Service Instructions
MAN-02-08-77-0714-EN Rev. 2
September 2020

Bettis™ SMART EHO (Electro-Hydraulic Operated)

Double-Acting Actuator

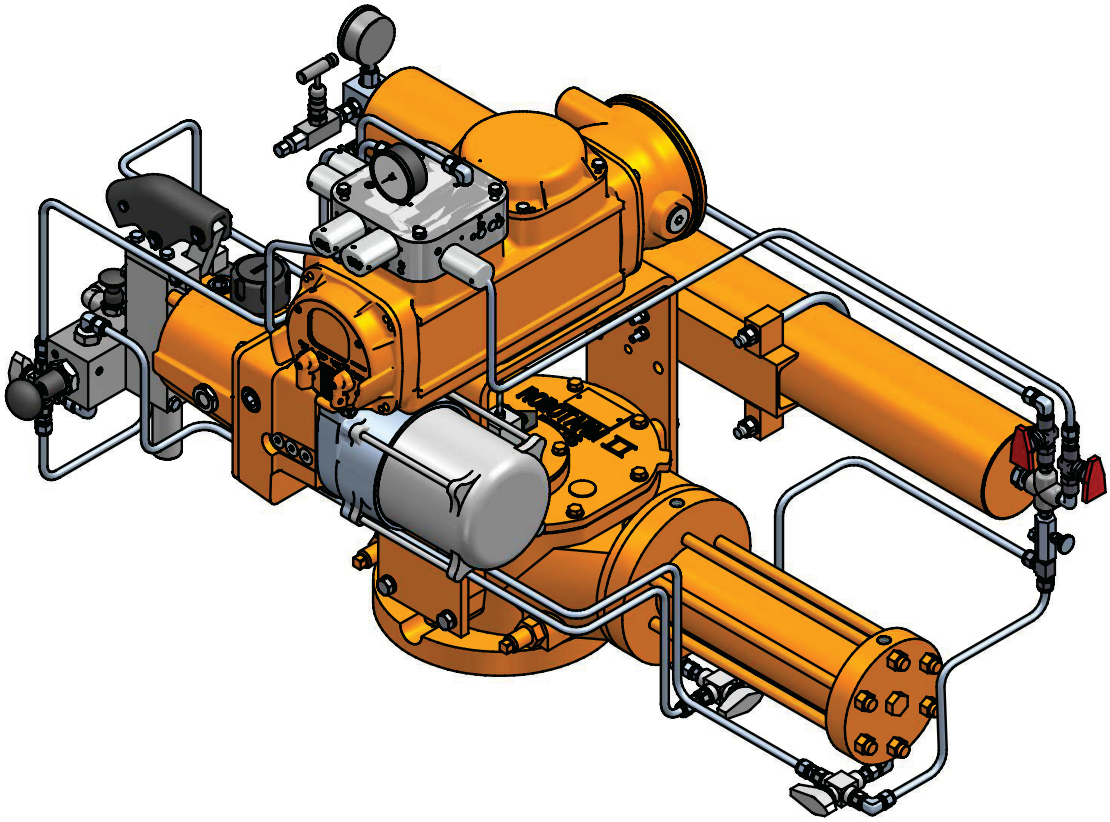

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Table of Contents

Section 1: Introduction

1.1 Scope

This manual is offered as a guide to be used along with locally approved and safe practices to install, operate, service and maintain the Bettis SMART EHO Actuator. Carefully follow the instructions in this manual and make sure you install the actuator correctly and according to your requirements.

1.2 General Information

1.2.1 Overview

The Bettis SMART EHO is a self-contained, quarter-turn, valve actuator that combines proven technologies from Emerson's Actuation Technologies. The actuator has been designed for critical shutdown applications where reliability is crucial. The SMART EHO utilizes a dependable double-acting actuator combined with an integral hydraulic power pack and electronic control module.

The SMART EHO accepts a wide range of single-phase, three-phase or DC power sources. A hydraulic hand pump can be used to stroke the actuator during commissioning or in the event of an emergency power loss.

Electronic modules are contained within an explosion proof, IP68 enclosure and all electronic components are isolated from the customer connection terminals.

The SMART EHO provides a compact design with actuator and control components that have been field proven for decades in critical service applications.

The SMART EHO is designed for modulating ESD applications and comes with alert, alarm, diagnostic, and self-calibration features.

1.2.2 Product Attribute

- Easy installation – Bettis™ SMART EHO actuator is a totally self-contained system and designed for compactness and adaptable to new or existing valves
- Bettis™ G-Series hydraulic double-acting or double-acting fail-safe actuator
- Shafer™ hydraulic control technology
- EIM™ electronics and communication technology
- Multiple input power options with either AC or DC
- Local lockable Remote/Local/Offline selector switch
- Local open/close selector knob
- Partial stroke test
- Fast speed of operation to fail-safe position if required
- Emergency shutdown – independent safety circuits and solenoid valve
- Dual sealed Separate Terminal Chamber, allows installation wiring to be performed or fuses to be replaced without exposing control components to hostile environmental conditions

- Control enclosure is made of low-copper aluminum alloy, salt resistant also rated for IP68 ingress protection
- Hydraulic hand pump manual override
- Accumulators (optional)
- Operating pressures up to 3000 psi with standard components
- Easy control over actuator stroking speeds – The stroking speed is controlled through adjustable hydraulic flow control valves. This enables field personnel to easily adjust actuator stroking speed to comply with field requirements
- Communication support through Modbus, HART, Foundation Fieldbus
- Supports configuration, monitoring, and diagnostics with DCMlink
- Over 15 alerts and alarms
- Diagnostics and self-calibration features
- Modulate with 4-20 mA analog input

1.3 Safety Information

Safety notices in this manual detail precautions the user must take to reduce the risk of personal injury and damage to the equipment. The user must read these instructions in their entirety. Failure to observe these safety notices could result in serious bodily injury, damage to the equipment, void of the warranty. Take special notice of all tags, warning labels and instructions presented on the actuator. These may provide more specific and significant information regarding the actuator than this general manual.

It is the responsibility of the user to ensure proper safety practices are utilized. Always take necessary precautions and use proper protective equipment when dealing with compressed gasses, compressed hydraulic fluid, pinch points and electricity.

Safety notices are presented in this manual in three forms (Warning, Caution and Note) as follows:

⚠ WARNING

Alerts user of potential danger; failure to follow the warning notice could result in serious personal injury or death.

⚠ CAUTION

Identifies precautions the user must take to avoid personal injury or equipment damage.

NOTE:

Highlights information critical to the user's understanding of the Bettis SMART EHO valve actuator installation or operation.

1.4 Abbreviation Definitions

Abbreviations used in this manual and their definitions are listed in the table below:

Table 1. Abbreviation Definitions

Abbreviation	Definition
IOM	Installation Operation Manual
ESD	Emergency Shutdown
FS	Fail-safe
SR	Spring-Return
DA	Double-Acting
MAWP	Maximum Allowable Working Pressure
MOP	Maximum Operating Pressure
STC	Separate Terminal Chamber
PST	Partial Stroke Test
FST	Full Stroke Test
LDM	Local Display Module
RDM	Remote Display Module
CBM	Circuit Breaker Module
PCB	Printed Circuit Board
LS	Limit Switch
PS	Pressure Switch
NC	Normally Closed
NO	Normally Open
CCW	Counterclockwise
CW	Clockwise
OL	Overload
PPE	Personal Protective Equipment
GA	General Arrangement Drawing
SOV	Solenoid Valve
NO	Normally Open
NC	Normally Closed
CAM	Communication Adapter Module

Section 2: Installation

2.1 Preparation

2.1.1 Delayed Usage

If for any reason the actuator is not to be installed immediately, Bettis recommends the following procedures. Failure to comply, with recommended procedures, could lead to actuator malfunction and possibly void the warranty. For storage procedures exceeding one year, consult Bettis for further recommendations.

As shipped from the factory, the Bettis SMART EHO actuator is an inherently weatherproof unit, providing that all compartment covers and cable entry plugs remain intact. The actuator should be immediately stored in a clean, dry warehouse, free from vibration and rapid temperature changes, until it can be installed and energized.

If the actuator must be stored outside, store it off of the ground at an elevation sufficient to prevent it from being immersed in water or buried in snow. Check for any unpainted or exposed metal surfaces and make sure they are protected with a coating of grease to prevent any corrosion. Cover the actuator to prevent damage from site debris.

2.1.2 Tools and Materials Required

To complete these procedures, you will need the following documentation for the Bettis SMART EHO Actuator and items indicated in the table below:

- General Arrangement Drawing
- Bill of Material
- Hydraulic System Schematic
- System Wiring Diagram

Table 2. Tools and Material Requirements

Tools and Material Requirements
Primary Power Source for the SMART EHO (check the SMART EHO System Electrical Diagram for requirements)
Supplemental quantity of hydraulic fluid, if needed (See 2.7, Hydraulic Fluid and SMART EHO specification, for required fluid type)
Nitrogen Source (if an Accumulator is supplied with the SMART EHO)
Hand Tools: complete complement of open end (SAE and metric) wrenches, screw drivers Philips and flat blade and a set of hex wrenches
Chains and lifting straps that are inspected and certified for the weight of the SMART EHO Actuator (check shipping weights)
Sealant for all cable and conduit entries (approvable by the National Electric Code or your country standard and applicable local codes)

2.2 Valve Preparation

2.2.1 Remove Valve Gearing if equipped.

2.2.2 If valve is equipped with stops, remove valve stem extension housing. Examine the valve stops to ensure no foreign material is present that would restrict normal travel of the valve. Some valves are equipped with inspection ports in the valve housing for ease in examining the stops.

2.2.3 Check alignment of stem key slot to the position of the valve. Normally with the valve in the open position, the key slot is in line with the run of the pipeline. With the valve in the closed position, the key slot should be 90° to the run of the valve.

2.2.4 The SMART EHO Actuator may be mounted to the valve at any time regardless of whether or not the valve is under pressure.

2.3 Actuator Preparation

2.3.1 Once the SMART EHO Actuator is uncrated and cleaned for installation, check to ensure there will be no interference with piping or other structure when the actuator is properly mounted to the valve.

NOTE:

At this point, check to see that when the actuator is mounted to the valve and in its final orientation, the outboard end of the power cylinder positioned below the Hydraulic Reservoir Breather. If this is not possible, contact Bettis for further instructions on piping to elevate the breather. See Vertical Mounted Actuator 2.4.4.

2.3.2 Check that all mounting materials such as fasteners, adapters, brackets etc. are on hand and ready for use.

2.3.3 Check the actuator and valve to see that they are in the same relative position, that is either open or closed. If the actuator has to be moved, use the hand pump provided. For hand pump operation, remove the plug in the reservoir and install the breather (refer to 4.4 Hand Pump Operation).

2.4 Lifting the EHO Actuator

NOTE:

All Bettis EHO G-Series Considerations
When handling any EHO G-Series, be aware of tubing, accessories, hand pump, accumulators, Pushbutton module and control enclosures. Straps and chains can become entangled and cause damage to these components. Never use chains on the spring cartridge as it may warp and cause the actuator not to function correctly or may cause personal injury.

NOTE:

Do not use hydraulic tubing and electrical cable for lifting.

⚠ CAUTION

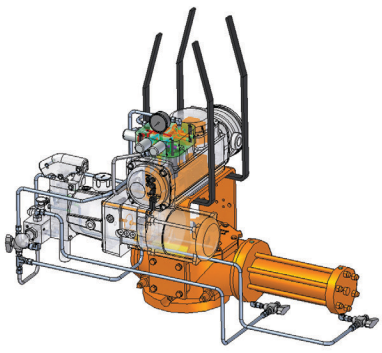
Be sure to use appropriately rated crane/hoist and straps/chains to raise and lower the actuator.

2.4.1 G01X – G2 and All E-Series Actuators

2.4.1.1 Horizontal Pipeline Vertical Stem

The small G-Series and all E-Series actuators mounting on a horizontal pipeline with a vertical valve stem should be supported under the "C" bracket and a two-point attachment for balance. A strap may be attached to the stabilization tab on the spring module to balance the unit while lifting. The weight of the actuator must be supported at the "C" bracket, not the stabilization tab. See Figure 1.

Figure 1 G01 – G2 and all E-Series Actuators with Horizontal Pipeline and Vertical Stem



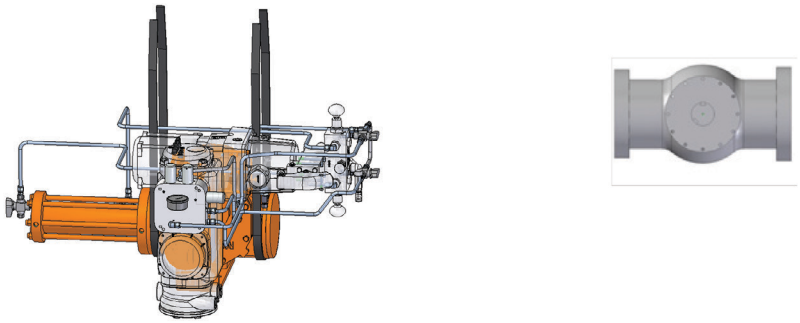
⚠ CAUTION

Never lift the actuator with a valve attached. Always handle actuator/valve assemblies by attaching lifting equipment to the valve only.

2.4.1.2 Horizontal Pipeline Horizontal Stem

The small G-Series and all E-Series actuators mounting on a horizontal pipeline with a horizontal valve stem should be supported on the ends of the drive module. A strap may be attached to the stabilization tab on the spring module to balance the unit while lifting. The weight of the actuator must be supported at the drive module, not the stabilization tab. See Figure 2.

Figure 2 G01 – G3 and all E-Series Actuators with Horizontal Pipeline and Horizontal Stem

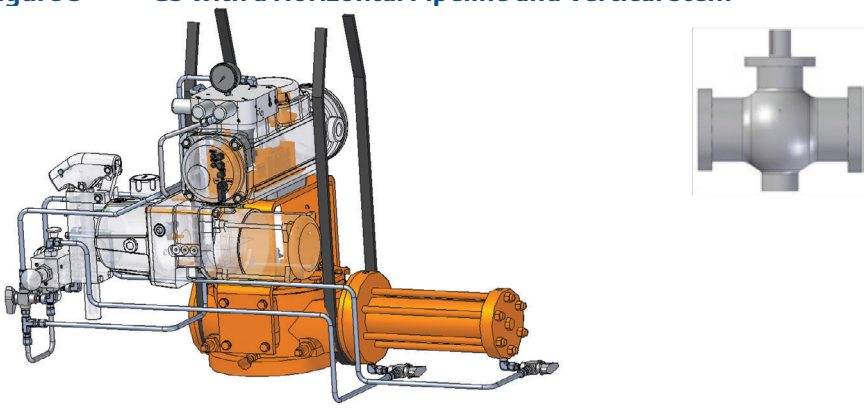


2.4.2 G3-Series Actuators

2.4.2.1 Horizontal Pipeline Vertical Stem

The G3-Series actuator mounting on a horizontal pipeline with a vertical valve stem should be supported at the ends of the drive module. A strap may be attached to the stabilization tab on the spring module to balance the unit while lifting. The weight of the actuator must be supported at the drive module, not the stabilization tab. See Figure 3.

Figure 3 G3 with a Horizontal Pipeline and Vertical Stem



⚠ CAUTION

Never lift the actuator with a valve attached. Always handle actuator/valve assemblies by attaching lifting equipment to the valve only.

2.4.2.2 Horizontal Pipeline Vertical Stem

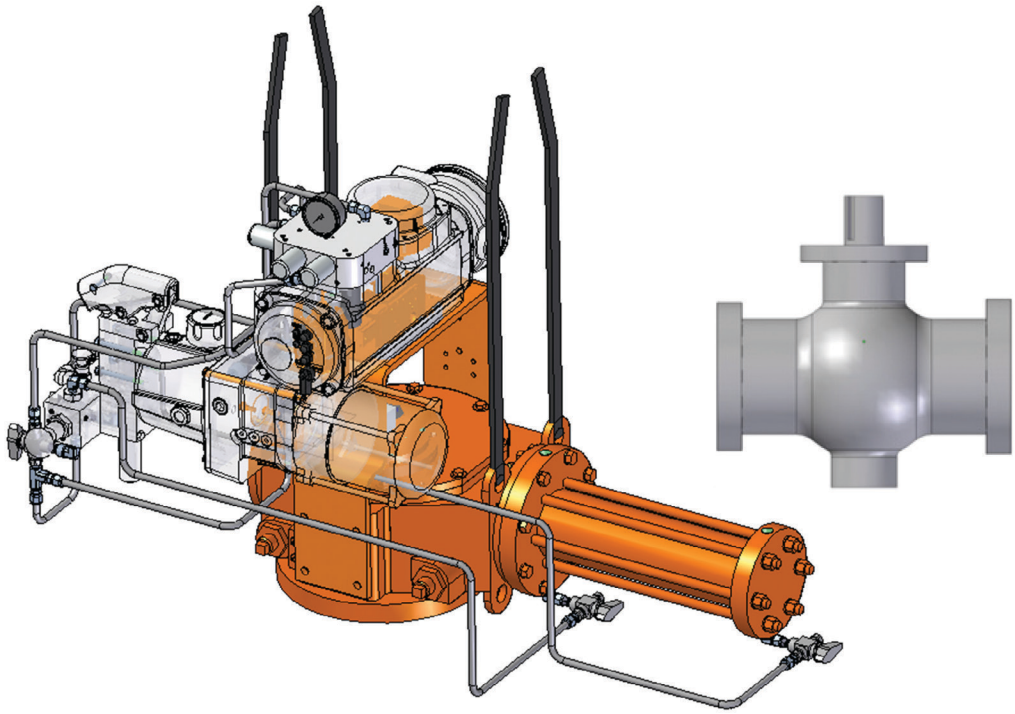
The G3-Series actuator mounting on a horizontal pipeline with a horizontal valve stem should be supported on the ends of the drive module. A strap may be attached to the stabilization tab on the spring module to balance the unit while lifting. The weight of the actuator must be supported at the drive module, not the stabilization tab. Be sure to use appropriately rated crane/hoist and straps/chains to raise and lower the actuator. See Figure 2 above.

2.4.3 G4 – G7 Series Actuators

2.4.3.1 Horizontal Pipeline Vertical Stem

The G4 – G7 Series actuators mounting on a horizontal pipeline with a vertical valve stem should be supported using the lift lugs attached to the drive module. A strap may be attached to the stabilization tab on spring module to balance the unit while lifting. The weight of the actuator must be supported by the lugs at drive module, not the stabilization tab. See Figure 4.

Figure 4 G4 – G7 with a Horizontal Pipeline and Vertical Stem



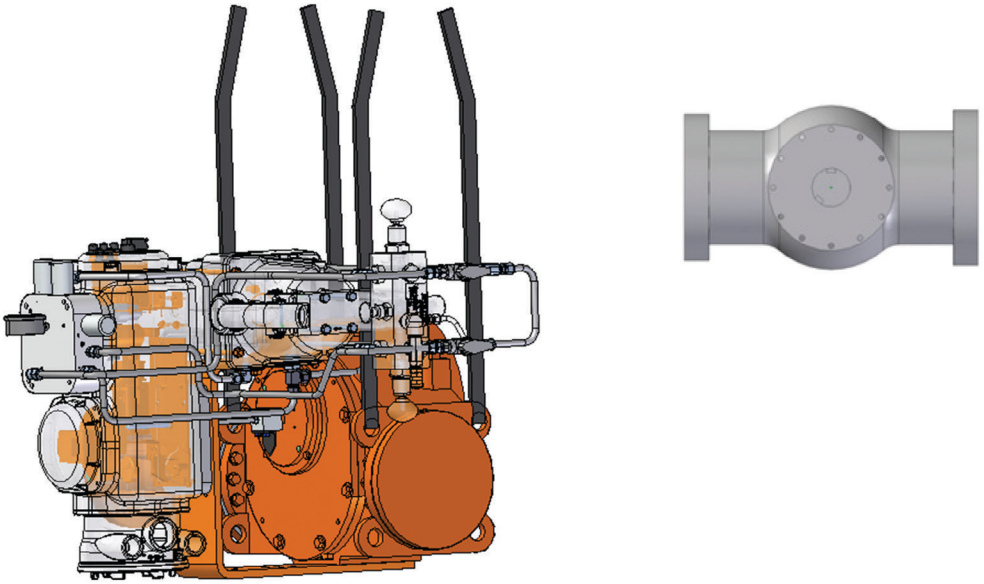
⚠ CAUTION

Never lift the actuator with a valve attached. Always handle actuator/valve assemblies by attaching lifting equipment to the valve only.

