WOODWARD

Product Manual 26836
(Revision G, 5/2021)
Original Instructions

VariStroke-I
Servo Replacement Procedure

Repair Procedure

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 *publications page* of the Woodward website:

www.woodward.com/publications

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 get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside 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.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26836

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Warnings and Notices

Important Definitions

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

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠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

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

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 on 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 because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the servo.

Chapter 1.
General Information

Purpose

The purpose of this document is to describe the steps necessary to perform the replacement of all service kits prepared for VariStroke-I maintenance. This manual contains the list of tools and detailed descriptions of the replacement process.

This manual is for Woodward Service Staff, Authorized Service Facilities (Channel Partners), and customer technical staff.

List of Replacement Kits

1. Servo Valve Replacement Kit—Integrated Version
- 9907-1335 – V45, 6, 8 and 10 inch cylinders, fail-safe direction: extend
- 9907-1336 – V45, 6, 8 and 10 inch cylinders, fail-safe direction: retract
- 9907-1452 – V45, 4 and 5 inch cylinders, fail-safe direction: extend
- 9907-1453 – V45, 4 and 5 inch cylinders, fail-safe direction: retract
- 9907-1473 – V45, 5 inch cylinder, fail-safe direction: extend (For Top Level 9907-1468 ONLY)

2. Servo Valve Replacement Kit—Remote Version
- 9907-1256 – V45, fail-safe direction: extend
- 9907-1333 – V45, fail-safe direction: retract

3. Manifold Seals Replacement Kit
- 8923-2068 – for 6, 8, and 10 inch bore actuators
- 8923-2165 – for 4 and 5 inch bore actuators
- 8923-2243 – for 5 inch bore actuators (For Top Level 9907-1468 ONLY)

4. Special Tools Kit Needed for Replacement
- 8923-2508 - special tool

Woodward drawing 9999-1590 shows all replacement kits.

Chapter 2.
Servo Valve Replacement Kit—Integrated Version

Required Tools

Special Tools

- Socket - 6-point deep, 1-1/8" size, 3-1/4" overall length; part number: 1013-6844 (Part of Tool Kit 8923-2508)
- Socket - 6-point deep, 1" size, 3-1/4" overall length; part number: 1013-6924 (Part of Tool Kit 8923-2508)

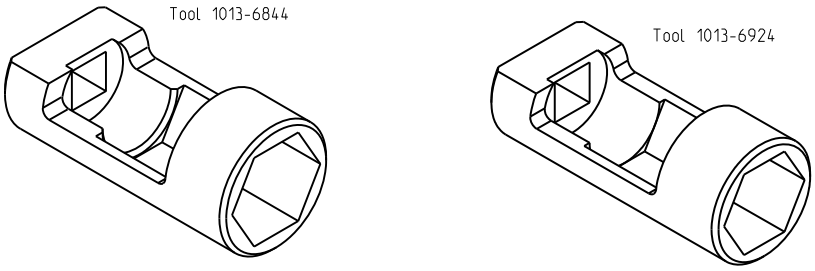


Figure 2-1. Tool 1013-6844 and Tool 1013-6924

Standard Tools and Other Materials

- Hex key; hex size 1.5 mm ( )
- Socket size 2 ¼" [58 mm] ( )
- Screwdriver or Phillips bits, Tip number 2 ( )
- Screwdriver with small slotted tip ( )
- Open end torque wrench and socket size ¾" (19 mm) ( )
- Adjustable wrench
- Hex key; hex size 8 mm ( )
- Hex key; hex size 10 mm ( )
- Loctite 242 or equivalent
- Torque wrench (range of used torques 0.6 to 150 N·m / 5.5 to 1320 lb-in)
- Molykote G-N paste (Woodward P/N 0901823) or equivalent
- Wire ties
- Absorbing mats
- Lubricant (petroleum based hydraulic oil or SAE 10 engine lube oil)
- Hand wire brushes
- Isopropanol or equivalent
- Woodward manual 26727

IMPORTANT **The tools listed above are for servo replacement. For customer interface, additional tools may be needed.**

Table 2-1. Torque Values

Drive Module Cover	120–150 N·m (90–110 lb-ft)
Set Screw	0.6–0.7 N·m (5.5–6.2 lb-in)
0.500-13 UNC Hex Head Screws	61–75 N·m (45–55 lb-ft)
Body of a Cable Gland	92–111 N·m (68–82 lb-ft)
Cable Gland Nut	31–37 N·m (23–27 lb-ft)
Pan Head Philips Screws	1.2–1.5 N·m (11–13 lb-in)
0.750-14 NPT Threads	17–28 N·m (150–250 lb-in)
0.500-14 NPT Threads	7–9 N·m (60–80 lb-in)
Ground	5.1 N·m (45 lb-in)
M10x1.5 Screws	34–48 N·m (25–35 lb-ft)
M12x1.75 Screws	48–61 N·m (35–45 lb-ft)

Kit Contents

Depending on which type of fail-safe direction actuator is being replaced, there are two separate kits available per cylinder size:

Table 2-2. Kit Contents

Woodward Kit Number	Cylinder Bore Size (Inches	Fail-Safe Direction	Servo-Valve Size	Kit Drawing
9907-1335	6, 8, 10	Extend	V45	9999-1590-1
9907-1336	6, 8, 10	Retract		
9907-1452	4, 5	Extend		
9907-1453	4, 5	Retract		
9907-1473	5 (9907-1468 only)	Extend		

Table 2-3. Kit 9907-1335 Content

Component Part Number	Quantity Each	Description
6300-1353-E	1	Actuator - (T-6300-1353),Assembly, Hydraulic Servo, 1.750 Diameter, VariStroke-I, Fail Extend
8923-2174	1	SPARE PARTS FOR INTEGRATED VSI SERVO REPLACEMENT - 6, 8 AND 10 INCH BORE DIA CYLINDER
1355-1835	6	O-ring
1355-411	1	O-ring
1355-1042	1	O-ring
3082-1630	1	NAMEPLATE - VARISTROKE SERVO
3550-1971	1	COVER - VARISTROKE I, ELECTRONICS ACCESS WITH ARTWORKS

Table 2-4. Kit 9907-1336 Content

Component Part Number	Quantity Each	Description
6300-1353-R	1	Actuator - (T-6300-1353),Assembly, Hydraulic Servo, 1.750 Diameter, VariStroke-I, Fail Retract
8923-2174	1	SPARE PARTS FOR INTEGRATED VSI SERVO REPLACEMENT - 6, 8 AND 10 INCH BORE DIA CYLINDER
1355-1835	6	O-ring
1355-411	1	O-ring
1355-1042	1	O-ring
3082-1630	1	NAMEPLATE - VARISTROKE SERVO
3550-1971	1	COVER - VARISTROKE I, ELECTRONICS ACCESS WITH ARTWORKS

Table 2-5. Kit 9907-1452 Content

Component Part Number	Quantity Each	Description
6300-1353-E	1	Actuator - (T-6300-1353),Assembly, Hydraulic Servo, 1.750 Diameter, VariStroke I , Fail Extend
8923-2175	1	SPARE PARTS FOR INTEGRATED VSI SERVO REPLACEMENT - ONLY 4 AND 5 INCH BORE DIA CYLINDER
1355-1835	6	O-ring
1355-411	1	O-ring
1355-1107	1	O-ring
3082-1630	1	NAMEPLATE - VARISTROKE SERVO
3550-1971	1	COVER - VARISTROKE I, ELECTRONICS ACCESS WITH ARTWORKS

Table 2-6. Kit 9907-1453 Content

Component Part Number	Quantity Each	Description
6300-1353-R	1	Actuator - (T-6300-1353),Assembly, Hydraulic Servo, 1.750 Diameter, VariStroke I , Fail Retract
8923-2175	1	SPARE PARTS FOR INTEGRATED VSI SERVO REPLACEMENT - ONLY 4 AND 5 INCH BORE DIA CYLINDER
1355-1835	6	O-ring
1355-411	1	O-ring
1355-1107	1	O-ring
3082-1630	1	NAMEPLATE - VARISTROKE SERVO
3550-1971	1	COVER - VARISTROKE I, ELECTRONICS ACCESS WITH ARTWORKS

Table 2-7. Kit 9907-1473 Content

Component Part Number	Quantity Each	Description
6300-1353-E	1	Actuator - (T-6300-1353),Assembly, Hydraulic Servo, 1.750 Diameter, VariStroke I , Fail Extend
8923-2245	1	SPARE PARTS FOR INTEGRATED VSI SERVO REPLACEMENT - 5 INCH BORE DIA CYLINDER (TOP LEVEL 9907-1468 ONLY)
1355-1835	6	O-ring
1355-411	1	O-ring
1355-1037	1	O-ring
3082-1630	1	NAMEPLATE - VARISTROKE SERVO
3550-1971	1	COVER - VARISTROKE I, ELECTRONICS ACCESS WITH ARTWORKS

Basic Mechanical Components and Installation Interfaces

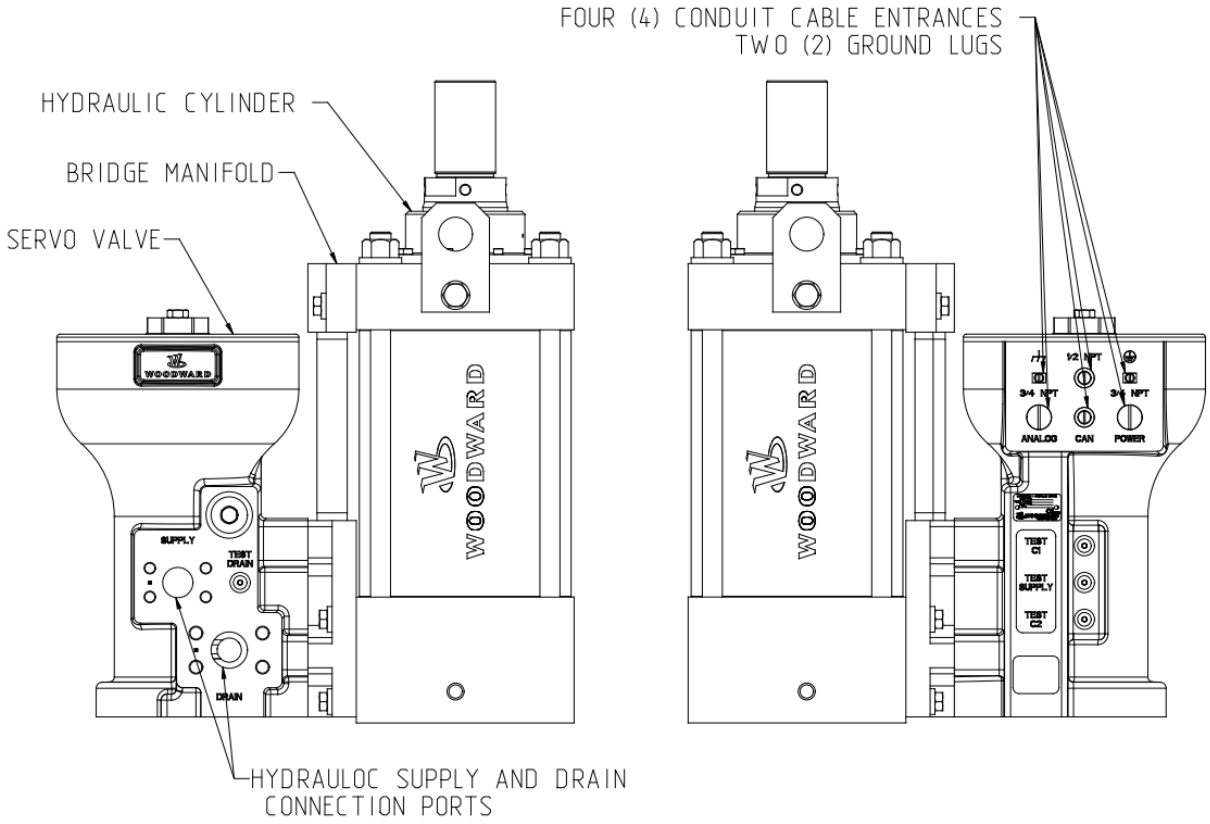


Figure 2-2. Basic Mechanical Components and Installation Interfaces

General Safety

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure and rod end force have been removed from the actuator before beginning any maintenance or repairs.

