MTS®

Product Manual

Series 252 Servovalves

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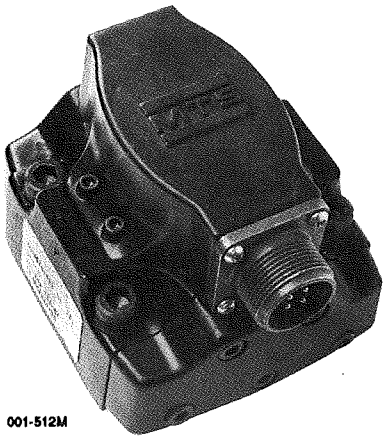
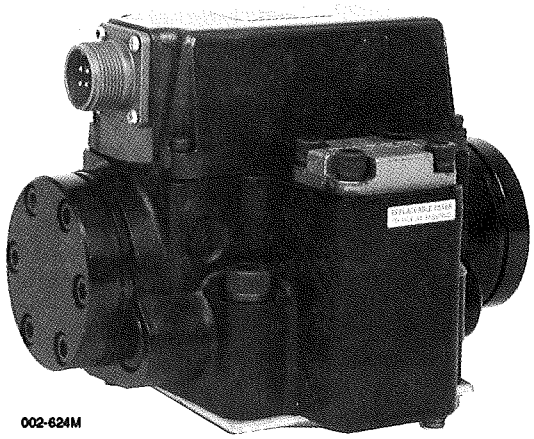
Introduction

The MTS Series 252 Servovalves regulate the rate and direction of hydraulic fluid flow to and from a hydraulic actuator. They are designed for use with actuators requiring 1 to 60 gpm (3.8 to 227 ℓ/min) of fluid flow. Figure 1-1 shows the different types of Series 252 Servovalves. Subsection 1.1 describes the function of the servovalve, and Subsection 1.2 details the differences between the models.



252.2X, 252.4X, and 252.5X



252.3X

Figure 1-1. MTS Series 252.2X, 252.4X, 252.5X, and 252.3X Servovalves

1.1 Functional Description

In a closed-loop hydraulic system, the Series 252 Servovalve uses the control signal from an electronic control device to operate a valve that regulates the movement of a hydraulic actuator (see Figure 1-2). The control signal is created by comparing the program command signal (corresponding to the desired actuator position) and the feedback signal from a transducer (corresponding to the actual actuator position). When the program command signal does not equal the feedback signal, the voltage difference between the two (called dc error) forces the mechanism of the servovalve to supply hydraulic fluid to the actuator until the desired actuator position is achieved.

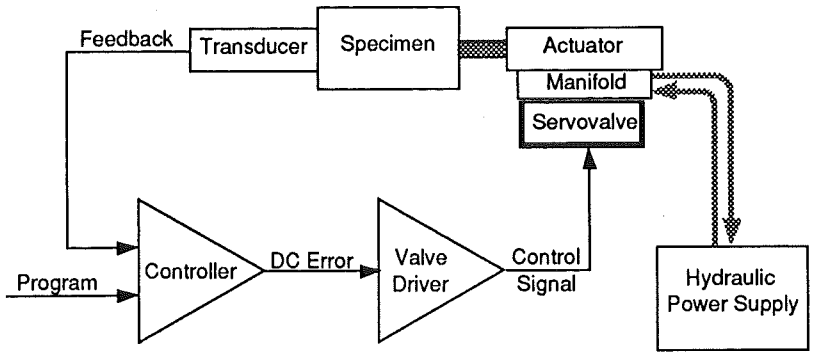


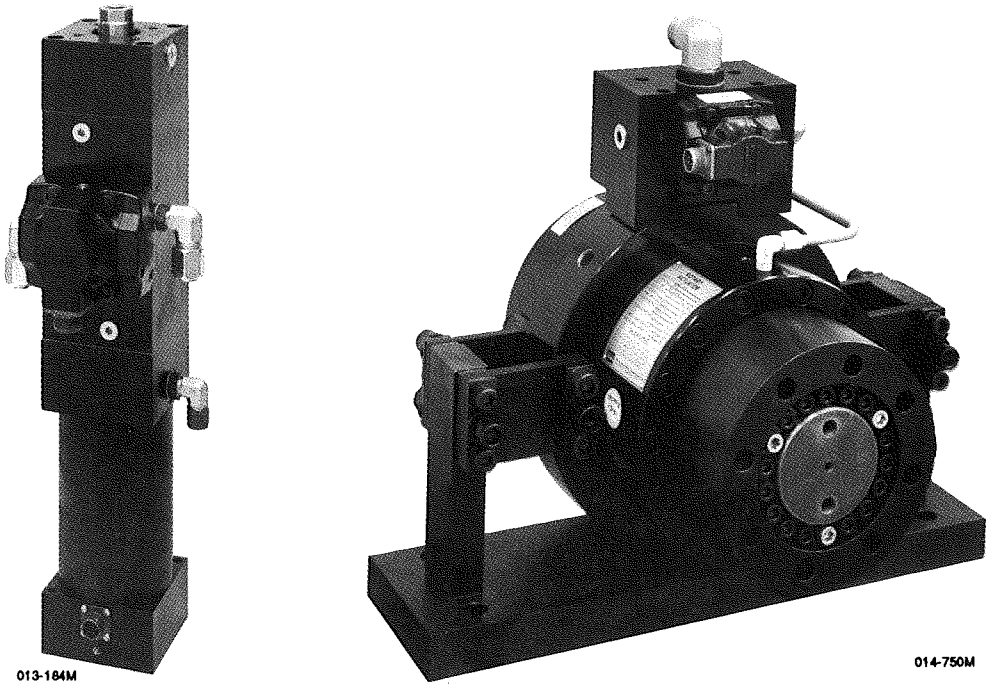
Figure 1-2. Typical Closed-Loop System

Operation

The servovalve converts the control signal to a physical movement of an internal spool, causing the controlled porting of fluid to and from the actuator. The polarity of the control signal determines the direction the spool will move, and the amplitude of the control signal determines how far the spool will move. Thus, the control signal can accurately regulate the direction and rate of fluid flow to the actuator.

