MTS Advantage™ Optical Extensometer (AOX)

Simplified non-contacting axial strain measurement & control

Benefits:

SIMPLE

- Easy to set up and operate
- Laser-assisted alignment
- No specimen grids or patterns required

PRECISE

- Always measuring in real-time
- Real time data rate: 300-3000 Hz
- Meet or exceeds requirements for calibration according to ISO 9513 Class 0.5 and ASTM E83 Class B1 standards

VERSATILE

- Accommodates a wide variety of specimens and uniaxial test applications
- Load frame mounts have quick-attach, multi-frame mobility

As simple to use as a traditional contacting extensometer, the MTS Advantage™ Optical Extensometer (AOX) also provides all the precision and productivity advantages of a non-contacting strain measurement solution.

Remarkably Easy to Use

Following a few seconds of laser-assisted alignment the MTS AOX actively searches for contrasting specimen gage marks and instantly provides real-time reporting. This extensometer's ability to begin measuring without extensive operator intervention is a time-saving feature.

Drives Productivity

The MTS AOX does not need to be re-positioned for each test. It is always measuring, so changing specimens is easy and fast. The Instant Reset feature allows you to auto-start repetitive tests without touching the extensometer, greatly accelerating test program completion.

Variety of Applications

Whether you are measuring QC tensile strength, long-term fatigue or crack growth, the MTS AOX optics packages can accommodate everything from the fine resolution measurements needed for low modulus ceramic and metallic materials, to the high-elongation requirements (>1000% strain) for viscoelastic plastic and elastomer materials. The MTS AOX is also an ideal solution for evaluating challenging specimens, such as those created from foils, fine wires and polymer films.

Advantages

Faster Test Completion

Similar to a contacting extensometer, once the MTS AOX is set up, it is always measuring. This capability saves time, especially when running repetitive tests. Other productivity enhancements include:

- Faster Throughput: Instant Reset feature auto-starts strain measurement for the next specimen, increasing productivity for repetitive QC testing
- Real-time Digital Output: High-speed data stream with software tools for control and status
- Faster Testing: Save time with industry-leading 200+ Hz dynamic range and automatic gain compensation filters
- No Post-processing Required: Even when using the highest data rates, all data is sent directly to your test system.

Improved Accuracy

From pre-test calibration and alignment to reliable measurement, the MTS AOX provides the accuracy you require:

- A2LA Accredited Factory Calibration: Fully calibrated using comprehensive processes to correct for scaling, skew, lens distortion, and uneven lighting
- Laser-Assist Alignment System: Provides an instant visual check for specimen alignment and optics positioning
- Retractable, High-stiffness Mounting: Maintains maximum dynamic range and vibration avoidance
- Reliable, Automatic Mark Detection: Accurate tracking of bright or dark marks beyond 1000% strain and speeds >1500 mm/second
- Precision Telecentric Lens Option: Helps compensate for out-of-plane measurement errors
- Robust Strain Control: Built-in high-speed 16-bit analog output; not susceptible to unpredictable cyclic bias errors.

Simple Set-up & Operation

The MTS AOX runs on the test system computer and therefore does not require an additional computer and monitor. Other ways this extensometer simplifies testing:

- No Grids or Bars Required for Pre-test Calibration: Can start your test sooner
- Multi-line Specimen Marking: Optional methods automatically identify and report the region of highest strain concentration, in real-time
- Admin/User Modes: Define, save and reload settings for specific specimens and test methods, then lock them in User Mode
- Wide Range of Filter and Optical Settings: Easily optimize performance for many different materials and specimens
- Selectable Strain Metrics: Report strain measurements choosing from five different finite or small strain theories.

Precise Performance

The MTS Advantage Optical Extensometer performance combines the latest in optical and algorithmic measurement techniques to deliver the high resolution, data rates and accuracy needed for uniaxial testing.