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the VariStroke-I actuator.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

⚠WARNING

Take care not to damage the electronics cover's seal, the cover surface, the threads, or the VariStroke-I housing mating surface while removing or replacing the cover. Be sure to loosen the small setscrew in the electronics cover before removing cover.

⚠WARNING

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 on 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*.

⚠WARNING

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.

Procedure

NOTICE

Before any replacement work, check if the purchased servo kit is the correct kit for your VariStroke-I actuator.

Verify that the replacement kit provided by Woodward has all listed components (see "Kit Contents" section above).

1. Recommend downloading and saving a .wset file from the service unit to upload into the replacement servo later.
   a. To save the settings, connect the unit to the PC and open the service tool.
   b. Click ‘Settings’ and follow the comments shown on the screen to save the file.
2. Make sure that all power has been removed and locked out.
3. Make sure that all hydraulic pressure has been removed.
   Disconnect all hydraulic fittings/plumbing from servo.

IMPORTANT

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 reason, spilled hydraulic oil should be dried by absorbing mats or other environmentally friendly methods.

4. After loosening the setscrew with the 1.5 mm hex key, remove the Electronics Driver Module cover.
5. Disconnect customer interface cables connections from the PCB.
6. Disconnect all customer interface fittings containing electrical cables.

7. Carefully remove all customer cables and cables fittings from the electronics housing.
8. Remove the metal cover with wiring labels by unscrewing seven pan head Philips screws.

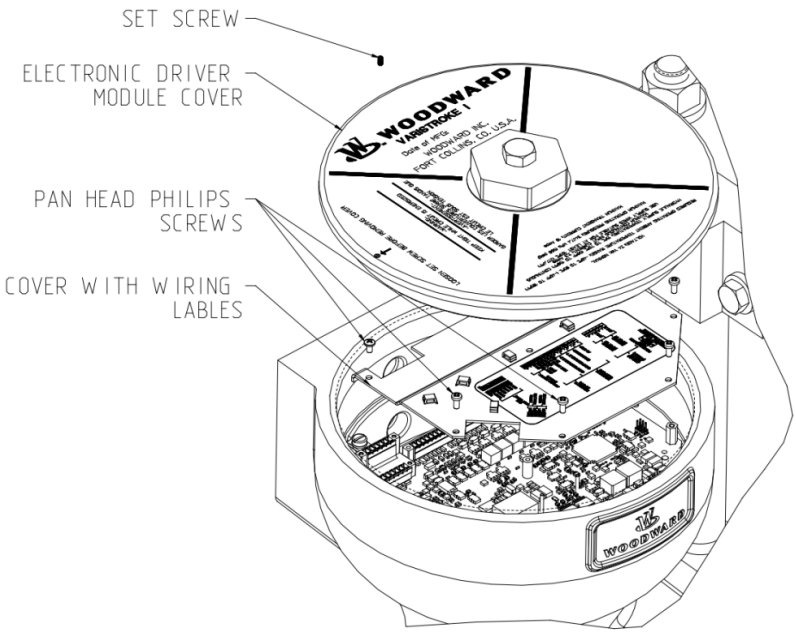


Figure 2-3. Cover with Screw Locations

9. Disconnect the position sensor cables.
10. Unscrew the cable gland nut using tool: 1013-6844. Remove the bushing from the Position Sensor cable. Unscrew and remove the gland body using tool: 1013-6924.

NOTICE

The cable gland was added to the new 6300-1353-R and 6300-1353-E servo part numbers. There is no cable gland in older units released before September 2014. However, the old-design servo can be replaced by a servo with cable gland (in that case skip step 10).

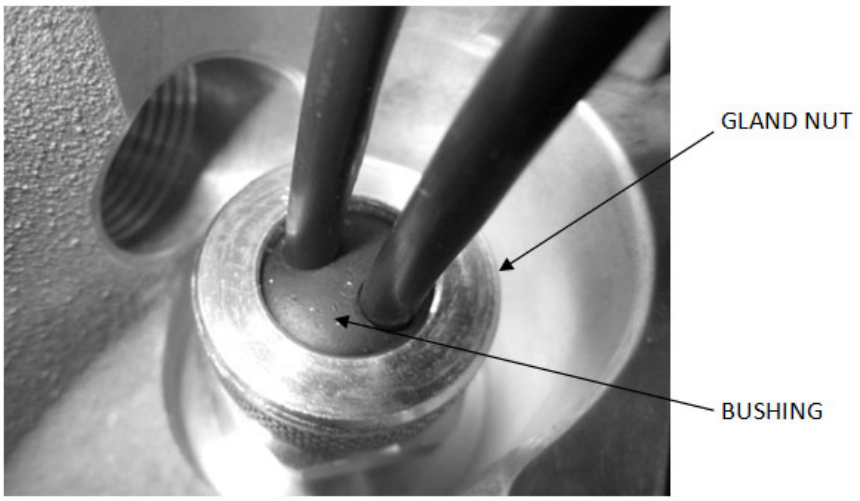


Figure 2-4. Gland Nut and Bushing Identification

11. Re-install the metal cover with wiring labels by screwing seven screws to protect the PCB from damage.
12. Place the position sensor wires in such a way as to be easily fit through the cable passage when the servo is removed from the cylinder.
13. Install the Electronics Driver Module cover back onto the top of the servo valve. Tighten the cover using a 2-¼" wrench.
14. Remove the 0.500-13 hex head cap screw from the top of the Electronics Driver Module using a ¾" socket/wrench.
15. Install the lifting lug into the 0.500-13 thread on the Electronics Driver Module cover (a forged lifting lug is recommended).
16. Remove 6 0.500-13 UNC hex head cap screws. These bolts are located on the bridge manifold.

NOTICE

Remember to support the servo during disassembly.

Make sure that the crane, cables, straps, and all other lifting equipment, and the lifting lug you are using for servo-valve transportation, are able to support the servo-valve weight.

IMPORTANT

Whenever possible, put a rubber mat (about 6 mm / 1/4" thick) under the servo in order to support it.
(For 5 inch bore actuator (Top Level 9907-1468 ONLY) use 4.5 mm/ 0.175" thick)

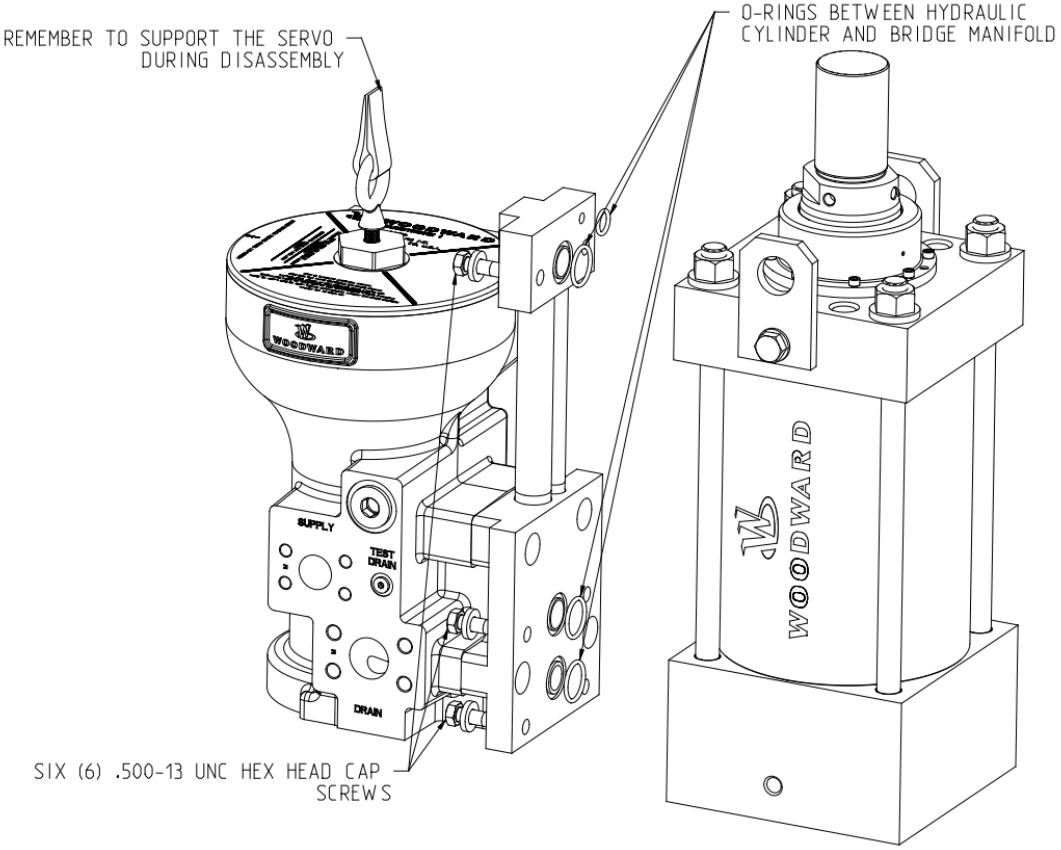


Figure 2-5. Hex Head Cap Screw and O-Ring Locations

17. Carefully disconnect the servo valve and bridge manifold from the hydraulic power cylinder. Take special care to protect the position sensor wires from damage.
18. Remove all O-rings present between the hydraulic power cylinder and the bridge manifold.

