WOODWARD

Component Maintenance Manual
Bronze Level

Product Name: VariStroke-I (VS-I) Family

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General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the Woodward website:

www.woodward.com

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to receive the latest copy.

Proper Use

Any unauthorized modifications to, or use of this equipment outside of its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty, thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

1. GENERAL INFORMATION

INTRODUCTION

This Component Maintenance Manual is intended to be used by customers and Woodward authorized service centers for repair or service of the VS-1 family of hydraulic actuators. Bronze level service is preventative and routine maintenance that requires little to no specialized tooling, testing, or calibration procedures to maintain the product between normal overhaul intervals. This manual is written with the assumption that the reader has access to the product manual and other Woodward literature referenced within this document.

1.1 Regulatory Compliance

The VS-I is subject to safety regulatory certifications. See product manual 26727 (VS-I Double Acting) or 35119 (VS-GI Single Acting) for additional details. The service center performing the work on the VS-I must not alter the construction such that the certifications are invalidated.

⚠WARNING

FLAMEPATH

Disassembling the product will require handling critical components used in a Zone 1 Flameproof and/or Division 1 Explosion proof design. Special care must be taken as to not damage these parts as it could compromise the product's protection method. Flamepaths are identified in drawing 9989-7006.

Threaded Flamepaths: Care must be taken during handling and assembly to not damage threads. Inspect for damage to threads which includes, but is not limited to galling, cross threading, and excessive wear. Damage to threads and/or thread fit can compromise the effectiveness of the protection method. If any damage is discovered, contact Woodward prior to reinstallation or assembly into the system.

Radial and Flat Joint Flamepaths: Care must be taken during handling and assembly to not damage the flat surface of the flamepath. Inspect the primary surface and mating surface for damage, including but not limited to scratches, porosity, and marks due to impact. Damage to these surfaces can compromise the effectiveness of the protection method. If any damage is discovered, contact Woodward prior to reinstallation or assembly into system.

Repair of Flamepaths: The flameproof joints are not intended to be repaired. Return to Woodward for repair and maintenance if joints are damaged.

WARNING

Explosion Hazard— Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 1 or 2, or Zone 2 applications.

WARNING

Do not damage the cover seal, cover surface, threads, or the VS-I surface while removing or replacing the cover. Damage to sealing surfaces may result in moisture ingress, fire, or explosion. Clean the surface with isopropanol if necessary. Inspect the cover joint surfaces to ensure that they are not damaged or contaminated.

WARNING

For Division 1/Zone 1 products: Proper torque on all joints is critical to ensure that the unit is sealed properly.

1.2 Warnings and Notices

This is the safety alert symbol to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

1 **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.

2 **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.

3 **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.

4 **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).

5 **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered, includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Disconnect Power Supply

Before performing maintenance, always disconnect power and any hazardous voltages that may be connected. Follow all appropriate lockout/lockdown procedures.

⚠WARNING

Hazards due to insufficiently qualified personnel!

If unqualified personnel perform work on or with the product, hazards may arise, which can cause serious injury and substantial damage to property. Therefore, all work must be carried out by appropriately qualified personnel.

⚠WARNING

Remove pressure before servicing. Failure to do so may damage the VS-I and/or cause injury.

1.3 Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors of a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control:

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible as they do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. After removing the old PCB from the control cabinet, immediately place it in the antistatic protective bag.

1.4 List of Woodward Literature

Required Documents	
Product Manual **26727**	VariStroke-I (VS-I) Electro-hydraulic Actuator
Product Manual **35119**	VariStroke-GI (VS-GI) Electro-hydraulic Actuator (Single Acting)
Manual **35148**	VariStroke-I Service Tool
Manual **35132**	VariStroke-DX Duplex Hydraulic Servo Skid
CMM-**03013**	Component Maintenance Manual Bronze Level, VariStroke DX
CMM-**02003**	VariStroke-I (VS-I) CMM Silver Level
Replacement Kits **9999-1590**	Bronze and Silver Level Replacement Kits, Tabulation Drawing
Installation Drawing **9999-1590-10**	Kit, VSI, Torsional Spring V45
Installation Drawing **9999-1590-1**	Kit, VSI, Integrated Servo Replacement V45
Installation Drawing **9999-3189**	Kit, VSI, Remote Servo Replacement V45
Installation Drawing **9999-1590-20**	Kit, VS-GI, Integrated Servo Replacement V45
Installation Drawing **9999-1895**	Kit, VS-GI, Remote Servo Replacement V45
Installation Drawing **9999-1590-3**	Kit, VSI, Manifold Seal Replacement 6, 8, 10 inch bore
Installation Drawing **9999-1590-4**	Kit, VSI, Manifold Seal Replacement 4, 5 inch bore
Installation Drawing **9999-1590-6**	Kit, VSI, Manifold Seal Replacement 5 inch bore (Top level 9907-1468 only)
Installation Drawing **9999-1590-22**	Kit, VS-GI Manifold Seal Replacement 6, 8, 10 inch bore
Installation Drawing **9999-1590-7**	Kit, VSI, Cylinder Rod Seals
Installation Drawing **9999-1590-29**	Kit, VS-GI Dump Valves Replacement Kits
Drawing **9989-7006**	FLAMEPATH, VARISTROKE 1
Reference Documents	
Manual **26455** –	Customer Publication Cross Reference and Revision Status & Distribution Restrictions
Manual **82715** –	Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, & Modules

For latest documents and software visit our SharePoint site **https://collab.woodward.com/portal/indust**
Request access permissions through your Woodward account manager.

1.5 List of Required Hardware or Materials

Specialty Tools	• 1013-6844 - socket - 6-point deep, 1-1/8" size, 3-1/4" overall length • 1013-6924 - socket - 6-point deep, 1" size, 3-1/4" overall length
Torque wrenches	• 5.3 - 6.2 lb-in (0.6 to 0.7 Nm), Allen hex key; Size 1.5 mm • 90 - 110 lb-ft (120 – 150 Nm), socket or flat wrench; size 2.25 in (2 1/4) • 45 – 55 lb-ft (61 – 75 Nm), socket wrench; size ¾ inch • 45 – 55 lb-ft (61 – 75 Nm), flat wrench; size ¾ inch • 23 - 27 lb-ft (31 to 37 Nm) for tool 1013-6844 • 68 - 82 lb-ft (92 to 111 Nm) for tool 1013-6924 • 11 - 13 lb-in (1.2 to 1.5 Nm), screwdriver PH 2
Basic Tools	• Flat wrench; size 2.25 inch • Flat wrench; size 3/4 inch • Socket wrench; size 3/4 inch • Allen hex key; size 1.5 mm • Type: Phillips; Tip size: PH 2 • Type: slotted; Tip size: 2.5 X 0.4 mm • Socket wrench extension bar; 3 inch, ½ in Drive • Wire cutters; small
Others	• Oil absorbent pads / mats • Lifting strap (minimum capacity 1000 lbs / 455 kg) • ISOPROPANOL cleaning fluid • GN Paste (Molykote DX Paste or similar) • Petroleum jelly to O-ring lubrication • Loctite 242 (Loctite Threadlocker Blue 242) • PC computer with Woodward PC Service Tool installed
NOTICE **Tools are not contained within the replacement kit. Please order separately.**	

1.6 Required Software

9927-2177 – VS-I Customer Service Tool Installer.

For latest documents and software, visit our SharePoint site **https://collab.woodward.com/portal/indust**
Request access permissions through your Woodward account manager.

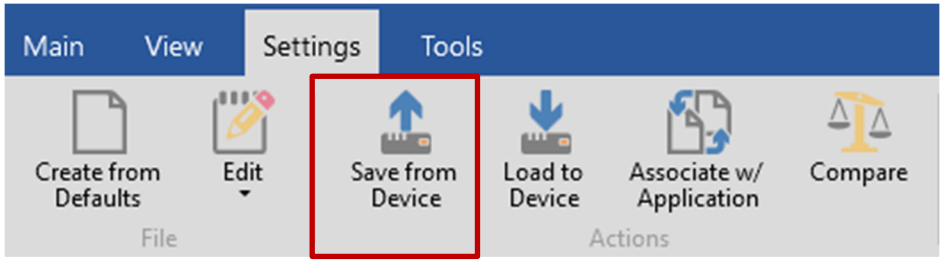
1.7 General Instructions

- Lifting:
  - Double Acting - For proper and safe lifting instructions and diagrams, see product manual **26727** Chapter 3.
  - Single Acting - For proper and safe lifting instructions and diagrams, see product manual **35119** Chapter 4.
- Review this CMM and the installation drawing before starting the replacement to be sure that all necessary tools are available, and instructions are clear.
- Check the replacement parts kit to verify all replacement parts listed in the installation drawing are present. Sort all parts for easy assembly. For questions, contact Woodward.
- If all parts are not used, the unit or units must be inspected for completeness.
- Contact Woodward if an error is found during the replacement process.
- Clean the exterior of the VS-I by hand prior to disassembly to prevent dirt and debris from contaminating the interior.
- O-rings:
  - Use the correct tool to install or remove O-rings. If using a protective cone on small O-rings, lubricate the O-ring and slide it onto the part being sure it does not twist.
  - If a cone is not used on large O-rings, use a pick under the O-ring to lift it onto the part until it is in the desired location.
- Helicoils:
  - To prevent damage to mid-grip helicoils, install screws at a slow speed. DO NOT USE A HIGH-SPEED TOOL. Stainless steel screws MUST be lubricated with an anti-seize lubricant before turning them into mid-grip helicoils or aluminum parts.
- Disassembly:
  - Parts that have been disassembled and will be reused must be inspected closely for damage and replaced if necessary. Parts that have been disassembled should be kept in a clean container such that they can be readily identified against this procedure, reference drawings, or visual aids for proper reassembly.
- Screws:
  - All screws loosen with counterclockwise (CCW) direction. In other situations, the direction will be specified.

1.8 Unit Inspection and Settings Saving

Before starting any disassembly, perform the following steps:

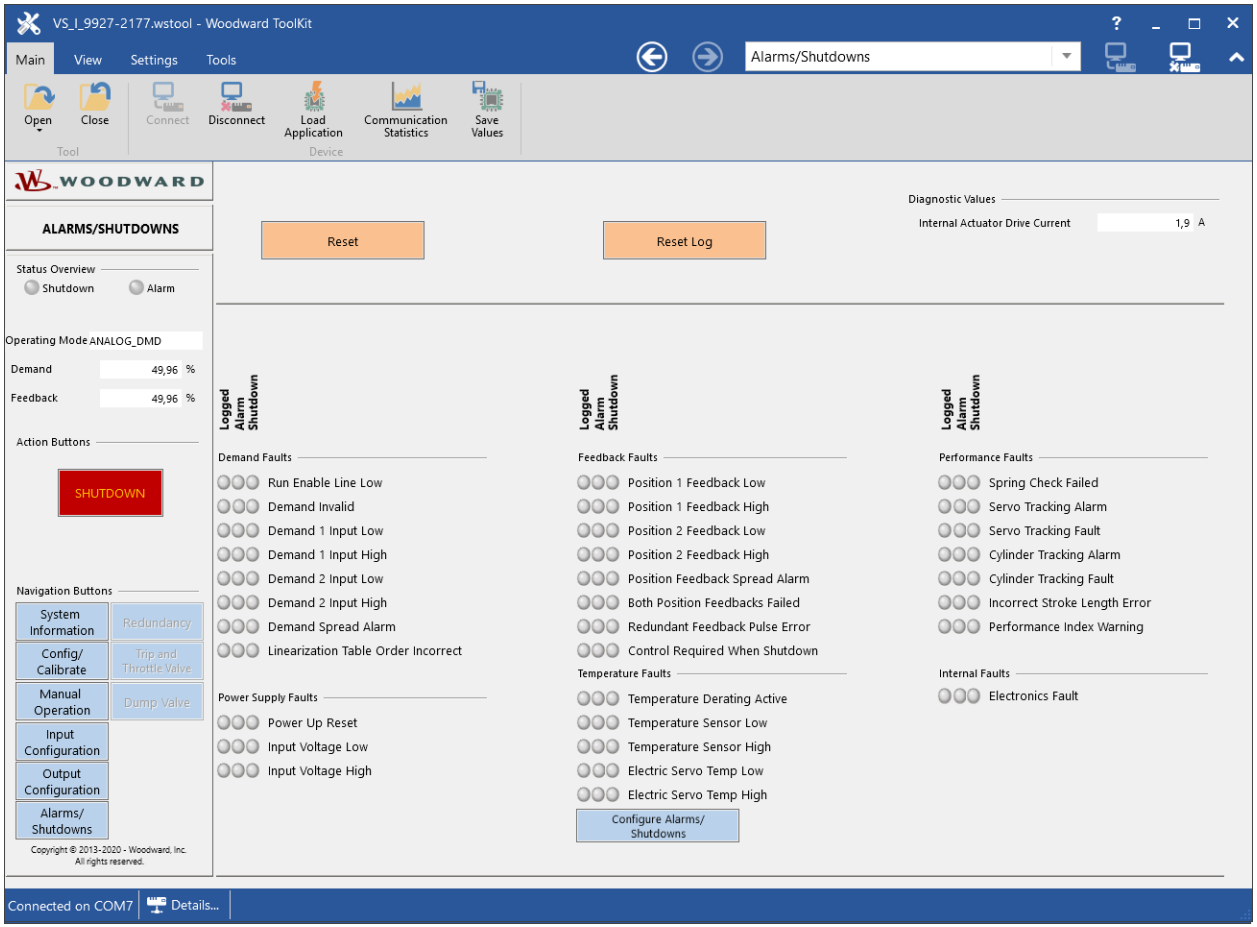
- The unit external inspection:
  - Inspect all external joints between components for any external leaks.
  - Inspect cylinder rod surface for any scratches or damages.
- Launch the Customer Service Tool (9927-2177) and save current unit settings. Go to “Settings” and save parameters from device to file “Save From Device”. For more info, see Product Manual **35148**.



IMPORTANT

Best practice is to save settings files from each VariStroke in the plant. Files should be saved and stored after each successful/finalized configuration change or calibration performed. This is to ensure that settings are backed up in case of unit replacement or further configuration modifications leading to improper behavior. Downloaded files should have the name that clearly identifies when and what location/device it is taken from, e.g. Date_serial number_functional location

- Go to the “Alarms/Shutdowns” screen and review all active alarms. Check the Internal Status page for more inside events related to electronics. In case of an active alarm, review the “Troubleshooting” section in the product manual.



- Overhaul and maintenance kits.
  - Refer to product manual **35119** or **26727**, chapter “Asset Management, Scheduled Maintenance Intervals, and Refurbishment Kits” to review recommendations for the Woodward VS-I overhaul and maintenance.
  - Based on visual inspection, manual info, and Service Tool alarms, prepare a list of replacement kits. Ensure that all tools are available.

2. SERVO VALVE AND MANIFOLD SEAL REPLACEMENT – INTEGRATED VERSION

2.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of servo valve and manifold seal (integrated version) replacement:

DOUBLE ACTING Version:
Servo Valve Replacement (Double Acting VS-I):
- KIT P/N: 9907-1335 – fail-safe direction; extend; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-1336 – fail-safe direction; retract; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-1452 – fail-safe direction; extend; cylinder size 4 and 5 in
- KIT P/N: 9907-1453 – fail-safe direction; retract; cylinder size 4 and 5 in
- KIT P/N: 9907-1473 – fail-safe direction; extend; cylinder size 5 in (TOP LEVEL 9907-1468 ONLY)
- KIT P/N: 9907-2360 VALVE V45TD-E-CR HYDRAULIC SERVO, FAIL EXTEND, VSI, **CHEMICALLY RESISTANT**
- KIT P/N: 9907-2361 VALVE V45TD-R-CR HYDRAULIC SERVO, FAIL RETRACT, VSI, **CHEMICALLY RESISTANT**

Woodward recommends replacing MANIFOLD SEAL REPLACEMENT KIT in addition to the parts kit(s) above.

Manifold Seal Replacement (Double Acting VS-I):
- KIT P/N: 8923-2068 – integrated version; cylinder size 6, 8, and 10 in
- KIT P/N: 8923-2165 – integrated version; cylinder size 4 and 5 in
- KIT P/N: 8923-2243 – integrated version; cylinder size 5 in (TOP LEVEL 9907-1468 ONLY)
- KIT P/N: 8923-3221 - KIT MANIFOLD SEAL REPLACEMENT KIT: 6, 8 & 10 INCH BORE, VSI, **CHEMICALLY RESISTANT**

SINGLE ACTING Version:
Servo Valve Replacement (Single Acting VS-GI):
- KIT P/N: 9907-2340 – fail-safe direction; extend; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2341 – fail-safe direction; retract; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2342 – fail-safe direction; TTV; extend; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2343 – fail-safe direction; TTV; retract; cylinder size 6, 8, and 10 in

Woodward recommends replacing MANIFOLD SEAL REPLACEMENT KIT in addition to the parts kit(s) above.

Manifold Seal Replacement (Single Acting VS-GI):
- KIT P/N: 8923-3021 – integrated version; cylinder size 6, 8, and 10 in

NOTICE **Review this CMM and Installation Drawing before starting the replacement process to be sure that all necessary tools are available and everything is clear. Contact Woodward for any questions.**

2.2 Disassembly Procedure

⚠WARNING

Failure to remove the setscrew could compromise the method of protection.

NOTICE

Before starting the disassembly, connect to the VS-I using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

FLAMEPATHS - Refer to Section 1.1 for specific instructions.

A. Loosen the setscrew before removing the cover (hex key; size 1.5 mm); see Figure 2-2. Remove the cover from the servo valve (flat wrench; size 2.25 inch).

B. Launch the Customer Service Tool (9927-2177) and save current unit settings. Go to “Settings” and save parameters from device to file “Save From Device”. For more info, see product manual 35148.

Note: A prompt to choose the file location appears. Once download is complete, the file will be saved to this location.

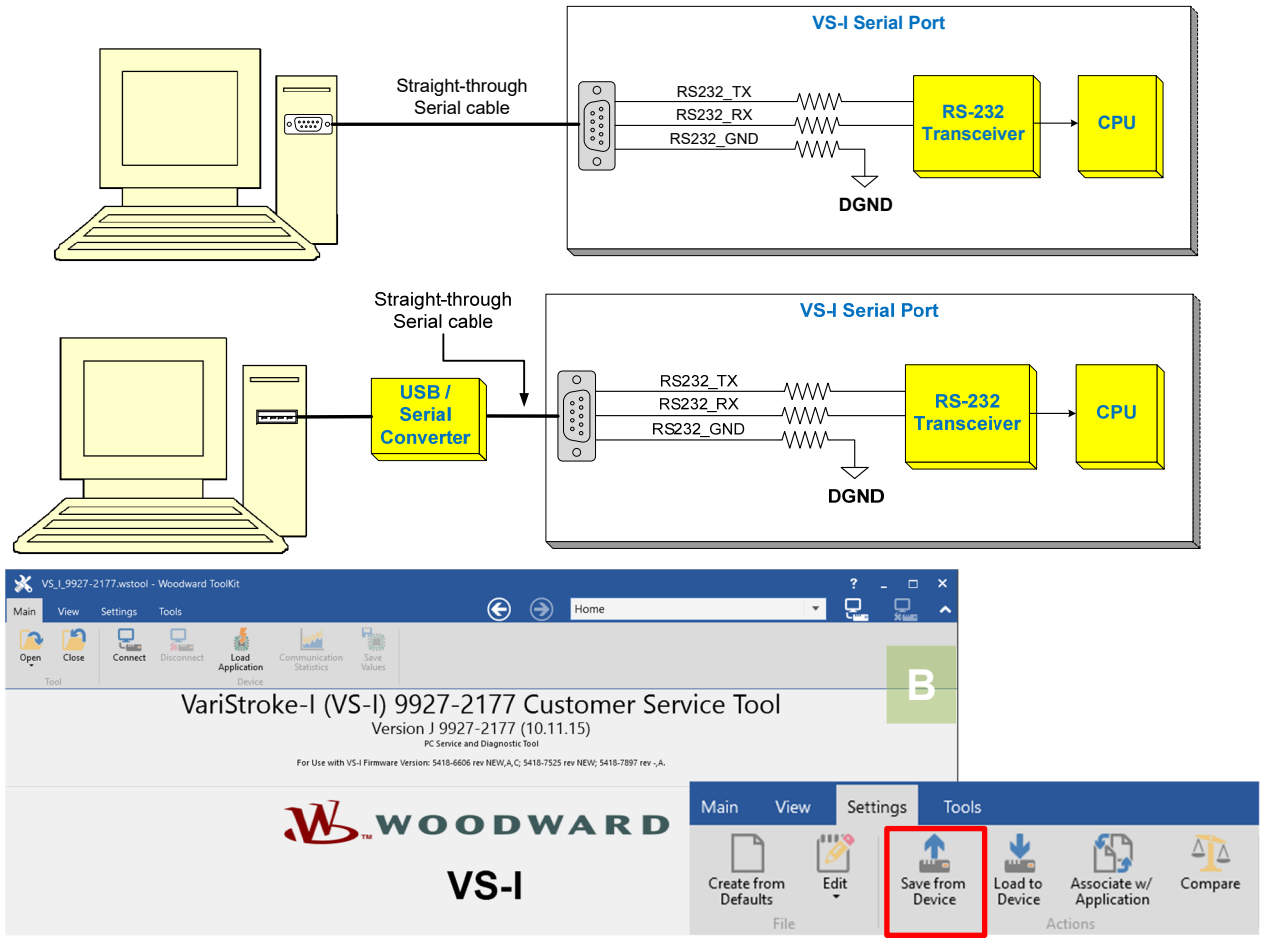


Figure 2-1. Service Tool Connection and Settings Dropdown Menu

⚠WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing the hydraulic system.

C. Disconnect the hydraulic lines and electrical cables on the external interface.

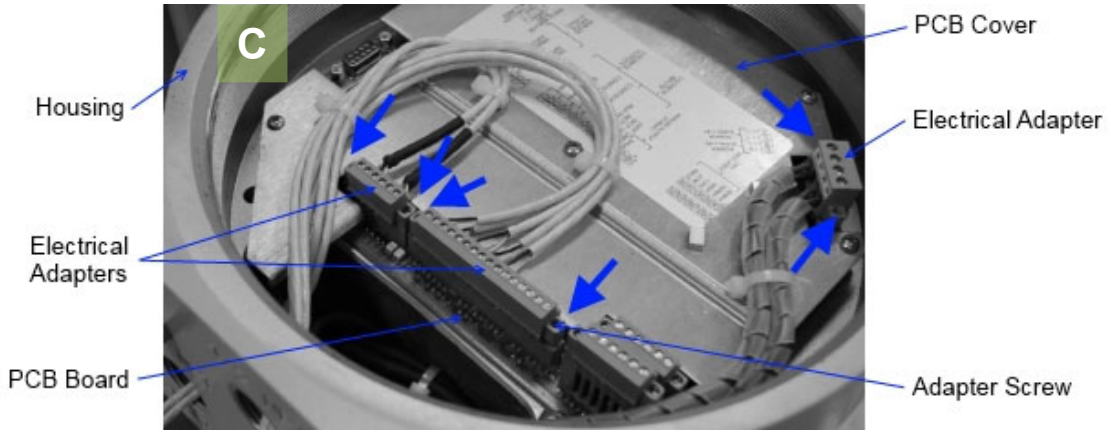


Figure 2-2. Valve Cover and Housing; Components on Outside of PCB Board

NOTICE

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may be spilled when the hydraulic fittings are disconnected. For safety reasons, spilled hydraulic oil should be dried by absorbing mats or other environmentally friendly methods.

D. Using a PH2 screwdriver, remove the seven screws from the PCB cover.

Note: There are two different screw lengths (L – long, S – short); see picture.

E. Using a size 2.5 X 0.4 mm screwdriver, disconnect the cylinder position sensor wires from the terminal block.

F. Carefully cut and remove the two cable ties to loosen the cylinder position sensor cable bundles.

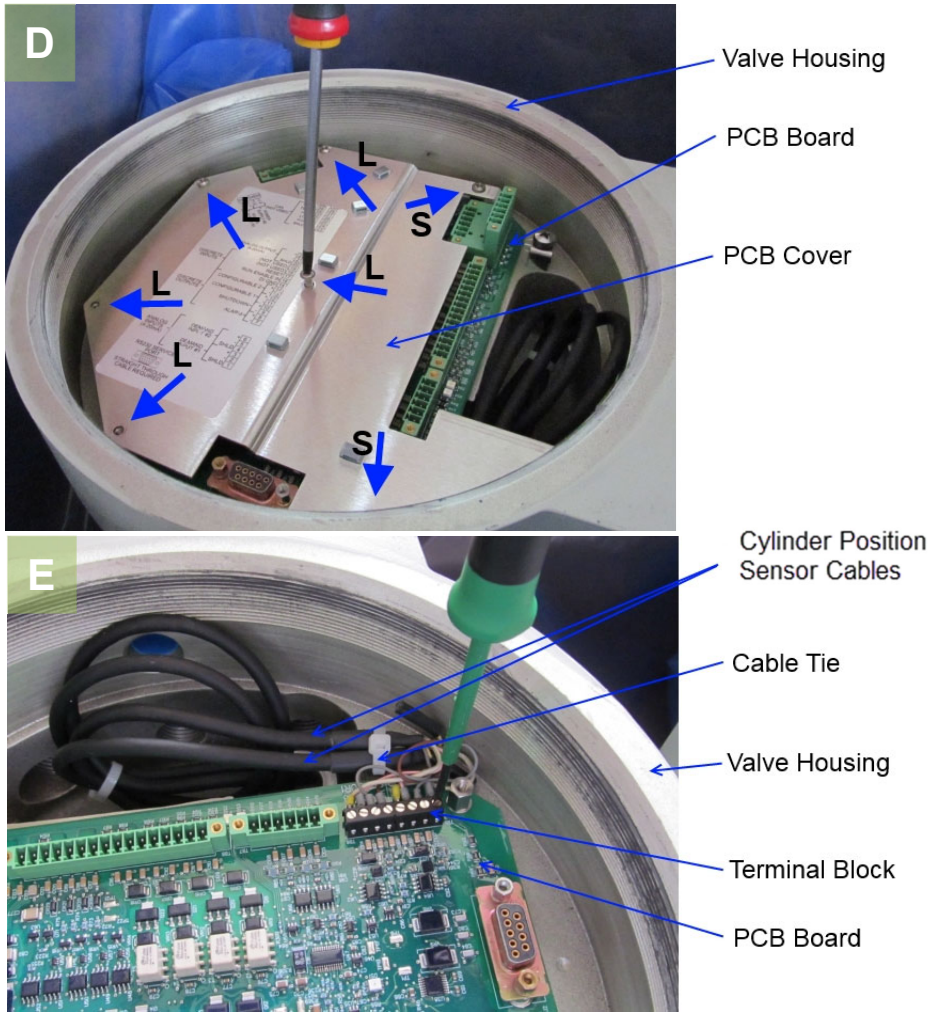


Figure 2-3. Removing the PCB Cover and Cylinder Position Sensor Wires

G. Using tool 1013-6844, unscrew the cable gland nut. Remove the bushing from the cylinder position sensor cable.

H. Prior to the next step, it is recommended that you replace the cover to protect the servo section from potential damage from paint intrusion and dropped tools.

