Tytron™ 250
Microforce Testing System

Static and Dynamic Testing for:

- Electronics
- Biomaterials and medical devices
- Polymers and thin films
- Basic materials research
**Microforce Testing**

**A strategic advantage for product development and materials research**

Mechanical testing can speed up the evaluation of new product and component designs and help you get products to market faster. The new Tytron 250 test system from MTS Systems Corporation extends this advantage to the microforce range. With a load capacity from 0.001 N to 250 N, the Tytron 250 system opens up new mechanical-testing applications in electronic and medical product development and basic research. Its static and dynamic capabilities make the Tytron 250 system ideal for monotonic, durability, and fatigue testing.

**Electronics**

In the development of electronic products, the system can be used to simulate thermal cycling and produce fatigue data in a fraction of the time that conventional thermal cycling tests would take. Fatigue data on connectors and packaging, acquired in days instead of months, can help your designers and engineers produce more competitive products and help you get them to market faster.

Tests can be run under load or deformation control, and a high-temperature environment is available to simulate service conditions. Electronic components for which the system is ideally suited include:

- Integrated circuits (ICs), with or without packaging and leads
- Thin-film ICs
- Gold wire connectors
- Polymer encapsulations (PEMs)
- IC metallization layers

**Medical devices**

To accelerate the development of implantable medical devices, the Tytron 250 system accurately simulates the stresses that devices experience in service. Environmental baths are available with the system to simulate in vivo conditions for more accurate results. The Tytron 250 system produces fatigue data quickly to help you evaluate materials and product designs early in the design cycle and gain a competitive advantage. The system is ideal for testing soft tissue and other tissue-engineering applications.

**Polymers and other materials**

The microforce testing capabilities of the Tytron 250 system open new avenues of research to material scientists and a broad range of product developers. Small-scale fatigue properties and other data can be acquired to characterize the mechanical properties of pure materials, composites, and interfaces.

**Analytical modeling**

Because it can produce tensile, fatigue, shear, and other mechanical data on a scale of tens of microns, the Tytron 250 system is a valuable adjunct to analytical modeling. Data from the system can be used as input to finite element models and to validate model assumptions. By enhancing your modeling capabilities, the Tytron 250 system can help you improve your component and product designs.

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Comparison of thermal and mechanical cycling data. The close agreement between the two types of data demonstrates the validity of mechanical testing as a time-saving alternative to thermal cycling for determining the durability and fatigue characteristics of electronic components. (Data courtesy of Japanese Society of Mechanical Engineering, Working Group 144. Research performed by Yokohama National University under Professor Masaki Shiratori.)
The Tytron 250
Material Testing System Advantage

Flexible and accurate
The innovative Tytron 250 material testing system is designed specifically to test small specimens with low loads (0.001 to 250 N). This general-purpose system provides precise control for static and dynamic testing. Its advanced linear servomotor and high-speed digital control give the system unmatched speed, frequency, and strain ranges (see specification table on page 11).

These unique capabilities make the Tytron 250 system the perfect solution for mechanical testing of electronic components, biomaterials and medical devices, polymers, and other small specimens and components.

To ensure precise control, accurate results, and ease of use, the Tytron 250 system incorporates advanced technologies and special features, including

- A directly coupled linear DC servomotor capable of speeds ranging from one µm/hr to 0.5 m/sec.
- A high-stiffness, thin-film air bearing for frictionless actuator motion.
- High-speed digital control. The MTS TestStar™ IIs control system has been modified with special enhancements and tuning parameters to support ultra-precise, high-resolution testing.
- State-of-the-art mechanical frame. Noise is minimized through the use of very high damping material, the same material used in some atomic force microscopes.
- The cable management system and single interface access panel simplify system setup and operation.

- The fully adjustable force reaction frame provides free space between the actuator and load cell that is adjustable from 0 to 500 mm. This variability allows the system to accommodate a wide range of specimens, fixtures, and chambers.
- Built-in storage area for accessories, specimens, and tools.

A complete system
The Tytron 250 system includes everything you need for reliable, productive testing. The basic configuration includes a load unit, TestStar IIs control system, amplifier, and software. A full range of grips, load cells, and environmental chambers ensures that you can configure the system to meet any special needs. The Tytron 250 system runs on standard AC current (from 100 to 240 V and 50 to 60 Hz).

The Tytron microforce system uses closed-loop servo control to deliver unmatched testing flexibility and precision. The system is designed for fatigue and durability testing and service-life simulation. You can use it to run tests in load, displacement, and strain control modes.

