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Introduction

This manual documents Series 359 Load Units. These small load units are available in the following configurations:

- The axial load unit has an actuator that applies linear forces to specimens.
- The axial-torsional load unit combines an axial actuator with a torsional actuator to simultaneously apply axial and torsional forces to specimens.

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The axial unit shown here is a base unit (no options).
The axial-torsional unit shown includes most of the available options.
MTS Systems Corporation assumes that you know how to use your controller. See the appropriate manual for information about performing any controller-related step in this manual’s procedures. You are expected to know how to perform the following procedures:

- Turning hydraulic pressure on and off
- Selecting a control mode
- Manually adjusting the actuator position
- Zeroing a sensor signal
- Zeroing a sensor output
- Using your grips and fixtures
- Defining a simple test
- Running a test

The Series 359 Load Unit includes several other products. See the following product information manuals for product-specific information and maintenance procedures.

- The Series 111 Accumulator Product Information manual (part number 011-553-304)
- The Series 252 Servovalve Product Information manual (part number 011-182-906)
Components Identification

Rear View of an Axil-Torsional Load Unit

- ADT
- Rotary Actuator
- LVDT
- Lifting Rings
- Crosshead Lifts
- Accumulators
- Crosshead
- Manifold
- Clamp Ring
- Servo valves
- Linear Actuator
- Control Panel (located on the front of the load unit)
- Force Transducer
- Isolation Pads

Rear View of an Axil-Torsional Load Unit
## Component Descriptions

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td>Measures the angle of the rotary actuator’s travel. The angular displacement transducer (ADT) is coupled to the rotary actuator.</td>
</tr>
<tr>
<td>Rotary actuator</td>
<td>Applies rotational forces to a specimen. The rotary actuator is coupled to the linear actuator for axial-torsional load units.</td>
</tr>
<tr>
<td>LVDT</td>
<td>Measures the displacement of the linear actuator’s travel. The linear variable displacement transducer (LVDT) is located inside the actuator.</td>
</tr>
<tr>
<td>Lifting rings</td>
<td>Allow the load unit to be moved by lifting the entire load unit.</td>
</tr>
<tr>
<td>Crosshead lifts</td>
<td>Raise and lower the crosshead hydraulically to accommodate different specimen sizes. The lifts are small hydraulic actuators.</td>
</tr>
<tr>
<td>Crosshead</td>
<td>Moves up and down the column to accommodate different sized specimens and fixtures. The crosshead is stiff and light weight; it is one end of the force train.</td>
</tr>
<tr>
<td>Clamp ring</td>
<td>Provides additional protection against the crosshead slipping. The clamp ring can be positioned anywhere along one of the columns.</td>
</tr>
<tr>
<td>Force transducer</td>
<td>Measures the forces applied to specimen. It is a strain gage type, accurate in both dynamic and static tests. Both axial and axial-torsional force transducers are available.</td>
</tr>
<tr>
<td>Isolation pads</td>
<td>Dampen the load unit’s natural frequency to about 20 Hz.</td>
</tr>
<tr>
<td>Accumulators</td>
<td>Store hydraulic fluid under pressure to increase the actuator’s response time. One accumulator connects to the pressure line; the other to the return line.</td>
</tr>
<tr>
<td>Manifold</td>
<td>Serves as the junction point between the hydraulic power unit (HPU), accumulators, servovalve, and actuator. The manifold is mounted to the crosshead. It is also a hydraulic circuit that connects the hydraulic components.</td>
</tr>
<tr>
<td>Servovalues</td>
<td>Control both the amount and the direction of fluid entering the actuator using a high response valve. It determines how fast the actuator can move. A servovalve is required for each actuator.</td>
</tr>
<tr>
<td>Linear actuator</td>
<td>Applies axial forces to specimens. The actuator is a hydraulically powered device that provides linear displacement of (or forces into) a specimen. Grips and fixtures can be mounted to the actuator.</td>
</tr>
<tr>
<td>Control panel</td>
<td>The <strong>Emergency Stop</strong> button is standard, the other controls are optional. See “Control Panel” on page 22 for more information.</td>
</tr>
<tr>
<td>Grip controls</td>
<td>Clamp and unclamp hydraulically controlled grips during specimen installation and removal.</td>
</tr>
<tr>
<td>Crosshead lift control</td>
<td>Controls the crosshead lifts to raise and lower the crosshead hydraulically.</td>
</tr>
<tr>
<td>Emergency stop</td>
<td>Removes hydraulic pressure from the load unit and issues an interlock signal to the controller to stop the test program.</td>
</tr>
</tbody>
</table>
**Functional Description**

The load unit is a stand alone testing structure. It consists of the following components:

- Load frame
- Crosshead lifts
- Manifold
  - Actuators
  - Servovalves
  - Accumulators
- Two or more transducers

**Load frame**
The load frame is the basic structure. Two columns allow a crosshead to be moved up or down to accommodate different size specimens and fixtures. The crosshead is one of the two reaction masses in the force train and the base of the load frame is the other. A control panel lets you perform specimen installation procedures.

**Crosshead**
The crosshead has the actuator, servovalve, manifold, and accumulators mounted to it. It usually has a grip or special fixtures attached to the actuator of the crosshead to install one end of the test specimen.

The crosshead can be positioned anywhere along the load frame columns. This lets you test specimens of different lengths. It can be moved along the column manually or with hydraulic lifts. When the crosshead is in an appropriate test position, it is manually clamped to that position.

**Manifold**
The actuator manifold acts as the hydraulic interface between the HPU and the components mounted to the manifold (actuator, servovalves, and accumulators) of the load unit. It contains the required hydraulic porting and plumbing to accommodate the various hydraulically controlled components. The manifold can also control the hydraulic pressure to the load unit.

**Actuator**
The linear actuator is located in the middle of the crosshead. It is a hydraulically powered piston that applies displacement of (or force into) a specimen. It can apply equal power in tension and compression. One end of the test specimen is installed into a fixture mounted to the end of the actuator rod.

The rotary actuator is coupled to the linear actuator. It is a hydraulically powered piston that applies angular displacement of (or torsional force into) a specimen.

**Servovalves**
The servovalve regulates the rate and direction of hydraulic fluid flow to and from a hydraulic actuator. The load unit usually includes a Series 252 Servovalve. Each actuator requires a servovalve.
Accumulators

The accumulators suppress line-pressure fluctuations. The load unit includes a pressure-line accumulator to provide fluid storage so a constant line pressure can be maintained at the servovalves for maximum performance. The return-line accumulator minimizes return-line pressure fluctuations.

Pressure control

The load unit can be configured for several pressure configurations.

- The free low configuration passes the hydraulic pressure from the HPU (or hydraulic service manifold) through the manifold to the hydraulic components. This configuration has no pressure controls, the hydraulic pressure is controlled by the HPU.
- The on/off configuration applies or removes high-hydraulic pressure to the load unit.
- The high/low/off configuration applies high or low hydraulic pressure to the load unit.
- The proportional valve configuration applies high or low hydraulic pressure to the load unit using a proportional valve to ramp the pressure transitions.

Transducers

The axial load unit includes a force transducer and an LVDT to measure linear forces and displacements. The axial-torsional load unit includes an axial-torsional force transducer, an LVDT, and an ADT.

