Series 252 Servovalves
Table of Contents

I. Introduction
   1.1 Functional Description  1-1
   1.2 Specifications  1-4
   1.2.1 General Specifications - Flow Ratings  1-5
   1.2.2 General Specifications - Performance Characteristics  1-5

II. Service
   2.1 Filter Element Replacement (Series 252.3X Servovalve)  2-1
   2.2 Mechanical Null Adjustment  2-3
   2.2.1 Mechanical Null Adjustment Procedures  2-3
   2.2.2 Mechanical Null Adjustment Using a Readout Device  2-6
   2.3 Troubleshooting Guide  2-6

III. Installation
   3.1 Servovalve Mounting  3-1
   3.2 Servovalve Removal  3-3
   3.3 Electrical Cable Connections  3-4

IV. Theory of Operation

List of Figures
   1-1 MTS Series 252.2X, 252.4X, and 252.3X Servovalves  1-1
   1-2 252 Servovalve Mounted to an Actuator via a Manifold  1-2
   1-3 Dual 252 Servovalves Mounted to an Actuator via a Manifold  1-2
   1-4 252 Servovalve Mounted Directly to an Actuator  1-2
   1-5 252 Servovalve used as a Pilot Stage for a High Flow Servovalve  1-2
   1-6 Typical Closed Loop System  1-3
   1-7 Hydraulic Fluid Flow  1-3
   1-8 Dual Servovalves  1-3
   1-9 Flow Versus Frequency Performance Curves  1-6
   2-1 Series 252.3X Servovalve -- Exploded View  2-2
   2-2 Mechanical Null Adjustor Pin  2-5
   3-1 Servovalve Locating Pin  3-2
   3-2 Torquing Order of Mounting Screws  3-2
   3-3 Servovalve Coils/Connector and Cable Wiring Variations  3-4
   4-1 Series 252 Servovalve -- Cross-Sectional View  4-1
Table of Contents (continued)

List of Tables

1-1  Servovalve Specifications  1-4
1-2  Servovalve Flow Ratings  1-5
2-1  Troubleshooting Guide  2-7
Section I
Introduction

The MTS Series 252 Servovalves (refer to Figure 1-1) are two stage, four-way valves that are designed for low-to-medium flow requirements (1 to 60 gpm, 3.8 to 227 l/min). They function as the final control element in an MTS closed loop servohydraulic system by regulating the rate and direction of hydraulic fluid flow to the actuator.

![MTS Series 252 Servovalves](252.2X, 252.4X, and 252.3X Servovalves)

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

1.1 Function Description

The 252 Servovalve is typically mounted on a manifold, which is mounted on an actuator (refer to Figure 1-2), or it is mounted directly on an actuator (refer to Figure 1-4). It can also serve as a pilot stage to position a main stage servovalve spool (refer to Figure 1-5). The servovalve receives a control signal from an electronic control device (refer to Figure 1-6). The control signal is a composite of the program command and the transducer feedback signal. The servovalve converts this control signal to a physical movement of an internal spool, allowing the controlled porting of hydraulic fluid to and from the actuator (refer to Figure 1-7). 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 controlling the direction and rate of hydraulic fluid flow to the actuator).
Figure 1-2. 252 Servovalve Mounted to an Actuator via a Manifold

Figure 1-3. Dual 252 Servovalves Mounted to an Actuator via a Manifold

Figure 1-4. 252 Servovalve Mounted Directly to an Actuator

Figure 1-5. 252 Servovalve used as a Pilot Stage for a High Flow Servovalve
Figure 1-6. Typical Closed Loop System

Figure 1-7. Hydraulic Fluid Flow

Figure 1-8. Dual Servo valves
As the amplitude of the control signal decreases to zero the spool returns to its null (no-flow) position, thereby stopping the flow of hydraulic fluid to and from the actuator.

For applications requiring a higher flow than is available in a single standard 252 Servovalve, two servovalves may be mounted in parallel, using a dual servovalve manifold to double the flow rating and in some applications increase the system response rate (refer to Figures 1-3 and 1-8).

1.2 Specifications

Table 1-1 lists the specifications for the Series 252 Servovalves.