19. Remove 4x 0.500-13 UNC hex head cap screws. These bolts attach the bridge manifold to the servo valve.
20. Remove all O-rings present between the bridge manifold and servo valve.
21. Prepare the new hydraulic servo valve unit.
22. Remove all plastic protecting plugs received with the shipment.
23. After loosening the setscrew, remove the Electronics Driver Module cover.
24. Remove the metal cover with wiring labels by unscrewing seven pan head Philips screws.
25. Unscrew the body of the gland and nut. (These are hand tightened, but you may need to use tools 1013-6844 and 1013-6924 to unscrew them.)
26. Install the Electronics Driver Module cover back onto the top of the servo valve. Tighten the cover using a 2 ¼" wrench.

IMPORTANT

Before starting the reassembly process, make sure that all surfaces and grooves for seals are clean and without any contamination.

Using a wire brush and isopropanol (or equivalent fluid), hand-clean any old Loctite remaining on the screws and threads.

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

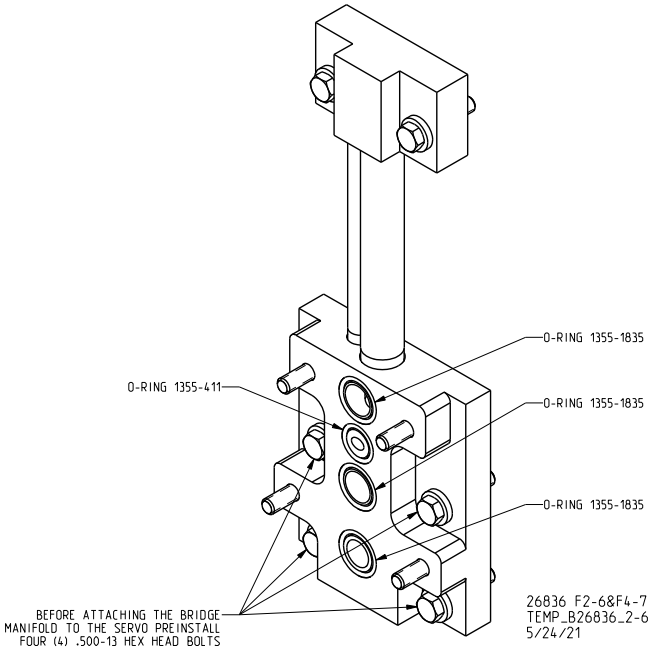


Figure 2-6. Bridge Manifold O-Ring Locations (Servo Side)

28. Attach the bridge manifold to the servo using 4x 0.500-13 UNC hex head cap screws. Torque them to (61 to 75) N·m / (45 to 55) lb-ft.
29. Lubricate with petroleum jelly and place new O-rings on the bridge manifold from the hydraulic power cylinder side.

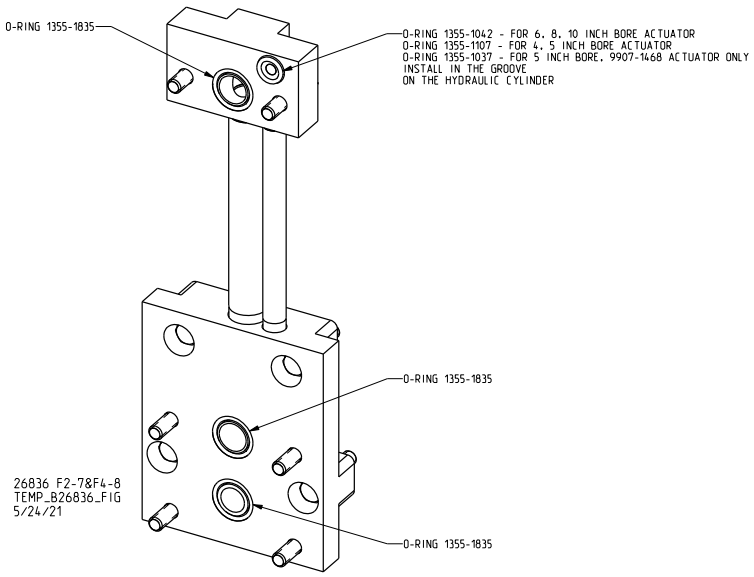


Figure 2-7. Bridge Manifold O-Ring Locations (Cylinder Side)

30. Carefully route the position sensor wires through the servo valve passage up to the electronics housing.
31. Install 6x 0.500-13 UNC hex head cap screws after applying thread locking compound Loctite 242 or equivalent. Torque them to (61 to 75) N·m / (45 to 55) lb-ft.
32. Remove the lifting lug used for servo valve transportation.
33. Re-install the 0.500-13 hex head cap screw on the top of the Electronics Driver Module using a ¾" socket.
34. Remove the Electronics Driver Module cover.
35. Install the body of the gland in to housing. Apply MOLYKOTE G-N paste. Torque to (92 to 111) N·m / (68 to 82) lb-ft (tool: 1013-6924).

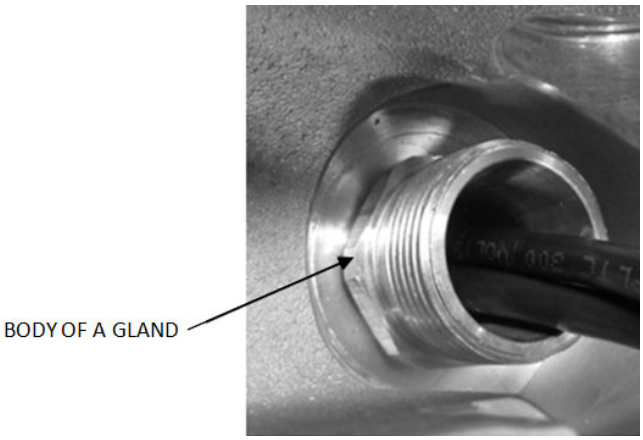


Figure 2-8. Body of a Gland Example

36. Install the bushing on the position sensor wiring and cable gland nut. Torque to (31 to 37) N·m / (23 to 27) lb-ft (tool: 1013-6844).

37. Connect the position sensor cables according to the scheme below:

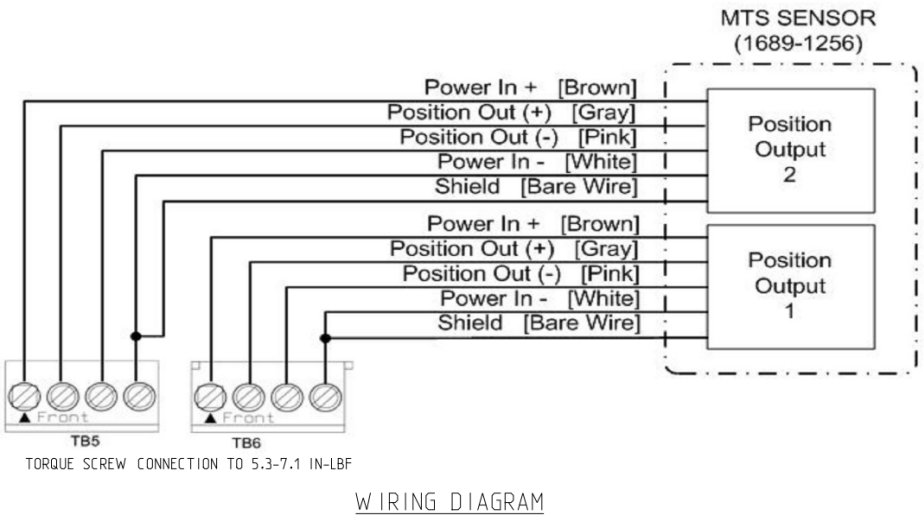


Figure 2-9. Sensor Cable Wiring Diagram

38. Install the metal cover with wiring labels. Torque seven screws to (1.2 to 1.5) N·m / (11 to 13) lb-in.

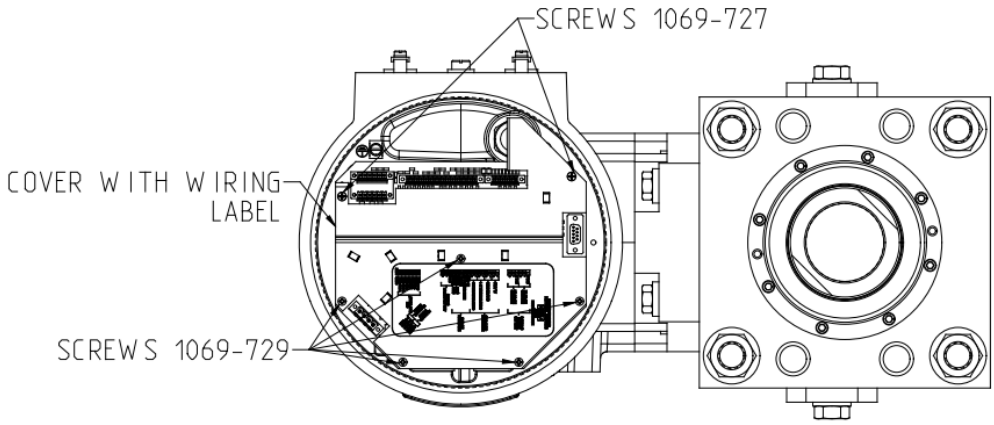


Figure 2-10. Metal Cover and Screw Locations

39. Re-install all electrical wires through their appropriate housing openings. Ensure that power and signal wires use separate conduit entrances.
40. Connect all fittings containing electrical cables. Tighten them to the torques as follows:
    - 0.750-14 NPT Threads: (17 to 28) N·m / (150 to 250) lb-in, lubricate thread
    - 0.500-14 NPT Threads: (7 to 9) N·m / (60 to 80) lb-in, lubricate thread
    - Ground: 5.1 N·m / 45 lb-in

41. Connect all cables connections to the PCB per electrical schematic (see Woodward manual 26727). We recommend using wire ties to attach wires to the cover.