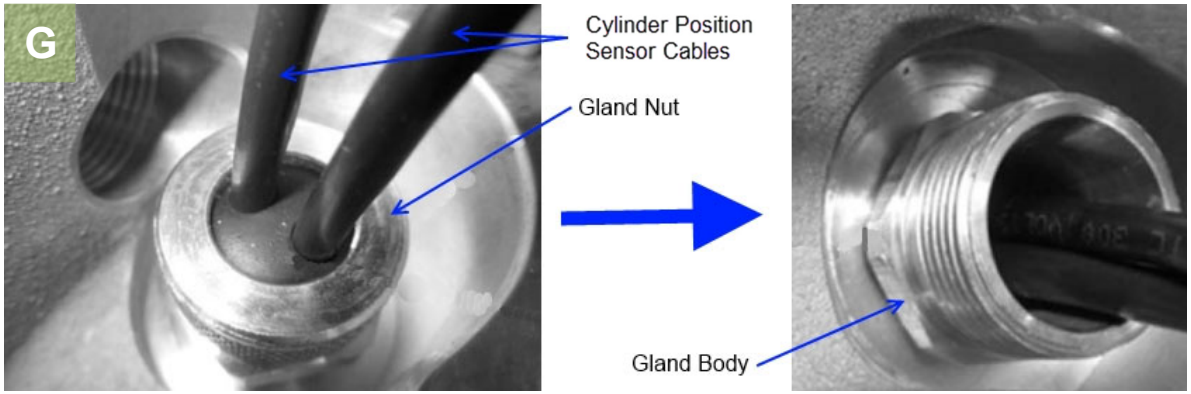


Figure 2-4. Remove Gland Nut and Cylinder Position Sensor Cable Bushing

Note: Potential for residual oil spillage exists. It is recommended that you place the servo assembly on top of oil absorbent pads to contain the flow of oil.

I. Using a flat wrench, remove all six 0.500-13 UNC hex head cap screws (as shown in Figure 2-5). These bolts are located on the bridge manifold (upper and lower parts).

NOTICE

The bridge manifold for single acting units has different internal passages with different internal features and seals. The CMM shows the double acting design. The main disassembly and assembly steps are the same for both designs (single and double acting).

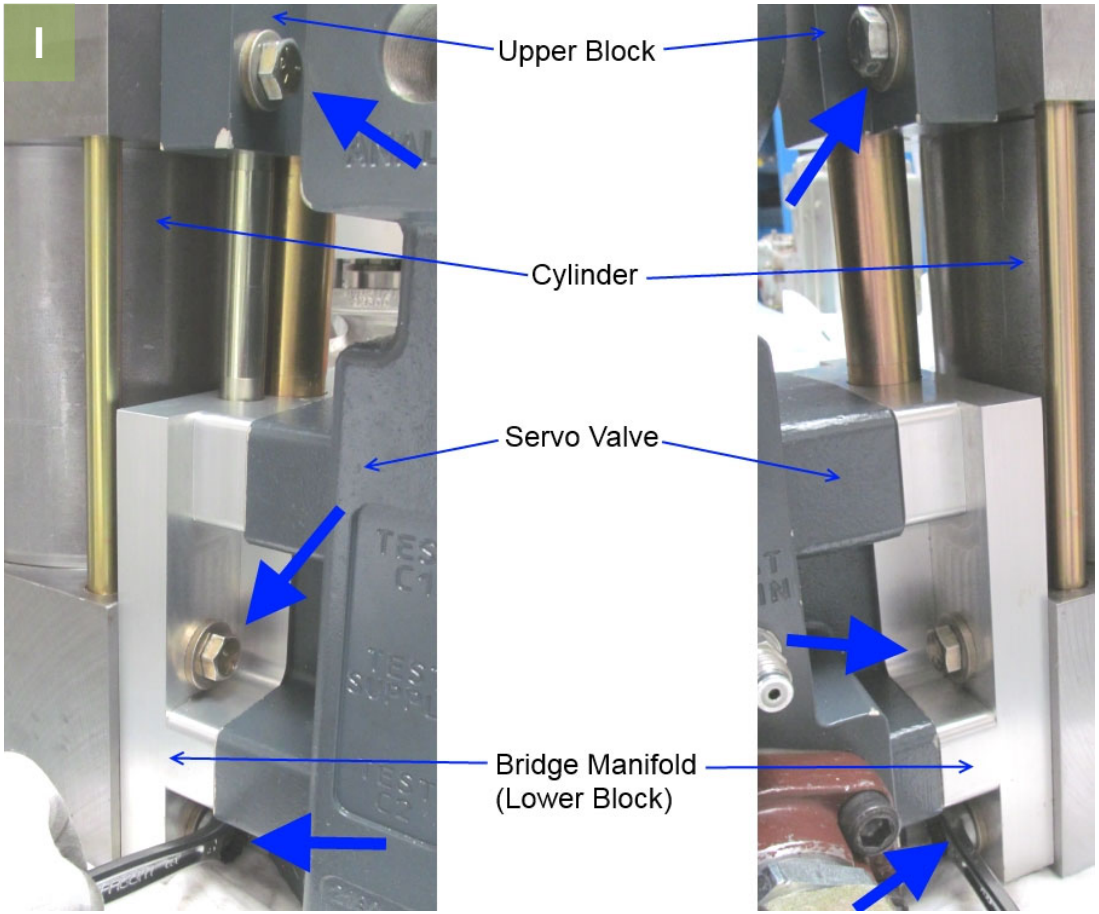


Figure 2-5. Remove UNC Screws from Bridge Manifold

⚠WARNING

Remember to support the servo during disassembly. Ensure that the crane, cables, straps, and all other lifting equipment, as well as the lifting lug being used for servo valve transportation are able to support the servo valve weight.

J. Carefully disconnect the servo valve and bridge manifold from the cylinder. Take special care to protect the cylinder position sensor wires from damage.

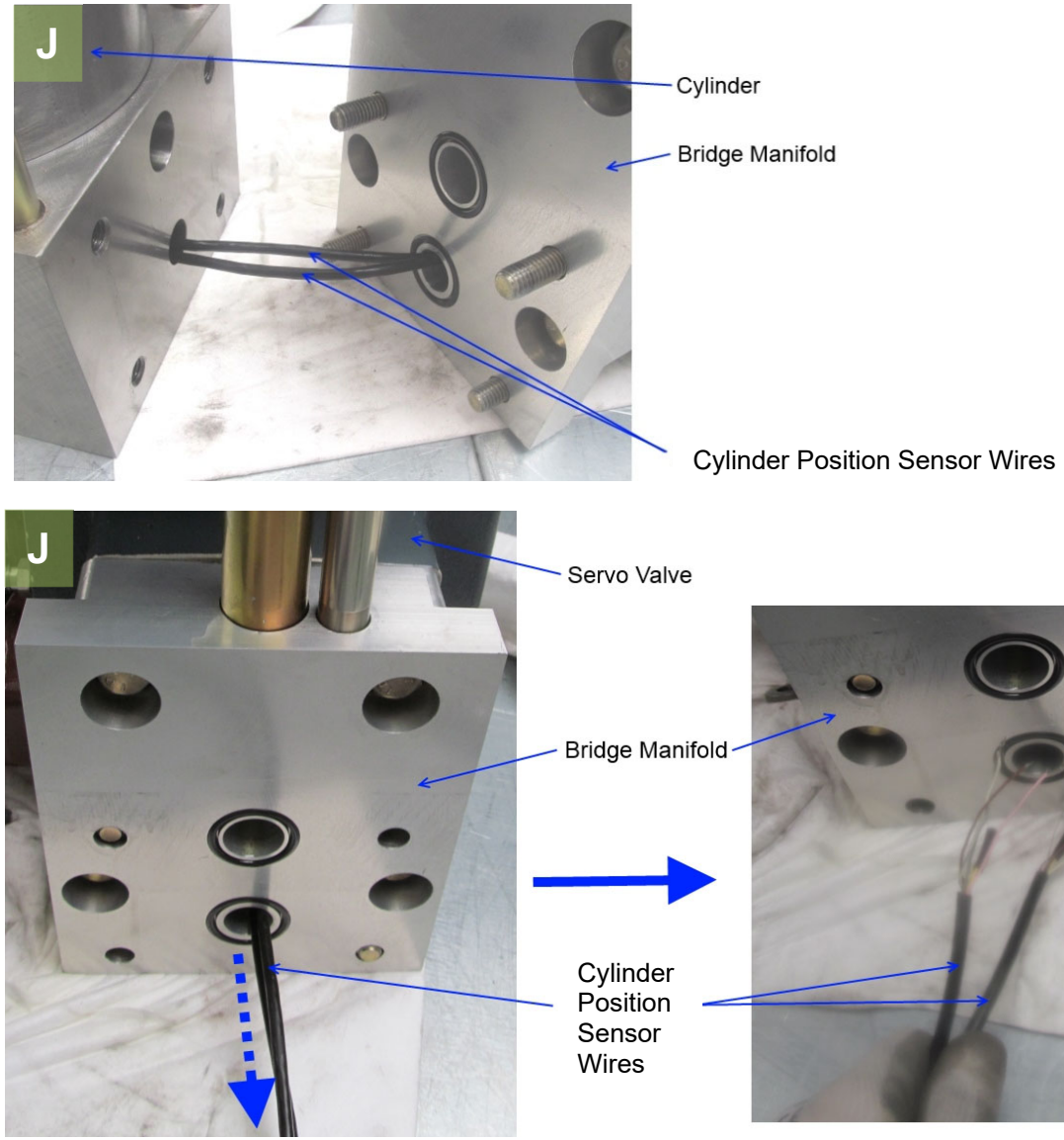


Figure 2-6. Disconnect Servo Valve and Bridge Manifold

K. Remove the four O-rings located between the cylinder and the bridge manifold.

L. Remove the four 0.500-13 UNC hex head cap screws (socket wrench; size 3/4 inch).

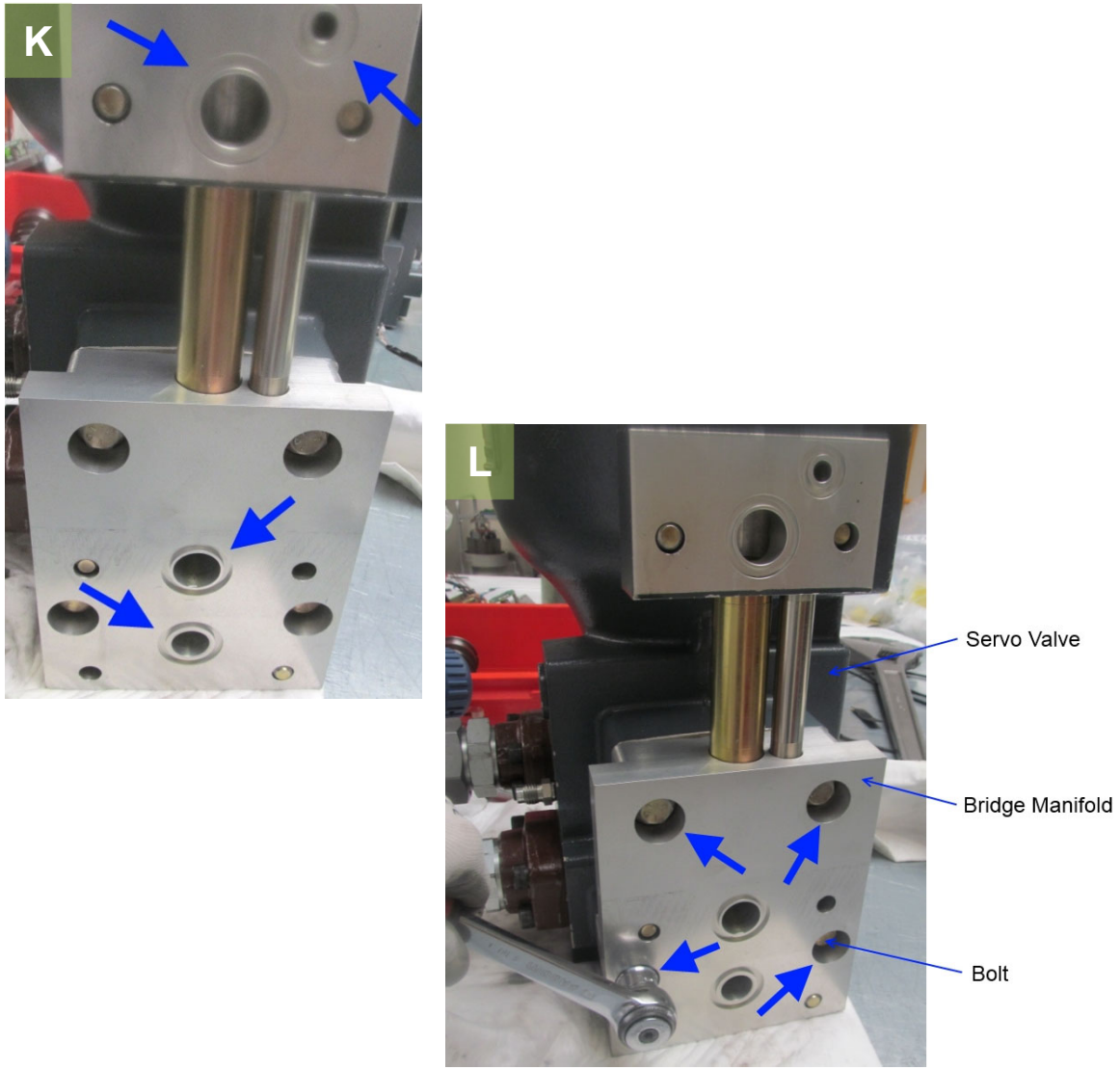
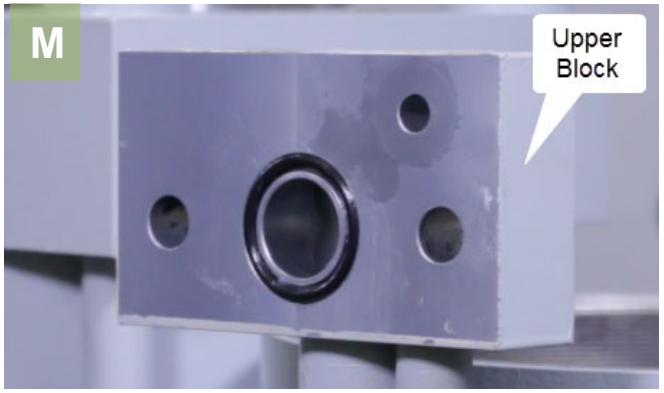
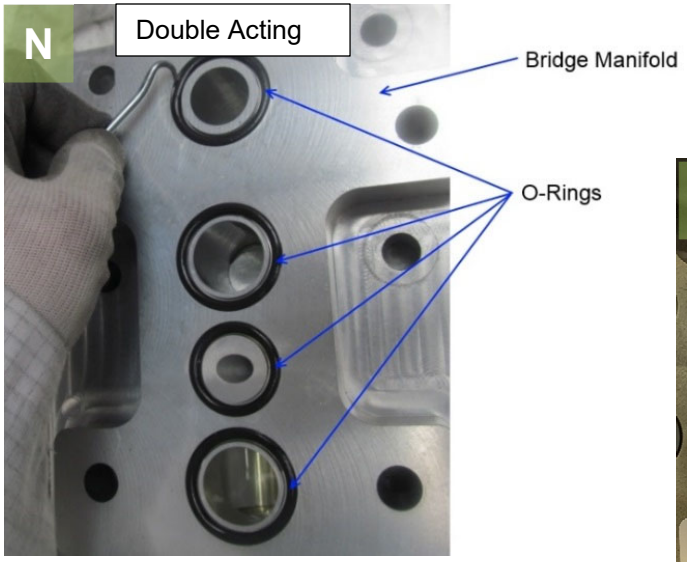
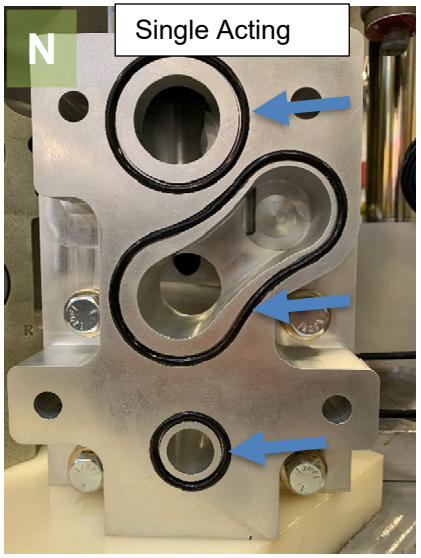


Figure 2-7. Remove O-rings and UNC Hex Screws from Bridge Manifold

M. Carefully disassemble the manifold bridge.
N. Remove the O-rings from the quill tubes and manifold bridge.
O. Use ISOPROPANOL cleaning fluid to clean all surfaces of the bridge manifold, quill tubes, cylinder, and servo valve.







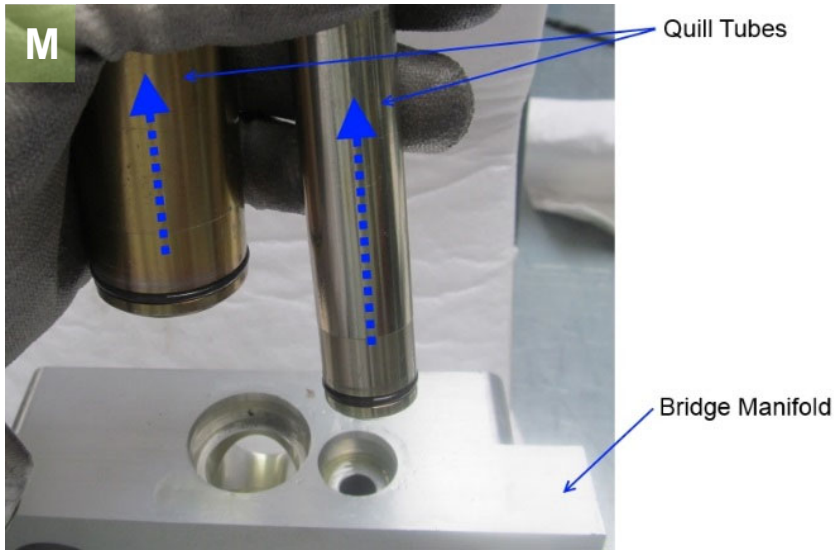


Figure 2-8. Disassemble Bridge Manifold and Remove O-rings

2.3 Assembly Procedure

⚠WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

A. Check the replacement parts kit to verify that all replacement parts listed in the Installation Drawing are present.

B. Prepare the new hydraulic servo valve unit. Remove all plastic protecting plugs received with the shipment.

C. After loosening the set screw, remove the cover.

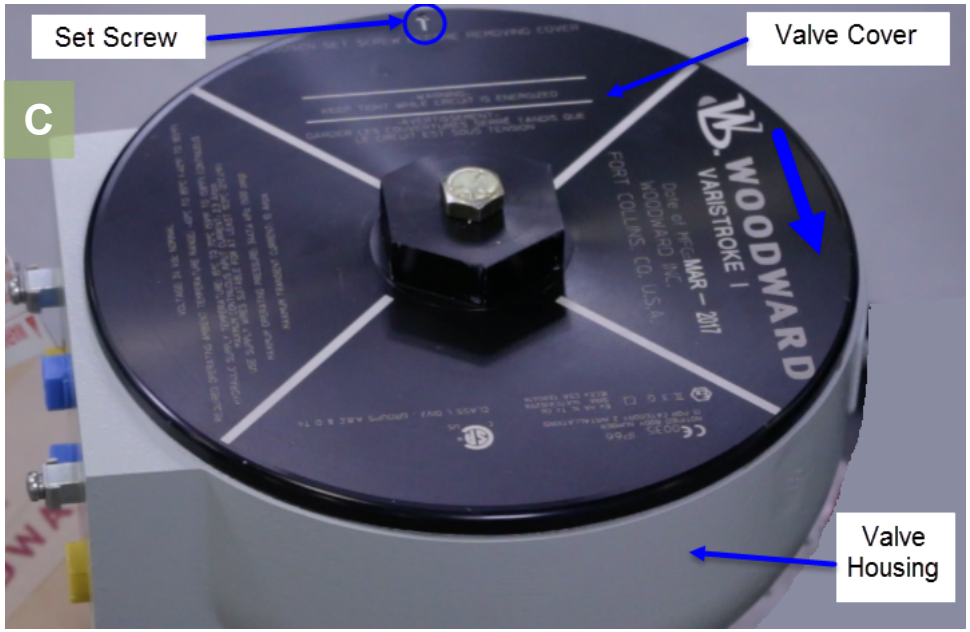


Figure 2-9. Prepare New Servo Valve Unit

D. Using the PH2 screwdriver, remove all seven screws from the PCB cover.

Note: There are two different screw lengths (L – long, S – short); see picture.

E. Using tool 1013-6844, unscrew the cable gland nut.

Note: Use the socket wrench extension if needed.

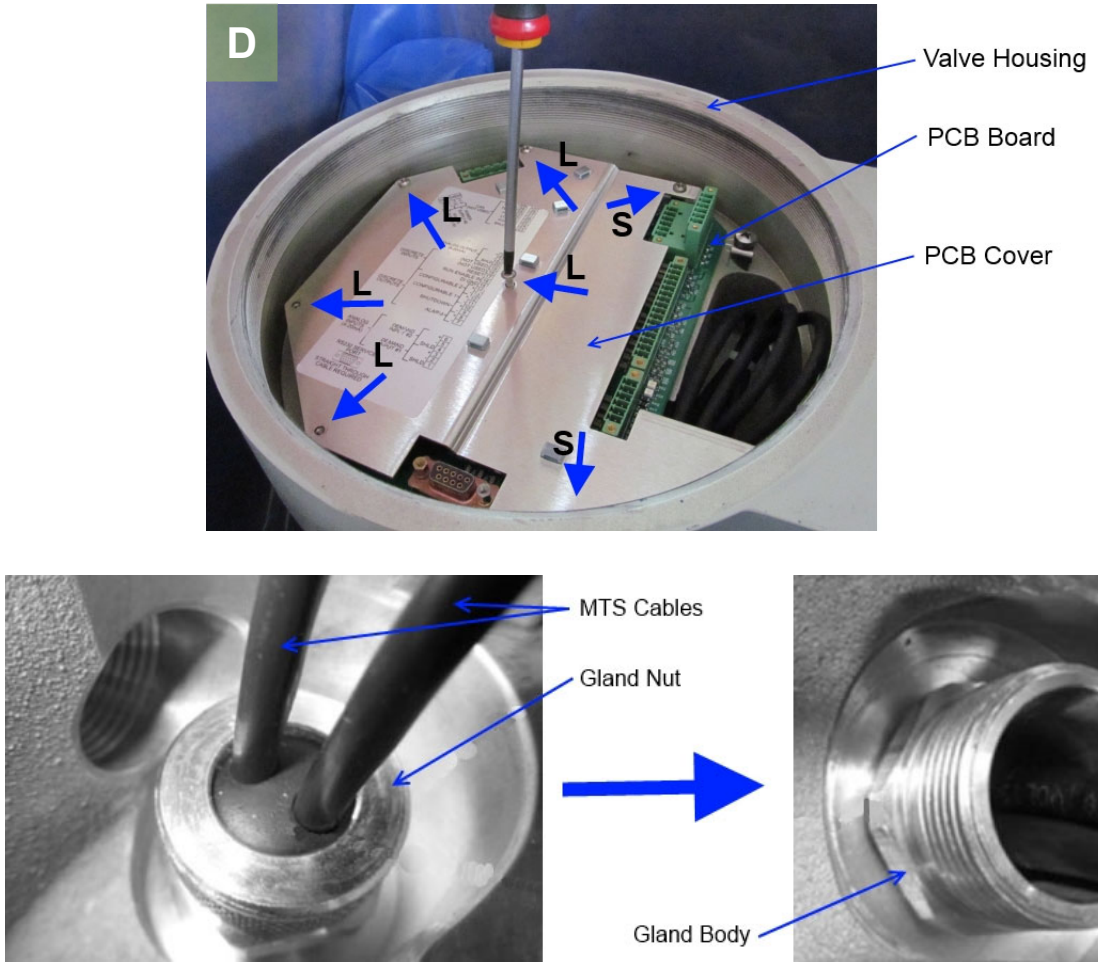


Figure 2-10. Remove PCB Cover Screws, Gland Body, and Gland Nut

F. Lubricate the new O-rings with petroleum jelly before placing them on the bridge manifold from the servo valve side.

G. Depending on the version (double or single acting), install proper O-rings.

H. Insert the four washers and bolts into the bridge manifold holes as shown. The bolts will connect the cylinder.

Note: You will not be able to install the bolts after the bridge manifold is installed on the servo.

NOTICE

The bridge manifold for single acting units has different internal passages with different internal features and seals. This CMM shows the double acting design. The main disassembly and assembly steps are the same for both designs (single and double acting).

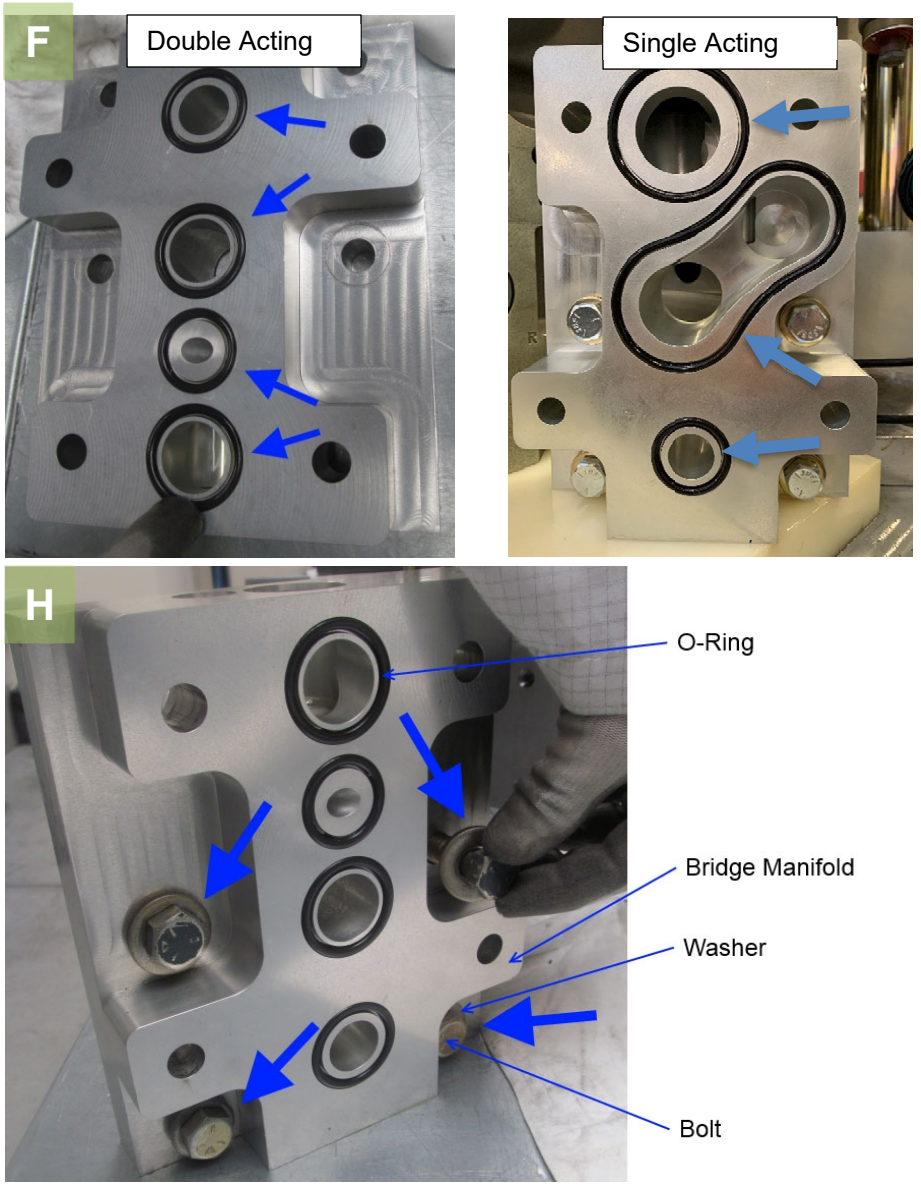


Figure 2-11. Install O-rings, Washers, and Bolts

I. Attach the bridge manifold to the servo using four 0.500-13 UNC hex head cap screws with washers. Make sure that all O-rings are in place. Torque them to 50 ±5 lb-ft.