2.4.3.2 Horizontal Pipeline Horizontal Stem

The G4 – G7 Series actuators mounting on a horizontal pipeline with a vertical valve stem should be supported using the lift lugs attached to the drive module. A strap may be attached to the stabilization tab on spring module to balance the unit while lifting. The weight of the actuator must be supported by the lugs at drive module, not the stabilization tab. See Figure 5.

Figure 5 G4 – G7 with a Horizontal Pipeline and Horizontal Stem



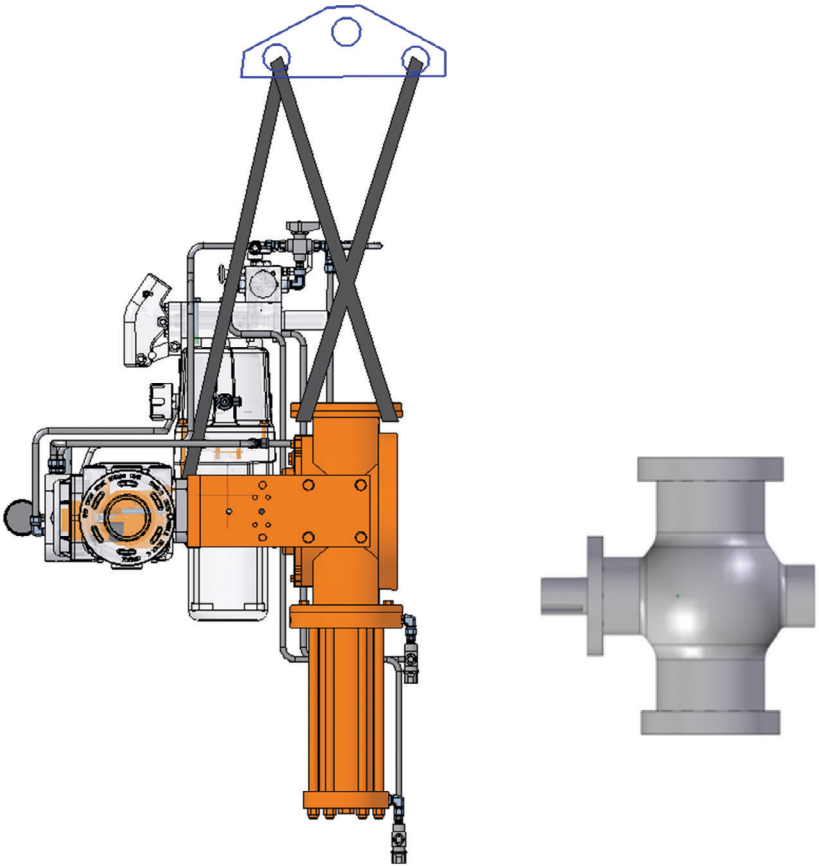
⚠ CAUTION

Never lift the actuator with a valve attached. Always handle actuator/valve assemblies by attaching lifting equipment to the valve only.

2.4.4 Mounting the Actuator in a Vertical Orientation on a Horizontal Stem

When mounting an Bettis EHO Actuator in a vertical orientation, the Spring Module must be positioned up. The actuator may be supported by using two straps in the configuration shown in Figure 6. A third strap or small chain may be attached to the stabilization tab on spring module to balance the unit while lifting. The weight of the actuator must be supported by the straps running over the spring module and under the drive module flange.

Figure 6 Vertical Actuator Lift



⚠ CAUTION

Never lift the actuator with a valve attached. Always handle actuator/valve assemblies by attaching lifting equipment to the valve only.

NOTE:

When a vertical EHO Actuator is mounted to the valve, and in its final orientation, the spring module must be up and outboard end of the power cylinder positioned below the Hydraulic Reservoir Breather. If not possible, contact Bettis for further instructions on piping to elevate the breather.

2.5 Installing the EHO Actuator on the Valve

The actuator will be bolt-mounted directly to a bracket or adaptor that will be bolted securely to the mounting flange top works of the valve.

2.5.1 Check to see that the dimensions of the bracket or adaptor are suitable for use with the valve mounting flange and stem.

2.5.2 Check valve direction of rotation and the actuator direction of rotation to see they match (for example: CW = close, CCW = open).

2.5.3 Check to see the actuator and valve are in the same relative position (see 2.3.3).

2.5.4 Check all mounting surfaces, they must be clean and free of debris to permit proper fit up.

2.5.5 Prior to mounting, grease the coupling bore and the bore of the actuator.

NOTE:

Do not apply grease to the mounting flange surfaces on the valve or the adaptor.

2.5.6 Install the stem key and grease it (keys may be held in place with tape).

2.5.7 Install the coupling onto the stem and stem key.

2.5.8 Install the coupling key and grease it.

2.5.9 Carefully align the coupling and key to the bore and keyway in the actuator and slide the actuator onto the coupling until the adapter (bracket) bottoms out on the valve bonnet.

NOTE:

Ensure the adapter seats out on the valve bonnet, without interference, before installing fasteners.

2.5.10 Use the required fasteners to firmly attach the adapter to the valve bonnet. Tighten the fasteners to their manufacturer's recommended maximum torque (dry or lubricated).

2.6 Setting the Stroke Limit Stops

2.6.1 The Bettis G or E-Series Actuator is provided with bi-directional travel stops allowing 80° to 100° total travel (+/- 5° adjustment at each end of the 90° stroke).

2.6.2 Actuators are shipped from the factory with the travel stops adjusted for approximately 90° rotation. Generally, it is necessary to make slight travel stop adjustments once the actuator is installed on the valve. Refer to the valve manufacturer's recommendations for specific requirements.

2.6.3 When the valve has internal stops, the actuator stops must be set so that the load is applied to them, not the valve stops.

2.6.4 If adjustment is required, use the hand pump to move the actuator off the stop at the Fail-safe Position before attempting to turn the adjusting screw (refer to 4.4, Hand Pump Operation).

⚠ CAUTION

Always use the hand pump to move the actuator off the stop before attempting to turn the adjusting screw.

2.6.5 With the Fail-safe Position stop set, use the hand pump to move the actuator to the other end of the stroke and check the stop position. If adjustment is required, slowly pump the actuator off the full stroke position.

2.7 Hydraulic Fluid

Bettis Electro-Hydraulic Operated actuators are shipped with the reservoir filled to operation level. Before commissioning and periodically afterwards, check to see the fluid level is correct. The oil fill cap is provided with a dipstick marked with a green and a red mark. When the optional accumulator is drained of fluid and the actuator is at Fail-safe Position, the oil should be at the green mark. The reservoir also has a sight gauge for the purpose of seeing fluid is present. Should fluid need to be added or replaced, use only factory approved hydraulic fluid.

This specification covers hydraulic fluids which are approved by engineering for use in Bettis Electro-Hydraulic Operated actuator in a temperature range from -40°F to 140°F (-40°C to 60°C).

2.7.1 Approved Fluids

Standard Fluid [use with -20°F to 140°F (-29°C to 60°C) applications]

ConocoPhillips Megaflow™ AW HVI Hydraulic Oil 22

Shell Tellus S2 V 22

Mobil DTE 10 Excel™ 22

Low Temperature Fluid [use with -40°F to 140°F (-40°C to 60°C) applications]

Mobil Univis™ HVI 13

Although other brands of fluid matching the same specifications may be used, to maintain the warranty and ensure trouble free operation, always check with the factory before substituting any other fluid.

2.8 Accumulator (Optional)

2.8.1 Introduction

The Bettis SMART EHO Actuator may be equipped with an accumulator for modulating valve control or to enable manual operation of the actuator if there is a loss of electrical power. Accumulators always have the nitrogen pressure drained for shipping.

When using this procedure, refer to the Bettis SMART EHO Actuator General Arrangement drawing and Hydraulic Schematic for the unit being worked on. Schematics shown in this document are for illustration purposes only.

⚠ WARNING

This unit contains high-pressure hydraulic fluid and nitrogen gas. Exercise caution when performing any type of maintenance. Wear proper safety attire and required personal protective equipment, including safety glasses.

2.8.2 Accumulator Pre-charge

a. Locate Isolation Valve (Nitrogen Blow Down and Fill) for the Customer Nitrogen Fill Connection, called out on the General Arrangement Drawing and Hydraulic Schematic (see illustration below).

b. Close the Isolation Valve (Nitrogen Blow Down and Fill) and remove the pipe plug from the adaptor.

NOTE:
The Adaptor is tapped with a 1/4-NPTF thread.

c. Ensure 3-way Isolation Valve is turned fully counterclockwise.

d. Slowly open Isolation Valve (Accumulator drain) and drain all the fluid back to the reservoir.

e. Connect a nitrogen supply to the Customer Nitrogen Fill Connection at Isolation Valve (Nitrogen Blow Down and Fill).

f. Open the Isolation Valve (Nitrogen Blow Down and Fill) and charge the Accumulator, to the pre-charge pressure as specified by the Pressure versus Temperature Graph on the General Arrangement Drawing.

NOTE:

For temperatures, which do not appear on the graph, the formula to calculate the pre-charge pressure shown on the General Arrangement Picture Assembly should be used.

NOTE:

Recheck the pre-charge pressure after a time interval sufficient to insure the nitrogen pressure is equal to the ambient temperature (a minimum of 4 hours). Adjust the pre-charge pressure as required to conform to the Pressure versus Temperature graph.

g. After the nitrogen filling is complete, close the Isolation Valve (Nitrogen Blow Down and Fill).

h. Disconnect the nitrogen supply and remove the female pipe adaptor from Isolation Valve (Nitrogen Blow Down and Fill).

i. Install the straight thread plug and O-ring, shipped as an accessory, into Isolation Valve (Nitrogen Blow Down and Fill).

NOTE:

The straight thread plug must be installed, after filling is complete, to prevent accidental leakage of nitrogen from Isolation Valve (Nitrogen Blow Down and Fill).

j. Close Isolation Valve.

Figure 7 Typical EHO Optional Accumulator System

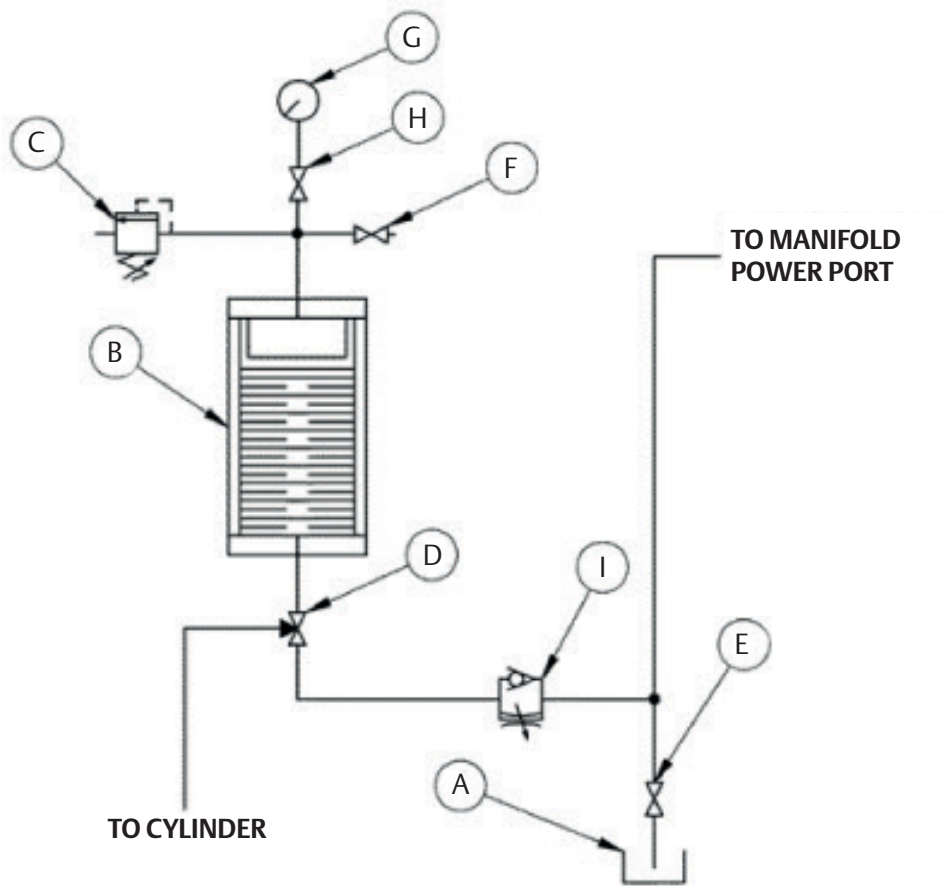


Table 3. Typical EHO Optional Accumulator System

Part Number	Part Name
A	Reservoir
B	Accumulator
C	Nitrogen Relief Valve
D	3-way Isolation Valve
E	Isolation Valve (Accumulator Drain)
F	Isolation Valve (Nitrogen Blow Down and Fill)
G	Nitrogen Pressure Gauge
H	Nitrogen Gauge Isolation Valve
I	Speed Control

2.8.3 Pre-charge Verification

Check the nitrogen pre-charge in the accumulator periodically to ensure the accumulator is at full potential. Follow the steps below and record final readings for reference.

a. Shut off the hydraulic power supply to the accumulator.

b. Ensure 3-way Isolation Valve (D) is turned fully counterclockwise.

c. Slowly open Isolation Valve (Accumulator drain) (E) and drain all the fluid back to the reservoir.

d. Read the pressure at the nitrogen pressure gauge (G) and compare it to the Oil/Temperature Chart shown on the General Assembly Drawing for the job being checked.

e. If the pre-charge is low, add nitrogen to increase the pressure to the requirements listed on the GA Oil/Temperature Chart. See 2.8.2, Accumulator Pre-charge, if the pre-charge is high relieve pressure to equal the GA Oil/Temperature Chart.

f. Record Information below.

g. With bypass valve closed, reconnect the hydraulic power supply and bring the accumulator back up to full pressure.

h. Check the entire nitrogen circuit for leaks using a liquid leak detector such as Snoop (manufactured by Swagelok). As the unit is self-contained, only a zero leak rate is acceptable. Corrective action must be taken for any leaks found.

⚠ WARNING

This unit contains high-pressure hydraulic fluid and nitrogen gas. Exercise caution when performing any type of maintenance. Wear proper safety attire and required personal protective equipment, including safety glasses. Ensure the accumulator has been drained of all hydraulic and nitrogen pressure before attempting any repair.

2.8.4 Nitrogen Pre-charge Maintenance Record

Serial Number: _____

Tag Number: _____

Date	Initial Pre-charge	GA Chart Requirement	Final Pre-charge	Nitrogen Leak Test	Signed

Section 3: Electrical Connections

3.1 Remove Separate Terminal Chamber (STC) Cover

⚠ WARNING

Always verify electrical power is disconnected before removing the STC cover.

3.1.1 Remove cover with a strap wrench, drift, or pinch bar by rotating the cover counterclockwise.

Figure 8 Remove STC Cover Turning Counterclockwise

Figure 9 Lay Cover Aside

3.2 Sealing Cable/Conduit Entries

Seal the cable and conduit entries in accordance with the National Electric Code or your country standard and applicable local codes. All conduit entries should be sealed against the site environment. All unused conduit entries must be sealed with threaded metal plugs.

3.3 Recommended Terminal Connections

The Bettis Electro-Hydraulic actuator terminal block connectors are wire binding screw connectors with rising captive plates. Connections can be made one of three ways:

- Strip and connect bare wire
- Strip and install wire ferrule
- Strip and install crimp-on insulated or non-insulated ring or fork-tongue connectors for either M3 control signal terminal block screws or M4 power terminal screws.

3.3.1 Loosen terminal block connectors L1, L2, L3 and GND screws with a common or Phillips head screwdriver.

3.3.2 If bare wire is being used, strip insulation a maximum of 1/2 inch (12 mm).

3.3.3 Insert wire or wire lug under terminal block connector screw clamps and tighten.

Figure 10 Power Terminal Connection Length of Bare Wire Strip

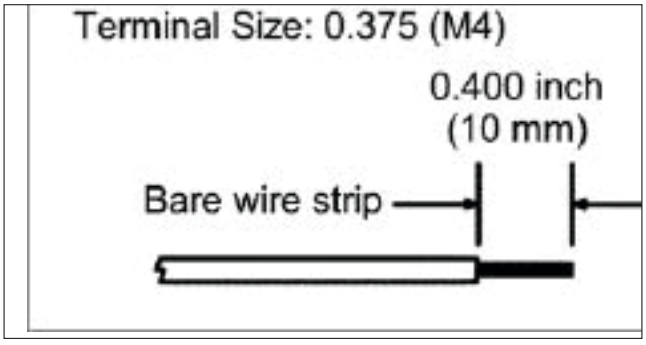
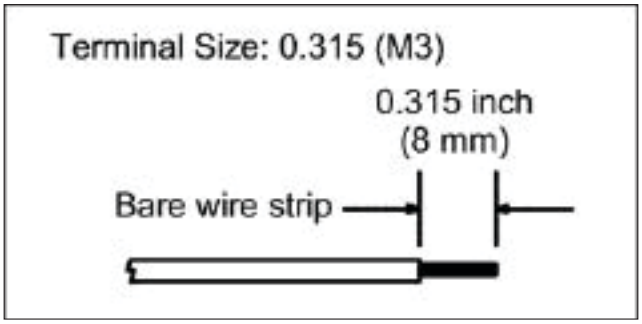


Figure 11 Control Terminal Connection Length of Bare Wire Strip



3.4 Separate Terminal Chamber (STC) Connections

3.4.1 Connect the main power supply cables, including an Earth/Ground (refer to the job specific Wiring Diagram).

3.4.2 Use the barrier strip clamp screws to connect the control wiring (refer to the job specific Wiring Diagram).

3.4.3 Ensure all connections are hand tight, including any unused terminals.

NOTE:

The main power supply and ground wire connections are screw size M4.
The control connection screw size is M3.

3.5 Replace Terminal Chamber Cover

3.5.1 Clean electrical enclosure threads thoroughly and lightly grease with dielectric grease before closing.

3.5.2 Replace the cover by reversing the order of the steps to remove the cover.

3.6 External Earth/Ground Connections

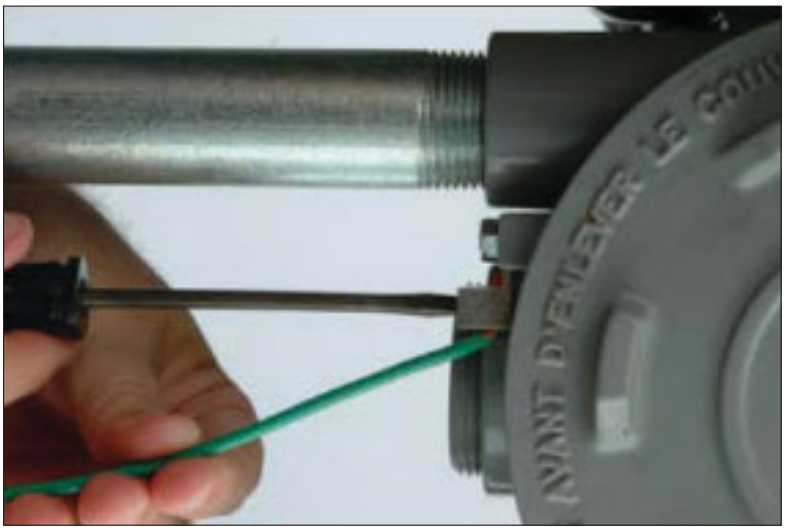
External connection points are provided on the operator for attaching earth/ground in accordance with local electric codes for installation cables.