Table 1-1. Servovalve Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operating pressure</td>
<td>3000 psi (21 MPa)¹</td>
</tr>
<tr>
<td>Minimum operating pressure</td>
<td>200 psi (1.4 MPa)</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>−40°F to +275°F (−40°C to +135°C)</td>
</tr>
<tr>
<td>Seals</td>
<td>Buna-N standard²</td>
</tr>
<tr>
<td>Rated full flow input signal current</td>
<td>25 mA (series)</td>
</tr>
<tr>
<td></td>
<td>50 mA (differential)</td>
</tr>
<tr>
<td></td>
<td>50 mA (parallel)</td>
</tr>
<tr>
<td>Coil resistance</td>
<td>80Ω per coil</td>
</tr>
<tr>
<td>Weight</td>
<td>2.3 lbs (1.03 kg)</td>
</tr>
<tr>
<td>252.2X/.4X</td>
<td></td>
</tr>
<tr>
<td>252.3X</td>
<td>7.75 lbs (3.5 kg)</td>
</tr>
<tr>
<td>Recommended hydraulic fluid³</td>
<td>Mobil DTE 25 or Shell Tellus 46</td>
</tr>
</tbody>
</table>

¹ Higher operating pressures, up to 5000 psi (35 MPa), are available on request. (Contact MTS for further information.)

² Special seals are available as options. Contact MTS for details on optional seal materials.

³ For information on hydraulic fluid refer to the MTS Service Manual - Appendix A, MTS p/n 118312-04.

Specifications are subject to change without notice. Contact MTS for verification of specifications critical to your needs.
1.2.1 General Specifications - Flow Ratings

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

Table 1–2. Servovalve Flow Ratings

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Full-Flow Rating$^1$</th>
<th>90° point at 10% command</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gpm</td>
<td>l/min</td>
</tr>
<tr>
<td>252.21C</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>252.22C</td>
<td>2.5</td>
<td>9.5</td>
</tr>
<tr>
<td>252.23C</td>
<td>5.0</td>
<td>19</td>
</tr>
<tr>
<td>252.24C</td>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>252.25C</td>
<td>15</td>
<td>56</td>
</tr>
<tr>
<td>252.31A$^2$</td>
<td>25</td>
<td>93</td>
</tr>
<tr>
<td>252.32A$^2$</td>
<td>40</td>
<td>151</td>
</tr>
<tr>
<td>252.33A$^2$</td>
<td>60</td>
<td>227</td>
</tr>
<tr>
<td>252.41A</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>252.42A</td>
<td>2.5</td>
<td>9.5</td>
</tr>
<tr>
<td>252.43A</td>
<td>5.0</td>
<td>19</td>
</tr>
</tbody>
</table>

$^1$ Flow ratings are for 1000 psi (7 MPa) pressure drop across the servovalve. Higher flows are available at higher pressure drops.

$^2$ This servovalve can be converted to external pilot pressure in the field (with auxiliary pilot port). 90° point at 40% command.

1.2.2 General Specifications - Performance Characteristics

The flow versus frequency performance curves shown in Figure 1–9 indicate the relative performance capability of the servovalves at various frequencies. The curves are derived by using a sine wave at the indicated frequency and the servovalve being driven at ± full current to the coil, with a 1000 psi (7 MPa) pressure drop across the servovalve.
Servovalve performance at higher frequencies (where curves are shown dashed) is a function of variables introduced by system components, actuator response, and characteristics of the load specimen.

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

Figure 1-9. Flow Versus Frequency Performance Curves
Service requirements for the Series 252 Servovalves typically involve the changing of the filter element (Series 252.3X only) and 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 Systems Corporation does not recommend changing of the filter element on the Series 252.2X/.4X Servovalve. The system hydraulic fluid is filtered at 3 microns absolute at the hydraulic power supply and at the hydraulic service manifold. These system filters will trap most solid particle contaminants. The 252.2X/.4X Servovalve contains a 35 micron filter. If servovalve performance has deteriorated and the cause has been isolated down to the servovalve filter, return the servovalve to MTS Systems Corporation.

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 and other causes, such as, plugged system filters or hydraulic power supply wear have been eliminated.

NOTE

A filter kit (part number 328441-01) containing all necessary parts 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 the manifold/actuator ports.

1. Turn off electrical and hydraulic power to the system and 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).

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

4. Remove the large O-rings from the filter plug.
5. Remove the small O-ring from the filter.

6. Remove the filter.

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

8. Lightly lubricate the large O-rings with clean hydraulic fluid, install them onto the filter plug and install the filter plug.

