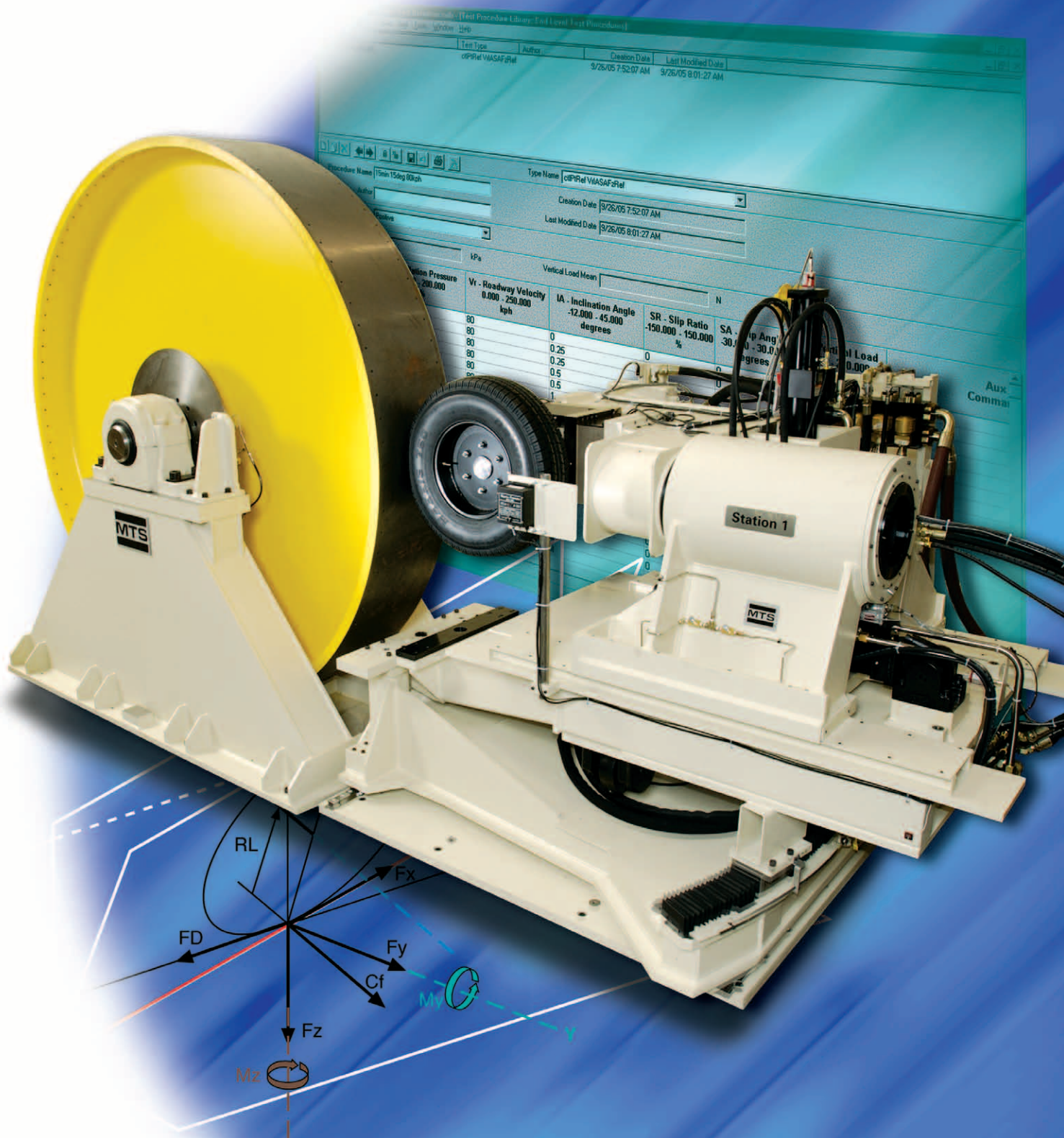


Tire Tread Wear Simulation System



- ▶ Fast, Repeatable Wear Replication
- ▶ Precise Control of Tire Loads and Positions
- ▶ Capture Wear Rate and Irregular Wear
- ▶ Flexible Automated Digital Controller
- ▶ Unparalleled MTS Global Support



Tire Tread Wear Simulation System

The MTS Tire Tread Wear Simulation System sets the standard for tread wear simulation by simulating real world tread wear faster and with more repeatability than alternative methods. How? By accurately and precisely reproducing the forces and motions a tire experiences on the road. When you need speed, precision, repeatability, and dependability, MTS will help you move your tread wear testing off the track and into the lab.

Gain efficiency and convenience while improving correlation and replication of complex wear patterns.