Connect the external earth/ground connection as follows.

3.6.1 Using a slotted tip screwdriver, back out the 5/16-inch set screw.

3.6.2 Connect 14 AWG or larger earth/ground wire, tighten setscrew.

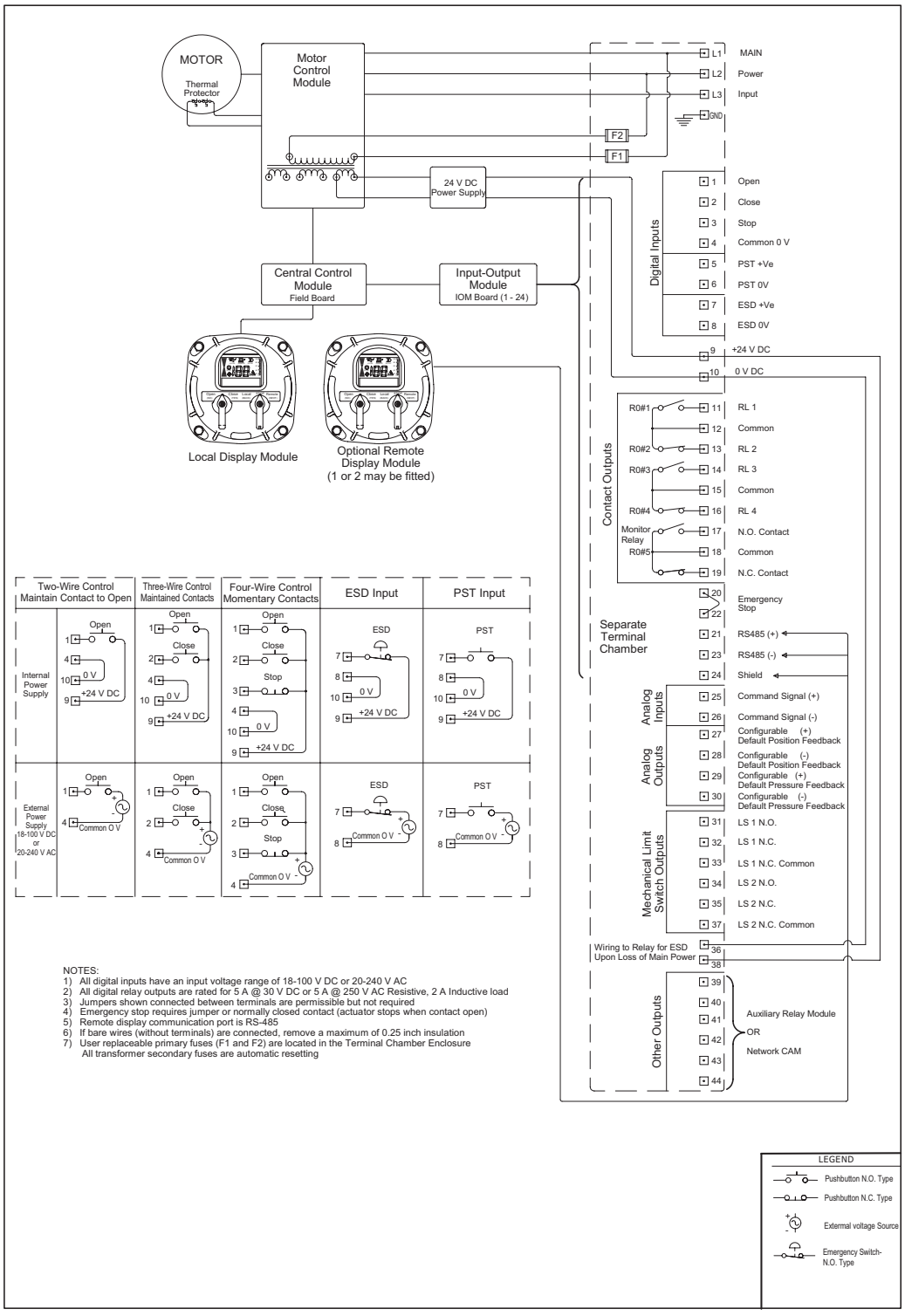
Figure 12 External Earth/Ground Connection



3.7 Discrete Controlled Inputs Connection

The actuator can be controlled by discrete inputs: two-wire control, three-wire control, four-wire valve control. Connect the power for these discrete inputs as detailed in Figures 13. See Section 3.3, Electrical Connections, for general electrical connection requirements.

Figure 13 STC Wiring Diagram



Section 4: Set-up/Start-up Procedure

In addition to this set-up/start-up procedure, the following documentation will be necessary to fulfill all set-up and start-up requirements.

1. General Arrangement drawing
2. Bill of Material
3. Schematic drawing
4. Wiring Diagram drawing

When using these instructions, refer to the schematic diagram, wiring diagram,general arrangement drawings for the Bettis SMART EHO and the certified bills of material.

Numbers in **[ ]** correspond to components labeled on the wiring diagram.
Numbers in **( )** correspond to components labeled on the schematic diagram.
Information in **(( ))** is descriptive.

When the Bettis SMART EHO is delivered to the job site, it has been both pressure and function tested. The oil reservoir was filled to operation level when it shipped from factory.

4.1 Preparation

4.1.1 Safety First

Hydraulic Pressure

⚠ WARNING

Ensure that test personnel and witnesses are properly informed of the hazards involved with high pressures and the proper safety barriers are employed.

Never check for leakage using your fingers or hands. Fluid under high pressure can inject into the skin and cause severe damage or death. Always use an implement such as a piece of paper.

Safety Equipment

⚠ WARNING

All personnel in the testing area must always wear safety glasses.

4.1.2 Material and Equipment for Start-up and Set-up

To complete this procedure, you will also need the following materials and equipment:

Table 4. Required Material and Equipment

Required Material and Equipment
Miscellaneous fittings, adapters and Hand Tools: complete complement of open end ((SAE and metric)) wrenches, screw drivers Philips and flat blade and a set of hex wrenches
Primary Power Source for the SMART EHO ((check the SMART EHO System Electrical Diagram for requirements))
Supplemental quantity of hydraulic fluid, if needed ((See 2.6, Hydraulic Fluid, and SMART EHO specification for required fluid type))
Nitrogen Source ((if an Accumulator is supplied with the SMART EHO))

4.2 Initial Check of the Unit

4.2.1 Check to ensure all hydraulic tube fittings are tight. Vibration during shipment may have loosened connections.

4.2.2 Visually inspect the unit to make sure tubing, hand valves, gauges and other equipment have not been damaged.

4.2.3 Using the Schematic drawing, verify that the Flow Control Valves are fully opened ((turn stem completely counterclockwise)).

4.2.4 Ensure Isolation Valve (Accumulator drain) is closed ((if applicable)).

4.2.5 Ensure Isolation Valve (Nitrogen Blow Down and Fill) is closed ((if applicable)).

4.3 Initial Connections

Electrical connections should have been made to the STC (Separate Terminal Chamber). If power is not connected, follow the instructions under Section 3, Electrical Connections, before continuing. If an ((optional)) Circuit Breaker Module is provided, ensure it is turned to OFF.

⚠ CAUTION

Before the actuator is stroked, check to see it has been filled with fluid to the proper level. (See 2.7, Hydraulic Fluid)

4.4 Hand Pump Operation

4.4.1 2-Way Remote Electric without ESD solenoid function

NOTE:

Hand Pump Isolation Valve
The components referenced below are referencing Schematic 4.4.1. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.4.1.1 Check the Reservoir (I) to see the hydraulic is at the proper level.

4.4.1.2 Rotate downward in the horizontal position both Hand Pump Selector Valves (M).

4.4.1.3 Select and push inward the open or close knob located on the Hand Pump Selector Manifold (L).

4.4.1.4 Use supplied Hand Pump Handle to discharge hydraulic fluid into the open or close side of the actuator cylinder.

4.4.1.5 Continue hand pumping until the actuator completes the open or close stroke and contacts the actuators adjustable end stops.

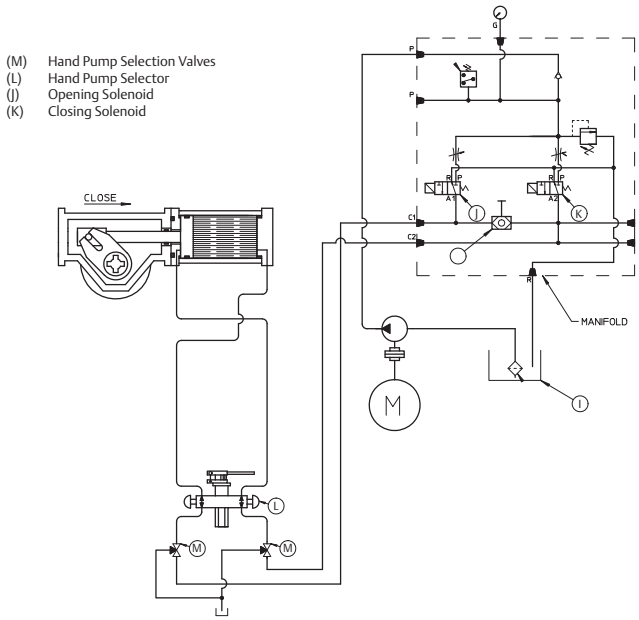
4.4.1.6 Once completion of the Hand Pumping operation, push the Pump Bypass Valve located on the top of the Hand Pump Selector Manifold (L) and pull the pump handle downward retracting the pump ram into the pump body.

4.4.1.7 Rotate both Hand Pump Selector Valves back into the upward vertical position.

4.4.1.8 Check the Reservoir (I) to see the hydraulic fluid is at the proper level.

4.4.2 2-Way Remote Electric with an ESD solenoid function

Figure 14 2-Way Remote Electric Without an ESD Solenoid Function Schematic



NOTE:

The components referenced below are referencing Schematic 4.4.2. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.4.2.1 Check the Reservoir (I) to see the hydraulic is at the proper level.

4.4.2.2 Close Hand Pump Isolation Valve (O).

4.4.2.3 Rotate downward in the horizontal position both Hand Pump Selector Valves (M).

4.4.2.4 Select and push inward the open or close knob located on the Hand Pump Selector (L).

4.4.2.5 Use supplied Hand Pump Handle to discharge hydraulic fluid into the open or close side of the actuator cylinder.

4.4.2.6 Continue hand pumping until the actuator completes the open or close stroke and contacts the actuators adjustable end stops.

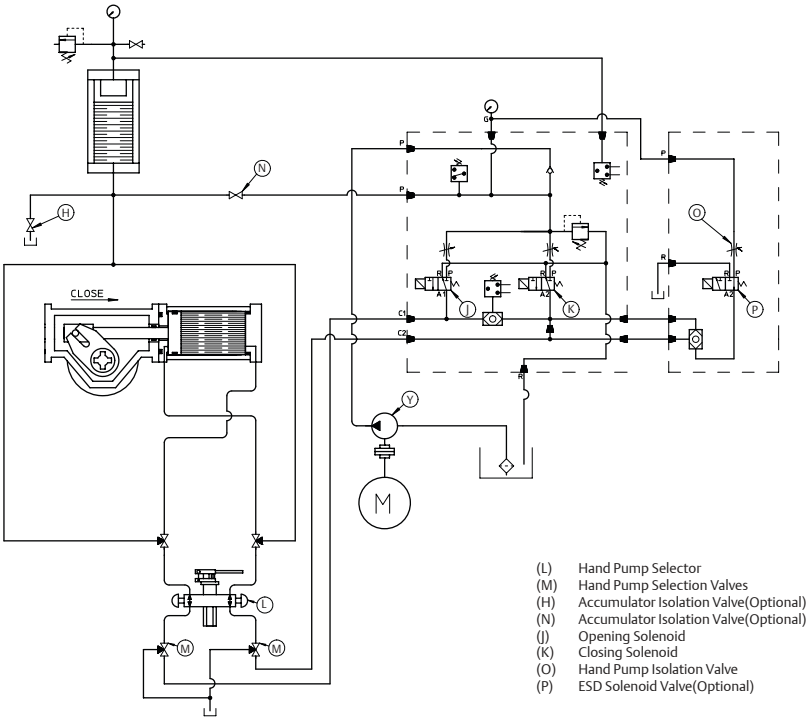
4.4.2.7 After completion of the Hand Pumping operation, push the Pump Bypass Valve located on the top of the Hand Pump Selector (L) and pull the pump handle downward retracting the pump ram into the pump body.

4.4.2.8 Rotate both Hand Pump Selector Valves (M) back into the upward vertical position.

4.4.2.9 Check the Reservoir (I) to see the hydraulic fluid is at the proper level.

4.4.2.10 Once the ESD solenoid signal is re-established, slowly open Hand Pump Isolation Valve (O).

Figure 15 2-Way Remote Electric With an ESD Solenoid Function Schematic



4.4.3 Manual Open or Close with Accumulator Override feature (Optional)

NOTE:

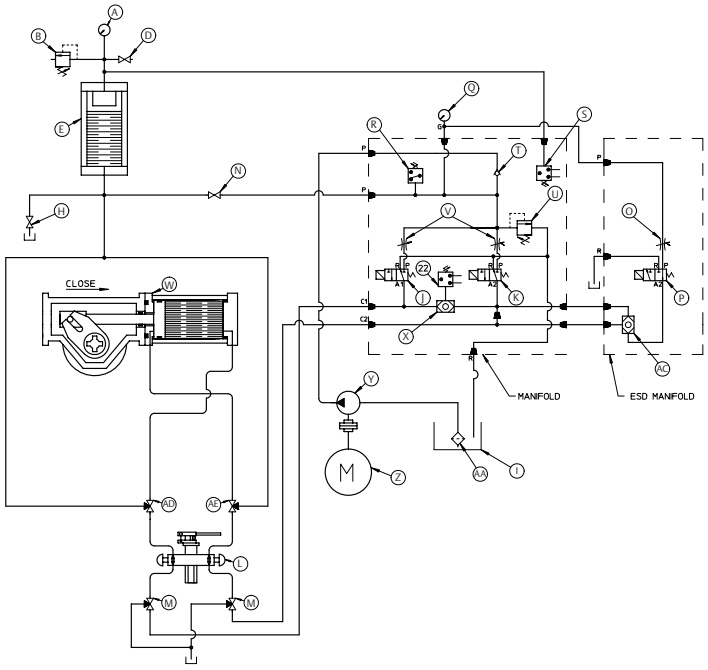
The components referenced below are referencing Schematic 4.4.2. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.4.3.1 Select and slowly open the Accumulator override Isolation Valve (AD) for actuator open stroke and (AE) for actuator closing stroke. The Isolation Valve is in the actuator stroking position when rotated downward to the horizontal position.

4.4.3.2 After completion of the Accumulator manual override stroke, return the Isolation Valve (AD) or (AE) to the upward vertical position.

Figure 16 2-Way Remote Electric With Emergency Shutdown Feature Powered by an Electro-hydraulic power unit

(A) Pressure Gauge (Optional)
(B) Nitrogen Relief Valve (Optional)
(D) Isolation Valve (Optional)
(E) Hydraulic Accumulator With Nitrogen Blanket Charge (Optional)
(H) Accumulator Isolation Valve (Optional)
(N) Accumulator Isolation Valve (Optional)
(R) Pressure Switch
(Q) Hydraulic Pressure Gauge
(S) Pressure Transmitter (Optional)
(T) Check Valve
(V) Adjustable Flow Controls
(U) Relief Valve
(O) Hand Pump Isolation Valve (Optional)
(W) Bettis G-series Double-Acting Actuator
(AB) Pressure Transmitter (Optional)
(J) Opening Solenoid
(K) Closing Solenoid
(P) ESD Solenoid Valve (Optional)
(X) Shuttle Valve (Optional)
(AC) Shuttle Valve (Optional)
(Y) Hydraulic Pump
(AD) Accumulator override valve to open (Optional)
(AE) Accumulator override valve to close (Optional)
(Z) Electric Motor
(AA) Suction Strainer
(I) Fluid Reservoir
(L) Hand Pump
(M) Hand Pump Selection Valves



4.5 Hydraulic Test

The system has been hydrostatic and function tested at the factory before shipping. This test is to discover if any leaks have developed in the hydraulic fittings during shipping.

NOTE:
The components referenced below are referencing Schematic 4.4.2. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.5.1 Rotate both Hand Pump Isolation Valves (O) to the downward horizontal position.

4.5.2 Select and push inward the open or close knob located on the Hand Pump Selector (L).

4.5.3 Use supplied Hand Pump Handle to discharge hydraulic fluid into the open or close side of the actuator cylinder.

4.5.4 Once the actuator is fully stroked and makes contact with the actuators adjustable stops, observe if any leakage is detected at any tube fittings or port connections from the Hand Pump to the Actuators operating ports.

4.5.5 Push the Pump Bypass Valve located on the top of the Hand Pump Selector (L) and pull the pump handle downward retracting the pump ram into the pump body.

4.5.6 Select and push inward the opposite open or close knob located on the Hand Pump Selector (L).

4.5.7 Repeat steps 4.5.3 thru 4.5.5.

4.5.8 Rotate both Hand Pump Selector Valves (M) back into the upward vertical position.

4.6 Check Rotation

NOTE:
The components referenced below are referencing to schematic found in Section 10.2 and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

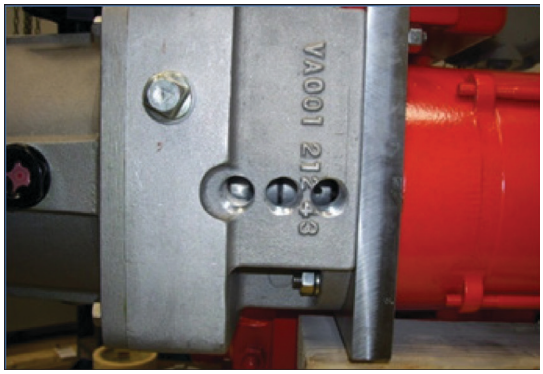
4.6.1 Turn on the electrical supply to the unit. If an ((optional)) Circuit Breaker Module is supplied, turn the Circuit Breaker to ON.

4.6.2 Turn the LOCAL-OFF-REMOTE selector switch to LOCAL.

4.6.3 Ensure Flow Control Valves (V) are adjusted fully counterclockwise for maximum flow.

4.6.4 Open inspection port on side of unit to observe the rotation of the motor/pump shaft.

Figure 17 Inspection Port for Motor Rotation



4.6.5 While observing the inspection port, for motor rotation, push and release the OPEN/CLOSE Selector Switch to Power Stroke the actuator and release the OPEN/CLOSE Selector Switch. Motor rotation should be counterclockwise when looking at the back of the motor.

4.6.6 If needed, correct motor rotation.

NOTE:
If the EHO Actuator is supplied with optional ESD, before operating a motor-powered stroke, a customer supplied ESD signal must be present and Solenoid Valve (P) energized.

4.6.7 Toggle the OPEN/CLOSE Selector Switch to Power Stroke the actuator. The Electric Motor (Z) will start to run driving Hydraulic Pump (Y). The Hydraulic Pump (Y) draws fluid from Reservoir (I) and pushes it into the Bettis G-series hydraulic cylinder (W).

4.6.8 Shut off the electrical power going to the unit, if an (optional) Circuit Breaker Module is supplied, turn the Circuit Breaker to OFF.

4.7 Self-Calibration

NOTE:
Self-calibration must be performed once the SMART EHO is mounted to the valve or if the stop bolts have been adjusted on the actuator.

Self-Calibration establishes the position range of the SMART EHO. The EHO has the ability to automatically find its precise full open and full close set points after adjustments to the mechanical stops is completed. Self-Calibration must be performed after the SMART EHO is securely installed on the valve and before the SMART EHO performs normal operations.