Applications

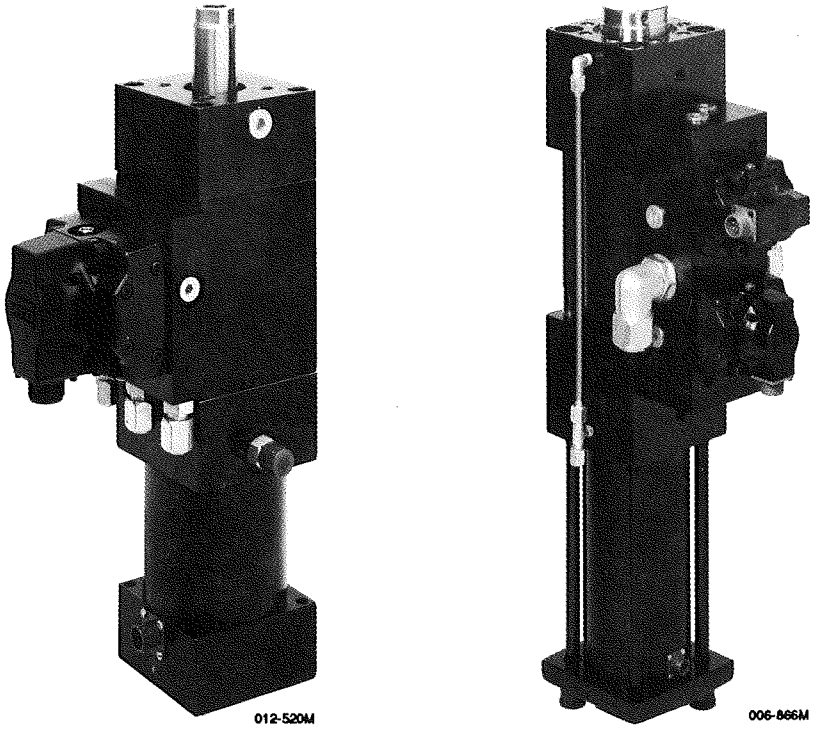
The ability of the servovalve to convert changes in voltage into precise changes in the rate and direction of hydraulic fluid flow makes it suitable for a variety of applications. It may be mounted directly to a linear or rotary actuator (shown in Figure 1-3), or single or dual servovalves may be mounted to a manifold (shown in Figure 1-4), which in turn is mounted to an actuator.



Linear Actuator

Rotary Actuator

Figure 1-3. Series 252 Servovalve Mounted Directly to an Actuator



Single Servovalve Dual Servovalves

Figure 1-4. Series 252 Servovalves Mounted to a Manifold

Figure 1-5 shows a cross section of a single servovalve mounted to a manifold. Figure 1-6 shows a cross section of dual servovalves mounted to a manifold. Mounting two servovalves to a manifold doubles the flow rate and may improve the frequency response for some systems.

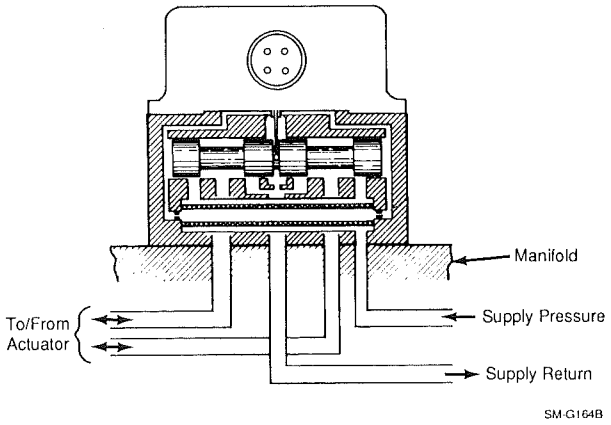


Figure 1-5. Single Series 252 Servovalve Mounted to a Manifold

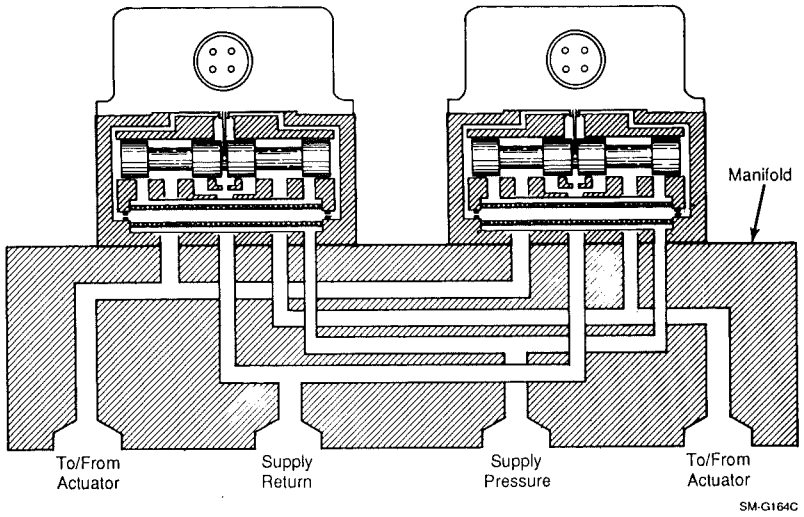


Figure 1-6. Dual Series 252 Servovalves Mounted to a Manifold

Finally, a small servovalve may be mounted to a large servovalve, enabling the fluid flow from the smaller one to be used to move the spool of the larger one. This configuration (shown in Figure 1-7) enables the control signal to effectively regulate a flow rate substantially greater than the full-flow rating of the smaller servovalve.

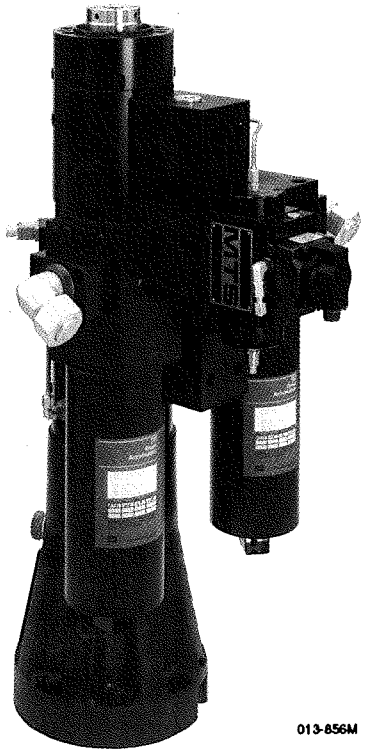


Figure 1-7. Series 252 Servovalve Mounted to a Larger Servovalve

1.2 Specifications

Table 1-1 lists the specifications for the Series 252 Servovalves. Figures 1-8 and 1-9 show the dimensions of the different servovalve models.

