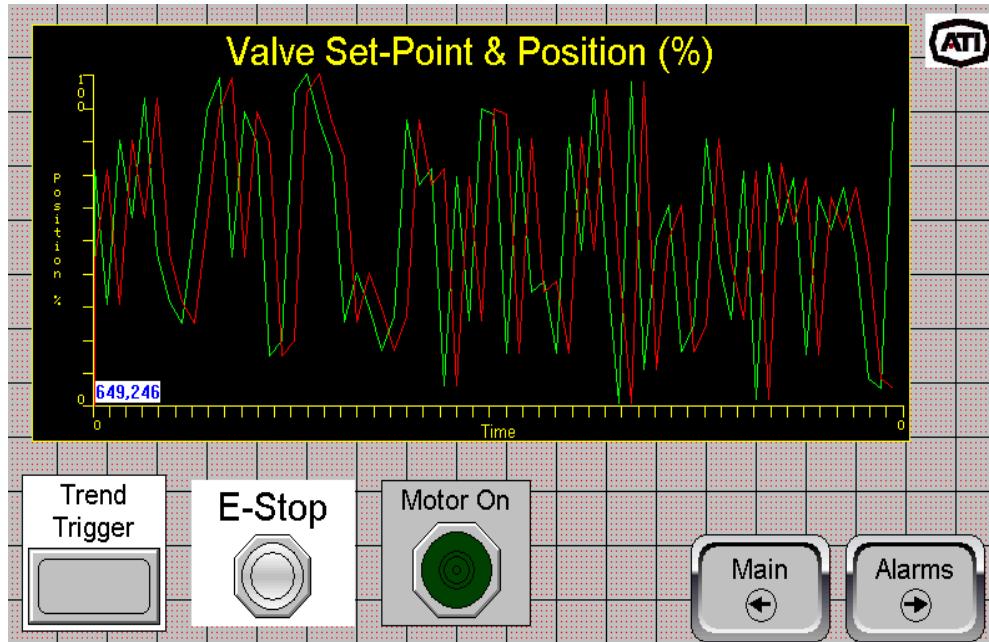
Ensure Active Control is functioning by pushing the **Auto Manual** button on and push the **Position SP** dialog box, sequentially select the following valve positions; 0%, 25%, 50%, 75% and 100% ensuring feedback position matches control set-point position within  $\pm 1\%$ . Give the control system a few seconds to respond when making a valve position change.

Next, ensure Auto Remote is functioning while in Active Control by pushing the **Auto Remote** button on and changing the DCS control set-point signal sequentially to 4, 8, 12, 16, and 20 mA (0%, 25%, 50%, 75% and 100% valve position) ensuring feedback position matches set-point position within  $\pm 1\%$ . Give the control system a few seconds to respond when making a valve position change. Note, Active Auto Remote will only function if the 4-20 mA control set-point is not lost.

Next, select Off by pushing the **Off** button on and validate that the valve maintains previous position.

Note, Active control will be stopped whenever the **Stop Control** button or **E-Stop** button is pushed.

13. Validate that the trends screen is functioning by going into the Trends Screen and pushing the **Trend Trigger** button on, ensure valve position feedback follows control set-point within  $\pm 1\%$  when making a valve position change as shown in the below figure. Give the control system a few seconds to respond when making a valve position change.



*Figure 4: Trends Screen*

14. Ensure basic alarm functionality is functioning as shown below and in the next Figure.

Basic Alarming is as follows:

- If the valve is 10% within being opened or closed then an alarm will occur
- If the **E-Stop** button is pushed then an alarm will occur preventing Active or Passive Control to be on even after an electrical power loss
- If the motor turns on and off then an alarm will occur for a motor on and a motor off event
- If the control set-point signal is lost or out of range then an alarm will occur (less than 4 mA) preventing Passive Control to be on

An alarm occurs with a Date and Time stamp and the date and time can be configured by pushing the external System button on the PLC and then going into Set Date/Time option.

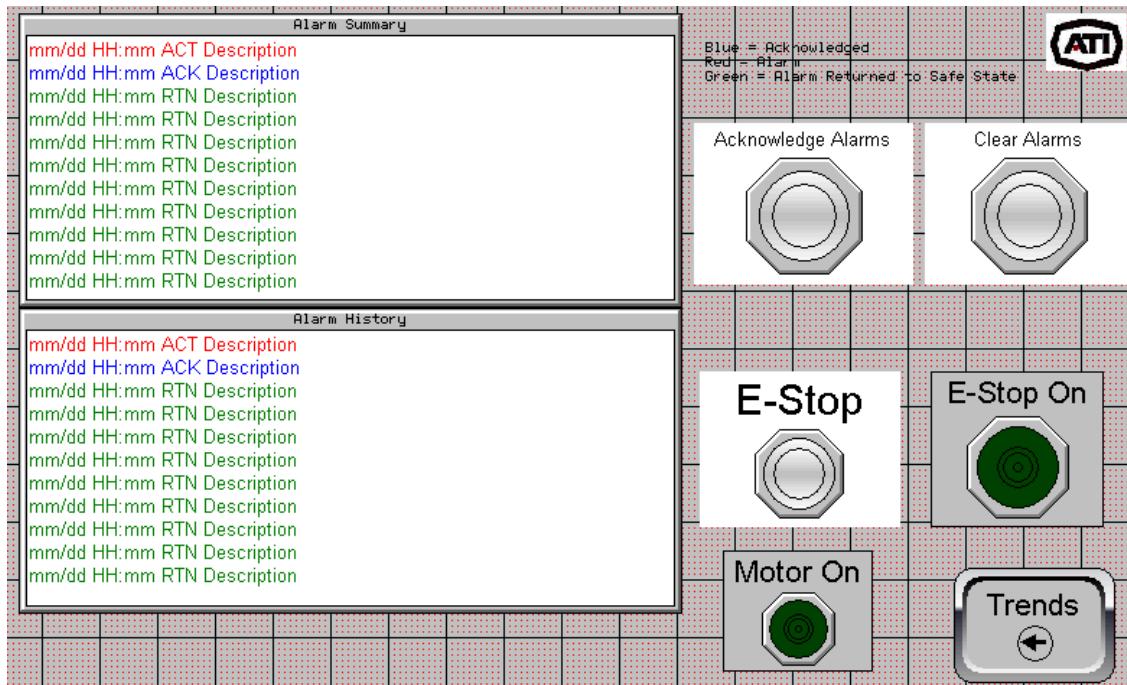


Figure 5: Alarms Screen

Figure 6: Alarms Screen

15. Validate overall functionality of EH controls unit including speed of stroke (etc.) according to [QF0024 - Pipeline Products Test & Inspection Form.pdf](#)
16. In accordance with the applicable protective coating specification(s), repair any protective coating that has been damaged during transport, storage or assembly.

## 9 Maintenance & Operation

For assistance when troubleshooting the EH control system, contact your nearest ATI representative. Contact details are in Section 1.3.