- Resolution
  - <0.5 µm quasistatic
  - <2.5 µm dynamic
  - <0.1 µm creep; typical RMS resolution at typical settings. Resolution is a function of the optics and filter settings.
- Extensometer Accuracy Class: ISO 9513 Class 0,5 and ASTM E83 Class B-1 or better, typical, for gage lengths ≥10 mm
- Real time data rate: 300-3000 Hz

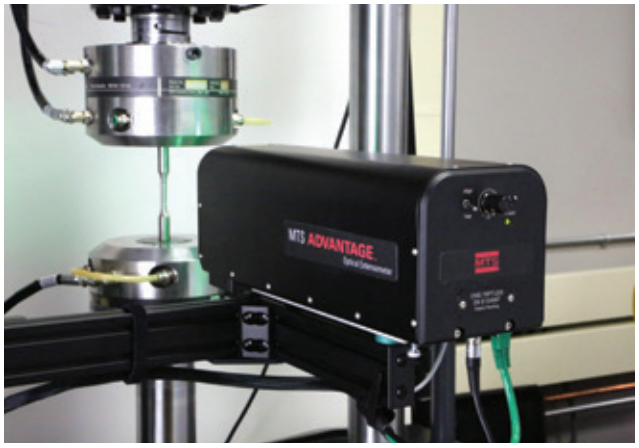
As a result, the MTS Advantage Optical Extensometer is equipped with the accuracy and fine resolution required to measure modulus, offset yield, stress-strain curves, and strain at failure for both low and high modulus materials.

MTS Advantage Optical Extensometer Applications

Composites, Metals, Ceramics

The MTS AOX models with telecentric lenses are engineered to provide the accuracy and fine resolution required for testing high-modulus materials such as metals, composites, ceramics, and CMCs:

- Equipped to measure modulus, offset yield, stress-strain curves, and strain at failure for all these materials
- Typical resolution: <0.5 µm , <2.5 µm dynamic, <0.1 µm creep; typical RMS resolution at typical settings. Resolution is a function of the optics and filter settings.
- Extensometer Accuracy Class: ISO 9513 Class 0.5 and ASTM E83 Class B-1 or better, typical, for gage lengths ≥10 mm
- Typical resolution at selected filter settings and rigid, well-aligned grips are recommended for these applications.



Plastics, Elastomers

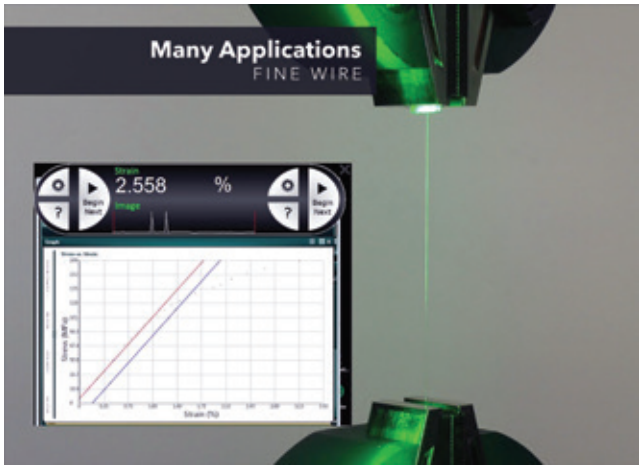
The MTS AOX-500CE optics option can measure more than 1000% strain (500 mm field-of-view and 10 or 25 mm gage length):

- Optics and data processing algorithms ensure that specimen marks are tracked even when their contrast is reduced due to specimen extension
- Conventional entocentric lens – recommended for high elongation applications and for measuring strain values of ~2% or greater; suitable for smaller strains in some applications

Foil, Wire, Polymer Films

Non-contact strain measurement is the best way, and sometimes the only way, to measure strain with delicate, fine, and thin specimens. Use the AOX extensometer to measure modulus, offset yield, stress-strain curves, and elongation to break with wire, metal foil, polymer film, high-modulus fibers, and polymer filaments:

- Depending on the specimen's total elongation, the MTS AOX-200CE can accommodate gage lengths between 10-180 mm
- Ultra-high camera resolution, real-time data rates up to 3000 Hz, and signal processing techniques provide high strain resolution and accuracy with the lowest noise.