4.7.1 To start Self-Calibration, the SMART EHO must be in the setup menu. Refer to Section 8.1 Entering the Setup Menu and Section 8.2 Change Settings for instructions on how to enter the setup menu, enter the passcode, and navigate the setup menu.

4.7.2 Navigate the setup menu until [S][C] appears on the LCD display. [S][C] is the Menu Key for Self-Calibration. Toggle the NO/YES Selector Switch to Yes to enter self-calibration.

4.7.3 Prior to starting Self-Calibration, the SMART EHO has the following Self-Calibration settings that must be confirmed first:

4.7.3.1 Self-Calibration Cycle Count [S][t] – Set the number of full cycles for the SMART EHO to cycle during self-calibration. One cycle is defined as one open and one close stroke. The parameter can be set to 3 to 5. 3 is the default setting.

4.7.3.2 Pressure Unit [P][u] – Set the pressure unit for the SMART EHO. The parameter can be set to 0(psi), 1(bar), 2(kP). 0(psi) is the default setting. This parameter is factory set.

4.7.3.3 Pressure Spike During Hydraulic Stroke [P][S] – Set the maximum hydraulic pressure of the SMART EHO during self-calibration. This setting is only for motor-based SMART EHO's. Depending on the Pressure Units set in 4.7.3.2, this parameter can vary in its display:
10 - 50 (psi - in multiples of 100)
7 to 35 (bar - in multiples of 10)
7 to 35 (kPa - in multiples of 1000)
This parameter is factory set.

⚠ WARNING

The Pressure Unit and Pressure Spike During Hydraulic Stroke is factory set based on valve torque and safety factor provided. These parameters do not need to be adjusted during commissioning.

4.7.4 Once the Self-Calibration settings have been confirmed, Self-Calibration can now begin. The LCD Display will display [S][c] to designate Self-Calibration is ready to begin. Toggle the NO/YES Selector Switch to YES to start Self-Calibration. Toggle the NO/YES Selector Switch to NO to cancel Self-Calibration.

4.7.5 Once Self-Calibration starts, the SMART EHO will stroke the valve based on the Self-Calibration Cycle Count and set the open and close limits based on the pressure limits set by the Pressure Spike During Hydraulic Stroke and Maximum Operating Pressure set. During Self-Calibration, the LCD Display will show [C][a] to indicate the SMART EHO is calibrating the open and close limits.

4.7.6 Once Self-Calibration is complete, the LCD Display will show either [S][F] to indicate Self-Calibration Failed or [S][P] to indicate Self-Calibration Passed.

NOTE:

If Self-Calibration fails, check for any alarms displayed on the LCD display. If any alarms are displayed, correct each alarm before starting Self-Calibration again. See Section 8.5. Alarms for the list of alarms and the causes of the alarms. If the Self-Calibration continues to fail with no alarms active, please contact an Emerson representative.

4.8 Limit Switch Adjustment

4.8.1 To complete limit switch adjustment, the actuator will need to be stroked from a fully closed position to a fully open position etc. several times. In the following instructions, the electric motor is used to Power Stroke the actuator. If it is not safe or possible to use the electric motor at this time, use the Hand pump to Power Stroke the actuator.

4.8.2 The limit switch adjustments are found in a covered compartment in line with the valve stem and on the opposite side of the control box. Remove the limit switch compartment cover by loosening the four corner bolts retaining it. All covers have tapped holes for jackscrews to aid in removing the cover. Use the retaining screws in these holes to lift the cover evenly at each corner. Use caution to not allow the cover to bind during removal.

Figure 18 Remove Cover for Limit Switch Chamber

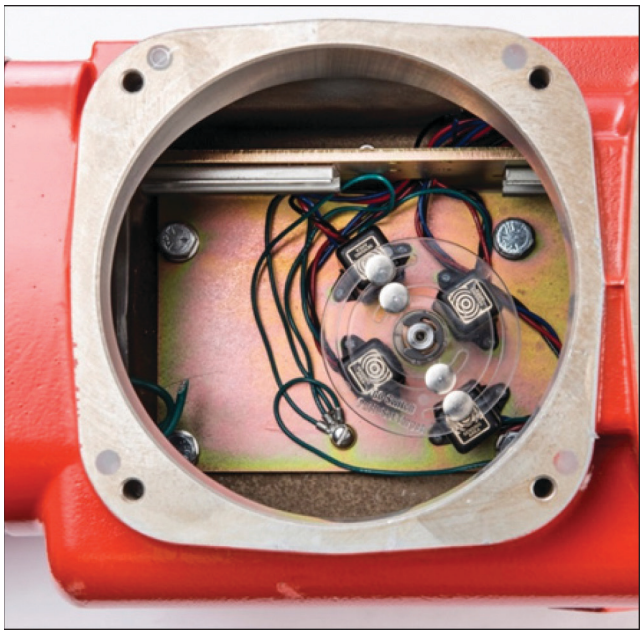
⚠ WARNING

If the actuator is being installed in a hazardous area, use extreme care. This procedure requires the limit switch cover to be open while electrical power is connected to the unit. Follow these steps only when the atmosphere is free of explosive gases.

4.8.3 Close Limit Switch Adjustment

4.8.3.1 The Open and Close Limit Switches, shown in Figure 20, are operated by targets mounted in a plastic disk that rotates with the actuator stroke. To adjust a Target, push down on it and slide it in a clockwise or counterclockwise direction.

Figure 19 View of Limit Switch Targets



NOTE:
The Switch Targets will be labeled to identify the switch they operate.

4.8.3.2 With the actuator in the Close Position, rotated fully clockwise, the Target for CLOSE LS-2 will need to be adjusted.

4.8.3.3 Reconnect electrical power to the unit.

4.8.3.4 Push down on the Target for CLOSE LS-2 and move clockwise until it is off of the switch in the clockwise direction. Both the OPEN and the CLOSE lights on the LDM ((Local Display Module)) should be illuminated at this point.

4.8.3.5 Now, push down and slide the Target for CLOSE LS-2 counterclockwise until the OPEN light just goes out. It is important to always adjust a Target in the opposing direction of the valve travel to get an accurate setting.

4.8.3.6 With the LOCAL/OFF/REMOTE Selector Switch set to LOCAL, toggle the OPEN/CLOSE Selector Switch to OPEN and allow the Actuator to travel to the OPEN position, rotated fully counterclockwise.

4.8.3.7 Push down and slide Target for OPEN LS-1 counterclockwise until it is off the switch in the counterclockwise direction.

4.8.3.8 Now, push down and slide the Target for OPEN LS-1 clockwise until the CLOSE light just goes out.

4.8.3.9 Toggle the OPEN/CLOSE Selector Switch to CLOSE and allow the actuator to rotate clockwise to the fully closed position and check to see CLOSE LS-2 is operated; the OPEN light should go out. Cycle the actuator open and closed a few times checking the setting of CLOSE LS-1 and OPEN LS-2.

4.8.4 Open Limit Switch Adjustment

4.8.4.1 With the actuator in the Open Position, rotated fully counterclockwise, the Target for OPEN LS-1 will need to be adjusted.

4.8.4.2 Reconnect electrical power to the unit.

4.8.4.3 Push down on the Target for OPEN LS-1 and move counterclockwise until it is off of the switch in the counterclockwise direction. Both the OPEN and the CLOSE lights on the LDM should be illuminated at this point.

4.8.4.4 Now, push down and slide the Target for OPEN LS-1 clockwise until the CLOSE light just goes out. It is important to always adjust a Target in the opposing direction of the valve travel to get an accurate setting.

4.8.4.5 With the LOCAL/OFF/REMOTE Selector Switch set to LOCAL, toggle the OPEN/CLOSE Selector Switch to CLOSE and allow the Actuator to travel to the Close position, rotated fully clockwise.

4.8.4.6 Push down and slide Target for CLOSE LS-2 counterclockwise until it is off the switch in the clockwise direction.

4.8.4.7 Now, push down and slide the Target for CLOSE LS-1 clockwise until the OPEN light just goes out.

4.8.4.8 Toggle the OPEN/CLOSE Selector Switch to OPEN and allow the actuator to rotate counterclockwise to the fully open position and check to see OPEN LS-2 is operated; the CLOSE light should go out. Cycle the actuator open and closed a few times, checking the setting of CLOSE LS-1 and OPEN LS-2.

4.8.5 Four Limit Switch Models

4.8.5.1 If your unit utilizes four switches LS-3 OPEN and LS-4 CLOSE, adjust in the same manner except you will need to use a continuity tester on the terminal strip to detect switch operation. LS-3 is connected to terminals A31, A32 and A33. LS-4 is connected to A35, A36 and A37. Look at these switches on the wiring diagram for exact configuration.

4.9 Function Test

4.9.1 Double-Acting Actuator without an ESD Solenoid Valve

NOTE:

The components referenced below are referencing Schematic 4.8.1. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.9.1.1 Ensure both Hand Pump Selector Valves (M) are in the automatic open position.

4.9.1.2 Energize the desired solenoid valve (J) to open the actuator or (K) to close the actuator.

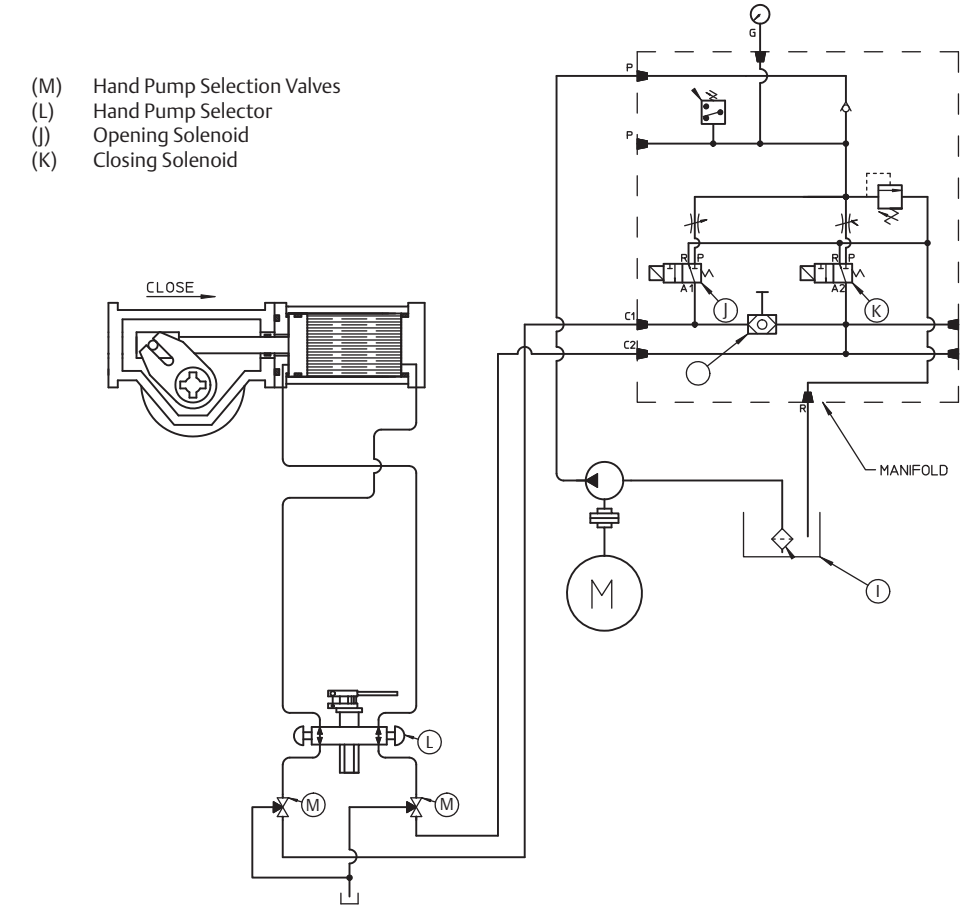
4.9.1.3 Toggle the OPEN/CLOSE Selector Switch to start the Electric Motor. The Hydraulic Pump Draws Fluid from the Reservoir and discharges fluid thru either the opening solenoid (J) or the closing solenoid (K) which ever one is energized.

4.9.1.4 Upon completion of the open or close stroke, the Pressure Switch will reach its set point and stop the Electric Motor.

4.9.1.5 Upon completion of the open or close stroke, the Limit Switch(s) can be configured to de-energized the solenoid that is energized. Some field installations can use the customer's control room logic to de-energize the solenoids after the actuator stroke open or close is reached.

4.9.2 Double-Acting Actuator with an (Optional) ESD Solenoid Valve and Accumulator

Figure 20 2-Way Remote Electric Without an ESD Solenoid Function Schematic



NOTE:

The components referenced below are referencing Schematic 4.8.2. and is for illustration purposes only. When using this procedure refer to the Bettis EHO Actuator General Arrangement Drawing and Hydraulic Schematic for the unit being worked on.

4.9.2.1 Ensure both Hand Pump Selection Valves (M) are in the automatic open position.

4.9.2.2 ESD (Emergency Shut Down) Solenoid Valve (P)is constantly energized closed.

4.9.2.3 Ensure Isolation Valve (H) is closed and Isolation Valves (N) and (O) are both open.

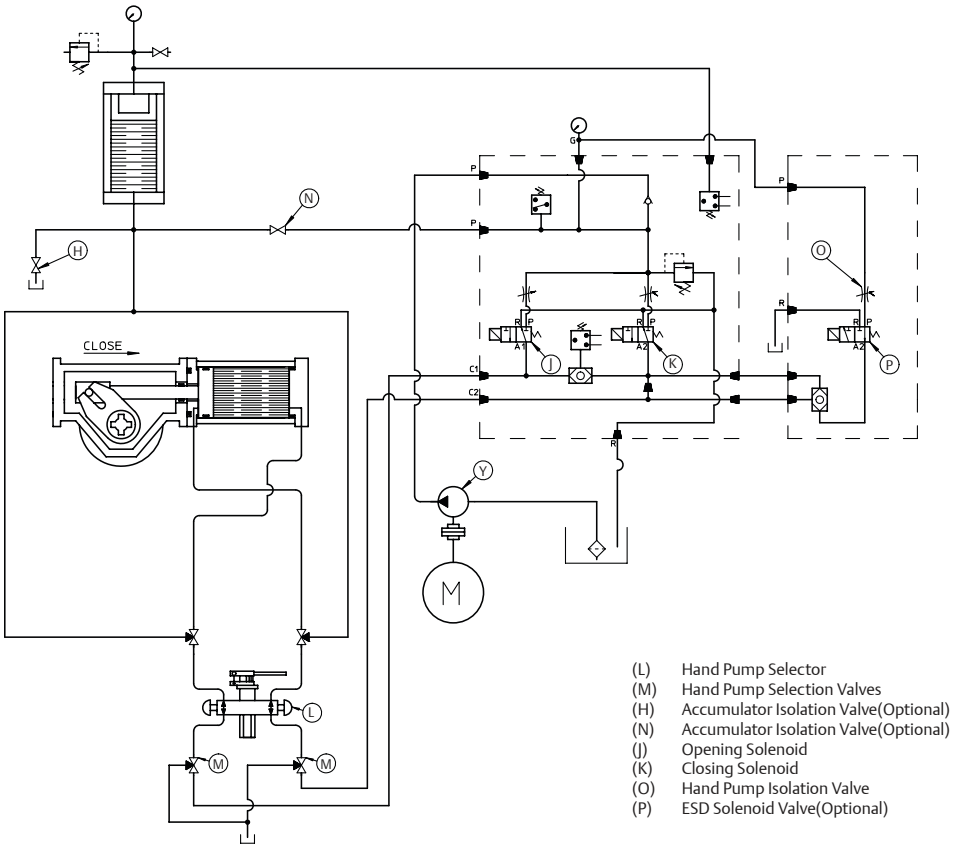
4.9.2.4 Toggle the OPEN/CLOSE Selector Switch to start the Electric Motor. The Hydraulic Pump Draws Fluid from the Reservoir and discharges fluid to the nitrogen pre-charged accumulator.

4.9.2.5 Upon completion of the charging of the accumulator, the pressure switch set point will be reached and it will stop the electric motor.

4.9.2.6 Energize the desired solenoid valve (J) to open the actuator or (K) to close the actuator.

4.9.2.7 Upon completion of the open or close stroke, the Limit Switch(s) can be configured to de-energized the solenoid that is energized. Some field installations can use the customer's control room logic to de-energize the solenoids after the actuator stroke open or close is reached.

Figure 21 2-Way Remote Electric With an ESD Solenoid Function Schematic



4.10 Other Options

Other options such as Partial Stroke Test may have been supplied with this order.
Refer to supplemental start-up procedures supplied with these options for start-up and test.

The functional test of the Electro-Hydraulic Actuator is now complete.
The Bettis EHO Actuator is now operational and ready for service.

Section 5: Communication Protocols

Digital control networks can interface with several different network protocols through the use of a Communication Adaptor Module (CAM), and currently, Modbus, FOUNDATION™ Fieldbus, and HART protocols are supported. All networks offer real-time data acquisition, diagnostics and alarms.

5.1 Modbus RTU

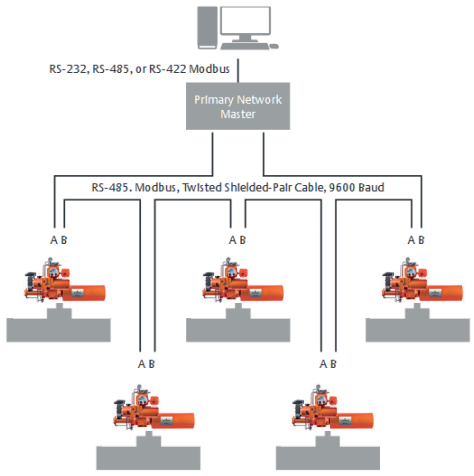
All standard Modbus function codes are supported. Up to 254 actuators can be installed in a single network, and the overall length of network cabling can be extremely long without degrading network performance or response time. Length of cable between each actuator, or between controller and first actuator in network, can be up to 1500 meters (5000 feet) and there is no need to use separate repeaters. Total network distance can be up to 320 km (200 miles).

Fully redundant networks comprising a serial loop topology are a standard feature, and no single cable fault, open-circuit, short-circuit, or ground fault will cause a loss of communication to any actuator. Hot-standby, redundant network masters are a standard option.

5.1.1 Serial E>Net Redundant Loop Topology

- Two data paths to each device from network master
- Open-circuit and short-circuit protected
- Redundant cabling included
- Long cable distances can be installed
- Maximum distance between valves can be up to 1500 meters (5000 ft)
- Total network distance can be up to 320 km (200 miles)
- Maximum number of valves in network can be 254
- Redundant “hot-standby” network master option available

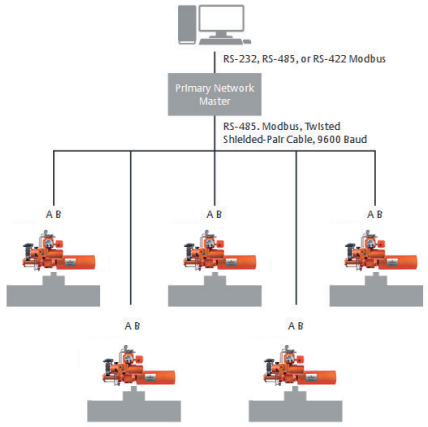
Figure 22 Modbus/Serial E>Net Redundant Loop Topology



5.1.2 Multi-drop Bus Topology

- Only one data path to each device from network master
- No short-circuit or ground fault protection in network
- Open-circuit protection only to the first cable fault
- No redundancy included
- Maximum network cable length is only 1200 meters (4000 ft)
- Maximum number of valves in network is 32
- Repeaters required to extend the network

Figure 23 Modbus/Multi-drop Topology



5.1.3 STC Terminal Connections

Table 5. STC Pin Connections

STC PIN CONNECTIONS	MODBUS CONNECTIONS
39	CHA +
40	Shield
41	CHA -
42	Shield
43	CHB +
44	CHB -

5.2 HART

The EHO actuators are capable of offering HART7 communication protocol over the widely used 4-20 mA analog channels. The HART CAM interface board certified by the Fieldcom group (previously HART Communication Foundation or HCF) is capable of offering Point-to-Point, Multi-drop and WirelessHART communication topologies. Networks may extend up to 3000 meters with Point-to-Point topology; and from 250 meters to 2000 meters when 1 to 10 devices are connected using Multi-drop topology. The WirelessHART supports up to 100 devices when connected to one Emerson Gateway, extending the number of devices when multiple Emerson Gateways are installed.