### 9.1 Safety Reminder

**IMPORTANT: BEFORE CARRYING OUT ANY MAINTENANCE OPERATION, IT IS NECESSARY TO ISOLATE FEED LINES AND EXHAUST ALL PRESSURE FROM THE ACTUATOR AND ALL CONTROL MANIFOLDS AND VESSELS. ENSURE THAT ANY ELECTRICAL CONNECTIONS TO ACTUATOR CONTROLS ARE DE-ENERGIZED. IF PRODUCT OPERATION IS REQUIRED FOR TROUBLESHOOTING OR PARTIAL STROKE TESTING, THE MAINTENANCE PERSONNEL MUST ENSURE THAT ELECTRICAL AND PRESSURE CONNECTIONS ARE IN A CONTROLLED STATE (LOCKOUT/TAGOUT) FOR SAFE OPERATION.**

If the EH Control system is designed for any hazardous area, **DO NOT OPEN THE ELECTRICAL ENCLOSURE WHEN HAZARDOUS FLAMMABLE GAS IS PRESENT AS THIS MAY CAUSE AN EXPLOSION. EVEN WITH ELECTRICAL COMPONENTS DEENERGIZED, CAPACITORS IN THE ELECTRICAL COMPONENTS WILL STILL HAVE STORED ENERGY.**

### 9.1.1 Routine Maintenance

The EH control system is suitable to work for long periods with minimal maintenance. As with any electrical equipment, the service interval is determined by stroke frequency, environmental conditions, and other conditions of use. The customary service interval for routine maintenance is one (1) to five (5) years.

It is advisable to periodically check the actuator as follows:

1. Check that the actuator operates the valve correctly and with the required operating times. If the actuator operation is infrequent, carry out a few opening and closing operations with all existing controls (remote control, local control, emergency controls, etc.), if site conditions allow.
2. Check that the signals to the remote-control device are correct.
3. Check that the supply pressure value is within the required range as described in the P&ID.
4. Oil should be sampled periodically to check for cleanliness and water content. Refer to Section 4.5.6 for recommended contamination thresholds. Filters in the control circuit should be cleaned or replaced regularly. Filters of a sintered cartridge style should be washed with nitrate solvent and purged with pressurized air. Filters made of cellulose must be replaced when clogged.
5. Check the reservoir is 95% full periodically, oil may have evaporated from the reservoir
6. Check that the external components of the actuator are in good conditions. Tighten any loose connections.
7. Check that there are no leaks in the hydraulic connections.
8. In accordance with the applicable protective coating specification(s), repair any protective coating that has been damaged.

## 9.2 Operation and Calibration of Standard TOPWORX Position Transducer

These instructions are for calibrating the 4-20 milliamp transmitter on an Emerson TopWorx DXP-(L/M/K/E/T/Z/0)(X/H)1\*\*\*\* position transducer and for setting limit switches in the DXP position transducer.

These instructions are guide to the proper setup and calibration of the DXP when installed on ATI linear actuator models SRE, SRR, & DA.

### Specific Reference Documents

- Emerson TopWorx IOM ES-01857-1 R17 D-Series IOM

### Tools Required

- Oyster/Fluke sensor, alligator clips, wiring

### Safety Warning

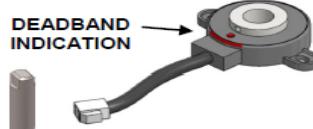
**NOTE DO NOT CALIBRATE IN A HAZARDOUS AREA. HAZARD RATING OF COMPONENTS IS COMPROMISED WHILE THE DXP IS OPEN DURING CALIBRATION.**

**THIS IS NOT A COMPLETE ASSEMBLY PROCEDURE FOR AN ATI ACTUATOR. DO NOT INSTALL, OPERATE, OR MAINTAIN AN ATI ACTUATOR UNLESS TRAINED AND QUALIFIED IN PRODUCT AND ACCESSORY INSTALLATION & OPERATION.**

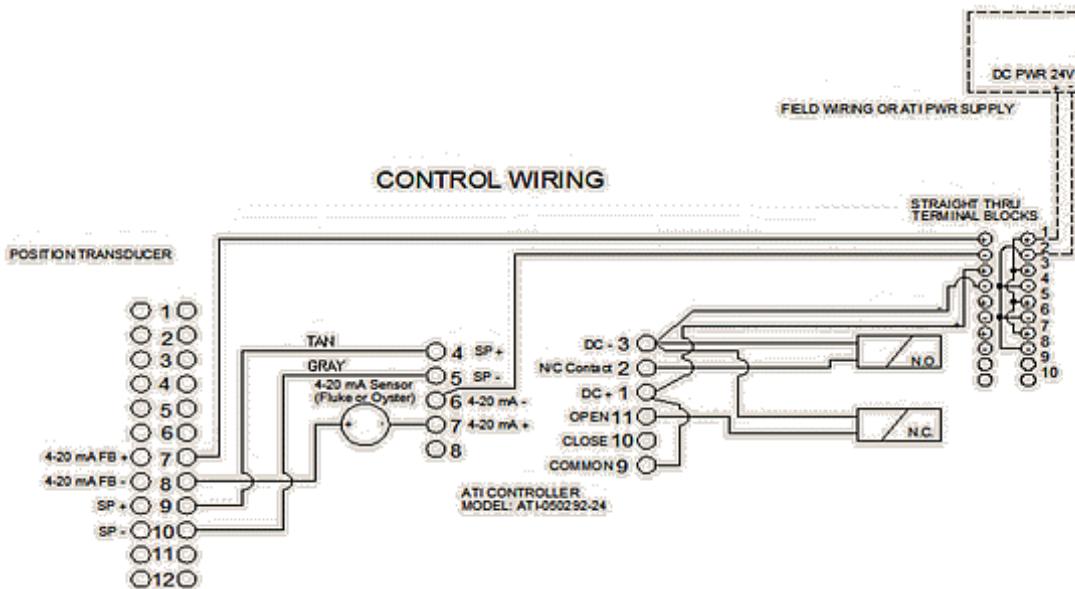
### Transmitter Calibration Instructions

Calibrate the 4-20 milliamp position transmitter (the following calibration covers the TopWorx LX/MX/KX/EX/TX/ZX/0X Non-HART & LH/MH/KH/EH/ZH/OH HART models) as follows:

1. Open the TopWorx case, a button beside the LED light allows one to calibrate the position transducer for any position, i.e. open can be 4 milliamps or close can be 4 milliamps, it does not matter what angle the shaft rotates through **as long as the reference dot does not pass through the dead-band, hence, position the shaft accordingly.**



2. Set-up the wiring to complete calibration as follows using an Oyster or Fluke meter. You will be measuring the feedback signal with the Oyster or Fluke meter in series with the feedback signal (the below schematic shows a positioner ATI-050292-24 controlling an SRR actuator):



**WARNING:** Oyster sensor interferes with loop-power circuit of some position transducers when sensing current in series (specifically the TopWorx DXP), in which case the Fluke meter must be used.