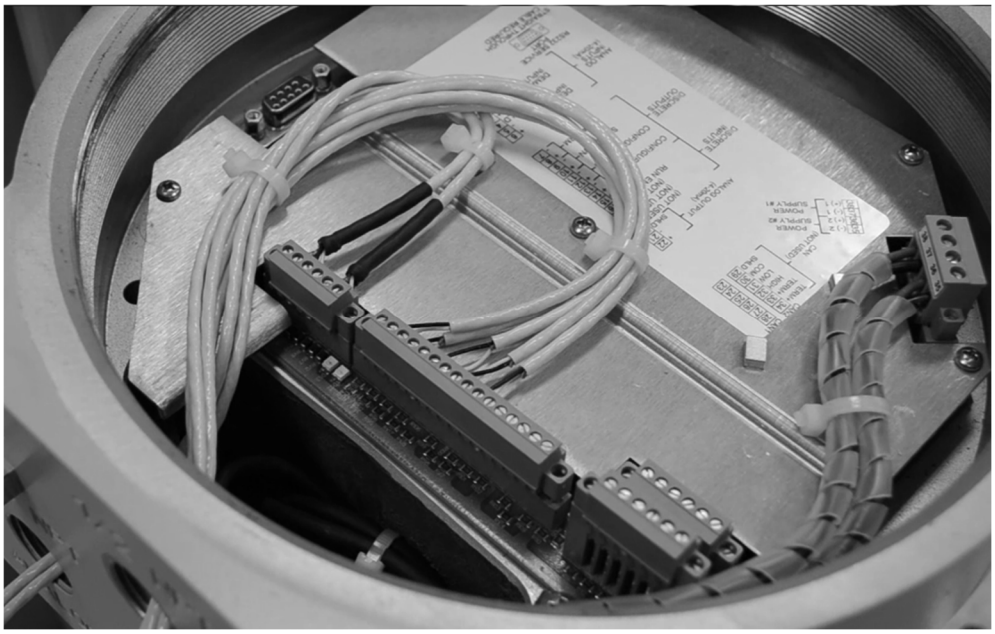


Figure 2-11. Cables Connected to PCB

42. Connect the Hydraulic Supply and Hydraulic Drain. Tighten them to the torques as follows:
    - Hydraulic Supply:
      4x M10x1.5 Screws Torque to (34 to 48) N·m / (25 to 35) lb-ft
    - Hydraulic Drain:
      4x M12x1.75 Screws Torque to (48 to 61) N·m / (35 to 45) lb-ft

NOTICE **Make sure that there is no contamination anywhere on the hydraulic connections provided by customer.**

43. Power the unit up and plug in the PC service tool.
44. If you have a .wset file saved from previous unit, upload it to the new one. If not, you will need to recalibrate and reconfigure your VariStroke (see Woodward manual 26727). During this process, remember to input the values for the Cylinder Length, Cylinder Diameter, and Sensor Length.
    a. After opening the service tool, navigate to the Remote Cylinder Setup.
    b. Input the proper values. For cylinders manufactured by Woodward, enter Sensor Length values based on the table below.

Table 2-8. Woodward Cylinder Sensor Length Specifications

Actuator Stroke	Transducer Length
4 inch	105 mm / 4.1338 inch
6 inch	160 mm / 6.2992 inch
8 inch	210 mm / 8.2677 inch
10 inch	260 mm / 10.2362 inch
12 inch	310 mm / 12.2047 inch

45. Install the Electronics Driver Module 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.
46. The replacement process is complete.

Chapter 3.
Servo Valve Replacement Kit—Remote Version

Required Tools

Standard Tools and Other Materials

- Hex key; hex size 1.5 mm ( )
- Socket size 2 ¼" [58 mm] ( )
- Screwdriver or Phillips bits, Tip number 2 ( )
- Screwdriver with small slotted tip ( )
- Adjustable wrench
- Hex key; hex size 8 mm ( )
- Hex key; hex size 10 mm ( )
- Loctite 242 or equivalent
- Torque wrench (range of used torques 0.6 to 150 N·m / 5.5 to 1320 lb-in)
- Wire ties
- Absorbing mats
- Lubricant (petroleum based hydraulic oil or SAE 10 engine lube oil)

IMPORTANT **The tools listed above are needed for servo replacement. For customer interface, additional tools may be needed.**

Table 3-1. Torque Values

Drive Module Cover	120–150 N·m	90–110 lb-ft
Set Screw	0.6–0.7 N·m	5.5–6.2 lb-in
0.500-13 UNC Hex Head Screws	61–75 N·m	45–55 lb-ft
Pan Head Philips Screws	1.2–1.5 N·m	11–13 lb-in
0.750-14 NPT Threads	17–28 N·m	150–250 lb-in
0.500-14 NPT Threads	7–9 N·m	60–80 lb-in
Ground	5.1 N·m	45 lb-in
M10x1.5 Screws	34–48 N·m	25–35 lb-ft
M12x1.75 Screws	48–61 N·m	35–45 lb-ft

Kit Contents

Depending on which type of fail-safe direction actuator is being replaced, there are two separate kits:

Table 3-2. Kit Contents

Woodward Kit Number	Fail-Safe Direction	Servo-Valve Size	Installation Drawing
9907-1256	Extend	V45	9999-3189
9907-1333	Retract		

Table 3-3. Kit 9907-1256 Content

Component Part Number	Quantity Each	Description
6300-1350-E	1	Actuator – (T-6300-1350), Remote Servo-Valve, Size V45, Fail Extend, VSI

Table 3-4. Kit 9907-1333 Content

Component Part Number	Quantity Each	Description
6300-1350-R	1	Actuator – (T-6300-1350), Remote Servo-Valve, Size V45, Fail Retract, VSI

Basic Mechanical Components and Installation Interfaces

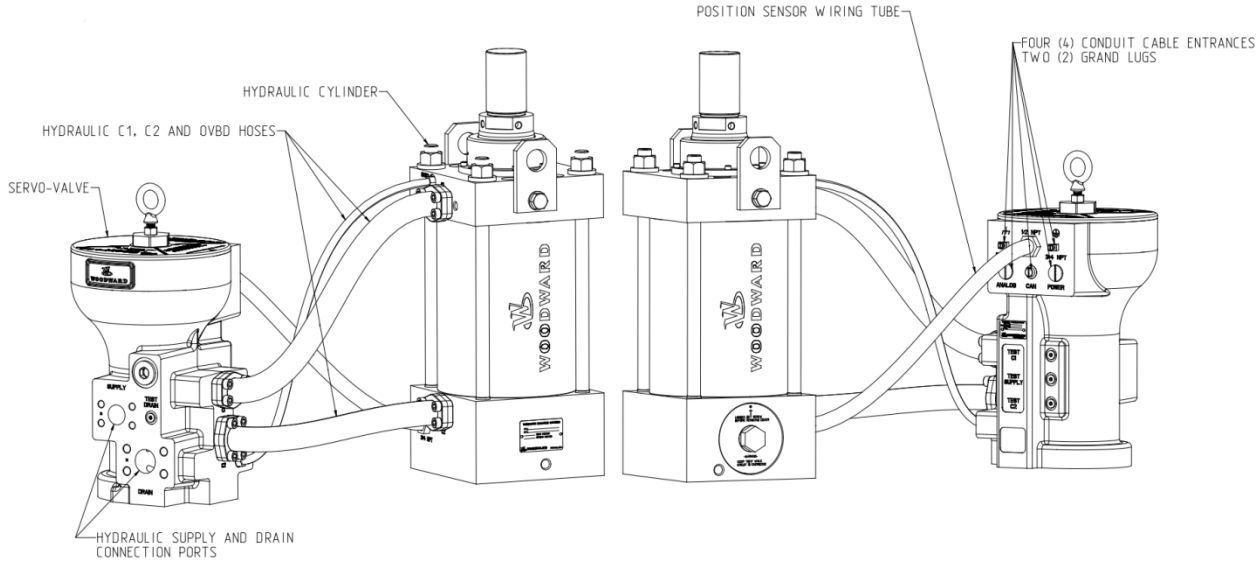


Figure 3-1. Basic Mechanical Components and Installation Interfaces

General Safety

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure and rod end force have been removed from the actuator before beginning any maintenance or repairs.

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the VariStroke-I actuator.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

⚠WARNING

Take care not to damage the electronics cover's seal, the cover surface, the threads, or the VariStroke-I housing mating surface while removing or replacing the cover. Be sure to loosen the small setscrew in the electronics cover before removing cover.

⚠WARNING

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 on 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*.

⚠WARNING

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.

Procedure

NOTICE

Prior to beginning any replacement work, check if the purchased servo kit is the correct kit for your VariStroke-I actuator.

Verify that the replacement kit provided by Woodward has all listed components (see "Kit Contents" section above).

1. Recommend downloading and saving a .wset file from the service unit and uploaded into the replacement servo later.
   a. To save the settings, connect the unit to the PC and open the service tool.
   b. Click ‘Settings’ and follow the comments shown on the screen to save the file.
2. Make sure that all power has been removed and locked out.
3. Make sure that all hydraulic pressure has been removed.
   Disconnect Hydraulic Supply, Drain, C1, C2, and OVBD.

IMPORTANT

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may spill during disconnection of hydraulic fittings. For safety reason, dry spilled hydraulic oil by using absorbing mats or other environmentally friendly methods.

4. After loosening the setscrew with the 1.5 mm hex key, remove the Electronics Driver Module cover.
5. Disconnect customer interface cables connections from the PCB.
6. Disconnect all customer interface fittings containing electrical cables.

7. Carefully remove all customer cables and cables fittings from the electronics housing.
8. Remove the metal cover with wiring labels by unscrewing seven pan head Philips screws.

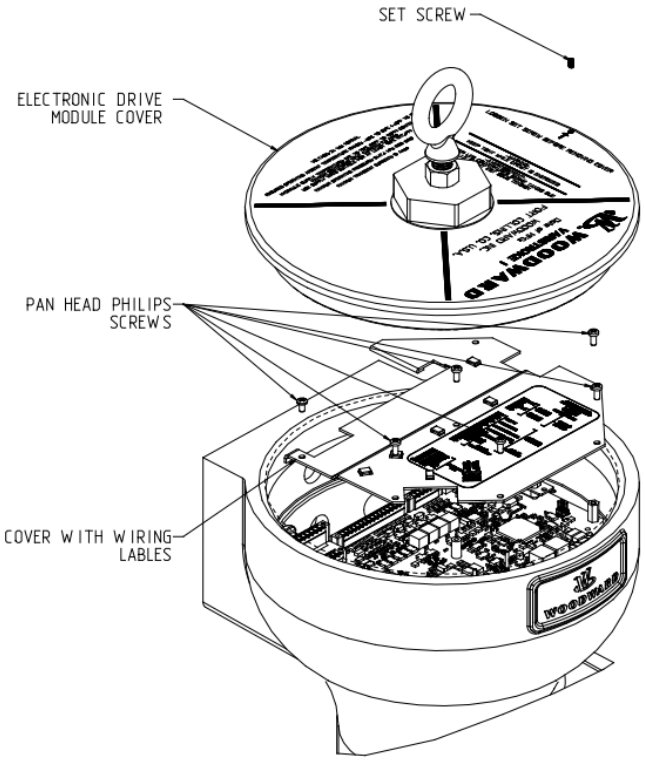


Figure 3-2. Cover with Screw Locations

9. Disconnect the position sensor cables.
10. Re-install the metal cover with wiring labels by screwing seven screws to protect the PCB from damage.
11. Re-install the Electronics Driver Module cover onto the top of the servo valve. Tighten the cover using a 2 ¼" wrench.
12. Install a lifting lug into the 0.500-13 thread on the Electronics Driver Module cover (a forged lifting lug is recommended).
13. Remove the three M16X2 mounting screws from the bottom of the servo.