Table 6. HART Pin Connections

STC PINS	HART CONNECTIONS
41	HART 0+ (AO+)
42	HART 0- (AO-)
43	HART I+
44	HART I-
24	Shield

Figure 24 HART Topology

5.3 FOUNDATION™ Fieldbus

EHO actuators supporting FOUNDATION™ Fieldbus H1 protocol are fully certified by the Fieldbus Foundation and provide direct connection to the fieldbus with guaranteed interoperability with other certified devices. Each network can comprise up to 32 devices, with power for devices being provided via network cabling (assuming intrinsically safe devices are not connected to the same network). Networks may extend up to 1,900 meters (6,000 ft) long, and repeaters may be used to extend the distance or to incorporate more than 32 devices.

Figure 25 FOUNDATION Fieldbus Topology

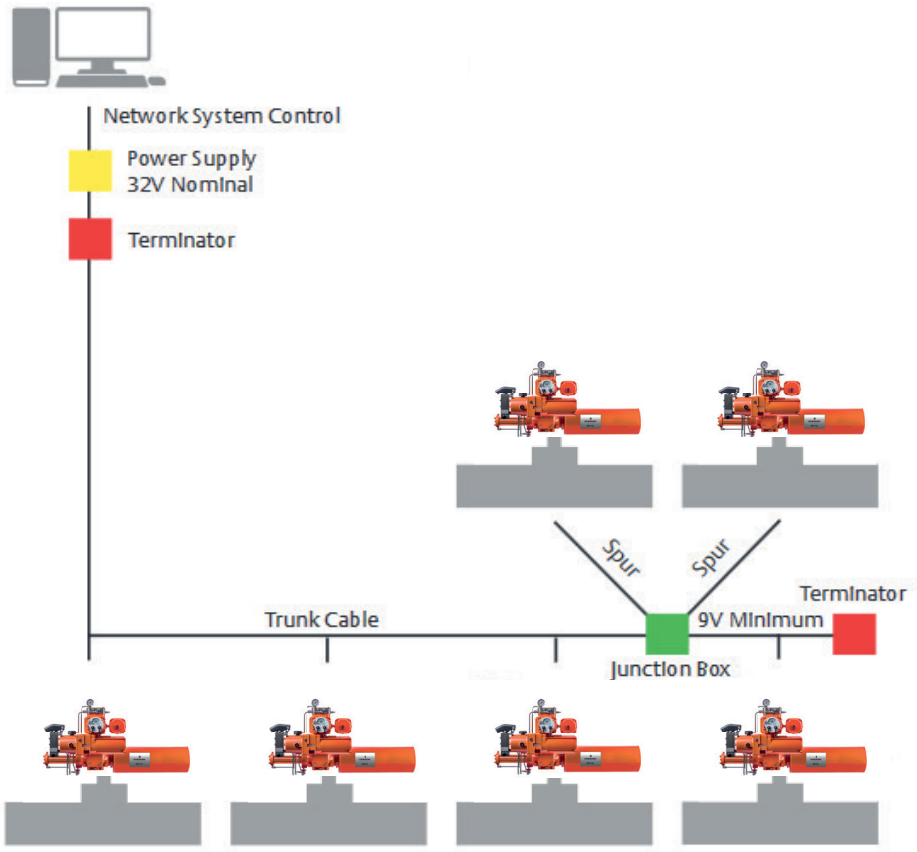


Table 7. FOUNDATION™ Fieldbus Pins

PIN CONNECTIONS	FIELDBUS CONNECTIONS
43	FIELDBUS +
44	FIELDBUS -
42	Shield

Section 6: Operation

After initial start-up and commissioning procedures have been accomplished, the Bettis EHO Actuator provides a simple self-contained means of operation for a quarter turn valve. In case of a power failure the actuator can be operated by the use of the supplied hand pump.

6.1 Hydraulic Power System

The Hydraulic System, powered by an electric motor, contains manifold based valves and controls with minimal piping. The system will drive the actuator to the OPEN/CLOSE position as selected by operation personnel.

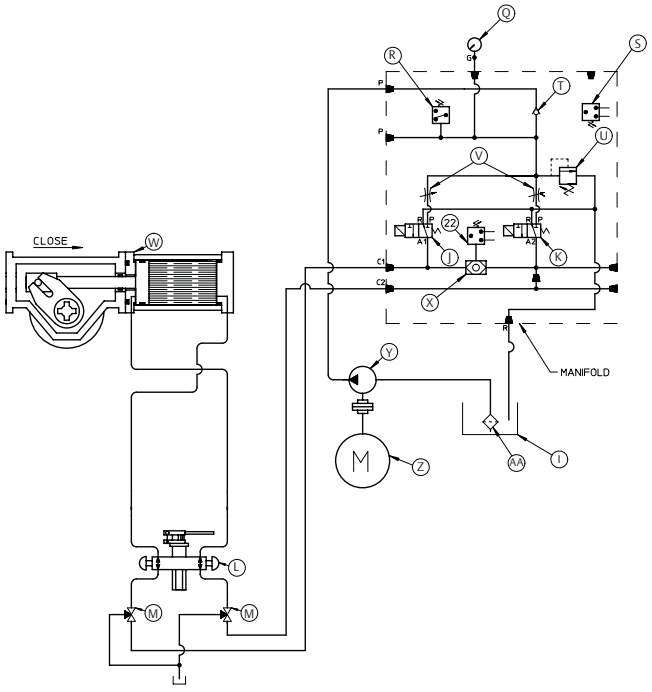
6.2 Reservoir

The Bettis Self-contained Electro Hydraulic Actuator includes a fluid reservoir sized to contain the hydraulic fluid required to operate the actuator cylinder and controls. The standard unit has a sight gauge to ensure presence of fluid and a dipstick measure attached to the fill/breather cap to more accurately gauge the quantity of fluid contained.

6.3 Main Components

Figure 26 Basic Double-Acting

(Q) Hydraulic Pressure Gauge
(R) Pressure Switch
(S) Pressure Transmitter (Optional)
(T) Check Valve
(U) Relief Valve
(V) Adjustable Flow Controls
(W) Bettis G-series Double-Acting Actuator
(J) Opening Solenoid
(K) Closing Solenoid
(X) Shuttle Valve (Optional)
(Y) Hydraulic Pump
(Z) Electric Motor
(AA) Suction Strainer
(I) Fluid Reservoir
(L) Hand Pump
(M) Hand Pump Selection Valves



NOTE:
Item numbers correspond to attached schematic drawing 11794-S.

(W) Bettis G-series Double-Acting Actuator

(Z) Electric Motor

(Y) Hydraulic Pump

(I) Fluid Reservoir

(K) 3-Way Normally Closed Solenoid Valve for closing the actuator

(J) 3-Way Normally Closed Solenoid Valve for opening the actuator

(V) Adjustable Flow Controls. There are two flow controls located upstream of the open and close solenoid valve items (J) & (K).

(AA) Suction Strainer

(T) Check Valve

(U) Relief Valve: A pressure relief valve is provided to protect the actuator and control system from over-pressurization caused by the pump or thermal expansion of the hydraulic fluid.

(Q) Hydraulic Pressure Gauge

(R) Pressure Switch

(L) Hand Pump: Used to manually stroke the actuator open or closed.

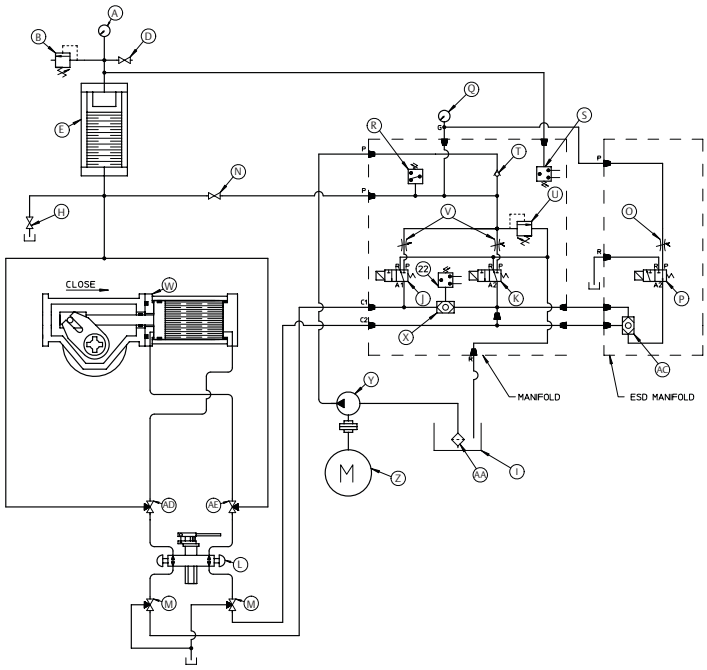
(M) Hand Pump Selection Valves: These two valves are engaged to isolate the control system before using the hand pump. Note: Both selection valves are engaged at the same time when the hand pump is used to open or close the actuator.

(X) Shuttle Valve; (Optional) Used with an optional pressure transmitter.

(S) Pressure Transmitter(Optional)

Figure 27 Main Components Double-Acting with ESD Solenoid and Accumulator

(A) Pressure Gauge (Optional)
(B) Nitrogen Relief Valve (Optional)
(D) Isolation Valve (Optional)
(E) Hydraulic Accumulator With Nitrogen Blanket Charge (Optional)
(H) Accumulator Isolation Valve (Optional)
(N) Accumulator Isolation Valve (Optional)
(R) Pressure Switch
(Q) Hydraulic Pressure Gauge
(S) Pressure Transmitter (Optional)
(T) Check Valve
(V) Adjustable Flow Controls
(U) Relief Valve
(O) Hand Pump Isolation Valve (Optional)
(W) Bettis G-series Double-Acting Actuator
(AB) Pressure Transmitter (Optional)
(J) Opening Solenoid
(K) Closing Solenoid
(P) ESD Solenoid Valve (Optional)
(X) Shuttle Valve (Optional)
(AC) Shuttle Valve (Optional)
(Y) Hydraulic Pump
(AD) Accumulator override valve to open (Optional)
(AE) Accumulator override valve to close (Optional)
(Z) Electric Motor
(AA) Suction Strainer
(I) Fluid Reservoir
(L) Hand Pump
(M) Hand Pump Selection Valves



(W) Bettis G Double-Acting Actuator

(Z) Electric Motor

(Y) Hydraulic Pump

(I) Fluid Reservoir

(K) 3-Way Normally Closed Solenoid Valve for closing the actuator

(J) 3-Way Normally Closed Solenoid Valve for opening the actuator

(V) Adjustable Flow Controls. There are two flow controls located upstream of the open and close solenoid valve items (J) & (K).

(AA) Suction Strainer

(T) Check Valve

(U) Relief Valve: A pressure relief valve is provided to protect the actuator and control system from over-pressurization caused by the pump or thermal expansion of the hydraulic fluid.

Q) Hydraulic Pressure Gauge

(R) Pressure Switch

(L) Hand Pump: Used to manually stroke the actuator open or closed.

(AD) Optional accumulator override 3-way isolation valve to open the actuator

(AE) Optional accumulator override 3-way isolation valve to close the actuator

(M) Hand Pump Selection Valves: These two valves are engaged to isolate the control system before using the hand pump. Note: Both selection valves are engaged at the same time when the hand pump is used to open or close the actuator.

(X) Shuttle Valve; (Optional) Used with an optional pressure transmitter.

(P) (Optional) ESD 3-Way Normally Open Solenoid Valve

(E) (Optional) Hydraulic Accumulator w/nitrogen blanket charge: The accumulator is used to stroke the actuator open or close with an additional override feature

(B) (Optional) Nitrogen Relief Valve: The relief valve is provided to prevent the nitrogen gas pressure to reach an over pressurization point caused by the pump or excessive thermal expansion.

(N) (Optional) Accumulator Isolation Valve: Used to isolate the accumulator for repair or maintenance.

(AB) (Optional) Pressure Transmitter: Used to transmit the pressure required to stroke the valve over time as a diagnostic feature.

(H) (Optional) Accumulator Isolation Valve: This valve allows the hydraulic pressure to bypass back to the reservoir.

(D) (Optional) Isolation Valve: Used to blow down or decay the nitrogen pressure from the accumulator for repair or maintenance.

(A) (Optional) Pressure Gauge: Illustrates the accumulator nitrogen blanket pressure.

(O) (Optional) Hand Pump Isolation Valve: This valve isolates the ESD solenoid and must be closed prior to using the hand pump for stroking the actuator open or closed.

(AC) (Optional) Shuttle Valve: This valve allows the actuator to close by either remote electric by energizing the closing solenoid item (K) or by losing the electric signal thru the ESD solenoid item (P).

(S) (Optional) Pressure Transmitter: Used to transmit the accumulator nitrogen blanket pressure.

6.4 Functional Description

The following is a functional description of the Bettis Electro Hydraulic Actuator and a brief explanation of the main components. Throughout this explanation, numbers which appear in in [ ] correspond to components labeled on the wiring diagram. Numbers in ( ) correspond to components labeled on the schematic diagram. Information in (( )) is descriptive.

6.4.1 Double-Acting Without Accumulator and ESD Solenoid Valve

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NOTE:
Refer to Section 10.1 for Hydraulic Schematic 11794-S, however the project specified schematic may be slightly different in the numbering sequence and should be referred to determine the actual options provided.

6.4.1.1 Power Stroke ((Open/Close))

Either one of the two closing or opening solenoids (J) or (K) are energized open and the motor (Z) drives the hydraulic pump (Y) to supply the actuator open or closing port thru the energized solenoid.

6.4.1.2 Manual Hand Pump Stroke

a. Open the hand pump selection isolation valve (M) to the pump position. Note: both isolation valves (M) must be engaged whether hand pumping open or close.

b. Select and push the open or close knob on the hand pump (L).

c. Stroke the hand pump (L) until the OPEN/CLOSE stroke is completed.

d. Push the manual relief valve located on the hand pump to retract the pump ram back into the pump body and pull the pump handle down.

e. Upon completion of the OPEN/CLOSE hand pump stroke, return both hand pump selection isolation valves back to the automatic position.

6.4.2 Double-Acting with Optional Accumulator and ESD Solenoid Valve Functional Description

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NOTE:
Refer to Section 10.2. for Hydraulic schematic 11516-S, however the project specified schematic may be slightly different in the numbering sequence and should be referred to determine the actual options provided.

6.4.2.1 Accumulator Charge

The motor (Z) drives the hydraulic pump (Y) and discharges fluid to the nitrogen blanket pre-charged accumulator (E).

6.4.2.2 Power Stroke ((Open/Close))

Upon completion of the accumulator charging, the pressure switch (R) set point is reached and stops the motor. Either one of the two closing or opening solenoids (J) or (K) are energized open and the accumulator (E) provides hydraulic pressure to flow thru the energized solenoid, either (J) or (K) and the actuator strokes open or closed.

6.4.2.3 ESD Operation ((Optional))

In an ESD application the ESD Solenoid (P) is constantly energized closed. This customer supplied signal is held as long as the signal is present. Upon loss of the signal to the ESD solenoid, the solenoid will de-energize and open allowing hydraulic supply fluid from the accumulator (E) to pass thru the ESD solenoid and to the closing port of the actuator (W).

6.4.2.4 Manual Hand Pump Stroke

1. Open the Hand Pump Selection Isolation Valve (M) to the pump position.

NOTE:

Both Hand Pump Selection Isolation Valves (M) must be engaged whether hand pumping open or close.

2. Select and push the open or close knob on the Hand Pump (L).
3. Stroke the hand pump until the OPEN/CLOSE stroke is completed.
4. Push the manual relief valve located on the hand pump to retract the pump ram back into the pump body and pull the pump handle down.
5. Upon completion of the OPEN/CLOSE hand pump stroke, return both hand pump selection isolation valves back to the automatic position.

6.4.2.5 Accumulator override Feature ((Optional))

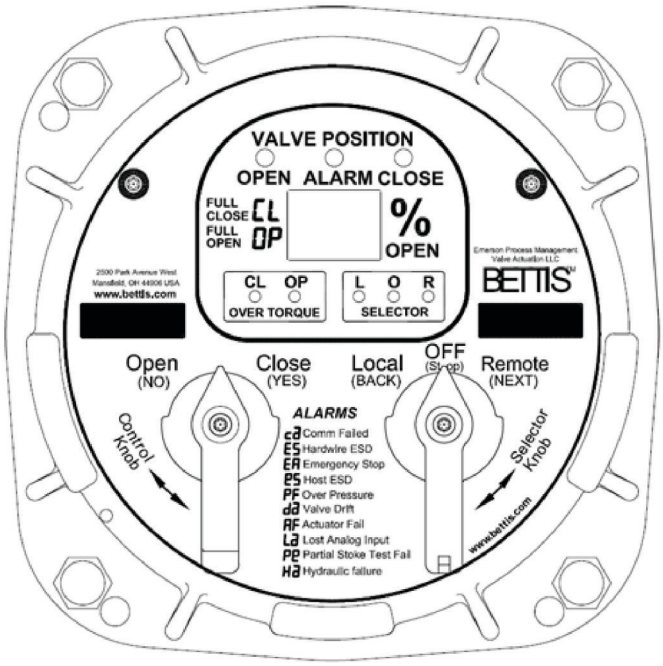
To stroke the actuator OPEN or CLOSED using the accumulator override isolation valves , open valve (AD) to stroke the actuator open, or open (AE) to stroke the actuator closed.

Section 7: Local Display Module (LDM)

The Local Display Module consists of the following as shown in Figure 28:

- Two Small Pilot Lights: Close (CL), Open (OP)
- Two Small Pilot Lights: Local (L), Off (O), Remote (R)
- Two Digit Display: Position, Alarm, and Setup feedback
- Three Pilot Lights: OPENING/OPEN, CLOSING/CLOSE and Alarm
- Selector Knobs: OPEN/CLOSE Selector Knob and LOCAL/OFF/REMOTE Selector Switch

Figure 28 Local Display Module (LDM)



7.1 Positions and Functions of Selector Knob

Table 8. Selector Knob

Selector Knob	Rotate	Control Mode Function
OFF (Stop)	Return position	Stop movement: Prevents motor operation
REMOTE (Auto)	Clockwise	Remote control: Allows control from remote location
LOCAL (Hand)	Counterclockwise	Local operation: Allows control from the local control knob

Table 9. Control Knob

Selector Knob	Rotate	Control Mode Function
CLOSE	Clockwise	Actuator moves to close position
OPEN	Counter clockwise	Actuator moves to open position
Default		No Action

Table 10. Default Actuator Position LEDs

Actuator Position LEDs	Valve Closed	Valve Closing Mid Stroke	Stopped	Valve Opening Mid Stroke	Valve Open	Alarm
Red	ON	Blinking	OFF	OFF	OFF	OFF
Green	OFF	OFF	OFF	Blinking	ON	OFF
Yellow	OFF	OFF	OFF	OFF	OFF	Flashing

Table 11. Selector LEDs

Selector LEDs	Local	OFF	Remote
Local (Amber)	ON	OFF	OFF
Off (Amber)	OFF	ON	OFF
Remote (Amber)	OFF	OFF	ON

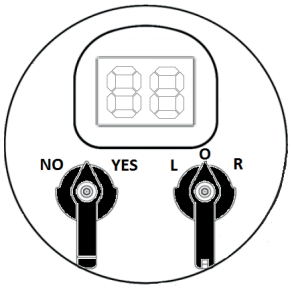
Section 8: Customizing SMART EHO Settings

The SETUP mode must be entered to modify any configuration settings.