⚠WARNING

It is critical to apply proper torque to ensure that the unit is sealed properly.

J. Lubricate the O-rings with petroleum jelly and place them on the quill tubes.

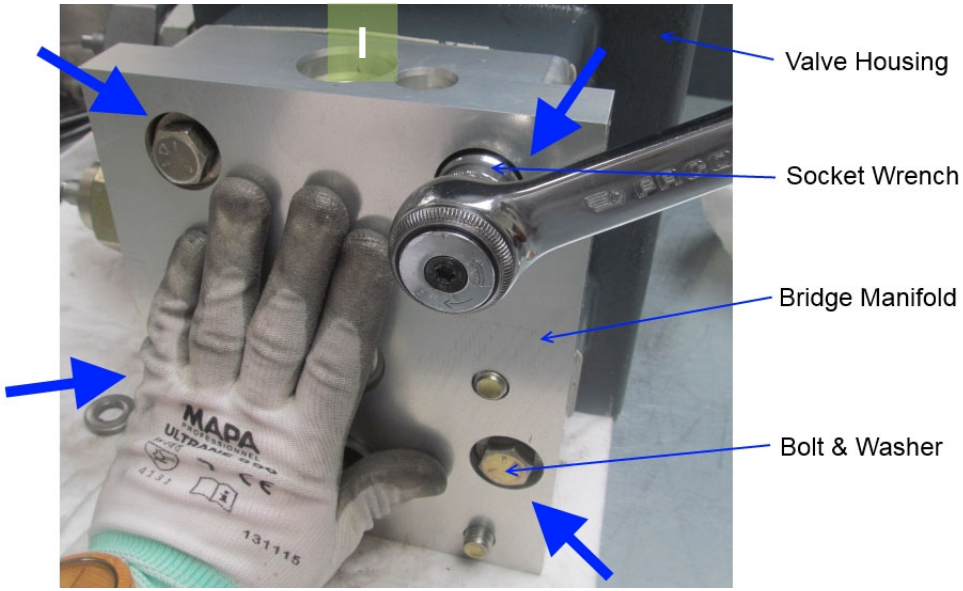


Figure 2-12. Attach Bridge Manifold to Servo and Attach O-rings to Quill Tubes

K. Install the quill tubes into the bridge manifold. Gently tap the quill tube into the bridge manifold using a soft (rubber or plastic) mallet.

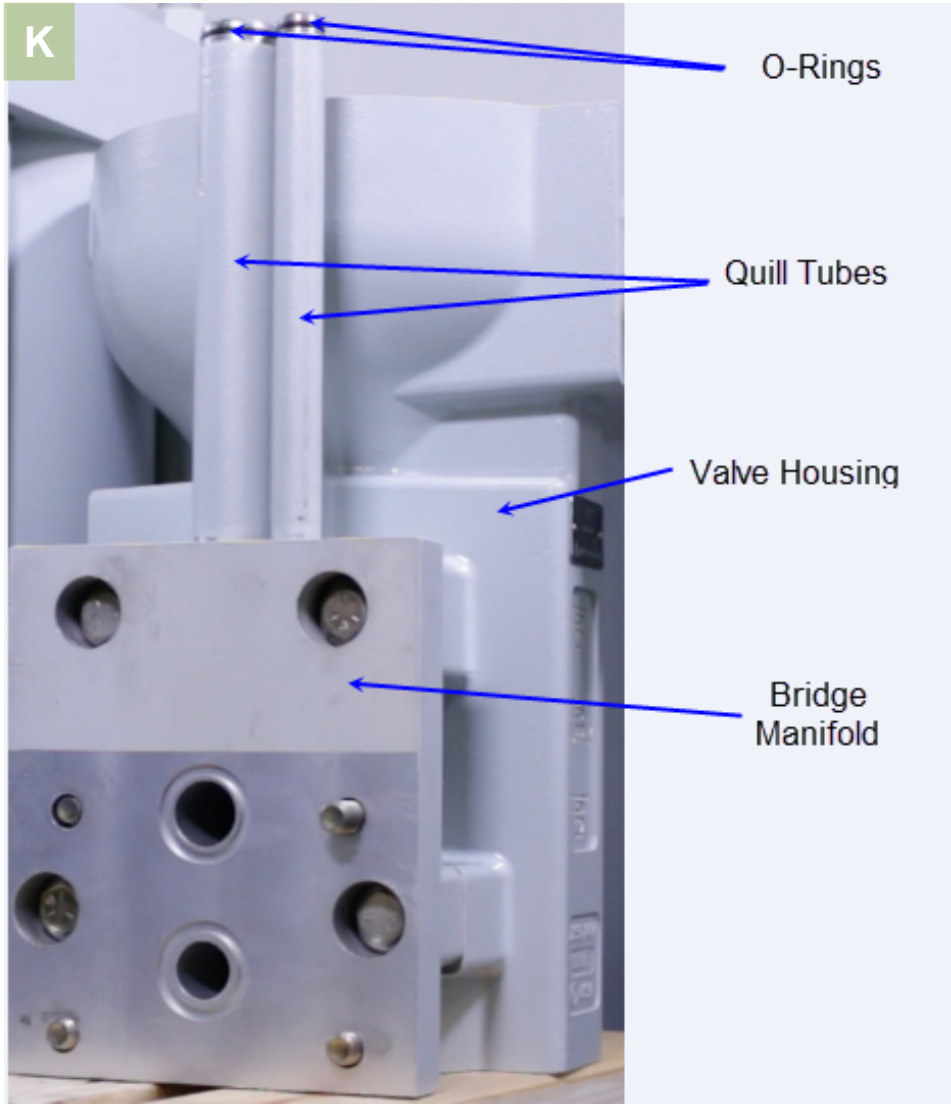


Figure 2-13. Install Quill Tubes in Bridge Manifold

L. Install the upper block onto the quill tubes. Gently tap the upper block into the quill tubes using a soft (rubber or plastic) mallet.

M. Lubricate the new O-ring with petroleum jelly and place it on the upper block. Then insert the two 0.500-13 UNC hex head cap bolts into the holes.

N. Lubricate the new O-rings with petroleum jelly and place them into the counterbores of the bridge manifold.

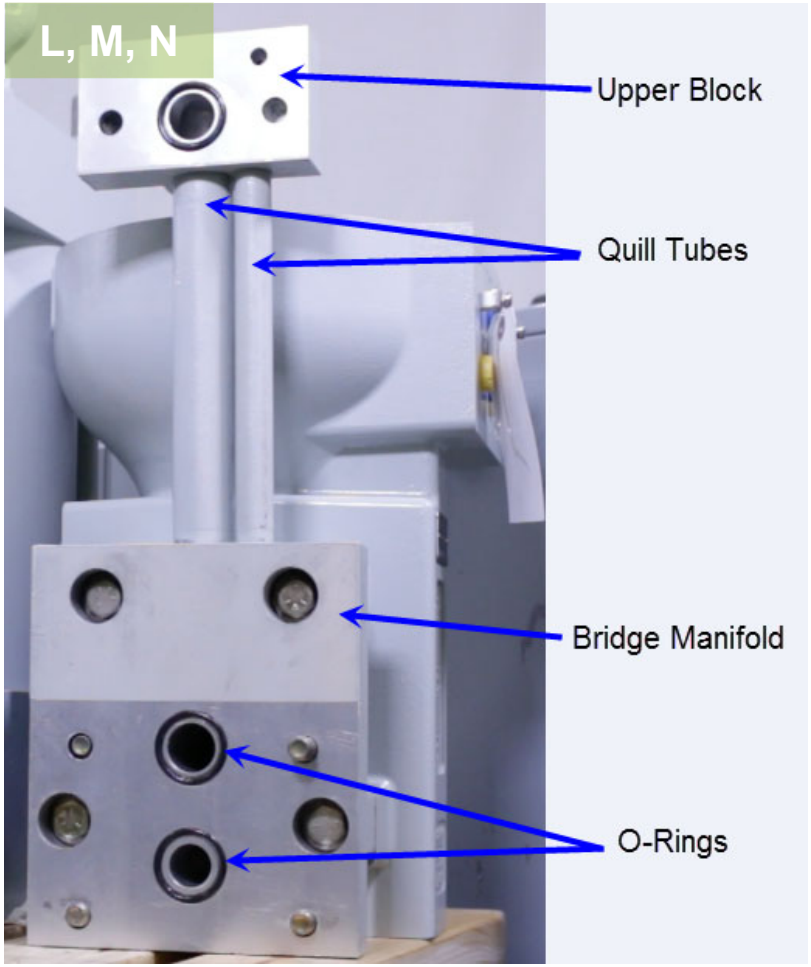


Figure 2-14. Install Upper Block onto Quill Tubes

O. Tape a long wire tie (approx. 12”) to the end of the sensor cables.

Carefully route the wire tie and gently pull the cylinder position sensor cables through the servo valve passage up into the electronics housing.

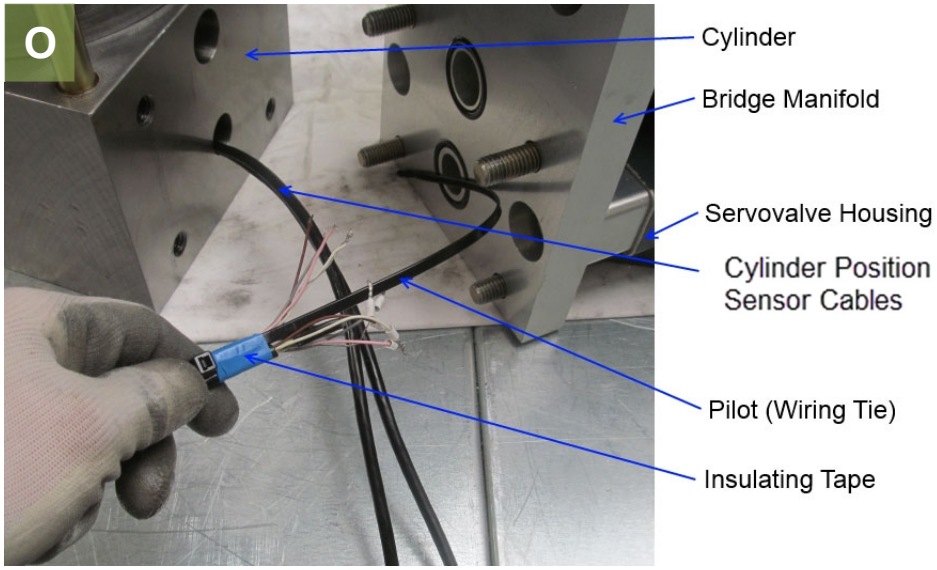


Figure 2-15. Route Cylinder Position Sensor Cables through Servo Valve

P. Move the servo valve with the bridge manifold close to the cylinder. Place the servo assembly on the rubber pad or washers (about .25 in thick). Set both parts to align the bolts with holes as shown. Ensure the cylinder position sensor cables are not pinched between the bridge manifold and cylinder. Gently tighten the cables from the electronics housing side. Apply thread locking compound Loctite 242 (or equivalent) to six protruding bolts.

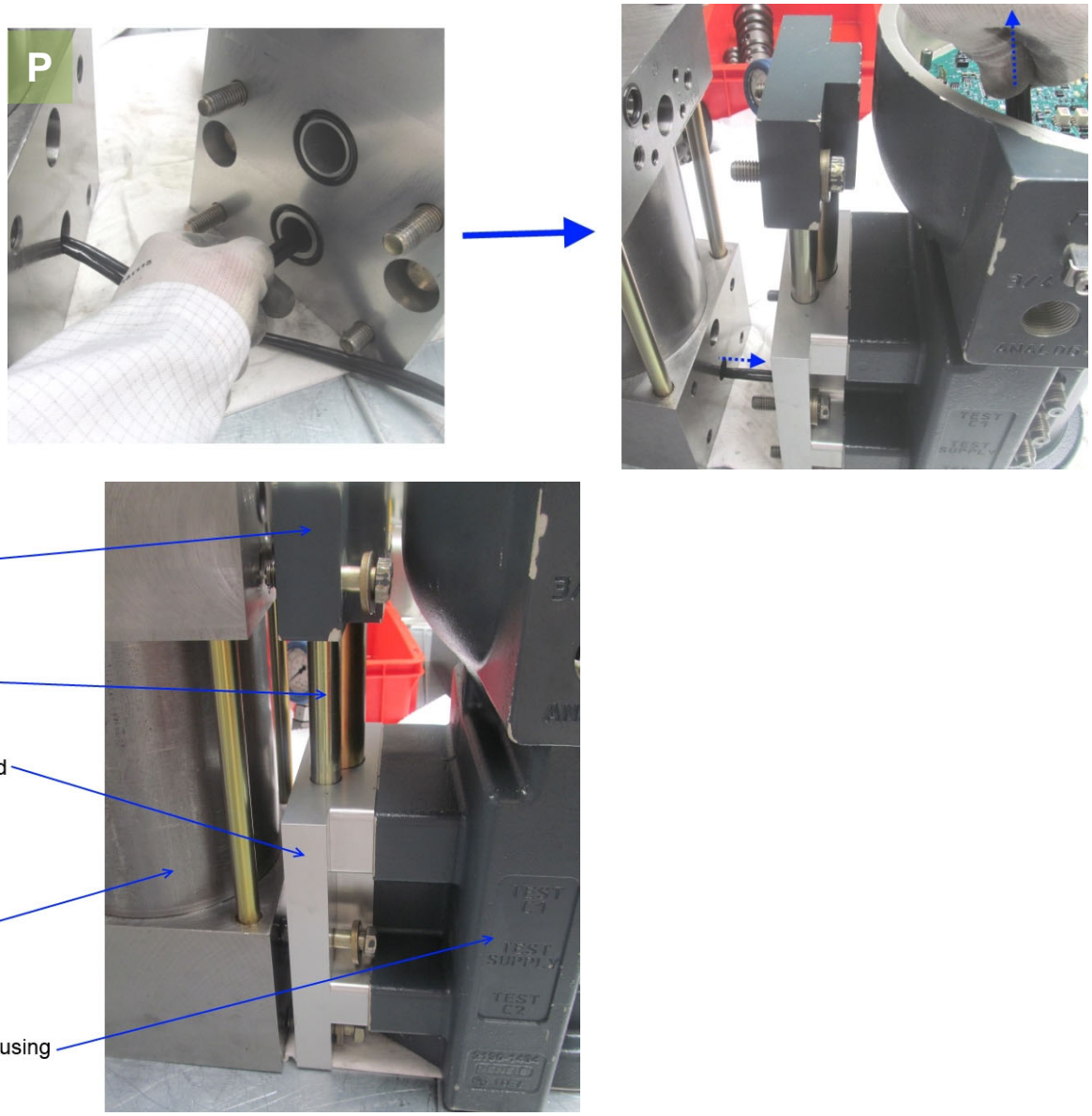


Figure 2-16. Position Servo Valve and Bridge Manifold

Q. Tighten the six 0.500-13 UNC hex head cap screws. Torque the screws to 50 ±5 lb-ft.

⚠WARNING

Applying proper torque is critical to ensure that the unit is sealed properly.

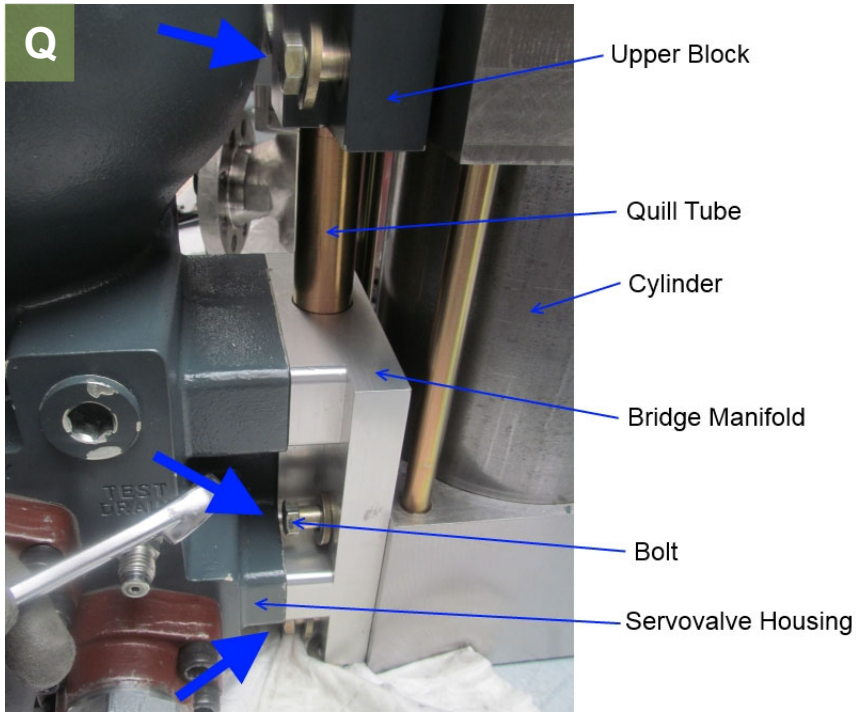


Figure 2-17. Tighten Screws and Install Gland Body

R. Install the cylinder position sensor cables into the gland bushing and insert into the gland body.

S. Install the gland nut on the gland body. Set appropriate length of cylinder position sensor cables and tighten the nut using tool 1013-6844. Torque to 25 ±2 lb-ft (31 to 37 N·m).

T. Using a 2.5 X 0.4 mm screwdriver, connect cylinder position sensor wires to the PCB. The order of the sensor's installation is unimportant. Sensors are equivalent. After tightening screws, tug on the wires to verify they are firmly connected.

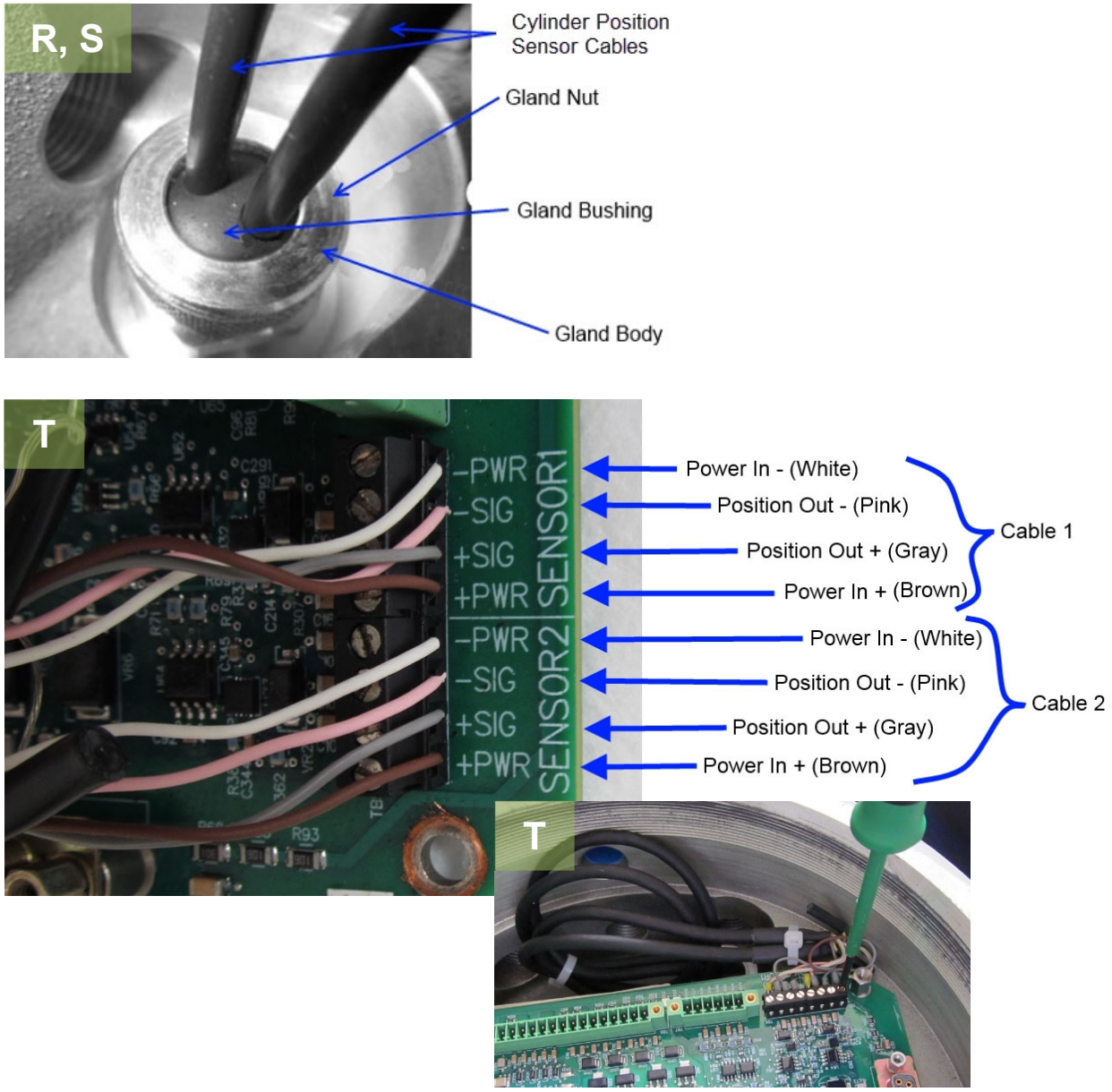


Figure 2-18. Install and Connect Cylinder Position Sensor Cables and Install Gland Nut

U. Install the seven screws into the PCB cover. Torque to 12 ±1 lb-in (1.2 to 1.5 N·m). Note that are two different screw lengths (L – long, S – short); see picture.

V. Re-install all electrical wires through their appropriate housing openings. Ensure that power and signal wires use separate conduit entrances.

W. Connect the hydraulic supply and hydraulic drain.

X. Install the cover. Torque the cover to (120 to 150) N·m / (90 to 110) lb-ft. Torque the set screw to (0.6 to 0.7) N·m / (5.5 to 6.2) lb-in.

⚠WARNING

It is critical to apply proper torque to ensure that the unit is sealed properly.

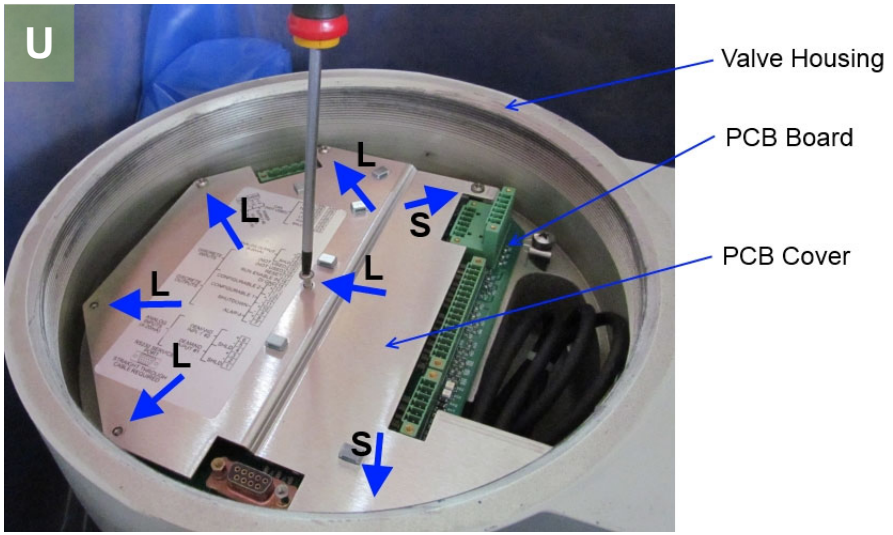


Figure 2-19. Install PCB and Servo Valve Covers with Proper Connections

2.4 Verification & Calibration

A. Remove the top cover of the VS-I taking care to not damage or contaminate the threaded surface.

B. Verify that the hydraulic and electrical connections are correct. See product manual for more information.

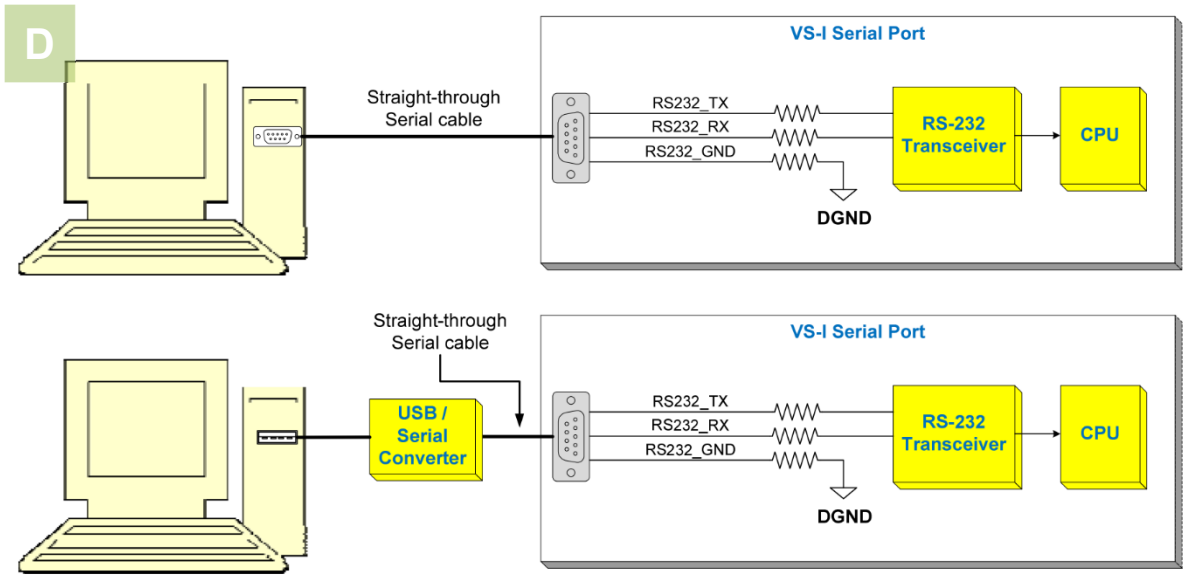
C. Confirm that the hydraulic and electrical power to the VS-I is turned off.