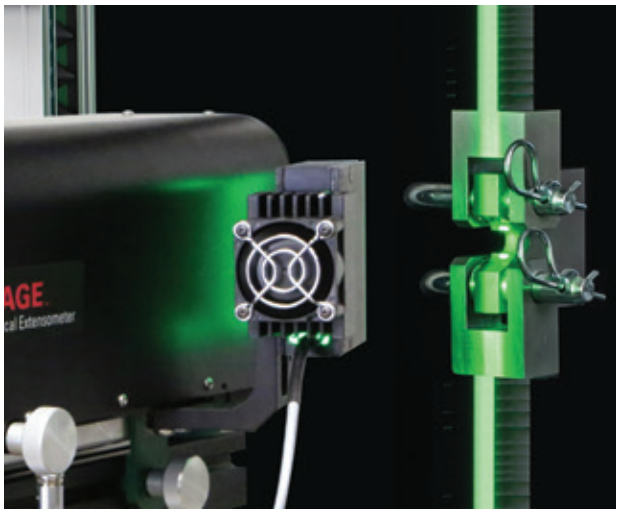
Non-Contact COD Gage

KIC, JIC, fatigue crack growth (da/dN) and related applications can be performed using the MTS Advantage Optical Extensometer as a non-contact COD gage. An optics package with a telecentric lens is recommended due to the stringent accuracy requirements and out-of-plane specimen motion in these applications. Features:

» Narrow and precise optical path measures crack opening displacements that are often too small to be measured by most clip-on COD gages

» No moving parts and high real-time data rates allow for fatigue crack growth testing frequencies up to 100 Hz – much faster than clip-on COD gages

» High resolution and accuracy combined with a large measuring range provide precise non-contact JIC and KIC testing.

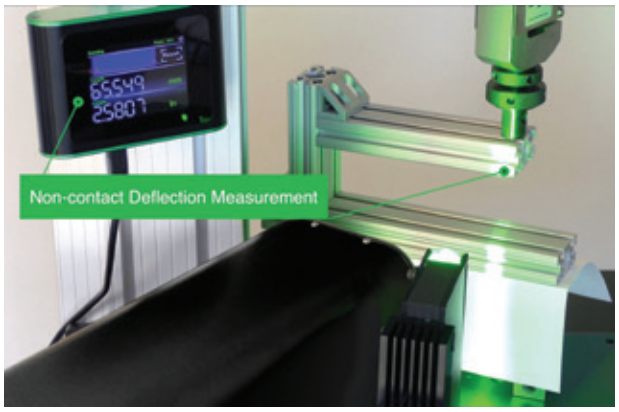


Non-Contact Deflectometer

The MTS Advantage Optical Extensometer is also a non-contact deflection gage. It can measure components, assemblies or structures over a wide range of time scales and in either monotonic or cyclic fatigue up to 100 Hz:

» Measures the initial distance and change in distance between two coplanar marks that are within the field-of-view, no matter where the marks are placed

» Can be used in any orientation as long as the marks it is tracking are in a single measurement plane.



Always On, Always Real-Time

As soon as marks are detected, the MTS Advantage Optical Extensometer is measuring strain in real-time:

» Continuously measures strain or actively searches for marks using its Automatic Mark Detection

» Doesn't have to be started and stopped for each specimen

» Strain output is always in real time at data rates up to 3000 Hz (data rates vary with lighting, filters and test setup).

