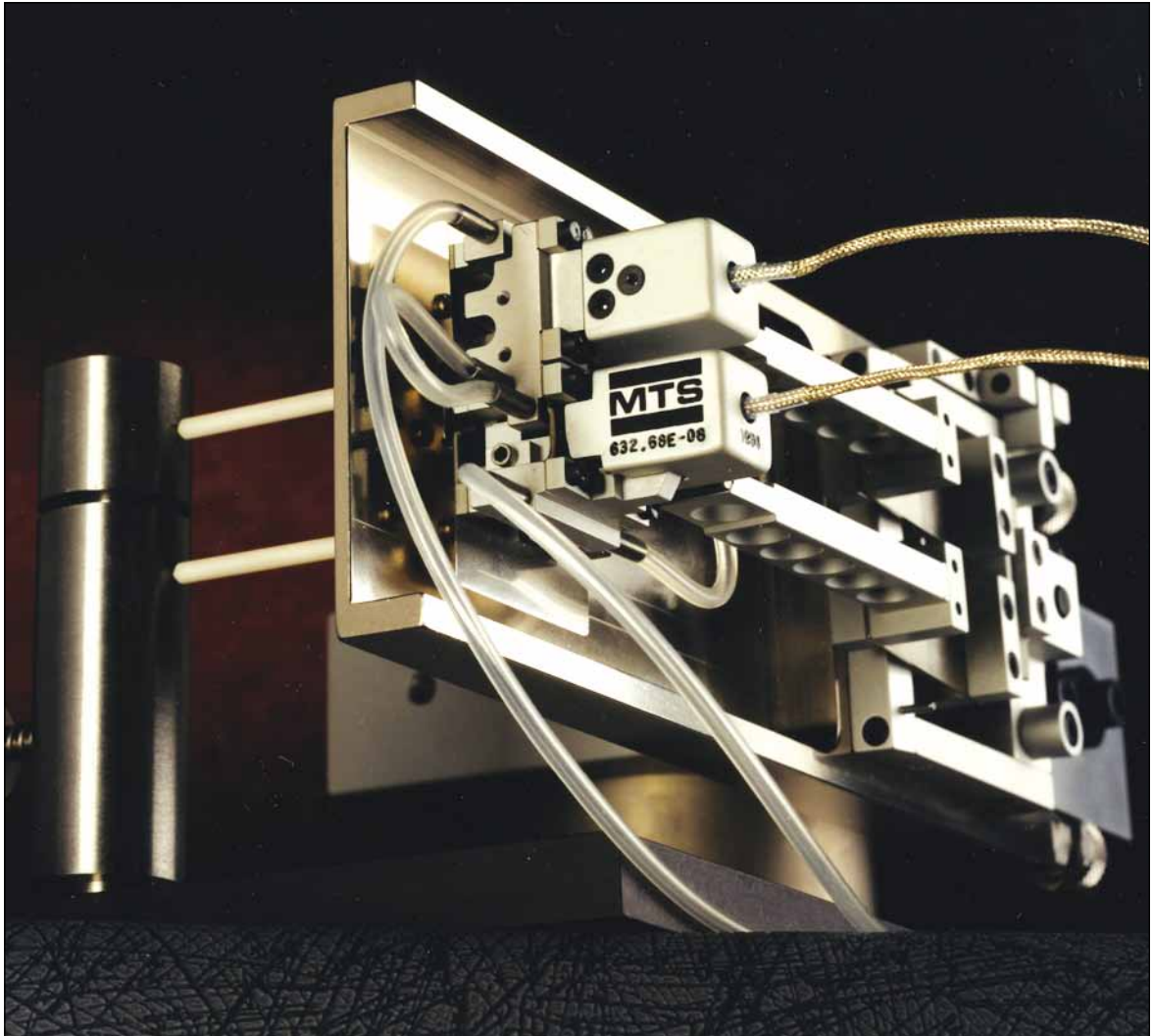




## ***632.68 High-Temperature Axial/Torsional Extensometer***



**Measure Axial Deflection And Torsional Strain  
At Temperatures Up To 1200°C (2200°F)  
With A Single Extensometer**

## An Overview Of The 632.68 Axial/Torsional Extensometer

### The 632.68 Advantage

◆ **Simultaneously Measures Axial Deflection And Torsional Strain**

Each sensor unit provides a separate output for control or feedback.