D. Connect a PC Service Tool to the VS-I. See product manual **35148** for more information.

E. Apply electrical power to VS-I.

F. **If you have a .wset file saved from a previous unit, upload it to the new one**. If not, you will need to recalibrate and reconfigure your VariStroke (see manual 35148).

During this process, remember to input the values for the cylinder length, cylinder diameter, and sensor length. See tables on the next page.



NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the manual operation button.

Figure 2-20. PC Tool Connection With/Without USB/Serial Converter

G. If a *.west file is not available, go to **Config/Calibrate** screen.

H. Press the "**Remote Cylinder Setup**" button and update all values (see tables).

I. Check the "Reverse Acting" option and modify if necessary. This option is only available for the double acting version. Default values are:
   - For Fail Retract, ReverseActing=NO
   - For Fail Extend, ReverseActing=YES

J. Press the "Apply" button to save all changes.

NOTICE

To enable the configuration and calibration functions of the VS-I, user must set the RUN ENABLE line low and/or put the analog input demand(s) below 2 mA (suggest 0 mA).

H

Bore Diameter (OD)	Rod Diameter (ID)
Code 10 - 4 inches (101.6 mm)	1.75 inches (44.5 mm)
Code 12 - 5 inches (127.0 mm)	1.75 inches (44.5 mm)
Code 15 - 6 inches (152.4 mm)	2.5 inches (63.5 mm)
Code 20 - 8 inches (203.2 mm)	3.5 inches (88.9 mm)
Code 25 - 10 inches (254.0 mm)	4.5 inches (114.3 mm)

H

Code	Cylinder Stroke	Position Sensor Length for each stroke
05	50.8 mm (2in)	2.1654 [55 mm]
07	76.2 mm (3in)	3.1496 [80 mm]
10	101.6 mm (4in)	4.1338 [105 mm]
15	152.4 mm (6in)	6.2992 [160 mm]
20	203.2 mm (8in)	8.2677 [210 mm]
25	254.0 mm (10in)	10.2362 [260 mm]
30	304.8 mm (12in)	12.2047 [310 mm]

Figure 2-21. Cylinder and Sensor Dimensions

K. For the **single acting** design, install external force/load. See table for the min load value. For the spring assist version, additional external load is not required.

L. Start the hydraulic supply system. **The supply pressure:**

- 50 PSI for single acting

- 80 PSI for double acting

NOTICE

For the spring assist version, set the supply pressure based on spring force value. The force generated by oil pressure must be at least 20% higher than max spring force.

M. Adjust the supply pressure accordingly on the Config/Calibrate screen in the Customer Service Tool (press "Save Configuration" button to apply changes).

N. Operate the unit using the VS-I PC Service Tool. Go to the **Manual Operation** screen.

		Cylinder Bore Size mm (inch)		
		152 (6)	**203 (8)**	**254 (10)**
Min Inertia Load kgf (lbf)	Fail Extend	108 (240)	185 (410)	290 (640)
	Fail Retract	131 (290)	231 (510)	362 (800)

IMPORTANT

Make sure that load value is stable through full cylinder stroke.

Figure 2-22. Min Load for Single Acting Design

O. Purge all air from the system. Adjusting the position setpoint up and down (steps around 10%) several times will aid in purging the air. Allow for warm-up time.

NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be at less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the Manual Operation button.

P. **Examine the unit for external leakage**.

Q. Go to the **Alarms/Shutdowns** screen and review the faults that were triggered. Reset active and logged faults.

NOTICE

Upon startup and reset commands, the VS-I performs a brief test to ensure that the servo valve return spring is functioning properly. This is performed before moving the actuator away from the fail-safe position and will not move the actuator. This critical safety function cannot be disabled by anyone other than authorized Woodward personnel.

R. Go to the **Calibration** screen and press the **"Find Minimum AND Maximum Stops"** button. Save the calibration results (see Service Tool manual 35148 for more information about the calibration process).

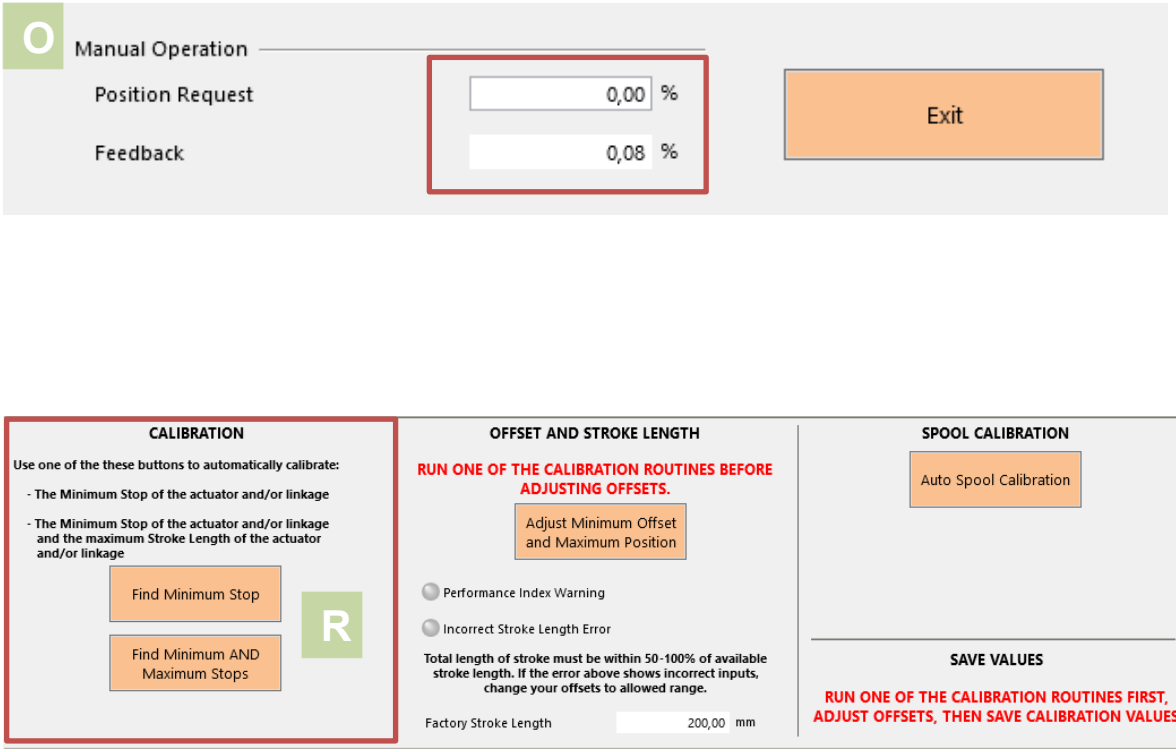


Figure 2-23. Cylinder Calibration

NOTICE

Perform the calibration for "Find Minimum AND Maximum Stops" without an external load for double acting cylinder and with 20% of load for single acting cylinder.

S. Verify the fail-safe direction is correct by going to the **Manual Operation** screen and inputting 30% as a position request.

T. Remove electrical power to VS-I. Any shut down or loss of the input power will result in the actuator moving in the fail-safe direction. Verify the direction the actuator moved upon loss of power is correct for the fail-safe direction.

U. Reapply electrical power to the VS-I.

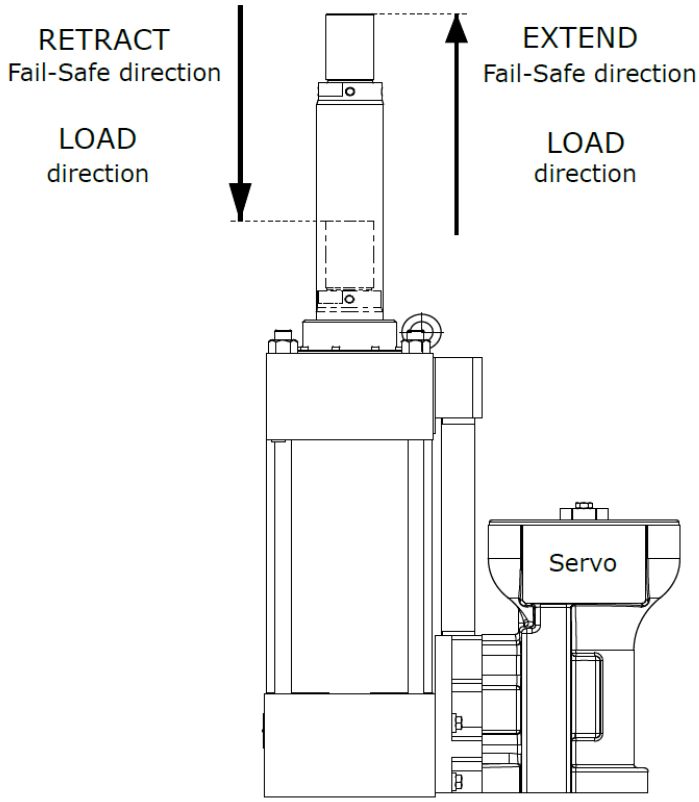


Figure 2-24. Fail Extend and Retract Verification

3. SERVO VALVE REPLACEMENT – REMOTE VERSION

3.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of servo valve (remote version) replacement:

DOUBLE ACTING Version:
Servo Valve Replacement (Double Acting VS-I):
- KIT P/N: 9907-1256 – fail-safe direction: extend
- KIT P/N: 9907-1333 – fail-safe direction: retract
- KIT P/N: 9907-2113 SERVO V45V-E-CR, SERVOVALVE ONLY, FAIL-SAFE EXTEND, VSI, **CHEMICALLY RESISTANT**
- KIT P/N: 9907-2112 SERVO V45V-R-CR, SERVOVALVE ONLY, FAIL-SAFE RETRACT, VSI, **CHEMICALLY RESISTANT**

SINGLE ACTING Version:
Servo Valve Replacement (Single Acting VS-GI):
- KIT P/N: 9907-2117 – fail-safe direction; extend; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2116 – fail-safe direction; retract; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2130 – fail-safe direction; TTV; extend; cylinder size 6, 8, and 10 in
- KIT P/N: 9907-2131 – fail-safe direction; TTV; retract; cylinder size 6, 8, and 10 in

NOTICE **Review the CMM and Installation Drawing before starting the replacement process to be sure that all necessary tools are available and everything is understood. Contact Woodward for any questions.**

3.2 Disassembly Procedure

⚠WARNING

Failure to remove the setscrew could compromise the method of protection.

NOTICE

Before starting the disassembly, connect to the VS-I using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

FLAMEPATHS - Refer to Section 1.1 for specific instructions.

A. Loosen the setscrew before removing the cover (hex key; size 1.5 mm); see Figure 3-2. Remove the cover from the servo valve (flat wrench; size 2.25 inch).

B. Launch the Customer Service Tool (9927-2177) and save current unit settings. Go to “Settings” and save parameters from device to file “Save From Device”. For more info, see product manual 35148.

Note: A prompt to choose the file location appears. Once download is complete, the file will be saved to this location.

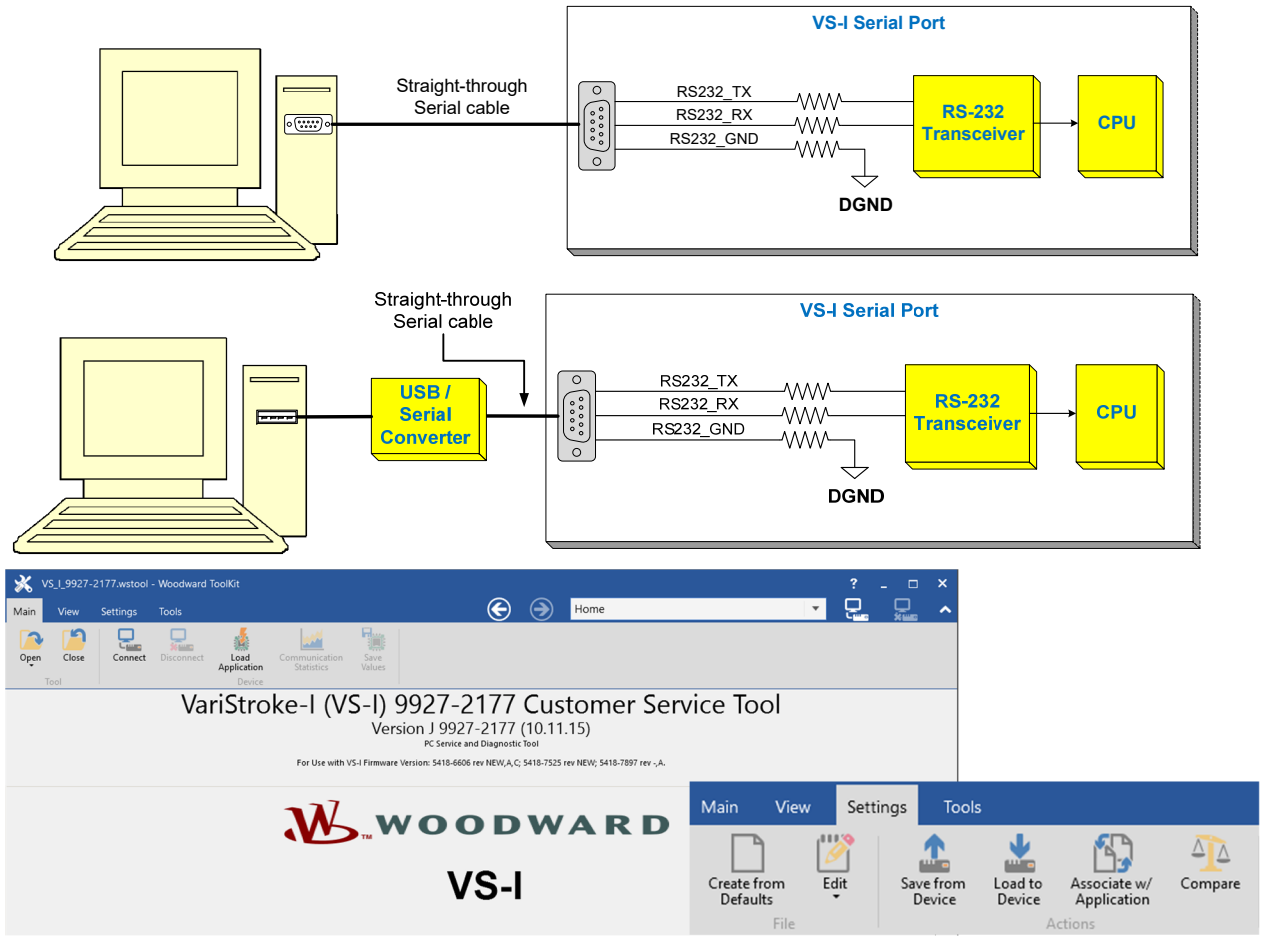


Figure 3-1. Service Tool Connection and Settings Dropdown Menu

⚠WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing the hydraulic system.

C. Disconnect the hydraulic lines and electrical cables on the external interface.

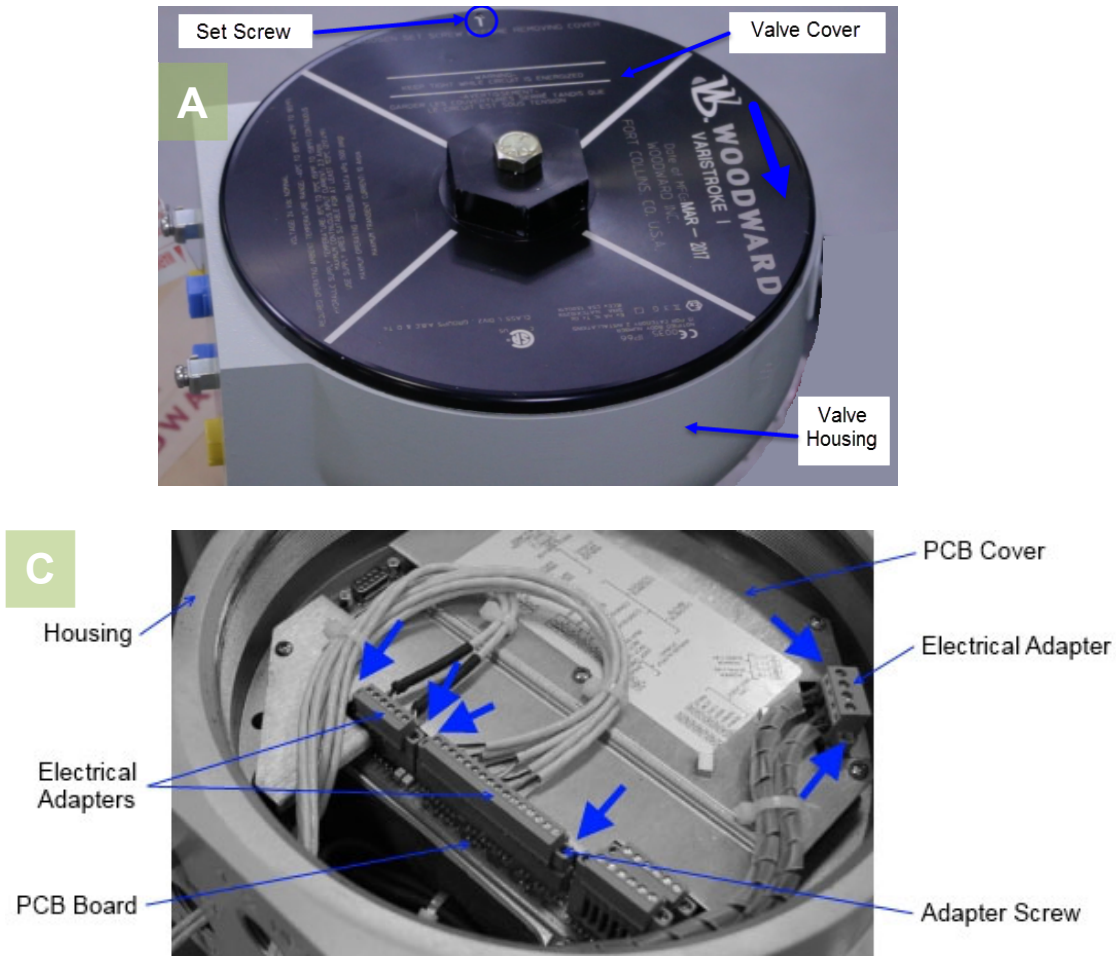


Figure 3-2. Remove Outside Cover and Disconnect External Interface

NOTICE

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may be spilled during disconnection of hydraulic fittings. For safety reasons, spilled hydraulic oil should be dried by absorbing mats or other environmentally- friendly methods.

D. Remove the seven screws from the PCB cover.

   Note: There are two different screw lengths (L – long, S – short); see picture.

E. Disconnect the cylinder position sensor wires from the terminal block (screwdriver size 2.5 X 0.4 mm).

F. Replace the cover to protect servo section from potential damage from paint intrusion and dropped tools.

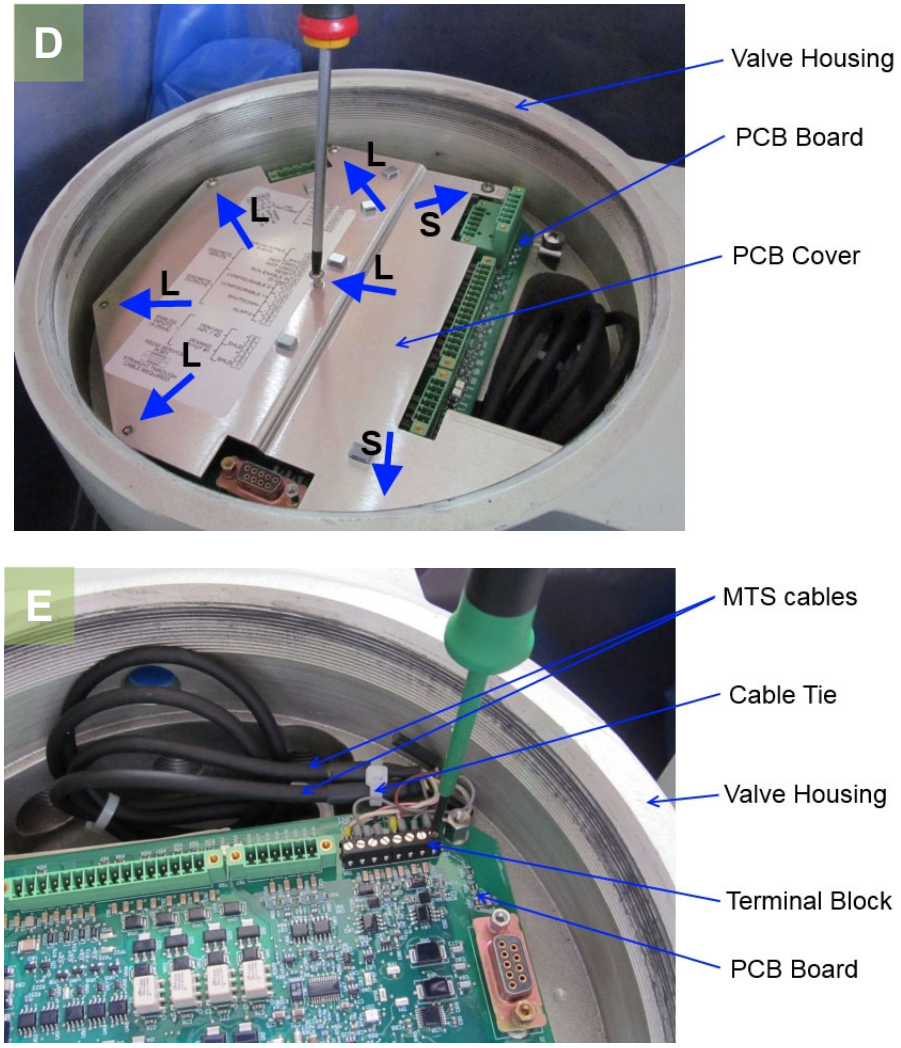


Figure 3-3. Remove PCB Cover and Disconnect Cylinder Position Sensor Wires

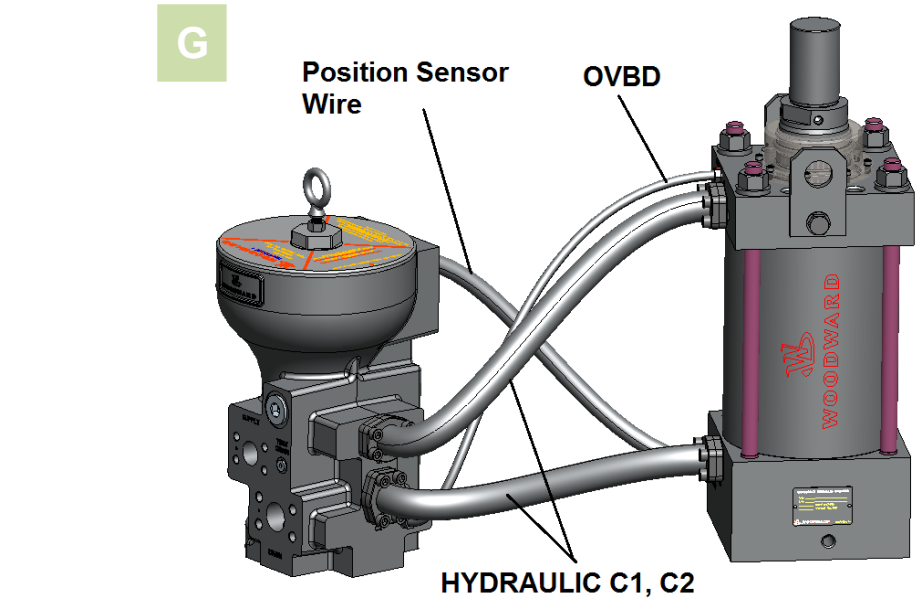
G. Remove the hose fittings from C1 and C2 ports for the double acting version and C1 port for the single acting version.

H. Remove the hose fittings from OVBD and position sensor. For the single acting version, the OVBD is not connected to the servo.

⚠WARNING

Remember to support the servo during disassembly. Ensure the crane, cables, straps, and all other lifting equipment, as well as the lifting lug you are using for servo valve transportation can support the servo valve weight.

I. Clean all surfaces of bridge manifold, quill tubes, cylinder, and servo. Use ISOPROPANOL cleaning fluid.



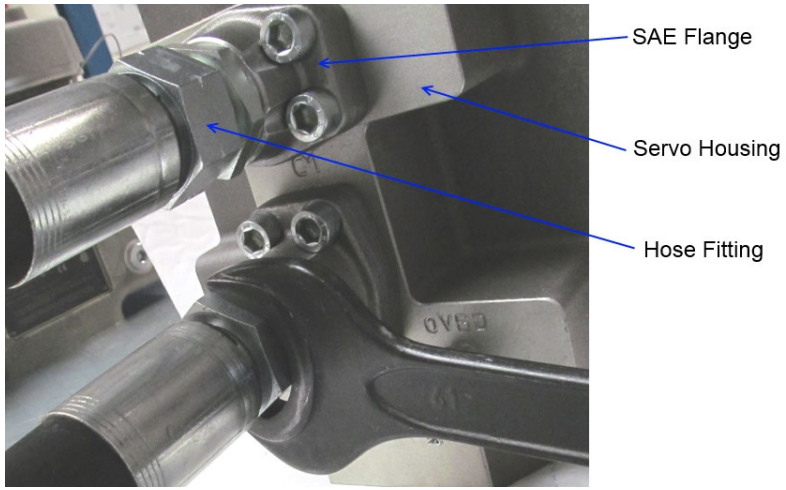


Figure 3-4. Hose Fitting Removal

3.3 Assembly Procedure

⚠WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

A. Inventory the replacement parts kit to verify that all replacement parts listed in the Installation Drawing are present.

B. Prepare the new hydraulic servo valve unit. Remove all plastic protecting plugs received with the shipment.

C. After loosening the setscrew, remove the cover.

D. Remove all seven screws from the PCB cover (screwdriver PH 2). Note there are two different screw lengths (L – long, S – short); see picture.

