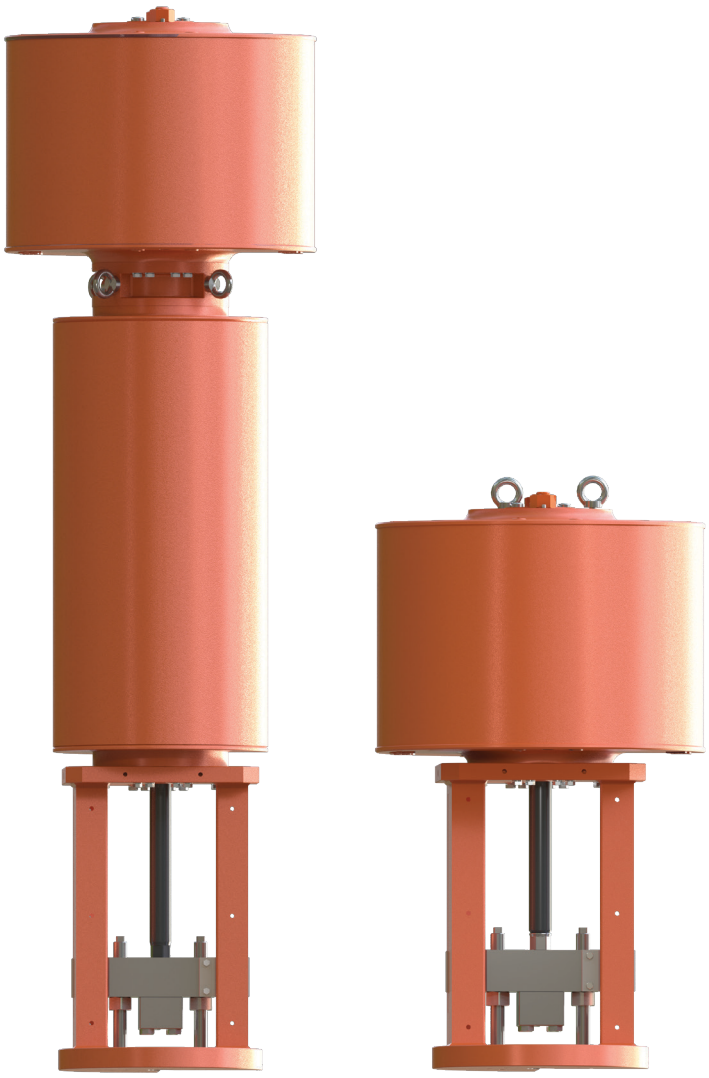
Installation, Operation and Maintenance Manual
VA-DC-000-1884 Rev. 0
March 2021

Bettis GVO - G01 through G10

Spring-Return and Double-Acting Pneumatic Linear Actuators



BETTIS™

EMERSON™

This page intentionally left blank

Table of Contents

Section 5: Field Conversions

Section 6: Actuator Support Information

Section 7: Testing and Troubleshooting

Appendix A: List of Drawings

Section 1: Introduction

1.1 General Service Information

1.1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis™ GVO-G01, GVO-G2, GVO-G3, GVO-G4, GVO-G5, GVO-G7, GVO-G8, GVO-G10 Double-Acting and Spring-Return Series Pneumatic Linear Actuators.

1.1.2 Normal recommended service interval for this actuator series is five years.

NOTE:
Storage time is counted as part of the service interval.

1.1.3 This procedure is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator.

1.1.4 Remove all piping and mounted accessories that will interfere with the module(s) that are to be worked on.

1.1.5 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.

1.1.6 Numbers in parentheses, ( ) indicate the bubble number (reference number) used on the Bettis assembly drawing and Actuator Parts List.

1.1.7 This procedure is written using the pneumatic outer end cap (3-80) as the top of the actuator.

1.1.8 Actuator module weights and height are listed in actuator performance datasheet part number VA-DC-000-1901.

1.1.9 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.

1.1.10 Use a non-hardening thread sealant on all pipe threads.

⚠ CAUTION

Follow manufacturer's instructions. Apply the thread sealant per the manufacturer's instructions.

1.1.11 Bettis recommends that disassembly of the actuator components should be done in a clean area on a workbench.

1.2 Definitions

⚠ WARNING

If not observed, user incurs a high risk of severe damage to actuator and/or fatal injury to personnel.

⚠ CAUTION

If not observed, user may incur damage to actuator and/or injury to personnel.

NOTE:

Advisory and information comments provided to assist maintenance personnel to carry out maintenance procedures.

1.3 General Safety Information

Products supplied by Bettis, in its “as shipped” condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by well trained, equipped, prepared and competent personnel.

⚠ WARNING

Read warning signs. For the protection of personnel working on Bettis actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be noted to the WARNINGS, CAUTIONS and NOTICE contained in this procedure.

⚠ WARNING

Follow plant safety procedures. This procedure should not supersede or replace any customer’s plant safety or work procedures. If a conflict arises between this procedure and the customer’s procedures the differences should be resolved in writing between an authorized customer's representative and an authorized Bettis representative.

1.4 Bettis Reference Materials

1.4.1 Assembly Drawing for GVO-G2-SR through GVO-G5-SR model actuators with one Pneumatic Power Module and one Spring Module use assembly drawing VA-ED-008-4541.

1.4.2 Assembly Drawing for GVO-G2-FS through GVO-G5-FS model actuators with one Pneumatic Power Module and one Spring Module use assembly drawing VA-ED-008-4542.

1.4.3 Assembly Drawing for GVO-G01 through GVO-G10 model actuators with Pneumatic Power Module use assembly drawing VA-ED-008-4558.

1.5 Service Support Items

1.5.1 Bettis module service kits.

1.5.2 Commercial leak testing solution.

1.5.3 Non-hardening thread sealant.

1.6 Lubrication and Fluid Requirements

NOTE:
Lubricants, other than listed in step 1.6.1 should not be used without prior written approval of Bettis Product Engineering.

1.6.1 Lubricants:
Standard and high temperature services (-20 °F to +350 °F)/ (-29 °C to 176 °C) use Bettis ESL 5 and ESL 10 lubricant. ESL 5 and ESL 10 lubricant is contained in the Bettis module service kit in tubes or cans and they are marked ESL 5 and 10 lubricant. For low temperature service (-40 °F to 150 °F)/ (-40 °C to 65.6 °C) use ESL 15 lubricant. ESL 15 lubricant is contained in low temperature Bettis module service kits in tubes or cans and they are marked ESL 15 lubricant.

1.7 General Tool Information

1.7.1 Tools:
All tools/Hexagons are American Standard inch. Large adjustable wrench, two (2) large screwdrivers, Allen wrench set, set of open/box end wrenches, rubber or leather mallet, torque wrench (up to 120 lb-ft / 1627 Nm), breaker bar, small drift punch and a drive socket set. For recommended tool and wrench sizes refer to Section 6, Tables 6.6 through 6.13.

1.8 Actuator Storage

For applications where the actuator is not placed into immediate service, it is recommended that the actuator be cycled with regulated clean/dry pneumatic pressure at least once per month. Indoor storage, if available, is recommended for all actuators. Care should be taken to plug all open ports on actuator and controls to keep out foreign particles and moisture. Actuators should not be stored in an atmosphere that is harmful to resilient seals. Contact factory for extended storage period.

1.9 Actuator Installation

1.9.1 Since there are many valve and actuator combinations, it is not practical to include detailed instructions for each type. Mountings are designed to be as simple as possible to keep the guess work out of the installation.

1.9.2 Actuators that are shipped from the factory with the travel stops adjusted for the required stroke length. Generally, it is necessary to make slight travel stop adjustments once the actuator is installed onto the valve. Refer to the valve manufacturer's recommendations for specific requirements. When the valve has internal stops, the actuator should be adjusted at the same points.

NOTE:

The actual "stopping" should be done by the actuator. If the valve does not have internal stops, adjust the actuator to the fully open position. Using this as a reference point, move the valve to close and adjust to the valve manufacturer's specifications for stroke rotation.

1.9.3 Good instrument practices are also recommended. Clean/dry regulated pneumatic pressure is essential for long service life and satisfactory operation. It should be noted that new pneumatic lines often have scale and other debris in them, and these lines should be purged of all foreign material.

NOTE:

Scale and debris can damage control valves, solenoids, and seals.