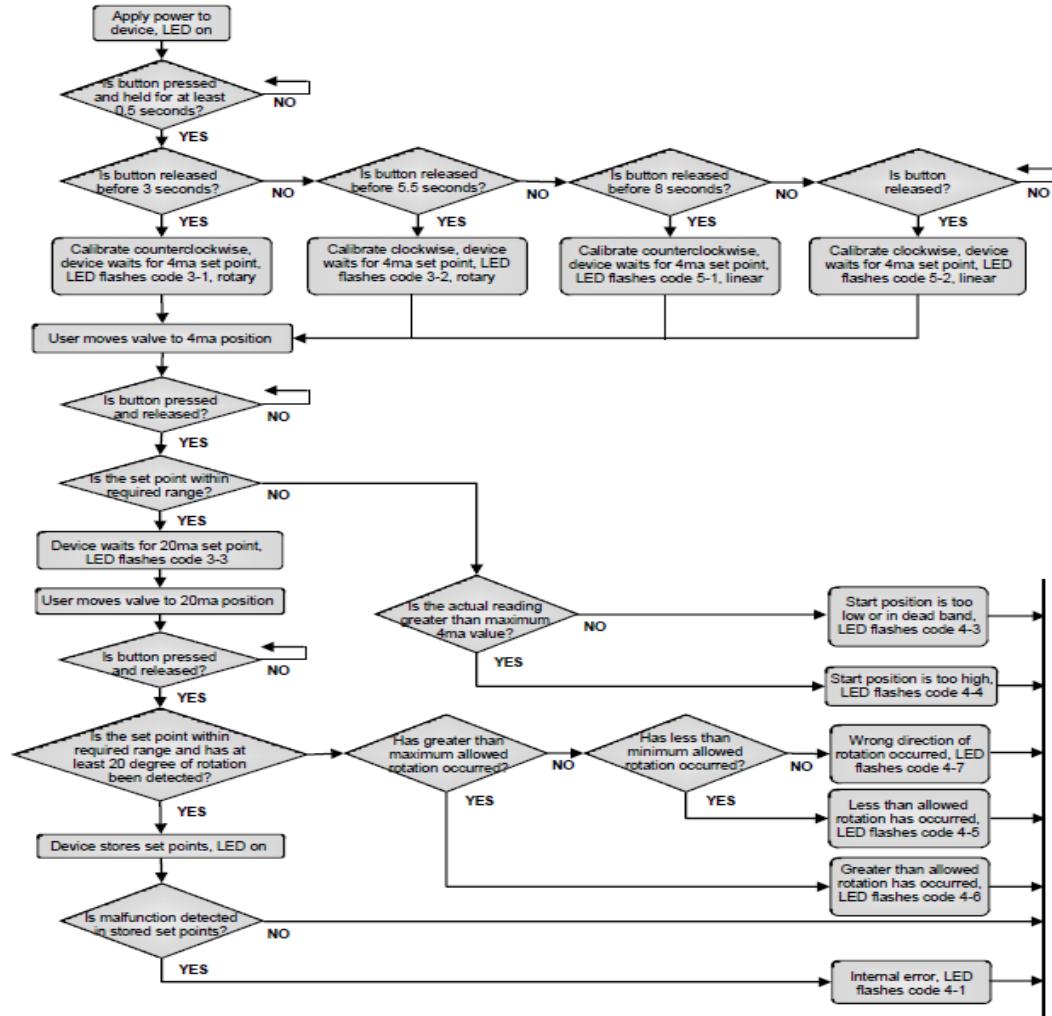
3. Power the electronics up and turn on the test power unit and put the positioner in manual mode if an ATI positioner is being used. **NOTE, opened position is 20 milliamps & closed position is 4 milliamps for all position transducers EXCEPT WHEN THE ATI-050292-24 IS USED ON AN SRR ACTUATOR, FOR THIS CASE, OPENED POSITION IS 4 milliamps AND CLOSED POSITION IS 20 milliamps.**

4. Follow the below flowchart (by pressing the button beside the LED light) noting as before what signal corresponds to the opened or closed position:

**Continued**

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

**Calibration Flow Chart**



5. Error codes are shown below just in case there is an issue (**REMEMBER YOU CANNOT ROTATE THE REFERENCE DOT THROUGH THE DEAD BAND OR ELSE YOU WILL GET AN ERROR CODE LIKE 4-4!**):

Continued

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

Troubleshooting

Error Code and Problem Table

Problem	Probable Cause/Solution
Transmitter Module has no current output	If the LED on the Transmitter Module is not lit - Loose or shorted signal connection (fix connection) - Controller Board not responding (Replace Transmitter Module)
	If the LED on the Circuit Board is lit - Potentiometer is disengaged from shaft (must be returned for repair) - Defective controller board (Replace Transmitter Module)
Transmitter does not output 4 or 20mA (+/-1%) at desired end of travel	Unit not calibrated (calibrate) Unit is calibrated (recalibrate - if still fails, replace board)
Output is not linear or does not track valve position or rotation	Input signal is not linear - Linkage or drive mechanism is introducing non-linearity - Unit is not calibrated (calibrate)
Error Code 4-3	Start position is too low or in the dead-band position.
Error Code 4-4	Start Position is too high
Error Code 4-5	Start and stop positions are less than 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

#### Operation of the 4-20mA Current Position Transmitter

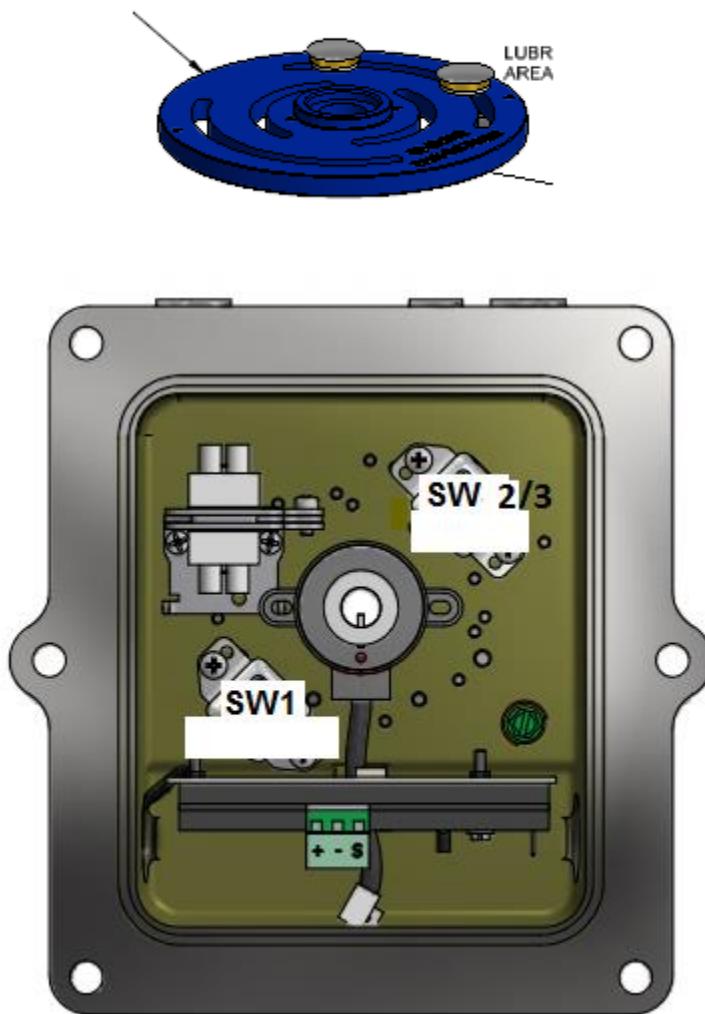
During run mode, the 4-20mA position transmitter will output 4-20mA for valve positions between and including the set points. The module has an optional over or under travel correction if the valve position exceeds the high or low set point by +/-3%. In other words, the output will be 4mA for +/-3% over and under travel on the low end and 20mA for +/-3% over and under travel on the high end. If the valve position exceeds 3% of over travel then values below 4mA or above 20mA will be output. The user selectable other option is to calibrate the device without the over and under travel capability. See the calibration procedure in this document for additional information.