MTS configures our system with a specially designed multi-axial sensor package and motion systems to provide dynamic simultaneous control of lateral force, normal force, wheel torque, and inclination angle. This control enables highly accurate replication of tread wear that occurs during real-world vehicle maneuvers. The benefit of simultaneous multi-axial control is improved correlation between indoor tests and outdoor driving.

Not only can you cut testing time significantly, you can improve your ability to replicate complex wear patterns by precisely controlling influential variables such as temperature, speed, road surface, and driver inputs. Testing can be performed at constant or variable speeds, and simulations can run 24 hours a day – seven days a week.

All the flexibility you need to handle the twists and turns of real world testing in your lab.

MTS Tire Testing Systems make it easy to program, save, and recall different tests with different time history profiles. That flexibility lets you run the wide range of tests you need, while quickly adapting your system to handle the many different tire-vehicle drive files associated with these tests.

The system uses the same intuitive software as the MTS Flat-Trac[®] Tire Test System. This familiar interface boosts productivity by enabling users to operate both machines easily. Common calibration methods, test definition, and reporting add to the benefits. Now it's easier than ever to get the advanced data you need to evaluate tire construction and compounds earlier in the design process.

Complete range of testing capabilities for passenger car, light truck, and heavy truck applications.

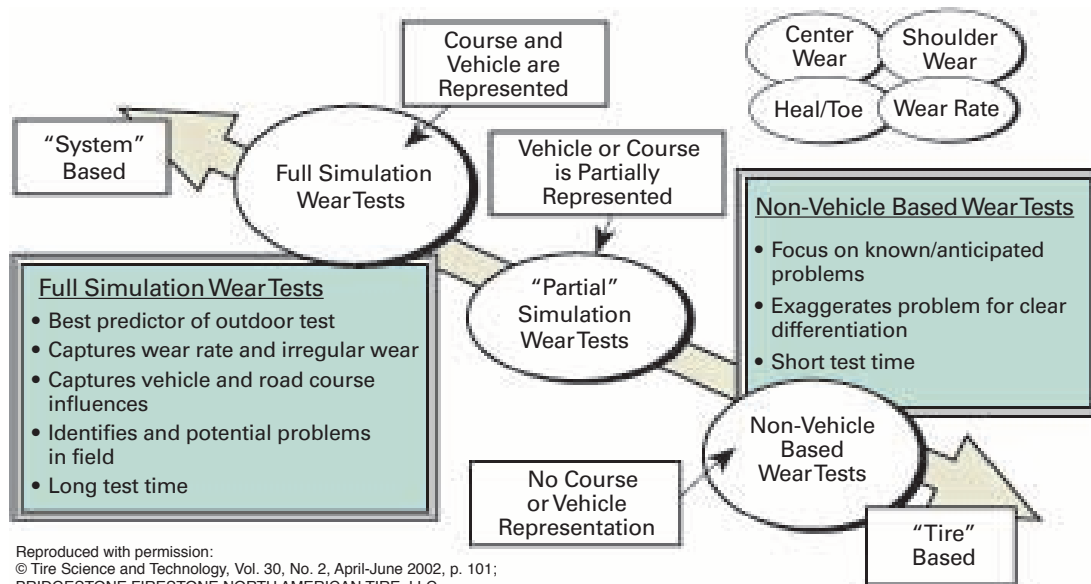
The MTS Tire Tread Wear Simulation Systems are configured in two sizes to cover the complete range of tire sizes from passenger car to heavy truck. These systems build on over 30 years of tire testing experience to deliver the right combination of machine control features to simulate complex wear patterns, while ensuring the validity and repeatability of the test results.

From Akron to Stuttgart, from Shanghai to Seoul – we deliver the support you need, whenever and wherever you need it.