NOTICE

Remember to support the servo during disassembly.

Make sure that the crane, cables, straps, and all other lifting equipment, and the lifting lug you are using for servo-valve transportation, are able to support the servo-valve weight.

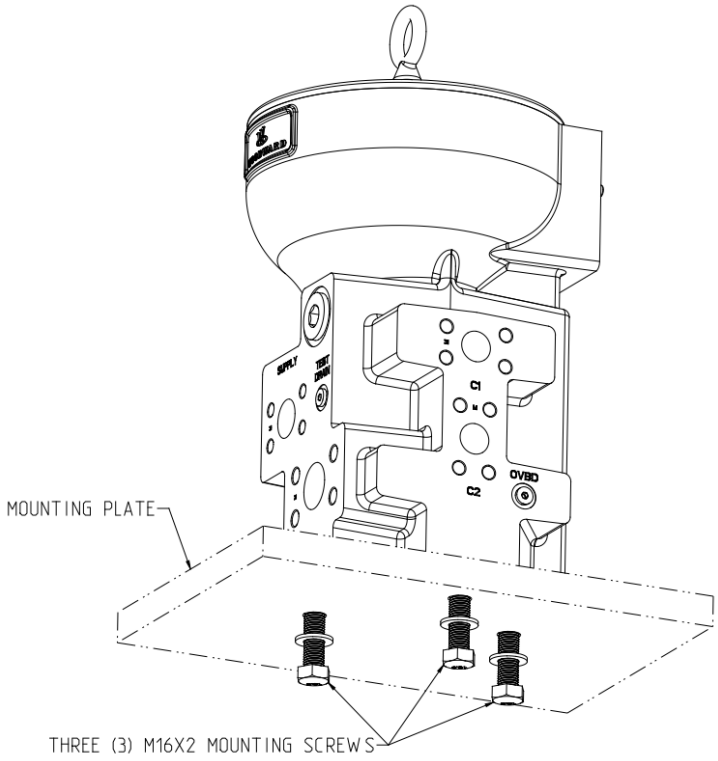


Figure 3-3. Mounting Plate Mounting Screws Locations

14. Prepare the new hydraulic servo-valve unit.
15. Install the servo-valve using three M16X2 mounting screws.
16. Remove the lifting lug used for servo-valve transportation and all plastic protecting plugs received with the shipment.
17. After loosening the setscrew, remove the Electronics Driver Module cover.
18. Remove the metal cover with wiring labels by unscrewing seven pan head Philips screws.
19. Fit the position sensor cables through the ½ NPT channel.
20. Connect the position sensor cables according to the scheme below:

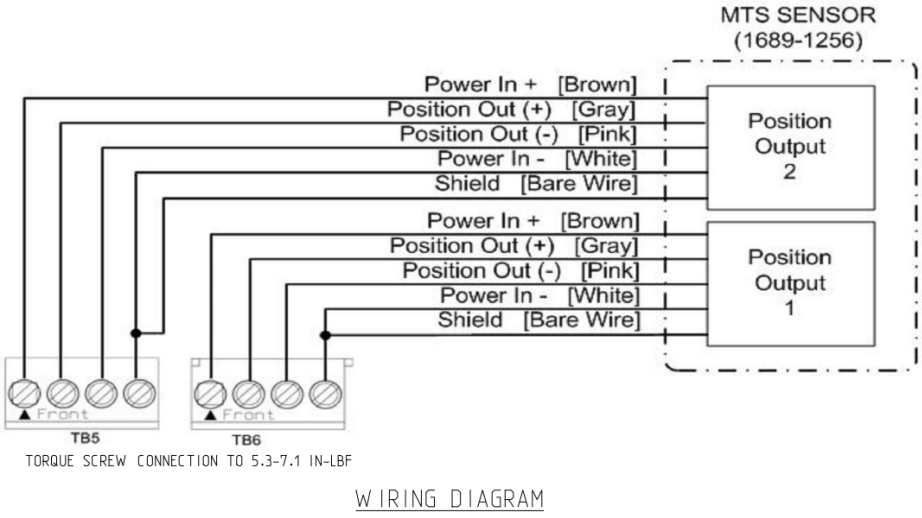


Figure 3-4. Position Sensor Cable Wiring Diagram

21. Install the metal cover with wiring labels. Torque seven screws to (1.2 to 1.5) N·m / (11 to 13) lb-in.

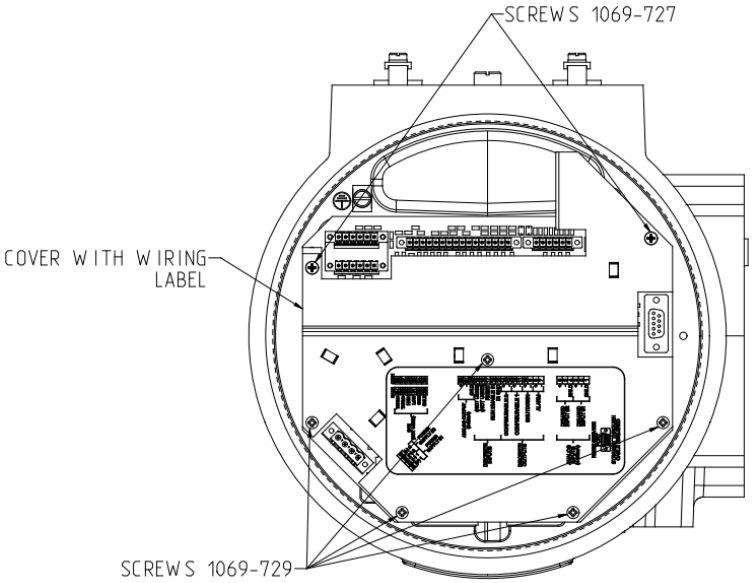


Figure 3-5. Metal Cover and Screw Locations

22. Re-install all electrical wires through their appropriate housing openings. Ensure that power and signal wires use separate conduit entrances.
23. Connect all fittings containing electrical cables. Tighten them to the torques as follows:
    - 0.750-14 NPT Threads: (17 to 28) N·m / (150 to 250) lb-in, lubricate thread
    - 0.500-14 NPT Threads: (7 to 9) N·m / (60 to 80) lb-in, lubricate thread
    - Ground: 5.1 N·m / 45 lb-in
24. Connect all cables connections to the PCB per electrical schematic (see Woodward manual 26727). We recommend using wire ties to attach wires to the cover.

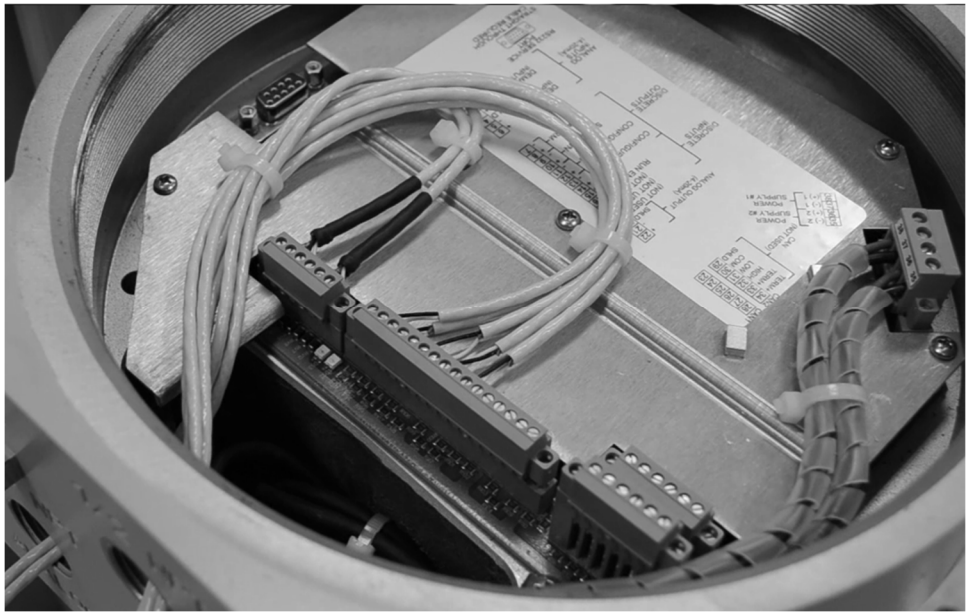


Figure 3-6. Cables Connected to PCB

25. Connect the Hydraulic Supply and Hydraulic Drain. Tighten them to the torques as follows:
- Hydraulic Supply:
  4x M10x1.5 Screws Torque to (34 to 48) N·m / (25 to 35) lb-ft
- Hydraulic Drain:
  4x M12x1.75 Screws Torque to (48 to 61) N·m / (35 to 45) lb-ft

NOTICE **Make sure that there is no contamination anywhere on the customer provided hydraulic connections.**

26. Power the unit up and plug in the PC service tool.
27. If you have a .wset file saved from previous unit, upload it to the new one. If not, you will need to recalibrate and reconfigure your VariStroke (see Woodward manual 26727). During this process, remember to input the values for the Cylinder Length, Cylinder Diameter, and Sensor Length.
    a. After opening the service tool, navigate to the Remote Cylinder Setup.
    b. Input the proper values. For cylinders manufactured by Woodward, Sensor Length values should be entered based on the table below.

Table 3-5. Woodward Cylinder Sensor Length Specifications

Actuator Stroke	Transducer Length
4 inch	105 mm / 4.1338 inch
6 inch	160 mm / 6.2992 inch
8 inch	210 mm / 8.2677 inch
10 inch	260 mm / 10.2362 inch
12 inch	310 mm / 12.2047 inch

28. Install the Electronics Driver Module 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.
29. This completes the replacement procedure.