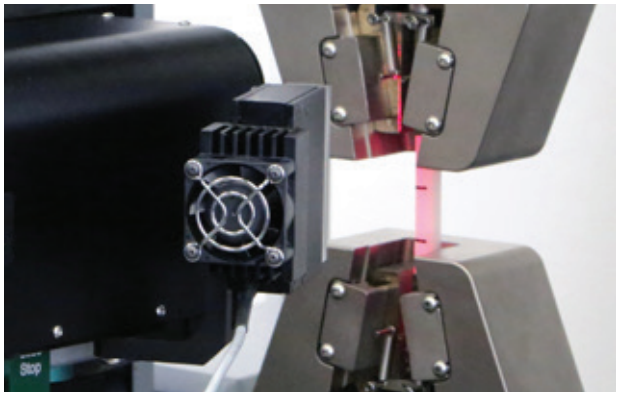
Laser-Assist Alignment System

Set-up is faster with the Laser-Assist Alignment System:

» Spot-checks specimen alignment

» Sets distance to the specimen—eliminating the need for calibration grids or gage length bars.

The MTS Advantage Optical Extensometer is factory calibrated. Upon startup, adjust the distance to the specimen, connect your controller to receive the calibrated ±10V input, and start testing.



Specifications

Specifications	
Field-of-view	50 - 500 mm FOV Optics Packages; other ranges available – contact MTS
Real-Time Data Rate	300-3000 Hz; includes image frame rate, analog output, and digital output
Strain Outputs: Analog Output	±10V, short-protected, selectable units and range; includes 2.4 m (8 ft) shielded output cable
Digital Output	16-64 bit over RS232 with selectable units & data type; 2900 strain readings per second Typical data rate @32 bits; includes 1.8 m (6 ft) shielded null modem cable
Resolution	<0.5 µm <2.5 µm dynamic <0.1 µm creep; typical RMS resolution at typical settings. Resolution is a function of the optics and filter settings
Extensometer Accuracy Class	ISO 9513 Class 0.5 and ASTM E83 Class B-1 or better typical at ≥10 mm gage length
Absolute Accuracy	PT models: <±1 µm or 0.5% of value, not exceeding ±30 µm typical CE models: <±1 µm or 0.5% of value
Minimum Specimen Size	< Ø20 µm (0.001")
Gage Length	2 mm minimum, ≥4x specimen width or diameter recommended; for smaller sizes contact MTS
Maximum Elongation	>1000%, limited by field-of-view and gage length
Maximum Tracking Speed	>1500 mm/second (90,000 mm/minute)
Cyclic Testing	>100 Hz cyclic test frequency, waveform independent
Strain Control	Suitable for monotonic and cyclic strain control applications
Out-of-Plane Sensitivity	Allowable out-of-plane motion for ISO 9513 Class 0,5 @15 mm gage length and ASTM E83 Class B-1: <1000 µm (0.040") for AOX-PT-xx <25 µm (0.001") for AOX-CE-xx
Power Supply	100-240 VAC, 50-60 Hz, 100W, IEC 320 C14 receptacle. Specify plug type when ordering
System Environment *(environments)*	10-40°C (50-100°F), for use and storage; 20-80% relative humidity non-condensing
Host PC (optional):	Requires Windows 10 PC, 900×550 minimum display, one serial or USB port

Options

» Mounting Systems for testing machine base mount or cylindrical column mount
» AOX-TI-1 Touch Interface Module – allows local (close to the frame) control of AOX settings
» Customized Specimen Marking – for users that require customized gage lengths

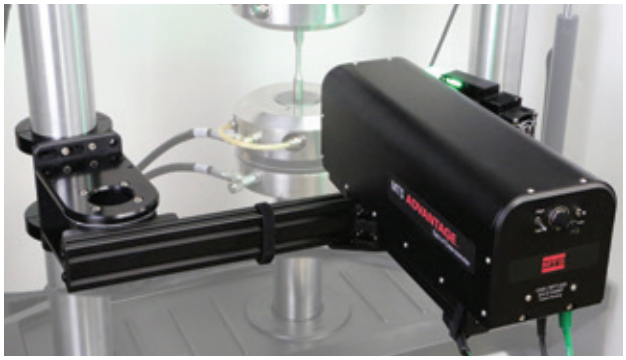
Specimen marking is simple and fast. Templates and paint pens are included with every Optics Package.