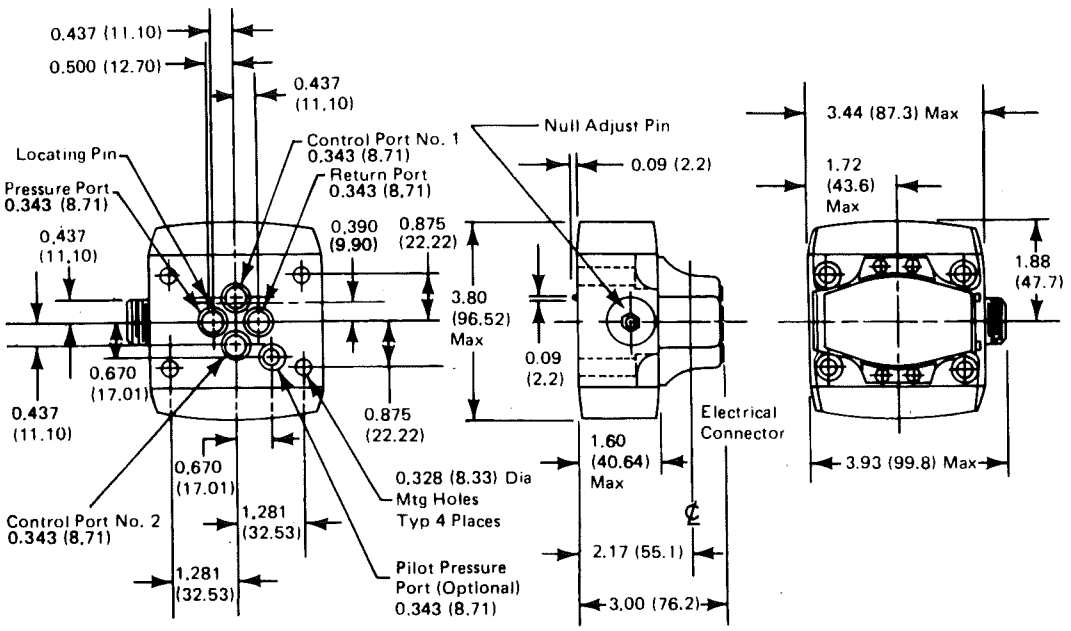
Table 1-1. Series 252 Servovalve Specifications

Parameter	Specification
Maximum operating pressure	3000 psi (21 MPa)*
Minimum operating pressure	200 psi (1.4 MPa)
Operating temperature range	-40°F to +275°F (-40°C to +135°C)
Seals	Buna-N standard†
Rated full flow input signal current	25 mA (series) 50 mA (differential) 50 mA total (parallel)
Coil resistance	80 Ω per coil
Weight 252.2X/.4X/.5X 252.3X	 2.3 lbs (1.03 kg) 7.5 lbs (3.5 kg)
Recommended hydraulic fluid‡	Mobil DTE 25 or Shell Tellus 46

* Higher operating pressures, up to 5000 psi (35 MPa), are available on request. Contact MTS for further information.

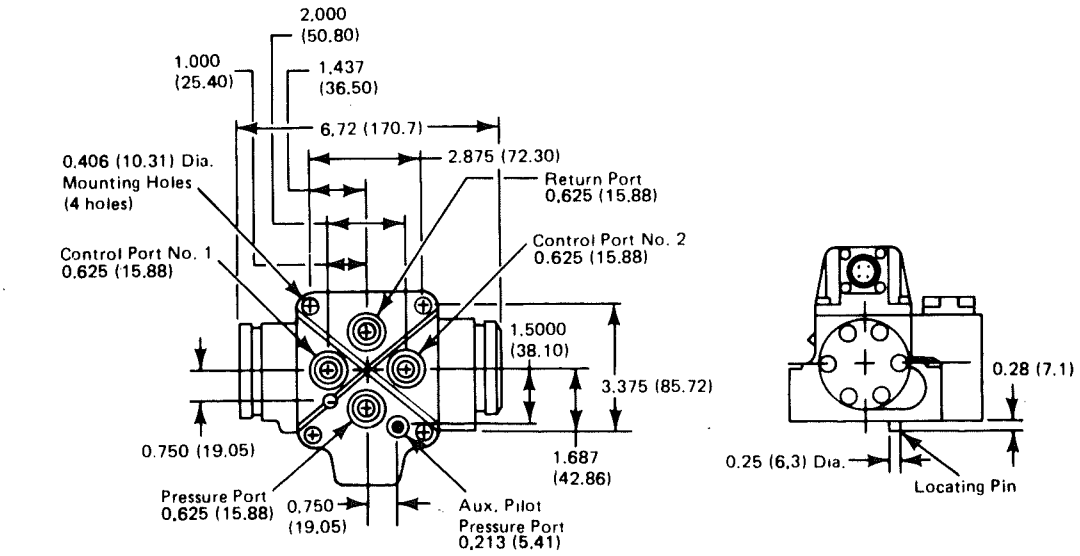
† Special seals are available as options. Contact MTS for details on optional seal materials.

‡ Do not mix different types or brands of hydraulic fluid. Mixing different hydraulic fluids can create contaminants and degrade fluid additives. For information on hydraulic fluid refer to the MTS service manual supplied with your servovalve.



Note: Dimensions are in inches with millimeters in parentheses. The pressure port, control ports 1 and 2, and return port use O-ring size -013, and the optional pilot pressure port uses O-ring size -012. For the mounting screws use 5/16 - 18 x 1 1/2.

Figure 1-8. Series 252.2X, 252.4X, and 252.5X Servovalve Dimensions



Note: Dimensions are in inches with millimeters in parentheses. The pressure port, control ports 1 and 2, and return port use O-ring size -019. The auxilliary pilot pressure port uses O-ring size -012. For the mounting screws use 3/8 - 16 x 2.

SM-G165D

Figure 1-9. Series 252.3X Servovalve Dimensions

1.2.1 Flow Ratings

Table 1-2 lists the flow ratings for the Series 252 Servovalves.

Table 1-2. Servovalve Flow Ratings

Model	Full-Flow Rating*		90° point at 10% command	Null Flow†	
	gpm	L/min		gpm	L/min
252.21C	1.0	4.0	240 Hz	0.29	1.10
252.22C	2.5	9.5	240 Hz	0.38	1.44
252.23C	5.0	19.0	240 Hz	0.60	2.27
252.24C	10.0	37.0	200 Hz	0.60	2.27
252.25C	15.0	56.0	170 Hz	0.60	2.27
252.31A‡	25.0	93.0	80 Hz	1.47	5.56
252.32A‡	40.0	151.0	60 Hz	1.47	5.56
252.33A‡	60.0	227.0	50 Hz	2.20	8.33
252.41A	1.0	4.0	300 Hz	0.29	1.10
252.42A	2.5	9.5	280 Hz	0.38	1.44
252.43A	5.0	19.0	280 Hz	0.60	2.27
252.51B	1.0	4.0	230 Hz	0.29	1.10
252.52B	2.5	9.5	230 Hz	0.38	1.44
252.53B	5.0	19.0	230 Hz	0.60	2.27
252.54B	10.0	37.0	180 Hz	0.60	2.27
252.55B	15.0	56.0	130 Hz	0.60	2.27

* Flow ratings are for 1000 psi (7 MPa) pressure drop across the servovalve. Higher flows are available at higher pressure drops.

† The maximum internal null flow is specified at 3000 psi (21 MPa). The null flow at the first stage is 0.20 gpm (0.76 L/min) for all Series 252 Servovalves.

‡ This servovalve can be converted to external pilot pressure in the field (with auxiliary port). The 90° point is at 40% command.