Force

The force transducer (also called load cell or force sensor) measures the amount of tension or compression applied to it. It has four strain gages that form a balanced Wheatstone bridge. When forces are applied to the bridge, it becomes unbalanced and produces an electrical signal that is proportional to the force applied to it. The axial-torsional transducer includes two Wheatstone bridges; one to measure linear forces and the other to measure rotational forces. Force transducers are resistive devices and require a DC conditioner to process the signals from each Wheatstone bridge.

LVDT

The LVDT measures the linear actuator’s travel. The LVDT consists of a transformer with one primary and two secondary coils wound on a common cylinder. The coil is stationary inside the actuator. A core is attached to the piston rod of the actuator. As it moves inside the coil, it produces an electrical signal that represents the position of the piston rod. The phase of the signal indicates the direction the actuator rod is moving. An LVDT requires an AC conditioner to process the signal.

ADT

The ADT measures the amount of rotation produced by the rotary actuator. It is coupled to the rotary actuator. An ADT is a capacitive device and requires a DC conditioner to process its signals.
## Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Load frame</strong></td>
<td></td>
</tr>
<tr>
<td>Lifts</td>
<td>Optional on axial, standard on axial-torsional</td>
</tr>
<tr>
<td>Locks</td>
<td>Manual</td>
</tr>
<tr>
<td>Grip control</td>
<td>Optional, hydraulic control</td>
</tr>
<tr>
<td>Axial stiffness</td>
<td>$275 \times 10^6$ N·m ($1.57 \times 10^6$ in·lb) (measured)</td>
</tr>
<tr>
<td>Torsional stiffness</td>
<td>$1,810$ kN·m/rad ($16.0 \times 10^6$ in·lb/rad)</td>
</tr>
<tr>
<td>Torsional stiffness with drive assembly</td>
<td>$175$ kN·m/rad ($155 \times 10^3$ in·lb/rad) at maximum crosshead height</td>
</tr>
<tr>
<td><strong>Service manifold</strong></td>
<td></td>
</tr>
<tr>
<td>Axial</td>
<td>On/off control or optional proportional valve</td>
</tr>
<tr>
<td>Torsional</td>
<td>Proportional valve standard, adjustable low-pressure setting</td>
</tr>
<tr>
<td><strong>Axial actuator</strong></td>
<td></td>
</tr>
<tr>
<td>Static force capacity</td>
<td>$15$ kN (3.3 kip), $25$ kN (5.5 kip)</td>
</tr>
<tr>
<td>Stroke</td>
<td>$100$ mm (4.0 in)</td>
</tr>
<tr>
<td><strong>Torsional actuator</strong></td>
<td></td>
</tr>
<tr>
<td>Static torque capacity</td>
<td>$200$ N·m (2000 in·lb)</td>
</tr>
<tr>
<td>Torsional displacement</td>
<td>$270^\circ$ (calibrated)</td>
</tr>
<tr>
<td><strong>Rotational motor</strong></td>
<td></td>
</tr>
<tr>
<td>Torque capacity</td>
<td>$40$ N·m (400 in·lb)</td>
</tr>
<tr>
<td>Rotation, displacement control</td>
<td>$3600^\circ$ (10 turns)</td>
</tr>
<tr>
<td>Rotation, rpm control</td>
<td>$330$ rpm</td>
</tr>
<tr>
<td><strong>Linear variable differential transformer</strong></td>
<td>requires an AC conditioner</td>
</tr>
<tr>
<td><strong>Angular displacement transducer</strong></td>
<td>requires a DC conditioner</td>
</tr>
<tr>
<td>Accuracy</td>
<td>$&lt;0.3%$ of full scale, throughout $280^\circ$, on a $300^\circ$ full-scale unit</td>
</tr>
<tr>
<td>Resolution</td>
<td>Infinite</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>approximate</td>
</tr>
<tr>
<td>Axial</td>
<td>$192.8$ kg (425 lb)</td>
</tr>
<tr>
<td>Axial-Torsional</td>
<td>$240.4$ kg (530 lb)</td>
</tr>
</tbody>
</table>
# Force Transducers

<table>
<thead>
<tr>
<th><strong>PARAMETER</strong></th>
<th><strong>SPECIFICATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Static overload capacity 150% of rating.</td>
</tr>
<tr>
<td>Model 661.19F-02</td>
<td>10 kN</td>
</tr>
<tr>
<td>Model 661.19F-03</td>
<td>15 kN</td>
</tr>
<tr>
<td>Model 661.19F-04</td>
<td>25 kN</td>
</tr>
<tr>
<td>Maximum excitation input</td>
<td>20 V DC</td>
</tr>
<tr>
<td>Bridge resistance</td>
<td>Axial = 350 Ω; Torsional = 700 Ω</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>0.15% of full scale</td>
</tr>
<tr>
<td>Nonlinearity</td>
<td>0.3% of full-scale axial, 0.15% of full-scale torsional</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.002% of full scale°C (0.001%/°F)</td>
</tr>
<tr>
<td>Usable range</td>
<td>-54°C (-65°F) to +93°C (+200°F)</td>
</tr>
<tr>
<td>Compensated range</td>
<td>-0°C (-18°F) to +66°C (+153°F)</td>
</tr>
<tr>
<td>Output</td>
<td></td>
</tr>
<tr>
<td>Model 661.19F-02</td>
<td>2.0 mV/V</td>
</tr>
<tr>
<td>Model 661.19F-03</td>
<td>1.0 mV/V</td>
</tr>
<tr>
<td>Model 661.19F-04</td>
<td>2.0 mV/V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PARAMETER</strong></th>
<th><strong>SPECIFICATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Axial-Torsional</td>
</tr>
<tr>
<td>Model 662.20D-03</td>
<td>10 kN / 100 N·m</td>
</tr>
<tr>
<td>Model 662.20D-04</td>
<td>15 kN / 150 N·m</td>
</tr>
<tr>
<td>Model 662.20D-05</td>
<td>25 kN / 250 N·m</td>
</tr>
<tr>
<td>Maximum excitation input</td>
<td>15 V DC</td>
</tr>
<tr>
<td>Bridge resistance</td>
<td>350 Ω Axial, 700 Ω Torsional</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>0.15% of full scale</td>
</tr>
<tr>
<td>Non-linearity</td>
<td>0.3% of full-scale axial, 0.15% of full-scale torsional</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.036% of reading/°C (0.02%/°F)</td>
</tr>
<tr>
<td>Usable range</td>
<td>-46°C (-50°F) to +93°C (+200°F)</td>
</tr>
<tr>
<td>Compensated range</td>
<td>+21°C (+70°F) to +77°C (+170°F)</td>
</tr>
<tr>
<td>Output</td>
<td>1.5 mV/V at full-scale load (662.20-03, 04)</td>
</tr>
<tr>
<td></td>
<td>2 mV/V at full-scale load (662.20-05)</td>
</tr>
</tbody>
</table>
Dimensions

The following figure shows the dimensions of the axial and axial-torsional load units.
Thread Sizes

Axial

- M16 X 2.00 mm (supplied with eye bolts for lifting)
- M12 X 1.25 mm (actuator and load cell)
- M12 X 1.75 mm (baseplate and bottom of crosshead)

Axial-Torsional

- M16 X 2.00 mm (supplied with eye bolts for lifting)
- M12 X 1.25 mm (actuator axial-torsional adapter and load cell*)
- M8 X 1.25 mm on 78.7 mm diameter bolt circle (actuator axial-torsional adapter and load cell*)
- M12 X 1.75 mm (baseplate and bottom of crosshead)

* The 25 kN/250 N·m axial-torsional force transducer is provided with an adapter with an M12 X 1.25 mm center thread and an M8 X 1.25 mm on 78.7 mm diameter bolt circle to match the actuator axial-torsional adapter.
This section describes how to install the Series 359 Load Unit.

