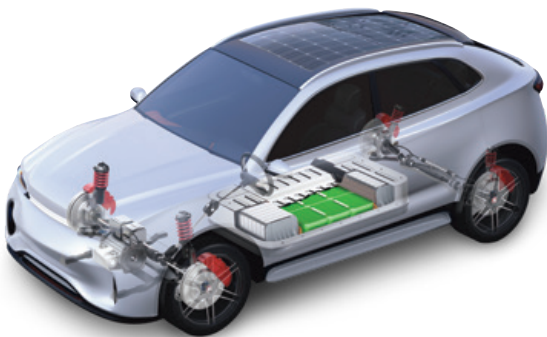


MTS GROUND VEHICLE SOLUTIONS



Sustainable Vehicle Engineering

Automotive OEMs and suppliers worldwide rely on MTS for the testing technologies, expertise, and support needed to accelerate next generation vehicle development while meeting energy efficiency and decarbonization targets. Visit Booth 8515 and explore how MTS solutions can help you achieve more sustainable vehicle engineering and thrive in a competitive global market.



Booth 8515

Next-Generation MTS Innovation



Gen 2 EMA Damper Test Systems - page 2



Gen 4 SilentFlo™ 525 HPU – page 4

Innovation Showcase

Developing an Integrated EV Battery Vibration Test Cell

Electric vehicle battery testing presents unique challenges to OEMs, suppliers and contract test labs as it requires the integration of separate systems to apply multi-axial vibration, cycle current, simulate environmental conditions, and ensure the safety of test equipment and personnel. This presentation will explore a fully integrated EV battery vibration test cell developed by Centro Tecnológico de Automoción de Galicia (CTAG) to provide OEMs and Tier 1 suppliers with a turnkey 6DOF MAST solution for validating Li-Ion battery packs. An application case will be presented detailing an actual test of an EV traction battery performed in the integrated test cell.

Date: Day 1, Tuesday, May 20, 2025

Time: 14.00 - 16.00

Stage: Hall 8



Carlos Rodríguez San Luis
Head of Energy Storage
Technologies and Validation
CTAG