8.1 Entering the Setup Menu

8.1.1 Place the BACK/STOP/NEXT Selector Switch to the STOP position.

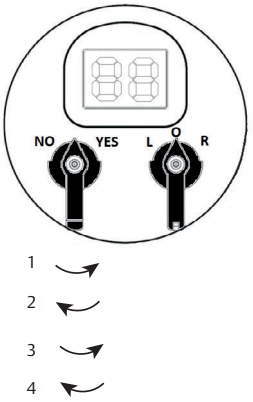
Figure 29 Viewing the Setup Menu (1)



NOTE:
The BACK/STOP/NEXT Selector Switch is the same Selector Switch as the LOCAL/OFF/REMOTE Selector Switch.

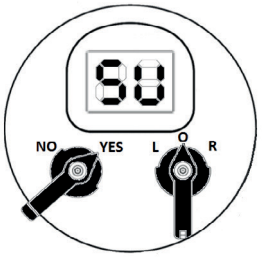
8.1.2 Toggle the NO/YES Selector Knob to YES, then NO, then YES, then NO in rapid succession and then release to initiate Setup Mode. If Setup Mode has been successfully initiated, The LOCAL/OFF/REMOTE Selector LCD will flash and the Menu Key [S][U] will appear on the LCD Display.

Figure 30 Viewing the Setup Menu (2)



NOTE:
The direction of the arrows show which way to turn the knob. Do not hold the knob in any one position longer than 0.5 seconds or the SMART EHO will not recognize you are trying to enter the Setup Mode.

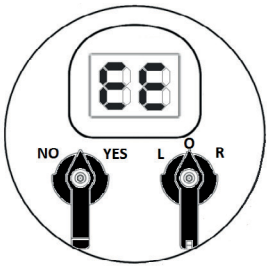
Figure 31 Viewing the Setup Menu (3)



8.1.3 To enter Setup Mode, toggle the NO/YES Selector Knob to YES.

8.1.4 To exit Setup Mode and return to normal operation, toggle the NO/YES Selector Knob to NO until [E][E] is displayed on the LCD display, [E][E] is Exit. Once [E][E] is displayed on the LCD Diisplay, toggle the NO/YES Selector Knob to YES to exit Setup Mode.

Figure 32 Viewing the Setup Menu (4)

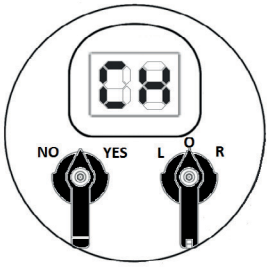


8.2 Change Settings

Once the Setup Menu has been entered, the SMART EHO configurations can begin to be changed.

8.2.1 To navigate through the SMART EHO settings, use the NO/YES Selector Knob. A toggle of NO will move to the next setting. A toggle of YES will either enter a setting or confirm a setting.

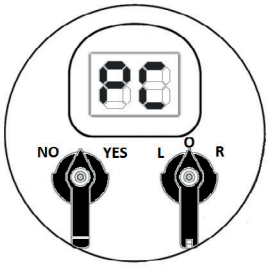
Figure 33 Change Settings (5)



8.2.2 Toggle the NO/YES Selector Knob to NO to navigate through the setup selections until [C][H] displays on the Menu Key. [C][H] is the Change Settings Menu Key. Toggle the NO/YES Selector Knob to YES to enter Change Settings.

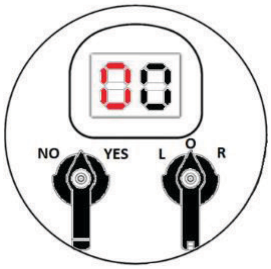
8.2.3 Before settings can be viewed or changed, a Passcode is requested by the SMART EHO. The Passcode's Menu Key is [P][C]. The Passcode is a four digit combination of letters and/or numbers code that must be entered before accessing the Change Settings Menu. The Passcode prevents unauthorized changes to the SMART EHO's settings.

Figure 34 Change Settings (6)



8.2.3.1 Toggle the NO/YES Selector Knob to YES to begin entering the Passcode.

Figure 35 Change Settings (7)



8.2.3.2 [0][0] will appear on the Menu Key, with the [0] on the left of the LCD Display flashing. The flashing digit signifies which of the two digits is being modified.

8.2.3.3 Toggle the NO/YES Selector Switch to NO until the correct Passcode number or letter is found.

8.2.3.4 Toggle the NO/YES Selector Switch to YES when the correct Passcode number or letter is found.

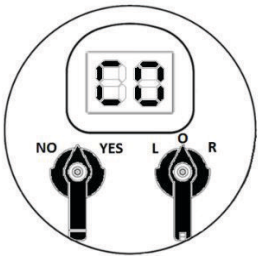
8.2.3.5 Repeat steps 8.2.3.3 to 8.2.3.4. until all four Passcode numbers and/or letters have been entered.

8.2.3.6 Once the correct Passcode has been entered, Change Settings can be accessed and the SMART EHO's settings can now be viewed and changed.

NOTE:
If an incorrect Passcode has been entered, the SMART EHO Menu will return to the [C][H] Menu item and the Passcode will have to be attempted again. Repeat steps 8.2.2. to 8.2.3.6 to re-attempt entering the correct passcode.

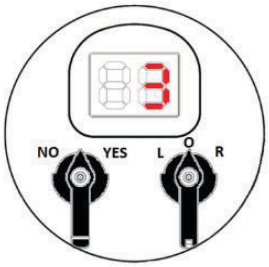
8.2.4 Toggle the NO/YES Selector Switch to navigate through the setting categories. Toggle the NO/YES Selector Knob to YES to enter a setting category.

Figure 36 Change Settings (8)



8.2.5 Please modify so that it shows the switch pointing to YES.

Figure 37 Change Settings (9)



8.2.6 Once in a Setting Category, the LCD Seven will show the Setting and its value by flashing between the Menu Key and the Setting's value.

8.2.7 To navigate through the Settings, toggle the NO/YES Selector Switch to YES to move to the next Setting.

8.2.8 To change a Setting's value, toggle the NO/YES Selector Switch to NO.

8.2.9 Once in a Setting, the LCD Display will show the Setting and its value by flashing between the Menu Key and the Setting's value.

8.2.10 Toggle the NO/YES Selector Switch to NO to navigate through the Setting's values until the correct Setting's value is found. Toggle the NO/YES Selector Switch to YES to confirm the Setting's value selected.

NOTE:
Section 8.4 EHO Configuration Menu for an overview of the entire EHO Configuration Menu and descriptive definitions and options of each setup selection displayed on the LCD Display.

8.2.11 If additional configurations must be made in the current Setting Category, repeat steps 8.2.5 and 8.2.8. To exit the current setting category, toggle the NO/YES Selector Knob to YES until the Setting Category is displayed on the LED Display.

8.2.12 If additional configurations must be made in another setting category, repeat steps 8.2.3. to 8.2.9.

8.2.13 When all setting changes have been made, toggle the NO/YES Selector Switch to NO until [E][E] is displayed on the LCD Display. [E][E] is Menu Key for the exit option in the Setup Menu. Toggle the NO/YES Selector Switch to YES to exit Setup Mode. Once Setup Mode has been exited, the SMART EHO display will return to the normal display mode.

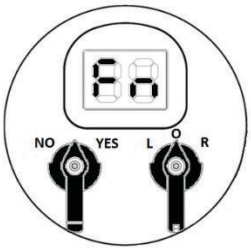
8.3 Find Setting Feature

The SMART EHO comes with a find feature to quickly find a setting by entering a Menu Key. This will avoid having to navigate through the entire EHO Configuration Menu before finding a setting.

8.3.1 Enter the Setup Menu. See Section 8.1 Enter the Setup Menu for instructions on how to enter the Setup Menu.

8.3.2 After entering the Setup Menu, toggle the NO/YES Selector Switch to NO until [F] [n] is displayed on the LCD Display. [F][n] is the Menu Key for the find feature.

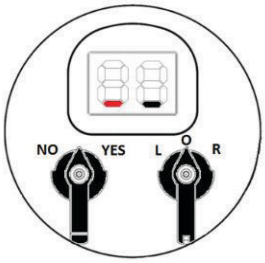
Figure 38 Change Settings (10)



8.3.3 Toggle the NO/YES Selector Knob to YES to enter the Find feature.

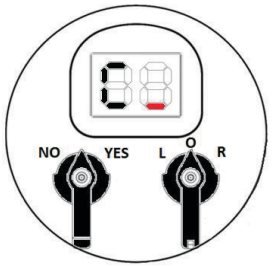
8.3.4 Once in the Find feature, two underscores will appear on the LCD Display. The underscore on the left will be flashing.

Figure 39 Change Settings (11)



8.3.5 Toggle the NO/YES Selector Knob to NO until the left the LCD display displays the number or letter corresponding to the desired Menu Key. Toggle the NO/YES Selector Knob to YES once the number or letter for the Menu Key is found.

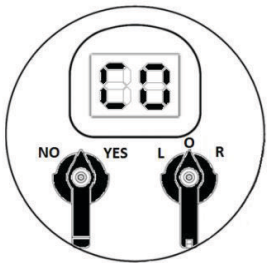
Figure 40 Change Settings (12)



8.3.6 The underscore on the right of the LCD Display will now be flashing.

8.3.7 Toggle the NO/YES Selector Knob to NO until the right digit of the LCD Display displays the number or letter corresponding to the Menu Key. Toggle the NO/YES Selector Knob to YES once the number of letter for the Menu Key is found.

Figure 41 Change Settings (13)



8.3.8 Have switch pointing to YES.

8.3.9 After the setting has been entered, the Passcode must be entered. See instructions in Section 8.2.3.1. to 8.2.3.6 for instructions on how to enter the Passcode.

8.3.10 Once the Passcode has been accepted, the SMART EHO will navigate directly to the entered Menu Key.

NOTE:

When changing a factory setting(which cannot be changed), all the lights will flash for 2 seconds to signify this setting is a factory setting and cannot change.

8.4 EHO Configuration Menu

NOTE:

Feedback Only Factory Set parameters cannot be changed. If an attempt is made to change a Feedback Only Factory Set parameter, all LEDs on the LDM will blink for 2 seconds and the parameter's value will remain unchanged.

Table 12. Configuration Table (1)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
SETUP Enter Setup to set parameters of the SMART EHO. See Section 8.1 for instructions to get into the EHO Configuration Menu.	SU	Yes/No	N/A
FIND SMART EHO parameter quick search feature. See section 8.1 for instructions on how to use the SMART EHO quick search feature.	Fn	Yes/No	N/A
CHANGE SETTINGS Allows user to make changes to the configuration settings.	CH	Yes/No	N/A
PASSCODE User must enter a passcode to make any changes to the parameters of the EHO.	PC	0 0 0 0 (Firmware after 2018) 4 8 6 3 (Firmware before 2018)	N/A
VALVE CONTROL SETUP Parameters related to controlling the actuator.	CS	Yes/No	N/A
CONTROL MODE Set the method of remote control. See wiring diagram for remote control configurations.	CO	0 = 2 Wire 1 = 3 Wire 2 = 4 Wire 3 = Analog 4 = Network	1 = 3 Wire
ACTUATOR CLOSE DIRECTION The actuator closing direction. Note: This will be factory set.	Cd	0 = Close CCW 1 = Close CW	Feedback Only
VALVE CLOSE DIRECTION Configure the close and open position of the valve. Note: This will be factory set.	rt	0 = CW Valve 1 = CCW Valve	Feedback Only
LED COLOR Change color of LEDs used to indicate actuator status (Open/Close/Opening/Closing).	LE	0 = Run LED Red, Port LED Green 1 = Run LED Green, Port LED Red	0 = Run LED Red, Port LED Green
ENCODER POSITION Reports if the encoder is installed properly. If the encoder is replaced or out of position, user must check this parameter to determine if the encoder has been set to the correct position. Note: This is factory set.	EP	0 = Incorrect Position 1 = Correct Position	Feedback Only

Table 13. Configuration Table (2)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
LOCAL CONTROL Set the SMART EHO's local control OPEN/ CLOSE selector switch to momentary or maintained. Momentary is described as a quick toggle of the OPEN/CLOSE selector knob will complete the stroke. Maintained is described as holding the OPEN/CLOSE selector knob to complete the stroke. If the OPEN/CLOSE selector knob is released, the actuator will stop the travel.	Lc	0 = Momentary 1 = Maintained	0 = Momentary
REMOTE CONTROL Set the SMART EHO's remote controls to momentary or maintained. Only applicable to discrete signals. A discrete remote input signal will cause the actuator to complete a full stroke. Only a discrete stop input signal will stop the travel. The direction of the actuator can be reversed by a discrete remote signal in the opposite direction.	rc	0 = Momentary 1 = Maintained	0 = Momentary
WRITE PROTECT By enabling write protect, the user can prevent the actuator from configuration changes through HART and Foundation Fieldbus communication.	ro	0 = Disable 1 = Enable	0 = Disable
POSITION CONTROL BANDWIDTH Sets the minimum resolution.	Pb	0.5 to 5.0	0.6 (%) (Modulating) 2.0(%)(On/Off)
ENABLE SETPOINT TRACKING Enable or disable setpoint tracking feature.	Et	0 = Disabled 1 = Enabled	0 = Disabled
LIMIT SWITCH TRIGGER POINT A Set the SMART EHO's limit switch range. The limit switch will be triggered between 0% and the limit switch trigger setpoint. Any position greater than the limit switch trigger setpoint, the limit switch will be triggered off. 0% will be designated as [C][L] on the two-digit display and 100% will be designated as [O][P] on the two-digit display.	La	0 - 100 The values 0 and 100 would be displayed as [O][P] for Open and [C][L] for Close	25(%)

Table 14. Configuration Table (3)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
LIMIT SWITCH TRIGGER POINT B Set the SMART EHO's limit switch range. The limit switch will be triggered between the limit switch trigger setpoint and 100%. Any position less than the limit switch trigger setpoint, the limit switch will be triggered off. 0% will be designated as [C][L] on the two-digit display and 100% will be designated as [O][P] on the two-digit display.	Lb	100(%) - 0(%) The values 0 and 100 would be displayed as [O][P] for Open and [C][L] for Close	75(%)
VALVE STALL DELAY Set the SMART EHO's time duration to move the valve position 1% before a valve stall alarm is initiated.	Sd	5s to 9s	8s
ENABLE LOG JAM Enabling Log Jam will give the actuator three attempts to stroke the actuator in the direction of a valve stall in the event of a valve stall alarm. On each attempt, the actuator will reverse position in the opposite direction 5% before the actuator reattempts stroking the actuator in the valve stall direction.	EL	0 = Log Jam Disable 1 = Log Jam Enable	0 = Log Jam Disable
ENABLE COARSE SOV Motor based Smart EHO shall have an optional coarse SOV. It can be enabled/disabled. Note: This will be factory set.	ec	0 = Disable 1 = Enable	Feedback Only
COARSE SOV SWITCHOVER POSITION Valve spring stroke is controlled by coarse SO (if enabled) and fine SOV. When both coarse and fine SOVs are enabled, then the COARSE SOV SWITCHOVER POSITION parameter will configure the valve position at which the actuator spring stroke control will transfer from coarse SOV to fine SOV.	CP	0 to 100	50
VOLTAGE CONFIGURATION Power supply voltage configuration. Note: This will be factory set.	CP	0 = 115 1 = 208 2 = 220/230 3 = 380/415 4 = 460 5 = 575 6 = 90 V DC 7 = 220 8 = 230 9 = 380 10 = 400 11 = 415 12 = 550 13 = 660 14 = 690	Feedback Only

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
FREQUENCY CONFIGURATION The power supply frequency configuration. Note: This will be factory set.	Fc	0 = DC 1 = 50 Hz 2 = 60 Hz 3 = Not defined	Feedback Only
PHASE CONFIGURATION The power supply phase configuration. Note: This will be factory set.	Pc	0 = Single Phase 1 = Three Phase	Feedback Only
HYDRAULIC LEAK ALARM DEBOUNCE COUNT Set the maximum number of Valve Drift Alarms allowed per hour. If Valve Drift Alarm Frequency is more than the Hydraulic leak Alarm Debounce Count, then the Hydraulic Leak Alarm will be generated. If Valve Drift Alarm is less than the Hydraulic Leak Alarm Debounce Count then Hydraulic Leak Alarm will be automatically cleared.	dC	2 to 10	2
LOW OIL ALARM ENABLE If oil level sensor is present, then this parameter can be used to Enable or Disable the Low Oil Alarm.	LO	0 = Disable 1 = Enable	Feedback Only
DISCRETE INPUT SETUP Set the discrete input logic.	di	Yes/No	N/A
DISCRETE INPUT 1 Set if Discrete Input for OPEN command should be Active on Close contact or Open Contact.	d1	0 = Active on Close contact 1 = Active on Open contact	0 = Active on Close contact
DISCRETE INPUT 2 Set if Discrete Input for CLOSE command should be Active on Close contact or Open Contact.	d2	0 = Active on Close contact 1 = Active on Open contact	0 = Active on Close contact
DISCRETE INPUT 3 Set if Discrete Input for STOP/PST command should be Active on Close contact or Open Contact.	d3	0 = Active on Close contact 1 = Active on Open contact	0 = Active on Close contact
DISCRETE INPUT 4 Set if Discrete Input for OPEN INHIBIT command or OIL LEVEL SENSOR input should be Active on Close contact or Open Contact.	d4	0 = Active on Close contact 1 = Active on Open contact	0 = Active on Close contact
DISCRETE INPUT 5 Set if Discrete Input for CLOSE INHIBIT command should be Active on Close contact or Open Contact.	d5	0 = Active on Close contact 1 = Active on Open contact	0 = Active on Close contact
DISCRETE OUTPUT SETUP Set the configurable output relays customer can use to monitor for various parameters. Refer to wiring diagram for relay terminal connection.	dO	Yes/No	N/A

Table 15. Configuration Table (4)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
RELAY1 FUNCTION Set SMART EHO's configurable relays to provide various actuator status indication. Note: Generic(Host Control) - Host can activate, deactivate, or control the relay.	r1	0 = Limit Switch Open (LSO) 1 = Limit Switch Close (LSC) 2 = Limit Switch A (LSA) 3 = Limit Switch B (LSB) 4 = Opening 5 = Closing 6 = Local Mode 7 = Stop Mode 8 = Remote Mode 9 = Valve Drift Alarm 10 = Power Monitor Alarm 11 = Phase Monitor Alarm 12 = Motor Thermal Alarm 13 = Hardwired ESD Alarm 14 = ESD Active Alarm 15 = Lost Analog Input 1 Alarm 16 = Generic (Host Control) 17 = Electronic Fault Alarm 18 = Moving 19 = Valve Stall Alarm 20 = Actuator Fail Alarm 21 = Unit Alarm 22 = SOV Failure Alarm 23 = Hydraulic Circuit Failure Alarm 24 = Self-Calibration Failure Alarm 25 = Over Pressure Alarm 26 = Emergency Stop Alarm 27 = Host Command ESD	0 = Limit Switch Open (LSO)

Table 16. Configuration Table (5)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
RELAY1 SETTING Configure Relay1 to provide either a continuous or flashing signal if Relay1 Function is met. Flashing will be in 1 second intervals.	S1	0 = Continuous 1 = Flashing	0 = Continuous
RELAY2 FUNCTION Set SMART EHO's configurable relays to provide various actuator status indication. Note: Generic (Host Control) - Host can activate, deactivate, or control the relay.	r2	0 = Limit Switch Open (LSO) 1 = Limit Switch Close (LSC) 2 = Limit Switch A (LSA) 3 = Limit Switch B (LSB) 4 = Opening 5 = Closing 6 = Local Mode 7 = Stop Mode 8 = Remote Mode 9 = Valve Drift Alarm 10 = Power Monitor Alarm 11 = Phase Monitor Alarm 12 = Motor Thermal Alarm 13 = Hardwired ESD Alarm 14 = ESD Active Alarm 15 = Lost Analog Input 1 Alarm 16 = Generic (Host Control) 17 = Electronic Fault Alarm 18 = Moving 19 = Valve Stall Alarm 20 = Actuator Fail Alarm 21 = Unit Alarm 22 = SOV Failure Alarm 23 = Hydraulic Circuit Failure Alarm 24 = Self-Calibration Failure Alarm 25 = Over Pressure Alarm 26 = Emergency Stop Alarm 27 = Host Command ESD	1 = Limit Switch Close (LSC)