- After calibration is complete then move the actuator up and down with the positioner in manual mode (if an ATI positioner is being used) ensuring correct feedback milliamp signal is observed.
- Next step **is to set the limit switches, if limit switches are not on position transducer then next steps are to** calibrate the ATI positioner at 4 milliamps and 20 milliamps in auto mode if an ATI positioner is being used.

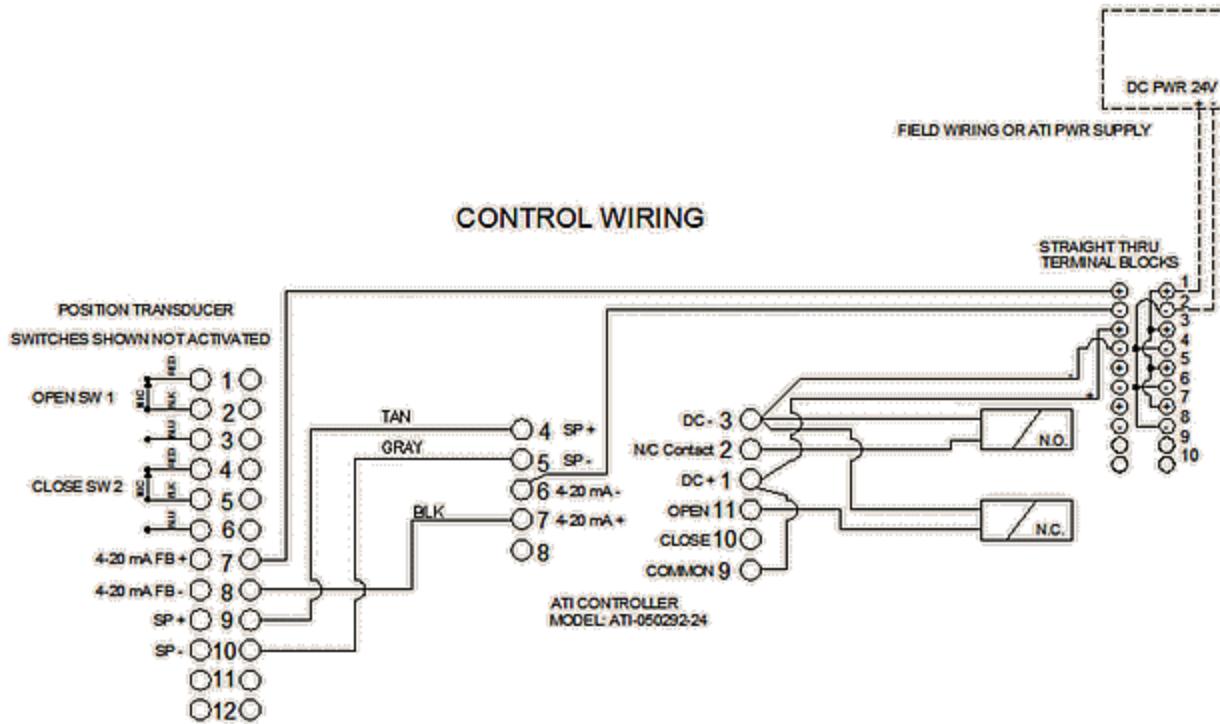
## Limit Switch Instructions

Follow these steps when setting the limit switches on the DXP-L(X/H)1XXXX position transducer:

1. The magnet targets can be moved freely by pushing down on them, set one of the magnet targets so when the actuator is in the open position that this target is over top of switch 1 or switch 2/3 and vice versa for the closed position. Note, the magnetic limit switch relays will function without the position transducer powered on (4-20 milliamp position feedback signals not loop powered).



2. Move the actuator in the open and close position and ensure the below switch terminals on the position transducer are open loop using a resistance meter as shown in the below wiring schematic (the below schematic shows a positioner ATI-050292-24 controlling an SRR actuator position). For example, if switch 1 is open then in the open actuator position terminals 1 and 2 will be open loop while if switch 2 is close then in the close actuator position terminal 4 and 5 would be open loop.



In mid actuator position, terminals 2 and 3 as well as 5 and 6 would be open loop. Calibrate until functionality is satisfied.

### 9.3 Operation and Calibration of Standard 4-20 milliamp ATI Positioner

These instructions are for calibration and tuning 4-20 milliamp ATI Positioners.

These instructions are a guide to the proper setup and calibration of ATI-050292-24 (SRE), ATI-110585 (SRR), and ATI-112357 (DA) Positioners when installed on ATI linear actuator models SRE, SRR, & DA.

#### Specific Reference Documents

- IOM API 3200 G M420 cal
- IOM ATI 050292-24 operation
- IOM ATI 110585 operation
- IOM ATI 112357 operation

#### Tools Required

- Two (2) Oyster/Fluke simulators/sensors
- Alligator clips and wire jumpers

### Safety Warning

**NOTE DO NOT CALIBRATE IN A HAZARDOUS AREA. HAZARD RATING OF COMPONENTS IS COMPROMISED WHILE THE DXP IS OPEN DURING CALIBRATION.**

**THIS IS NOT A COMPLETE ASSEMBLY PROCEDURE FOR AN ATI ACTUATOR. DO NOT INSTALL, OPERATE, OR MAINTAIN AN ATI ACTUATOR UNLESS TRAINED AND QUALIFIED IN PRODUCT AND ACCESSORY INSTALLATION & OPERATION.**

