

ASTM E646 Test Method for Tensile Strain-Hardening Exponent (*n-Values*) of Metallic Sheet Materials

TEST METHOD SUMMARY

This special tensile testing method per ASTM E646 is used to determine the strain-hardening exponents by utilizing stress-strain data of metallic sheet materials, which exhibit a continuous stress-strain curve in the plastic region.

Uniaxial displacement or strain is applied to rectangular material specimens with reduced parallel sections and the normal tensile load and strain are measured. The true stress, true strain, the strain-hardening exponent and the strength coefficient are calculated.

Solutions for ASTM E646 typically include these types of components:

LOAD FRAME OPTIONS*

MTS offers electromechanical Criterion® and Exceed® universal test systems and dynamic servohydraulic Landmark® test systems that are ideal for performing accurate and repeatable monotonic tensile testing of metallic materials per ASTM E646.

MTS Criterion universal testing systems are engineered to support the needs of advanced Research & Development. MTS Exceed universal testing systems are best suited for Quality Control testing by delivering the reliable performance needed to meet the uptime demands of high-volume production environments.

The MTS Criterion and the MTS Exceed universal testing machines range from tabletop to floor-standing electromechanical models with force ratings of up to 600 kN / 135 kip. Many of the models have dual-zone test spaces to reduce set-up times if you frequently change test requirements.

The MTS Landmark dynamic servohydraulic test system with its superior stiffness and alignment capabilities, is an ideal choice if additional fatigue and fracture testing capabilities are required. Systems are available in highly configurable floor-standing and tabletop models with force ratings from 5 kN / 1 kip to 500 kN / 110 kip.

As an alternative to a new load frame, you can replace outdated controls / hydraulics of existing MTS or another manufacturer's electromechanical, servohydraulic or custom test systems, including:

**Instron®, **Zwick®, **Tinius Olsen™, **SATEC®, **Baldwin® and more with an MTS ReNew™ Upgrade.

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EXTENSOMETRY OPTIONS*

ASTM E646 requires that extensometers conform to ASTM E83. MTS offers a variety of extensometer types, ranging from clip-on, automatic to non-contacting optical and video extensometers that meet or exceed requirements for calibration according to ASTM E83 Class B1 and ISO 9513 Class 0.5 standards. Factors like the specimen material, shape and dimension, the requirements for test efficiency and budget need to be considered when choosing the appropriate strain measurement solution.



MTS Criterion® & MTS Exceed®
Electromechanical Universal Test Systems



MTS Landmark®
Servohydraulic Test Systems



MTS ReNew™
Upgrade for Hydraulic & Electromechanical Test Systems



Clip-on Extensometers

- » Most commonly used economical strain measurement solution
- » Provide reliable, repeatable means to accurately measure axial strain for testing round or flat specimen geometries



Automatic Extensometer

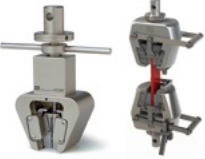



- » Automatic specimen attachment and self-adjusting gage length positioning ensures test consistency and supports high-volume testing by eliminating the need for operator intervention
- » Optional transverse strain measurement to support the calculation of the plastic strain ratio "r-value" for sheet metals



Non-Contacting Extensometer

- » The MTS Advantage™ Video Extensometer is just one of many non-contacting strain solutions available for tension testing of metals
- » Potential options for analyzing all critical tensile properties include 1D, 2D, and 3D measurements, real-time display, post-test analysis, video replay, specimen reanalysis, and more