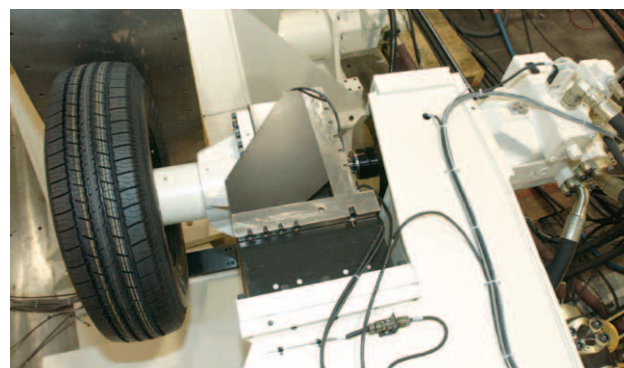
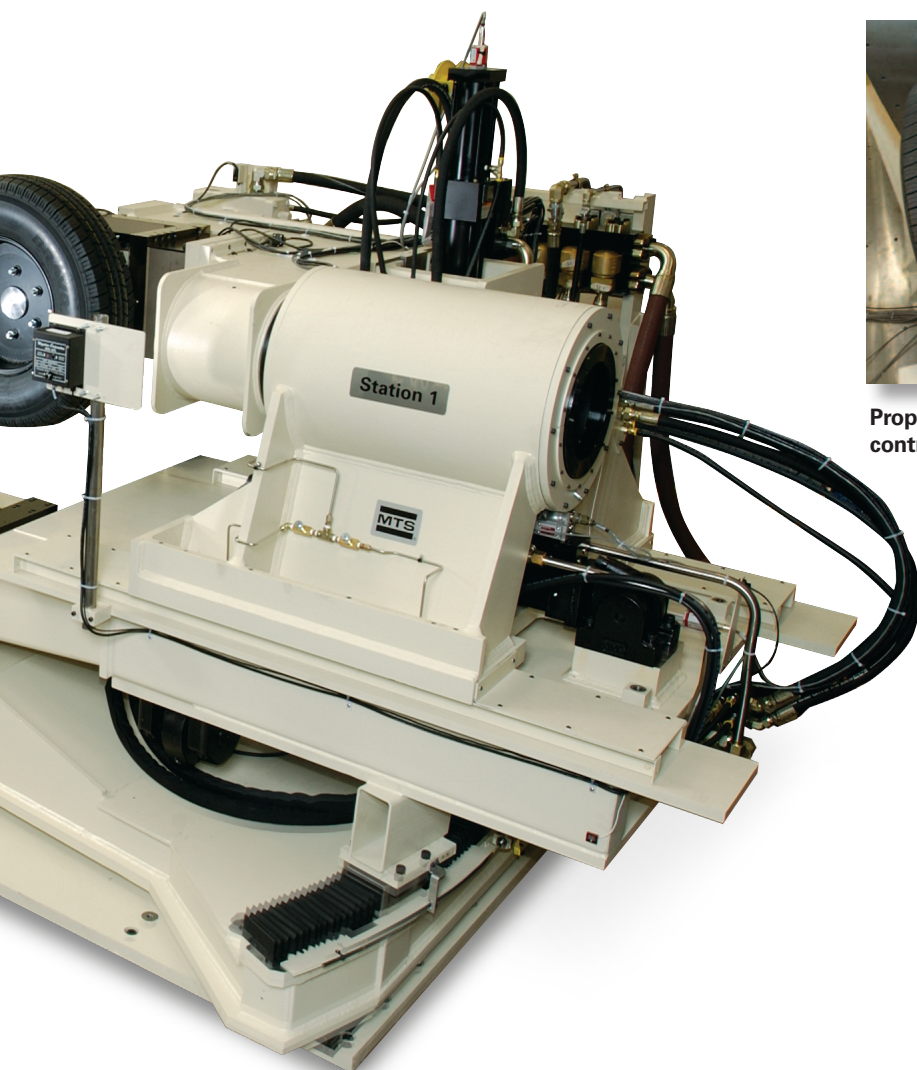
MTS fields the largest service, support, and consulting staff of any automotive testing solution provider. This global team of highly experienced professionals provides a comprehensive range of services including preventative maintenance and system lifecycle management. You can be sure that we will be there to meet your training and support needs – whenever and wherever you need us to maximize your testing productivity.



Precision tolerances, system-level calibration, software compensation, and flexible controls deliver the accurate, repeatable results you need.



Gain important knowledge from a broad range of tests, some that cannot be done outdoors.



Proprietary multi-axial sensor package and precise motion control system improve wear replication and cut test time.

Applications

- ▶ Evaluate constructions and compounds earlier in the vehicle design – before prototype vehicles or suspensions exist.
- ▶ Screen new designs for irregular and premature wear.
- ▶ Predict wear for a given application.
- ▶ Assess the effect of tire and vehicle design changes on tire life.
- ▶ Evaluate suspension geometry kinematic effects on tire wear.
- ▶ Confirm suspension alignment settings.
- ▶ Assess performance in accordance with the Uniform Tire Quality Grading Standard (UTQG).

Better Performance Through Better Engineering

As the recognized leader in multi-axial measurement and control technology, MTS has been designing, building, and integrating force transducers into tire test systems for over 30 years. Today, the MTS Tire Tread Wear Simulation System gives you a test system that accelerates your wear testing and helps you meet your engineering objectives – with confidence.

Key System Features

1. Center Section

The large 3-meter diameter drum minimizes tire patch distortion relative to a flat running surface. Its stiff cast construction eliminates weld fatigue concerns and minimizes deflection under load. The drum is mounted on a durable precision axle and oversized bearings to provide years of life.

2. Sector Plates

MTS engineered the large drum so that removable sector plates can be attached to the outside surface. The plates are designed to let you vary the surface texture.