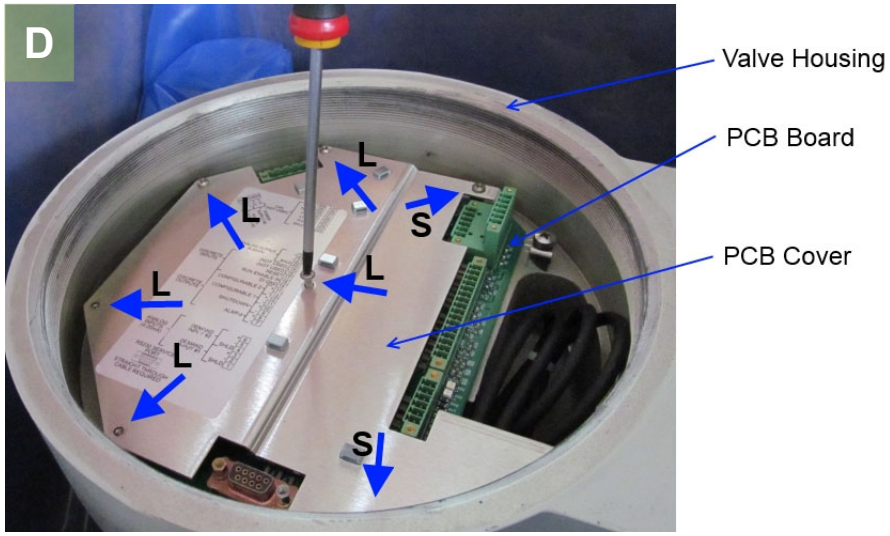


Figure 3-5. Remove Exterior and PCB Covers

E. Reinstall all fittings: hose fittings from C1 and C2 ports, hose fittings from OVBD, and position sensor. See manual for proper torque value.

⚠WARNING

It is critical to apply proper torque to ensure the unit is sealed properly.

F. Fit the position sensor cables through the ½ NPT channel.

G. Using a 2.5 X 0.4 mm screwdriver, connect cylinder position sensor wires to the PC board. The order of the sensor's installation is unimportant. Sensors are equivalent. After tightening screws, tug on wires to verify they are firmly connected.

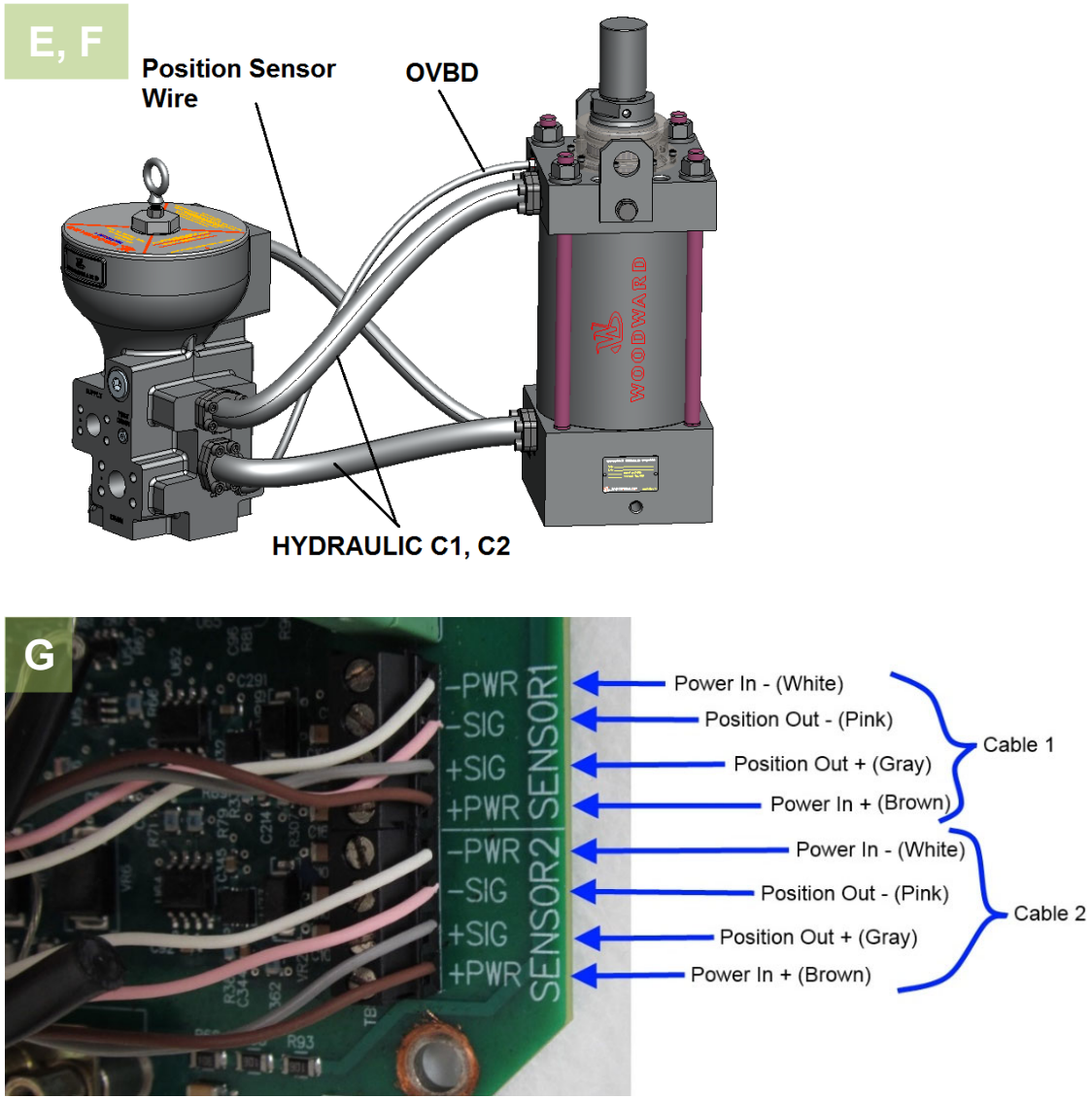


Figure 3-6. Reinstall Fittings, Wires, and Cables

H. Install the seven screws into the PCB cover. Torque to 12 ±1 lb-in (1.2 to 1.5 N·m). Note that there are two different screw lengths (L – long, S – short); see picture.

I. Re-install all electrical wires through their appropriate housing openings. Ensure that the power and signal wires use separate conduit entrances.

J. Connect the hydraulic supply and hydraulic drain.

K. Install the cover. Torque the cover to (120 to 150) N·m / (90 to 110) lb-ft; torque set screw to (0.6 to 0.7) N·m / (5.5 to 6.2) lb-in.

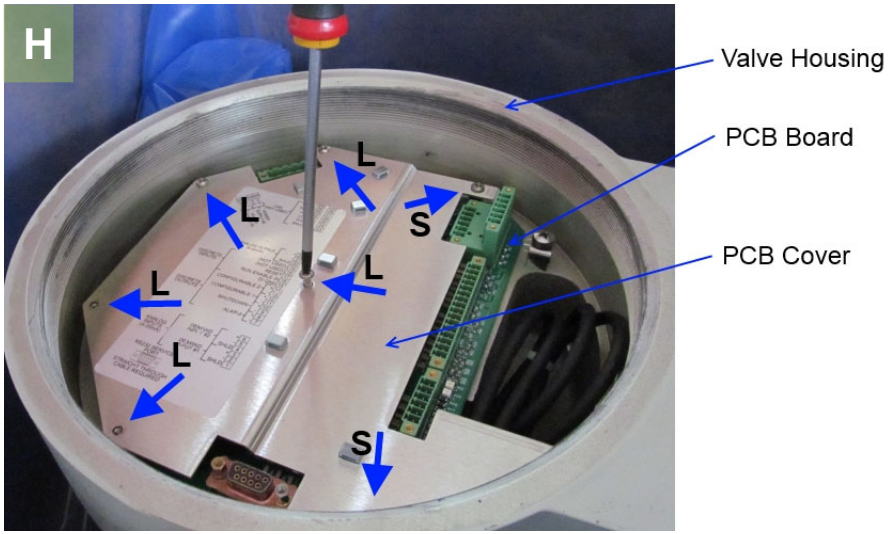


Figure 3-7. Install Covers and Connect Hydraulic Supply and Drain

3.4 Verification & Calibration

See Section 2.4

4. CYLINDER ROD SEALS REPLACEMENT

4.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of cylinder rod seals replacement (single and double acting):

- KIT P/N: 8935-1216-10, 4 in bore,
- KIT P/N: 8935-1216-12, 5 in bore,
- KIT P/N: 8935-1216-15, 6 in bore,
- KIT P/N: 8935-1216-20, 8 in bore,
- KIT P/N: 8935-1216-25, 10 in bore,

- KIT P/N: 8935-1383-15 KIT VSI, CYLINDER ROD SEALS, 6 IN BORE, **CHEMICALLY RESISTANT**
- KIT P/N: 8935-1383-20 KIT VSI, CYLINDER ROD SEALS, 8 IN BORE, **CHEMICALLY RESISTANT**
- KIT P/N: 8935-1383-25 KIT VSI, CYLINDER ROD SEALS, 10 IN BORE, **CHEMICALLY RESISTANT**

NOTICE

Review the CMM and Installation drawing before starting the replacement to be sure that all necessary tools are available and everything is understood. If you have questions, please contact Woodward.

⚠WARNING

Refer to Section 1.1 for specific instructions.

FLAMEPATHS

4.2 Disassembly Procedure

⚠WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing the hydraulic system.

A. Remove all eight screws from bushing (hex key; size 3/16).

B. Use two of eight removed screws to remove bushing. Install the two screws in the two threaded holes located on the bushing flange as shown. Tighten the screws about a half turn at a time in alternating sequence (hex key; size 3/16).

C. To prevent damage to the seal bushing assembly during removal and replacement, install electrical tape over the threads on the piston.

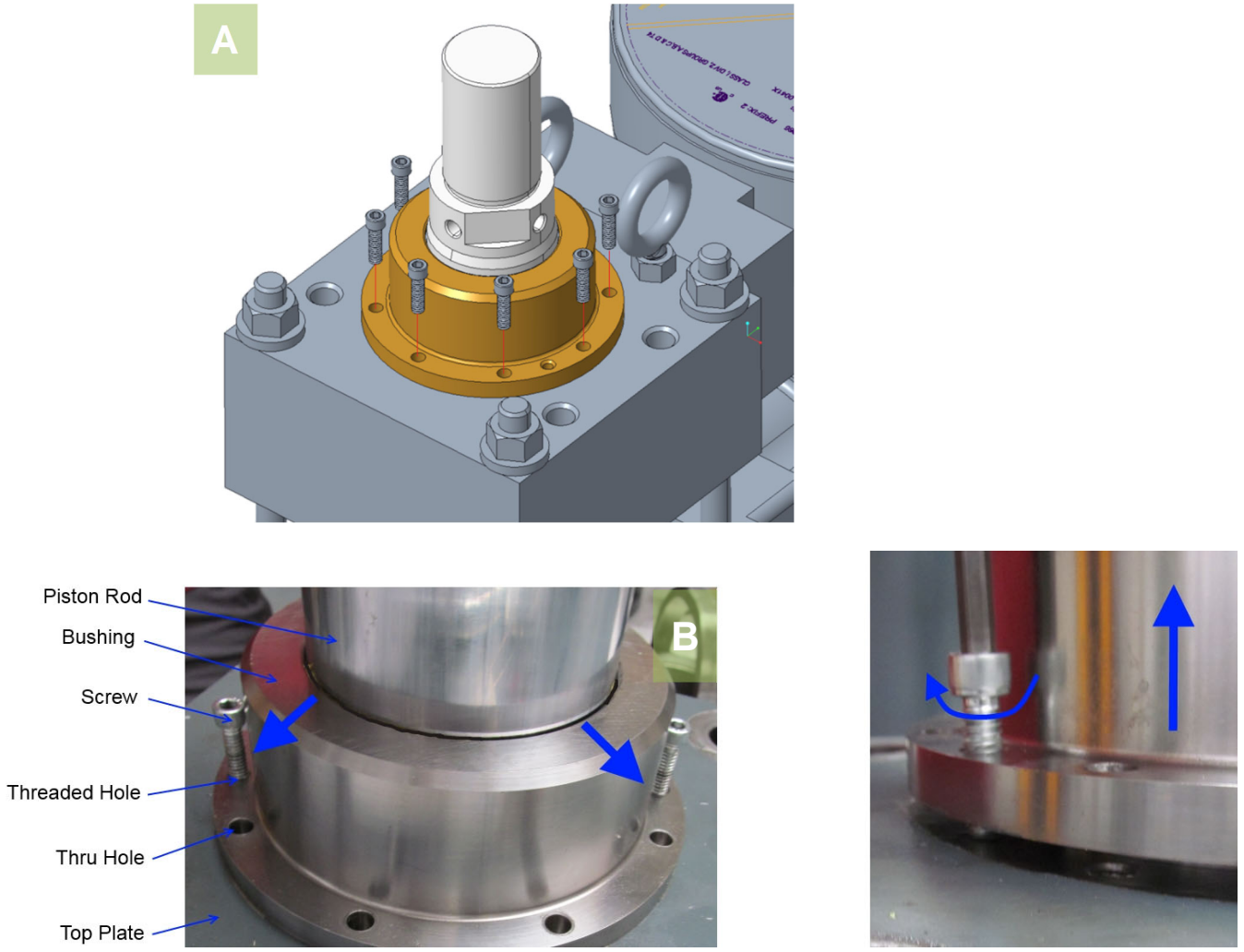


Figure 4-1. Bushing Removal

D. Remove bushing. Use mallet if needed.

E. Remove all inside and outside seals from the bushing.

CAUTION, use pick tool carefully to prevent damage to O-ring/seal grooves.

F. Clean all surfaces (cylinder rod and bushing). Use ISOPROPANOL cleaning fluid and visually inspect all surfaces.

Preferred/Acceptable Condition:

No visual evidence of wear, damage, or corrosion that cannot be removed easily with green paper (such as 3M™ Lapping Film 261X, 30.0 Micron Sheet) or chemical cleaning.

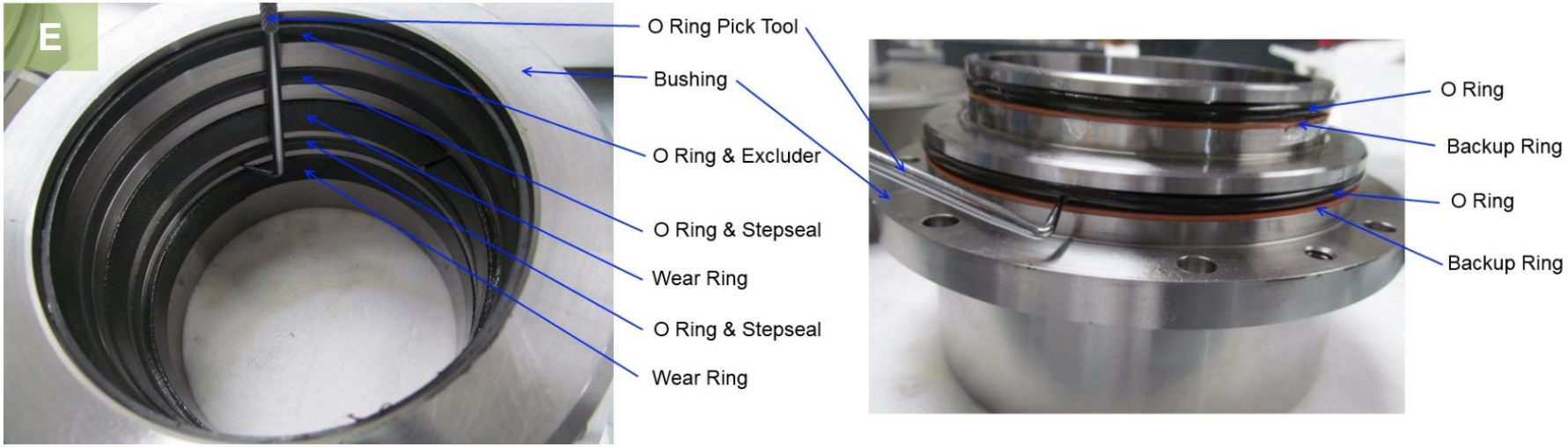


Figure 4-2. Bushing Removal (Cont.)

4.3 Assembly Procedure

A. Inventory replacement parts kit to verify all replacement parts listed in the Installation Drawing are present.

B. Place the rod bushing onto the assembly bench with the smaller OD end down.

C. Lubricate two wear rings with petroleum jelly and install one wear ring into each of the two ID grooves of the rod bushing. Position the scarf cuts of the wear rings approximately 180 degrees of each other.

D. Lubricate two O-rings with petroleum jelly and install one O-ring into each of the two lower grooves of the rod bushing.

E. Lubricate two stepseals with petroleum jelly. Install one stepseal into each of the two lower grooves of the rod bushing over the previously installed O-rings. Orient the smaller ID of the stepseals downwards.

F. Lubricate O-ring with petroleum jelly and install into the upper ID groove of the rod bushing.

G. Lubricate the last ring with petroleum jelly. Install below and on the bottom of the O-ring in the upper ID groove of the rod bushing.

H. Re-position the rod bushing to orient the smaller OD upwards.

I. Lubricate backup rings with petroleum jelly. Keeping the side with raised circles against the surface of the OD and the smooth side against the O-ring, install into the larger and smaller OD groove of the rod bushing.

J. Lubricate O-ring with petroleum jelly and install into the larger and smaller OD groove of the rod bushing above or outside the previously installed backup ring.

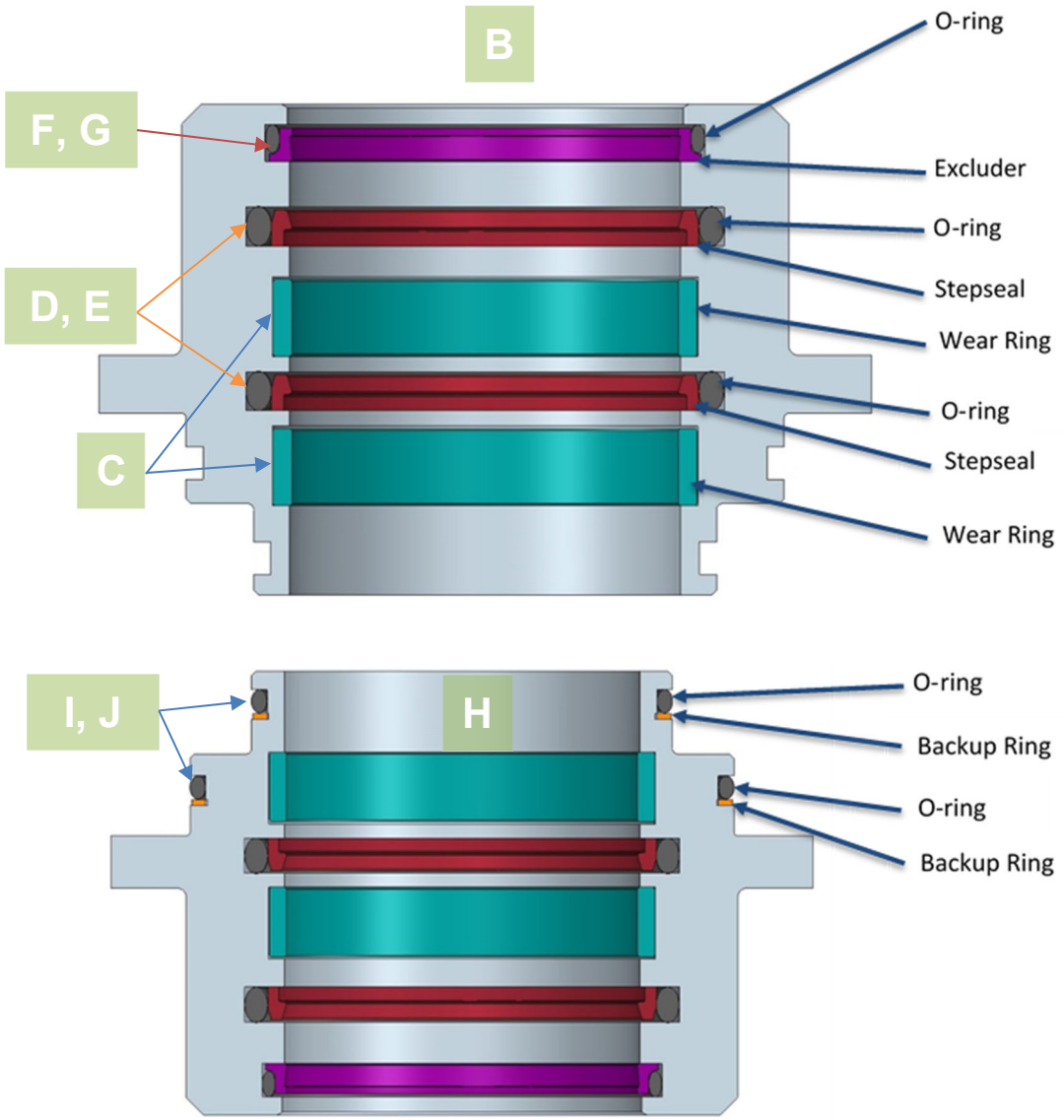


Figure 4-3. Install Rings and Seals into and onto Rod Bushing

K. To prevent damage to the seal bushing assembly, install electrical tape over the threads on the piston.

L. Install the bushing assembly over the cylinder rod.

M. Align the screw holes of the rod bushing with the screw holes of the top plate and install the rod bushing.

N. Apply Loctite 242 to the threads of eight screws and install them through the flange of the rod bushing into the top plate.

O. Tighten screws in a crosshatch pattern to push the bushing into the top of the manifold plate. Torque screws according to the values in the table below:

Cylinder Size	Torque
4, 5, 6, 8 bore	72-96 IN-LB
10 bore	120-132 IN-LB

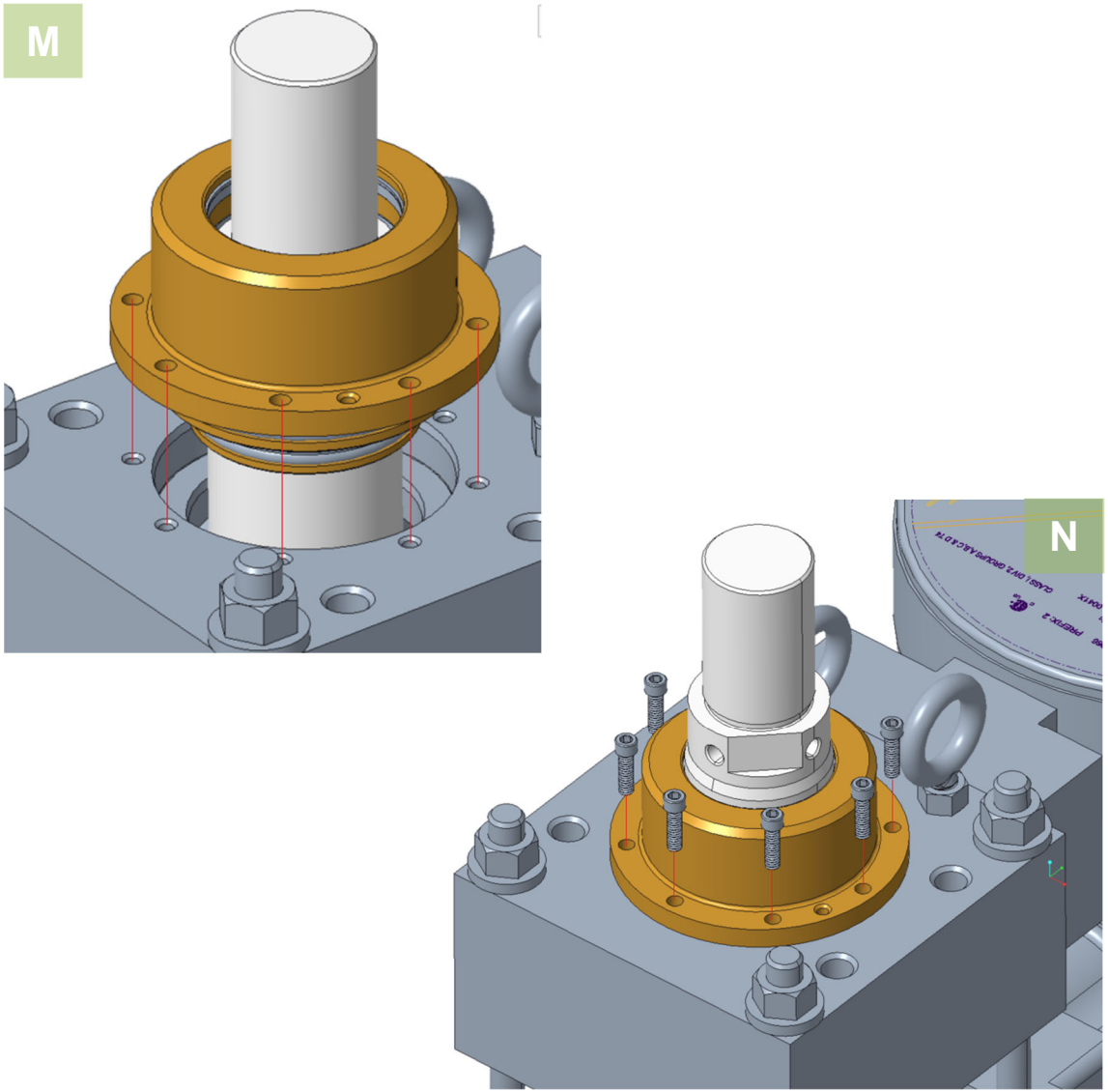
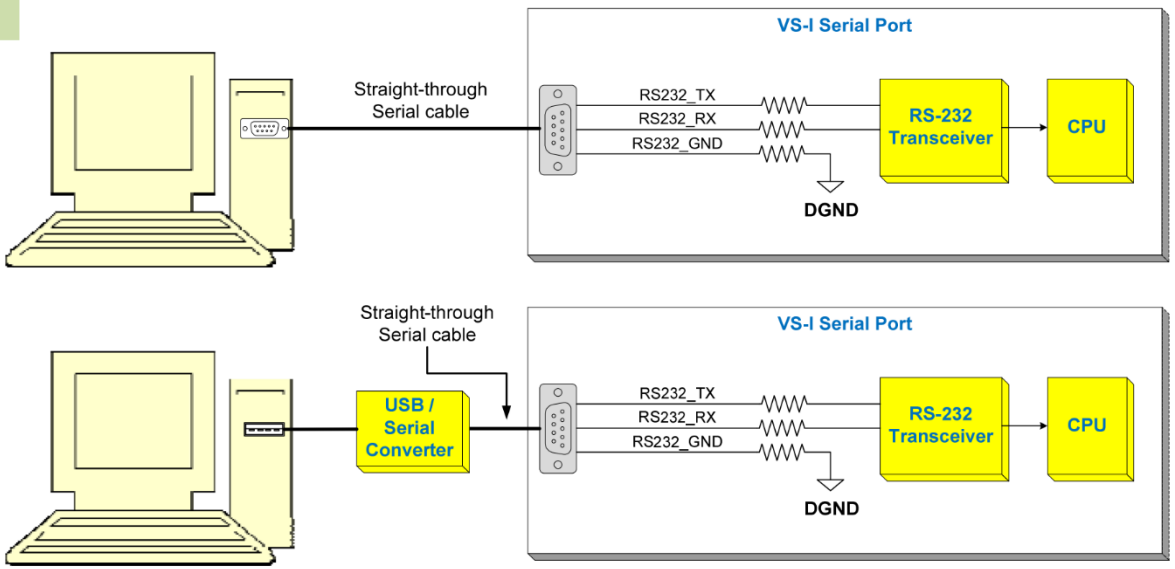


Figure 4-4. Install Rod Bushing into Top Plate

4.4 Verification & Calibration

A. Remove the top cover of the VS-I taking care not to damage or contaminate the threaded surface.
B. Verify that the hydraulic and electrical connections are correct. See product manual for more information.
C. Confirm that the hydraulic and electrical power to the VS-I is turned off.
D. Connect a PC Service Tool to the VS-I. See product manual 35148 for more information.
E. Apply electrical power to the VS-I.