The TestStar IIs controller that comes with the Tytron 250 system is our most advanced single-channel controller. It comes with Basic TestWare® software so you can begin testing immediately. Advanced software for more complex testing is also available.

The power amplifier is a linear drive that uses feedback signals from analog Hall Effect sensors, mounted in the brushless linear motor, for commutation and DC current control.
### System Overview

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Displacement</td>
<td>Max. 100 mm</td>
</tr>
<tr>
<td></td>
<td>(with high resolution option)</td>
</tr>
<tr>
<td></td>
<td>Min. 0.0001 mm</td>
</tr>
<tr>
<td>Load</td>
<td>Max 250 N</td>
</tr>
<tr>
<td></td>
<td>(with high resolution option)</td>
</tr>
<tr>
<td></td>
<td>Min 0.001 N</td>
</tr>
<tr>
<td>Frequency</td>
<td>Up to 50 Hz</td>
</tr>
<tr>
<td></td>
<td>(see performance curve on page 11)</td>
</tr>
<tr>
<td>Weight</td>
<td>170 kg (approx.)</td>
</tr>
<tr>
<td>Power</td>
<td>100, 110, 220, 240-volt single phase</td>
</tr>
<tr>
<td>Footprint</td>
<td>1.275 m x 375 mm</td>
</tr>
</tbody>
</table>
Electronics

The Tytron system is the ideal tool for determining the fatigue properties of components used in the microelectronics industry. Connectors and packaging, such as solder balls and ball grid arrays (BGAs), are subject to thermal fatigue as boards and circuits are powered up and down. Thermal cycling tests can produce fatigue data, but these tests can be prohibitively time consuming. As a time-saving alternative, the Tytron 250 system can collapse months of testing into just days with high-speed mechanical cycling.

The Tytron 250 system is the ideal solution for a wide range of applications in the microelectronics industry, including:

- Tensile and fatigue testing of thin films and foils
- Creep testing of metals and plastics
- Simple peel tests of plastic films on a substrate
- Strength-of-adhesion testing through mixed mode crack growth via four-point bending
- Fatigue and tension testing of lead wire materials, such as copper and gold
- Three- and four-point bending testing of flexible printed circuit boards
- Component testing for handling and fatigue damage
- Fatigue of Flip Chip BGAs
- Lead pull out testing
- Die bond adhesion testing

Biomaterials and implantable devices

The Tytron 250 system provides unique capabilities to biomaterials researchers and implantable device developers. A biological fluid chamber lets you test your specimens in a simulated in vivo environment to produce higher quality data. Biological applications of the Tytron 250 system include:

- Tensile, compression, and fatigue testing of connective and other soft tissues
- Tensile, compression, and constitutive characterization of hard tissues
- Simple and complex testing of biological implant materials and components. The Tytron 250 system can simulate the mechanical load and deformation conditions that materials and components will experience after they are implanted.
Plastics

The Tytron 250 system is a reliable tool for conducting common tests on plastics and similar materials. Such tests include:

- Tear testing
- Simple tensile pulls
- Compression testing
- Creep testing
- Fatigue and fracture testing

Basic materials research

Any time you need to conduct low-force tension, shear, compression, or fatigue testing of small specimens under load, stress, strain, or deformation control, the Tytron 250 system provides reliable performance and advanced data acquisition capabilities to make your job easier and your time more productive.

To handle unique and unusual testing requirements, the Tytron 250 system can be configured with a variety of environmental chambers, grips, and force transducers. These accessories are readily available from MTS Systems. Be sure to contact your MTS sales representative if you need special fixturing.

Chambers

Testing chambers are available to simulate various environmental conditions:

- Hot/cold chamber. This specially designed chamber controls the temperature to which the specimen is exposed, from -75 to 200°C. It isolates mechanical noise and vibration from the test system and maintains an adjustable air flow to ensure that the specimen is not exposed to extraneous forces.
- Fluid chamber. This chamber allows the specimen to be immersed in a fluid, such as saline solution, ringers solution, or bovine serum, and held at 37°C to simulate in vivo conditions.

Load cells

The basic configuration of the Tytron 250 system includes a load cell calibrated at ±250 N and ±25 N. This load cell can provide a resolution of 25 milliNewtons. More sensitive load cells are available optionally with calibrations of

- ±25 N and ±2.5 N. This load cell can provide a resolution of 2.5 milliNewtons. Properly mounted, this load cell can support a 2-kg mass mounted 75 mm from its front face.
- ±5 N and ±1 N. This load cell can provide a resolution of less than 1 milliNewton. Properly mounted, this load cell can support a 500-g mass mounted 75 mm from its front face.