1.10 Actuator Start-Up

1.10.1 Prestart-up checks

1. Inspect to ensure the unit has been mounted onto valve properly. Gear flange mounting bolts, stem key, setscrew(s) are installed and secured.
2. No tubing damaged or accessories dislodged during the shipping or the installation
3. Indicated position confirms valve position.
4. All switching valves in normal operating position as per SCHEMATIC / INSTRUCTIONS.

1.10.2 Check Connections

1. Pneumatic / hydraulic components connected as per schematic enclosed or in service manual supplied.
2. Pneumatic supply connected to the identified ports.
3. Electrical connection terminals are secured.
4. Wiring as per enclosed diagram or service manual supplied.

1.10.3 When actuator is first placed into service, it should be cycled with regulated pneumatic pressure. This is necessary because the seals have been stationary, causing them to take a "set". Therefore, the actuator should be operated through several cycles to exercise the seals to achieve a service ready condition.

1.10.4 The actuator speed of operation is determined by several factors includes:

1. Power supply line length
2. Power supply line size
3. Power supply line pressure
4. Control valve and fitting orifice size
5. Thrust requirements of the valve
6. Size of the actuator
7. Setting of speed controls
8. Hydraulic manual override (where available)

1.10.5 Due to the interaction of these variables, it is difficult to specify a "normal" operating time. Faster operating time may be obtained by using one or more of the following:

1. Larger supply lines
2. Larger control valve
3. Higher supply pressure *
4. Quick exhaust valves

* Not to exceed maximum operating pressure of actuator or control components

1.10.6 Slower operating time may be obtained by using flow control valves to meter the exhaust. Excessive exhaust flow metering may cause erratic operation.

1.11 Actuator Operation

1.11.1 GVO-G double-acting linear actuators utilize a pneumatically controlled piston that moves inside of a cylinder to generate thrust. A seal contained on the circumference of the piston provides a seal between the top and bottom of the cylinder, preventing supply pressure leakage.

1.11.2 GVO-G spring-return linear actuators utilize a spring in spring module below the power module that will drive the piston rod upon a loss of supply pressure. This fail action will result in forcing an attached control valve to either fail-open or fail-closed.

1.11.3 From an equilibrium state, the actuator operates by reacting to a force unbalance that is created by increasing supply pressure on one side of the piston and decreasing it on the other. This moves the piston up or down, and results in a repositioning of the attached valve. Travel can be adjusted using travel stops within the actuator or a valve control instrument, which limit the travel range of the actuator. The optional manual override does not have the ability to act as a hard travel stop.

1.11.4 An optional manual override (top mounted handwheel jackscrew or side mounted handpump) is capable of extending or retracting the actuator manually and can be engaged at any position from full open to full close. The top-mounted handwheel utilizes an engagement lever that couples the handwheel and piston rod. The handpump has a hydraulic cylinder attached to the piston rod. This enables the handpump to operate the actuator manually, unless the handpump is set to bypass position.

NOTE:

All pressure must be vented or equalized on both sides of the pneumatic piston prior to manual operation.

Section 2: Actuator Assembly and Valve Adaptation

2.1 Double-Acting Actuator Assembly

⚠ WARNING

Remove all operating pressure. If not already removed disconnect all operating pressure from actuator power cylinders.

2.1.1 Ensure that the mating surfaces of the pedestal, valve, and actuator are clean and free from burrs.

2.1.2 Lift the power module onto the top of Pedestal (15-10), pay attention to the assembly drawing for orientation of pressure ports relative to the Pedestal.

2.1.3 Ensure that actuator piston rod is retracted to approx. 2" out from the Power Module and the wrench flats (if applicable) on Rod Adapter (30-180) are fully accessible.

2.1.4 Check to verify the O-ring (4-90) is properly seated in its seal groove located on the inner end cap (3-10), bolt the Pedestal to the power module and torque the hex cap screws (15-140) with lock washers (15-150) as specified.

2.1.5 Screw the Stem Connector assembly or Piston Rod Stem Nut onto the Rod Adapter (30-180) as follows:

2.1.5.1 If stem connector assembly is not free to rotate within yoke space, use the wrench flats (if applicable) on the Piston Rod to rotate the piston rod.

NOTE:

Steps 2.1.5.2 and 2.1.5.4 is used for tightening piston rod through the power module outer end cap.

2.1.5.2 Remove pipe plug (3-120); stop screw (for TSP/ESP) or jackscrew (for M3) from outer end cap (3-80) of power module depends on the configuration.

2.1.5.3 Using a male square drive extension, go through outer end cap (3-80) and rotate the piston rod (3-40).

2.1.5.4 Torque tighten piston rod (3-40) as follows:

2.1.5.4.1 G01 or G3 torque to 90 lb-ft lubricated.

2.1.5.4.2 G4 or G10 torque to 240 lb-ft lubricated.

2.1.6 Insert set screw (if provided) into the Stem Connector Body.

2.1.7 If anti-rotate feature is called for, install the Anti-Rotate Plate (15-20-40) to the Stem Connector Assembly protrude through the slots on the yoke frame.

2.1.8 Set the upward stop adjustment screws (15-20-20) (if applicable) so that the wings of the Stem Connector Assembly are 1/8 inch (3.2 mm) from the top of the slots. Set the downward stop adjustment screws (if applicable) so that the Piston Rod can stroke to its maximum stroke length.

2.2 Spring-Return Actuator Assembly

⚠ WARNING

Springs in extended position. The spring cartridge must be checked to verify that the spring(s) are in their extended position before the pneumatic power module is assembled onto.

2.2.1 Lubricate Rod Bushing (6-40 or 30-80), Rod Wiper (30-90) and O-ring (30-70), and then assemble Bushing, Rod Wiper and O-ring into Adapter (30-20) and check the O-ring (6-10) sits in the groove correctly before bolting Adapter (30-20) on the Spring Module outer end cap (5-10/10-110).

2.2.2 For Fail Extend Actuator, skip step 2.2.2. For Fail Retract Actuator, lubricate O-ring (30-70), Rod Wiper (30-90) and O-ring (30-160) and assemble O-rings into and onto the Insert (30-150), place the insert to the Inner End Cap (5-10/10-80) of the spring module in the correct direction.

2.2.3 Install the Connection Rod (30-30) and Tension Rod (30-50) into the Lock Nut (30-40), tighten the threads to the end.

2.2.4 Install the tension rod assembly into the spring module, make sure the Connection Rod (30-30) is always in the direction towards the housing (30-10). Make sure the Lock Nut (30-40) sits in the Spring Guide (5-10/10-10) hexagon concave.

2.2.5 Lubricate O-ring (6-10) and assemble it onto Spring module Outer End cap (5-10/10-110) prior to bolt the Adaptor (30-20) to Spring module, bolt on the Adapter (30-20) to the Outer End Cap (5-10/10-100) of the assembled spring module, tighten the threads to the end.

NOTE:

1. Fail Retract Actuator and Fail Extend Actuator use different connection rod and tension rod sizes.
2. Use Adapter (30-20) surface of the spring module for Fail Retract Actuator and Inner End Cap (5-10/10-80) of the spring module for Fail Extend Actuator for step 2.2.8.
3. It is recommended to assemble the actuator in horizontal in the following steps.

2.2.6 Lubricate O-ring (4-90) and assemble it onto Power module Inner End cap (3-10) prior to bolt the Housing (30-10) to Power module, bolt on the Housing (30-10) to the power module as indicated in assembly drawing, tighten the threads to the end.

2.2.7 Ensure the power module Piston Rod (3-40) is completely extended for Fail Extend Actuator, or completely retracted for Fail Retract Actuator.

⚠ WARNING

Spring cartridge must be tightened on work bench prior to assemble with Power module when the spring-return linear actuator is assembled in horizontal.

2.2.8 Use lifting equipment move the power module assembly with Housing (30-10) to align with the spring module's interface, see Note below.

NOTE:
Don't bolt the Housing (30-20) to Spring module before the connection of Piston rod (3-40) with Tension rod assembly (30-30, 30-40, 30-50) is completed.

2.2.9 Use the wrench flats on the tension rod assembly to hold the tension rod, remove pipe plug (3-120); stop screw (for TSP/ESP) or jackscrew (for M3) from outer end cap (3-80) of power module depends on the configuration.