1.2.2 Performance Characteristics

The flow versus frequency performance curves shown in Figures 1-10 through 1-13 indicate the relative performance capabilities of the servovalves at various frequencies. The curves are derived by driving the servovalve at the indicated frequency with a sine wave control signal and ± full current to the coil. There is a 1000 psi (7 MPa) pressure drop across the servovalve.

Servovalve performance at higher frequencies is a function of variables introduced by system components, actuator response, and specimen characteristics.

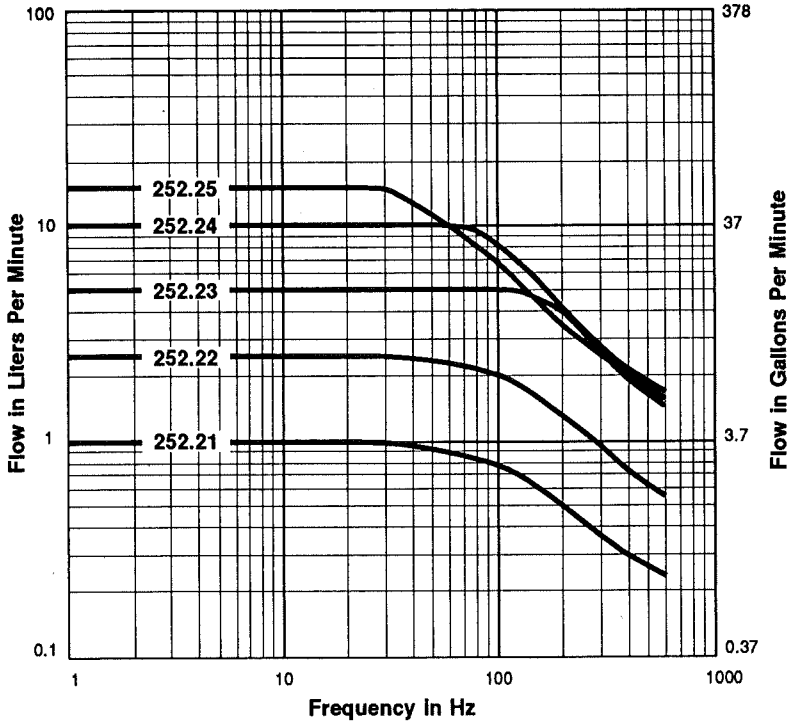
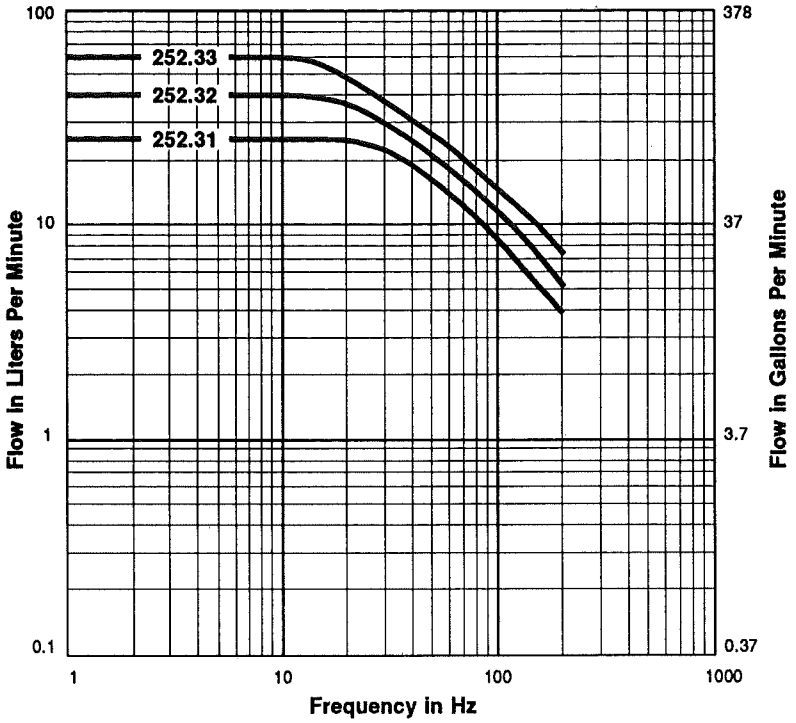
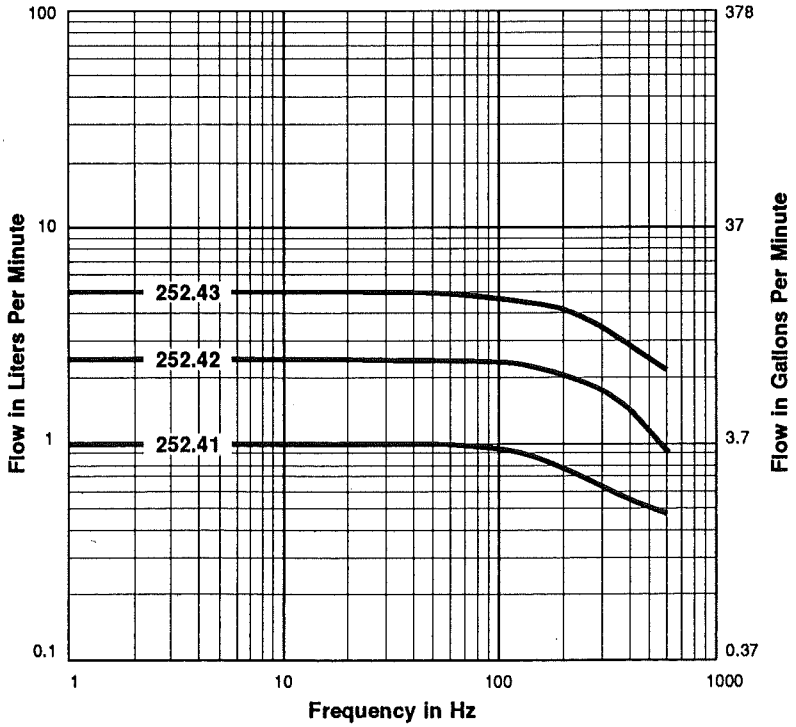


Figure 1-10. 252.2X Flow versus Frequency Performance Curves



Note: Performance is with 21 MPa (3000 psi) pressure supplied and 7 MPa (1000 psi) pressure drop across the servovalve

Figure 1-11. 252.3X Flow versus Frequency Performance Curves



Note: Performance is with 21 MPa (3000 psi) pressure supplied and 7 MPa (1000 psi) pressure drop across the servovalve