### Calibration & Tuning Instructions

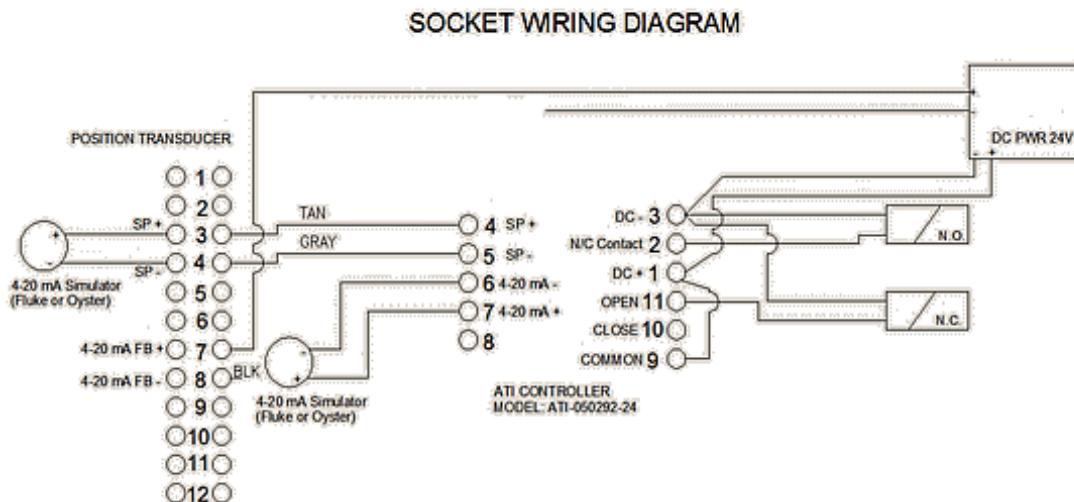
Familiarize yourself with the relevant IOM reference for ATI-050292-24, ATI-110585 or ATI-112357, to understand the operation of the positioner controlling the actuator.

Note, if control system is already in operation and is not performing well. Tune before doing a full positioner calibration.

The below calibration is for the ATI-050292-24 positioner controlling an SRE actuator (NOTE, position transducer terminals may be different on other position transducers)

Calibrations are equivalent for the ATI-110585 controlling an SRR actuator, ATI-112357 positioner controlling a DA actuator, and for the special case when the ATI-050292-24 controls an SRR actuator with all applications using a DXP-(L/M/K/E/T/Z/O)(X/H)1\*\*\*\* position transducer or equivalent:

1. Set-up the wiring to calibrate the positioner as follows without using the test power unit:



2. Power up the electronics and **let electronics warm up for 30 minutes** before continuing.
3. Apply a simulated 4 millamps for the feedback position and control set-point and adjust the **zero** according to the below document, likewise apply a simulated 20 millamps for the feedback position and control set-point and adjust the **span** according to the below document (note one turn is 360 degrees):

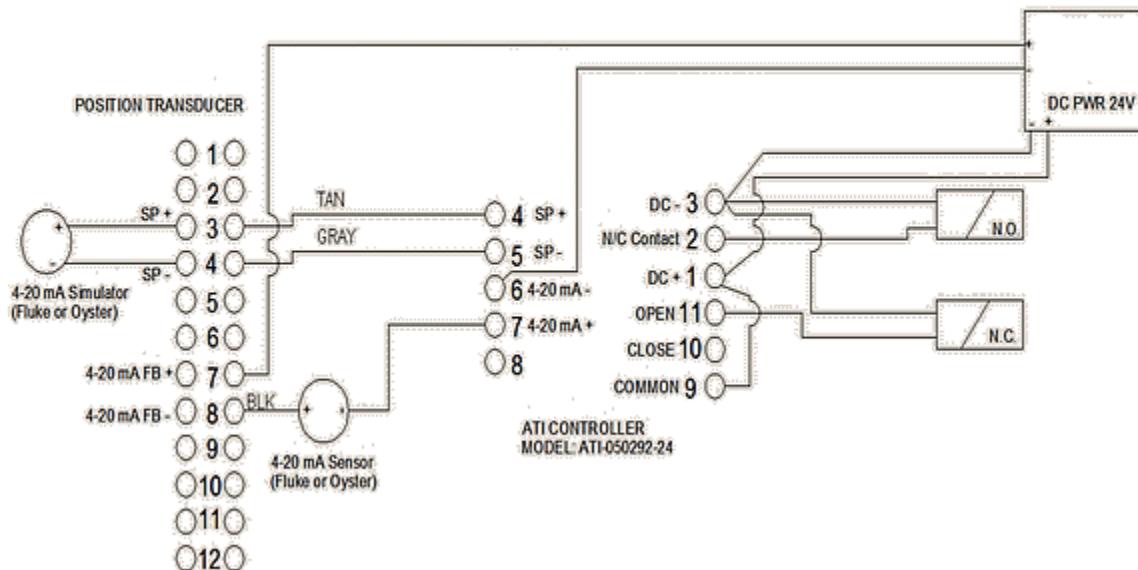
**API 3200 G M420 Calibration procedure:**

1. Equipment required:
  - a. API 3200 G M420
  - b. Proper power supply for the unit (115VAC, 230 VAC or 24VDC as specified on label)
  - c. Two (2) NIST traceable calibrator/simulator (Fluke Model 787 or equivalent)
  - d. Relay load visual indicator to verify relay open and close action
  - e. Connecting cables and socket
- Allow a minimum of 30 minutes of equipment warm up time for equipment temperature stabilization
2. Observing proper polarity connect one Calibrator/Simulator to the control input terminals (terminals 4 & 5) for the API 3200 G M420 and the other calibrator/simulator to the feedback input terminals (terminals 6 & 7) for the API 3200 G M420 and set the output from both Calibrator/Simulators for a 4.00 mA output.
3. Preset the API 3200 G M420 deadband to the minimum position (potentiometer to its fully CCW position)
  - Note: The deadband potentiometer is a twelve turn potentiometers so turn it 13 turns in the specified direction and ensure that there is no “bounce back” from the potentiometer end of travel as this potentiometer have no “positive” end stops
4. Turn the zero potentiometer on the side of the unit to its mid position.
  - Note: Since the zero potentiometer is a twelve turn potentiometer that has no “positive” end stops turn it 13 turns in a CW direction and then turn it 6 complete turns in a CCW direction to ensure that it is in the mid position.
5. Turn the zero potentiometer three complete turns in each direction from its mid position and observe that the Relay Bi-Color LED goes from green (open) to no color to red (close).
6. Verify that the relay load visual indicator indicates that the relay output goes from open to close
7. Adjust the zero potentiometer so that the Relay Bi-Color LED is out and the zero potentiometer is at the mid-point of travel between the Relay Bi-Color LED going from green to red.
8. Adjust the output from both Calibrator/Simulator to the API 3200 G M420 so that it applies 20.0 mA to both the control input terminals and the feedback input terminals
9. Turn the span potentiometer on the side of the unit to its mid position.
  - Note: Since the span potentiometer is a twelve turn potentiometer that has no “positive” end stops turn it 13 turns in a CW direction and then turn it 6 complete turns in a CCW direction to ensure that it is in the mid position.
10. Turn the span potentiometer three complete turns in each direction from its mid position and observe that the Relay Bi-Color LED goes from green (open) to no color to red (close).
11. Verify that the relay load visual indicator indicates that the relay output goes from open to close
12. Adjust the span potentiometer so that the Relay Bi-Color LED is out and the span potentiometer is at the mid-point of travel between the Relay Bi-Color LED going from green to red.
13. Calibration is complete return API 3200 G M420 to service

4. Rewire according to below wiring and close Speed Control Valve/s (Clockwise) then open 1/2 turn CCW. This allows for very tight control but slower response time. **REMEMBER TO OPEN THE FLOW CONTROL VALVE/S ½ TURN CCW. Test Control Set-Points at 4, 8, 12, 16, and 20 millamps using the power unit, recording feedback signal at each set-point.**

**WARNING:** Oyster sensor interferes with loop-power circuit of some position transducers when sensing current in series (specifically the TopWorx DXP), in which case the Fluke meter must be used.