**Contents**

Connecting Cables  18
Connecting Hydraulics  19

**Note**  Your load unit may have additional components installed at MTS Systems Corporation (such as a force transducer, adapter fixtures, and grips).

**Procedure**  Perform the following installation procedure to install the Series 359 Load Unit.

1. **Unpack the load unit.**

   The load unit is shipped on a wooden pallet in a wooden crate.
   
   A. As needed, remove the shipping container.
   
   B. Make sure the two lifting eyes are tight.
   
   C. Remove the tie-down bolts holding the load unit to the pallet (unless you choose to move the load unit with a fork lift, then go to Step 3).

2. **Inspect the load unit for damage.**

   Look for the following:
   
   • Scratches in the load unit or lift cylinder columns
   
   • Damaged electrical connections
   
   • Damaged hydraulic connections
   
   • Dents and other structural damage
   
   • Torn, kinked, or breaking hoses

   Report any damage found to both the carrier and MTS. In the U.S. and Canada, call the MTS HELPLine at 1-800-328-2255. Elsewhere, contact your local MTS office.
3. **Move the load unit.**

The load unit can be moved with a forklift as long as it remains attached to its pallet. Otherwise use the lifting eyes mounted to the top of each column.

- The axial load unit weighs about 195 kg (425 lb).
- The axial-torsional load unit weighs about 240 kg (530 lb).

A. Center the overhead crane directly over the load unit.
B. Attach straps to the lifting eyes.
C. Adjust the straps so that each strap carries about the same weight. Remove any slack in the slings.
D. Keep the straps vertical to avoid straining the lifting eyes—do not let them get more than 30° from the vertical.
E. Lift the load unit clear of its pallet and move it to its location.

4. **Secure the load unit.**

The load unit must be secured to an adequate platform before it can be operated. The base of the load unit has a threaded hole in each corner (M12 x 1.75 mm).

A. If necessary, drill four mounting holes for the load unit. The load unit hole pattern is shown below.

B. Position the load unit onto its isolation pads.
C. Align the load unit with the mounting holes. Install the threaded stud into the threaded hole in each corner of the load unit.
D. Mount the load unit on the workbench using the hardware included with the isolation tie-down kit.

5. Connect the signal cables.

All of the cables connect to your controller. See your controller documentation or a cable assembly drawing for information about connections and cable assembly numbers. Complete “Connecting Cables” on page 18 and return to this procedure.

6. Connect the hydraulics.

The hydraulic connections vary with the load unit configuration. Complete the procedure “Connecting Hydraulics” on page 19 and return to this procedure.

**WARNING**

Never operate hydraulic crosshead lifts before bleeding air from these lifts.

Air trapped in these lifts could let the crosshead drop. You can be hurt and your equipment damaged.

See “Bleeding the Hydraulic Lift Cylinders” on page 36 for instructions to bleed the lifts.

7. If you have hydraulic lifts, bleed the air out of the hydraulic lift cylinders.

Go to “Bleeding the Hydraulic Lift Cylinders” on page 36. Complete that procedure and return to this procedure.

8. Install the grips and/or fixtures required for your test.

See your grip manual or fixture drawings for installation information.
Connecting Cables

Your controller manual should have cabling information about the connections described in this section. Most controller manuals provide the signal pinouts of the connector, assembly numbers for standard MTS cables, and cable specifications for cables you may build.

**Note** Skip any steps in the following procedure that do not apply to your load unit. For example, an axial load unit does not have an ADT or second servovalve.

**Prerequisite**

You must have either a cable assembly drawing of your entire system, or you must know the system controller well enough to determine each type of cable connection.

1. The ADT connects to a DC conditioner in the controller for the torsional channel.
2. The LVDT connects to an AC conditioner in the controller for the axial channel.
3. The manifold connects to the hydraulic service manifold connection at the controller.
4. The servovalves connect to a valve driver in the controller.
5. The force transducer connects to a DC conditioner in the controller. An axial torsional force transducer has two connectors which are connected to two DC conditioners.
6. The load unit control panel connects to the controller. It contains the emergency stop signal.
Connecting Hydraulics

The internal hydraulic connections to accessories such as the hydraulic lifts should already be made. The relevant connections are shown below.

1. Connect the pressure, return, and drain lines from the hydraulic power unit (HPU) to the hydraulic ports on the load unit.
   - The hydraulic lines may be connected to the base of the load unit or directly to the manifold.
   - The manifold has type -6 connections. The base of the load unit has type -8 connections.
   - The connections you use depend on the type of HPU and the configuration of your load unit. Adapters may be needed.

2. Turn on the HPU and check for any hydraulic pressure leaks.

3. Turn on the actuator manifold (also called a hydraulic service manifold or HSM) and check for hydraulic leaks in the load unit.
Operation

This section explains how to use the Series 359 Load Unit.

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- Control Panel  22
- Installing a Specimen  23
  - Moving the Crosshead Hydraulically  25
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- Adjusting the Grips’ Clamping Rate  27
- Adjusting the Grips’ Force  28
- Installing an Auxiliary Force Transducer  29
This section describes the front panel controls of the Series 359 Load Unit.

### Control Panel

<table>
<thead>
<tr>
<th>Control</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic Grip Control</strong></td>
<td>Controls the optional hydraulic grips. Hydraulic grips let you quickly and easily install and remove specimens. The left handle controls the lower grip and the right handle controls the upper grip. See “Installing a Specimen” on page 23.</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>Adjusts the amount of hydraulic pressure to the grips. The adjustment range is 1–21 MPa (100–3000 psi). Adjust the control clockwise to increase the hydraulic pressure. Use the pressure gage to measure the clamping pressure. See “Adjusting the Grips’ Force” on page 28.</td>
</tr>
<tr>
<td><strong>Rate</strong></td>
<td>Adjusts how fast the grips clamp and unclamp. Adjust the control clockwise to slow the clamping of the specimen. See “Adjusting the Grips’ Clamping Rate” on page 27.</td>
</tr>
<tr>
<td><strong>Crosshead Lift Control</strong></td>
<td>Controls the movement of the crosshead. The handle raises and lowers the crosshead. The crosshead shouldn’t be moved while it is clamped. See “Installing a Specimen” on page 23.</td>
</tr>
<tr>
<td><strong>Emergency Stop</strong></td>
<td>Shuts down the hydraulic pressure and stops the test program. The button stays down after you press it. Twist the button clockwise to release it. Use the Emergency Stop button to shut down your test if something unexpected should happen.</td>
</tr>
</tbody>
</table>
Installing a Specimen

The procedure to install a specimen varies due to the variety of test fixtures, grips, and the type of specimen being installed. This section should be considered a guideline. You need to modify this procedure to suit your equipment.