Figure 1-12. 252.4X Flow versus Frequency Performance Curves

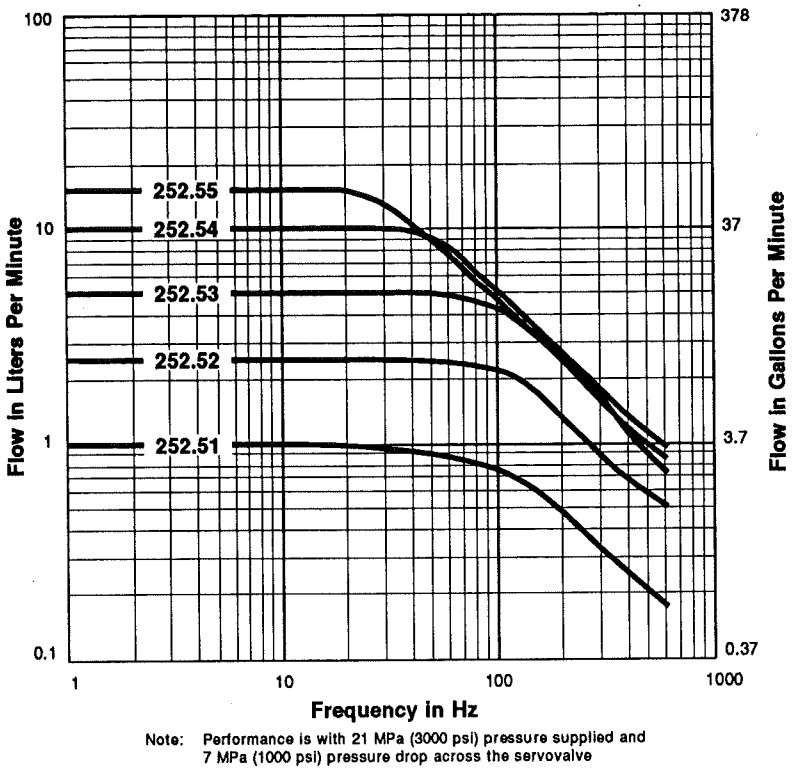


Figure 1-13. 252.5X Flow versus Frequency Performance Curves

Section 2
Service

Service requirements for the Series 252 Servovalves typically involve changing the filter element (Series 252.3X only) and setting the mechanical null adjustment. Except for these procedures, further disassembly, inspection, or repair of the servovalve is not recommended and may void the servovalve warranty.

MTS does not recommend changing the 35-micron filter element in the Series 252.2X/.4X/.5X Servovalve. MTS hydraulic power supplies filter the system hydraulic fluid at 3-microns absolute. The system filters will trap most solid particle contaminants. If servovalve performance has deteriorated and the cause has been isolated down to the servovalve filter, return the servovalve to MTS.

2.1 Filter Element Replacement (Series 252.3X Servovalve)

Under normal operating conditions, the 20-micron stainless steel filter used in the Series 252.3X Servovalve should be replaced only if servovalve performance has deteriorated. Ensure that other possible causes of poor performance, such as plugged system filters and/or hydraulic power supply wear, have been eliminated before replacing the servovalve filter.

NOTE A filter kit (MTS part number 328441-01) containing all necessary filter element replacement parts for Series 252.3X Servovalves is available from MTS Systems Corporation.

To replace the filter element, perform the following procedure. Care should be exercised to prevent dirt or other contaminants from entering the servovalve body, filter passages, or manifold/actuator ports.

1. Turn off electrical and hydraulic power to the system. Allow sufficient time for residual hydraulic pressure in the system to reduce to zero.

2. Remove the four socket head screws and washers that secure the filter cover plate to the filter housing (refer to Figure 2-1).

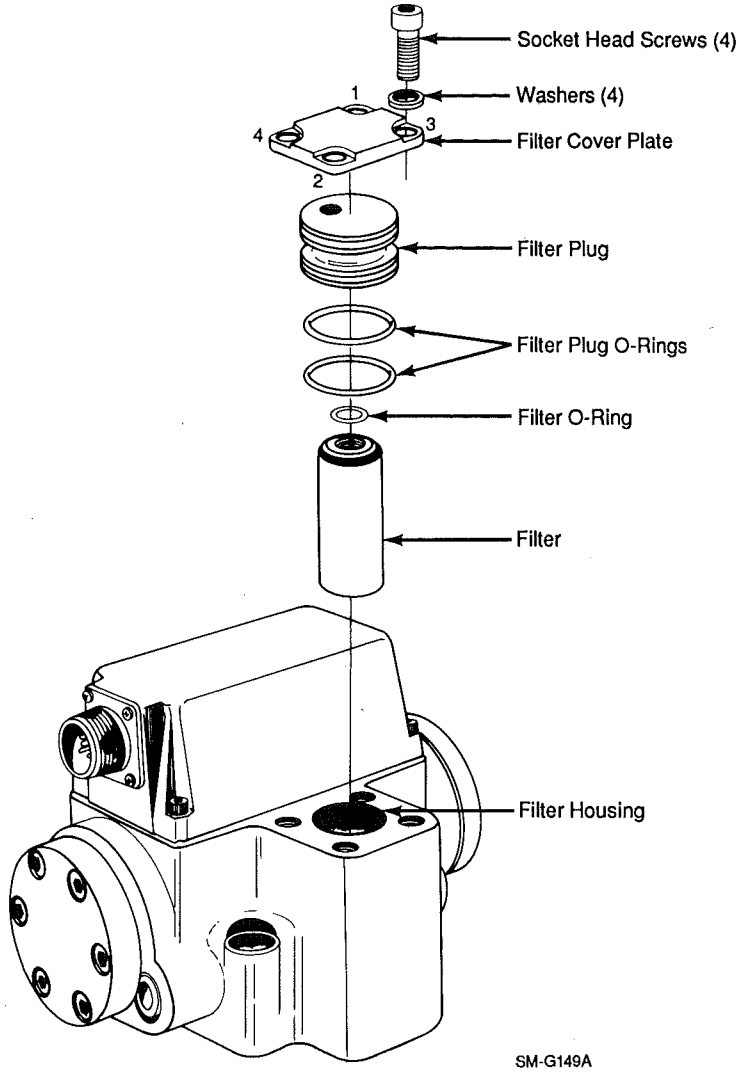


Figure 2-1. Series 252.3X Servovalve – Exploded View

3. Remove the filter cover plate.

4. Remove the filter plug by threading one of the socket head screws, removed in step 2, into the filter plug and pulling it out of the filter housing.

5. Remove the filter plug O-rings from the filter plug.

6. Remove the filter O-ring from the filter.

7. Remove the filter.

8. Lightly lubricate the filter O-ring with clean hydraulic fluid, install it on the replacement filter and insert the filter into the housing.

9. Lightly lubricate the filter plug O-rings with clean hydraulic fluid, install them on the filter plug and install the filter plug.

10. Secure the filter cover plate to the housing using the four socket head screws and washers removed in step 2. Tighten each socket head screw until it is firmly seated against the filter cover plate. Using the pattern shown in Figure 2-1, tighten the socket head screws to 40 lbf-in. (4.5 N•m). Continue using the pattern and tighten the socket head screws to a final torque of 85 lbf-in. (9.60 N•m).