◆ **Cross Flexure Design**

Each sensor unit uses this unique cross-flexure design to provide high accuracy, reliability and linearity. This cross-flexure design also provides low activation force which allows the contact force between the contact points and the specimen to be reduced without extensometer slippage.

◆ **Patented Reference Frame And Hold-down Support System<sup>1</sup>**

Isolates the Extensometer from inherent load unit deflections and holds the Extensometer securely in place while allowing full movement of the extension rods.

◆ **Ceramic Extension Rods**

For use at temperatures up to 1200°C (2200°F).

◆ **Water Cooled**

To provide excellent thermal stability.

<sup>1</sup>Covered by U.S. Patent No. 4,537,082

The MTS Series 632.68 Axial/Torsional Extensometers are high-temperature Extensometers designed to simultaneously measure the axial deflection and torsional angle-of-twist over the gage length of the specimen. The Extensometer is typically used when performing testing on solid or tubular composite or metal specimens at specimen temperatures up to 1200°C (2200°F).

The Extensometer consists of two sensor units. The axial (lower) sensor unit (refer to the parts identification/dimensional drawings, Figures 1 and 2) measures the deflection over the axial gage length of the specimen. The torsional (upper) sensor unit measures the torsional angle over the axial gage length of the specimen.

## Flexibility

### ***Mounting***

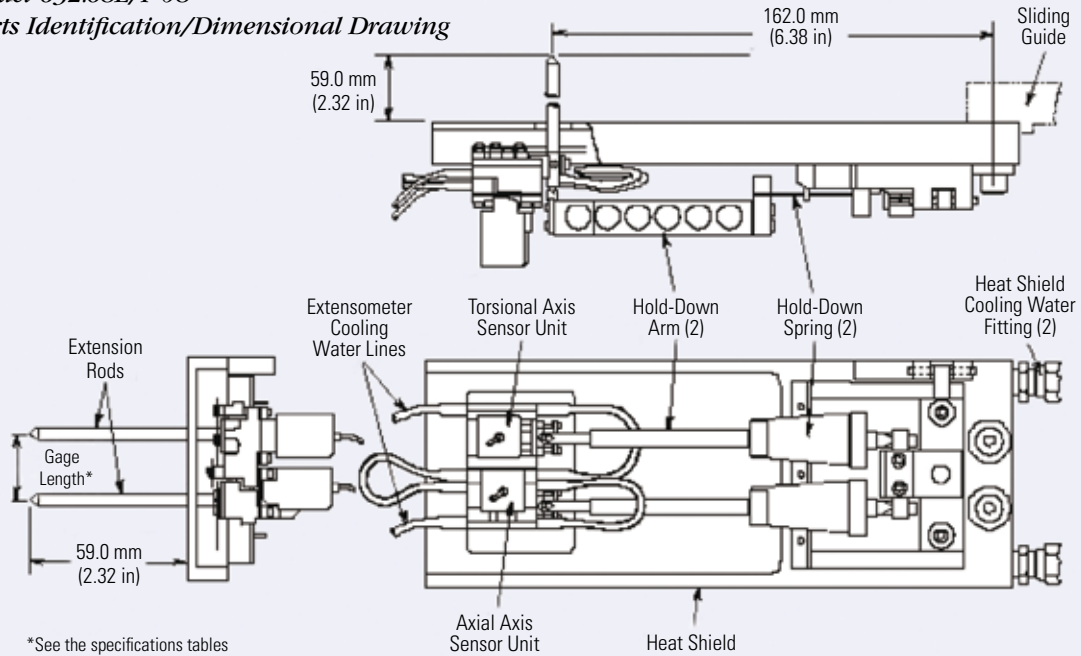
Ceramic extension rods are connected to the active element of each sensor unit. The rods pass through access holes in the water-cooled heat shield into the hot zone surrounding the specimen until the conical points make contact with the dimple indents in the specimen. These indents must be precisely aligned along the axis of the specimen and to the gage length of the Extensometer. A precision aligned punch fixture with the required gage length is provided with the Extensometer.

The Extensometer, with extension rods positioned against the specimen, is held in position by placing the end of each spring-loaded hold-down arm over the exposed end of each rod. The counter sunk, dimpled pin on the end of each hold-down arm seats each rod end to hold the Extensometer securely in place. This patented hold-down system allows full movement of the rods in both of the axes of interest.