**Prerequisite**

You should have the necessary grips and/or fixturing installed. You should also have the controller set up to control the actuator movement, and you should have a test program defined.

**WARNING**

Be careful when working in a crush zone.

The crosshead can drop suddenly, crushing hands, damaging grips, and smashing specimens.

Ensure you have hydraulic pressure on before unlocking the crosshead.

The crosshead Lift Control must be in the stop “O” position before you unlock the crosshead.

The crosshead cannot securely clamp greasy or wet columns. Keep them clean and dry. See “Cleaning the Load Unit Columns” on page 33.

Air in the lifts will make the crosshead move roughly. If it moved roughly when last used, bleed the lifts before unlocking the crosshead. See “Bleeding the Hydraulic Lift Cylinders” on page 36.

**Procedure**

1. Set things up for specimen installation.

   A. Be sure that the crosshead is locked.
   
   B. Turn on system electrical power.
   
   C. If necessary, reset any active interlocks at the test controller.
   
   D. Turn on low hydraulic pressure; turn on high hydraulic pressure if low pressure is not available.
   
   E. Determine the size of the test area.
      
      You need to know the length of the specimen, the height of the grips and fixtures, and the displacement of the test. This information lets you determine the approximate position for the crosshead and actuator.
   
   F. Use your controller to move the actuator to its start position (usually mid-displacement).
      
      The starting position of the actuator depends on the type of fixtures, grips, and test being set up.
2. **Move the clamp ring out of the way.**

Loosen the clamp ring (located on one of the columns) and slide it down the column.

---

**CAUTION**

**Do not leave a crosshead unlocked.**

*It can drift slowly down when hydraulic pressure is turned off and damage any test fixtures, grips, and specimen in its path.*

Unlock the crosshead only to reposition it. Always lock the crosshead after you have repositioned it.

---

3. **Set the crosshead position.**

- If you have hydraulic lifts, go to “Moving the Crosshead Hydraulically” on page 25 to position the crosshead.

- If you have manual lifts, go to “Moving the Crosshead Manually” on page 26 to position the crosshead.

4. **Clamp the specimen.**

Each type of grip requires the specimen or specimen fixture to fit properly into the grip. See the appropriate grip manual to determine the required specimen size and shape that will fit into the grip.

**Note**  
The axial-torsional load unit requires hydraulic lifts.

If you have manual grips, see the grip product manual for information about clamping the specimen.

If you have hydraulic grips, perform the following:

A. Use the **Hydraulic Grip Controls** to clamp the specimen into the upper grip or fixture.

B. You can use the controller to fine-tune the position of the actuator so that the bottom of the specimen is located in the lower grip.

C. Use the **Hydraulic Grip Controls** to clamp the specimen into the lower grip or fixture.

5. **Zero the transducer signals.**

Depending on your test requirements, use the controller to zero the displacement, force, and (if available) torsional signals so that each signal represents the null point.
Moving the Crosshead Hydraulically

This procedure describes how to position a crosshead for a Series 359 Load Unit equipped with hydraulic crosshead lifts.

1. Pressurize the lift actuators. The crosshead may have shifted position while hydraulic pressure was turned off.

   Briefly turn the Crosshead Lift Control to the lift crosshead position to apply a slight upward pressure to the crosshead.

   Then return the lift control to the stop position “O”.

2. Unclamp the crosshead. Loosen the four bolts that clamp the crosshead to the columns.

3. Use the Crosshead Lift Control to move the crosshead to a point where you can install the specimen (or specimen fixture) into the upper grip or fixture without obstruction.

   Set the control to the stop position “O” before proceeding.

   Note Always lower the crosshead to where you want it. The pressure remaining in the lift cylinders after raising the crosshead can slightly shift its alignment. Lowering the crosshead to its final position removes this pressure and improves alignment.

4. Tighten the crosshead clamping bolts to secure the crosshead in place.

   Torque the clamping bolts according to the torque settings shown for Step 1 in the following table. Use the bolt sequence shown above. Then torque the crosshead bolts to the values in Step 2 and so on until Step 4 is complete.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 N·m (25 lbf·ft)</td>
<td>70 N·m (50 lbf·ft)</td>
<td>100 N·m (75 lbf·ft)</td>
<td>135 N·m (100 lbf·ft)</td>
</tr>
</tbody>
</table>

5. Position the clamp ring.

   Slide the clamp ring on the column just under the crosshead position and tighten it.

6. Return to Step 4 on page 24 of “Installing a Specimen” to continue.
Moving the Crosshead Manually

Some load units do not have hydraulic lifts and locks. This procedure describes how to position a crosshead for an axial load unit with manually with two people. You may use any device that can lift the weight of the load unit.

**Be careful when working in a crush zone.**

*The crosshead can drop suddenly, crushing hands, damaging grips, and smashing specimens.*

Ensure that the crosshead is braced or the people moving the crosshead are expecting the weight of the crosshead before unlocking the crosshead.

The crosshead cannot securely clamp greasy or wet columns. Keep them clean and dry. See “Cleaning the columns” on page 2.

**Note**  
The weight of the crosshead is approximately 45 kg (100 lb).

1. Determine where you want to position the crosshead along the columns.

2. With one person on each side of the crosshead, each person should be prepared to support the crosshead when it is loosened.

3. Loosen the clamping bolts.

4. With both people working together, raise or lower the crosshead to the desired position (if needed, use supports until the crosshead is clamped).

5. Tighten the crosshead clamping bolts to secure the crosshead in place.

   Torque the clamping bolts according to the torque settings shown for Step 1 in the following table. Use the bolt sequence shown above. Then torque the crosshead bolts to the values in Step 2 and so on until Step 4 is complete.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 N·m</td>
<td>70 N·m</td>
<td>100 N·m</td>
<td>135 N·m</td>
</tr>
<tr>
<td>(25 lbf·ft)</td>
<td>(50 lbf·ft)</td>
<td>(75 lbf·ft)</td>
<td>(100 lbf·ft)</td>
</tr>
</tbody>
</table>

6. Position the clamp ring.

   Slide the clamp ring on the column just under the crosshead position and tighten it.

7. Return to Step 4 on page 24 of “Installing a Specimen” to continue.
Adjusting the Grips’ Clamping Rate

The clamping rate determines how fast the grip can clamp a specimen.

1. Make sure both the upper grip control and lower grip control are in the unclamp position.
2. Turn on electrical power at the test controller.
3. Turn on low or high hydraulic pressure.
4. If needed, move the crosshead or actuator so that a dummy specimen can be easily installed in the lower grip.
5. Turn the Rate control fully clockwise for the slowest clamping speed.

---

**WARNING**

Do not position yourself in a crush zone. The area in the grips where the specimen is clamped is a crush zone.

The crosshead can drop suddenly, crushing hands, damaging grips, and smashing specimens.

Keep your fingers and hands out of the crush zones except when actually installing the specimen.

---

6. Install a dummy specimen in the lower grip.

7. Cycle the lower grip control between the clamp and unclamp positions to clamp and unclamp the specimen.
   
   A. Watch the speed at which the lower grip clamps and unclamps the specimen.
   
   B. Adjust the Rate control counterclockwise for the desired speed.
Adjusting the Grips’ Force

The **Pressure** control adjusts the hydraulic pressure applied to the grips. The **Rate** control adjusts the grips’ clamping speed. They must be adjusted before the grips can be used.