Mounting Systems for MTS Criterion® and MTS Exceed® Electromechanical Test Systems

The AOX MS-02 Mounting System attaches directly to the load frame's lower base plate using the left accessory mounting bolt pattern.

DATA CONNECTIONS

- Connection to the system computer by a serial cable from the AOX controller is used for filter and lighting set-up
- Analog data connections (+/-10 VDC) are made by a single BNC to RJ cable to the strain 1 input.

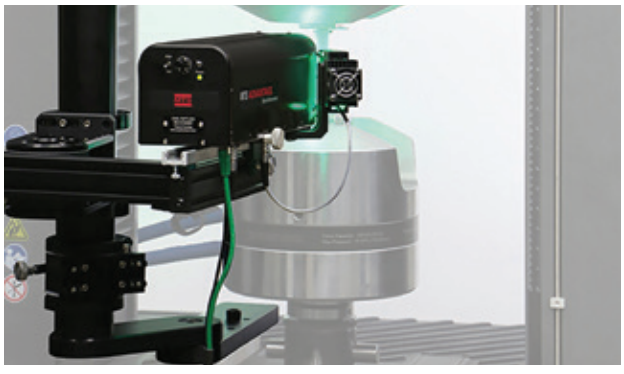


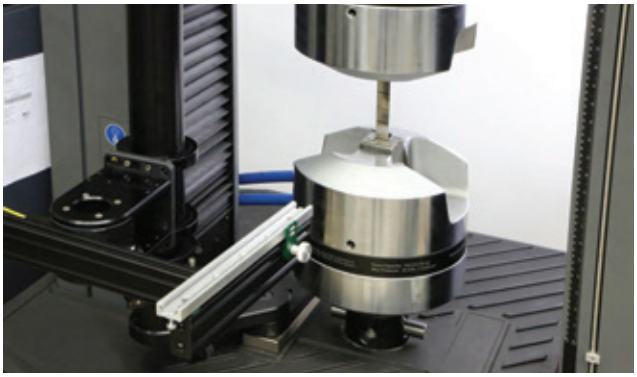
Mounting Systems for MTS Landmark® and MTS Acumen® Dynamic Test Systems

The AOX MS-03 Mounting System attaches directly to the load frame's left column allowing the unit to be rotated clear of the test area as needed.

DATA CONNECTIONS

- Connection to the system computer by a serial cable from the AOX controller is used for filter and lighting set-up
- Analog data connections (+/-10 VDC) are made with the FlexTest controller by one of two methods:
  1. A single BNC to RJ cable to an open DUC (digital universal conditioner) (494.26 controller)
  2. A single BNC to BNC cable to an open A/D channel (494.45 controller)





Base AOX package includes:

- Extensometer with Selected Optics
- Laser-Assist Alignment System
- Lighting Module
- Sensor Controller
- Mounting Interface Subassembly
- Specimen Marking Kit
- Cables
- High-quality, Foam-lined Case

Applicable for testing with many uniaxial ISO and ASTM standards, including:

- ISO 6892-1, 527-2, 527-4, 527-5
- ASTM E8, E9, D3039, D638, A370, D3552, E646

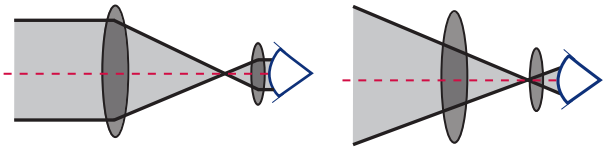
Choosing Your AOX Optics

Choose from six different quick-attach optics packages to provide the optimum resolution and measurement range for your test environment. First decide whether to use precision telecentric lenses (PT) or conventional entocentric (CE) lenses. For applications requiring higher precision, the optics packages using PT lens systems are recommended.