D



NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be at less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the Manual Operation button.

Figure 4-5. PC Tool Connection With/Without USB/Serial Converter

F. For the **single acting** design, install external force/load. For the min load value, see table. For the spring assist version, an additional external load is not required.

G. Start the hydraulic supply system.

The supply pressure:

- 50 PSI for single acting

- 80 PSI for double acting.

NOTICE

For the spring assist version, set the supply pressure based on spring force value. The force generated by oil pressure must be at least 20% higher than max spring force.

H. Adjust the supply pressure accordingly on the Config/Calibrate screen in the Customer Service Tool (press "Save Configuration" button to apply changes).

I. Operate the unit using VS-I PC Service Tool. Go to the **Manual Operation** screen.

		Cylinder bore size mm (inch)		
		152 (6)	**203 (8)**	**254 (10)**
Min inertia load kgf (lbf)	Fail Extend	108 (240)	185 (410)	290 (640)
	Fail Retract	131 (290)	231 (510)	362 (800)

IMPORTANT

Ensure the load value is stable through full cylinder stroke.

Figure 4-6. Min Load for Single Acting Design

J. Purge all air from the system. Adjust the position setpoint up and down (steps around 10%) several times to aid purging air. Allow for warm-up time.

NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be at less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the Manual Operation button.

K. **Examine the unit for external leakage**.

L. Reinstall all mechanical connections (linkage etc.)

M. Re-commission the unit following the standard instructions in the product manual and the Customer Service Tool. This will include ensuring the input, output, and alarm/shutdown configurations are all correct.

N. To complete this replacement procedure, the “Find Minimum Stop” OR “Find Minimum AND Maximum Stops” calibration routine must be run. Some calibration values may appear to be correct, but re-calibration is still required. See product manual for more information.

5. TORSIONAL SPRING REPLACEMENT

5.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of torsional spring (FAIL EXTEND/RETRACT) replacement (single and double acting):

- KIT P/N: 8935-1216, VS-I.

Woodward recommends replacing the MANIFOLD SEAL REPLACEMENT KIT in addition to the parts kit above. See tabulation drawing for more info.

NOTICE **Review the CMM and Installation Drawing before starting the replacement to ensure that all necessary tools are available and everything is understood. If you have questions, please contact Woodward.**

5.2 Disassembly Procedure

NOTICE

Before starting disassembly, connect to the VS-I using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

A. Disassemble the servo valve from the cylinder if access to the servo bottom is limited. Depending on the VSI version, see the following chapters (integrated–Chapter 2 or remote – Chapter 3).

B. Remove six screws (use Allen hex key; size 5/32 in) and cover.

C. Note the letter (E or R) facing the bottom of the servo.

Figure 5-1. Remove Cover Screws and Note Letter on Spring Assembly Face

D. Remove two (of three) screws using hex key size 7/64 inch.

E. Put a rod in one of the open holes to hold the spring in place.

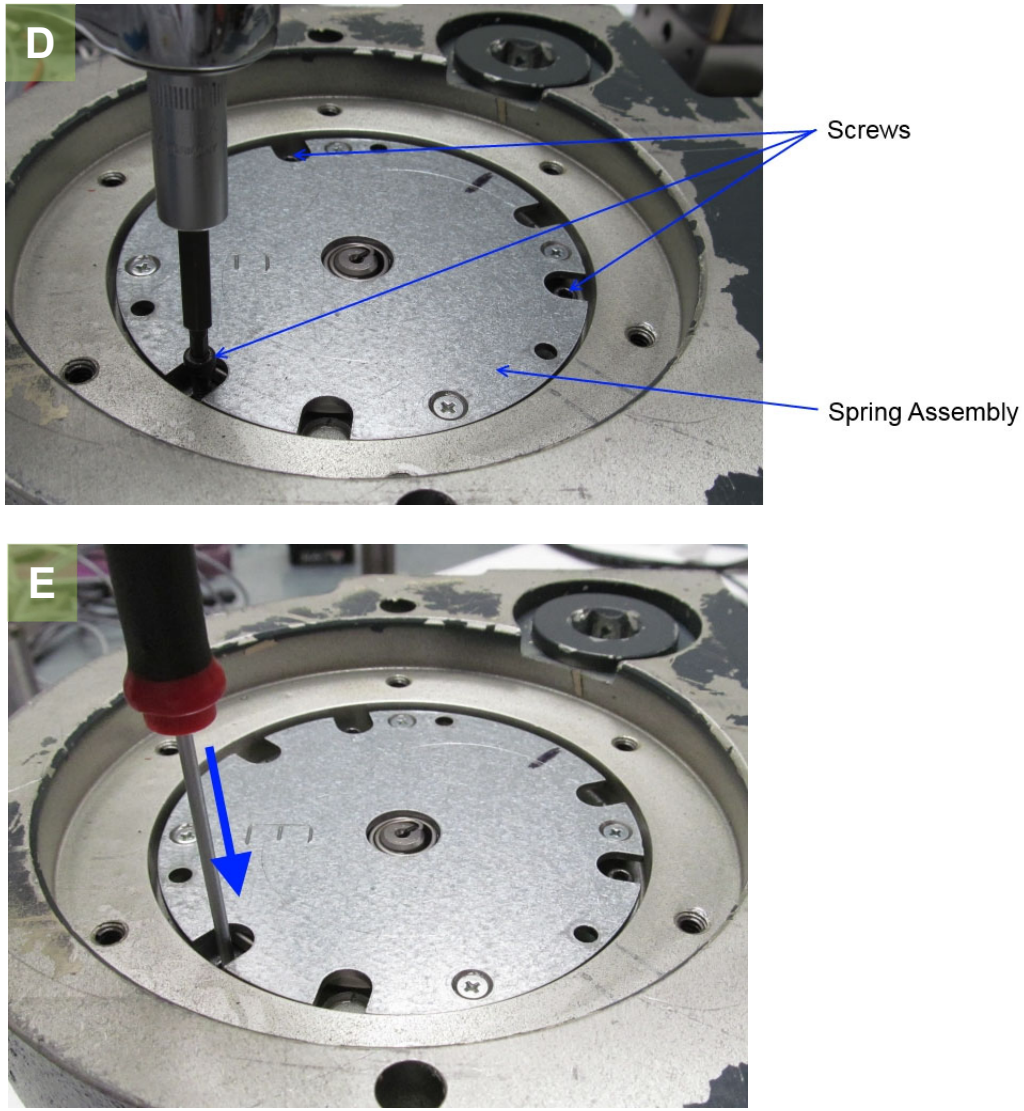


Figure 5-2. Remove Screws and Secure Spring

F. Remove the remaining screw.

⚠CAUTION

Spring is under tension, use caution when removing.

G. Holding the spring assembly with one hand, remove the rod with other hand.

Note: The spring will rotate over three turns. The spring is under slight tension, so its release is not dangerous.

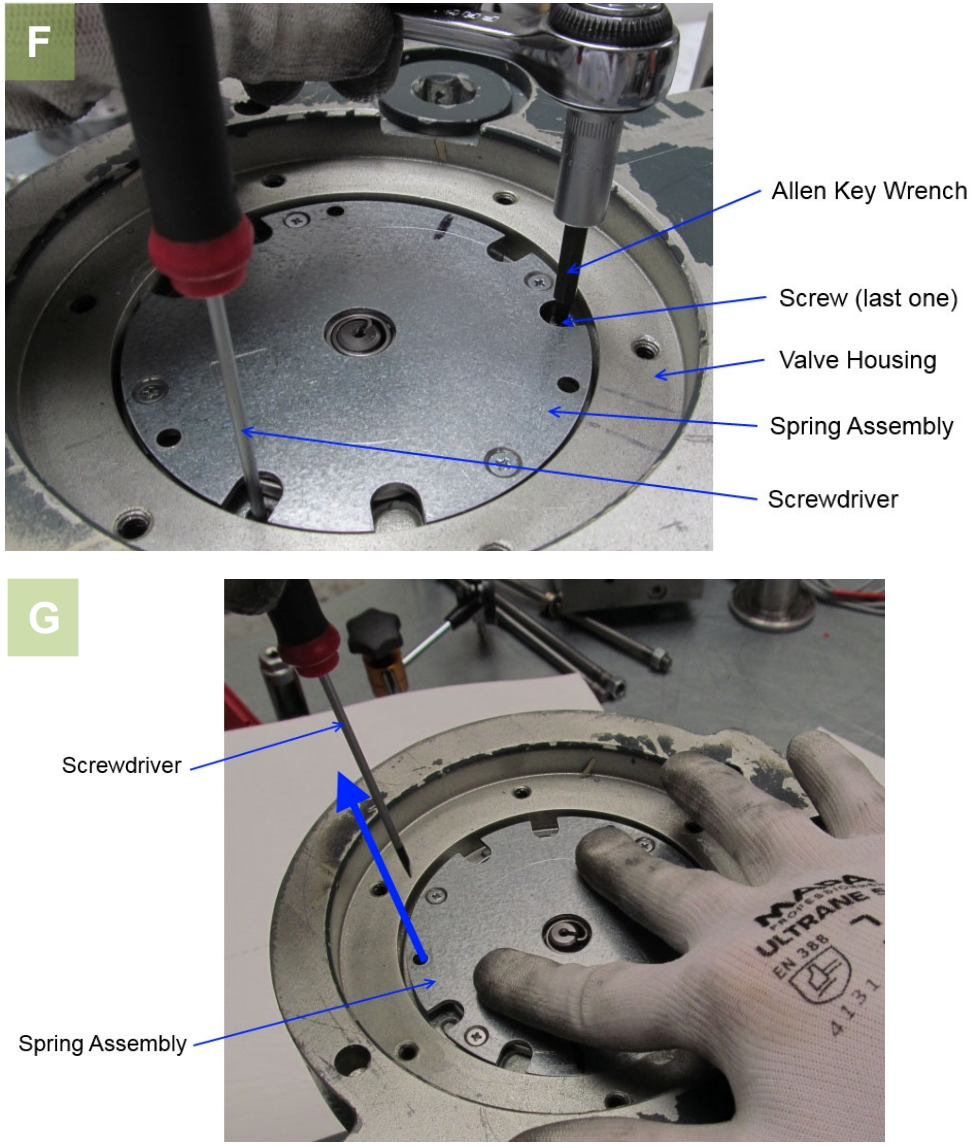


Figure 5-3. Remove Remaining Screw and Remove Rod

H. Remove old spring assembly.

I. Remove O-ring.

J. Clean all surfaces. Use ISOPROPANOL cleaning fluid and visually inspect all surfaces.

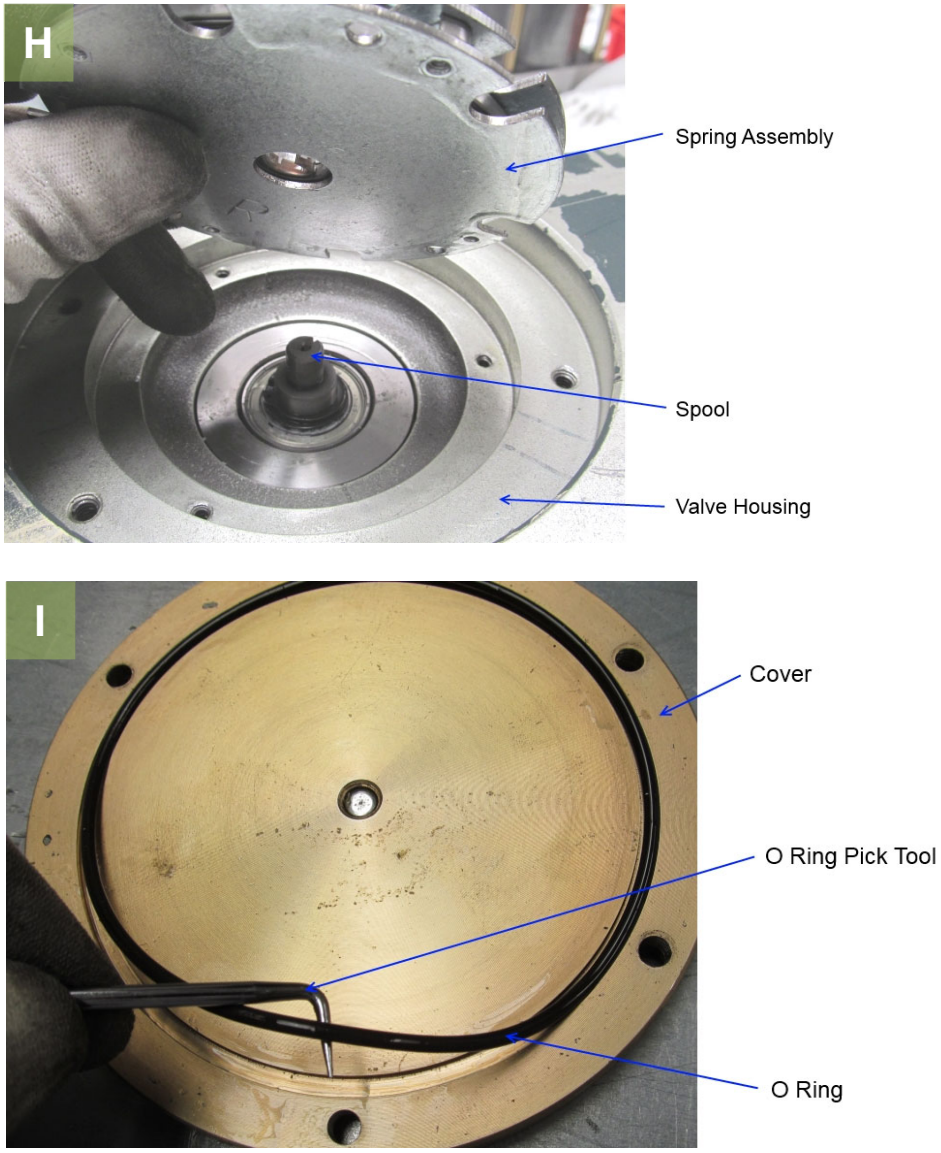


Figure 5-4. Remove Spring Assembly and O-ring

6.3 Assembly Procedure

A. Inventory the replacement parts kit to verify all replacement parts listed in the Installation Drawing are present.

B. Ensure the shaft is in the home position. Use a flat screwdriver to set the position– turn the control shaft fully CCW direction to hard stop – for “Fail Extend Valves” and turn the control shaft fully CW direction to hard stop – for “Fail Retract Valves”.

NOTICE

The single acting version has the spring oriented with the “**R**” stamp out away from the valve housing. The fail direction (fail extend or fail retract) is implemented by software parametrization.

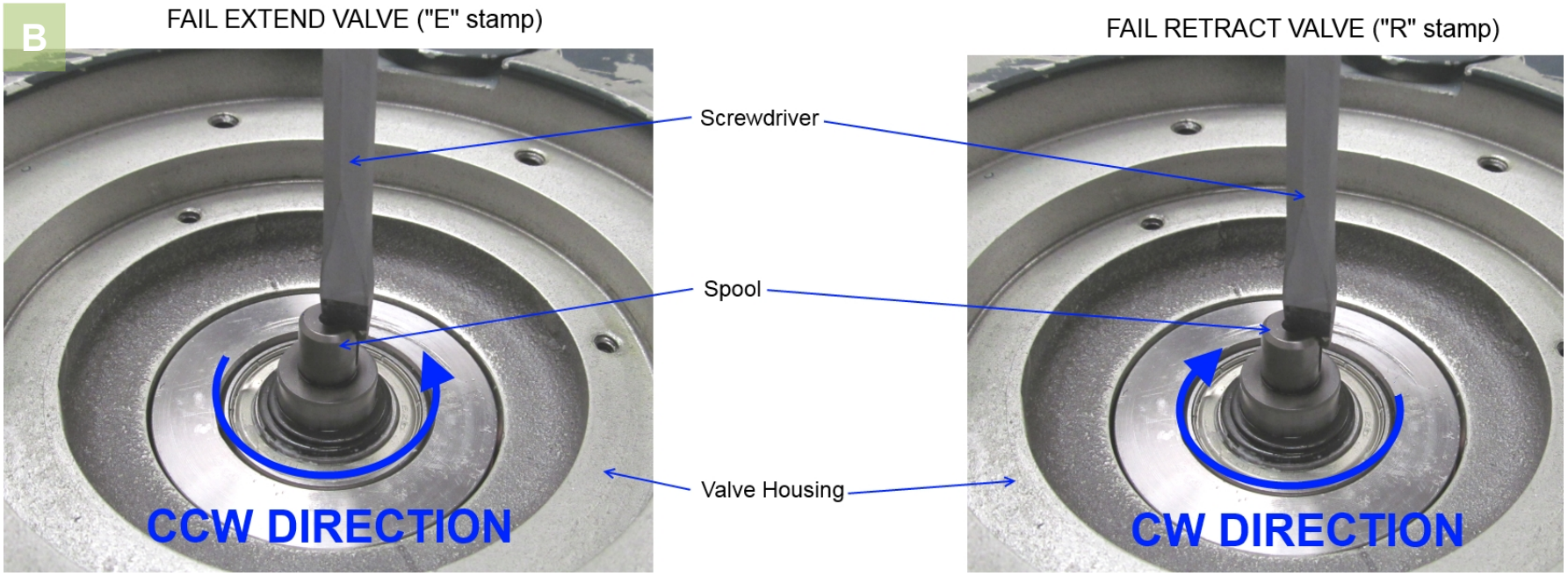


Figure 5-5. Position Control Shaft in Proper Orientation

C. Verify the spring orientation:

Double acting version:

- Fail extend valve is oriented with the “**E**” stamp faced away from the valve housing.
- Fail retract valve is oriented with “**R**” stamp faced away from the housing.

Single acting version:

- Fail extend and fail retract valve is oriented with the “**R**” stamp faced away from the valve housing.

D. Install spring assembly into the valve housing being sure to engage the spring tang into the slot of the spool as shown. See step B before spring assembly.

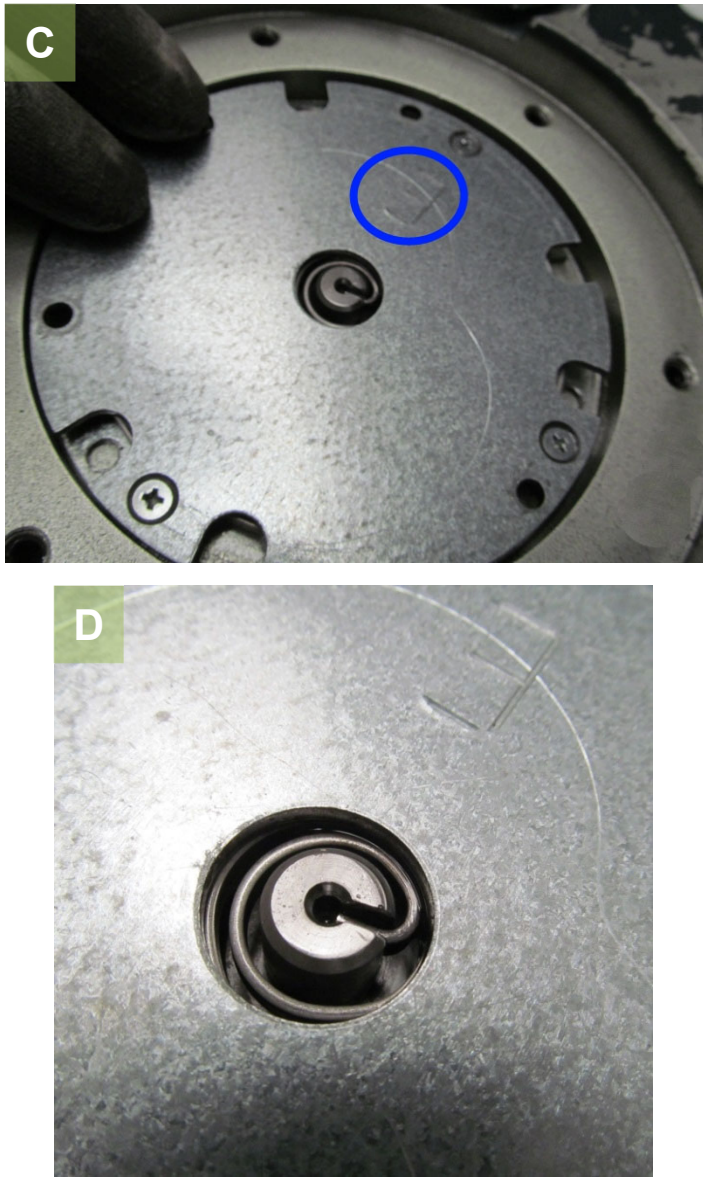
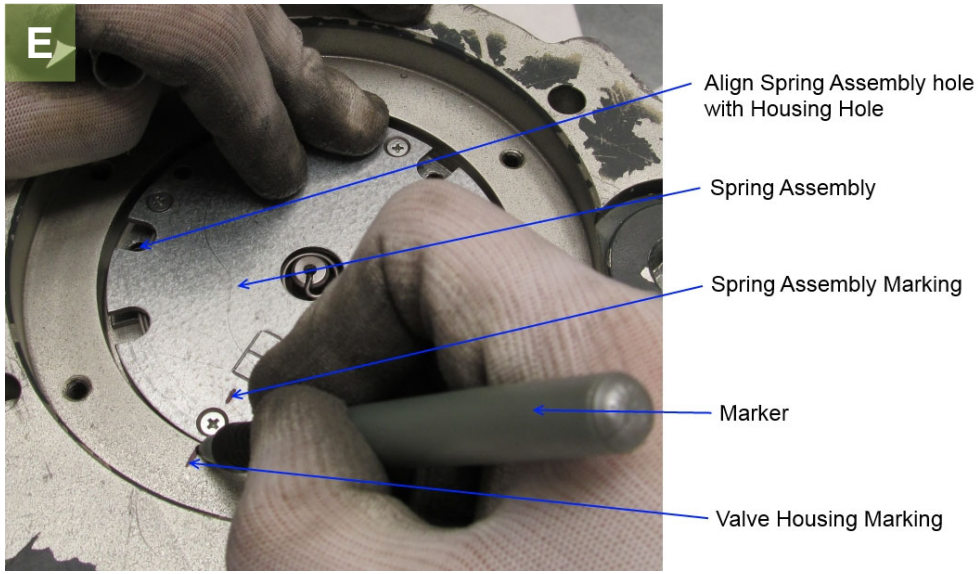


Figure 5-6. Verify Spring Orientation and Install Spring Assembly

E. Use a marker to mark the return spring and housing as shown. Make sure that the holes overlap. If not, rotate the spring slightly in the correct direction and then mark. See the picture below for correct direction. The direction depends on “FAIL” option.

F. Rotate the spring assembly three turns in the appropriate direction and hold. After winding, the "key" on the spring should be lined up with the “key” of the valve housing. The direction depends on the stamped letter.



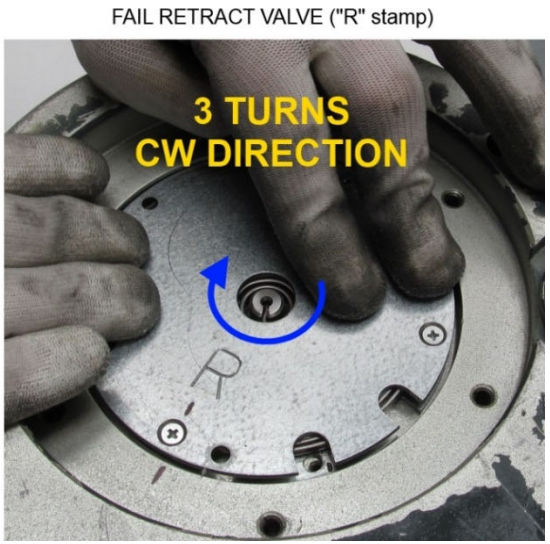


Figure 5-7. Mark Return Spring and Housing, Rotating Spring

G. Put a rod (e.g. other screwdriver) in one of the open holes to hold the spring in place.

H. Install two (of three) screws through the spring assembly plate into the valve housing using hex key size 7/64 inch.

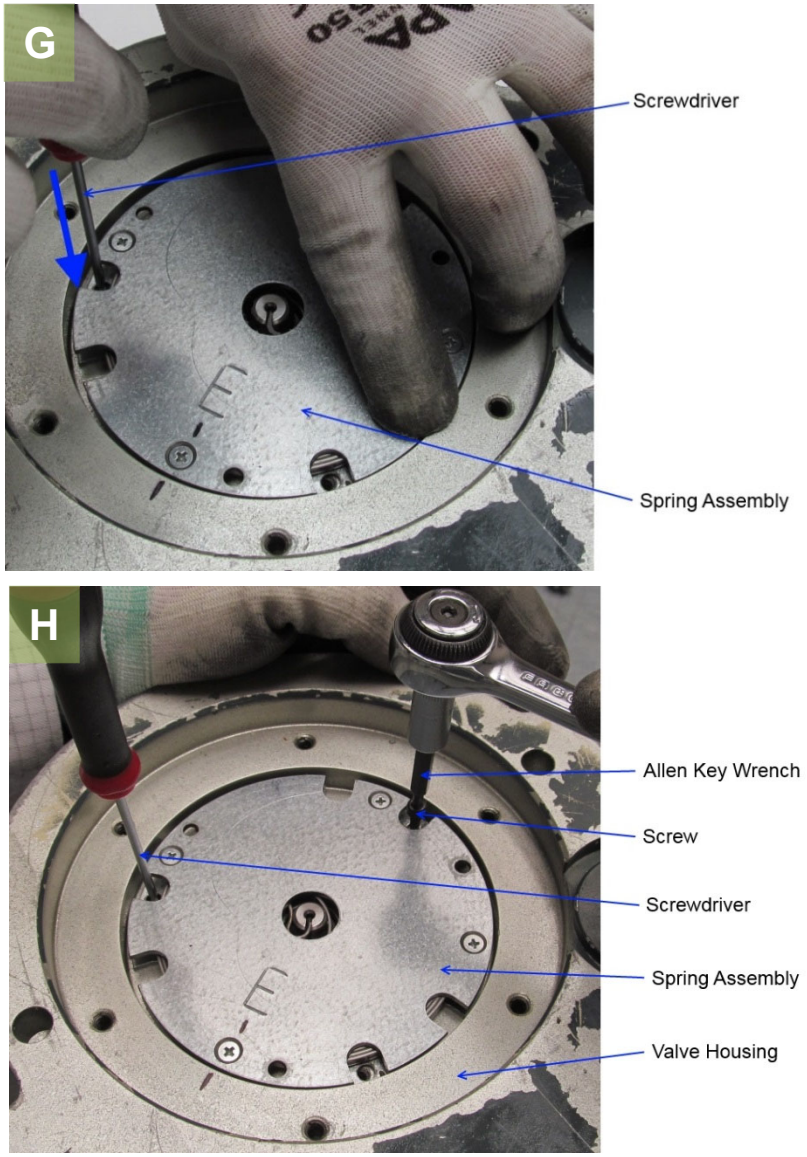


Figure 5-8. Secure Spring and Install Screws into Plate

I. Remove rod (screwdriver) and install the last screw. Torque all three screws to 26 lb.- inches, ± 2 lb.- inches (hex key, size 7/64 inch).