### SOCKET WIRING DIAGRAM



5. Rewire according to the manufacturing drawing and complete a final test on the controls ensuring control set-points are met (without measuring the position feedback, eye the position) using the test power unit)

#### Notes:

1. **For operational tuning;** If the positioner is pulsating solenoids during normal operation, try to reduce flow on the flow control valve and lastly increase the dead-band in the CW direction. Likewise, if the operator wants tighter control then reduce the dead-band in the CCW direction while in positioner Auto mode. Increasing the flow to the actuator will reduce the response time but create overshooting & pulsating of the solenoids. Note, reducing the dead-band will also cause pulsating of the solenoids.

The control system is calibrated and tuned.

## 9.4 Programming the HYDAC Pressure Switch

These instructions are used for calibrating an EDS 4000 pressure switch.

These instructions are a guide to the proper calibration of the pressure switch for use in ATI controls for use with valve actuators.

### Specific Reference Documents

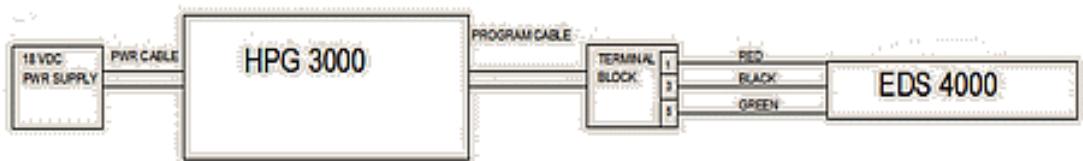
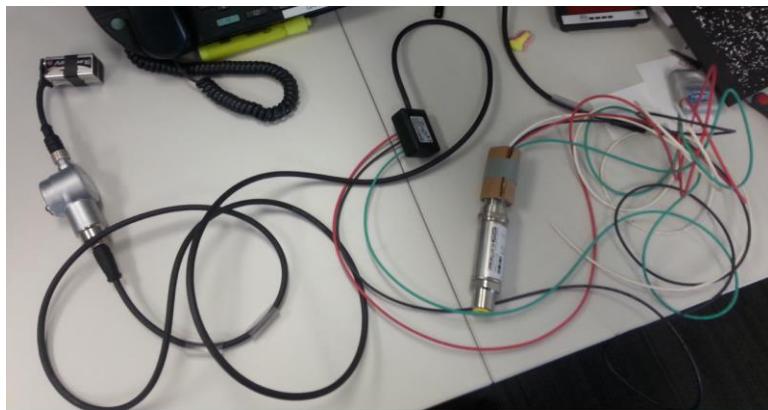
- IOM HPG 3000
- IOM Pressure Switch, BA EDS 4000 ATEX-CSA-IECEx\_ExD\_D\_E 2014-01-08

### Tools Required

- Pressure Switch EDS 4000
- Programming Unit HPG 3000 with PWR cable
- Terminal block unit
- Programming Cable
- 18 VDC (two 9 volt batteries) Power Supply

### Programming Instructions

The pressure switch can be programmed before or after the switch is installed into the control system with hydraulic pressure (pressure switch can be programmed without a 0-psi pressure reference point). The switch is connected to the programming unit as shown below and as shown in the wiring schematic (components are positioned in similar fashion in both depictions):



The EDS-4XXX-3000-1P has one switching point (SP 1). The pressure switch is set as a normally closed contact in its off position.

The general goal is to set the rising pressure set point (SP 1) of the control system to be slightly below (25-50 psi) the operating pressure of the pump which in this example is 1900 psi. Thus, the rising pressure set point or SP 1 will be  $\approx 1875$  psi.

The back-switch point is to be 50-300 psi less than the rising pressure set point and also greater than the minimum supply pressure of the actuator as per the P&ID. Thus, if SP 1 is set at 1875 psi, the back-switch point can be set at 1575 psi, 300 psi less than the rising pressure switch point. The Hysteresis can then be calculated as 1875-1575 psi = 300 psi.

The “switch on” delay (r.on 1) is the time in milliseconds that must elapse after the switch point has been reached (or exceeded) before switching will occur. This value, r.on 1, is set at 500 ms by default.

The “switch off” delay (r.of 1) is the time in milliseconds that must elapse after the pressure has fallen below the switch-back point before switching will occur. This value, r.of 1, is set at 500 ms by default.

To complete all programming, connect the unit as shown in the above depictions and follow the program flow chart for the EDS 4000 in the [IOM HPG 3000](#).

## 9.5 Lubricating Mechanism

For normal duty, a hydraulic actuator is self-lubricated for the life of the Product.

Oil in a hydraulic system performs multiple functions of lubrication, power transmission and corrosion protection. The oil is a vital factor for long-term reliability of the actuator and all system components. The EH control system reservoir must be filled completely with a hydraulic fluid that provides inherent corrosion protection to carbon steel materials. This hydraulic fluid should be inspected regularly to ensure that water and other contaminants are properly filtered and to ensure that air remains purged.

The following oils are used by ATI for standard working temperature and are suitable for use with the Product:

<b>MANUFACTURER</b>	EXXONMOBIL	CHEVRON	SMITTY'S
<b>TYPE</b>	HUMBLE HYDRAULIC H32	AW32	SUPERS R&O 32
<b>COLOR</b>	AMBER	YELLOW	AMBER
<b>VISCOSITY AT 40°C</b>	31 cST	30.4 cST	30-42 cST
<b>FLASH POINT</b>	206°C / 403°F	220°C / 428°F	200°C / 390°F
<b>POUR POINT</b>	-18°C / 0°F	-25°C / -13°F	-23°C / -10°F

The following oils are used by ATI for cold temperatures and are recommended for use with the Product:

<b>MANUFACTURER</b>	CHEVRON	PHILLIPS66
<b>TYPE</b>	HYDRAULIC OIL 5606A	ARCTIC LOW POUR
<b>COLOR</b>	RED	YELLOW
<b>VISCOSITY AT 40°C</b>	15 cST	15 cST
<b>FLASH POINT</b>	82°C / 180°F	103°C / 217°F
<b>POUR POINT</b>	-63°C / -81°F	-60°C / -76°F

Use of other hydraulic fluids may be suitable if proven compatible with seal specification in the actuator. Consult ATI with questions on alternatives.

The use of nitrogen atmospheres is optional. If operating oils of a vegetable-base or other bio-based fluids, operating the system with a nitrogen purge will limit the oxidizing effects of air, and extend the life of the hydraulic fluid and the corrosion protection of the hydraulic fluid system.

## 9.6 Parts Ordering

Every ATI actuator is assigned a unique serial number prior to shipment. In correspondence with ATI or your local ATI Representative, include the serial number from the ATI EH control system nameplate. If documentation from the original order is available, include the ATI part number from the ATI Order Acknowledgement or ATI Shipping Documents.