9. Secure the filter cover plate to the housing using the four socket head screws and washers removed in step 2. Tighten the socket head screws in increments per the pattern indicated on Figure 2-1 to a final torque of 85 lbf-in. (9.60 N-m).

Figure 2-1. Series 252.3X Servovalve—Exploded View
10. Turn on electrical and hydraulic system power.

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

12. 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 positions the servovalve spool so that with no control signal there is minimal actuator movement. It is strongly suggested that this procedure be read in its entirety to familiarize the user with the hazards that can be encountered when performing this procedure. Perform the servovalve mechanical null adjustment only after the electronic balancing procedure has been performed and the results are judged unsatisfactory. (Refer to the appropriate electronic controlling device product manual for the electronic balancing procedure.)

#### 2.2.1 Mechanical Null Adjustment Procedures

The following procedure is used when adjusting the servovalve mechanical null. This procedure applies when the Series 252 Servovalves are used on either a linear or rotary actuator.

No specimen should be mounted between the actuator and the reaction surface. The actuator must be able to move full displacement in either direction without contacting anything.

⚠️ **WARNING** ⚠️

The following procedure is potentially dangerous and may cause serious injury to personnel and/or damage to the equipment due to sudden and abrupt actuator rod movement. Ensure that all tools are removed from the path of the actuator rod and that all personnel are clear of the actuator rod.
NOTE

Depending on the device controlling the servovalve, select the control mode that controls the displacement of the actuator. (Refer to the appropriate controlling device product manual for selection of displacement control.)

1. Select displacement control on the controlling device.

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-V, 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 controlling device.

⚠️ WARNING ⚠️

The following step is potentially dangerous and may cause serious injury to personnel and/or damage to the equipment due to sudden and forceful actuator rod movement. Ensure that all tools are removed from the path of the actuator rod and that all personnel are clear of the actuator rod.

7. Disconnect the servovalve electrical cable and observe the actuator rod. If the actuator rod:

   A. has no noticeable movement, the servovalve is at the null position and does not need to be adjusted. Proceed to step 19.

   B. 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 adjuster pin.
Figure 2-2. Mechanical Null Adjustor Pin

CAUTION

Step 9 involves turning the adjustor pin in order to minimize actuator movement. If the pin does not turn using very little force, stop. Excessive torquing may shear off the adjustor pin eccentric. Perform step 10.

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

10. Reduce system pressure to low pressure (refer to the appropriate controlling device product manual) and repeat step 9. If the adjustor pin does not turn after repeating step 9, skip to step 11.

11. Remove hydraulic and electrical power from the system.

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 adjuster pin socket.

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

15. Turn the adjuster pin until the scribe mark on the adjuster 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 adjuster 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 adjuster pin on the servovalve, while utilizing the controls and readout devices present in the electronics controlling the servovalve. Refer to the appropriate controlling 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: the servovalve is getting the proper command, the valve is getting full system pressure and flow, and the hydraulic fluid in the system is clean.
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output flow obtained from one control port only (actuator is hardover, or hydraulic motor is rapidly rotating: Does not respond to electrical command signal)</td>
<td>Plugged inlet filter element</td>
<td>Replace filter element (252.3X only)¹</td>
</tr>
<tr>
<td>Poor response (servovalve output lags electrical command signal)</td>
<td>Partially plugged filter element</td>
<td>Clean inlet orifices or clean/replace filter element (252.3X only)¹; check for dirty hydraulic fluid in system</td>
</tr>
<tr>
<td>High null bias (high input current required to maintain hydraulic cylinder or motor stationary)</td>
<td>1. Incorrect (mechanical or electrical) null adjustment</td>
<td>1. Readjust null</td>
</tr>
<tr>
<td></td>
<td>2. Partially plugged inlet orifice assembly</td>
<td>2. Clean inlet orifices</td>
</tr>
<tr>
<td></td>
<td>3. Partially plugged filter element</td>
<td>3. Clean/replace filter element (252.3X only)¹; check for dirty hydraulic fluid in system</td>
</tr>
</tbody>
</table>

¹ For a Series 252.2X or 252.4X Servovalve, return to MTS Systems Corporation.
Section III
Installation

3.1 Servovalve Mounting

The following procedure is used when mounting the Series 252 Servovalve to an actuator manifold, or directly on an actuator, or when mounting two servovalves on a dual servovalve manifold.

This procedure assumes that all electrical and hydraulic power to the system is off, and that the residual 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.