2.2.10 Using a male square drive extension, go through outer end cap (3-80) and rotate the piston rod (3-40).

2.2.11 Slightly loose the hex cap screws (3-100) with lock washers (3-110) if contact is not made between tension rod assembly and piston rod. Make orientation adjustment to allow thread engagement between tension rod assembly and piston rod. After confirming initial thread engagement rotate piston rod into tension rod assembly per the following table:

⚠ WARNING

Rotate piston rod properly. After initial thread engagement the piston rod must be rotated clockwise the minimum number of turns listed in Table 1.

Table 1. Minimum Turns

Actuator Model	Torque units	G01	G2	G3	G4	G5	G7	G8	G10
Minimum no turns	N/A	N/A	10	10	10	13	14	20	25

⚠ WARNING

Do not cross-thread. When screwing piston rod into tension rod assembly, make certain that the piston rod and tension rod assembly threads do not cross-thread.

2.2.12 Torque tighten piston rod and spring cartridge tension rod as listed in the following table:

Table 2. Piston Rod Torque

Actuator Model	Torque (±5%)		Actuator Model	Torque (±5%)	
	Lbf-ft.	Nm		Lbf-ft.	Nm
G01	90	122	G5	240	325
G2	90	122	G7	240	325
G3	90	122	G8	240	325
G4	240	325	G10	240	325

2.2.13 Bolt the Housing (30-10) to the Spring module and tighten the hex cap screws (3-100) with lock washers (3-110) to the end.

2.2.14 Check the length of the tension rod out from the spring module end, this dimension should match with Dimension “D” in the Table 3.

Table 3. Spring-Return Actuator Dimension D

Actuator Size	Dimension D (inch)			
	(Fail down) as assembled	(Fail up) as assembled	(Fail down) Stroke ”0”	(Fail up) Stroke ”0”
GVO-G2**-01R*	8.72	2.57	6.82	4.47
GVO-G2**-02R*	9.92	2.57	6.82	5.67
GVO-G3**-03R*	11.98	3.08	11.36	3.70
GVO-G4**-04R*	14.28	3.63	13.89	4.02
GVO-G5**-05R*	17.49	3.91	16.15	5.25
GVO-G7 and above	Consult Factory	Consult Factory	Consult Factory	Consult Factory

2.2.15 Follow steps 2.1.4 to 2.1.8 to assemble the pedestal to the actuator body.

2.3 Actuator and Valve Adaptation

2.3.1 Ensure the mating surface of the valve and the actuator are clean and free from burrs.

2.3.2 Using lifting equipment move the actuator to the top of valve, slowly lower it over the valve, taking care not to contact the stem in manner that could cause damage. Mount actuator to valve and secure it to the bonnet with the bonnet-to-actuator bolts.

2.3.3 Ensure the travel stop screws of actuator is disengaged and the actuator rod is fully retracted. For Fail Extended Actuators, it may be necessary to apply a temporary loading pressure to the bottom cylinder pressure connection to move the keep actuator rod retracted.

2.3.4 With the valve plug on the seat, attach the Stem Connector (15-50) to the valve stem, tighten the thread until coupling bottoms out then back off at least a quarter of a turn and at most one half of a turn.

2.3.5 Tighten the hex cap screws (15-60) with lock washers (15-70) to clamp the actuator rod to the valve stem.

2.3.6 Make sure to attach the travel indicator plate (15/20-40), confirm proper operation and check travel, travel indicator adjustment, etc.

2.3.7 Adjust the travel stop screws on Pedestal or on top of the actuator (for TSP/ESP, if applicable) to secure the desired stroke of the actuator/valve.

Section 3: Actuator Removal and Disassembly

3.1 General Disassembly

⚠ WARNING

Dangerous gas and/or liquids. It is possible, that the actuator may contain a dangerous gas and/or liquid. Ensure that all proper measures have been taken to prevent exposure or release of these types of contaminants before commencing any work.

3.1.1 Section 3 - Actuator Disassembly is written to either completely disassemble the entire actuator from valve or can be used to disassemble individual modules as needed (pneumatic power module).

⚠ WARNING

Do not remove spring module while spring is compressed.

3.1.2 The pneumatic power module can be disassembled while still attached to the pedestal or housing; the pneumatic power module can be removed from the pedestal or housing and disassembled separate to the actuator.

3.1.3 To ensure correct reassembly, mark or tag up (or down and mark mating surfaces.

3.1.4 Ensure the valve and actuator are de-energized (mechanical, pneumatic, and electric) and appropriately isolated.

3.1.5 Unscrew Hex cap screw (15-90) on side of the pedestal (15-10) and remove the Cover Plate (15-80) to allow access to the Stem connector assembly (15-20).

NOTE:

Use a means of capturing the hydraulic fluid that will be lost during the removal or disassembly of the override power module. Use a bucket, tub, or large container, etc.

3.2 Actuator Removal

⚠ WARNING

To avoid personal injury or equipment damage, use proper lifting and rigging practices while lifting the actuator assembly. To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector hex nuts when the stem connector has spring force applied to it. If not already removed disconnect all operating pressure from actuator power cylinders.

3.2.1 Disconnect the actuator tubing from the pressure connections on the pneumatic cylinder top and bottom end cap and control panel. Provisions may need to be made for Fail Extend Actuator: It may be necessary to apply a temporary loading pressure to the bottom cylinder pressure connection to move the piston rod away from the valve stem during removal. If it is not possible to provide a temporary loading pressure, exercise caution when removing the actuator to prevent damage to the valve stem or actuator rod.

3.2.2 Disconnect the stem connection by removing Hex cap screws (15-60) and Lock washer (15-70) from the Valve Stem connector (15-50).

3.2.3 Remove the bonnet-to-actuator bolting securing the actuator to the valve bonnet. Make sure the actuator is supported and secured by other means prior to loosening nuts.

3.2.4 Using the lifting points provided, hoist the actuator vertically taking care not to contact the stem in a manner that would cause damage.

3.3 Spring-Return Actuator Disassembly

⚠ WARNING

The spring cartridge must be checked to verify that the spring(s) are in their extended position before the pneumatic power module is disassembled from the housing.

3.3.1 Remove pipe plug (3-120); stop screw (for TSP or ESP) or jackscrew (for M3) from outer end cap (3-80) of power module depends on the configuration.

3.3.2 Using a male square drive extension, go through outer end cap (3-80) and rotate the piston rod (3-40) to unscrew piston rod from connection rod (30-30).

3.3.3 Unscrew Hex cap screw (3-100) and Lock washer (3-110) and remove power module from housing (30-10).

3.3.4 Unscrew Hex cap screw (5-20) and Lock washer (5-30) and remove housing (30-10) from spring module (5-10).

NOTE:

When removing power module from housing (30-10) and removing housing from spring cartridge assembly (5-10), be careful not to lose O-ring seals (4-90) and (6-20). It is recommended to disassemble the actuator in horizontal in the following steps.

3.3.5 Reset the stop adjustment screws (15/20-20 if applicable) to the allow Stem Connector Assembly is free to move 1/4" up and down.

3.3.6 Remove set screw (if provided) from the Stem Connector Body (15-50).

3.3.7 Use the wrench flats on the tension rod to unscrew the tension rod (30-50) from the Stem Connector Assembly (15-20).

3.3.8 Unscrew Hex cap screw (15-140) and Lock washer (15-150) and remove spring module from Pedestal weldment (15-10).

3.4 Double-Acting Actuator Disassembly

3.4.1 Reset the stop adjustment screws (15/20-20 if applicable) to allow the Stem Connector Assembly to be free to move up and down.

3.4.2 Remove set screw (if provided) from the Stem Connector Body (15-50).

3.4.3 Use the wrench flats on the Rod adapter (30-180) to unscrew the Piston rod (3-40) and Rod adapter (30-180) from the Stem connector assembly (15-20).

3.4.4 Unscrew Hex cap screw (15-140) and Lock washer (15-150) and remove power module from Pedestal weldment (15-10).

NOTE:

When removing power module from Pedestal weldment (15-10), be careful not to lose O-ring seal (4-90).

3.5 Pneumatic Power Module Disassembly

⚠ WARNING

Remove all operating pressure. If not already removed disconnect all operating pressure from actuator power cylinders.

3.5.1 Mark and record location of the ports on outer end cap (3-80) and inner end cap (3-10).

3.5.2 If actuator is equipped with a power module mounted extended stop (ESP) then rotate the ESP until clear of the piston rod (3-40).