Chapter 4.
Manifold Seals Replacement Kit

Required Tools

Special Tools

- Socket - 6-point deep, 1-1/8" size, 3-1/4" overall length; part number: 1013-6844 (Part of Tool Kit 8923-2508)
- Socket - 6-point deep, 1" size, 3-1/4" overall length; part number: 1013-6924 (Part of Tool Kit 8923-2508)

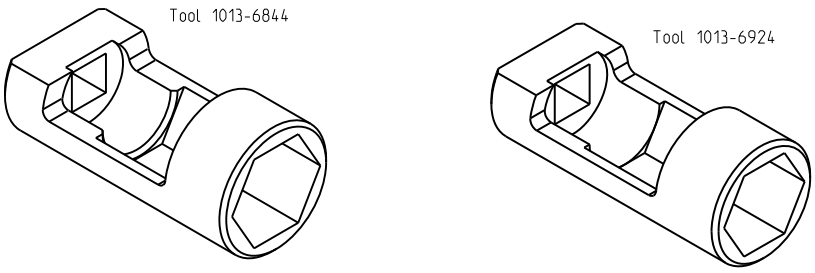


Figure 4-1. Tool 1013-6844 and Tool 1013-6924

Standard Tools and Other Materials

- Standard tools and other materials
- Hex key; hex size 1.5 mm ( )
- Socket size 2 ¼" [58 mm] ( )
- Screwdriver or Phillips bits, tip number 2 ( )
- Screwdriver with small slotted tip ( )
- Open end torque wrench and socket size ¾" (19 mm) ( )
- Adjustable wrench
- Hex key; hex size 8 mm ( )
- Hex key; hex size 10 mm ( )
- Loctite 242 or equivalent
- Torque wrench (range of used torques 0.6 to 150 N·m / 5.5 to 1320 lb-in)
- Molykote G-N Paste (Woodward P/N 0901823) or equivalent
- Wire ties
- Absorbing mats
- Lubricant (petroleum based hydraulic oil or SAE 10 Engine Lube Oil)
- Hand wire brushes
- Isopropanol or equivalent
- Manual 26727

IMPORTANT **The tools listed above are needed for servo replacement. For customer interface, additional tools may be needed.**

Table 4-1. Torque Values

Drive Module Cover	120–150 N·m	90–110 lb-ft
Set Screw	0.6–0.7 N·m	5.5–6.2 lb-in
0.500-13 UNC Hex Head Screws	61–75 N·m	45–55 lb-ft
Body of a Cable Gland	92–111 N·m	68–82 lb-ft
Cable Gland Nut	31–37 N·m	23–27 lb-ft
Pan Head Philips Screws	1.2–1.5 N·m	11–13 lb-in
0.750-14 NPT Threads	17–28 N·m	150–250 lb-in
0.500-14 NPT Threads	7–9 N·m	60–80 lb-in
Ground	5.1 N·m	45 lb-in
M10x1.5 Screws	34–48 N·m	25–35 lb-ft
M12x1.75 Screws	48–61 N·m	35–45 lb-ft

Table 4-2. Kit Contents

Woodward Kit Number	Kit Assembly Drawing	Size of Actuator
8923-2068	9999-1590-3	6, 8, 10 inch
8923-2165	9999-1590-4	4, 5 inch
8923-2243	9999-1590-6	5 inch (9907-1468 ONLY)

Table 4-3. Kit 8923-2068 Content

Component Part Number	Quantity Each	Description
1355-111	2	O-ring
1355-127	2	O-ring
1355-411	1	O-ring
1355-1835	6	O-ring
1355-1042	1	O-ring

Table 4-4. Kit 8923-2165 Content

Component Part Number	Quantity Each	Description
1355-111	2	O-ring
1355-127	2	O-ring
1355-411	1	O-ring
1355-1835	6	O-ring
1355-1107	1	O-ring

Table 4-5. Kit 8923-2243 Content

Component Part Number	Quantity Each	Description
1355-111	2	O-ring
1355-127	2	O-ring
1355-411	1	O-ring
1355-1835	6	O-ring
1355-1037	1	O-ring

Basic Mechanical Components and Installation Interfaces

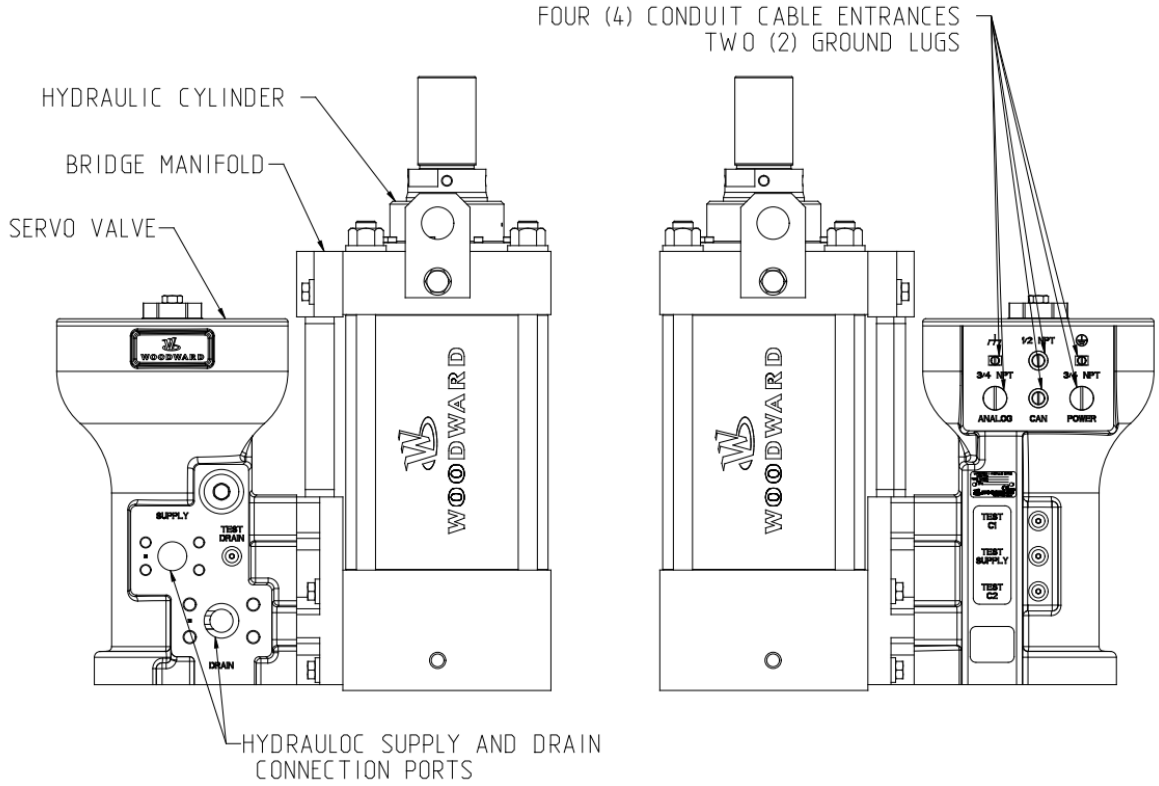


Figure 4-2. Basic Mechanical Components and Installation Interfaces

General Safety

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure and rod end force have been removed from the actuator before beginning any maintenance or repairs.

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the VariStroke-I actuator.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

⚠WARNING

Take care not to damage the electronics cover's seal, the cover surface, the threads, or the VariStroke-I housing mating surface while removing or replacing the cover. Be sure to loosen the small setscrew in the electronics cover before removing cover.

⚠WARNING

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 on 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*.

⚠WARNING

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.

Procedure

NOTICE

Before beginning any replacement work, check if the purchased servo kit is the correct kit for your VariStroke-I actuator.

Verify that the replacement kit provided by Woodward has all listed components (see "Kit Contents" section above).

1. Make sure that all power has been removed and locked out.
2. Make sure that all hydraulic pressure has been removed.
   Disconnect all hydraulic fittings/plumbing from servo.

IMPORTANT

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may spill during disconnection of hydraulic fittings. For safety reason, dry spilled hydraulic oil by using absorbing mats or other environmentally friendly methods.

3. After loosening the setscrew with the 1.5 mm hex key, remove the Electronics Driver Module cover.
4. Disconnect customer interface cables connections from the PCB.
5. Disconnect all customer interface fittings hosting electrical cables.
6. Carefully remove all customer cables and cables fittings from the electronics housing.
7. Remove the metal cover with Wiring Labels by unscrewing seven pan head Philips screws.

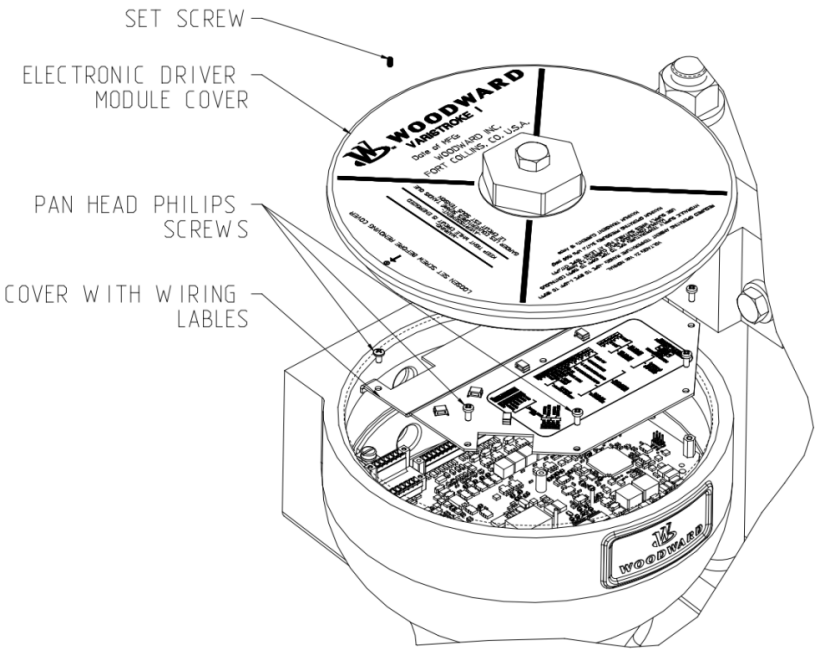


Figure 4-3. Parts Identification and Location

8. Disconnect the position sensor cables.
9. Using tool: 1013-6844, unscrew the cable gland nut. Remove the bushing from the Position Sensor cable. Using tool: 1013-6924, unscrew and remove the gland body.

NOTICE

The cable gland was added to the new 6300-1353-R and 6300-1353-E servo part numbers. There is no cable gland in older units released before September 2014. However, the old-design servo can be replaced by a servo with cable gland (in that case skip step 10).