Positioning stage

An X-Y micrometer positioning stage can be added to the headstock to allow ultra-precise positioning and movement of specimens.
Grips

All grips and fixtures for the Tytron 250 system are rigidly mounted to the system (or auxiliary) load cell and the servoelectric actuator by an M6X1 threaded hole in both the load cell and the actuator. Several types of grips are available for use with the system:

- 110-N pneumatic grips. These grips can be used with the system and 50-N load cells.
- 250-N mechanical clamp grip
- "Clothes Pin" Grip. This low-force (10 N or less) grip can be used with all load cells offered for the Tytron 250 system.
- 100-N mechanical thumb screw action grips. These grips come with 15-mm wide serrated faces and accommodate a specimen thickness of up to 4 mm. They can be used with all MTS load cells.
- 3- and 4-point bending fixture (model 642.05) can be used with the system load cell and the 25-N load cell.

High-resolution displacement gage

The Tytron 250 system can be configured with an optional strain measurement gage that provides a displacement range of ±2 mm with a resolution of better than 0.1 µm in the ±200 µm range. A ±6 mm displacement range option is also available, with a resolution of 0.0003 mm.

The high-resolution displacement gage is incorporated into the end of the actuator rod. It can be detached easily from the load train when not in use. The gage incorporates a fail-safe break-away design to prevent damage if used beyond its range and comes with standard calibrations of ±100% and ±10% of range.

Air supply options

Clean, oil-free, moisture-free air is required to operate the Tytron 250 system's air bearings. Three options for air are available:

- Customers can supply their own air. (Air specifications are given at the back of this brochure.)
- MTS can supply a filter and disiccation unit to clean air supplied by customers to meet the required standard. (Air specifications are given at the back of this brochure.)
- MTS can provide a complete air supply system.

Other extensometer options

Extensometry for the Tytron 250 system includes a broad range of options developed by MTS for material testing. We design and build our extensometers in-house to ensure consistent quality and reliability. If you have special needs for extensometry, be sure to discuss them with your MTS sales representative. We can meet most custom needs quickly and economically.

The extensometers used most commonly with the Tytron 250 system include:

- The 632.32 low-contact-force unit for direct measurement of strain at a 5 mm gage length
- The 632.29 subminiature series of extensometers for direct measurement and control of strain, with gage lengths as small as 3 mm

Microscope

The Tytron 250 system can be fitted with an optical microscope for visual inspection of specimens during testing.
The TestStar IIs Control System

The TestStar IIs control system is designed for users at all levels of experience. It is ideal for managing tests on many types of materials and components.

With the TestStar IIs control system, you set up, define, and perform material and component tests through a personal computer interface. The system runs in Microsoft’s Windows NT operating environment.

The TestStar IIs control system includes three primary components:

- The TestStar IIs system software
- The TestStar IIs remote station control (optional*)
- The TestStar IIs digital controller

Software is the heart of the TestStar IIs system. Through a series of menus, the main TestStar IIs window provides quick access to all the controls needed for test setup. These controls include windows for assigning transducers, setting limits, auto-zeroing sensors, and—when necessary—setting up parameters such as error limits and tuning. The various windows are easily accessible but conveniently hidden when not needed.

Accurate test control
The TestStar IIs system accurately controls your tests, combining a choice of adaptive compensation techniques with stable system tuning. This means the test will reach its programmed end levels even while specimen characteristics change.

MTS provides a range of adaptive compensation techniques, each optimized to meet specific application requirements. You can choose from peak/valley amplitude/mean control, amplitude and phase control, null pacing, or adaptive inverse control.

Peak/valley control adapts as specimen compliance changes to ensure peaks and valleys are maintained for any constant amplitude periodic waveform.

Amplitude and phase control adapts for phase changes as well as amplitudes of sinusoidal waveforms.

Null pacing will pace the test program to allow the system to reach programmed end levels without overprogramming.

Adaptive inverse control adapts for applications of linear systems, typically in conjunction with random or time-history files.

Easy data access and information sharing
The Windows NT operating system simplifies data sharing and makes it easy to integrate your TestStar IIs control system into your organization’s computer networks.