3.5.3 Remove breather assembly (12) from outer end cap (3-80) for fail-down or inner end cap (3-30) for fail-up.

3.5.4 Refer to assembly drawing Detail "F". Remove two socket cap screws (3-130), with lock washer (3-140), from outer end cap (3-80).

3.5.5 Remove two tie bar hex nuts (3-90) from outboard side of outer end cap (3-80).

3.5.6 The fit between cylinder (3-70) and outer end cap (3-80) is very tight. Break end cap free by tapping with a breaker bar on lip provided on the end cap. Remove outer end cap (3-80) from cylinder (3-70).

⚠ CAUTION

Do not damage O-ring groove when removing end cap from cylinder.

NOTE:

When removing cylinder (3-70) off piston (3-30), tilt the cylinder 15 to 30 degrees with respect to actuator centerline.

3.5.7 Remove cylinder (3-70) from inner end cap (3-10).

⚠ CAUTION

Do not use pipe wrench to remove tie bars.

3.5.8 Tie Bar Removal:

3.5.8.1 Remove tie bars (3-20) as follows:

NOTE:

1. G01, G2, G3 and G4 models have flats on outboard end of tie bars (3-20) for wrench placement.
2. G5 through G13 models have a female square socket on the outboard end of tie bars (3-20) for wrench placement.

3.5.8.2 Unscrew and remove tie bars (3-20) from inner end cap (3-10) and piston (3-30).

3.5.9 Remove piston as follows:

3.5.9.1 Refer to assembly drawing Detail "B" or “F”. Remove two split ring halves (3-50) and one retainer ring (3-60) from outboard side of piston (3-30).

NOTE:

Piston (3-30) acts as the retainer for inboard split ring halves (3-50). When removing the piston be careful to not lose inboard split ring halves (3-50).

3.5.9.2 Remove piston (3-30) and two split ring halves (3-50) from piston rod (3-40).

3.5.10 Remove O-ring seal (4-70) from piston rod (3-40).

3.5.11 Remove hex cap screws (3-100) with lock washers (3-110) from housing (1-10).

3.5.12 Remove inner end cap (3-10) off piston rod (3-40).

NOTE:

The piston rod (3-40) removal as outlined in step 2.2.14 is only required when the piston rod is being replaced or when the drive module is to be disassembled.

3.5.13 Unscrew and remove piston rod (3-40) from connection rod (30-30).

Section 4: Actuator Reassembly

4.1 General Reassembly

⚠ CAUTION

Check shelf life of seals. Only new seals, which are still within the seal's expectant shelf life, should be installed into the actuator being refurbished.

4.1.1 Remove and discard all old seals.

4.1.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.

4.1.3 All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder, tie bars and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

⚠ CAUTION

Inspect parts before use. Actuator parts that reflect any of the above listed characteristics should be replaced with new parts.

4.1.4 Before installation coat all moving parts with a complete film of lubricant. Coat all seals with a complete film of lubricant, before installing into seal grooves.

NOTE:

The parts and seals used in the actuator will be assembled using lubricant as identified in Section 1 step 1.6.1.

4.2 Power Module Reassembly

NOTE:

1. The power module reassembly process shall be done on a stand vertically (e.g. linear pedestal).
2. The pedestal must be in the appropriate overtravel position.

4.2.1 Lubricate piston rod (3-40) and insert it through the side of pedestal (15-10) or housing (30-10).

4.2.1.1 For Spring-return, screw piston rod (3-40) into connection rod assembly (30-30).

4.2.1.2 For Double-acting screw piston rod (3-40) into rod adapter (30-180) on the Connector Assembly (15-20).

4.2.2 Torque tighten piston rod (3-40) to the lubricated torque as listed in Table 4.

Table 4. Piston Rod Torque Information

Actuator Model	Torque (±5%)		Actuator Model	Torque (±5%)	
	Lbf-ft.	Nm		Lbf-ft.	Nm
G01	90	122	G5	240	325
G2	90	122	G7	240	325
G3	90	122	G8	240	325
G4	240	325	G10	240	325

⚠ CAUTION

Polypack seal facing piston side. Install the Polypak seal with energizer ring facing piston side of inner end cap (3-10).

4.2.3 Install one O-ring seal (4-90) into seal groove located on the inboard face of inner end cap (3-10).

4.2.4 Install inner end cap (3-10) on to pedestal (15-10) or housing (30-10).

NOTE:

The pressure inlet port should be positioned in the same position as recorded in Section 3.5 step 3.5.1.

4.2.5 Place lock washers (3-110) onto hex cap screws (3-100).

4.2.6 Install hex cap screws (3-100), with lock washers, through pedestal (15-10) or housing (30-10) and into inner end cap (3-10).

4.2.7 Refer to assembly drawing Detail "F". Install one O-ring seal (4-70) into the seal groove in piston rod (3-40).

4.2.8 Apply lubricant to two sets of rod T-seal components (4-50).

NOTE:

The T-seal is composed of one rubber seal and two split skive-cut back-up rings.

4.2.8.1 Install two sets of rod T-seals (4-50) into the internal diameter seal grooves of piston (3-30).

4.2.8.2 Install a back-up ring on each side of the T-seal.

4.2.8.3 When installing the back-up rings, do not align the skive-cuts.

4.2.8.4 If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor-sharp instrument.

4.2.9 Install two split ring halves (3-50) into the most inner groove in piston rod (3-40) and retain by installing the recessed area of piston (3-30) onto the piston rod and over the two split ring halves (3-50).

4.2.10 Install two split ring halves (3-50) into the piston rod, in front of the piston installed in the previous step and retain with retainer ring (3-60).

4.2.11 Install one O-ring seal (4-40) onto the outer diameter seal groove of inner end cap (3-10).

4.2.12 Coat one D-ring seal (4-60) with lubricant and install into the piston external seal groove.

NOTE:

The flat side of the D-ring seal goes down into the seal groove.

4.2.13 Coat two tie bars (3-20) with lubricant and install by carefully pushing tie bars through piston (3-30) and rod T-seal (4-50).

4.2.14 Screw tie bars (3-20) into inner end cap (3-10) and tighten until the threads bottom out.

4.2.15 Refer to assembly drawing Detail "F" or “B”. Coat two O-ring seals (4-80) with lubricant and install into outer end cap (3-80).

4.2.16 Apply lubricant to one O-ring seal (4-40) and install it into the outer diameter O-ring groove of outer end cap (3-80).

4.2.17 Apply lubricant to the bore of cylinder (3-70).

4.2.18 Install lubricated cylinder (3-70) over piston (3-30) and onto inner end cap (3-10). When installing the cylinder over the piston seal tilt cylinder 15 to 30 degrees to piston rod (3-40).

⚠ WARNING

Carefully install cylinder. If needed, when installing the cylinder, hammer on the end of the cylinder only with a non-metallic object.

4.2.19 Install outer end cap (3-80) over tie bars (3-20) and into cylinder (3-70).

NOTE:

The pressure inlet port should be positioned in the same position as recorded in Section 2.2 step 2.2.1.

4.2.20 Install tie bar nuts (3-90) onto tie bars (3-20). Torque tighten tie bar nuts, alternately in 100 lb-ft / Nm increments, until a final lubricated torque, as listed in Table 5, has been achieved.

Table 5. Tie Bar Nuts

Actuator Model	Torque (±5%)		Actuator Model	Torque (±5%)	
	Lbf-ft.	Nm		Lbf-ft.	Nm
G01	120	163	G5	400	542
G2	120	163	G7	500	678
G3	150	203	G8	500	678
G4	150	203	G10	1200	1627

4.2.21 Install lock washers (3-140) onto socket cap screws (3-130).

4.2.22 Install and tighten socket cap screws (3-130), with lock washers (3-140), into outer end cap (3-80).

4.2.23 If removed, using pipe dope, install pipe plug (3-120) into outer end cap (3-80).

4.2.24 Apply sufficient pneumatic pressure to outer end cap (3-80) pressure inlet port to move the piston to its full inboard position (next to inner end cap).

4.2.25 Remove pneumatic pressure from outer end cap (3-80).

4.2.26 Install breather assembly (12) in outer end cap (3-80) for fail down or inner end cap (30-10) for fail up.

NOTE:

Individual actuators may not have reducer bushing (14) depending on port and breather size.