The amount of hydraulic pressure applied depends on the type of grips you are using and what you are gripping. Use your grip manual to determine the correct hydraulic pressure before adjusting the force. Experiment with a dummy specimen to find the best setting.

1. Make sure both the upper grip control and lower grip control are in the unclamp position.
2. Turn on the electrical power at the test controller.
3. Turn on low or high hydraulic pressure.
4. If needed, move the crosshead or actuator so that a dummy specimen can be easily installed in the lower grip.

---

**CAUTION**

**Do not adjust grip pressure higher than the grip rating.**

**Too much pressure can damage both the grips and the specimen.**

See your grip manual to determine the correct hydraulic pressure to apply to your grips before adjusting the **Pressure** control.

---

5. Adjust the **Pressure** control for the desired hydraulic pressure.
Installing an Auxiliary Force Transducer

A small, low force auxiliary axial-torsional force transducer is available as an option for the axial-torsional version of the load unit. This auxiliary transducer installs on top of a standard Series 662.20x Force Transducer.

**Recommended equipment and supplies**

- 135 N·m (100 lbf·ft) torque wrench
- Molykote® G•n paste (MTS part 110102-07) or equivalent

**WARNING**

Do not position yourself in a crush zone. The area where the auxiliary force transducer is installed is a crush zone.

The crosshead can drop suddenly, crushing hands and damaging load unit components.

Be sure you lock the crosshead, turn off electrical power, and use the clamp ring as described in the following procedure.
1. Position the crosshead to get enough space to install the isolation plate and auxiliary force transducer.

   Lock the crosshead.

2. Position the clamp ring.

   Slide the clamp ring on the column just under the desired position and tighten it.

3. Turn off the hydraulic pressure. Also turn off electrical power to the controller.

4. Install the isolation plate.
   
   A. Lightly lubricate the isolation plate’s cap screws with Molykote.
   
   B. Following the sequence shown to the right, torque the cap screws to 15 N·m (10 lbf·ft).
   
   C. Then torque the cap screws to 26 N·m (19 lbf·ft).

5. Install the auxiliary force transducer.
   
   A. Lightly lubricate the auxiliary force transducer’s cap screws with Molykote.
   
   B. Following the sequence shown to the right, torque the cap screws to 25 N·m (18 lbf·ft).
   
   C. Then torque the cap screws to 53 N·m (39 lbf·ft).

6. Switch the transducer cables from the 662.20 Force Transducer to the auxiliary force transducer.

7. Mount the adapter plate to the torsional adapter on the actuator.

   **Note**  
   
   Remember to apply the proper calibration values for the auxiliary force transducer.

   You may also want to perform the force transducer alignment procedure (see "Aligning the Force Transducer" on page 44) to ensure the most accurate test results.
This section describes the maintenance requirements for the Series 359 Load Unit. It includes procedures which must be periodically done to ensure the continued safe and effective operation of your load unit. Not all procedures may apply to your load unit.

Contents
- Daily Inspection  32
- Cleaning the Load Unit Columns  33
- Preventing Rust  34
- Checking the Accumulators’ Precharge  35
- Bleeding the Hydraulic Lift Cylinders  36
- Lubricating the Axial-Torsional Actuator  39

Maintenance schedule
The following table lists the recommended interval for each of these procedures.

<table>
<thead>
<tr>
<th>WHAT TO DO</th>
<th>WHEN TO DO IT</th>
<th>HOW TO DO IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make daily inspections</td>
<td>Before the start of each day’s testing.</td>
<td>Review the information provided in “Daily Inspection” on page 32.</td>
</tr>
<tr>
<td>Clean the load unit columns</td>
<td>When the columns become greasy or dirty.</td>
<td>See “Cleaning the Load Unit Columns” on page 33.</td>
</tr>
<tr>
<td>Prevent rust†</td>
<td>Depends on the operating environment; more often in humid environments.</td>
<td>See “Preventing Rust” on page 34.</td>
</tr>
<tr>
<td>Check the accumulators’ precharge pressures†</td>
<td>Once a month or more often depending on operating conditions.</td>
<td>See “Checking the Accumulators’ Precharge” on page 35.</td>
</tr>
<tr>
<td>Bleed the hydraulic lift cylinders†</td>
<td>When the crosshead begins to move roughly; or, if the sealed side of the hydraulic supply is opened to air.</td>
<td>See “Bleeding the Hydraulic Lift Cylinders” on page 36.</td>
</tr>
<tr>
<td>Lubricate the actuator</td>
<td>Every 75–100 hours of operation and before beginning a long series of short stroke, high frequency tests.</td>
<td>See “Lubricating the Axial-Torsional Actuator” on page 39.</td>
</tr>
<tr>
<td>Service the actuator†</td>
<td>When the actuator begins leaking hydraulic fluid or its performance becomes poor.</td>
<td>Contact MTS Systems Corporation to arrange for service.</td>
</tr>
</tbody>
</table>

* Can be made part of a regular maintenance schedule.
† Cannot be repaired by the customer; contact your MTS service engineer.
Daily Inspection

Before the start of each day’s testing, do a quick inspection of your load unit. Following tasks should be checked daily. Ensure that:

- There are no leaks from the hydraulic lifts.
- There are no leaks from the actuator, hydraulic service manifold, servovalve, or accumulators.
- The electrical connections are tight, with no frayed or poorly routed cables.
- The hoses are routed properly and the fittings are not leaking.
Cleaning the Load Unit Columns

The crosshead locks can not securely clamp the crosshead to dirty or greasy columns.

**Recommended supplies**

You need the following items to clean the load unit columns:

- #1 grade kerosene
- Lint-free cloths

**WARNING**

Be careful when working in a crush zone.

Column cleaning takes place in a crush zone where the possibility of pinched fingers and crushed hands exist.

Always lock the crosshead after moving it. Always turn off hydraulic pressure before cleaning the columns. Wait two minutes for pressure to bleed off before starting work.

1. Make sure the crosshead is locked.
2. Using a clean, lint-free cloth, clean the exposed surfaces of the columns with #1 grade kerosene.
3. Turn on system electrical power.
4. Do not turn on hydraulic pressure yet.
5. Reset any active interlocks at the test controller.
6. Apply high hydraulic pressure to the load unit.

**WARNING**

Do not unclamp and reclamp the crosshead while the columns are damp from cleaning.

The crosshead can slip and possibly injure you or damage your equipment if the columns are still damp with the cleaning kerosene.

The crosshead locks cannot securely clamp on damp columns. Wait until the columns are dry to the touch before moving and locking the crosshead.

7. If there is a specimen in the load unit, remove it.
8. Move the crosshead to expose the uncleaned section of the columns and lock the crosshead.
9. If hydraulic pressure has been turned on, turn it off. Wait 2 minutes for the pressure to bleed off before going on to Step 10.
10. Clean the remaining sections of the columns.
Preventing Rust

Where you operate the load unit determines how often you take rust prevention measures. Humid and corrosive environments require more prevention. Use the following as a guide to rust prevention measures.