**Figure 1.**

Model 632.68E/F-08

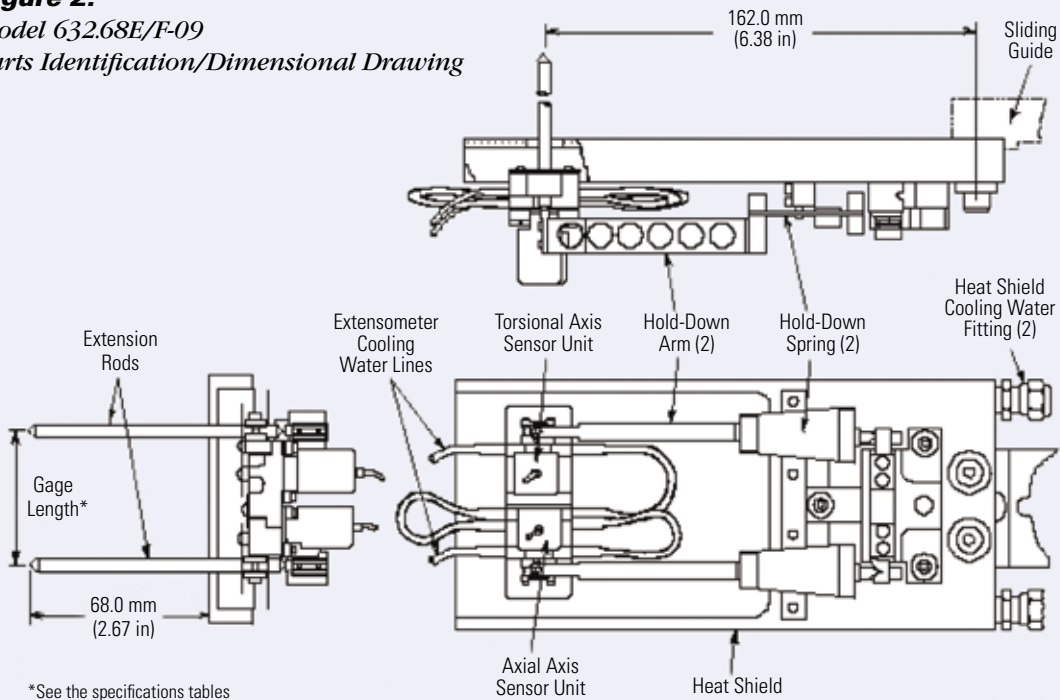
Parts Identification/Dimensional Drawing



**Figure 2.**

Model 632.68E/F-09

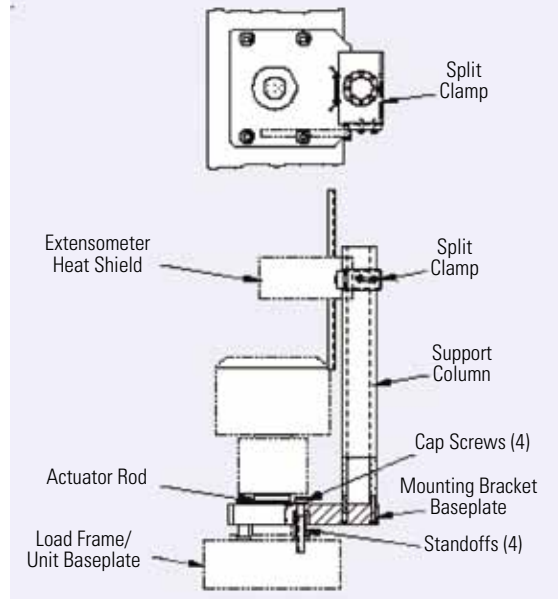
Parts Identification/Dimensional Drawing



### Extensometer Mounting Brackets

A specially designed mounting bracket, which is part of the patented reference frame and hold-down support system, attaches to the base plate of the load unit and supports the heat shield and Extensometer assemblies. The mounting bracket provides for both vertical and horizontal adjustment of the heat shield and Extensometer assemblies for simple and accurate alignment with the specimen. It also provides for minimal interaction between inherent load unit deflections and the strain measurements. Figure 3 illustrates a typical mounting bracket configuration. Mounting brackets will vary based on the load unit being used.

**Figure 3.**  
*Typical Mounting Bracket Configuration*



### Extensometer Cooling

Separate cooling water connections are provided on the Extensometer heat shield and on the Extensometer itself. Clean filtered water is necessary for cooling.