1. Remove the servovalve protective cover plate before mounting the servovalve onto the manifold or actuator. (Ensure that the O-rings between the servovalve and actuator manifold are lubricated with a light film of hydraulic fluid and are in their correct position.)

CAUTION

The pressure port on the servovalve must always mate to the pressure port on the manifold or actuator. The locating pin on the Servovalve is used to facilitate correct port mating.

2. Install the servovalve onto the manifold, aligning the locating pin on the servovalve with the locating hole on the manifold or actuator. Refer to Figure 3-1 for view of the locating pin.
Figure 3-1. Servovalve Locating Pin

NOTE

The 252.2X and 252.4X 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.

3. Mount the servovalve to the manifold or actuator using the four mounting screws. Lubricate with a light film of oil, and tighten in increments in the order shown in Figure 3-2. Tighten the mounting screws to 8 lbf-ft (10.83 N-m) torque for 252.2X and 252.4X servovalves, 14 lbf-ft (18.98 N-m) torque for 252.3X servovalves.

Figure 3-2. Torquing Order of Mounting Screws
4. Connect all hydraulic supply and return lines.

5. Make the electrical connections between the servovalve and the controlling device.

⚠️ WARNING ⚠️

Steps 6 and 7 require that the operator turn on system electrical power and apply hydraulic pressure to the actuator. Keep all personnel clear of the actuator when performing these steps. Possible injury may occur due to sudden high velocity actuator piston rod movement. Ensure that the controlling device indicates a zero reading when monitoring dc error. Refer to the appropriate controller product manual.

6. Turn on electrical and hydraulic system power.

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

8. Apply high hydraulic pressure and check for leaks.

### 3.2 Servovalve Removal

The following procedure should be used when removing the servovalve from the manifold or actuator for any reason (i.e., replacing the servovalve, replacing the filter, or flushing the system). This procedure applies to both single and dual servovalve configurations.

1. Ensure that electrical and hydraulic power to the system is off. Allow sufficient time for residual pressure to reduce to zero.

2. Disconnect the electrical cable from the servovalve.

**NOTE**

The 252.2X and 252.4X Servovalves use four 5/16-18 × 1-1/2 in. mounting screws and the 252.3X Servovalve uses four 3/8-16 × 1-3/4 in. mounting screws.
3. Remove the four mounting screws used to secure the servovalve to the manifold. Remove the servovalve.

**CAUTION**

Cover the manifold ports and the servovalve ports with a protective cover plate as soon as the servovalve is removed to prevent contamination from entering.

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 the connector wiring. Also illustrated in this figure are three variations of cable wiring that may be used, depending on the controlling device being used.

![Diagram of Series 252 Servovalve Internal Coils and Connector Wiring Variations](LA-F286)

Figure 3-3. Servovalve Coils/Connector and Cable Wiring Variations
Section IV
Theory of Operation

As the final control element in a servohydraulic test system, the MTS Series 252 Servovalve reacts to an electrical control signal by porting hydraulic fluid in a direction and amount determined by the polarity and magnitude of the control signal.

Although this discussion concerns one 252 Servovalve mounted on a linear or rotary actuator, the operational aspects discussed also apply when a servovalve(s) is manifold mounted to an actuator. Refer to Figure 4-1 during this discussion.

Figure 4-1. Series 252 Servovalve — Cross-Sectional View

The Series 252 Servovalve consists of a torque motor and two stages of hydraulic regulation. The torque motor stage consists of the coils, an upper and lower pole piece, the armature, and two magnets. It converts the electrical control signal into physical movement of the armature.
The first stage of hydraulic regulation 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. The armature/flapper assembly is supported by a flexure tube.

The second stage 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.

In operation, the control signal energizes the coils causing the armature to rotate in either a clockwise or counterclockwise direction, dependent on the polarity of the control signal. As the armature/flapper rotates it controls the flow of hydraulic fluid from 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 which is used to position the second stage spool.

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, trying to recenter the flapper.

The spool will move until the feedback wire torque equals the control signal torque and recenters the flapper. When the flapper recenters (nozzle openings equal), it will cause the pressure (not necessarily the area) at the ends of the spool to equalize, and the spool movement to cease. Hydraulic fluid will continue to flow to the actuator. This means that for any level of control signal, there will be a corresponding spool position, dependent upon the magnitude and polarity of the control signal.

When the control signal decreases to zero the flapper creates a pressure imbalance to 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.