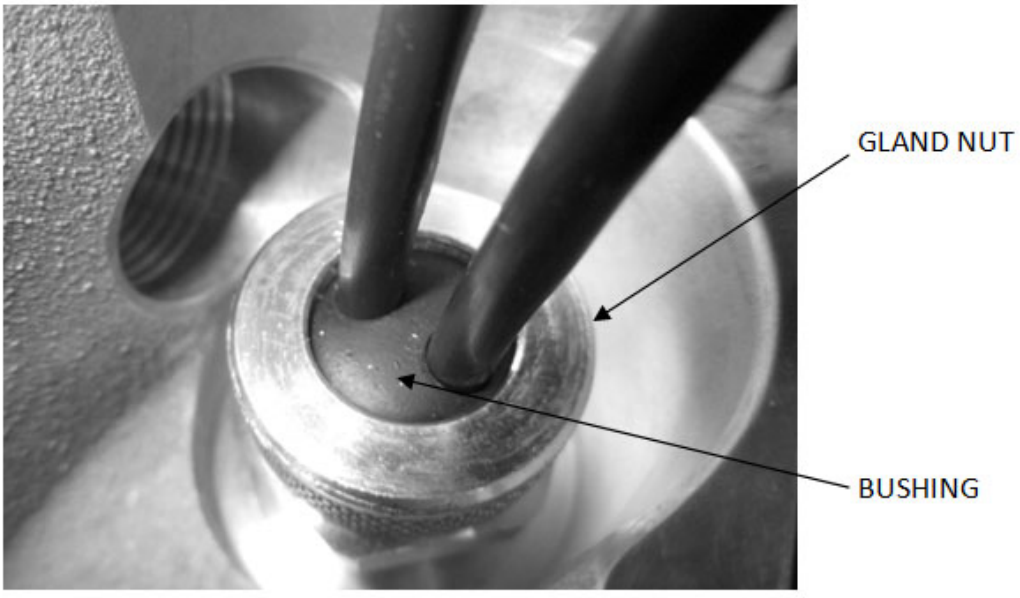


Figure 4-4. Gland Nut and Bushing Identification

10. Re-install the metal cover with wiring labels by screwing seven screws to protect the PCB from damage.
11. Place the position sensor wires in such a way as to be easily fit through the cable passage when the servo is removed from the cylinder.
12. Install the Electronics Driver Module cover back onto the top of the servo valve. Tighten the cover using a 2-¼" wrench.
13. Remove the 0.500-13 hex head cap screw from the top of the Electronics Driver Module using a ¾" socket.
14. Install the lifting lug into the 0.500-13 thread on the Electronics Driver Module cover (a forged lifting lug is recommended).
15. Remove 6 0.500-13 UNC hex head cap screws. These bolts are located on the bridge manifold.

NOTICE

Remember to support the servo during disassembly.

Make sure that the crane, cables, straps, and all other lifting equipment, and the lifting lug you are using for servo-valve transportation, are able to support the servo-valve weight.

IMPORTANT

Whenever possible, put a rubber mat (about 6 mm / 1/4" thick) under the servo in order to support it.

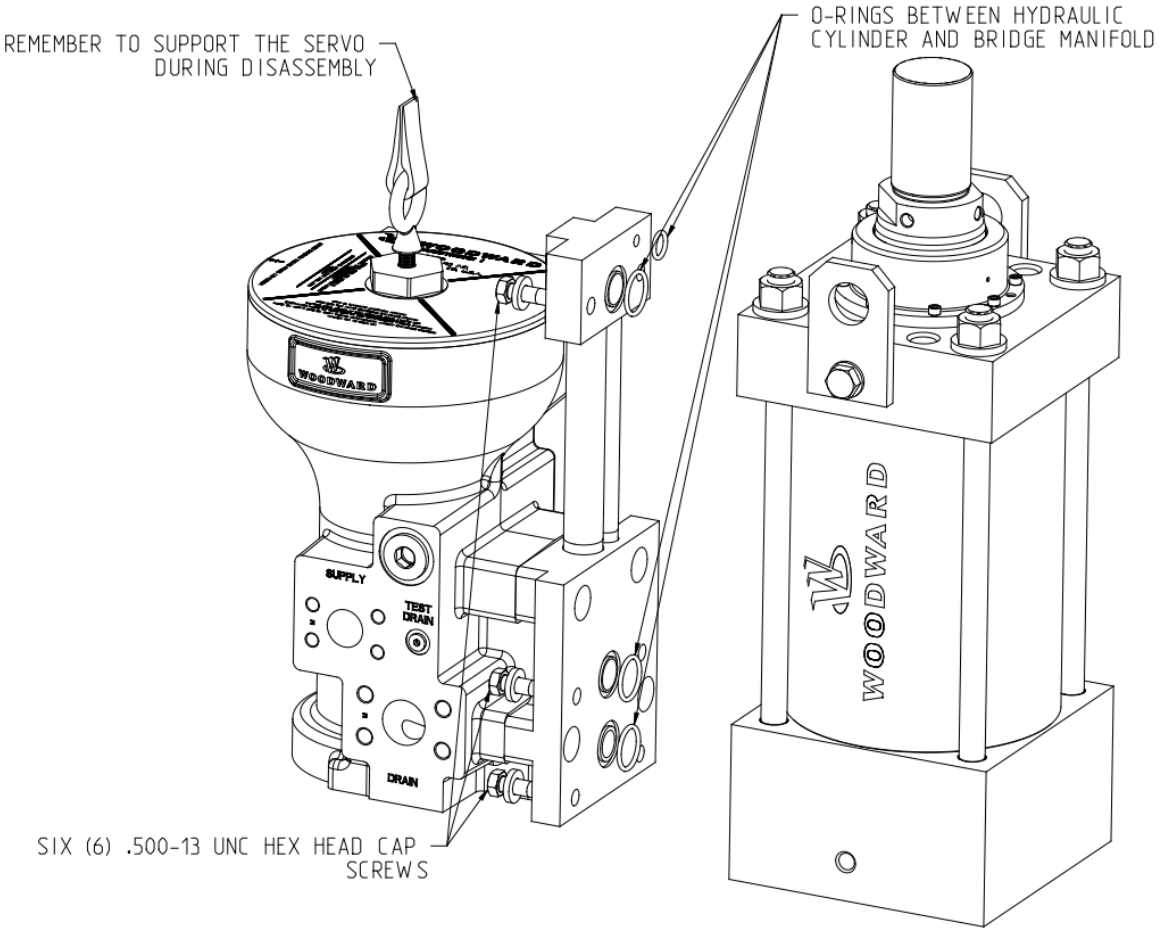


Figure 4-5. Hex Head Cap Screw and O-Ring Locations

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

17. Remove all O-rings present between the hydraulic power cylinder and the bridge manifold.
18. Remove 4x 0.500-13 UNC hex head cap screws. These bolts attach the bridge manifold to the servo valve.
19. Remove all O-rings present between the bridge manifold and servo valve.
20. Take off the upper manifold.
21. Remove the quill tube from the lower manifold and remove all O-rings placed on the tubes.
22. Prepare new O-rings provided in the kit.

IMPORTANT

Before starting the reassembly process, make sure that all surfaces and grooves for seals are clean and without any contamination.

Using a wire brush and isopropanol (or equivalent fluid), hand-clean any old Loctite remaining on the screws and threads.

23. Lubricate new O-rings with petroleum jelly, place them on the tubes, and reassemble them together with the lower and upper manifolds.

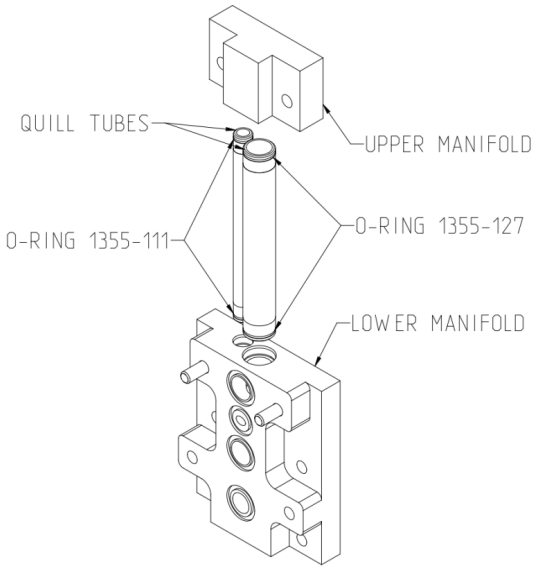


Figure 4-6. O-Ring and Quill Tube Location

24. Lubricate new O-rings with petroleum jelly and place them on the bridge manifold from the servo valve side.

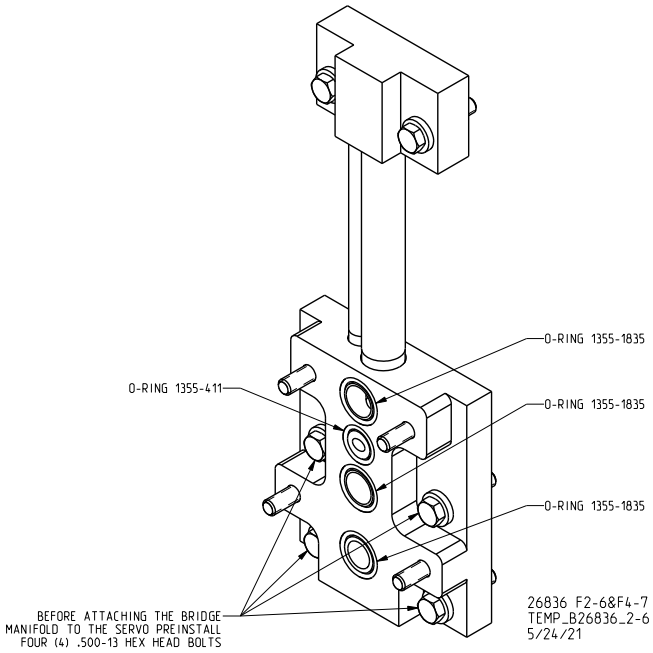


Figure 4-7. O-Ring Locations on Bridge Manifold

25. Attach the bridge manifold to the servo using 4x 0.500-13 UNC hex head cap screws. Torque them to (61 to 75) N·m / (45 to 55) lb-ft.

26. Lubricate with petroleum jelly and place new O-rings on the bridge manifold from the hydraulic power cylinder side.

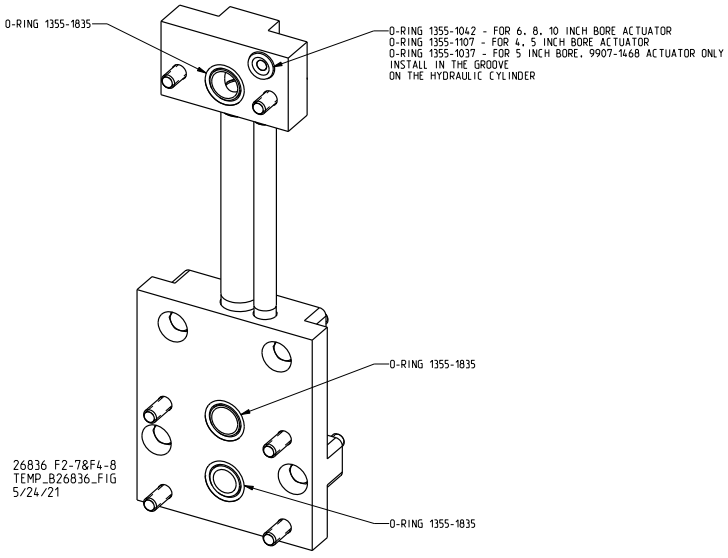


Figure 4-8. O-Ring Location on Cylinder and Manifold

27. Carefully route the position sensor wires through the servo valve passage up to the electronics housing.
28. Install 6x 0.500-13 UNC hex head cap screws after applying thread locking compound Loctite 242 or equivalent. Torque them to (61 to 75) N·m / (45 to 55) lb-ft.
29. Remove the lifting lug used for servo valve transportation.