Cooling water flow through the heat shield should be at least 500 cc/min (0.13 gpm). Cooling water flow through the Extensometer should be

between 150 to 200 cc/min (0.04 to 0.05 gpm) with a supply pressure of 70 kPa (10 psi) normal and 80 kPa (12 psi) maximum.

A constant water temperature should be maintained to reduce the effects of thermally induced errors, especially when testing in the lower travel/strain ranges.

### Specimens

This Extensometer is ideally suited for testing round solid or tubular, composite or metal specimens at specimen temperatures up to 1200°C (2200°F).

Table 1 lists the standard specimen diameters. Changing specimen dimensions will impact axial/torsional crosstalk (see footnote 2 and 3 in the specification tables) and will also require recalibration of the Extensometer. If other than the standard specimen dimensions will be used, consult MTS.

**Table 1.**  
*Standard Specimen  
Diameters*

mm	in.
10.0	0.500
12.0	1.000
22.0	2.000
23.0	
25.0	
26.0	
30.0	
32.0	
50.0	

## Performance

### **Accuracy And Calibration**

The 632.68 Axial/Torsional Extensometers are designed for extremely accurate strain measurements (refer to the specification tables).

- Nonlinearity is 0.25% of the travel range or less (typically 0.15% of this range).
- Maximum hysteresis is within 0.15% of the maximum travel range.
- Exceptional accuracy and linearity are provided by the unique cross flexure design, which ensures true center-point bending throughout the entire travel range of the Extensometer. The cross-flexure also provides very good lateral stability, requires low activation force and helps maintain Extensometer calibration over long periods of use.

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### **Conditioning Electronics**

The Extensometer is used with MTS conditioning electronics or other conditioning electronics capable of providing an excitation voltage of 10 volts (not to exceed 12 volts).

The output cable from each sensor unit is connected to a specified dc controller or dc

conditioner located in the system console.

The Extensometer output is approximately 2 millivolts per volt of excitation but will vary with the specimen diameter. Axial bridge resistance is 350 ohms. Torsional bridge resistance is 350 or 1000 ohms depending on the specimen diameter.

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### **Calibration**

The graphs on the opposite page illustrate actual data collected during calibration. The asterisks are the actual data points collected. The unshaded areas illustrate the permissible variation as defined by the ASTM or ISO standard.

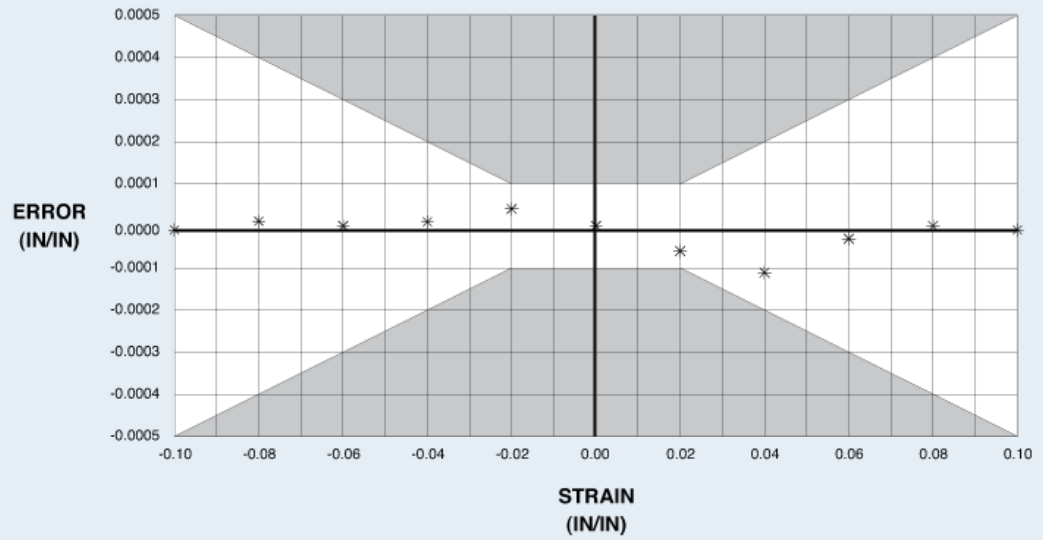
MTS offers in-plant calibration services using calibration standards traceable back to the U.S. National Institute of Standards and Technology.