Section 5: Field Conversions

⚠ WARNING

To avoid personal injury or equipment damage, use proper lifting and rigging practices while lifting the actuator assembly. To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector hex nuts when the stem connector has spring force applied to it. If not already removed disconnect all operating pressure from actuator power cylinders.

5.1 Fail Mode Reversal (-FS to -SR, or -SR to -FS)

⚠ WARNING

The spring cartridge must be checked to verify that the spring(s) are in their extended position before the pneumatic power module is disassembled from the housing.

NOTE:

The connection rod (30-30) and tension rod (30-50) use in -FS and -SR are NOT interchangeable, make sure the correct rods are available before start.

5.1.1 Remove pneumatic power module and spring module per Section 3.1-3.3.

5.1.2 Remove the connection rod (30-30), tension rod (30-50) and lock nut (30-40) from the spring module, mark the as needed.

5.1.3 Rotate the spring module and adapter assembly 180 degree and assemble the actuator per Section 2.2.1-2.2.14.

5.1.4 Reinstall the actuator to pedestal per Section 2.1.4-2.1.8.

5.2 Converting Double-Acting Actuator to Spring-Return

NOTE:

1. Before converting, make sure the power module and spring module has been properly sized based on the thrust table.
2. A spring module and related linear conversion module (FS or SR) are required for the conversion work.

5.2.1 Remove pneumatic power module per Section 3.1, 3.2 and 3.4.

5.2.2 Use Section 2.2 for installation.

5.2.3 Reinstall the actuator to pedestal per Section 2.1.4-2.1.8.

Section 6: Actuator Support Information

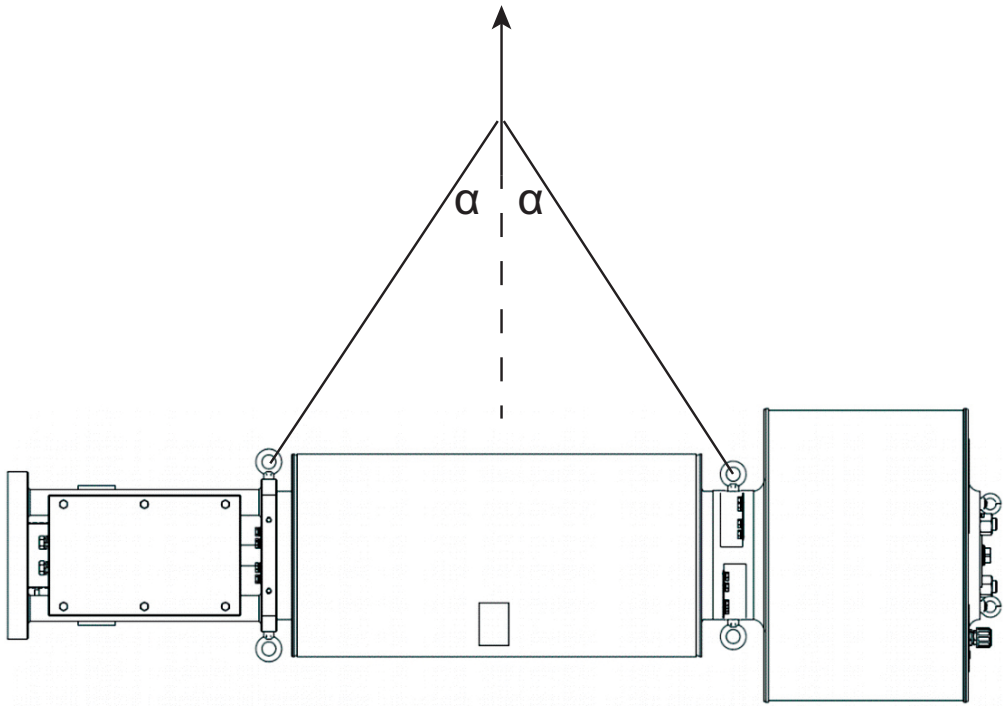
6.1 Lifting

6.1.1 Lifting from Housing and Pedestal Eyebolts

Table 6.

Spring-Return Actuator Size	Lifting Orientation	Lifting Points Used	Maximum Load at Eybolt Lifting Angle α≤45° (lb)
GVO-G02	Actuator centerline horizontal	2X DIN 580 M16	1984
GVO-G03		2X DIN 580 M16	1984
GVO-G04		2X DIN 580 M16	1984
GVO-G05		2X DIN 580 M20	3413
GVO-G07		Consult factory	
GVO-G08			
GVO-G10			

Figure 1

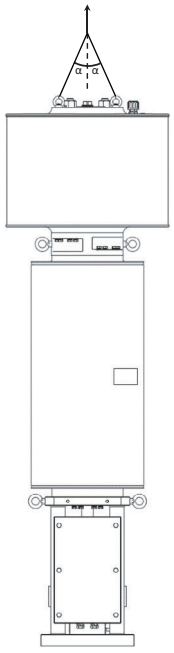


6.1.2 Lifting from Outer End Cap Eyebolts (Spring-Return)

Table 7. Lifting from Outer End Cap Eyebolts

Spring-Return Actuator Size	Lifting Orientation	Lifting Points Used	Cylinder Size	Maximum Load at Eyebolt Lifting Angle α≤45° (lb)
GVO-G02	Actuator centerline vertical	2X 3/8-16UNCX9/16	-	1855
		2X 3/8-16UNCX9/16	10, 12, 14, 16	1855
GVO-G03		2X 1/2-13UNCX3/4	20	3975
		2X 3/8-16UNCX9/16	12, 14, 16	1855
GVO-G04		2X 1/2-13UNCX3/4	20, 24, 28	3975
		2X 3/8-16UNCX9/16	16	1855
GVO-G05		2X 1/2-13UNCX3/4	20, 24, 28, 32, 36	3975
GVO-G07		Consult factory		
GVO-G08				
GVO-G10				

Figure 2

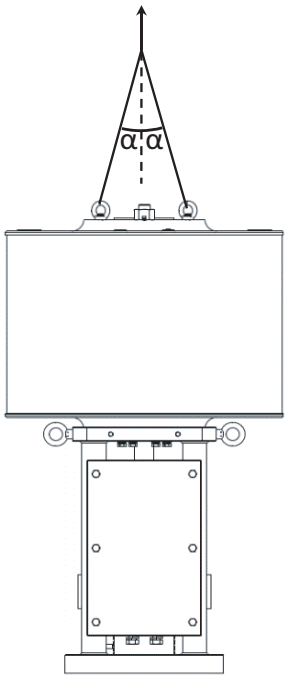


6.1.3 Lifting from Outer End Cap Eyebolts (Double-Acting)

Table 8. Lifting from Outer End Cap Eyebolts

Double-Acting Actuator Size	Lifting Orientation	Lifting Points Used	Cylinder Size	Maximum Load at Eyebolt Lifting Angle α≤45° (lb)
GVO-G01	Actuator centerline vertical	2X 3/8-16UNCX9/16	-	636
GVO-G02		2X 3/8-16UNCX9/16	-	636
GVO-G03		2X 3/8-16UNCX9/16	10, 12, 14, 16	636
		2X 1/2-13UNCX3/4	20	923
GVO-G04		2X 3/8-16UNCX9/16	12, 14, 16	636
		2X 1/2-13UNCX3/4	20, 24, 28	923
GVO-G05		2X 3/8-16UNCX9/16	16	1855
		2X 1/2-13UNCX3/4	20, 24, 28, 32, 36	3975
GVO-G07		Consult factory		
GVO-G08				
GVO-G10				

Figure 3



6.2 G01 Tool Style and Wrench Size

Table 9. G01 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	3/8”	2	Tie Bar (flats)	Open End or Adjustable
3-40	3/8” sq.	1	Piston Rod	Male Drive
3-90	1-1/8”	2	Standard Hex Nuts	Socket
3-100	9/16”	4	Hex Cap Screws	Socket
3-120	5/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	9/16”	4	Hex Cap Screws	Socket
7-80	9/16”	4	Hex Cap Screws	Socket
7-110	1/8” sq.	1	Square Head Pipe Plug	Open End or Adjustable
7-120	9/16” sq.	1	Square Head Pipe Plug	Square Head Pipe Plug
12	1”	1	Breather Assembly	Socket
13	3/4”	2	Vent Check Assembly	Open End
-	3/8” sq.	1	Tension rod	Male Drive