3. Talc Delivery System (not shown)

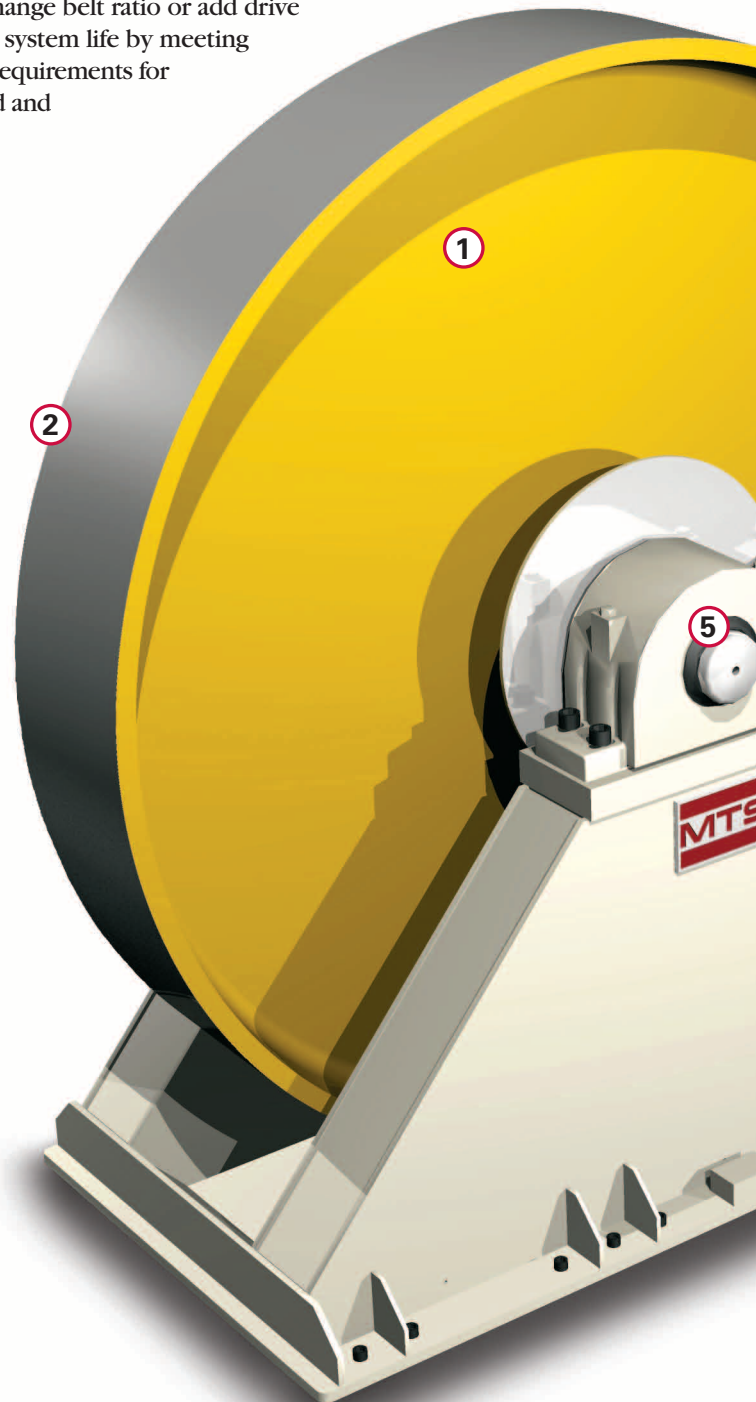
The talc delivery system is vital to achieving best wear results. Talc is a white powder used to coat the rubber particles shed from the tire so that they do not adhere to the roadway and change the surface or tire behavior – degrading system repeatability. The system sprays a controlled volume of talc on the roadway surface near the tire contact patch. Then the talc is extracted with a third-party supplied vacuum system.

4. Carriages

There are two sizes available: the pivot-slider carriage for passenger car and light truck tires and the focused-linkage carriage design for heavy truck tires. Both carriages provide dynamic control of tire forces and motions in standard tire coordinates. Both carriages work to eliminate the influence of tire scrubbing on test results by locating the pivot axis of the tire inclination angle tangentially on the roadway surface. Both carriages provide the durability necessary to dynamically simulate tire loads and motions for long term unattended testing profiles. The pivot-slider design has the added feature of lateral motion, which sweeps the tire back and forth across the entire abrading surface to extend the life of the surface.

5. Drive System

The sophisticated drive system features road wheel speeds of up to 160 km/h and is capable of handling the tractive force developed by the tire during braking and driving, as well as the drag force produced by tire slip angle. The system features both forward and reverse rotation, which can simulate tire placement in all four tire positions. Its power regeneration design (between spindle and road wheel hydraulic circuits) cuts operating costs, and the ability to change belt ratio or add drive power extends system life by meeting emerging test requirements for increased speed and acceleration.