- Calibration is performed at room temperature.
- Typical calibration ranges are 100%, 50%, 20% and 10% of the maximum travel range.
- The Extensometer and associated conditioning electronics may be recalibrated on-site by the customer or by trained MTS field service engineers, using a separately ordered Model 650.03 Calibrator with appropriate fixturing or they may be returned to MTS for recalibration.

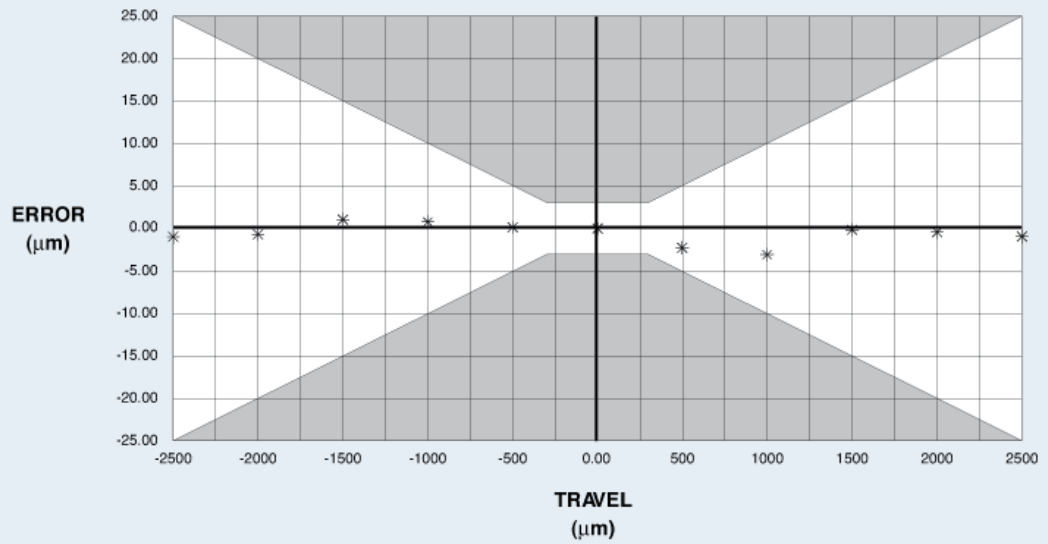
When required, calibration in accordance to ASTM E83-90 and ISO 9513:1989(E) is available. However, for full compliance with these standards, calibration must be performed using customer's conditioning electronics and readout device(s).

To schedule on-site calibration by an MTS field service engineer for this or any other MTS extensometer contact MTS using one of the numbers listed in the back of this document or by contacting your local MTS representative.

632.68E-08  
ASTM E83 CLASS B-1



632.68F-08  
ISO 9513 CLASS 1,0



## Specifications

(SI)

	Model 632.68F-08	Model 632.68F-09
Axial Gage length	25 mm	50 mm
Full scale travel range		
Axial	±2.5 mm	±2.5 mm
Torsional	±5°	±5°
Maximum strain (axial)	±10 %	±5%
Maximum crosstalk <sup>1</sup>		
Axial-into-torsional <sup>2</sup>	0.8% full scale torsional output	0.8% full scale torsional output
Torsional-into-axial <sup>3</sup>	0.8% full scale axial output	0.8% full scale axial output
Typical crosstalk <sup>1</sup>		
Axial-into-torsional <sup>2</sup>	0.25%	0.25%
Torsional-into-axial <sup>3</sup>	0.25%	0.25%
Maximum nonlinearity <sup>4</sup>		
Axial	±0.25% of range	±0.25% of range
Torsional	±0.25% of range	±0.25% of range
Typical nonlinearity <sup>4</sup>		
Axial	0.15% of range	0.15% of range
Torsional	0.15% of range	0.15% of range
Maximum hysteresis <sup>5</sup>		
Axial	0.15% of maximum travel range	0.15% of maximum travel range
Torsional	0.15% of maximum travel range	0.15% of maximum travel range
Typical hysteresis <sup>5</sup>		
Axial	0.10% of maximum travel range	0.10% of maximum travel range
Torsional	0.10% of maximum travel range	0.10% of maximum travel range
Maximum temperature	1200°C	1200°C
Hold-down spring force		
Upper	1100 g	750 g
Lower	700 g	750 g
Extensometer weight (without cable and connector)	92 g	92 g
Shipping weight	5 kg	5 kg

<sup>1</sup> Crosstalk is specified as a percent of full scale output of the axis which is acted upon. Crosstalk is measured with conditioning electronics for both axes ranged for the full scale outputs to correspond with the maximum travel range specified above.