Conventional or entocentric lens are acceptable when out-of-plane specimen movement is insignificant; however, many applications involve specimens that straighten or grips that are free to align under tensile loading. Unlike conventional lenses, telecentric lenses are insensitive to potential inaccuracies caused by these out-of-plane motions. With a telecentric lens:

- The image of the test specimen seen by the camera's sensor is the same size even if the specimen moves closer to or further away from the optics package
- Full strain measurement accuracy is maintained even if the specimen or grips move out of the testing axis, or out-of-plane, during the test.

Each optics package is supplied with an appropriate monochromatic LED lighting package incorporated to achieve the best illumination for your test.

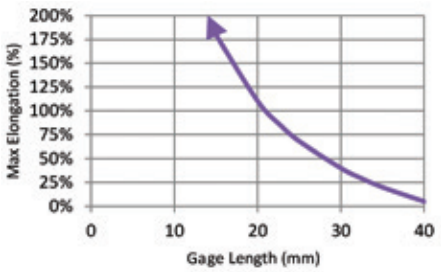
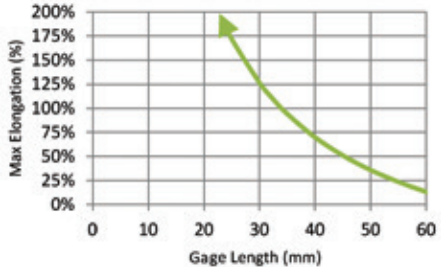
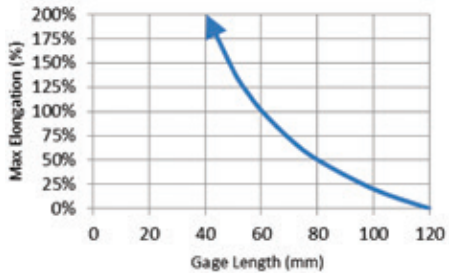


Precision Telecentric Lens

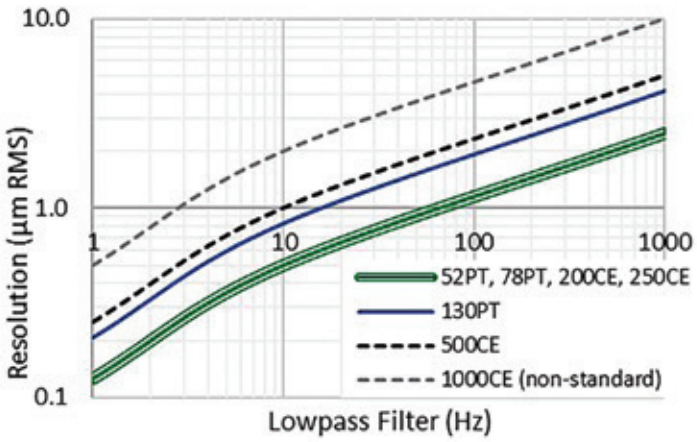
Conventional Entocentric Lens

Precision Telecentric Lens Packages

AOX PT lens systems are recommended for precision strain measurements (used for material strains <10%, normally metals, composites, etc.)

Precision Telecentric Lens Systems	Measuring Range	Typical Gage Lengths vs Maximum Strain/Travel		
	AOX-52PT-150 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-52PT-System** » Precision telecentric lens » 52 mm Field-of-View (FOV) » 150 mm Working Distance (WD)		10 mm	320%	32 mm
		12 mm	250%	30 mm
		20 mm	110%	22 mm
		25 mm	65%	17 mm
		30 mm	40%	12 mm
		40 mm	5%	2 mm
	AOX-78PT-200 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-78PT-System** » Precision telecentric lens » 78 mm Field-of-View (FOV) » 200 mm Working Distance (WD)		10 mm	580%	58 mm
		12 mm	470%	56 mm
		20 mm	240%	48 mm
		25 mm	170%	43 mm
		50 mm	35%	18 mm
		65 mm	5%	3 mm
	AOX-130PT-210 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-130PT-System** » Precision telecentric lens » 130 mm Field-of-View (FOV) » 210 mm Working Distance (WD)		10 mm	≥1000%	110 mm
		12 mm	900%	108 mm
		25 mm	380%	95 mm
		50 mm	140%	70 mm
		75 mm	60%	45 mm
		100 mm	20%	20 mm