**Recommended supplies**

Use the following supplies to keep your load unit looking new:

- 1 grade kerosene
- Silicone spray
- 000 emery cloth
- Gray touch up paint per 037-288-936
- Metal primer paint
- Lint-free cloths

Unpainted surfaces: Spray with silicone, and then wipe with a clean, lint-free cloth. Or, wipe with a clean, lint-free cloth dampened with clean hydraulic fluid.

Black oxide surfaces: Spray with silicone, and then wipe with a clean, lint-free cloth. Or, wipe with a clean, lint-free cloth dampened with clean hydraulic fluid.

Painted surfaces: For small scratches, use touch-up paint. For large scratches, sand, prime, and use touch-up paint.

Chrome plated surfaces: For micro-scratches, wipe with a clean, lint-free cloth dampened with #1 kerosene. For rust discoloration, polish with a very fine emery cloth, and then wipe down.
Checking the Accumulators’ Precharge

The accumulators’ correct precharge pressures are written on their labels. Begin by checking precharge pressures at least once a month.

See the Series 111 Accumulator Product Information manual for the complete details on checking the precharge intervals and servicing the accumulators.

Record both the pressures and the room temperature in a log book. Use these readings as a basis for increasing or decreasing the interval between pressure checks.

Generally, recharging is required when there is a change of 1.4 MPa (200 psi) in the pressure line accumulator or a 50% change in pressure in the return line accumulator.
Bleeding the Hydraulic Lift Cylinders

Bleed both hydraulic lift cylinders whenever the crosshead does not move smoothly (although some chatter is normal). Also bleed them whenever the sealed side of the hydraulic system has been opened to air. The following figure shows the location of the bleed ports of the lifts.

Do not leave a crosshead unlocked.

It can drift slowly down when hydraulic pressure is turned off and damage any test fixtures, grips, and specimen in its path.

Unlock the crosshead only to reposition it. Always lock the crosshead after you have repositioned it.

1. Make sure your crosshead is locked.
2. Turn on system electrical power. Do not turn on hydraulic pressure until instructed to do so.

3. Reset any active interlocks at the test controller.

4. Turn on low hydraulic pressure. If a low pressure setting is not available at your test controller, manually select low pressure at the hydraulic power unit.

5. If there is a specimen in the load unit, remove it.

---

**WARNING**

**Do not unscrew the bleed port screw all the way.**

The screw can fly out of its port at high velocity and it could hurt you or damage your equipment.

Unscrew the bleed port screw no more than 1/2 turn to vent the trapped air.

---

6. Use a 1/8-inch hex key to open one of the bleed ports.

Do not unscrew the bleed port screw more than 1/2 turn.

7. Briefly turn the **Crosshead Lift Control** to the lift crosshead position to pressurize the lift cylinders. Then return it to the stop crosshead position.

---

**Open to Bleed**

**Close When Bubble-Free**
8. Shut the bleed port when bubble-free fluid begins oozing out.
   If necessary, again pressurize the lift cylinders to force all the air out.

9. Repeat Step 6 through Step 8 to bleed the air out of the other lift cylinder.

   **Note**  If fluid continues to leak out of a shut bleed port, turn off hydraulic pressure to the load unit. Let the pressure in the lift cylinders return to zero. Then replace both bleed port screws (part number 100376-01).

10. Turn on high hydraulic pressure. If pressure was reduced at the hydraulic power unit, restore full pressure.

11. Briefly turn the **Crosshead Lift Control** to the lift crosshead position to pressurize the lift cylinders. Then return it to the stop crosshead position.

12. Unlock the crosshead and exercise the crosshead. Raise and lower the crosshead to check for smooth operation. Lock the crosshead when you are done.

13. If the crosshead does not move smoothly, go back to Step 4 and continue from there.
Lubricating the Axial-Torsional Actuator

The axial-torsional load unit has an axial-torsional coupling to connect its rotary and linear actuators. The load unit’s torque tube houses this coupling. The grease fitting (zerk) for this coupling is reached through one of two access holes in the torque tube.

![Image of Axial-Torsional Actuator]

Lubricate this coupling every 75 to 100 hours of operation and before beginning a long series of short stroke, high frequency tests.

**Recommended supplies**

Use the following supplies to lubricate the actuator:

- grease gun
- Shell Alvania® EP2 grease

**Procedure**

You must fully extend the actuator to expose the grease fitting. You may have to raise the crosshead to do this.

1. Turn on electrical power at controller.
2. Select displacement (rotation) control as both channels’ active control modes.
3. Turn on low hydraulic pressure.
4. Slowly fully extend the axial actuator.
5. Remove the caps from the torque tube’s access holes. Turn the rotary actuator until a grease fitting appears in one of the torque tube’s holes.
6. Apply two pumps of grease to the fitting. Cycle the actuator up and down a few times and apply two more pumps of grease to the fitting.
7. Reinstall the caps in the access holes.
Lubricating the Crosshead Locking Bolts

Lubricate the locking bolts when they get hard to turn.

**Recommended supplies**

Use the following supplies to lubricate the locking bolts:

- clean rags
- Molykote G•n past (MTS part number 110102-07) or equivalent
- 135 N•m (100 lbf•ft) torque wrench with a 1/2-inch hex key socket

**Procedure**

Perform the following procedure to lubricate the crosshead locking bolts.

1. Position the crosshead at a comfortable working height.
2. Lock the crosshead. Position and tighten the clamp ring just below the crosshead.
3. Remove a single locking bolt.
4. Clean the bolt threads with a stiff nylon brush. Use a degreaser if necessary. Dry the threads.

   Then lightly lubricate the threads with Molykote G•n paste.

5. Reinstall the locking bolt. Torque it to 135 N•m (100 lbf•ft).
6. Repeat Steps 3 through 5 to lubricate the other bolts.
This section describes service procedures that may need to be performed on the Series 359 Load Unit. If additional service is required, call your local MTS service representative.

**Important** This section describes service procedures that should be performed by a person who has experience servicing servohydraulic equipment. The procedures in this section require the load unit to be disassembled beyond what is needed for operation or maintenance.

We assume you are familiar with all operating aspects of your system controller (electronic and software controls) and you are familiar with the hardware components of your system.

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- Aligning the Force Transducer 44
- Replacing the Actuator Seals (Axial Only) 48
  - Removing the LVDT (Axial Only) 51
  - Installing the LVDT (Axial Only) 52
- Adjusting the LVDT Core 53
Replacing the Force Transducer

Several force transducers are available for the Series 359 Load Unit. This section describes how to install a force transducer on an axial only load unit or an axial-torsional load unit.

**WARNING**

Never replace a force transducer until you have locked the crosshead and turned off load unit hydraulic pressure.

Installation takes place in a crush zone. You could be hurt and your equipment damaged if the crosshead or actuator unexpectedly moves.

Always turn off hydraulic pressure and lock the crosshead before starting the installation.

The force transducer of the load unit is mounted to the base of the load unit.

- The axial force transducer is mounted to the base with a single threaded stud and nut.
- The axial-torsional force transducer is mounted to the base with eight socket head cap screws.

1. As needed, position the crosshead at a comfortable working height.
   - Make sure the crosshead is locked.
   - Make sure the load unit hydraulic pressure is off.
2. Turn off the electrical power to the controller.
3. Disconnect the cable from the force transducer.
4. Raise the load unit.

   The load unit must be raised above the mounting surface to access the threaded fasteners of the force transducer. The threaded fasteners are accessed from the bottom of the load unit.