11. Turn on electrical and hydraulic system power.

12. Apply low hydraulic pressure to the servovalve so that hydraulic fluid will gradually fill the filter cavity.

13. Apply high hydraulic pressure and check for leaks.

2.2 Mechanical Null Adjustment

The following procedures describe the Series 252 Servovalve mechanical null adjustment. The mechanical null adjustment aligns the servovalve spool to a position that allows little or no actuator movement when there is no control signal.

Before altering the mechanical null adjustment, it is strongly suggested that the user read this section in its entirety. The mechanical null adjustment is quite sensitive, and the user should be familiar with the hazards that can be encountered when performing the procedure.

Perform the servovalve mechanical null adjustment only after the electronic balancing procedure has been completed and the results are judged unsatisfactory. (Refer to the appropriate electronic control device product manual for the electronic balancing procedure.)

2.2.1 Mechanical Null Adjustment Procedure

During the servovalve mechanical null adjustment procedure, the actuator must be able to move through full displacement in either direction without contacting a reaction surface.

⚠ WARNING

Do not perform the following procedure without clearing the path of motion of the actuator.

Sudden and unexpected actuator rod movement can cause serious injury to personnel and/or damage to equipment.

Ensure that all personnel, specimen/structures, and tools are away from the path of motion of the actuator.

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1. Select displacement control on the control device. Refer to the appropriate control device product manual for information on selecting the control mode.
2. Set the RESET (may be labeled RESET AUTO or RESET INTEGRATOR) switch on the device controlling the servovalve to the OUT position.
3. Adjust the SET POINT control on the controller for mid-displacement.
4. Turn on electrical and hydraulic system power.
5. Adjust the SPAN control to 500, apply a 5 volt, 0.1 Hz sine wave command signal, and allow the actuator to warm up for approximately one-half hour.
6. After the warm up period, turn the SPAN control to zero and stop the program at the control device.
7. Disconnect the servovalve electrical cable and observe the actuator rod. If the actuator rod:
   - has no noticeable movement, the servovalve is at the null position and does not need to be adjusted. Proceed to step 19.
   - noticeably moves, the servovalve requires adjustment. Proceed to step 8.
8. Insert a 3/32-inch hex key into the adjustor pin socket. Refer to Figure 2-2 for the location of the adjustor pin.

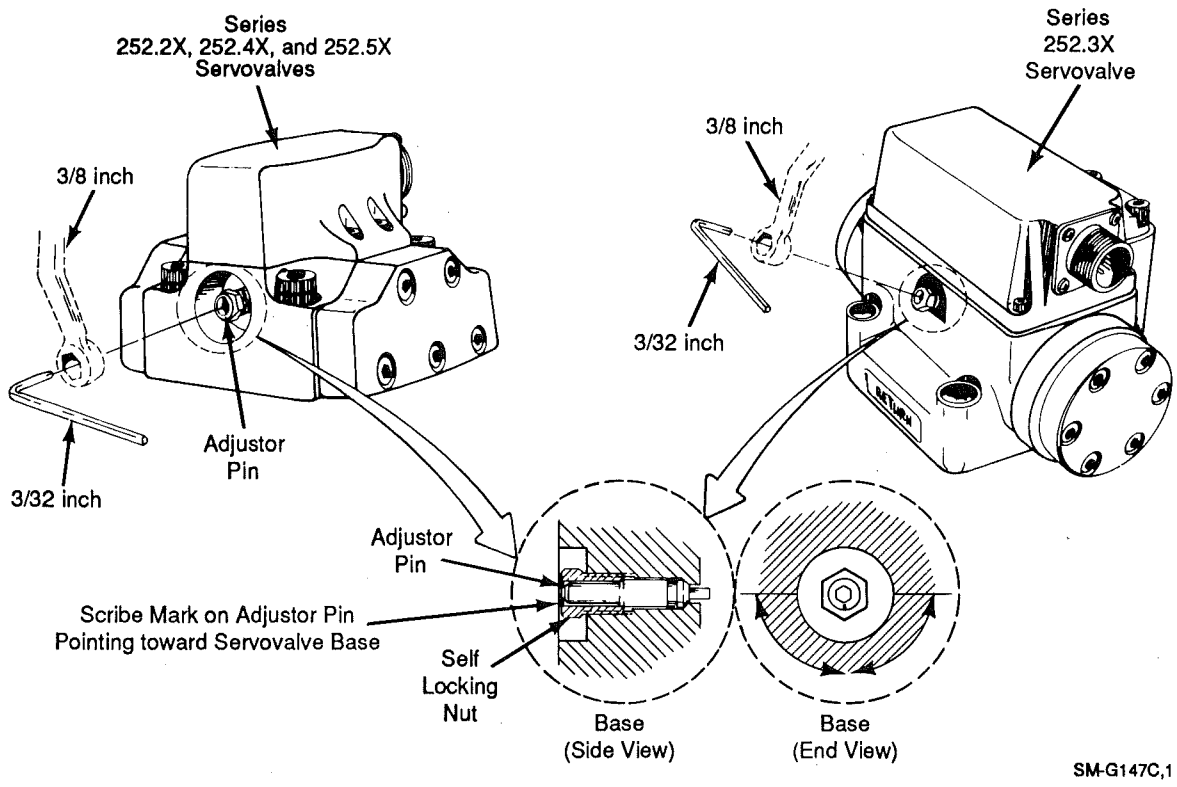


Figure 2-2. Mechanical Null Adjustor Pin

⚠ CAUTION

Do not apply more than 12 lbf-in. (1.36 N•m) of torquing force to the adjustor pin.

Excessive torquing may shear off the adjustor pin eccentric.

If the pin does not turn using very little force, proceed to step 10.

9. Slowly rotate the adjustor pin until the actuator movement is reduced to a minimum, and then proceed to step 19. If the pin does not turn using very little force, proceed to step 10.

10. Reduce system pressure to low pressure (refer to the appropriate controlling device product manual). Slowly rotate the adjustor pin until the actuator movement is reduced to a minimum, and then proceed to step 19. If the adjustor pin still does not turn, proceed to step 11.

11. Turn off electrical and hydraulic power to the system. Allow sufficient time for residual hydraulic pressure in the system to reduce to zero.

12. Remove the hex key and insert a 3/8-inch offset wrench over the self-locking nut (refer to Figure 2-2).

13. Insert a torque wrench with a 3/32-inch hex key head adapter into the adjustor pin socket.

14. Using the offset wrench, loosen (but do not remove) the self-locking nut.

15. Turn the adjustor pin until the scribe mark on the adjustor pin is pointing toward the base of the servovalve (refer to Figure 2-2).

16. Tighten the self-locking nut until 10 to 12 lbf-in. (1.13 to 1.36 N•m) of torque is needed to turn the adjustor pin, ensuring that the scribe mark remains pointing toward the base of the servovalve.