Data integrity
The TestStar IIs system’s calibration utility lets you calibrate system transducers to meet or exceed standards such as ASTM E4 and E83, ISO 9513 and 7500, BS 3846 and 1610, and DIN 51 301 and 51 307 to provide needed traceability.

The Mechanical Testing and Simulation Division of MTS Systems Corporation is ISO 9001 certified, and our controller and application software packages are designed and manufactured in accordance with ISO 9001 practices. We undergo routine internal audits as well as scheduled semi-annual audits by our registrar, Det Norske Veritas.

Dependable service and maintenance
TestStar IIs diagnostic utilities provide a board-by-board check of the TestStar IIs system hardware. Should you require further assistance in the United States or Canada, you can contact the MTS HELPLine.
at 1-800-328-2255 for connection with the appropriate MTS factory based service specialists or a trained field service engineer.

The MTS Metrology Laboratory is accredited to ISO Guide 25 by the American Association for Laboratory Accreditation.

Outside of North America, call your local MTS representative or the appropriate MTS regional business center as shown on the back cover of this brochure.

**Fast results**
The Basic TestWare application provides function generation and data acquisition capabilities from a single screen—an easy way to get quick results.

**Optional application software**
A variety of optional software packages are available for the TestStar II's control system, including:

- MultiPurpose TestWare software
- High-cycle, low-cycle, and advanced low-cycle fatigue
- Fatigue crack growth
- Fracture toughness
- TestWorks® (monotonic testing software)
- Programming libraries (Visual Basic®, C++, LabVIEW®)

These tightly integrated packages let you run your standard tests with ease and assure consistent, repeatable testing and accurate test results.

**The digital controller**
The TestStar II's digital controller performs the control system's real-time functions, including high-speed closed-loop control, data acquisition, function generation, and transducer conditioning.

The TestStar II's controller incorporates distributed processing rather than relying on the PC to control the system. Because the PC downloads operating code to the digital controller, new features can be added easily through software upgrades.

The digital controller chassis houses the modules that supply all of the control functions. Modules plug in easily for flexible configurability. The system can accommodate up to six modules. A valve driver module is required for the control channel. The remaining slots can be filled with digital universal controllers (DUCs) analog input modules and/or analog output modules. A typical configuration will include, in addition to the valve driver module, two DUCs (load and displacement) with the remaining three slots filled with DUCs and/or analog input modules. Each analog input module can bring in up to six external channels that can be used for control and/or data acquisition. Each D/A module can bring out up to six signals, which can be routed to external devices. These D/A signals can be used for readouts or program sources.

**The TestStar II's remote station control panel**
The TestStar II's remote station control panel provides convenient access—at the load frame or test stand—to all the controls you need to properly load specimens. In addition to hydraulic controls and an interlock indicator, it provides run, stop, and hold controls; a display screen and function keys; and an actuator positioning control for specimen loading. Once a specimen is loaded, transducers can be auto-zeroed from the computer, or from the remote station control using the control panel's function keys.

*Required to meet CE safety in material testing applications.*
System Service from MTS

A comprehensive set of system services is included with each Tytron 250 testing system to ensure that manufacturing and installation go according to plan. These services include:

- A trained MTS technician performs installation and operational checkout of the system at your site. Informal, one-on-one training on operation and maintenance occurs during this time.
- A 12-month software technical support and maintenance contract for your TestStar IIIs software is included with each system sale. You also receive TestStar IIIs software updates free during this 12-month period.
- A twelve month system warranty is included. This warranty starts from the date of acceptance or 15 months from the date of shipment, whichever occurs first. Extended warranty contracts are also available.
- System documentation is provided with each system, which includes hardware, software, and user information.

Additional Services

Field service
A worldwide network of trained MTS service representatives assures ongoing support for your system. A variety of service contracts are available, covering calibration, preventive maintenance, extended system warranty, and software maintenance. In addition, in the United States or Canada, a single toll-free number (1-800-328-2255) connects you with a host of MTS support services, including

- Hardware technical support
- Sales and application engineering support
- Order services
- Software support
- Field support scheduling

Outside of North America, call your local MTS representative or our general number on the back cover of this brochure.

Training
We provide extensive, regularly scheduled training programs—at MTS or your facility—to help you get the most out of your investment. These include classes on operation and maintenance of system hardware and software.