   A. Loosen the load unit’s legs from their mounting surface.
   B. Put blocks of wood under the load unit’s legs to increase the clearance between the load unit and its mounting surface.
   C. The load must be raised high enough to use a torque wrench on the force transducer’s threaded fasteners.

5. Remove the nuts (or screws) holding the force transducer in place.

6. Remove the threaded screws from the force transducer and clean them.

7. Install the threaded screws into the new force transducer.

8. Install the replacement transducer with the mounting bolt removed in Step 6.

9. Go to “Aligning the Force Transducer” on page 44 to align the force transducer, and then return to this procedure.

10. Torque the nuts (or screws) as follows.

    • For an axial system, tighten the center nut only to 85 N·m (62 lb·ft).
    • For an axial torsional system, tighten the screws using the sequence shown to the right. Torque the screws to 24 N·m (17 lb·ft)

11. Tilt the load unit back on its feet.

12. Go to “Aligning the Force Transducer” on page 44 to ensure the alignment hasn’t changed.
Aligning the Force Transducer

A force transducer must be aligned with the actuator piston whenever the force transducer is installed or the actuator serviced. The force transducer can also be aligned whenever you want to increase test accuracy.

Alignment has two major tasks:

- Find the Current Total Indicated Runout (TIR)
- Get the TIR within Specifications

TIR measures alignment accuracy and it is the difference between maximum and minimum dial indicator readouts. The smaller the TIR, the better.

**Recommended supplies**

You will need the following equipment to align a force transducer:

- 135 N·m (100 lbf·ft) torque wrench
- Nylon mallet
- 0.0025 mm (0.0001 in.) dial indicator with a magnetic base

**WARNING**

**Alignment takes place in a crush zone.**

The crosshead could drop suddenly, crushing hands and damaging load unit components.

Be sure you lock the crosshead, turn off electrical power, and use the clamp ring as described in the following procedure.

1. **Get things ready.**
   
   A. Be sure that the crosshead is locked.
   
   B. If grips are installed, remove them.
   
   C. Turn on system electrical power.
   
   D. If necessary, reset any active interlocks at the test controller.
   
   E. Loosen the clamp ring (located on one of the columns) and slide it down the column.
   
   F. Turn on low hydraulic pressure; turn on high hydraulic pressure if low pressure is not available.
   
   G. Position the actuator at midstroke.
Do not leave a crosshead unlocked.

It can drift slowly down when hydraulic pressure is turned off and damage any test fixtures, grips, and specimen in its path.

Unlock the crosshead only to reposition it. Always lock the crosshead after you have repositioned it.

2. Set the crosshead position.

Move the crosshead or actuator so that there is about 360 mm (14 in) between the bottom of the actuator and the top of the force transducer. You need enough room to use a dial indicator.

- If you have hydraulic lifts, go to “Moving the Crosshead Hydraulically” on page 25 to position the crosshead.
- If you have manual lifts, go to “Moving the Crosshead Manually” on page 26 to position the crosshead.

Set and enable the test controller’s upper and lower limit detect interlocks to limit the actuator’s movement to 2 mm (0.1 in) in each direction.

3. Check the alignment.

In this step, you check the alignment between the force transducer and the actuator.

A. Attach and Zero the Indicator

- Attach the dial indicator to the actuator.

  On a low profile force transducer, adjust the indicator to take the reading along the edge of the loading surface.

  On cylindrical style force transducers, adjust the indicator so that its stylus just touches the inside edge of the pilot.
B. Zero the dial indicator.

C. Slowly turn the actuator to rotate the indicator 360° around the force transducer.

Stop frequently to take dial indicator readings. Keep your hands off the actuator and indicator when taking the readings. Recording the TIR readings maps the direction the transducer is off center.

Compute the TIR. Take the maximum dial indicator reading and subtract the minimum dial indicator reading.

D. If the TIR is 0.038 mm (0.0015 in) or less, the force transducer is accurately aligned with the actuator. This completes the procedure.

If the TIR is greater than 0.038 mm (0.0015 in), the force transducer needs to be aligned with the actuator. Continue to the next step.

4. Raise the load unit.

The load unit must be raised above the mounting surface to access the threaded fasteners of the force transducer. The threaded fasteners are accessed from the bottom of the load unit.

A. Loosen the load unit’s legs from their mounting surface.

B. Put blocks of wood under the load unit’s legs to increase the clearance between the load unit and its mounting surface.

C. The load must be raised high enough to use a torque wrench on the force transducer’s threaded fasteners.
5. Adjust the force transducer alignment.
   A. Loosen the force transducer just enough so that it will move when tapped by a nylon mallet.
      • Loosen the threaded fastener that holds the axial force transducer.
      • Loosen the eight threaded fasteners that hold the axial-torsional force transducer.
   B. Based on the TIR results, tap the force transducer so it moves enough to produce an acceptable TIR deviation.
   C. Go to Step 3 on page 45 and determine if the force transducer and actuator are aligned.
      • If the force transducer is accurately aligned with the actuator, finish this procedure.
      • If the force transducer is not accurately aligned with the actuator, return to Step B of this step.
   D. Torque the nuts (or screws) as follows.
      • For an axial system, tighten the center nut only to 85 N·m (62 lb·ft).
      • For an axial torsional system, tighten the screws using the sequence shown to the right. Torque the screws to 24 N·m (17 lb·ft).

6. Check the alignment again.
   Take another reading to make sure the TIR remains within specifications.
   • If the TIR remains within specifications, continue to the next step.
   • If the TIR is out of specification, return to Step 3 in this procedure.

7. Lower the load unit.
   Remove the blocks of wood elevating the load unit and reattach the load unit to its mounting surface.
Replacing the Actuator Seals (Axial Only)

**Note**  The axial-torsional actuator cannot be serviced in the field. Contact MTS Systems if service is needed.

The axial actuator is equipped with a low-pressure wiper seal in each end cap. Replace the piston rod seals when excessive oil leaks past the seals, or whenever you disassemble the actuator.

**Note**  When the low-pressure seal or the piston seal is removed, the seals will probably be damaged. We recommend that a seal kit be available before performing the following procedure. The seal kit is MTS part number 100-005-103.

**Note**  Servicing the actuator should be performed in a clean environment to prevent contaminants from entering the actuator.

Note  There will be some hydraulic fluid loss during this procedure. Have a waste container and clean-up materials nearby to contain any spillage.

1. **Prepare the actuator for service.**

   Before you can perform any service procedures, you must remove any fixtures and disconnect the actuator from the test system.

   A. Remove any fixtures from the piston rod end.

   B. Extend the piston rod completely. This forces the fluid from the one half of the actuator.
C. Ensure that system hydraulic pressure has been reduced to zero before proceeding. To do this, turn off the hydraulic power unit and exercise the actuator until it stops moving.

**Note**  
The system hydraulic pressure must be at zero before proceeding.

D. Disconnect the pressure line at the actuator and cap the line. Connect a hose from the pressure port to a drain pan.

E. Press the piston rod into the actuator to push the remaining fluid out through the pressure port. Remove the hose and plug the open port.

F. Disconnect the return line and drain line from the actuator. Cap the lines and plug the open ports.

G. Disconnect the cables from the transducers and servovalves.

2. **Replace the front end cap seal.**

   A. Remove the retaining ring from the front end cap by inserting a small screwdriver into the slot on top of the ring and prying toward the piston rod.