17. Remove the torque wrench and offset wrench.

18. Perform steps 1 through 9.

19. Remove hydraulic and electric power from the system.

20. Reconnect the servovalve electrical cable.

2.2.2 Mechanical Null Adjustments Using a Readout Device

The mechanical null of the servovalve can be adjusted using the adjustor pin on the servovalve, while utilizing the controls and readout devices present in the electronics controlling the servovalve. Refer to the appropriate control device product manual for these adjustment procedures.

2.3 Troubleshooting Guide

The troubleshooting guide in Table 2-1 provides the symptom, probable cause, and remedy for some common servovalve malfunctions that may be encountered.

NOTE Before diagnosing a servovalve malfunction, ensure that: (a) the servovalve is getting the proper command, (b) the servovalve is getting full system pressure and flow, and (c) the hydraulic fluid in the system is clean.

Table 2-1. Troubleshooting Guide

Symptom	Probable Cause	Remedy
– Output flow from only one control port – Actuator is fully extended/retracted, or hydraulic motor is rapidly rotating – Does not respond to electrical command signal	Plugged inlet filter element	Replace filter element (252.3X only)*
Poor response (servovalve output lags command signal)	Partially plugged filter element	Clean inlet orifices or clean/replace filter element (252.3X only);* check for dirty hydraulic fluid
High null bias (high input current required to maintain hydraulic actuator in stationary position)	1. Incorrect (mechanical or electrical) null adjustment 2. Partially plugged inlet orifice assembly 3. Partially plugged filter element	1. Adjust null 2. Clean inlet orifices 3. Clean/replace filter element (252.3X only);* check for dirty hydraulic fluid
* For a Series 252.2X, 252.4X, or 252.5X Servovalve, return the unit to MTS.		

Section 3
Installation

3.1 Servovalve Installation

This section describes the procedure used when installing a Series 252 Servovalve. This procedure assumes that all electrical and hydraulic power to the system is off, and that the residual hydraulic pressure in the system is at zero. In a dual servovalve configuration, do not apply electrical or hydraulic power until both servovalves have been installed.

⚠ WARNING

Do not attempt to install, or replace a servovalve unless all electrical and hydraulic power to the system is off, and residual hydraulic pressure in the system is at zero.

Installing or replacing a servovalve while system electrical or hydraulic power is on can cause unexpected actuator motion and result in injury to personnel and/or damage to equipment.

Before installing or replacing a servovalve, ensure that all electrical and hydraulic power to the system is off, and residual hydraulic pressure in the system is at zero.

1. Remove the servovalve protective cover plate (attached to the bottom of the servovalve).

2. Ensure that the O-rings between the servovalve and actuator, manifold, or secondary servovalve are lubricated with a light film of hydraulic fluid and are in their correct position.

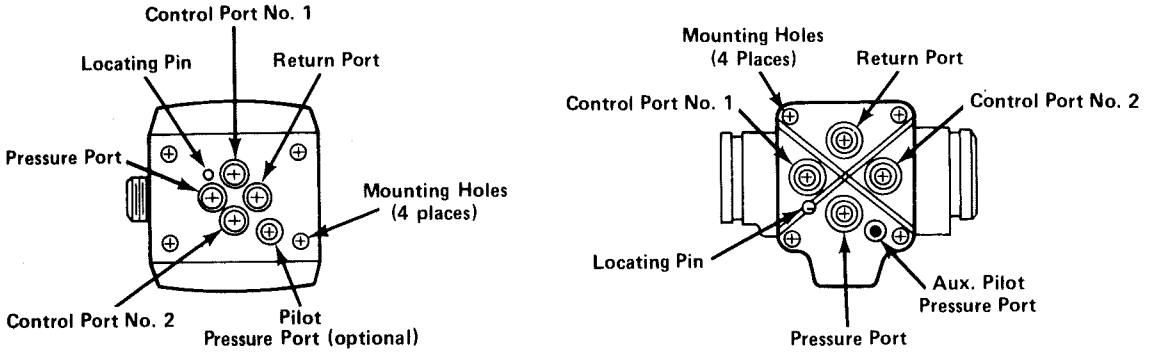
⚠ WARNING

Do not install the servovalve without first ensuring that the locating pin on the bottom of the servovalve is aligned with the locating hole on the actuator, manifold, or secondary servovalve.

Failure to correctly align the locating pin and locating hole can result in injury to personnel and/or damage to equipment.

Ensure that the locating pin on the bottom of the servovalve is correctly positioned within the locating hole of the actuator, manifold, or secondary servovalve.

3. Position the servovalve on the actuator, manifold, or secondary servovalve, aligning the locating pin on the servovalve with the locating hole on the actuator, manifold, or secondary servovalve. Refer to Figure 3-1 for the location of the locating pin.



Note: The pressure port, control ports 1 and 2, and return port use O-ring size -013. The auxilliary pilot pressure port uses O-ring size -012.

Note: The pressure port, control prots 1 and 2, and return port use O-ring size -019. The auxilliary pilot pressure port uses O-ring size -012.

SM-G145C

252.2X, 252.4X, and 252.5X

252.3X

Figure 3-1. Servovalve Locating Pin

NOTE The 252.2X, 252.4X, and 252.5X servovalves use four 5/16-18 x 1-1/2 in. mounting screws and the 252.3X servovalve uses four 3/8-16 x 1- 3/4 in. mounting screws. As the screws are successively tightened, those previously tightened will lose clamping force. Continue tightening until all screws are at the specified torque.

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4. After lubricating the mounting screws with a light film of oil, tighten each one until it is firmly seated. Using the pattern shown in Figure 3-2, tighten the socket head screws to 5 lbf-ft (6.78 N•m). Continue using the pattern and tighten the socket head screws to a final torque of 8 lbf-ft (10.84 N•m) for 252.2X, 252.4X, and 252.5X servovalves, or 14 lbf-ft (18.98 N•m) torque for 252.3X servovalves.

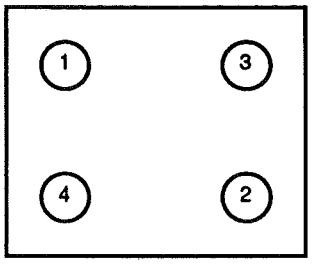

Figure 3-2. Torquing Order of Mounting Screws

5. Connect all hydraulic supply and return lines.

6. Connect the four-pin electrical cable from the control device to the servovalve.

⚠ WARNING

Uncontrolled actuator movement can result from applying hydraulic pressure to the system when the servovalve command (dc error) has not been zeroed.

If the servovalve command (dc error) does not equal zero when hydraulic pressure is applied to the system, equipment damage and/or personal injury can result.

Always ensure that the servovalve command is zero before applying hydraulic pressure to the system. Refer to the appropriate control device product manual for information on zeroing the dc error.