GRIP OPTIONS*

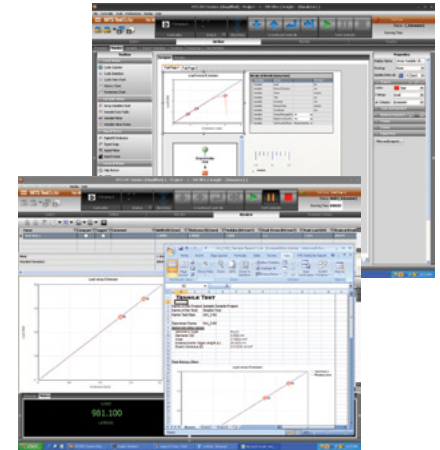
			
Mechanical Wedge Grips	Hydraulic Wedge Grip	Hydraulic Single Side-Acting Grips	Adapter for Pin-End Specimen
» Versatile, economical grip good for a variety of specimen types	» Adjustable gripping force to prevent specimen slippage or crushing	» Adjustable gripping force and centering to prevent specimen slippage or crushing	» For pin-end sheet specimen

GRIP FACE OPTIONS*


Wedge Grip Faces
» MTS wedges come in a variety of surfaces to meet test requirements for flat specimens of various material types

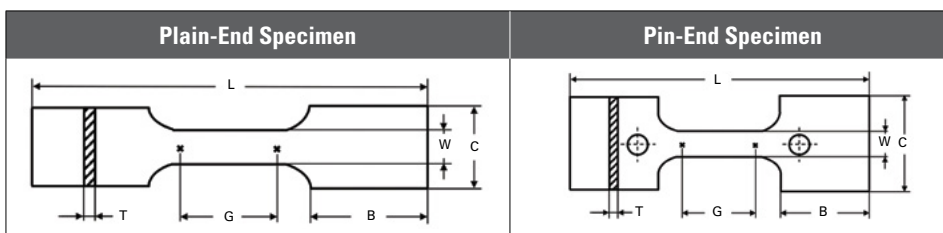
SOFTWARE & CONSULTING OPTIONS*

About MTS TestSuite™ TW	ASTM E646 Tensile Strain-Hardening Exponent Test Method Template
The efficient MTS TestSuite TW software provides the versatility required to address unique and complex testing requirements.	To simplify testing to ASTM E646, MTS has developed a TestSuite TW test method template that will set-up and run the recommended tensile tests.
twe TestSuite TW Elite includes all the test definition capacity and flexibility test designers need to create and edit custom test sequences while accommodating the specific runtime needs of lab personnel.	» Crosshead/actuator or extensometers can be used for strain measurement and control
twx TW Express is designed for the test operator and is used to run tests created with TW Elite and can be used without fear of inadvertently modifying the Test Method. This application allows the operator to easily execute even the most complex tests and monitor data or calculated values in runtime views that can be tailored by both test designers and operators.	» Post-test review tab and reports show data in stress-strain plots and highlight calculated values such as strain hardening exponent, strength coefficient, and more
	» Raw data can be exported in a variety of formats including CSV and TXT
	» Test methods, calculations, review displays, and report layouts can be customized by the user



MTS Consulting Can Enable LIMS Integration & Other Lab Efficiency Enhancements
MTS consultants are available to support seamless data integration from your TestSuite test templates to your laboratory information management system (LIMS). Lab Efficiency Enhancements could include:
» Integrating bar code scanners, reading data from micrometers and calipers, capturing video via webcam
» Automating the interface of two-way communications between TestSuite and virtually any LIMS system

*NOTE: This technical note is intended to show some of the more common solutions used for this particular application. Most often, additional options are available and necessary to accomplish more comprehensive test objectives.



APPENDIX - TEST SPECIMEN DETAIL

ASTM E646 supports rectangular specimens with reduced parallel section and plain-ends or pin-ends for gripping. Please consult ASTM E646 for more detailed information about the supported specimen geometries.

Specimen Type	Gage Length (G) mm/in	Gage Width (W) mm/in	Thickness (T) mm/in	Overall Length (L) mm/in	Width (C) mm/in	Length of Gripping Section (B) mm/in
Plain-End	50 / 2	12.5 / 0.5	Material Thickness	200 / 8	20 / 0.75	50 / 2
Pin-End					50 / 2	



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 100-530-189b ASTM E646 • Printed in U.S.A. • 08/23