J. Lubricate the new O-ring with petroleum jelly and install into the face groove in the base of the housing.

K. Apply GN paste to the screw threads and install through the cover into the housing. Torque screws to 22 lb.- inches, ± 2 lb.- inch. (hex key, size 5/32 in).

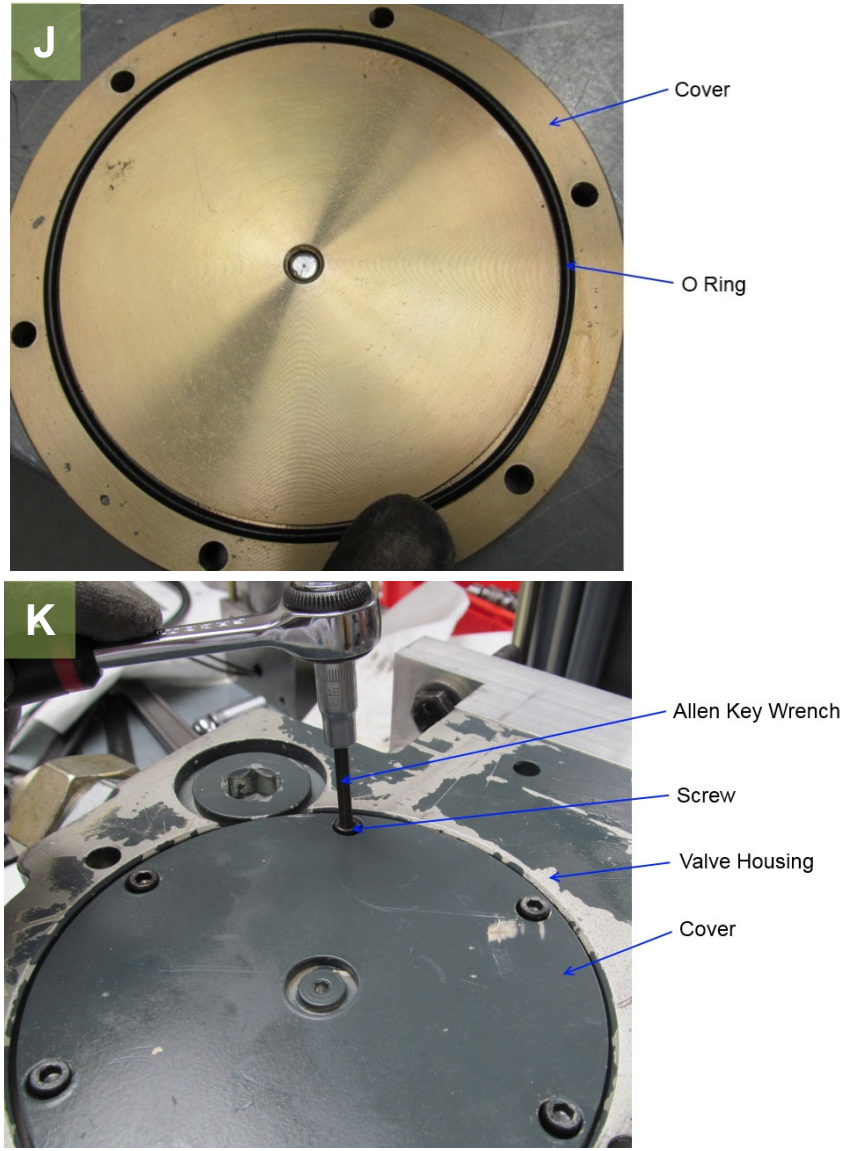


Figure 5-9. Install Spring Cover

6.4 Verification & Calibration

O. Remove the top cover of the VS-I taking care to not damage or contaminate the threaded surface.

P. Connect hydraulic and electric installation.

Q. Verify that the hydraulic and electrical connections are correct. See product manual for more information.

R. Confirm that the hydraulic and electrical power to the VS-I is turned off.

S. Connect a PC Service Tool to the VS-I. See product manual for more information.

T. Apply electrical power to the VS-I.

U. Start the hydraulic supply system.

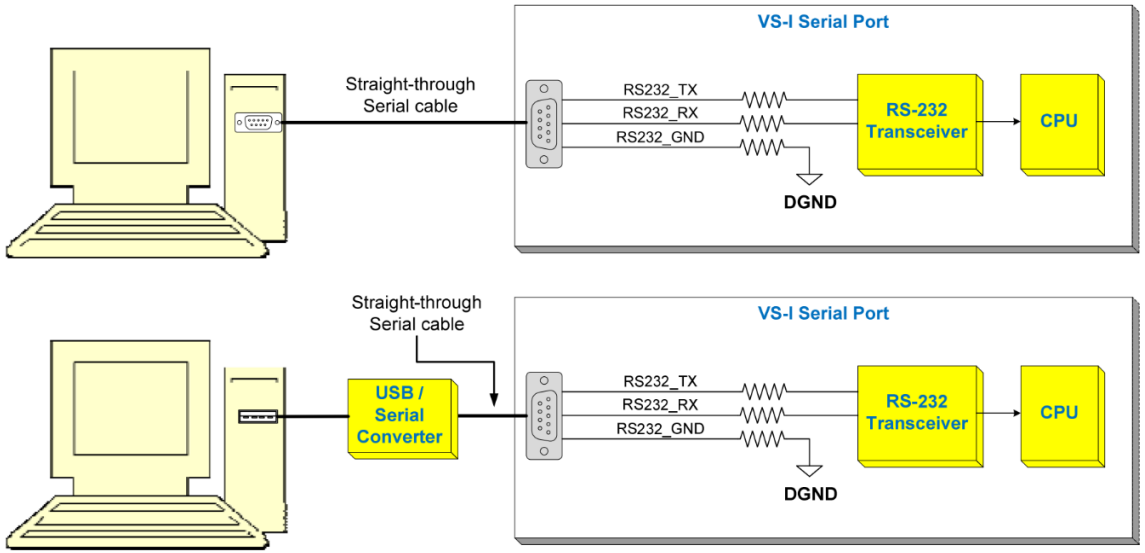


Figure 5-10. Serial Cable to Serial Port Configurations

V. Operate the unit using the VS-I PC Service Tool. Go to the **Manual Operation** screen.

NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be at less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the Manual Operation button.

W. Purge all air from the system. Adjusting the position setpoint up and down several times will aid in purging the air. Allow for warm-up time.

X. Examine the unit for external leakage.

Y. Go to the **Alarms/Shutdowns** screen and look at the faults that were triggered. Reset active and logged faults.

NOTICE

Upon startup and reset commands, the VS-I performs a brief test to ensure that the servo valve return spring is functioning properly. This is performed before moving the actuator away from the fail-safe position and will not move the actuator. This critical safety function cannot be disabled by anyone other than authorized Woodward personnel.

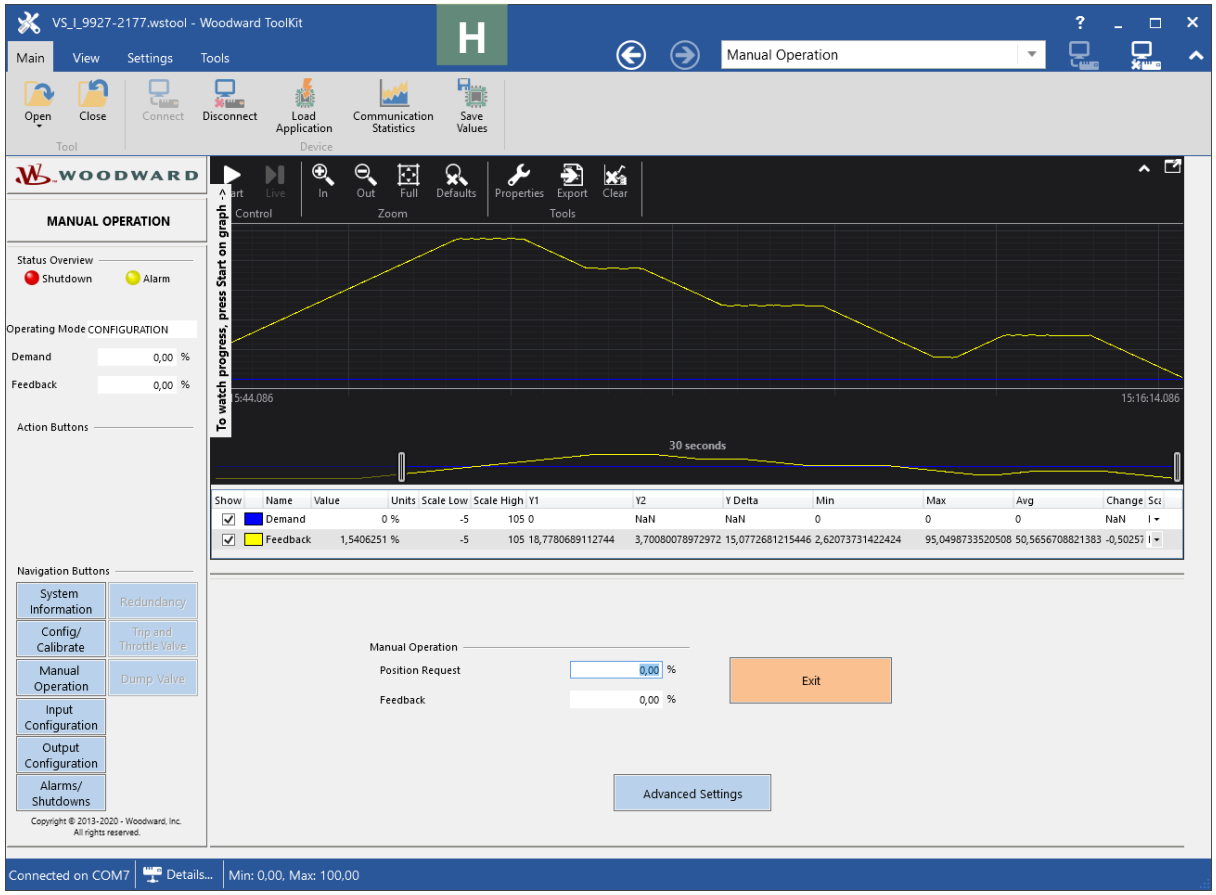


Figure 5-11. Service Tool Manual Operation Screen

Z. Go to the **Calibration** screen and **"Find Minimum AND Maximum Stops"**. Save the calibration results.

NOTICE

Perform calibration for "Find Minimum AND Maximum Stops" without external linkage.

AA. Verify if the fail-safe direction is correct by going to the **Manual Operation** screen and input 20% as a position request.

BB. Remove electrical power to the VS-I. A shutdown or loss of input power will result in the actuator moving in the fail-safe direction.

CC. Reinstall all mechanical connections (linkage etc.)

DD. Re-commission the unit following the standard instructions in the product manual and the Customer Service Tool. This will include ensuring the input, output, and alarm/shutdown configurations are all correct.

EE. To complete this replacement procedure, the "Find Minimum Stop" OR "Find Minimum AND Maximum Stops" calibration routine must be run. Some calibration values may appear to be correct, but re-calibration is still required. See product manual for more information.

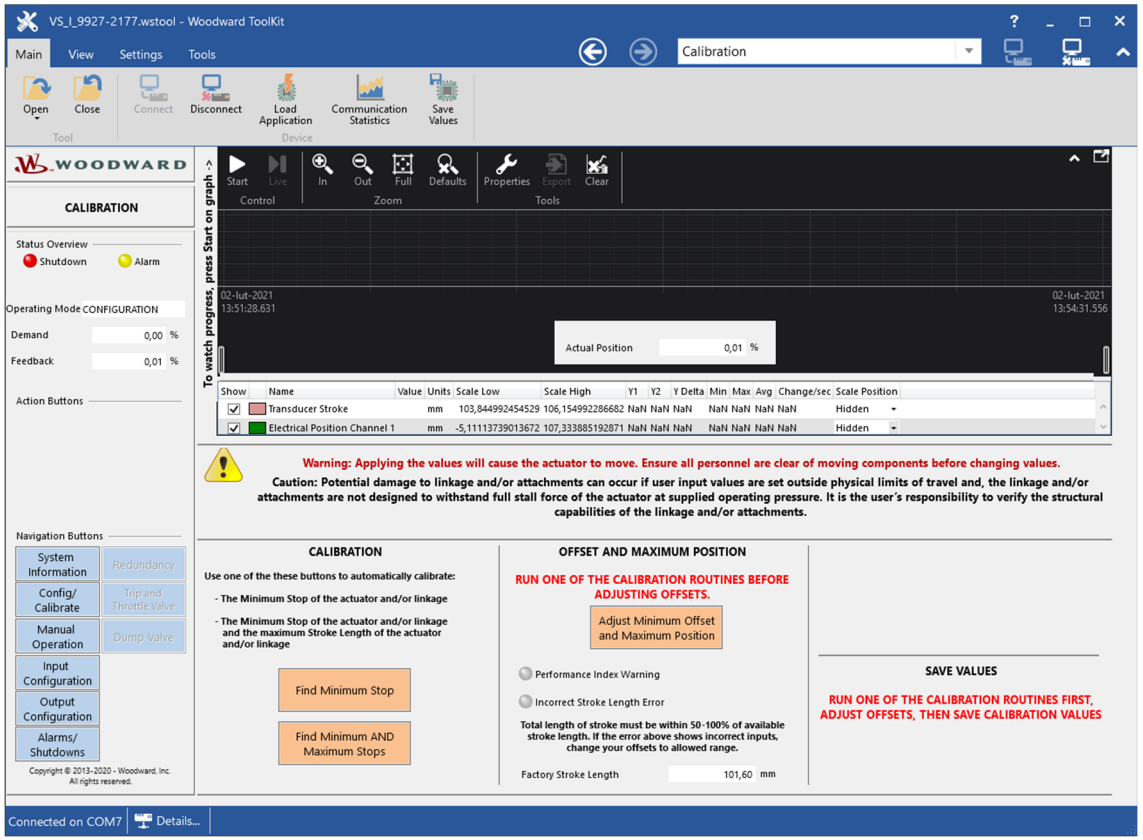


Figure 5-12. Service Tool Calibration/Manual Operation Screens

6. DV BLOCK AND DUMP VALVE ASSEMBLY REPLACEMENT

6.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of dump valve cartridges and DV block assembly (FAIL EXTEND/RETRACT) replacement:

- KIT P/N: 8923-3103 – 1.5 inch DV (DN40) – DV block assembly without quill tube and drain block (main DV block with cartridges, solenoid, orifices, and seals) – see assembly section
- KIT P/N: 8923-3104 – 2.0 inch DV (DN50) – DV block assembly without quill tube and drain block (main DV block with cartridges, solenoid, orifices, and seals) – see assembly section
- KIT P/N: 8935-1368-XX, VS-GI, DUMP VALVE ASSEMBLY, 1,5 INCH SIZE
- KIT P/N: 8935-1366-XX, VS-GI, DUMP VALVE ASSEMBLY, 2,0 INCH SIZE

Installation Drawing – 9999-1590-29

NOTICE **Review the CMM and Installation Drawing before starting the replacement process to be sure that all necessary tools are available and everything is understood. If you have questions, please contact Woodward.**

6.2 List of Required Hardware or Materials

Torque wrenches	• Kukko 224-2 bearing puller or similar • 3/4" socket • 5/16" hex bit socket • 1/4" hex bit socket • 3/8" hex bit socket • 3/4" hex bit socket • 15/16" socket • .5" hex bit socket • 1" offset wrench • Calibrated torque wrenches • Gauge pins - 1.5" DV in gauge sizes .548" - .572"; - 2" DV pin gauge sizes .674-.698
Others	• GN paste (Molykote DX paste or similar) • Petroleum jelly to lubricate O-ring
NOTICE **Tools are not contained within the replacement kit. Please order separately.**	

6.3 Disassembly Procedure

WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing the hydraulic system.

A. Ensure that the supply pressure is disconnected (no pressure inside hydraulic cylinder).
B. Disconnect the electric cables from the solenoid.
C. Remove the hydraulic control line from the dump valve.
D. Unit fail-safe direction:

Fail Extend Models:

First, loosen the four dump valve block mounting screws (hex bolts). Secure the DV block, then slowly remove screws and washers. Slowly lift the DV block to remove it from the quill tube. Secure the quill tube during DV block removal.

Fail Retract Models:

Loosen and remove the four drain block screws and washers. Slowly lift the drain block to remove it from the quill tube. Remove quill tube. Loosen the four hex head screws while supporting the DV block. Remove DV block.

⚠WARNING

Woodward does not recommend that the dump valve block internal components (other than the solenoid operator) be removed, altered, or repaired by untrained personnel. Incorrect repair could cause the system to malfunction, which could lead to an unsafe situation. The dump valve block assembly is a critical safety system that should be serviced and verified by an approved Woodward service facility.

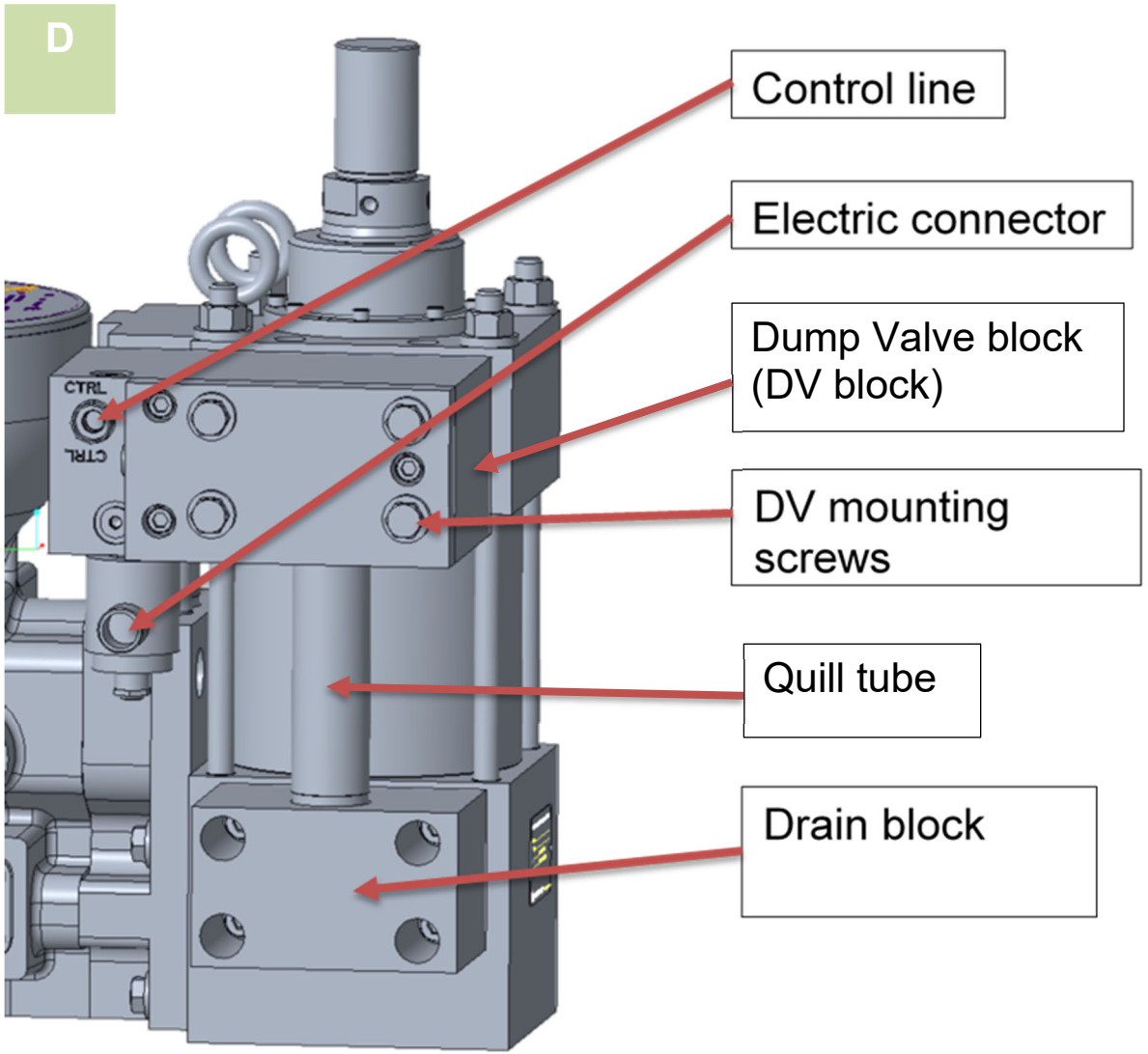


Figure 6-1. DV Disassembling

6.4 Assembly Process

Recommended installation order for the fail-retract version:

A. Lubricate new O-ring with petroleum jelly and install in the DV housing groove.
B. Lubricate new O-ring with petroleum jelly and install in the drain block groove.
C. Install DV block. Check if O-ring is installed (DV 1.5 - 1355-419; DV 2.0 - 1355-457). Apply Loctite 243 to four screws. Install all four screws but do not torque tight. Turn bolts max 3 times.

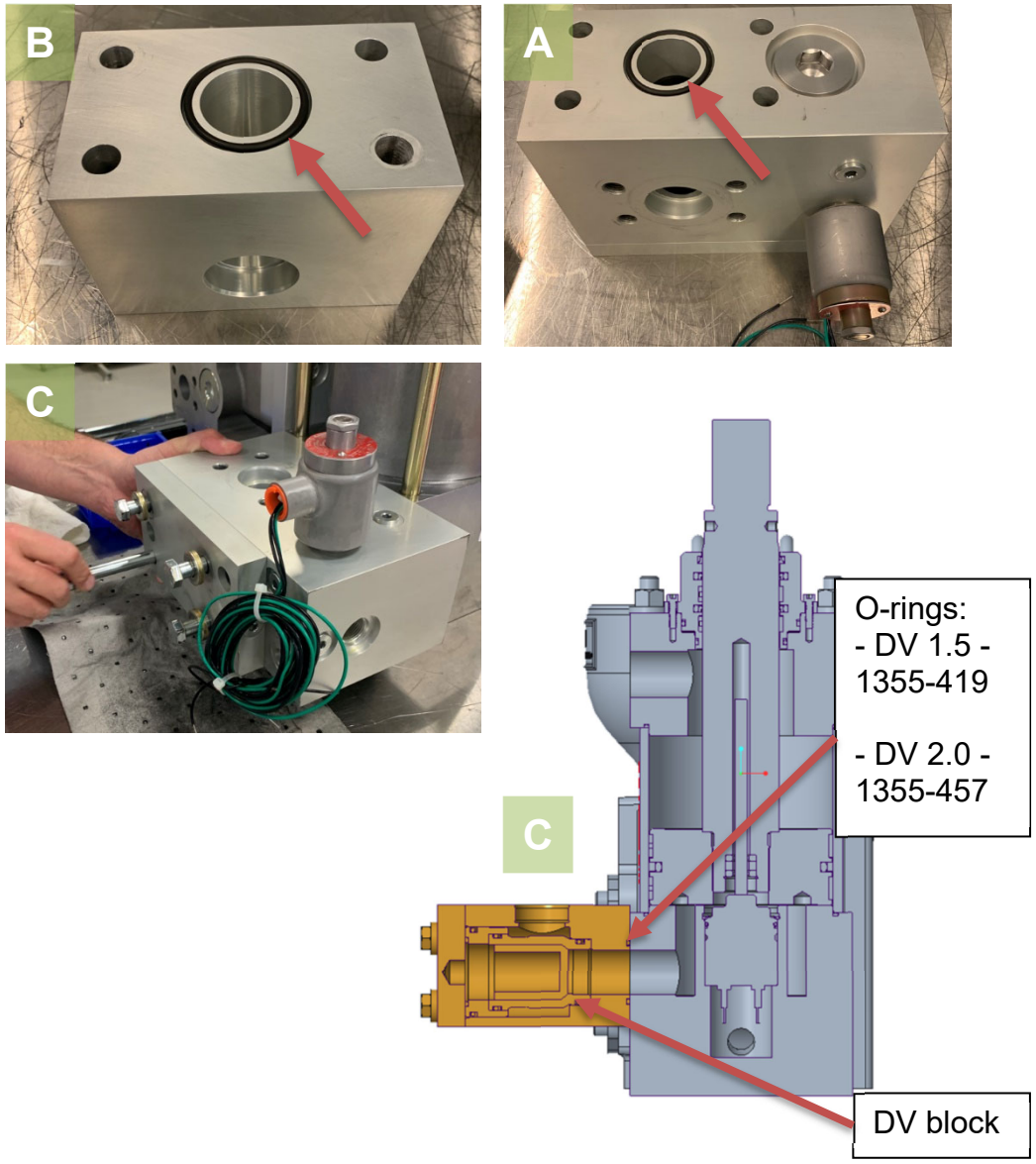


Figure 6-2. Install Dump Valve onto Cylinder, Fail Retract View, DV Block

D. Lubricate new O-rings with petroleum jelly and install in quill tube grooves. Apply petroleum jelly to the quill tube port seal lands in dump valve and drain block.
E. Install the quill tube. Ensure that O-rings (DV 1.5 - 1355-088; DV 2.0 - 1355-093) are installed on both sides.
F. Install the drain block. Check if the O-ring is installed (DV 1.5 - 1355-419; DV 2.0 - 1355-457). Apply Loctite 243 to four screws. Install the four screws but do not torque tight.
G. Align the blocks with cylinder plates then torque the bolts. See table below.

	DV Mounting Bolts	Drain Block Mounting Bolts
Dump Valve (1.5 inch)	HEX HD CAP,(T-085),.500-13 - Torque 50 to 60 ft-lb	SOC HD CAP,(T-077),.500-13 - Torque 43 to 52 ft-lb
Dump Valve (2.0 inch)	HEX HD CAP,(T-085),.625-11 - Torque 90 to 110 ft-lb	SOC HD CAP,(T-077),.625-11 - Torque 81 to 99 ft-lb

H. Inspect the assembly. Ensure that there is not a gap between blocks and cylinder plates caused by paint or other debris.
I. Connect electric cables.
J. Connect hydraulic control line to dump valve.
K. Connect supply pressure to VS-I (servo) and dump valve.