   B. Remove the tee fitting from the front end cap.

   C. Apply pressurized shop air through the tee fitting to blow the low-pressure seal out of the front end cap.

   D. Lightly oil the new seal with clean hydraulic fluid and gently work it into place.

   E. Reinstall the retaining ring (removed in Step A).

   F. Reinstall the tee fitting (removed in Step B).

3. **Remove the LVDT.**

   Go to "Removing the LVDT (Axial Only)" on page 51. Remove the LVDT and then return to this procedure.
4. Replace the rear end cap seal
   A. Remove the retaining ring from the rear end cap by inserting a small screwdriver into the slot on top of the ring and prying toward the piston rod.
   B. Apply pressurized shop air through the drainback fitting to blow the low-pressure seal out of the rear end cap.
   C. Install a new low-pressure seal. Lightly oil the new seal with clean hydraulic fluid and work the new seal into place. Install the retaining ring removed in Step A.
   D. Set the spacer tube in place on the rear end cap.

5. Reinstall the LVDT.
   Go to “Installing the LVDT (Axial Only)” on page 52. Install the LVDT, and then return to this procedure.

6. Reconnect the electrical cables.
   Reconnect the appropriate cables to the servovalve and the LVDT. See “Connecting Cables” on page 18 for cable identification. See the appropriate servovalve manual for connector identification.

7. Reconnect the hydraulics.
   Reconnect the hydraulic pressure and return lines to the actuator. See “Connecting Hydraulics” on page 19 for more information.

8. Adjust the LVDT.
   Go to “Adjusting the LVDT Core” on page 53. This procedure defines the midpoint of the actuator's movement as the zero position.

9. Check the LVDT calibration.
   Go to the controller manual and look for an LVDT calibration procedure (also called displacement or length).

10. Reconnect any fixtures.
    Reconnect the hydraulic pressure and return lines to the actuator. See “Installation” on page 15 for more information.

Note: Do not install any accessories to the piston rod until the LVDT has been adjusted.
Removing the LVDT (Axial Only)

**Note** The axial-torsional actuator cannot be serviced in the field. Contact MTS Systems if service is needed.

The linear variable differential transformer (LVDT) consists of two assemblies. The LVDT coil is attached to the mounting plate with a locking collar. The LVDT core has an extension that mounts the assembly to the actuator with the core mount setscrew.

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**CAUTION**

Avoid contact between the LVDT coil and other objects.

The LVDT coil can be damaged if it is handled roughly.

Be careful when removing the LVDT from the actuator.

1. Use a flat blade screwdriver to remove the locking setscrews and remove the LVDT core extension from inside the piston rod.

2. Remove the hex nuts securing the mounting plate to the actuator assembly.

   **Note** The studs go all the way through the spacer tube.

3. Remove the mounting plate and LVDT coil from the actuator.

   Pull the mounting plate straight away from the actuator so that the LVDT coil does not hit the piston rod, end cap, or cover tube.

4. Set the mounting plate and LVDT coil in a safe place.

5. Remove the cover tube.
Installing the LVDT (Axial Only)

**Note**  The axial-torsional actuator cannot be serviced in the field. Contact MTS Systems if service is needed.

Use the figure “LVDT Assembly” on page 53 for the following procedure.

1. Position the cover tube on the end cap of the actuator.

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**CAUTION**

Avoid contact between the LVDT coil and other objects.

The LVDT coil can be damaged if it is handled roughly.

Be careful when installing the LVDT into the actuator.

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2. Install the mounting plate assembly inside the piston rod. Do not damage the LVDT coil as it slides inside the piston rod.

3. Lightly oil the studs and fasten the mounting base to the rear end cap. Tighten the nuts to 8.1 N·m (6 lbf·ft), following the sequence shown in the figure to the right.

4. Insert the LVDT core extension into the piston rod and temporarily screw it into the piston rod a few turns. It will be adjusted later.

5. Place the ball bearing in the piston and screw the core mount setscrew into the rod. This is a temporary measure to keep the setscrew from getting lost.
Adjusting the LVDT Core

The LVDT core adjustment sets a mid-displacement (midstroke) zero reference point for the actuator piston rod. The core adjustment procedure must be performed when an LVDT has been removed from the actuator.

**Note** If you want to define the zero reference point at a position other than mid-displacement (midstroke) without adjusting the LVDT core, use the offset or zero control in your controller to achieve the desired reference point.
Piston rod banding is the erosion of the piston rod chrome plating in a band encircling the piston rod. It can occur when testing for a long period of time at a short displacement.

If the actuator is being used for this type of testing, the starting position of the actuator piston rod should be changed approximately every one million cycles (5.5 hours at 50 Hz). This will extend the life of the piston rod and minimize the possibility of banding.

Defining the midpoint of the actuator’s displacement ensures that you get the same amount of capacity for tension and compression. If you want to temporarily change the zero position of your displacement channel, use the offset or zero control in your controller to achieve the desired reference point.

1. Apply low system hydraulic pressure and fully retract the actuator piston rod.
2. Ensure that system hydraulic pressure has been reduced to zero before proceeding. To do this, turn off the hydraulic power unit and exercise the actuator until it stops moving.
3. Remove any accessories from the piston rod.
4. Measure and record the distance from the end of the piston rod to the lower end cap.
5. Apply low system hydraulic pressure and fully extend the actuator piston rod.
6. Measure and record the distance from the end of the piston rod to the lower end cap.
7. Add the distance recorded in Step 4 to the distance recorded in Step 6 and divide by 2.
8. Position the actuator so that the distance between the end of the piston rod and the lower end cap is the value determined in Step 7. This is the midpoint of the piston rod displacement (stroke).
9. Ensure that system hydraulic pressure has been reduced to zero before proceeding. To do this, turn off the hydraulic power unit and exercise the actuator until it stops moving.
Adjusting the LVDT core

The LVDT core adjustment requires that you know how to monitor the LVDT signal from your controller. Some systems require you to monitor the signal with an oscilloscope connected to the controller (or a module) while other systems may have a software scope where you can monitor the LVDT signal. Some systems have both; if you have a choice, use the software scope since it monitors the signal after all signal processing has occurred (which is what the controller software uses).

**WARNING**

**Do not adjust the LVDT while hydraulic pressure remains in the system.**

**Hydraulic pressure can cause unexpected high-velocity piston rod movement which can cause personal injury and damage to equipment.**

Make sure the hydraulic pressure is zero before you proceed.

1. Monitor the LVDT signal.
   - With an oscilloscope, monitor the AC signal from the conditioning circuit that is connected to the LVDT.
   - With a software scope, monitor the displacement signal.
2. Remove the locking setscrew from the piston rod and adjust the LVDT core mount setscrew for minimum sine wave amplitude.
3. Replace the ball bearing and tighten the locking setscrew to secure the core extension.
4. It is possible that the midpoint position may have moved while adjusting the core mount and tightening the locking setscrew. Recheck the actuator position to see if the midpoint position has physically changed.
5. After adjusting the LVDT you will need to check the electronic calibration of the LVDT with the controller. It may be necessary to recalibrate the LVDT. See your controller manual for appropriate procedures.