6. Wheel Torque

A powerful hydraulic spindle drive delivers 1600 Nm of torque up to 1000 rpm. Wheel torque is critical for accurate wear replication.

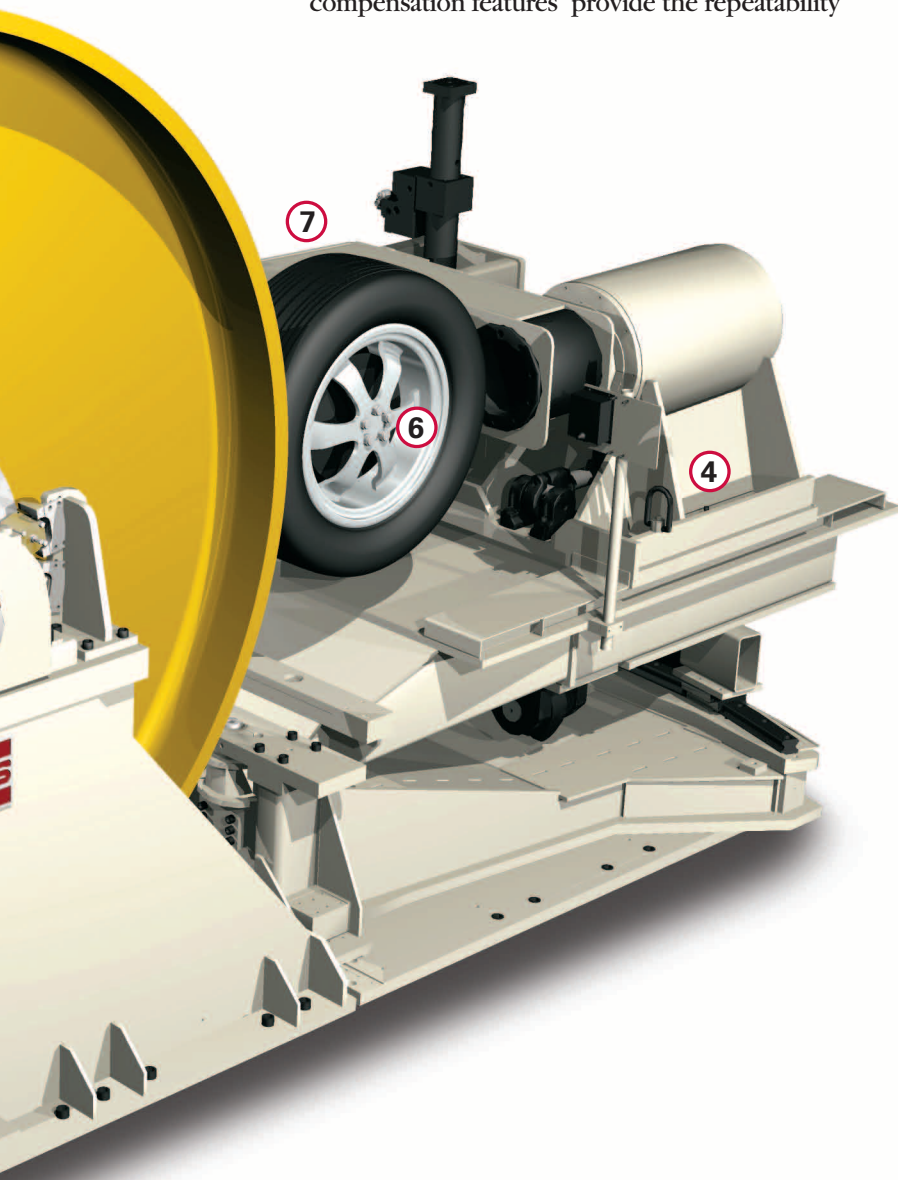
7. Sensor

MTS has engineered a multi-component sensor package specifically for the tread wear application to maximize the measurement accuracy and to minimize crosstalk and hysteresis – improving both control accuracy and wear correlation. Advanced compensation features provide the repeatability

and precision required for meaningful indoor wear testing. The optional telemetry feature for the torque sensor reduces maintenance costs and downtime.

8. Automated Control and Calibration

Automated control improves flexibility and productivity with the ability to define and deploy both industry standard and unique automated tire tests. The stand-alone Test Definition and Analysis Workstation, lets the operator create files or analyze test data. The real-time control system workstation lets the operator make adjustments for controlling, tuning, configuring and calibrating the system.