**Warning:** To ensure compliance to certification requirements, use only genuine ATI replacement parts. Rebuilding an ATI Product with components that are not supplied by ATI may void the Product warranty, void the Product Certification, adversely affect Product performance, and/or cause personal injury and property damage.

## 10 Disposal

At the end of its functional life, users may carry out recycling or disposal of the Product and its accessories using these instructions as a guide.

1. Any disposal or recycling must be performed according to site requirements and local regulatory requirements.
2. It is the user's responsibility to ensure Product is safely depressurized and that cleaning and disposal of any fluids is performed in accordance to local regulations. In some applications, the Product may have been in contact with caustic gases and fluids, which must be cleaned prior to Product disposal.
3. Product may be dismantled for part sorting. Read and follow the appropriate Product and accessory manual(s) before dismantling. Observe all warning instructions marked on the Product(s) and in the manual(s).
4. Sort dismantled parts according to their material. A majority of the material in the Product, more than 98% by weight, can be recycled. Forward sorted parts according to local practice for recycling or disposal.

Materials of construction may be noted in order documentation. If a list of materials is not available, the metal components may be sorted by using a magnet to inspect for ferrous content, as follows:

- Carbon steel may be recycled: Majority of material is carbon steel, ~90% by weight. Carbon steels are ferrous and will hold a magnet.
- Stainless steel may be recycled. Some minor materials – fittings and small fasteners – are stainless steel, typically 300 series, which will not hold a magnet.
- Bronze may be recycled.
- Aluminum may be recycled: Some special Product constructions many optional accessories contain aluminum components, less dense and lighter in weight than stainless steels, also non-magnetic.
- Plastic may be sorted for recycling or discarded with mixed waste: Optional accessory covers and some position indicators are made of plastic.
- Electronics must be disposed according to local regulation. Position switches may include solder or transistor components that can be harmful if allowed to decompose and leach into the environment. Recycling and disposal of electronics must be done according to applicable regulations.
- Soft parts—elastomeric seals and engineered (PTFE) seals throughout the assembly—are not recyclable. Soft goods that have been cleaned of caustic fluids may be discarded with mixed waste.

If local requirements disallow sorting for recycling or other disposal, contact ATI about returning Product to the manufacturer for recycling. ATI will only accept devices that have been cleaned of any caustic fluids, and a fee will be charged for labor and handling of the Product.

## 11 Terms and Conditions/Warranty

Except as otherwise expressly agreed to in writing by an authorized representative of Automation Technology, LLC. (hereinafter "ATI"), the following terms and conditions (these "Terms and Conditions") shall apply to all offers for the purchase or sale of products manufactured or supplied by ATI under brand names including, but not limited to "ATI", "Gevalco", etc.

**A. CONDITIONAL ACCEPTANCE; REJECTION OF PURCHASER TERMS** – All orders and acknowledgements of Purchaser shall constitute only consent to these Terms and Conditions and a representation that Purchaser is solvent. All quotations and offers of sale by ATI are expressly limited to these Terms and Conditions and are subject to written acceptance by ATI. Any such acceptance by ATI is expressly conditioned upon assent of Purchaser to these Terms and Conditions, and ATI hereby expressly objects to and rejects as material alterations to these Terms and Conditions any terms or conditions of Purchaser, whether contained in Purchaser's order, acknowledgement or otherwise, that are different from or in addition to these Terms and Conditions.

**B. PRICES** - ATI quotations are valid for thirty (30) days from date of issuance, unless otherwise stated by ATI in writing, and are subject to withdrawal or change at any time prior to acceptance by ATI. Prices are ex works, in United States Dollars, and firm for thirty (30) days from date of ATI's written acceptance of Purchaser's order and an unconditional authorization for the immediate manufacture based on customer supplied information. If for any reason authorization does not commence within such thirty (30) days, prices in effect at the time of release for manufacture will apply, unless otherwise stated in writing. All sales, use, excise, value-added, import, export and other taxes, duties, customs and the like (collectively "Taxes") are the responsibility of Purchaser and will be added to the price to the extent that ATI pays on Purchaser's behalf or is required by law to pay in connection with the sale. ATI reserves the right to invoice and be paid for any Tax at the time of shipment or any time thereafter. All orders are subject to laws and regulations that are in effect and that become effective prior to delivery. Typographical or clerical errors in quotations, orders and acknowledgements are subject to correction by ATI. Prices do not include installation or any other service, unless so stated expressly in the quotation or ATI's order acknowledgement. Prices include one (1) copy of any applicable manuals. Any additional manuals or other printed materials requested by Purchaser are subject to additional cost, to be quoted at or near the time that such materials are requested by Purchaser.

**C. PAYMENT** - Payment from Purchaser is due within thirty (30) days from date of first invoice, unless otherwise stated on ATI's quotation or order acknowledgement. For international orders, ATI reserves the right to require, before commencing filling the order, security in the form of a letter of credit or the like, in a form and from a bank or guarantor acceptable to ATI. Subject to any applicable usury law that would void or render invalid or unenforceable this sentence, in which case the specified rate will be deemed to be reduced to the maximum allowed by law, simple interest at the rate of 1.5 percent per month will apply to balances unpaid within 30 days from date of first invoice. ATI will invoice upon making available for shipment. ATI reserves the right to payment and Purchaser will be responsible for any cost associated with storage of products or delay in making products available for pickup that occurs at the request of Purchaser.

**D. FORCE MAJEURE** – In no event shall ATI be liable for non-delivery or delay in delivery, or for failure or delay in the performance of any obligation contained herein, that arises directly or indirectly from acts of God, unforeseeable circumstances, acts (including delays or failure to act) of any governmental authority (de jure or de facto), war (declared or undeclared), terrorism, riot, revolution, priorities, fires, floods, weather, strikes, labor disputes, sabotage, epidemics, factory shutdowns or alterations, embargoes, delays or shortages in transportation, delay in obtaining or procuring or inability to obtain or procure labor, materials or manufacturing facilities, delay in obtaining or inability to obtain timely instructions or information from the Purchaser, or any other cause or circumstance of any other kind beyond ATI's reasonable control. The foregoing provision shall apply even though such causes or circumstances may occur after ATI's performance has been delayed for other causes or circumstances.

**E. SHIPPING** – (a) Products are sold ex works. Risk of loss is the responsibility of and title transfers to Purchaser once products are made available at Seller's facility for pickup by Purchaser or its carrier.

(b) Acknowledged ship dates represent the estimated date of availability for pickup, rather than actual shipment or delivery at destination for which Purchaser is responsible. All indicated shipping dates are estimates, based on prompt receipt of all necessary information from Buyer necessary to process the order. ATI will use its best reasonable efforts to make products available for pickup by such dates, but there is no guarantee to do so. Indicated time periods for pickup availability are estimated from the latest to occur of: 1) ATI's acceptance of Purchaser's order, 2) ATI's receipt of valve dimensional information, if applicable, 3) ATI's receipt of Purchaser supplied components required to manufacture or supply the products, if applicable, or 4) ATI's receipt of drawings approved by Purchaser. Products ordered on an "in stock" basis are subject to prior sale to other customers. Acknowledged ship dates are subject to changes caused by additions to or modification of the original order agreed to by both Purchaser and ATI.