6.3 G2 Tool Style and Wrench Size

Table 10. G2 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	3/8”	2	Tie Bar (flats)	Open End or Adjustable
3-40	3/8” sq.	1	Piston Rod	Male Drive
3-90	1-1/8”	4	Standard Hex Nuts	Socket
3-100	9/16”	4	Hex Cap Screws	Socket
3-120	5/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	9/16”	6	Hex Cap Screws	Socket
7-80	9/16”	4	Hex Cap Screws	Socket
7-110	1/8” sq.	1	Square Head Pipe Plug	Open End or Adjustable
7-120	1/2” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/8” sq.	1	Tension rod	Male Drive

6.4 G3 Tool Style and Wrench Size

Table 11. G3 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	1/2”	2	Tie Bar (flats)	Open End or Adjustable
3-40	3/8” sq.	1	Piston Rod	Male Drive
3-90	1-5/16”	4	Standard Hex Nuts	Socket
3-100	9/16”	6	Hex Cap Screws	Socket
3-120	5/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	9/16”	6	Hex Cap Screws	Socket
7-80	9/16”	6	Hex Cap Screws	Socket
7-110	1/8” sq.	1	Square Head Pipe Plug	Open End or Adjustable
7-120	1/2” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/8” sq.	1	Tension rod	Male Drive

6.5 G4 Tool Style and Wrench Size

Table 12. G4 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	5/8”	2	Tie Bar (flats)	Open End or Adjustable
3-40	1/2” sq.	1	Piston Rod	Male Drive
3-90	1-5/8”	2	Standard Hex Nuts	Socket
3-100	3/4”	6	Hex Cap Screws	Socket
3-120	5/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	3/4”	6	Hex Cap Screws	Socket
7-80	3/4”	6	Hex Cap Screws	Socket
7-110	1/8” sq.	1	Square Head Pipe Plug	Open End or Adjustable
7-120	1/2” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	1	Tension rod	Male Drive

6.6 G5 Tool Style and Wrench Size

Table 13. G5 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	1/2” sq.	2	Tie Bar (flats)	Open End or Adjustable
3-40	1/2” sq.	1	Piston Rod	Male Drive
3-90	2”	2	Standard Hex Nuts	Socket
3-100	3/4”	8	Hex Cap Screws	Socket
3-120	1-1/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	3/4”	8	Hex Cap Screws	Socket
7-80	3/4”	8	Hex Cap Screws	Socket
7-110	1/8” sq.	1	Square Head Pipe Plug	Open End or Adjustable
7-120	1/2” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	1	Tension rod	Male Drive

6.7 G7 Tool Style and Wrench Size

Table 14. G7 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	3/4” sq.	2	Tie Bar (female square)	Open End or Adjustable
3-40	3/4” sq.	1	Piston Rod	Male Drive
3-90	2-3/8”	2	Standard Hex Nuts	Socket
3-100	15/16”	8	Hex Cap Screws	Socket
3-120	1-1/8” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	15/16”	8	Hex Cap Screws	Socket
7-80	15/16”	8	Hex Cap Screws	Socket
7-100	15/16”	8	Hex Cap Screws	Socket
7-110	9/16”	1	Flush Socket Head Pipe Plug	Allen
7-130	9/32” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	2	Tension rod	Male Drive

6.8 G8 Tool Style and Wrench Size

Table 15. G8 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	3/4” sq.	2	Tie Bar (female square)	Open End or Adjustable
3-40	3/4” sq.	1	Piston Rod	Male Drive
3-90	2-3/4”	2	Heavy Hex Nuts	Socket
3-100	1-1/8”	8	Hex Cap Screws	Socket
3-120	1-5/16” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	1-1/8”	8	Hex Cap Screws	Socket
7-80	1-1/8”	8	Hex Cap Screws	Socket
7-100	1-1/8”	8	Hex Cap Screws	Socket
7-110	9/16”	1	Flush Socket Head Pipe Plug	Allen
7-130	9/32” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	1	Tension rod	Male Drive

6.9 G10 Tool Style and Wrench Size

Table 16. G10 Tool Style and Wrench Size

Item No.	Wrench Size	Item Qty.	Location or Description	Recommended Tool Style
3-20	3/4” sq.	2	Tie Bar (female square)	Open End or Adjustable
3-40	3/4” sq.	1	Piston Rod	Male Drive
3-90	3-1/2”	2	Heavy Hex Nuts	Socket
3-100	1-5/16”	8	Hex Cap Screws	Socket
3-120	1-5/16” sq.	1	Pipe Plug	Open End or Adjustable
3-130	3/16”	2	Socket Cap Screws	Allen
5-20	1-1/8”	8	Hex Cap Screws	Socket
7-80	1-5/16”	8	Hex Cap Screws	Socket
7-100	1-5/16”	8	Hex Cap Screws	Socket
7-110	9/16”	1	Flush Socket Head Pipe Plug	Allen
7-130	9/32” sq.	1	Square Head Pipe Plug	Open End or Adjustable
12	1”	1	Breather Assembly	Open End
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	1	Tension rod	Male Drive

Section 7: Testing and Troubleshooting

7.1 Actuator Testing

7.1.1 Leakage Test - All areas where leakage to atmosphere may occur are to be checked, using a commercial leak testing solution.

⚠ CAUTION

Do not exceed maximum pressure. Pressure applied to the actuator is not to exceed the maximum operating pressure rating listed on the actuator name tag. Test the actuator using a properly adjusted self-relieving regulator, with gauge.

7.1.2 Cycle the actuator five times at the maximum operating pressure (MOP) as listed on the actuator's name tag or the customer's normal actuator supply pressure. If excessive leakage across the piston is noted, generally a bubble which breaks three seconds or less after starting to form, cycle the actuator five times as this will allow the seals to seek their proper service condition.

NOTE:

If excessive leakage across the piston remains, the actuator must be disassembled, and the cause of leakage must be determined and corrected.

7.1.3 Apply MOP pressure to the pressure port in inner end cap (3-10) for fail down or in outer end cap (3-80) for fail up and allow the actuator to stabilize.

7.1.4 Apply a commercial leak testing solution to the following areas:

- **7.1.4.1** For fail down, joint between inner end cap (3-10) and cylinder (3-70), for fail up, joint between outer end cap (3-80) and cylinder (3-70), this checks cylinder to inner/outer end cap O-ring seal.
- **7.1.4.2** The port hole in the outer end cap (3-80) for fail down or in the inner end cap (3-10) for fail up. This checks the piston D-seal to cylinder (3-70), O-ring seal (4-70), and rod T-seal (4-50).
- **7.1.4.3** The vent check port hole in housing. This checks Polypak seal (4-30) that seals piston rod (3-40) to inner end cap (3-10).
- **7.1.4.4** Remove pressure from the pressure inlet port.

7.1.5 If an actuator was disassembled and repaired, the above leakage test must be performed again.

7.1.6 Shell Pressure Test - Optional pressure test could be performed on PED certified actuator by applying pressure to both sides of the piston simultaneously for a period of two (2) minutes. If any leakage occurs across a static seal, the unit must be disassembled, and the cause of leakage determined and corrected.

⚠ WARNING

PED pressure testing. The actuators main pressure bearing parts will be tested in controlled conditions in accordance with the requirement of PED by pressuring both sides of the piston to avoid damage and over press of the actuator components. If further future testing in the field is necessary, Emerson should be contacted for guidance.

7.2 Fault Insertion

In the unlikely event of a fault developing, the following Fault Location Table is provided to assist the service engineer to perform troubleshooting. This table is designed to cover as wide a range of Emerson Bettis actuators as possible. Reference to equipment not supplied should be ignored.