Standard System Specifications

	Passenger Car/ Light Truck	Heavy Truck
RoadWheel OD	3048 mm	3048 mm
Maximum Speed	160 km/h	160 km/h
Maximum Radial Load	25000 N	45000 N
Lateral Load	± 9000 N	± 18000 N
Slip Angle	± 10 deg	± 10 deg
Camber Angle	± 8 deg	± 8 deg
Wheel Torque	1600 Nm	1600 Nm
Tire OD	1000 mm	1500 mm
Tire Width	425 mm	508 mm

Important Machine Control Features

- ▶ Precise lateral force control using the slip angle motion.
- ▶ Accurate control of radial loads to simulate road inputs and weight transfer during maneuvers.
- ▶ Accurate control of inclination angle and tire attitude relative to the roadway.
- ▶ Precise control of spindle braking and driving torque to simulate engine and brake inputs.

Automated Digital Controls for Fast, Flexible Tire Testing

MTS uses the same intuitive software that is used with the MTS Flat-Trac® Tire Test System. This familiar interface boosts productivity by enabling users to easily operate both machines. Common calibration methods, test definition, and reporting also increase productivity. The control system is oriented to laboratory testing with flexibility in developing and managing large custom test profiles, as well as the data produced by the test. The controller's intuitive graphical user interface, complete range of built-in standardized tests and analysis templates, plus simple operating procedures make it easy for your operators to run tests—without learning new software.

Real-Time Control Workstation combines precision and productivity.

The heart of the automated system is the Real-Time Control Interface. It is the primary human/machine interface that is used to perform calibrations and execute and monitor tests in real-time. The operator selects tests, views and manages sensor signals, digital inputs, outputs, and limit detection status on the display monitor.

The real-time control of the tests is performed on dedicated processors for best performance. Advanced PID control loops are used to precisely control the machine. A variety of control modes are available, including: position, force, deflection, and delta-mean offset. For intuitive operation, the test is controlled in tire coordinates rather than machine coordinates, but for data acquisition, the user may select from a number of different coordinate systems including SAE, JASO and ISO. The controller automatically maintains control of the machine, detects abnormal conditions, acquires data, and displays the test status to the operator.

Separate Test Definition and Analysis Workstation frees the Real-Time Control System for Testing.

A separate test definition and analysis PC lets the test engineer create tire test definition files and analyze test data offline, which keeps the real-time control interface workstation free to run tests. Once the test definition software creates tests, they are automatically transferred to the control system where they are put into the list of tests available to be run.

Tests are defined by specifying test procedures, tire descriptions, tire conditioning procedures, and data acquisition configurations. Test procedures can be defined to use inflation pressure and load information contained in the tire description so that a single procedure can be used for many different tires.

Although the primary data tire wear is the measured separately from this machine, the system controls provide the ability to record the forces and motions that the tire was subjected to during the test. This data acquisition capability is important for verification or troubleshooting purposes.

Precise controls let you develop correlation between lab and track.

Precisely controlling and measuring tire wear in the laboratory is key to correlating wear profiles with actual outdoor road results. The difference is in the details. MTS tire testing systems control the tire in SAE tire coordinates, which is important for accurate force measurements. While other systems may offer correct motion coordinates, the force measurement of these systems can be in error unless controlled in the proper coordinate system.

Also, in order to be most effective in delivering repeatable dynamic drive profiles, the system must feature cross-axis compensation. This compensation is standard on MTS Tread Wear Simulation Systems and provides the most accurate and precise simulation available. Built-in advanced compensation capabilities include:

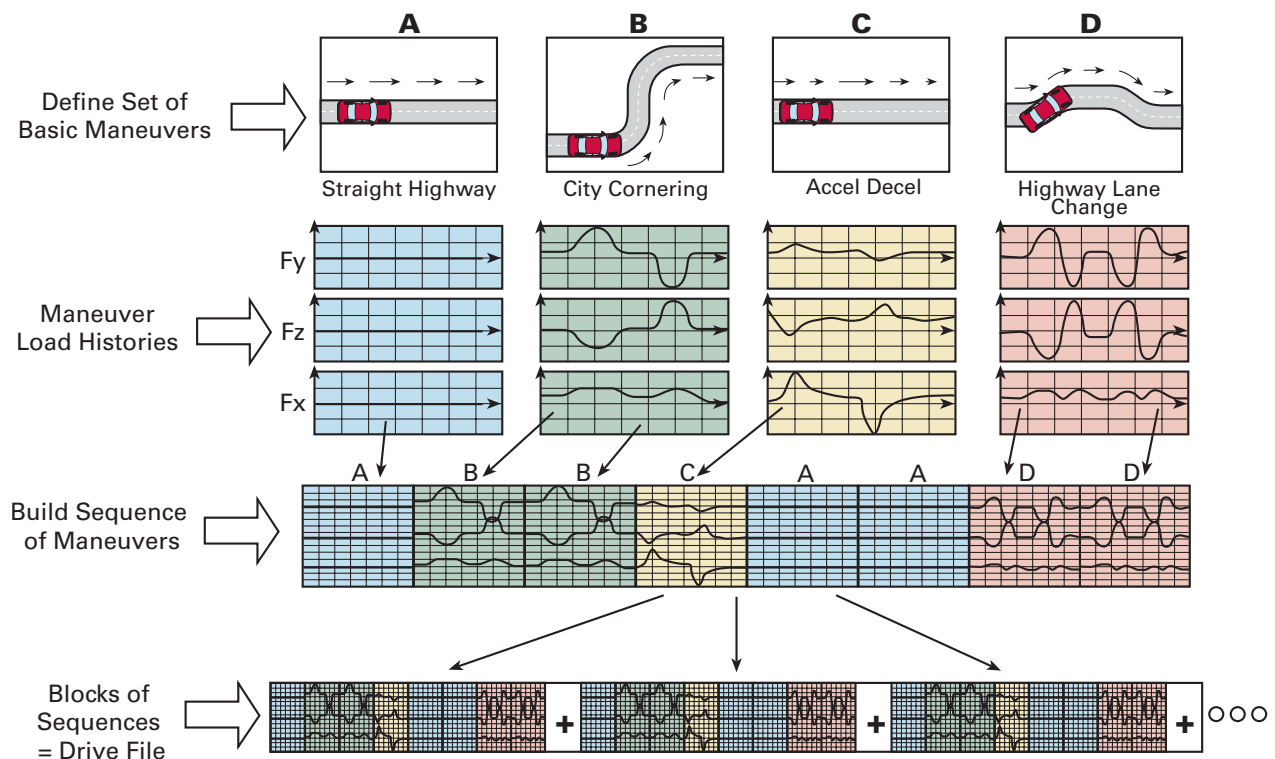
- Crosstalk Compensation
- Active Compliance Compensation
- Lateral Force Control Compensation
- Tare Weight Compensation

Partial List of Control Parameters

- Lateral force
- Normal force
- Wheel torque (continuous from driving to braking)
- Inclination angle (camber)
- Slip angle
- Roadway speed
- Powder delivery
- Inflation pressure (optional)



The system's software is revision controlled, flexible and automated – saving time and money.



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BRIDGESTONE FIRESTONE NORTH AMERICAN TIRE, LLC

The flexible software enables you to sequence predefined drive files to effectively replicate the tire's service environment.

MTS Offers a Wide Range of Tire and Vehicle Performance Testing Systems

Since 1966, the global automotive community has turned to MTS Systems Corporation for the innovative testing and simulation systems it needs to enhance productivity and engineer safer, cleaner, and more durable products. Today, we are recognized as the premier provider of full-vehicle, system, and component-level testing systems and software, with unparalleled engineering and technical experience and a growing set of core technologies.

SWIFT® Wheel Force Transducer

The SWIFT Spinning Wheel Integrated Force Transducer complements all MTS tire test systems. It provides faster testing, better data than any other technology available, and the best possible overall measurement of spindle loads. The data is useful for many applications, including analysis, design, and modeling of the system for creation of virtual models, and application in virtual testing.

The SWIFT system is available in a variety of sizes - ranging from the SWIFT Ultra up to the SWIFT 50 for medium and heavy trucks and other large vehicles.

This system significantly reduces instrumentation time for data acquisition tasks and laboratory-based simulation testing.

- ▶ It quickly attaches to a modified rim for data acquisition on the road, field, or proving ground and significantly cuts instrumentation costs.
- ▶ The SWIFT system measures loads directly at the spindle, eliminating the need to convert data.



Kinematic and Compliance Deflection Measurement Systems

The MTS K&C System measures the kinematics and compliance deflections of a vehicle's suspension to provide the information suspension designers need to achieve their handling objectives - faster. The K&C System applies precisely controlled displacements and forces to a vehicle's tires through four independent loading platforms while holding the body fixed. The resulting wheel displacements are measured with a six-axis wheel motion sensor and the forces produced at each wheel are measured with a six-axis load cell.



MTS K&C Systems are available to measure both static and dynamic kinematic and compliance deflection properties. A flexible control system and advance software tools let you program the sequencing of events, data report formats, and the user interface, all in a high-level language.

Capabilities include:

- ▶ Transient maneuver decomposition
- ▶ Frequency response
- ▶ Dynamic deflection
- ▶ Static deflection
- ▶ Inertia properties

Flat-Trac® Tire Test Systems

Virtually every major tire manufacturer and vehicle maker in the world depends on MTS Flat-Trac Tire Test Systems to deliver its most critical tire performance data. Whether you need precision, repeatability, or power, MTS Flat-Trac Tire Test Systems will help you meet your engineering objectives – with confidence. Data acquisition and control setups include access to all important test parameters such as roadway speed, tire spindle speed, normal force, lateral force, wheel torque, loaded radius, slip angle, inclination angle, and tire inflation pressure. Now it's easier than ever to get the advanced data you need to precisely optimize your tire performance.