<sup>2</sup> The axial-into-torsional crosstalk specification is based on a 25 mm (1.000 in) diameter specimen. An extensometer mounted on a 50 mm (2.000 in) diameter specimen will have a crosstalk approximately one half the percentage listed. Conversely an extensometer mounted on a 12.5 mm (0.500 in) diameter specimen will have crosstalk approximately 2 times the percentage listed.

<sup>3</sup> The torsional-into-axial crosstalk specification is based on a 25 mm (1.000 in) diameter specimen. An extensometer mounted on a 12.5 mm (0.500 in) diameter specimen will have a crosstalk approximately one half the percentage listed. Conversely an extensometer mounted on a 50 mm (2.000 in) diameter specimen will have a crosstalk approximately 2 times the percentage listed.

<sup>4</sup> Nonlinearity is specified as a percent of full scale output of any range and is the deviation from the straight line connecting the zero point and the 80% point of the full scale output.

<sup>5</sup> Hysteresis is measured over the ± maximum travel range of the axis in question and is specified as a percent of this full range.

Specifications are subject to change without notice.  
Contact MTS for specifications critical to your needs.



# Specifications

(U.S. Customary)

	Model 632.68E-08	Model 632.68E-09
Axial Gage length	1.000 in	2.000 in
Full scale travel range		
Axial	±0.100 in	±0.100 in
Torsional	±5°	±5°
Maximum strain (axial)	±10 %	±5%
Maximum crosstalk <sup>1</sup>		
Axial-into-torsional <sup>2</sup>	0.8% full scale torsional output	0.8% full scale torsional output
Torsional-into-axial <sup>3</sup>	0.8% full scale axial output	0.8% full scale axial output
Typical crosstalk <sup>1</sup>		
Axial-into-torsional <sup>2</sup>	0.25%	0.25%
Torsional-into-axial <sup>3</sup>	0.25%	0.25%
Maximum nonlinearity <sup>4</sup>		
Axial	±0.25% of range	±0.25% of range
Torsional	±0.25% of range	±0.25% of range
Typical nonlinearity <sup>4</sup>		
Axial	0.15% of range	0.15% of range
Torsional	0.15% of range	0.15% of range
Maximum hysteresis <sup>5</sup>		
Axial	0.15% of maximum travel range	0.15% of maximum travel range
Torsional	0.15% of maximum travel range	0.15% of maximum travel range
Typical hysteresis <sup>5</sup>		
Axial	0.10% of maximum travel range	0.10% of maximum travel range
Torsional	0.10% of maximum travel range	0.10% of maximum travel range
Maximum temperature	2200°F	2200°F
Hold-down spring force		
Upper	1100 g	750 g
Lower	700 g	750 g
Extensometer weight (without cable and connector)	92 g	92 g
Shipping weight	11 lb	11 lb

<sup>1</sup> Crosstalk is specified as a percent of full scale output of the axis which is acted upon. Crosstalk is measured with conditioning electronics for both axes ranged for the full scale outputs to correspond with the maximum travel range specified above.

<sup>2</sup> The axial-into-torsional crosstalk specification is based on a 25 mm (1.000 in) diameter specimen. An extensometer mounted on a 50 mm (2.000 in) diameter specimen will have a crosstalk approximately one half the percentage listed. Conversely an extensometer mounted on a 12.5 mm (0.500 in) diameter specimen will have crosstalk approximately 2 times the percentage listed.

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<sup>4</sup> Nonlinearity is specified as a percent of full scale output of any range and is the deviation from the straight line connecting the zero point and the 80% point of the full scale output.

<sup>5</sup> Hysteresis is measured over the ± maximum travel range of the axis in question and is specified as a percent of this full range.

Specifications are subject to change without notice. Contact MTS for specifications critical to your needs.

## Extensometer Accessories

The following accessories are not included as part of the Extensometer package but may be ordered separately.

- *Mating Connector (PT06A-10-6S)*

The mating connector may be purchased alone if you want to build your own Interface cable.