Table 17. Configuration Table (6)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
RELAY2 SETTING Configure Relay2 to provide either a continuous or flashing signal if Relay2 Function is met. Flashing will be in 1 second intervals.	S2	0 = Continuous 1 = Flashing	0 = Continuous
RELAY3 FUNCTION Set SMART EHO's configurable relays to provide various actuator status indication. Note: Partial Stroke Test(21) PASS indication will be available on this relay only. Note: Generic(Host Control) - Host can activate, deactivate, or control the relay.	r3	0 = Limit Switch Open (LSO) 1 = Limit Switch Close (LSC) 2 = Limit Switch A (LSA) 3 = Limit Switch B (LSB) 4 = Opening 5 = Closing 6 = Local Mode 7 = Stop Mode 8 = Remote Mode 9 = Valve Drift Alarm 10 = Power Monitor Alarm 11 = Phase Monitor Alarm 12 = Motor Thermal Alarm 13 = Hardwired ESD Alarm 14 = ESD Active Alarm 15 = Lost Analog Input 1 Alarm 16 = Generic (Host Control) 17 = Electronic Fault Alarm 18 = Moving 19 = Valve Stall Alarm 20 = PST-(Partial Stroke Test) 21 = Actuator Fail Alarm 22 = Unit Alarm 23 = SOV Failure Alarm 24 = Hydraulic Circuit Failure Alarm 25 = Self-Calibration Failure Alarm 26 = Over Pressure Alarm 27 = Emergency Stop Alarm 28 = Host Command ESD	0 = Limit Switch Open (LSO)

Table 18. Configuration Table (7)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
RELAY3 SETTING Configure Relay3 to provide either a continuous or flashing signal if Relay3 Function is met. Flashing will be in 1 second intervals.	S3	0 = Continuous 1 = Flashing	0 = Continuous
RELAY4 FUNCTION Set SMART EHO's configurable relays to provide various actuator status indication. Note: Partial Stroke Test(21) FAIL indication will be available on this relay only. Note: Generic (Host Control) - Host can activate, deactivate, or control the relay.	r4	0 = Limit Switch Open (LSO) 1 = Limit Switch Close (LSC) 2 = Limit Switch A (LSA) 3 = Limit Switch B (LSB) 4 = Opening 5 = Closing 6 = Local Mode 7 = Stop Mode 8 = Remote Mode 9 = Valve Drift Alarm 10 = Power Monitor Alarm 11 = Phase Monitor Alarm 12 = Motor Thermal Alarm 13 = Hardwired ESD Alarm 14 = ESD Active Alarm 15 = Lost Analog Input 1 Alarm 16 = Generic (Host Control) 17 = Electronic Fault Alarm 18 = Moving 19 = Valve Stall Alarm 20 = PST-(Partial Stroke Test) 21 = Actuator Fail Alarm 22 = Unit Alarm 23 = SOV Failure Alarm 24 = Hydraulic Circuit Failure Alarm 25 = Self-Calibration Failure Alarm 26 = Over Pressure Alarm 27 = Emergency Stop Alarm 28 = Host Command ESD	1 = Limit Switch Close (LSC)

Table 19. Configuration Table (8)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
RELAY4 SETTING Configure Relay4 to provide either a continuous or flashing signal if Relay4 Function is met. Flashing will be in 1 second intervals.	S4	0 = Continuous 1 = Flashing	0 = Continuous
RELAY5 FUNCTION Set SMART EHO's configurable relays to provide various actuator status indication.	r5	0 = Generic (Host Control) 1 = Monitor Alarms 2 = Unit Alarms	1 = Monitor Alarms
RELAY5 SETTING Configure Relay5 to provide either a continuous or flashing signal if Relay5 Function is met. Flashing will be in 1 second intervals.	S5	0 = Continuous 1 = Flashing	0 = Continuous
NETWORK SETUP Set communication protocol configurations for the SMART EHO.	nS	Yes/No	N/A
NETWORK NODE ADDRESS / SLAVE ADDRESS Set the node address/slave address for the SMART EHO. A unique node address/slave address must be assigned for each SMART EHO in a multi-actuator network.	Si	1 - 253	1
BAUD RATE Set the baud rate for the SMART EHO. Note: Baud rate can be changed for Modbus network adapters only for NETWORK ADAPTER options for 1 (MODBUS E>NET), 2(MODBUS BUS), 3(MODBUS TCP/IP). All other communication protocols will be factory set and cannot be changed.	br	0 = 4800 1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200	2 = 19200
PARITY Set the parity for the communication port in the SMART EHO.	Pn	0 = Even 1 = Odd 2 = None	0 = Even

Table 20. Configuration Table (9)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
NETWORK ADAPTER Set the communication protocol for the SMART EHO. Note: This is factory set.	nA	0 = No Network Adapter Installed 1 = MODBUS E>NET 2 = MODBUS BUS 3 = MODBUS TCP/IP 4 = CONTROLINC 5 = DEVICENET 6 = FOUNDATION FIELDBUS BLOCK MODE 7 = FOUNDATION FIELDBUS MODULATION MODE 8 = PROFIBUS 9 = HART BLOCK MODE 10 = HART MODULATION MODE	Feedback Only

Table 21. Configuration Table (10)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
SELF-CALIBRATION Self-Calibration establishes the position range of the SMART EHO actuator. The SMART EHO has the ability to automatically find its precise full open and full close set points after adjustments to the mechanical stops are completed.	SC	Yes / No	N/A
SELF-CALIBRATION CYCLE COUNT Set the number of full cycles for the SMART EHO to cycle during self-calibration. One cycle is defined as one open and one close stroke.	St	3 to 5	3
PRESSURE UNIT Set the pressure unit for the SMART EHO.	Pu	0 - psi 1- bar 2 - kPa	0 - psi
PRESSURE SPIKE DURING HYDRAULIC STROKE Set the maximum hydraulic pressure of the SMART EHO during self-calibration. Note: This setting is for On/Off SMART EHOs only. Note: This is factory set.	PS	10 - 50 (In psi - in multiples of 100) 7 to 35 (In bar - in multiples of 10) 7 to 35 (In kPa - in multiples of 1000)	Feedback Only
MAXIMUM OPERATING PRESSURE Set the maximum hydraulic pressure of the SMART EHO during standard operation. If the operating pressure exceeds the MAXIMUM OPERATING PRESSURE, an Over Pressure Alarm[P][F] will be displayed. Note: This is factory set.	Pr	10 - 50 (In psi - in multiples of 100) 7 to 35 (In bar - in multiples of 10) 7 to 35 (In kPa - in multiples of 1000)	Feedback Only
THERMAL ACCUMULATOR PRESSURE Set the thermal accumulator pressure value. Note: This will be factory set. The value allowed will always be less than or equal to Maximum Operating Pressure.	tP	5 to 50 (In PSI - in multiples of 100) 3 to 35 (In BAR - in multiples of 10) 3 to 35 (In KPASCAL - in multiples of 1000)	Feedback Only
START SELF-CALIBRATION Initiate the SMART EHO to start the self-calibration procedure.	Sc	Yes / No	N/A
CALIBRATING Status signal on the two digit display to inform the user self-calibration is ongoing.	Ca	N/A	Feedback Only
SELF-CALIBRATION FAILED (SC STATUS) Status signal on the two digit display to inform the user self-calibration failed. Refer to troubleshooting guide for possible solutions for self-calibration failures.	SF	N/A	Feedback Only
SELF-CALIBRATION PASSED (SC STATUS) Status signal on the two digit display to inform the user self-calibration passed.	SP	N/A	Feedback Only

Table 22. Configuration Table (11)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
ESD CONFIGURATION Configure the settings for the ESD controls. Caution: This is a software ESD action. The software ESD action will be initiated by the software of the electronics. The hard wired ESD is independent from the software ESD.	EC	Yes/No	n/a
ENABLE ESD FROM HARDWIRE Provides indication if hardwire ESD is enabled or disabled on the SMART EHO.	eH	0 = Disable 1 = Enable	1 = Enable
REDUNDANT ESD DELAY Delay for triggering Redundant ESD if Hardwired ESD fails or operates slowly	rE	0 to 60 seconds	0 seconds
ENABLE SOFTWARE ESD FROM LOST COMMUNICATION Enable the SMART EHO to go to fail safe position if Modbus communication link is lost for 5 seconds.	eC	0 = Disable 1 = Enable	0 = Disable
ENABLE ESD FROM HOST Enable host system to provide a command to take the Smart EHO to the fail safe position.	eE	0 = Disable 1 = Enable	0 = Disable
SOFTWARE ESD OVERRIDE LOCAL MODE Enable host system to provide a command to take the SMART EHO to the fail safe position.	eE	0 = Disable 1 = Enable	0 = Disable
SOFTWARE ESD ACTION Configure the action to be taken if Enable ESD from Lost Communication or Enable ESD from Host is enabled.	eA	0 = Stop / Stay put 1 = Open to Limit 2 = Close to Limit	Feedback Only
SOFTWARE ESD OVERRIDE LOCAL MODE Configure the SMART EHO to allow the host to override LOCAL mode control with a software ESD command. WARNING: Enabling this would allow the actuator to move during a software ESD command.	eL	0 = NO 1 = YES	1 = YES
SOFTWARE ESD OVERRIDE STOP MODE Configure the SMART EHO to allow the host to override STOP(OFF) mode control with a software ESD command. WARNING: Enabling this would allow the actuator to move during a software ESD command.	eS	0 = NO 1 = YES	1 = YES
SOFTWARE ESD OVERRIDE MOTOR THERMAL ALARM Configure the SMART EHO to allow the host to override a Motor Thermal Alarm with a software ESD command.	et	0 = NO 1 = YES	1 = YES
ESD OVERRIDE INHIBIT Configure the Smart EHO to allow the host to override Inhibit command with a software ESD command.	ei	0 = NO 1 = YES	1 = YES

Table 23. Configuration Table (12)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
ANALOG CONFIGURATION	CA	Yes/No	n/a
ANALOG OUTPUT 1 SOURCE Configure the Analog Out 1 Source to provide feedback on various parameters from the actuator to the host system.	A1	0 = Position 1 = Setpoint 2 = Host Control 3 = Hydraulic Circuit Pressure	0 = Position
ANALOG OUT 2 SOURCE Configure the Analog Out 2 Source to provide feedback on various parameters from the actuator to the host system.	A2	0 = Position 1 = Setpoint 2 = Host Control 3 = Hydraulic Circuit Pressure	3 = Hydraulic Circuit Pressure
ENABLE LOST ANALOG INPUT 1 ALARM Enable an alarm if analog input signal is lost. The actuator must be set up for analog input.	Ae	0 = Disable 1 = Enable	1 = Enable
LOST ANALOG ALARM DELAY If Analog Signal is disconnected, then Lost Analog Alarm would be generated after this delay.	Ad	0 to 60 Seconds	0 = 0 Seconds
LOST ANALOG INPUT ACTION Configure the actuator to move to a configurable position when analog input signal is lost. The actuator must be set up for analog input and the configurable position can be configured only through the DCMlink.	Ai	0 = stay put 1 = go to configurable position	1 = go to configurable position
LOST ANALOG SIGNAL - SETPOINT Configure the actuator to move to a setpoint if the analog signal is lost.	AS	0-100 The values 0 and 100 would be displayed as OPEN/CLOSE according to Close Direction	30(%)
ANALOG INPUT POLARITY CLOSE Configure the analog input signal polarity.	iP	0 = 4 - 20 mA (zero-span) 1 = 20 - 4 mA (zero-span)	0 = 4 - 20 mA (zero-span)
ANALOG OUTPUT POLARITY CLOSE Configure the analog output signal polarity. Note: this will reverse the analog signals configured in Analog Output 1[A1] and Analog Output 2[A2].	oP	0 = 4 - 20 mA (zero-span) 1 = 20 - 4 mA (zero-span)	0 = 4 - 20 mA (zero-span)
ANALOG CALIBRATION Calibrate Analog Input and Output channels.	Ac	Yes/No	N/A
ANALOG INPUT CALIBRATION Calibrate the analog input channel with an external current source. External current source needs to be connected to source 4 mA equivalent signal when this menu is being flashed. The signal has to be in the range 3.6 mA - 22 mA.	iC	Yes/No	N/A
CALIBRATE LOWER LIMIT OF ANALOG INPUT CHANNEL Calibrate the 4 mA value for the analog input channel.	iL	Yes/No	N/A
LOWER LIMIT VALUE CALIBRATED (CALIBRATION STATUS) If the current value input through the Analog Input channel is in valid range, then the device will be calibrated successfully with the value.	cL	N/A	Analog Input Calibration Status. Not Searchable/ Configurable
CALIBRATION FAILED (CALIBRATION STATUS) If the current value input through the analog input channel is out of the valid range then the device calibration will fail and the SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Input Calibration Status. Not Searchable/ Configurable

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
CALIBRATE UPPER LIMIT FOR ANALOG INPUT CHANNEL Calibrate the the analog input channel with an external current source. External current source needs to be connected to source 20 mA equivalent signal when this menu is being flashed. The signal has to be in the range 3.6 mA - 22 mA.	iU	Yes/No	N/A
UPPER LIMIT VALUE CALIBRATED (CALIBRATION STATUS) If the input value is valid, the device will return success.	cU	N/A	Analog Input Calibration Status. Not Searchable/ Configurable
CALIBRATION FAILED (CALIBRATION STATUS) If the input value is invalid, the device will return fail. The SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Input Calibration Status. Not Searchable/ Configurable
ANALOG OUTPUT 1 CALIBRATION Calibrate Analog Output 1 Channel	o1	Yes/No	N/A
CALIBRATE LOWER LIMIT OF ANALOG OUTPUT 1 Calibrate the Analog Output 1 Channel for 4 mA equivalent value. The Channel Output needs to be monitored externally.	oL	Yes/No	N/A
ANALOG OUTPUT 1 CALIBRATION CHOICE Select if the Analog Output 1 needs to be increased or decreased.	cC	0 = Increment 1 = Decrement	0 = Increment
CALIBRATING ANALOG OUTPUT 1 The Analog Output can be changed based on selection at cC menu. 'Yes' option at this menu means Accept the Output. 'No' option at this menu will Increase or Decrease the Output.	c1	Yes/No	N/A
LOWER LIMIT CALIBRATED (CALIBRATION STATUS) The Analog Output 1 channel is calibrated for the desired output.	cL	N/A	Analog Input Calibration Status. Not Searchable/ Configurable
CALIBRATION FAILED (CALIBRATION STATUS) Calibration for Analog Output 1 channel has failed. The SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Input Calibration Status. Not Searchable/ Configurable
CALIBRATE UPPER LIMIT OF ANALOG OUTPUT 1 Calibrate the Analog Output 1 Channel for 20 mA equivalent value. Note: The channel output needs to be monitored externally.	oU	Yes/No	N/A
ANALOG OUTPUT 1 CALIBRATION CHOICE Select if the Analog Output 1 needs to be increased or decreased.	cC	0 = Increment 1 = Decrement	0 = Increment
CALIBRATING ANALOG OUTPUT 1 The analog output can be changed based on selection at [c][C] menu. 'Yes' option at this menu means the output is accepted. 'No' option at this menu will increase or decrease the output.	c1	Yes/No	N/A
UPPER LIMIT CALIBRATED(CALIBRATION STATUS) The Analog Output 1 channel is calibrated for the desired output.	cU	N/A	Analog Output 1 Calibration Status. Not Searchable/ Configurable
CALIBRATED FAILED (CALIBRATION STATUS) Calibration for Analog Output 1 channel has failed. The SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Output 1 Calibration Status. Not Searchable/ Configurable
ANALOG OUTPUT 2 CALIBRATION Calibrate Analog Output 2 Channel	o2	Yes/No	N/A

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
CALIBRATE LOWER LIMIT OF ANALOG OUTPUT 2 Calibrate the Analog Output 2 Channel for 4 mA equivalent value. The channel output needs to be monitored externally.	oL	Yes/No	N/A
ANALOG OUTPUT 2 CALIBRATION CHOICE Select if the Analog Output 2 needs to be increased or decreased.	cC	0 = Increment 1 = Decrement	0 = Increment
CALIBRATING ANALOG OUTPUT 2 The Analog Output can be changed based on selection at [c][C] menu. 'Yes' option at this menu means accept the output. 'No' option at this menu will increase or decrease the output.	c2	Yes/No	N/A
CALIBRATION PASSED FOR LOWER LIMIT (CALIBRATION STATUS) The Analog Output 2 channel is calibrated for the desired output.	cL	N/A	Analog Output 2 Calibration Status. Not Searchable/ Configurable
CALIBRATED FAILED (CALIBRATION STATUS) Calibration for Analog Output 2 channel has failed. The SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Output 2 Calibration Status. Not Searchable/ Configurable
CALIBRATE UPPER LIMIT OF ANALOG OUTPUT 2 Calibrate the Analog Output 2 Channel for 20 mA equivalent value. The channel output needs to be monitored externally.	oU	Yes/No	N/A
ANALOG OUTPUT 2 CALIBRATION CHOICE Select if the Analog Output 2 needs to be increased or decreased.	cC	0 = Increment 1 = Decrement	0 = Increment
CALIBRATING ANALOG OUTPUT 2 The Analog Output can be changed based on selection at [c][C] menu. 'Yes' option at this menu means accept the output. 'No' option at this menu will increase or decrease the output.	c2	Yes/No	N/A
CALIBRATION PASSED FOR UPPER LIMIT (CALIBRATION STATUS) The Analog Output 1 channel is calibrated for the desired output.	cU	N/A	Analog Output 2 Calibration Status. Not Searchable/ Configurable
CALIBRATED FAILED (CALIBRATION STATUS) Calibration for Analog Output 2 channel has failed. The SMART EHO will maintain the previous calibrated value.	cF	N/A	Analog Output 2 Calibration Status. Not Searchable/ Configurable

Table 24. Configuration Table (13)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
PARTIAL STROKE TEST (PST)	PA	Yes/No	N/A
ENABLE PST Enable the PST on the EHO.	PE	0 = Disable PST 1 = Enable PST	0 = Disable PST
PST START POSITION Configure the position where the PST will start the test.	PP	0 = Fail-safe position 1 = Power stroke position	1 = Power stroke position
PST TRAVEL RANGE Configure the percent range the EHO will stroke the valve during the partial stroke test.	tr	1(%) to 30(%)	30(%)
PST PAUSE TIME Configure the time the EHO will pause at the position at the of the partial stroke test before returning to the position prior to initiating the partial stroke test.	Po	1(s) to 30(s)	5(s)
START PST Initiate the local partial stroke test using the LDM.	PL	Yes/No	N/A
PST STARTED Status signal on the two digit display to inform the user PST is in progress.	Pe	N/A	Feedback Only PST Status
PST PASSED Status signal on the two digital display to inform the user PST has passed.	P1	N/A	Feedback Only PST Passed
PST FAILED Status signal on the two digital display to inform the user PST has failed.	P2	N/A	Feedback Only PST Failed
INHIBIT	in	Yes/No	N/A
ENABLE INHIBIT CLOSE Configure Discrete Input 5 to accept a discrete 24 V DC signal to inhibit close. If Discrete Input 5 is provided a 24 V DC signal when inhibit close is enabled, close commands will not be functional. If Discrete Input 5 is not provided a 24 V DC signal when inhibit close is enabled, remote close commands will be functional.	ic	0 = Disable 1 = Enable	0 = Disable
ENABLE INHIBIT OPEN Configure Discrete Input 4 to accept a discrete 24 V DC signal to inhibit open. If Discrete Input 4 is provided a 24 V DC signal when inhibit open is enabled, open commands will not be functional. If Discrete Input 4 is not provided a 24 V DC signal when inhibit open is enabled, remote open commands will be functional.	io	0 = Disable 1 = Enable	0 = Disable