Table 17. Fault Location Table

Symptom	Potential Causes	Remedy
Erratic movement	Irregular supply of operating medium	Check operating medium for consistent supply pressure and correct as necessary.
	Inadequate lubrication	Dismantle, relubricate and reassemble.
	Worn parts	Dismantle, visually inspect for significant wear. Actuator replacement may be required.
	Defective valve	Consult the valve OEM's documentation.
Short stroke	Incorrectly set stops (valve and /or actuator)	Check the position of the travel stops and readjust as necessary.
	Hardened grease	Dismantle, remove any hard grease, relubricate and reassemble.
	Debris left in the cylinder during maintenance	Disassemble cylinder assembly to remove debris. Reassemble cylinder assemble as necessary.
	Defective valve	Consult the valve manufacturer's documentation.
Apparent lack of thrust	Inadequate supply pressure	Ensure supply pressure is above the minimum operating pressure of the actuator and that output torque produced at supply pressure exceeds valve torque demand.
	Incorrect speed control settings	Adjust speed controls to increase flow.
	Exhaust port blocked	Remove and clean the exhaust port silencers and replace.
	Pipe work blocked, crushed or leaking	Examine the pipe work for blockages, crushed pipe or leakage. Clear or replace as necessary.
	Defective controls	Examine the controls, refurbish or renew as necessary. Refer to component manufacturer's documentation.
	Defective piston seal	Dismantle the cylinder assembly, remove the defective piston seal. Fit new seal and reassemble.
	Defective rod seal	Dismantle the cylinder assembly, remove the defective rod seal. Fit new seal and reassemble.
	Defective housing seal	Dismantle the housing assembly, remove the defective seal. Fit new seal and reassemble.
	High valve torque or valve seized	Consult the valve OEM documentation.

7.3 Operational Test

7.3.1 Full Stroke Test

The “Full Stroke Test” (“On-line”) must be performed to satisfy the PFD_{avg} (average probability of failure on demand) value. The full stroke test frequencies will be defined by the final installer to achieve the defined SIL level.

7.3.1.1 Procedure

7.3.1.1.1 Stroke the actuator/valve assembly two complete open/close cycles with complete closing of the valve.

7.3.1.1.2 Verify the open/close cycles functioned correctly (e.g. check locally, or automatically via Logic solver, the correct movement of the actuator/valve).

Upon successful completion of the above described Full Stroke Test procedure, the “Test Coverage” can be considered 99%.

7.3.2 Partial Stroke Test (when requested)

The “Partial Stroke Test” (“On-line”) can be performed to improve the PFD_{avg} value and to satisfy PFD_{avg} (average probability of failure on demand) value. A typical partial stroke value is 15% of the stroke and the recommended test interval is about every one to three months.

7.3.2.1 Procedure

7.3.2.1.1 Operate the actuator/valve assembly for No 1 open/close cycles 15% of the stroke.

7.3.2.1.2 Verify the partial stroke test functioned correctly (e.g. check locally, or automatically via Logic solver, or via the PST system the correct movement of the actuator/valve was 15% of the stroke).

NOTE:

The above test is only applicable on systems equipped with a partial stroke feature.

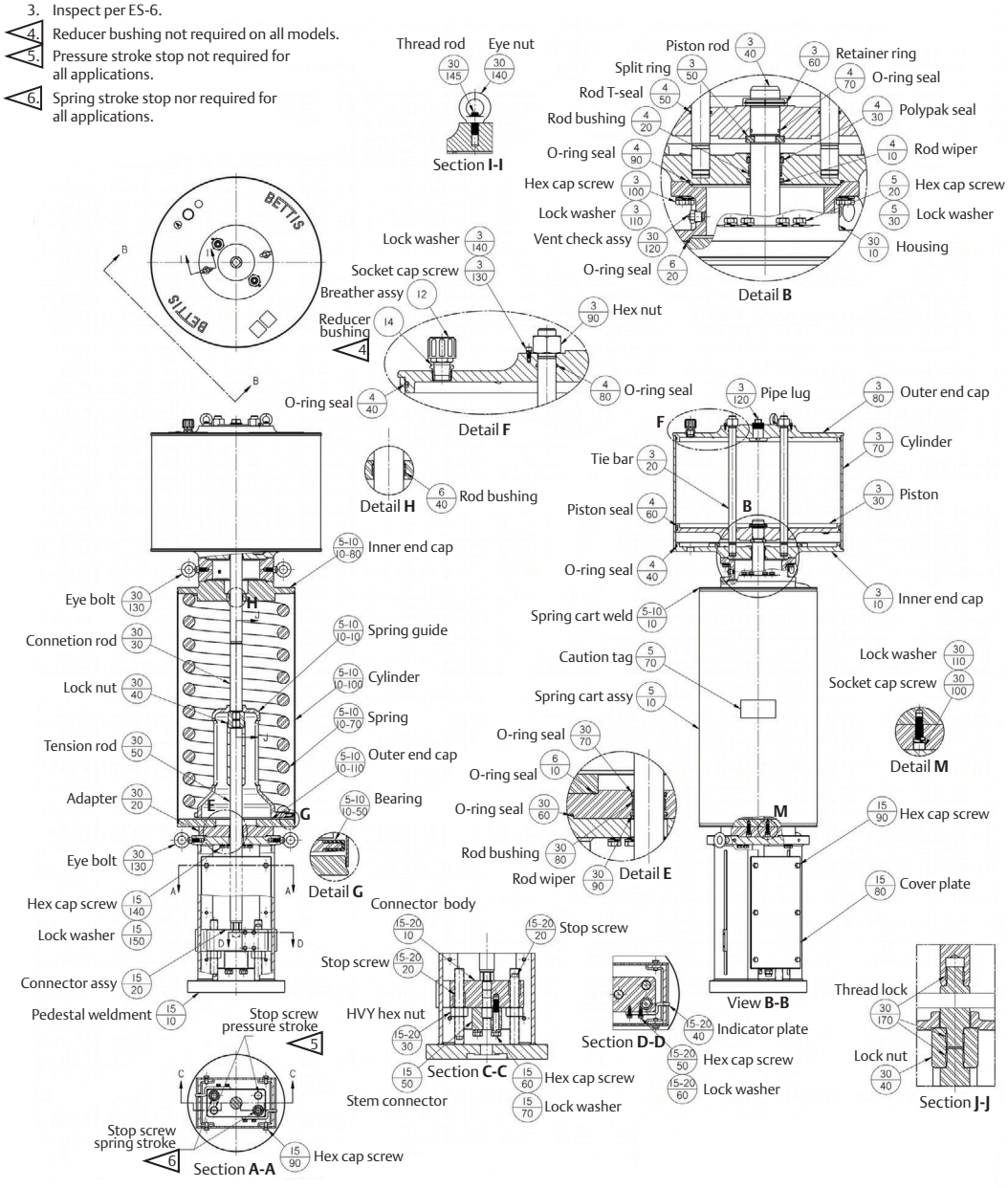
Appendix A: List of Drawings

A.1 Part No. VA-ED-008-4541, Pneumatic Linear Spring to Extend Assembly Drawing

Figure A-1

NOTES

1. All parts to be cleaned to remove all dirt and foreign matter prior to assembly.
2. Apply lubricant (500) to all moving parts and fastners.
3. Inspect per ES-6.
4. Reducer bushing not required on all models.
5. Pressure stroke stop not required for all applications.
6. Spring stroke stop nor required for all applications.