7. Turn on electrical and hydraulic system power.

8. Apply low hydraulic pressure to the servovalve so that the hydraulic fluid will gradually fill the filter cavity.

9. Apply high hydraulic pressure and check for leaks.

3.2 Servovalve Removal

The following procedure should be used when removing the servovalve, replacing the filter, or flushing the system. This procedure applies to both single and dual servovalve configurations.

1. Turn off electrical and hydraulic power to the system. Allow sufficient time for residual hydraulic pressure in the system to reduce to zero.

2. Disconnect the electrical cable from the servovalve.

NOTE The 252.2X, 252.4X, and 252.5X servovalves use four 5/16-18 x 1-1/2 in. mounting screws and the 252.3X servovalve uses four 3/8-16 x 1- 3/4 in. mounting screws.

⚠ CAUTION

Do not remove the servovalve unless the servovalve ports, and actuator, manifold, or secondary servovalve ports can be quickly covered with protective cover plates.

Failure to cover the servovalve ports, and actuator, manifold, or secondary servovalve ports with protective cover plates can allow contaminants to enter and damage the system.

After removing the servovalve, ensure that the servovalve ports, and actuator, manifold, or secondary servovalve ports are covered with protective plates as soon as possible.

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3. Remove the four mounting screws used to secure the servovalve to the manifold. Remove the servovalve.

4. Cover the servovalve and manifold ports with protective cover plates as soon as possible.

3.3 Electrical Cable Connections

Figure 3-3 illustrates the Series 252 Servovalve internal coils and connector wiring. The correct wiring configuration is determined by the requirements of the device used to control the servovalve. Refer to the appropriate controlling device product manual for information on servovalve electrical connections.

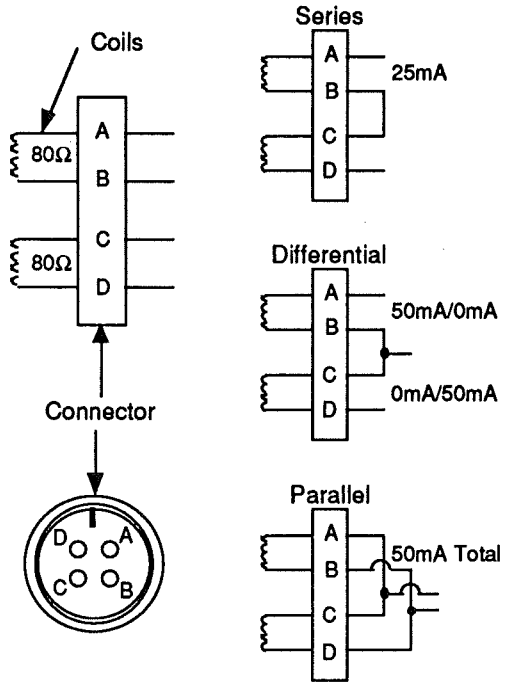

Figure 3-3. Servovalve Coils/Connector and Cable Wiring Variations

Section 4
Theory of Operation

This section describes the operation of the Series 252 Servovalve. Although the designs of the Series 252 Servovalve models differ slightly, they all conform to the same theory of operation. Figure 4-1 shows a typical servovalve cross section.

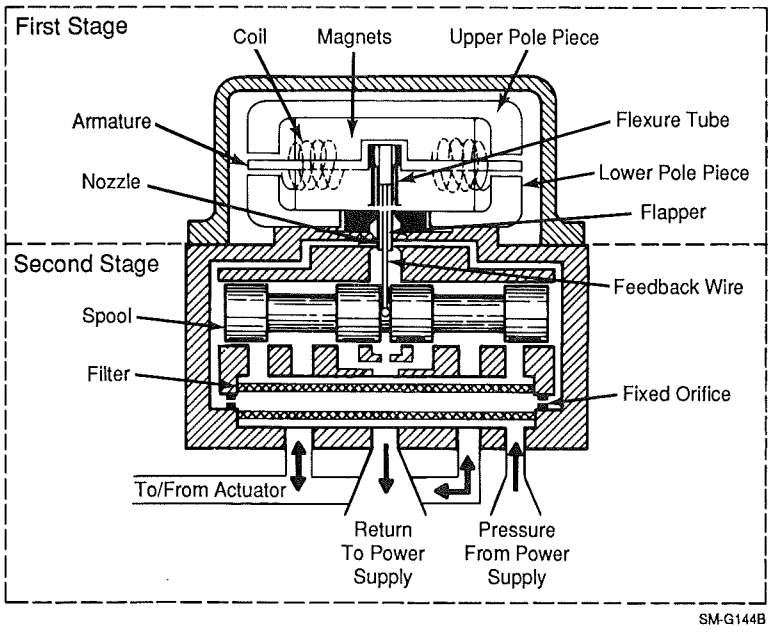

Figure 4-1. Typical Series 252 Servovalve – Cross-Sectional View

The Series 252 Servovalve uses changes in the polarity and amplitude of a control signal to regulate the direction and rate of fluid flow to an actuator, manifold, or secondary servovalve. This process is broken down into two stages of hydraulic regulation.

Components

The first stage of hydraulic regulation converts the control signal into the physical motion of the valve components. This is accomplished by a torque motor armature attached to a flapper valve. The torque motor consists of the coils, upper and lower pole pieces, armature, and magnets. The first-stage valve assembly consists of two fixed nozzles and two variable orifices formed by the nozzle openings and the flapper. The flapper is attached to the armature and moves from side to side as the armature rotates in either a clockwise or counterclockwise direction in response to changes in the control signal polarity and amplitude. The armature/flapper assembly is supported by a flexure tube.

The second stage of hydraulic regulation consists of a spool, which controls hydraulic fluid flow to and from the actuator, and a feedback wire, which provides the closed-loop control between the armature and the spool.

Operation

In operation, the control signal energizes the coils, causing the armature/flapper to rotate in either a clockwise or counterclockwise direction, depending on the polarity of the control signal. As the armature/flapper rotates, it controls the flow of hydraulic fluid from the two nozzles in the first stage in an inversely proportional manner; as the flow from one nozzle increases, the flow from the other decreases. The resultant change in the flow of hydraulic fluid creates a differential pressure at the ends of the second-stage spool, causing the spool to move.

As the spool moves in response to the difference in pressure, the feedback wire (which is attached to the armature/flapper assembly on one end and contacts the spool on the other end) exerts an opposite torque on the armature/flapper assembly, and attempts to re-center the armature/flapper.

The spool moves until the feedback wire torque equals the control signal torque and re-centers the flapper. When the flapper re-centers (nozzle openings equal), the pressures at the ends of the spool equalize, and spool movement ceases. Hydraulic fluid continues to flow to the actuator. This mechanism ensures that, for any level of control signal, there will be a corresponding spool position which is dependent upon the magnitude and polarity of the control signal.

When the control signal decreases to zero, the flapper creates a pressure imbalance at the opposite end of the spool. The spool moves back until the pressure is again equalized, thereby stopping the flow of hydraulic fluid to the actuator when the control signal reaches zero.