(c) Under no circumstances shall ATI have any liability whatsoever for loss of use or for any indirect or consequential damages as a result of delayed delivery.

(d) Purchaser is responsible for payment of carrier and all other shipping costs and for making all arrangements necessary for pickup, transport, export, import and delivery to Purchaser's destination. Without prejudice to any ex works rights of ATI and obligations of Purchaser, Purchaser consents in advance to ATI shipping collect any products that Purchaser fails to pick up, and Purchaser will remain responsible for all associated pickup, transport, export, import and delivery costs, including any unknown to ATI or Purchaser at the time of shipment.

**F. DESIGN** - Due to continuous product development, ATI reserves the right to modify designs, materials and specifications without prior notice.

**G. CANCELLATION** - Orders acknowledged by ATI are not subject to cancellation or suspension except with the advance written consent of ATI and upon terms which will compensate ATI for and indemnify ATI from and against loss or damage occasioned by such cancellation or suspension, including without limitation for all costs and expenses already incurred or commitments made by ATI in connection with the processing, purchasing, handling, and fabrication of equipment for the order and a reasonable profit thereon. ATI's determination of such termination charges shall be conclusive.

**H. INSPECTION** - Final inspection and acceptance of products must be made at ATI's facility and shall constitute a waiver by Purchaser of any claim for loss or damage, except for latent defects not reasonably discoverable by such inspection. Purchaser's representative may inspect products during normal business hours and must do so in a manner that does not interfere with ATI operations.

**I. ATI WARRANTY; EXCLUSIVE PURCHASER REMEDY** – All products manufactured by ATI are warranted against defects in material and workmanship for a period of two (2) years after the date that the products were made available for pickup by Purchaser. ATI's warranty excludes any defects resulting from improper or abnormal shipping, operation or maintenance. Purchaser must immediately, and in no event later than thirty (30) days after becoming aware of a suspected defect, notify ATI in writing of any such suspected defect. Within a reasonable time following ATI's receipt of such notice, investigation and confirmation of a defect, ATI will have the right and the obligation, in its sole discretion, to repair at no cost to Purchaser such defect or replace the defective product or component thereof with a non-defective product or component thereof. Repair or component replacement by non-ATI authorized agents WILL VOID all remaining warranty on the product. Products purchased by ATI from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. ATI's repair or replacement obligations under this Paragraph I do not extend to any labor or other loss or damage occasioned by, incidental to, or in consequence of any such defect. Purchaser's sole and exclusive remedy and ATI's obligation and liability for breach of warranty are expressly limited to such repair or replacement. Goods repaired or replaced during the warranty period shall be in warranty for the remainder of the original warranty or ninety (90) days, whichever is longer. All other remedies of Purchaser are hereby expressly excluded. **THE WARRANTY CONTAINED IN THIS PARGARAPH I IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY ATI WITH RESPECT TO ITS PRODUCTS AND SUPERSEDES AND IS IN LIEU OF ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, ALL OF WHICH ARE HEREBY EXPRESSLY DISCLAIMED.** Purchaser acknowledges and agrees that ATI Manuals, printed materials and any other documentation do not constitute warranties of any kind, including with respect to quality or performance. Purchaser is expected to determine the suitability of ATI products for ordinary and Purchaser's particular purposes.

**J. EXCLUSION OF CONSEQUENTIAL DAMAGES; LIMITATION OF DIRECT DAMAGES** - ATI shall not be liable for and Purchaser shall have no right to recover from ATI for any indirect, special or consequential damages, even if ATI has actual notice of any special circumstances from which any such damages might arise. Moreover, subject to Paragraph I which would completely bar any such recovery of direct damages if ATI honors its warranty, in no event shall any recovery of direct damages against ATI exceed the amount of the order price attributable to the portion of the product or products that is determined to have caused any alleged loss, damage or injury that is compensable under these Terms and Conditions and not remedied by ATI.

**K. RETURNS** – No product may be returned for credit or adjustment without written permission and tagging instruction from ATI. Upon receipt of approved returns, any handling/restocking charges and/or cost to recondition for resale, will be the responsibility of Purchaser.

**L. GOVERNING LAW; VENUE AND JURISDICTION** - All sales of products by ATI and any disputes arising out of or related to such sales or products or these Terms and Conditions shall be governed by, and these Terms and Conditions shall be construed in accordance with, the laws of the State of Texas, without regard to its conflicts of law principles that would apply the law of another jurisdiction. The United Nations Convention on Contracts for the International Sale of Goods is expressly disclaimed by and excluded from these Terms and Conditions. ATI's offer of sale may only be accepted in Harris County, Texas and any resulting contract is performable in whole or in part in Harris County, Texas. Venue for any litigation arising out of such sale, products or contract shall be proper in the state or federal district courts of Houston, Harris County, Texas, U.S.A., to the exclusive jurisdictions of which Purchaser hereby expressly submits.

**M. NON-WAIVER** – Any waiver by ATI of any breach of any of these Terms and Conditions must be set forth in a writing signed by an authorized representative of ATI and shall not constitute a waiver of or otherwise prejudice ATI's right to demand strict performance of any other term or condition of these Terms and Conditions.

**N. REMEDIES CUMULATIVE** – ATI's remedies pursuant to these Terms and Conditions and applicable law are cumulative in nature and election or pursuit of any such remedy shall not prohibit ATI from electing or pursuing any other such remedy.

**O. SEVERABILITY** – In the event that any provision or portion of any provision of these Terms and Conditions is held void, invalid or unenforceable, such void, invalid or unenforceable provision or portion thereof shall be deemed severed from these Terms and Conditions, and the balance of these Terms and Conditions shall remain in full force and effect.

**P. EXPORT / IMPORT** - Buyer agrees that all applicable import and export control laws, regulations, orders, and requirements, including without limitations those of the United States will apply to the receipt and use of the Goods and Services provided by ATI. In no event shall Buyer use, transfer, release, import, export, re-export Goods in violation of such applicable laws, regulations, orders, or requirements.

**Q. BUYER SUPPLIED DATA** – To the extent that Seller has relied upon any specification, information, representation of operating conditions or other data or information supplied by Buyer to ATI, in the selection, or design of the Goods and the preparation of ATI's quotation, and in the event that actual operating conditions or other data differ from those represented by Buyer and relied on by ATI, any warranties or other provisions contained herein are null and void. To the degree such data errors cause re-design or re-manufacture of the Goods, Buyer shall be responsible for additional costs incurred by ATI.

## 12 Revision Record

Refer to the NON-WARRANTY CLAUSE in section 4.5.9.

Rev #	Issue Date	Description	Reviewed	Approved
A	12/22/2016	Initial Release	G. Hunter	D. Leese
B	12/27/2016	Changes to Position Transducer, Positioner, and Pressure Switch component IOMs	G. Hunter	D. Leese
C	6/06/2017	Updated Start-up procedure with PLC/HMI information.	G. Hunter	D. Leese

## APPENDIX A

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