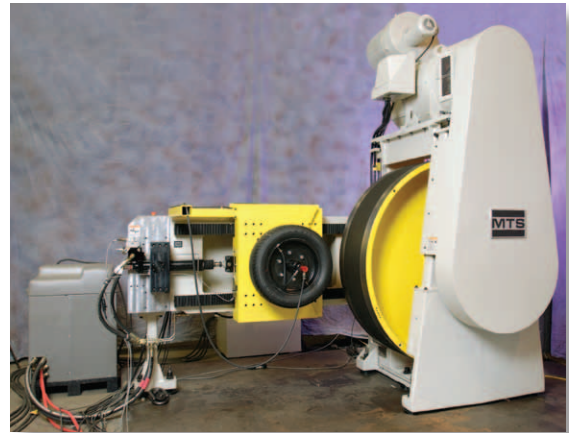
Capabilities include:

- ▶ Steady State Force and Moment
- ▶ Dynamic Force and Moment
- ▶ Residual Aligning Moment and Lateral Force
- ▶ Radial Deflection
- ▶ Effective Rolling Radius
- ▶ Slip Angle Sweep
- ▶ Slip Angle Sinusoidal
- ▶ Tire Traction
- ▶ Simulation



Tire Rolling Resistance Measurement System

The MTS Tire Rolling Resistance Measurement System is designed to meet all requirements of SAE Rolling Resistance Standard J1269, as well as other industry standard rolling resistance tests. The system's advanced control system is easy to use, more productive and more flexible than any competing system on the market today. This precision assembly is capable of measuring the tire's drag force with a unique multiaxial force transducer that is accurate to within 0.5N.



Other capabilities include:

- ▶ Precision tire displacement geometries supported by a stiff, robust test frame to assure accuracy and repeatability.
- ▶ Suitable for use with a wide range of passenger car and truck tires.
- ▶ Digital electronic test controller with intuitive operator interface for easy, flexible set-up and testing using pre-defined automated or manual test procedures.

Just-In-Time Support Around the Clock and Around the Globe

With reduced development cycles and innovative design requirements, you need to maximize the efficiency and effectiveness of your tire testing efforts. MTS has the expertise and the resources to understand your challenges and complement your skills wherever you need them. We are capable of providing daily or weekly consulting to meet your immediate needs, or we can provide engineering studies, comprehensive training, and development programs to address longer-term concerns.

We can tie your global operations together with one support organization.

We can help you tie your global operations together by helping you transfer your testing knowledge to new plants and R&D labs throughout the world. MTS is the one tire testing equipment company that has the breadth and depth to meet all of your global needs.

MTS has service and support offices on 6 continents and in over 50 countries for fast delivery of service and parts.

Our equipment service offerings are designed to maximize uptime and keep your lab running productively. MTS field service engineers are strategically located to give you the fast response time you need.

Services include:

- ▶ Calibration and verification services to ensure reliable test results.
- ▶ Preventive maintenance to minimize downtime.
- ▶ Scheduled and emergency repair services to bring your testing systems back up and running in the event of a failure.
- ▶ A worldwide parts distribution network that can supply the parts you need when you need them.

MTS fields the largest service support and consulting staff of any automotive testing solution provider.

We have the field support and consulting staff to meet your needs no matter where your facilities are. We can help you with troubleshooting, upgrading software, installing replacement parts, or just helping get the job done. Whatever you need, our experienced support engineers will help you keep your lab running smoothly.

Complete engineering support, knowledge transfer, and customer training whenever and wherever you need us.

All MTS training courses are designed to help you maximize the productivity and lifetime of your test system investment. The courses provide an opportunity for hands-on learning to ensure that you are familiar with every aspect of your test system. Our training courses cover systems and software operation and maintenance, testing principles, methodologies, and applications.



MTS provides in-depth, focused training on the operation and maintenance of your testing equipment at your site or at a convenient MTS location.



MTS offers a complete range of services and programs designed to maximize uptime and extend the life of your system.

MTS Service Agreements save you time and money.

Software and electronics technologies continue to change rapidly in our industry. This can create many challenges when trying to keep systems current and compatible with evolving PC technology, while meeting increasing workload demand. MTS offers service agreements that make it easy and cost-effective to maintain and enhance your systems with the assurance that experience MTS technical support is waiting to help.

Our Service Agreements include:

- ▶ Periodic software updates
- ▶ Easier budgeting with fixed costs
- ▶ Preferential technical assistance at no additional cost
- ▶ Locked-in support costs
- ▶ Multiple system support discounts

For More Information

Contact your MTS field sales engineer for more information. You can also write, call, FAX, or e-mail, MTS at the addresses on the back page.



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