Life-Cycle Software Agreements
Our optional Life-Cycle Software Agreement makes it easy and cost-effective for you to keep pace with our rapidly changing software technology.
System Specifications

**Load unit**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Stroke</td>
<td>100 mm</td>
</tr>
<tr>
<td>Maximum load</td>
<td>±250 N</td>
</tr>
<tr>
<td>Load control</td>
<td>Yes</td>
</tr>
<tr>
<td>Displacement control</td>
<td>Yes</td>
</tr>
<tr>
<td>Frequency</td>
<td>Up to 50 Hz (see performance curve below)</td>
</tr>
<tr>
<td>Maximum open loop velocity</td>
<td>500 mm/sec.</td>
</tr>
<tr>
<td>Power</td>
<td>100, 110, 220, 240-volt single phase</td>
</tr>
<tr>
<td>Footprint</td>
<td>1.275 m x 375 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>170 kg (approx.)</td>
</tr>
<tr>
<td>Test space</td>
<td>0 to 500 mm</td>
</tr>
<tr>
<td>System displacement resolution</td>
<td>0.005 mm normal</td>
</tr>
<tr>
<td></td>
<td>0.0001 mm with high-resolution option</td>
</tr>
</tbody>
</table>

**Linear servomotor**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed range</td>
<td>0.0000003 to 500 mm/sec</td>
</tr>
<tr>
<td>Frequency range</td>
<td>0.001 to 50 Hz</td>
</tr>
<tr>
<td>Displacement range</td>
<td>Up to 100 mm (±2 mm or ±6 mm with high-resolution displacement gage)</td>
</tr>
</tbody>
</table>

**Hot/cold chamber**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
<td>-75 to 200°C</td>
</tr>
<tr>
<td>Control range</td>
<td>± 1°C</td>
</tr>
<tr>
<td>Skin temperature</td>
<td>&lt; 55°C</td>
</tr>
</tbody>
</table>

**TestStar II controller**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed conditioners</td>
<td>Up to 5</td>
</tr>
<tr>
<td>Auxiliary A/D channels</td>
<td>6 channels per board</td>
</tr>
<tr>
<td>Auxiliary D/A channels</td>
<td>6 channels per board</td>
</tr>
<tr>
<td>D/A channels</td>
<td>2 channels</td>
</tr>
<tr>
<td>A/D and D/A resolution</td>
<td>16 bit</td>
</tr>
<tr>
<td>DIO channels</td>
<td>4 input/4 output</td>
</tr>
<tr>
<td>DDC loop closure rate</td>
<td>6 kHz</td>
</tr>
</tbody>
</table>

**Air supply options (for air bearing)**

**Air interface module**

For use when air available onsite meets the following criteria:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>6-8 Bar (90-120 psi)</td>
</tr>
<tr>
<td>Flow rate</td>
<td>128 L/min (4.5 scfm) or greater</td>
</tr>
<tr>
<td>Maximum particle size</td>
<td>0.05 micron or less</td>
</tr>
<tr>
<td>Maximum oil content</td>
<td>0.1 mg/m³ or less</td>
</tr>
<tr>
<td>Atmospheric dew point</td>
<td>-20°C (-4°F) or less</td>
</tr>
</tbody>
</table>

This interface module provides 10 meters of hose and an on/off valve. It connects to a 0.25-in.NPT thread.

**Air filtration and desiccation module**

For use when air available onsite does not meet the criteria above, but meets the following criteria:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>6-8 Bar (90-120 psi)</td>
</tr>
<tr>
<td>Flow rate</td>
<td>128 L/min (4.5 scfm) or greater</td>
</tr>
<tr>
<td>Maximum particle size</td>
<td>40 micron or less</td>
</tr>
<tr>
<td>Maximum oil content</td>
<td>5 mg/m³ or less</td>
</tr>
<tr>
<td>Atmospheric dew point</td>
<td>15°C (59°F) or less</td>
</tr>
</tbody>
</table>

This module provides air filtration and desiccation. It is typically mounted on a wall or behind a table/counter. It connects to a 6-mm quick connect or a 0.25-in NPT thread.

**Air supply module**

For use when air is either not available or cannot meet the criteria above. This module provides air of the correct quality, pressure, and flow rate to operate the air bearings as required. It requires either 220 or 240 V (AC) power of 50 or 60 Hz.

Year 2000 compliance: The operation of the Tytron 250 system for its intended purpose will not be affected by the year 2000 rollover and leap year.

MTS, TestWare, and TestWorks are registered trademarks, and TestStar and Tytron are trademarks of MTS Systems Corporation. Windows NT and Visual Basic are trademarks of Microsoft Corporation. LabVIEW is a registered trademark of National Instruments.

U.S. Patent # 5,767,402