MTS AOX Resolution by Model & Filter Setting

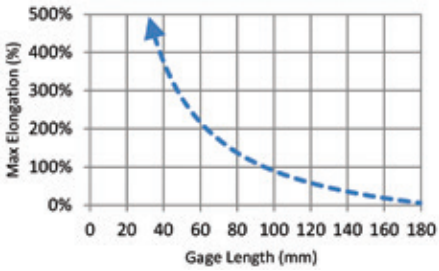
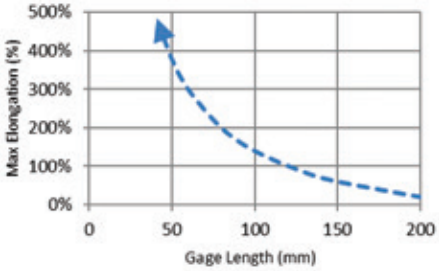
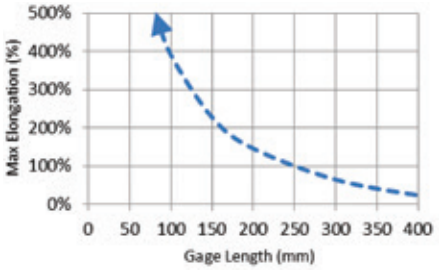


Resolution Varies by Model and Filter Setting (Hz)

- A typical tensile test may use a 10-100 Hz setting
- A creep test may use a 1 Hz setting
- A fatigue test may use a 100-1000 Hz setting

Conventional Entocentric Lens Packages

AOX CE lens systems are recommended for higher strain measurements (used for material strains >10%, normally plastics, elastomers, etc.)

Conventional Entocentric Lens Systems	Measuring Range	Typical Gage Lengths vs Maximum Strain/Travel		
	AOX-200CE-220 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-200CE-System** » Conventional entocentric lens » 200 mm Field-of-View (FOV) » 220 mm Working Distance (WD)		10 mm	>1000 %	180 mm
		25 mm	660 %	165 mm
		50 mm	280 %	140 mm
		75 mm	150 %	115 mm
		100 mm	90 %	90 mm
		150 mm	25 %	40 mm
		180 mm	5 %	10 mm
	AOX-250CE-280 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-250CE-System** » Conventional entocentric lens » 250 mm Field-of-View (FOV) » 280 mm Working Distance (WD)		10 mm	>1000 %	230 mm
		25 mm	860 %	215 mm
		50 mm	380 %	190 mm
		75 mm	220 %	165 mm
		100 mm	140 %	140 mm
		150 mm	60 %	90 mm
		200 mm	20 %	40 mm
	AOX-500CE-270 Measuring Range	**Gage Length**	**Max Strain**	**Max Elongation**
Model Number: **AOX-500CE-System** » Conventional entocentric lens » 500 mm Field-of-View (FOV) » 270 mm Working Distance (WD)		10 mm	>1000 %	480 mm
		25 mm	>1000 %	465 mm
		50 mm	880 %	440 mm
		100 mm	390 %	390 mm
		200 mm	145 %	290 mm
		300 mm	63 %	190 mm
		400 mm	23 %	90 mm

» The MTS AOX will work with any gage length that is within the range for the lens options that are listed above.

» The maximum strain values are approximate and include a margin of 5-10 mm to provide for reasonable ease-of-use.

» A gage length of 4 times (or more) of the specimen width or diameter is recommended for most applications.

** Additional Working Distance and Field-of-View options are available.*

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