- *Interface Cable*

This interface cable comes with a mating connector on both ends. The end with the PT06A-10-6s mating connector attaches to the connector on the extensometer cable. The other end connects to the MTS conditioning electronics.

- *Extension Rods*

Replacement ceramic extension rods may be purchased in sets of 2.

- *Load Unit Mounting Bracket*

A rigid mounting bracket is required for mounting the heat shield and Extensometer. Standard mounting brackets are available for mounting on the base plate of most MTS load units. Special mounting brackets can be built for non-MTS load frames.

- *Cooling Systems*

A coolant supply system is required to regulate and supply coolant to the Extensometer. Several cooling systems are available to fit a variety of testing needs.

- *Coolant Supply System (Option 201):*

The coolant supply system uses the tap water available at most sites to cool the Extensometer sensor unit, the small heat shields and the large heat shields. The system includes a filter, regulator, pressure gage, flow meter, water supply tubing, and tubing size reduction adapters. This system is not suitable for use with a vacuum chamber.

- *Aspirator Pump System (Option 202):*

The aspirator pump system uses tap water to power the aspirator pump, which draws cooling water through the Extensometer sensor unit and the small heat shields at negative pressure. Cooling water is supplied to the large heat shields at positive pressure. This system includes filters, controls, pressure gages, flow meter, water supply tubing and vacuum chamber feed-through adapters. This system is suitable for use with a vacuum chamber.

- *Self Contained Coolant Pump System (Options 203 and 204)*

This coolant pump system draws water through the Extensometer sensor unit, the small heat shields and the large heat shield making this unit suitable for use with a vacuum chamber.

This system includes an electric motor driven pump, water reservoir, heat exchanger, filters, controls, pressure gages, flow meter, tubing and a set of feedthroughs for a vacuum chamber.

- *Constant Temperature Circulation Bath System (Options 205 through 207)*

The circulation bath system is also self-contained. It supplies constant temperature water ( $\pm 0.1^{\circ}\text{C}$ ;  $\pm 0.18^{\circ}\text{F}$ ) to the Extensometer sensor unit and small heat shield. It does not, however, supply coolant to the large heat shield. The high level of stability obtained is particularly desirable for testing at small strain levels. The system includes a digital controller, flow meter, regulator, filter, tubing, and tubing adapters. This system can be used for vacuum applications.

- *Model 650.03 Calibrator*

This room temperature axial Calibrator comes in its own carrying case and serves as the mounting platform for the torsional calibrator fixture (see below). The combined axial/torsional calibrators allow sequential calibration of both axes without removing or changing the position of the Extensometer. The axial micrometer head may be ordered in SI or U.S. customary versions.

- *Torsional calibrator fixture*

The torsional calibrator fixture attaches to the Model 650.03 Calibrator. The micrometer head supplied with this fixture provides a linear movement to the end of the fixture arm. This linear movement translates into rotation of the torsional portion of the Extensometer mounting attachment for angular calibration. A chart provided with the fixture converts the micrometer head reading to degrees of rotation.

## **Options**

The following options are available for the Model 632.68 Axial/Torsional Extensometers. Options must be selected at the time of order.

- ***Cable lengths***

The Extensometer comes with a 55 centimeter (22 inch) cable. Optional cable lengths of 1.5, 2.0, or 2.5 meters (60, 80, or 100 inches) are available.

- ***Cable insulation***

Fiberglass braid is available to electrically isolate the outside shielding of the cable.

- ***Radiation protection***

The Model 632.68 Axial/Torsional Extensometers can be provided with radiation resistant coating and cable insulation.

- ***Vacuum applications***

The Model 632.68 Axial/Torsional Extensometers can be configured for use in vacuum environments to  $10^{-6}$  torr.

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## **Services**

- At the customer's request each Extensometer ordered can be calibrated by MTS using our automated calibration system.

- In addition, the Extensometer and associated conditioning electronics may be returned to MTS for repair and recalibration for a moderate fee.

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## **What's Included In The Basic Extensometer Package**

In addition to the accessories and options ordered you get:

- The Extensometer in a high-impact carrying case.

- One set of ceramic extension rods, factory installed on the Extensometer, and four additional sets.

- A tool kit containing the tools needed to change and align extension rods, as well as, to establish the proper gage length.

- A precision punch fixture which corresponds to the gage length of the Extensometer ordered.

- A product manual and appropriate installation drawings and, if the Extensometer is calibrated by MTS, a calibration data sheet.



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