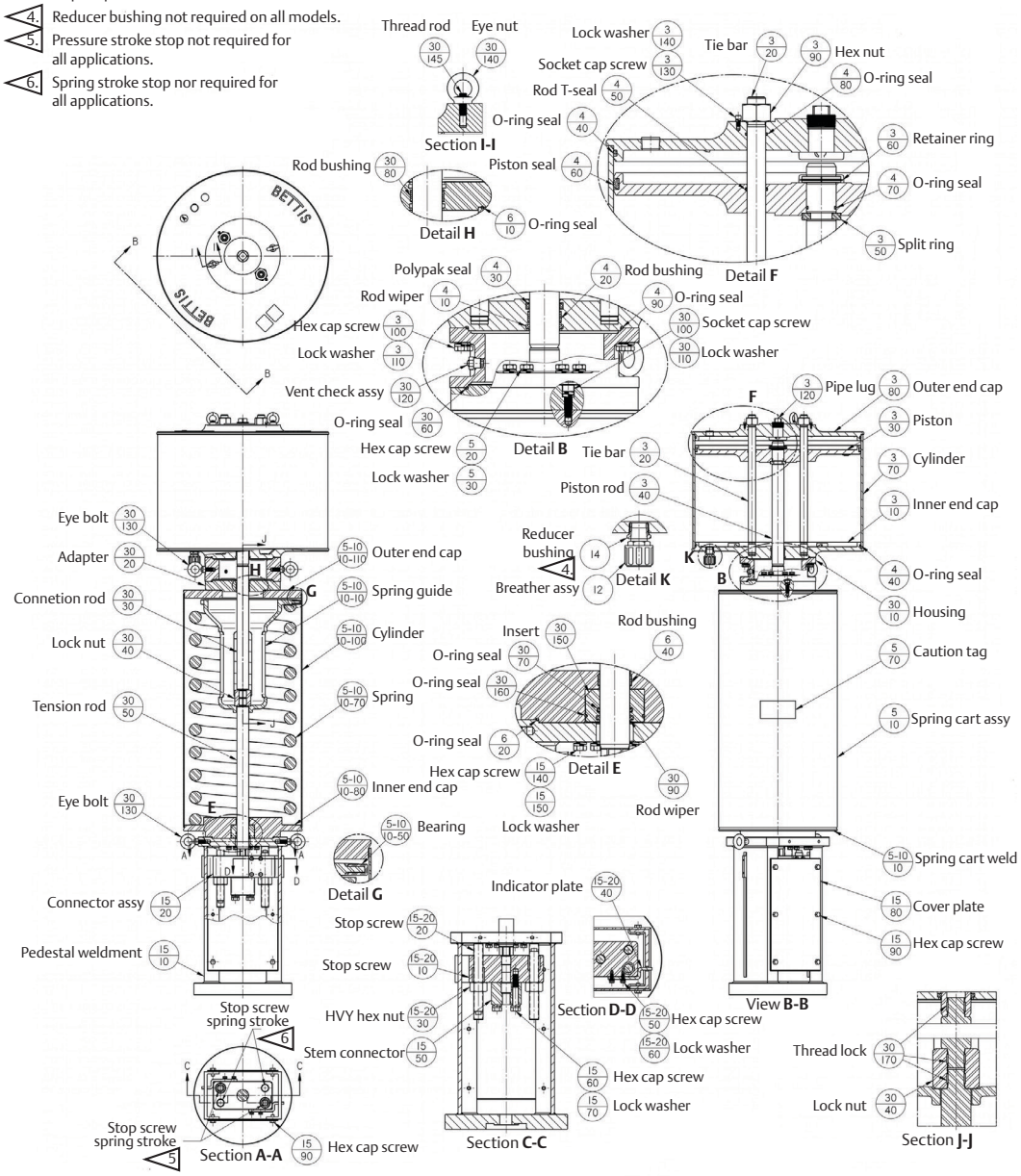


A.2 Part No. VA-ED-008-4542, Pneumatic Linear Spring to Retract Assembly Drawing

Figure A-2

NOTES

1. All parts to be cleaned to remove all dirt and foreign matter prior to assembly.
2. Apply lubricant (500) to all moving parts and fastners.
3. Inspect per ES-6.
4. Reducer bushing not required on all models.
5. Pressure stroke stop not required for all applications.
6. Spring stroke stop nor required for all applications.

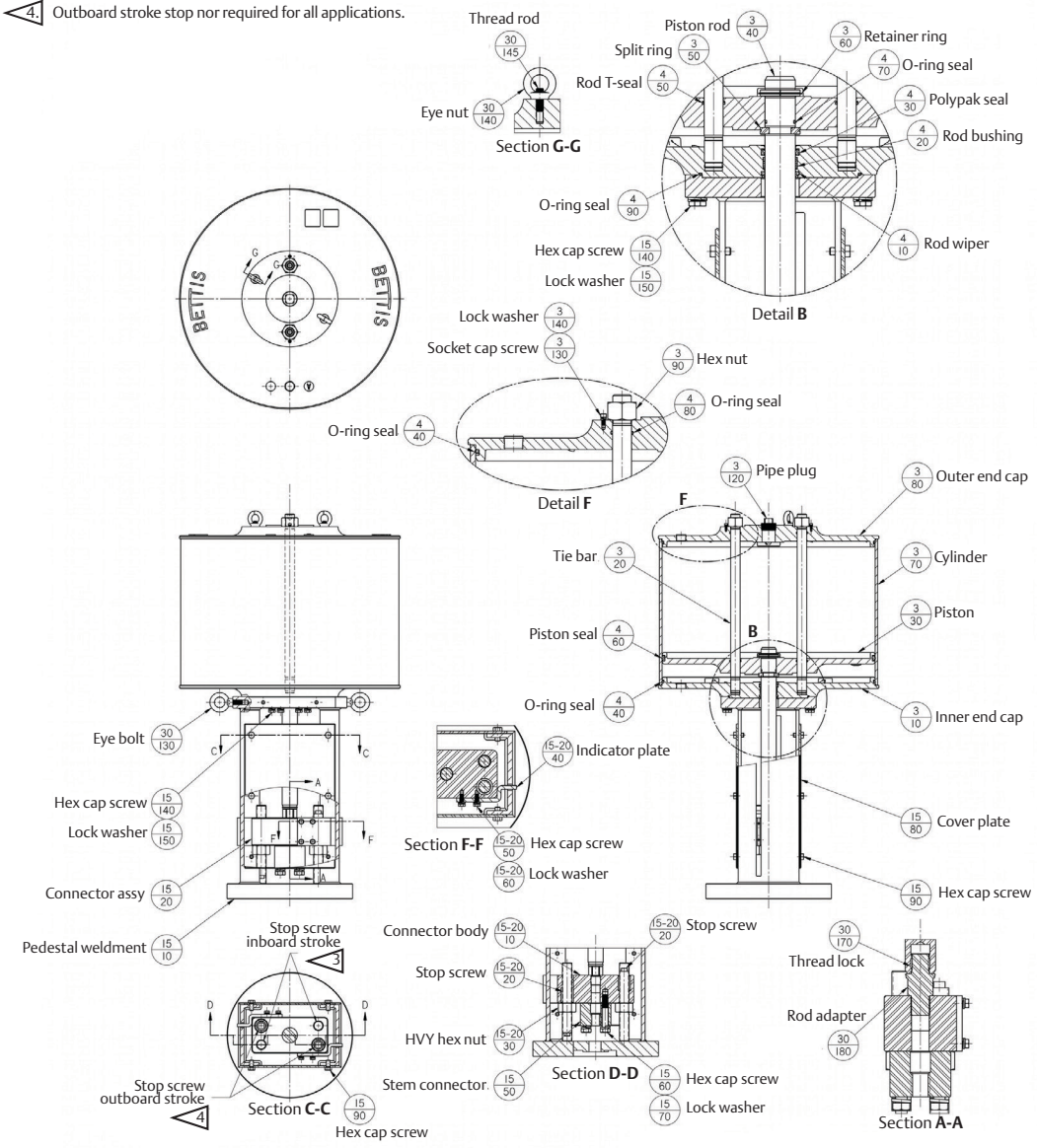


A.3 Part No. VA-ED-008-4558, Pneumatic Linear Double-Acting Assembly Drawing

Figure A-3

NOTES

1. All parts to be cleaned to remove all dirt and foreign matter prior to assembly.
2. Apply lubricant (500) to all moving parts and fastners.
3. Inboard stroke stop not required for all applications.
4. Outboard stroke stop nor required for all applications.



This page intentionally left blank

World Area Configuration Centers (WACC) offer sales support, service, inventory and commissioning to our global customers.
Choose the WACC or sales office nearest you:

NORTH & SOUTH AMERICA

19200 Northwest Freeway
Houston TX 77065
USA
T +1 281 477 4100

Av. Hollingsworth
325 Iporanga Sorocaba
SP 18087-105
Brazil
T +55 15 3413 8888

ASIA PACIFIC

No. 9 Gul Road
#01-02 Singapore 629361
T +65 6777 8211

No. 1 Lai Yuan Road
Wuqing Development Area
Tianjin 301700
P. R. China
T +86 22 8212 3300

MIDDLE EAST & AFRICA

P. O. Box 17033
Jebel Ali Free Zone
Dubai
T +971 4 811 8100

P. O. Box 10305
Jubail 31961
Saudi Arabia
T +966 3 340 8650

24 Angus Crescent
Longmeadow Business Estate East
P.O. Box 6908 Greenstone
1616 Modderfontein Extension 5
South Africa
T +27 11 451 3700

EUROPE

Holland Fasor 6
Székesfehérvár 8000
Hungary
T +36 22 53 09 50

Strada Biffi 165
29017 Fiorenzuola d'Arda (PC)
Italy
T +39 0523 944 411

For complete list of sales and manufacturing sites, please visit www.emerson.com/actuationtechnologieslocations or contact us at info.actuationtechnologies@emerson.com

www.emerson.com/bettis

BETTIS™

EMERSON™