30. Re-install the 0.500-13 hex head cap screw on the top of the Electronics Driver Module using a ¾" socket.
31. Remove the Electronics Driver Module cover.
32. Remove the metal cover with wiring labels by unscrewing seven pan head Philips screws.
33. Install the body of the gland in to housing. Apply MOLYKOTE G-N paste. Torque to (92 to 111) N·m / (68 to 82) lb-ft (tool: 1013-6924).

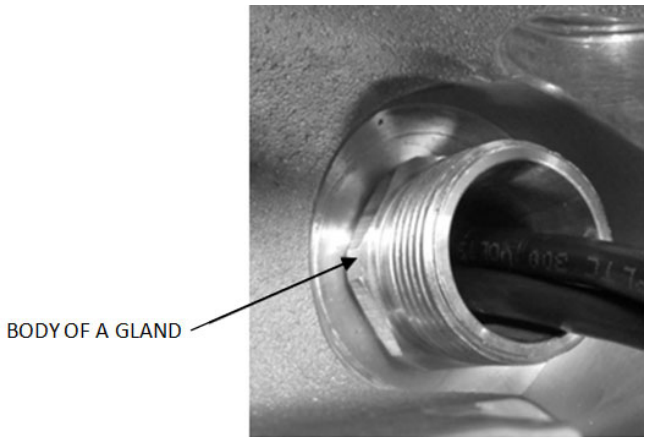


Figure 4-9. Body of Gland Example

34. Install the bushing on the position sensor wiring and cable gland nut. Torque to (31 to 37) N·m / (23 to 27) lb-ft (tool: 1013-6844).

NOTICE **The cable gland was added to the new 6300-1353-R and 6300-1353-E servo part numbers. There is no cable gland in older units released before September 2014.**

35. Connect the position sensor cables according to the scheme below:

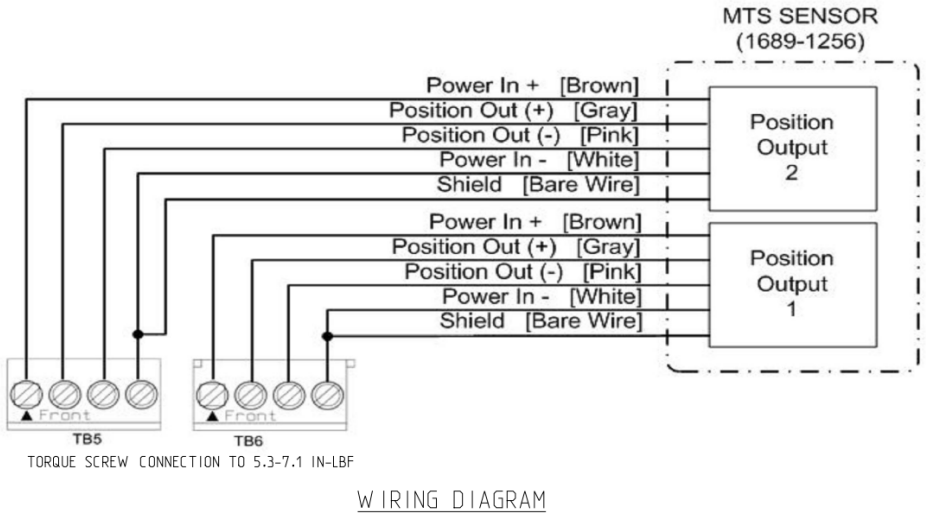


Figure 4-10. Position Sensor Cable Wiring Diagram

36. Install the metal cover with wiring label. Torque seven screws to (1.2 to 1.5) N·m / (11 to 13) lb-in.

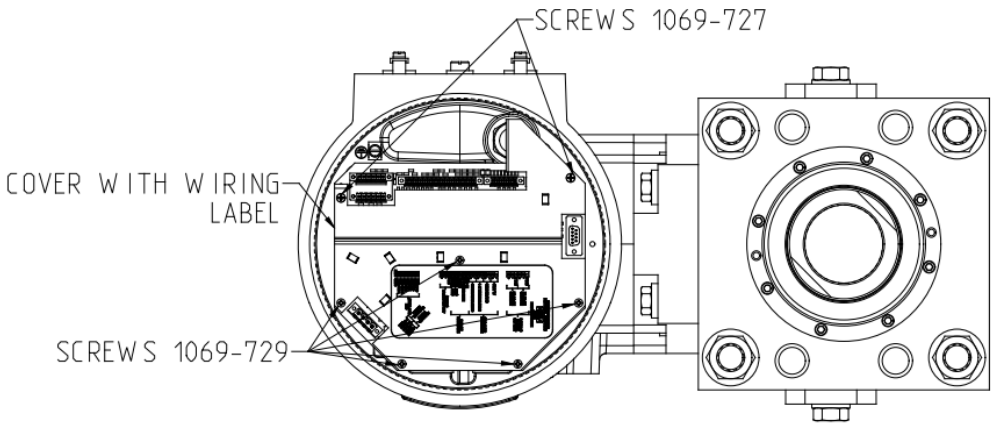


Figure 4-11. Cover and Screw Locations

37. Re-install all electrical wires through their appropriate housing openings. Ensure that power and signal wires use separate conduit entrances.
38. Connect all fittings containing electrical cables. Tighten them to the torques as follows:
    - 0.750-14 NPT Threads: (17 to 28) N·m / (150 to 250) lb-in, lubricate thread
    - 0.500-14 NPT Threads: (7 to 9) N·m / (60 to 80) lb-in, lubricate thread
    - Ground: 5.1 N·m / 45 lb-in
39. Connect all cables connections to the PCB per electrical schematic (see Woodward manual 26727). We recommend using wire ties to attach wires to the cover.

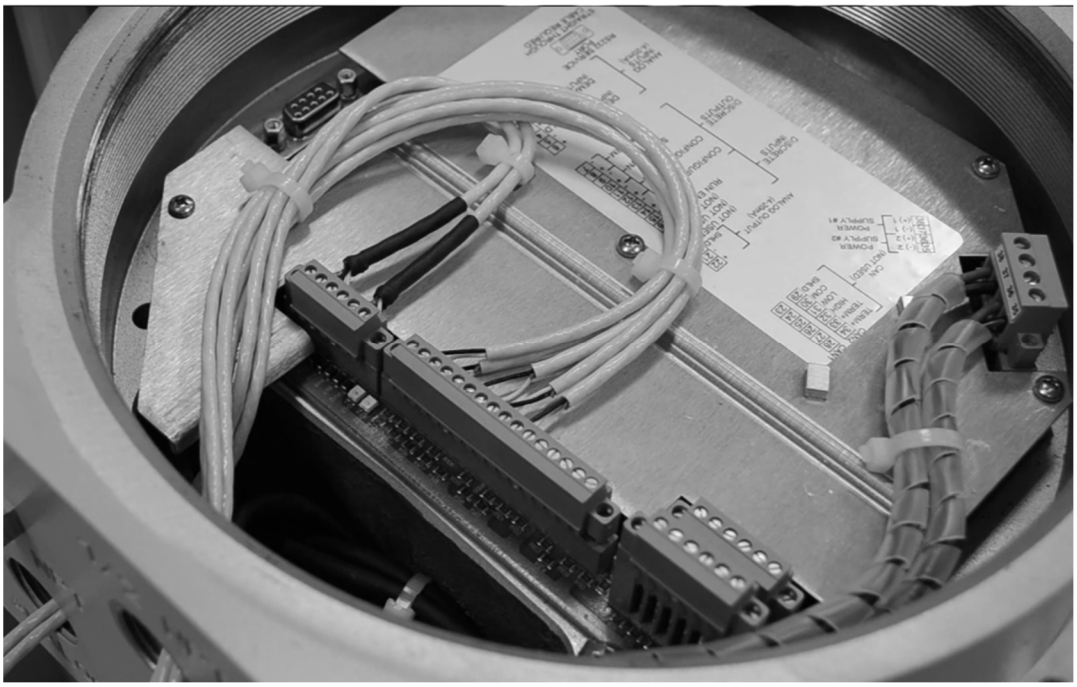


Figure 4-12. Cables Connected to PCB

40. Connect the Hydraulic Supply and Hydraulic Drain. Tighten them to the torques as follows:
    - Hydraulic Supply:
      4x M10x1.5 Screws Torque to (34 to 48) N·m / (25 to 35) lb-ft
    - Hydraulic Drain:
      4x M12x1.75 Screws Torque to (48 to 61) N·m / (35 to 45) lb-ft

NOTICE

Make sure that there is no contamination anywhere on the customer provided hydraulic connections.

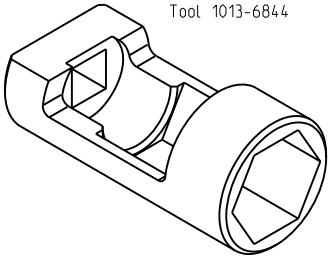
41. Install the Electronics Driver Module cover.
    - Torque the cover to (120 to 150) N·m / (90 to 110) lb-ft.
    - Torque set screw to (0.6 to 0.7) N·m / (5.5 to 6.2) lb-in.
42. Replacement procedure is complete.

Chapter 5.
Special Tools Kit

Below is a list of special tools custom made for assembly of VariStroke-I units.

Special Tools Kit number: 8923-2508 (Installation drawing: 9999-1590-5)

- Socket, 6-point deep, 1-1/8" size, 3-1/4" overall length; part number: 1013-6844
- Socket, 6-point deep, 1" size, 3-1/4" overall length; part number: 1013-6924



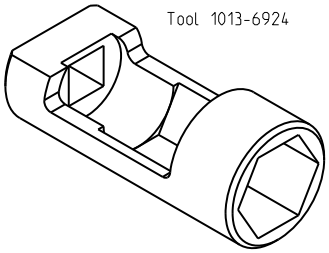


Figure 5-1. Tool 1013-6844 and Tool 1013-6924

Revision History

Changes in Revision G—

- Changed all Part Number 1355-415 references to Part Number 1355-1835 found in Tables 2-3, 2-4, 2-5, 2-6, 2-7, 4-3, 4-4, and 4-5. Also found in Figures 2-6, 2-7, 4-7, and 4-8.

Changes in Revision F—

- Edited instructions in ESD section

Changes in Revision E—

- Changed part number for special tools and tool kit
- Removed extended descriptions from part descriptions

Changes in Revision D—

- Restricted markings removed from front cover

Changes in Revision C—

- Add new version of spare parts for new 4 and 5 inch bore actuators
- Change the installation drawing numbers

Changes in Revision B—

- Update tool part numbers

Changes in Revision A—

- Update to kit content tables

Released

We appreciate your comments about the content of our publications.

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Please reference publication 26836.

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