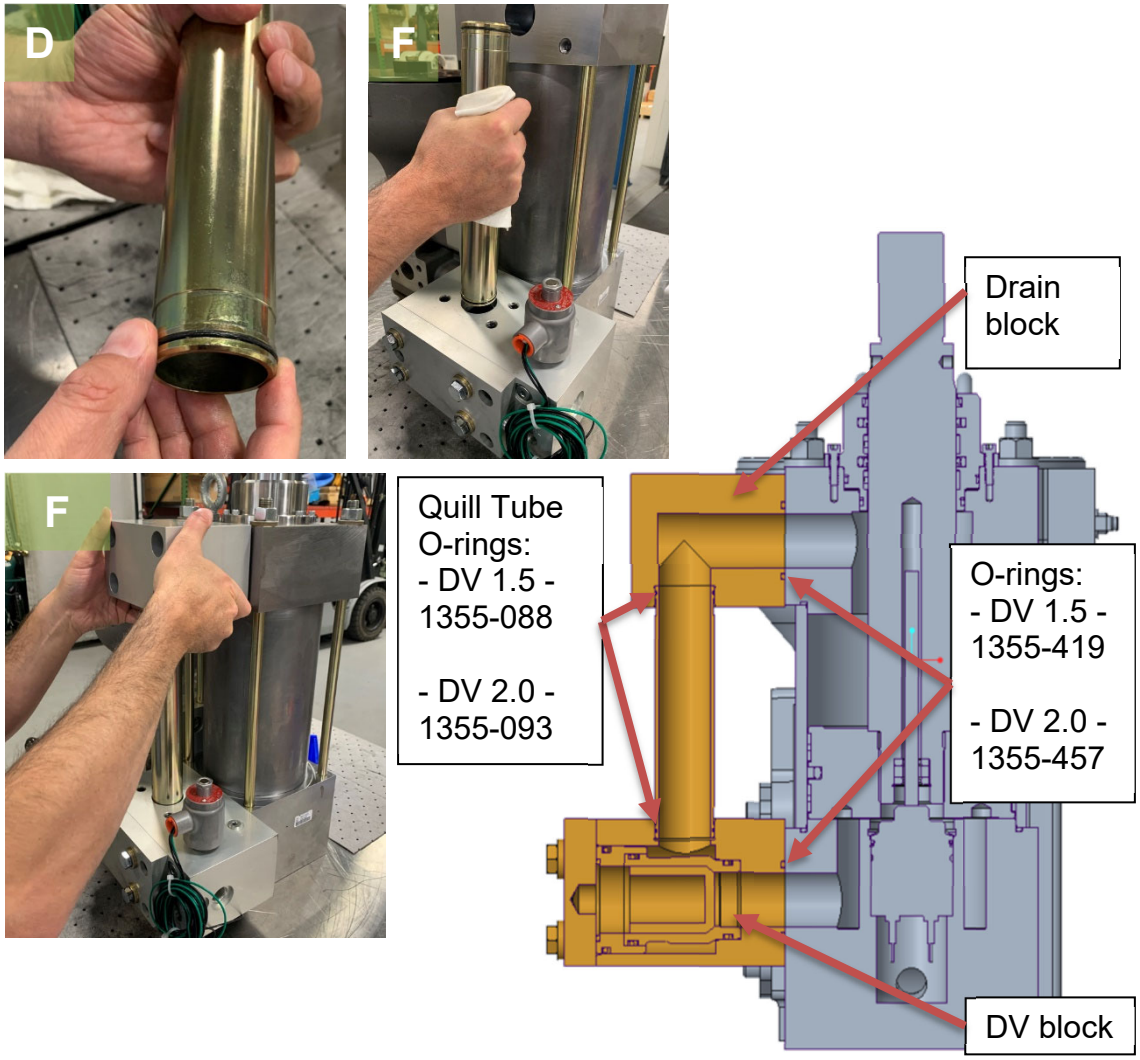


Figure 6-3. Install Dump Valve onto Cylinder, Fail Retract View

Recommended installation order for fail extend version:

A. Lubricate new O-ring with petroleum jelly and install in DV housing groove.
B. Lubricate new O-ring with petroleum jelly and install in drain block groove.
C. Install the drain block if it was removed. Check if the O-ring is installed (DV 1.5 - 1355-419; DV 2.0 - 1355-457). Apply Loctite 243 to four screws. Install the four screws but do not torque tight.
   Lubricate new O-rings with petroleum jelly and install in quill tube grooves. Apply petroleum jelly to quill tube port seal lands in dump valve and drain block
D. Install the quill tube. Ensure that O-rings (DV 1.5 - 1355-088; DV 2.0 - 1355-093) are installed on both sides.
E. Install the DV block over quill tube. Check if O-ring is installed (DV 1.5 - 1355-419; DV 2.0 - 1355-457). Apply Loctite 243 to four screws. Install all four screws but do not torque tight. Turn bolts three times maximum.

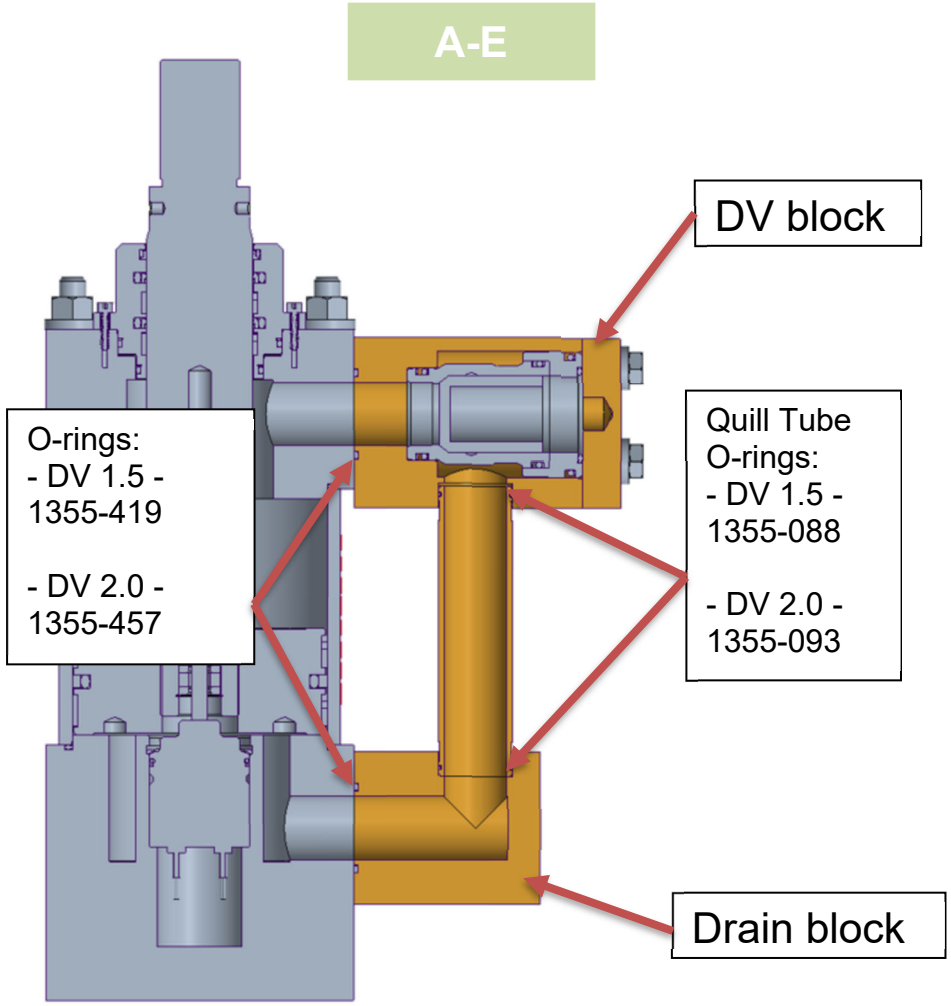


Figure 6-4. Install Dump Valve onto Cylinder, Fail Extend View

F. Align the blocks with cylinder plates then torque the bolts. See table below.

	DV Mounting Bolts	Drain Block Mounting Bolts
Dump Valve (1.5 inch)	HEX HD CAP,(T-085),.500-13 - Torque 50 to 60 ft-lb	SOC HD CAP,(T-077),.500-13 - Torque 43 to 52 ft-lb
Dump Valve (2.0 inch)	HEX HD CAP,(T-085),.625-11 - Torque 90 to 110 ft-lb	SOC HD CAP,(T-077),.625-11 - Torque 81 to 99 ft-lb

G. Inspect the assembly. Ensure there is not a gap between blocks and cylinder plates caused by paint or other debris.
H. Connect electric cables.
I. Connect hydraulic control line to dump valve.
J. Connect supply pressure to VS-I (servo) and dump valve.

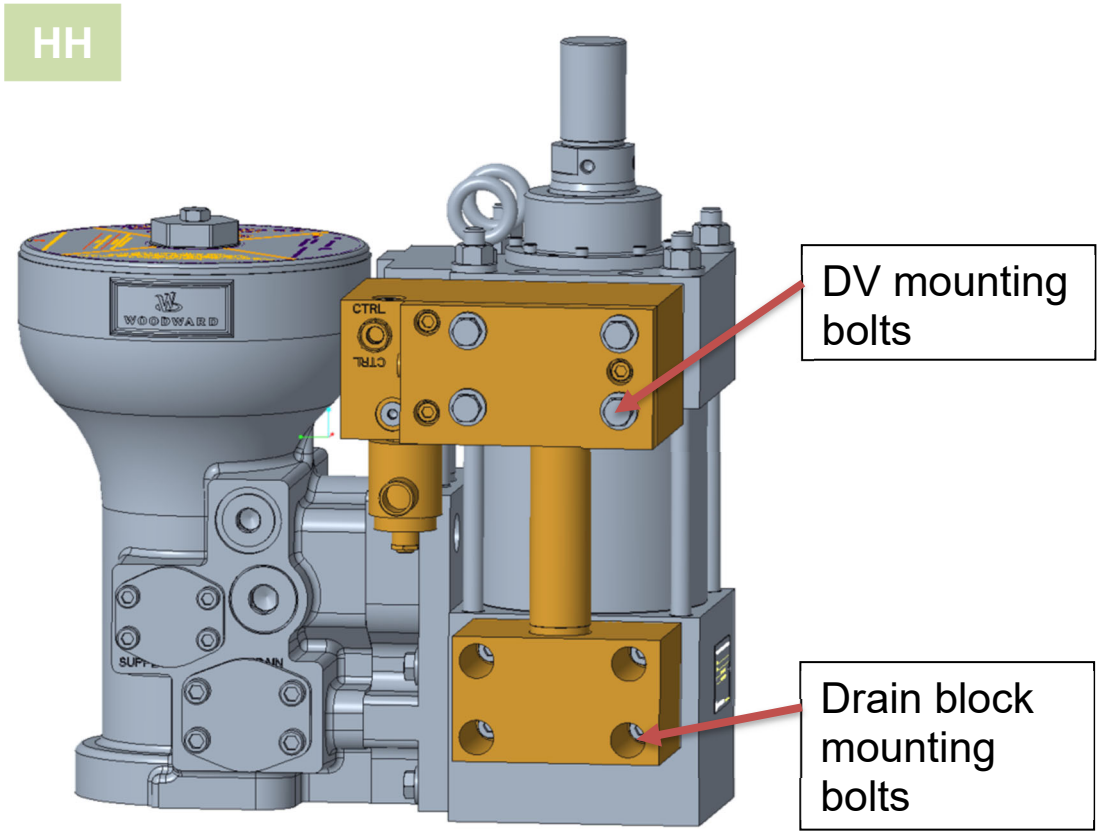


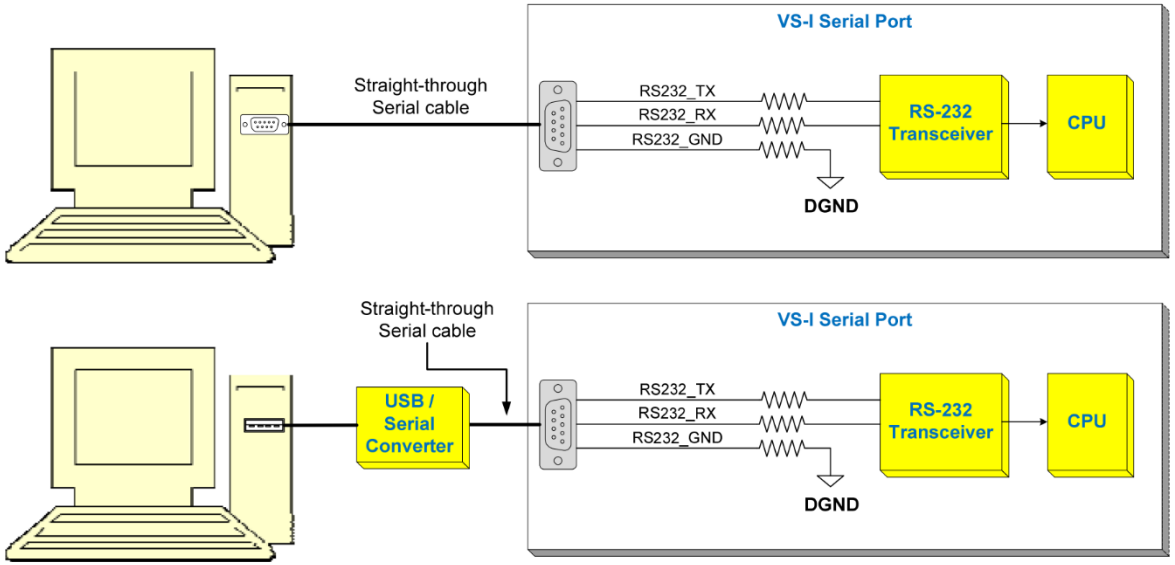
Figure 6-5. Torque Bolts with Appropriate Torque

6.5 Verification & Calibration

A. Remove the top cover of the VS-I taking care not to damage or contaminate the threaded surface.
B. Verify that the hydraulic and electrical connections are correct. See product manual for more information.
C. Make sure that the dump valve control line is connected, DV Control Port: 0.562-18 UNF STP.
D. Confirm that the hydraulic and electrical power to the VS-I is turned off.
E. Connect a PC Service Tool to the VS-I. See product manual for more information.
F. Apply electrical power to VS-I.

NOTICE

The dump valve can only operate with single acting actuator.



NOTICE

To enable manual operation, the RUN ENABLE line must be low and/or the analog input demands must be at less than 2 mA (0 mA recommended). The VS-I can be put into manual mode by pressing the Manual Operation button.

Figure 6-6. PC Tool Connection with/without USB/Serial Converter

G. For the single acting design, install external force/load. See table for the min load value. For the spring assist version, an additional external load is not required.

NOTICE

For the spring assist version, set supply pressure based on spring force value. The force generated by oil pressure must be at least 20% higher than max spring force.

H. Start the hydraulic supply system. **The supply pressure should be at least 50 PSI for single acting.**

NOTICE

For the spring assist version, set supply pressure based on spring force value. The force generated by oil pressure must be at least 20% higher than max spring force.

I. Operate the unit using VS-I PC Service Tool. Go to the **Manual Operation** screen.

G

		Cylinder Bore Size mm (inch)		
		152 (6)	**203.2 (8)**	**254.0 (10)**
Min inertia load kgf (lbf)	Fail Extend	108 (240)	185 (410)	290 (640)
	Fail Retract	131 (290)	231 (510)	362 (800)

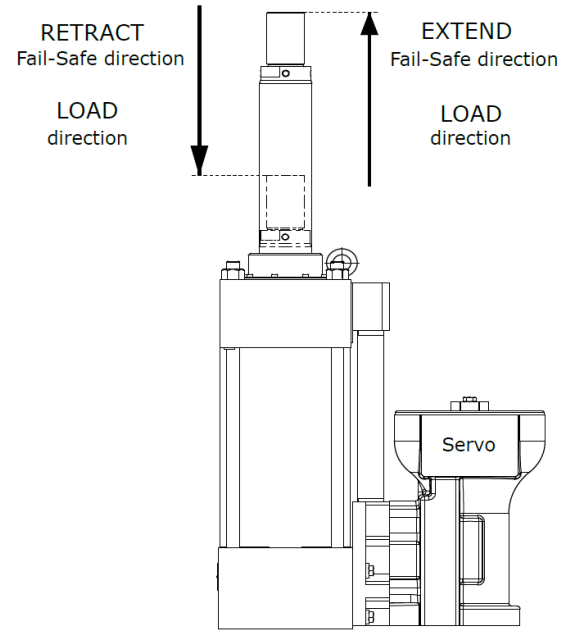


Figure 6-7. Min Load for Single Acting Design

J. Purge all air from the system. Adjusting the position setpoint up and down (steps around 10%) several times will aid in purging air. Allow for warm-up time.

NOTICE

Perform calibration for "Find Minimum AND Maximum Stops" without external load for double acting cylinder and with 20% of load for single acting cylinder.

K. Go to the **Manual Operation** screen and input 10% as a position request.

L. Switch off the dump valve (de-energize the solenoid) for 5 [s]. Record the piston position.

M. This test can be done using the internal Service Tool feature, which can record piston position (go to "Manual Operation"). Set the highest sample rate 11 millisecond for data recording. Record the demand and feedback signal.

N. During test the piston should go to the 0 cylinder position. See pictures.

O. **Examine the unit for external leakage**.

P. Go to the **Alarms/Shutdowns** screen and verify if alarms were triggered.

Q. It's recommended to download settings to "Save from Device" by using the user parameterization file (9927-2177) in the Customer Service Tool.

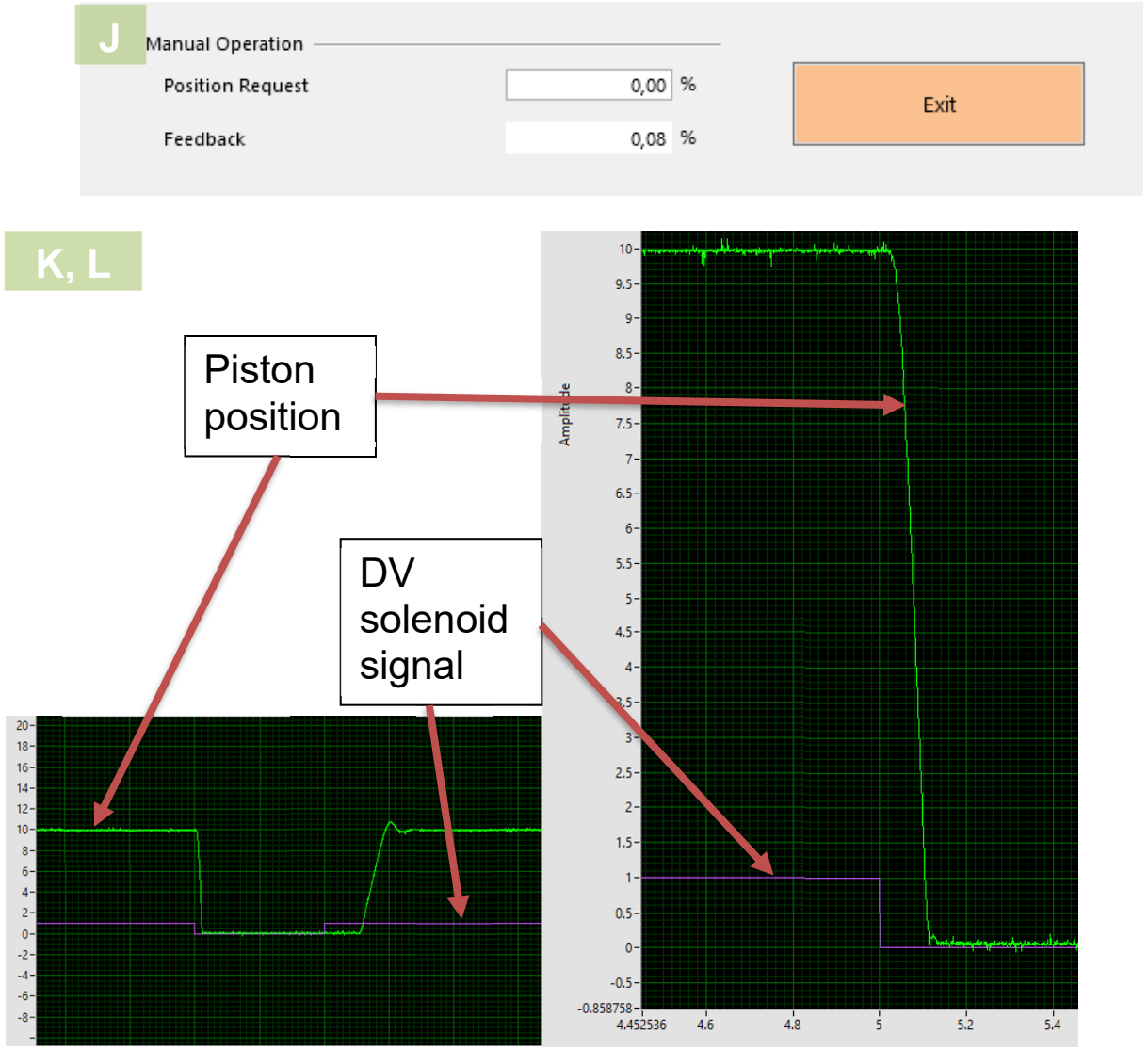


Figure 6-8. Dump Valve Test

7. DUMP VALVE SOLENOID REPLACEMENT

7.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of dump valve solenoid (FAIL EXTEND/RETRACT) replacement:

- KIT P/N: 8923-3024 – 1.5 inch DV (DN40) and 2.0 inch DV (DN50)

Installation Drawing – 9999-1590-29

NOTICE

Review the CMM and Installation Drawing before starting the replacement process to be sure that all necessary tools are available and everything is understood. If you have questions, please contact Woodward.

7.2 List of Required Hardware or Materials

Torque wrenches	• 3/4" socket • 5/16" hex bit socket • 1/4" hex bit socket • 3/8" hex bit socket • 3/4" hex bit socket • 1" offset wrench • Calibrated torque wrenches
Special Tools	• 1014-4293 O-ring bullet tool • 1014-4271 Size 16 cartridge valve installation tool
Others	• GN paste (Molykote DX paste or similar) • Petroleum jelly for O-ring lubrication
NOTICE **Tools are not contained within the replacement kit. Please order separately.**	

7.3 Disassembly Procedure

⚠WARNING

Disconnect power supply before performing maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Due to unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

A. Make sure that the supply pressure is disconnected.
B. Remove conduit and disconnect wires, if installed.
C. Remove the solenoid jam nut.
D. Unscrew the coil retaining nut.
E. Using a flat wrench, remove the solenoid cartridge.
F. Clean dirt from the solenoid cavity. Inspect the thread and O-ring contact surface.
G. If replacing solenoid seals, remove two O-rings and one backup ring. Clean solenoid cartridge surfaces.

Lubricate O-ring with petroleum jelly and install in groove above threads.

Lubricate backup ring and O-ring with petroleum jelly and install in groove in the orientation shown.

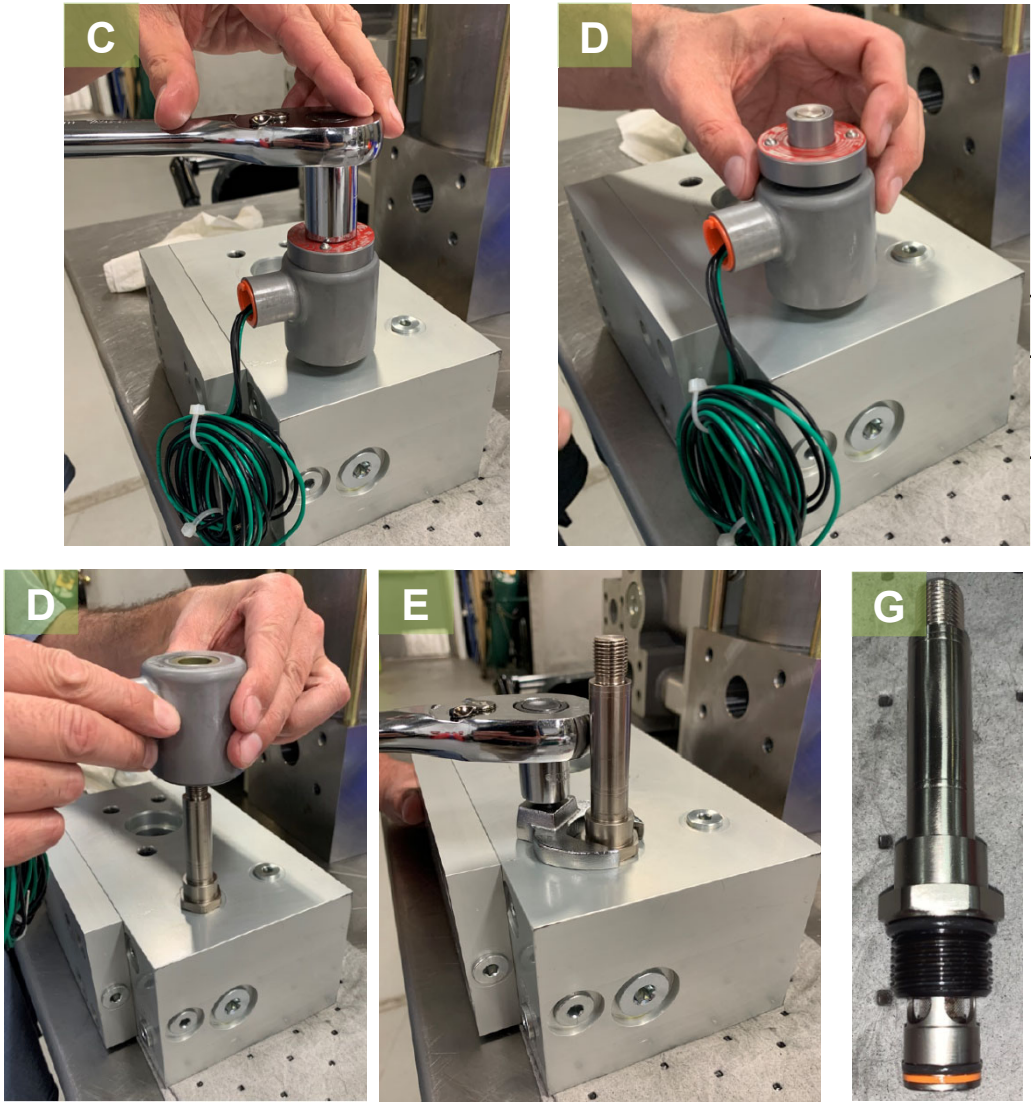


Figure 7-1. Remove Solenoid Nut and Electric Cables.

7.4. Assembly Procedure

A. Unpack the new solenoid. Verify all O-rings are installed.
B. Disassemble the jam nut, coil retaining nut, and solenoid coil from the cartridge. Lubricate O-rings with hydraulic oil or petroleum jelly.
C. Install the solenoid cartridge into the cavity. Torque to 21-25 LBFT.
D. Reinstall the coil onto the solenoid cartridge. Orient the electrical connector of the coil towards the housing face with the port marked "CTRL". Assemble the coil retaining nut hand-tight over the solenoid coil.
E. Install jam nut and torque 10-12 LBFT.
F. Connect the hydraulic control line to the dump valve.
G. Connect electrical cables.

Figure 7-2. Install Solenoid with O-rings.

7.5 Verification & Calibration

A. See Chapter 6.5.

8. REVISION HISTORY

REVISION DATE	REVISION LETTER	DESCRIPTION OF CHANGE	PAGE #
8/17	A	Added part numbers and drawing numbers to reference tables in Sections 1.4 and 1.5.	12 & 13
8/18	B	Changed steps N through U and added image #1; added numbers to images #2 and #3 to add clarity to the procedure.	130 & 163
03/22	C	Added cylinder rod seals section Added dump valve section Removed cylinder seals and MTS section. Moved to Silver Level CMM. Removed DV cartridge and DV seals section. Moved to Silver Level CMM.	50-55 72-88

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