Table 25. Configuration Table (14)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
FACTORY SETTINGS	dF	Yes / No	n/a
DEFAULT ALL PARAMETERS Reset all configurations on the EHO to factory settings.	dP	Yes/No	1) Control Mode 2) LED Color 3) Remote Control Signal 4) Local Control Signal 6) Relay 1 – 5 Functions 7) Relay 1 – 5 Settings 8) Actuator Close Time 9) Valve Stall Delay Time 10)Enable Logjam 11) Self-Calibration Stroke Count 12) Pressure Unit 13) Max Self Calibration Pressure 14) Max Hydraulic Circuit Pressure 15) Baud Rate 16) Parity 17) Network ID 18) LSA 19) LSB 20) PST Enable Flag 21) PST Start Position 22) PST Pause Time 23) PST Travel Range 24) Enable ESD From Hardwired 25) Enable ESD From Lost Comm 26) Enable ESD From Host 27) ESD Overrides Local 28) ESD Overrides Stop 29) ESD Overrides Motor Thermal 30) ESD Overrides Torque 31) AO1 Source 32) AO2 Source 33) Lost Analog Input Alarm 34) Lost Analog Input Action 35) Lost Analog Setpoint 36) Lost Analog Signal Delay 37) Analog Input Polarity Close 38) Analog Output Polarity Close

Table 26. Configuration Table (15)

MENU NAME	MENU KEY	CONFIGURATION/ CALIBRATION VALUE	DEFAULT ACTION
SAVE CONFIGURATION It appears before EXIT menu if any of the device configuration parameter is changed. One can choose if he wants to save the new configuration or switch to the last saved configuration.	SA	Yes/No	n/a
EXIT Exit the setup menu to return to normal operation.	EE	Yes/No	n/a

8.5 Alarms

Table 27. Configuration Table (16)

MENU NAME	MENU KEY	DEFAULT ACTION
ALARMS	AL	N/A
SOLENOID VALVE ALARM Alarm will activate when a coil failure in the solenoid has been detected.	SL	Stay Put ESD(hardwire, host) function remains active
PRESSURE TRANSMITTER ALARM Alarm will activate when the signal from the pressure transmitter has been lost.	Pt	Stay Put ESD(hardwire, host) function remains active
ENCODER ALARM Alarm will activate when the signal from the position encoder has been lost.	Ea	Stay Put ESD(hardwire, host) function remains active
OVER PRESSURE ALARM Alarm will activate when the hydraulic pressure of the SMART EHO exceeds the configured maximum operating pressure. Alarm will clear when pressure goes below maximum operating pressure.	PF	Stay Put - Modulating No Action - On/Off
PARTIAL STROKE TEST FAIL ALARM Alarm will activate when another alarm occurs during the partial stroke test, or if the partial stroke test is aborted by the user remotely or locally.	Pe	Action taken based on Failure Alarm Stay put when aborted by user until another command is given
LOST COM1 ALARM Alarm will activate when the Modbus communication signal is lost. The alarm is disabled by default and can only be configured via DCMlink. A loss of Foundation Fieldbus and HART communcation will not produce an alarm.	ca	No Action
VALVE STALL ALARM Alarm will activate when SMART EHO fails to move upon command. If log jam is enabled, the SMART EHO will initiate log jam sequence. If log jam sequence is unsuccessful in moving the valve, the Valve Stall Alarm will activate.	Sa	Stay Put
HARDWIRED ESD ALARM Alarm will activate when ESD event occurs with its associated ESD signal.	ES	Fail-Safe Position
HOST COMMAND ESD ALARM Alarm will activate when ESD command is sent over a communication protocol from the host system to the SMART EHO. The alarm will remain until the ESD command is removed.	HE	Fail-Safe Position
PHASE MONITOR ALARM Alarm will activate when the phase sequence is incorrect. This only applies to three phase power systems.	Ph	Stay Put

Table 28. Configuration Table (17)

MENU NAME	MENU KEY	DEFAULT ACTION
MOTOR THERMAL ALARM Alarm will activate when the thermostat within the windings of the motor exceeds the recommended operating temperature. The motor will stop running. Once the motor temperature returns to the recommended operating temperature, the [ta] alarm will automatically clear. Note: The Hydraulic Power Unit Fault Alarm[Ha] alarm will also activate if the SMART EHO has not moved to the desired position given to the actuator. After the [ta] alarm is cleared, the unit will require an additional movement command to clear the [Ha] alarm.	ta	Stay Put - On/Off Continues stroke with remaining pressure - Modulating
EMERGENCY STOP ALARM Alarm will activate if an optional emergency stop switch breaks continuity between terminals 20 and 22.	EA	Stay Put
VALVE DRIFT ALARM Alarm will activate when the SMART EHO detects the valve has moved more than the bandwidth setting configured in Position Control Bandwidth [Pb]. The SMART EHO will attempt to re-position the valve to the original desired set position. If the SMART EHO successfully positions itself back to the original desired set position, the alarm will deactivate.	da	Go To Set Position
POWER MONITOR ALARM Alarm will activate when the SMART EHO loses power. Battery backup is required for this alarm to activate during loss of power.	Pa	Go To Loss of Power Position
LOST ANALOG INPUT ALARM Alarm will activate when SMART EHO is configured for analog control in Control Mode[CO] Configuration 3 and the analog signal is lost. Enable Lost Analog Input 1 Alarm[Ae] must be enabled to activate the Lost Analog Input Alarm.	LA	Alarm Reports Only. Action will be taken per Lost Analog Input Action[AL] configuration
INVALID ANALOG INPUT RANGE ALARM Alarm will activate when the analog input signal is not within the analog 4-20 mA input range. The SMART EHO will accept analog signals between 3.6 to 22 mA before giving the alarm.	iA	Stay Put
HYDRAULIC POWER UNIT FAULT ALARM Alarm will activate when a movement command is given to the SMART EHO and the pressure and position of the SMART EHO does not change as expected within ten seconds.The alarm will also activate when the motor does not operate as expected.	Ha	Stay Put
ACTUATOR FAIL ALARM Alarm will activate when the motor thermal contact trips, position encoder fails, or phase sequence is incorrect.	AF	Alarm Reports Only

Table 29. Configuration Table (18)

MENU NAME	MENU KEY	DEFAULT ACTION
LIMIT NOT SET ALARM Alarm will activate if the travel limits have not been configured. Self-calibration must be performed to deactivate this alarm.	LF	Alarm Reports Only
ELECTRONIC FAULT Alarm will be activated if there is a failure in any of the following: 1) Encoder communication 2) DAC communication 3) ADC communication 4) IOM Board SPI communication 5) Field Board SPI communication 6) EEPROM communication, 7) RDM 8) Network CAM 9) Digital Inputs 10) Reversible Contactor 11) CPU Hrdware	EF	Alarm Reports Only
RTC BATTERY LOW ALARM Alarm will be activated if RTC battery voltage drops below the limit.	bt	Alarm Reports Only
BEYOND LIMITS ALARM Alarm will be generated if Actuator moves beyond the limits.	bL	Alarm Reports Only
MOTOR OVERRUN ALARM Alarm will be generated if Motor runs beyond the limit. The alarm clears automatically after reduced motor usage.	or	Stops Motor Operation
OPEN INHIBIT ALARM Alarm will be generated if Open Inibit Configuration is enabled and Open Inhibit Discete Input is active.	oi	Stops ongoing Open Operation, Inhibits Open Operation
CLOSE INHIBIT ALARM Alarm will be generated if Close Inibit Configuration is enabled and Open Inhibit Discete Input is active.	ci	Stops ongoing Open Operation, Inhibits Open Operation
OPEN INHIBIT FAILURE ALARM If Open Inibit Configuration is disabled and Open Inhibit Discete Input is active, if there is any open operation, then this alarm will be generated.	oF	Alarm Reports Only
CLOSE INHIBIT FAILURE ALARM If Close Inibit Configuration is disabled and Close Inhibit Discete Input is active, if there is any close operation, then this alarm will be generated.	cF	Alarm Reports Only
24 V DC BATTERY LOW This alarm will be generated if the power supply voltage falls below the limit. Note: This alarm is applicable for only SMART EHOs powered by 24 V DC.	LP	Alarm Reports Only
HYDRAULIC LEAK ALARM This alarm is generated if the number of Drift Alarms exceed the limit within one hour.	HL	Alarm Reports Only
LOW OIL ALARM This alarm is generated if the oil in the reservior is less than the limit.	Lo	Alarm Reports Only

Section 9: Troubleshooting

⚠ WARNING

To prevent personal injury, the actuator must be in double-acting, Fail-safe Position and all hydraulic pressure drained, including an optional accumulator, before opening any tube lines or attempting replacement operations below.

Of all the system components, the actuator itself is least likely to malfunction and require the most time and effort to service.

Table 30. Troubleshooting

Symptoms	Possible Reason
EHO does not turn on	1. Ensure voltage is adequate to the unit. 2. Check to see that the electrical power is connected to the correct terminals. 3. Branch circuit fuse blown out.
EHO is on, but motor does not run	1. Ensure the Local/Off/Auto switch is in the proper position. 2. Ensure the field power wiring is an adequate size. 3. Power supply is insufficient. 4. Check to see if thermal overload is tripped.
EHO motor runs, but fails to develop sufficient pressure to open the valve	1. Low fluid level in reservoir. 2. Wrong motor shaft rotation. 3. Hand pump isolation valve (O) is closed (if optional accumulator is provided). 4. ESD solenoid is not energized because signal power is insufficient. 5. The Relief valve is cracking open. Check to ensure setting set to factory setting.
ESD solenoid (optional)	1. Ensure the Local/Off/Auto switch is in the proper position when initiating the open/close command. 2. Hand pump isolation valve (O) is closed; preventing ability to stroke to the Fail-safe Position.

Should any issue be experienced besides the symptoms noted above, please consult factory.

Important check points for automatic operation of the EHO:

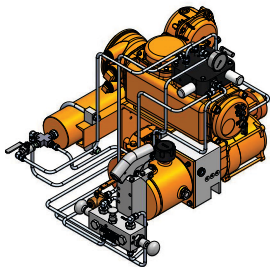
1. Ensure oil level is at the proper level.
2. Ensure hand pump isolation valve (O) is open.
3. Check to see that the ESD (optional) signal power is on.

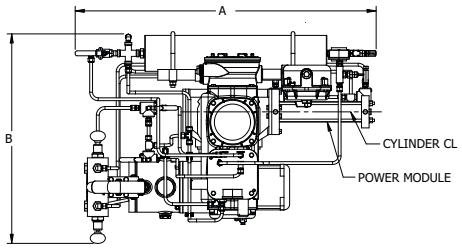
Section 10: Hazardous Area Classification and SIL Certification

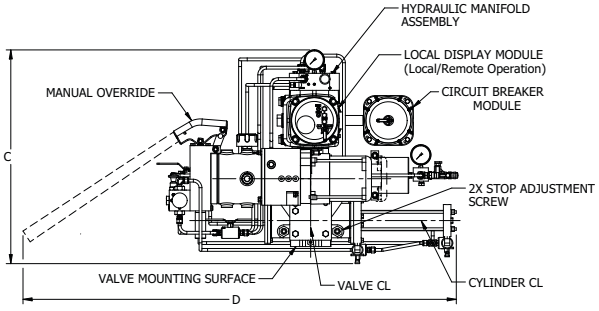
- CSA, Canadian Standard Association Certification Class I, Division I, Groups, C and D. Group B configuration available upon request.
- FM, Factory Mutual Certification Class I, II, and III, Groups C, D, E, F, G, Division I, T4. Group B configuration upon request.
- ATEX Directive EExd IIB T4.
- IECEx Certificate of Conformity Ex d IIB T4.
- This product is only intended for use in large-scale fixed installations excluded from the scope of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2).

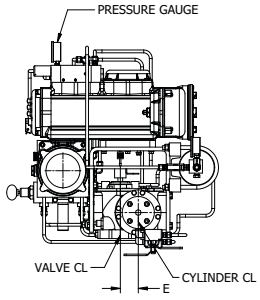
Section 11: Weights and Dimensions

11.1 SMART EHO Double-Acting









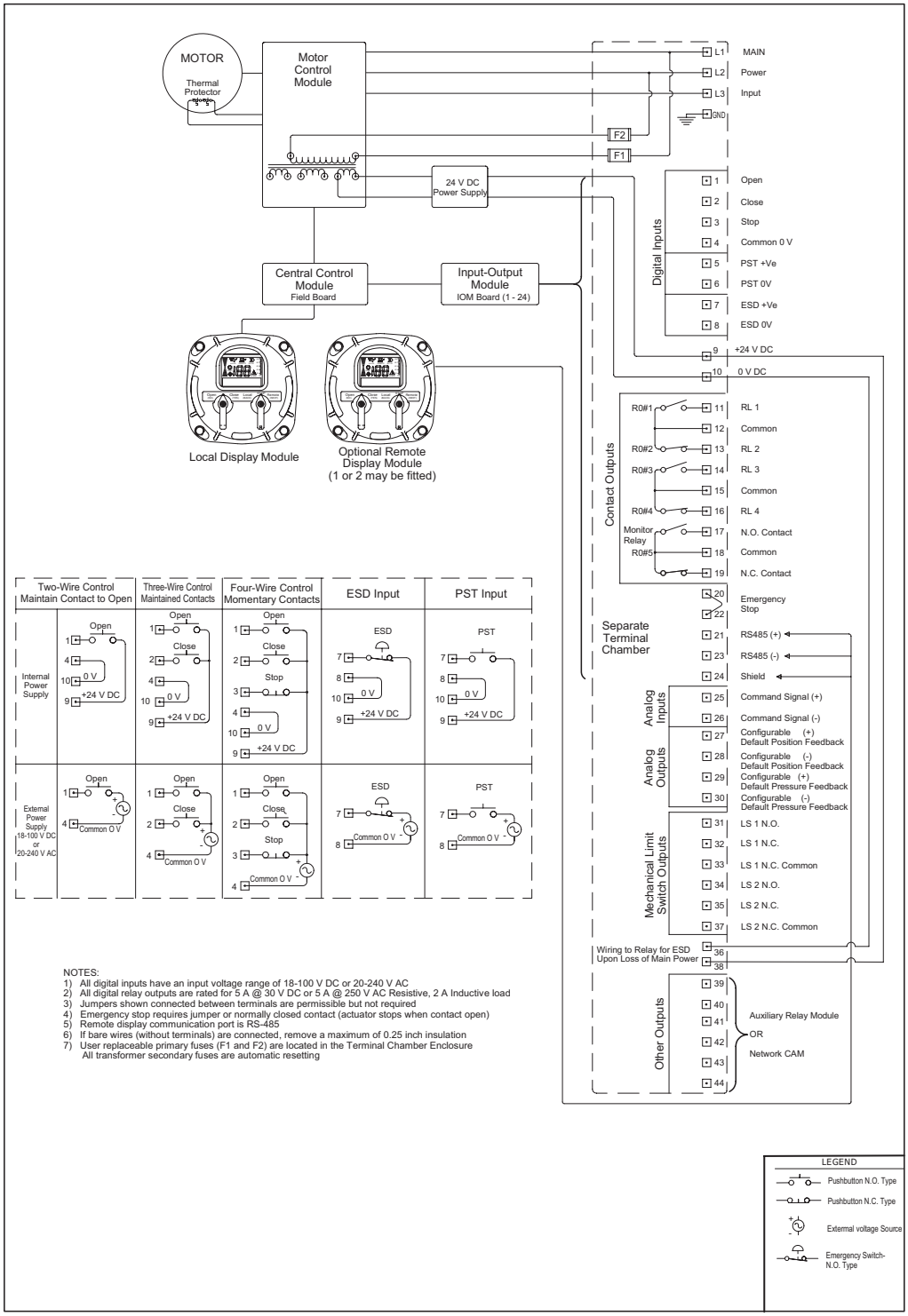
OUTLINE DIMENSION AND DETAILS												
Actuator	A		B		C		D		E		Approximate Weight	
	INCH	MM	INCH	MM	INCH	MM	INCH	MM	INCH	MM	Lbs	KG
G01001.5	39.8	1010.9	27.7	703.6	28.3	718.8	57.9	1470.7	2.4	61.0	513	233
G2002.0	40.6	1031.2	28.7	729.0	29.0	736.6	58.3	1480.8	2.9	73.7	546	248
G3004.0	46.8	1188.7	30.1	764.5	32.5	825.5	61.5	1562.1	3.5	88.9	626	284
G4003.0	52.0	1320.8	34.5	876.3	31.9	810.3	66.8	1696.7	4.3	109.2	770	349
G4004.0	53.0	1346.2	35.5	901.7	32.9	835.7	67.8	1722.1	5.3	134.6	783	355
G5004.0	58.3	1480.8	37.4	950.0	34.8	883.9	73.2	1859.3	5.5	139.7	1141	518
G5005.0	59.3	1506.2	38.4	975.4	35.8	909.3	74.2	1884.7	6.5	165.1	1300	590
G7005.0	64.3	1633.2	40.4	1026.2	39.7	1008.4	81.6	2072.6	6.8	172.7	1786	810
G7008.0	65.3	1658.6	41.4	1051.6	40.7	1033.8	82.6	2098.0	7.8	198.1	1829	830
G8008.0	76.5	1943.1	427.0	1085.8	39.5	1003.3	87.5	2222.5	8.0	203.2	2461	1116
G10008.0	93.6	2377.4	46.9	1191.3	43.6	1107.4	99.4	2524.8	10.5	266.7	3754	1703

NOTE:

Weights and dimensions shown are nominal values, for accurate weights and dimensions always refer to the General Arrangement Drawing for the unit being worked on.

11.2 STC Wiring Diagram

Figure 42 STC Wiring Diagram



Section 12: Maintenance

12.1 Storage Procedures

The actuator should be immediately stored in a clean, dry warehouse, free from vibration and rapid temperatures changes, until it can be installed and energized.

If the actuator must be stored outside, it should be stored off of the ground at an elevation sufficient to prevent it from being immersed in water or buried in snow, and covered to prevent damage from site debris.

If the actuator is not attached to a valve, the preferred orientation is with the motor and electrical compartment horizontal.

Care should be taken to plug all open ports on the actuator and all controls to keep out foreign contaminates.

12.2 Service Interval

Routine maintenance is generally unnecessary. Normally recommended service interval for Bettis actuators is five years or maximum actuator seal life cycle, whichever occurs first.

NOTE:
Storage time is considered as part of the Service Interval time.

It is recommended that Service Kits be ordered approximately three (3) months prior to scheduled maintenance to assure availability.

12.3 Lubrication Requirements

NOTE:
Lubricant, other than listed below should not be used without prior written approval of Bettis Product Engineering:

- All temperature services -40°C to 60°C (-40°F to 140°F) use Bettis™ ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Module Service Kit in tubes and the tube is marked ESL-4, 5 & 10 lubricant.
- Hydraulic fluids, other than those listed below should not be used without prior written approval of Bettis Product Engineering.
- Standard temperature service (-29°C to 60°C/-20°F to 140°F) use CONOCO Megaflow® AW HVI 15 Fluid.
- Low temperature service (-40°C to 60°C/-40°F to 140°F) use EXXON Univis J13 Fluid.

12.4 Recommended Annual Inspection

It is recommended the following components and features of the Bettis™ SMART EHO to be evaluated at least once a year.

- Check hydraulic fluid levels
- Check the pressure gauge
- Check bolts and fittings for tightness
- Check for external oil leaks
- If an accumulator is provided, check the nitrogen blanket
- Check hand pump operation functions properly
- If/When possible, perform a function test(See section 4.9 for instructions on how to perform a function test)
- Check the breather on the hydraulic reservoir

Qualified service personnel are available upon request for problems, which our customers do not wish to handle. If the requirement should arise please feel free to contact:

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