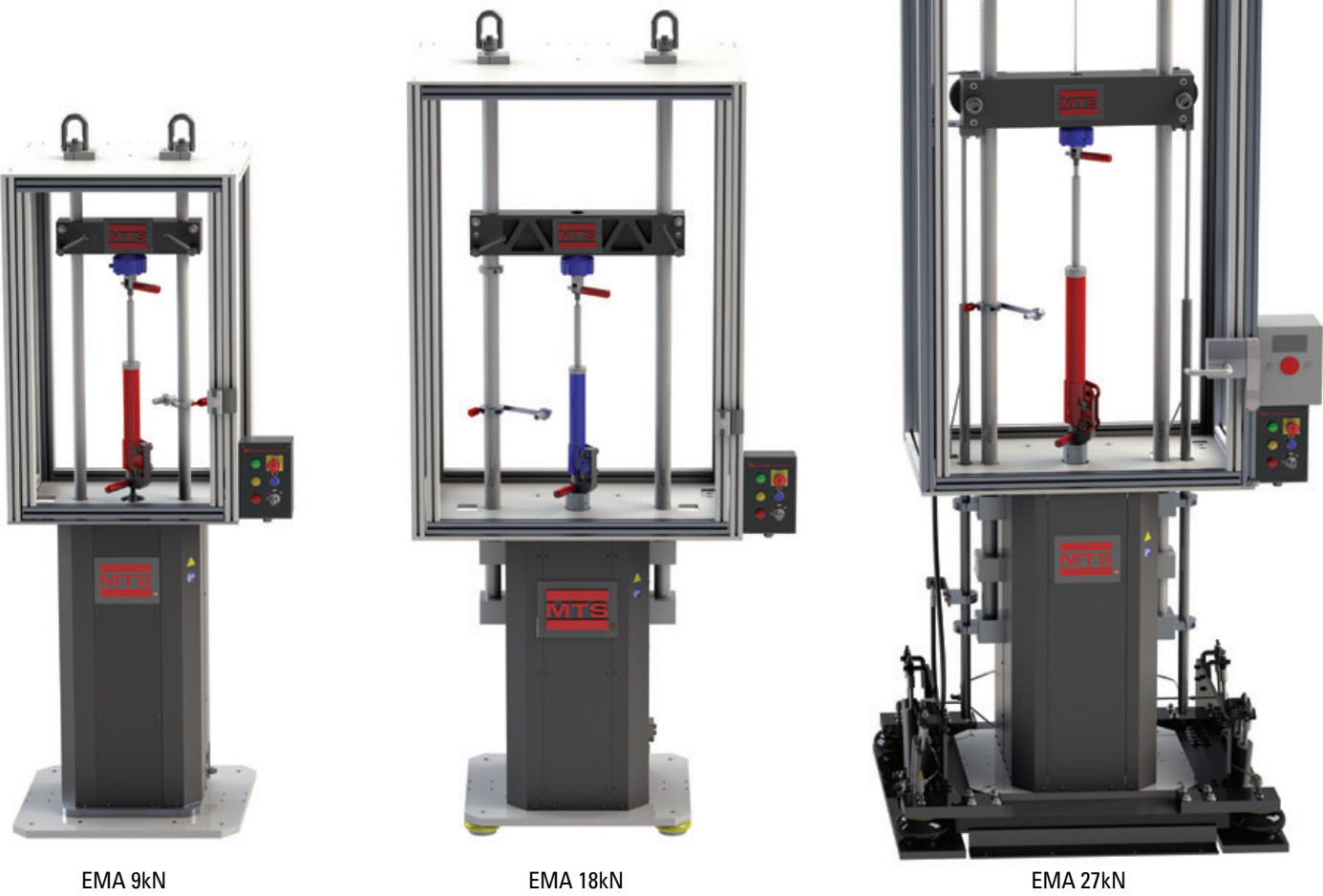


Stefan Pettersson
Senior Application Engineer
MTS Systems Corporation

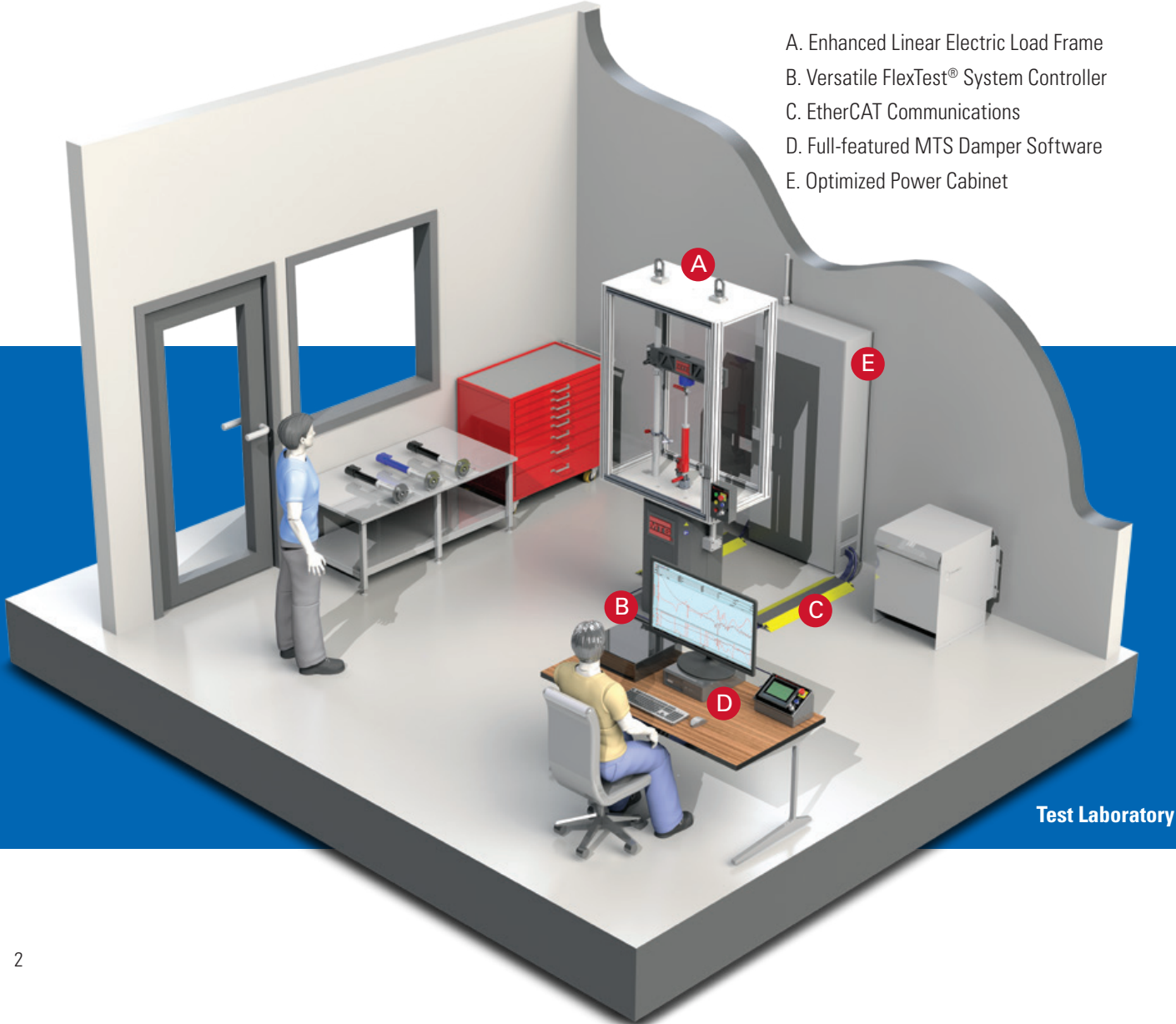
Next-Generation
EMA Damper Performance Test Systems



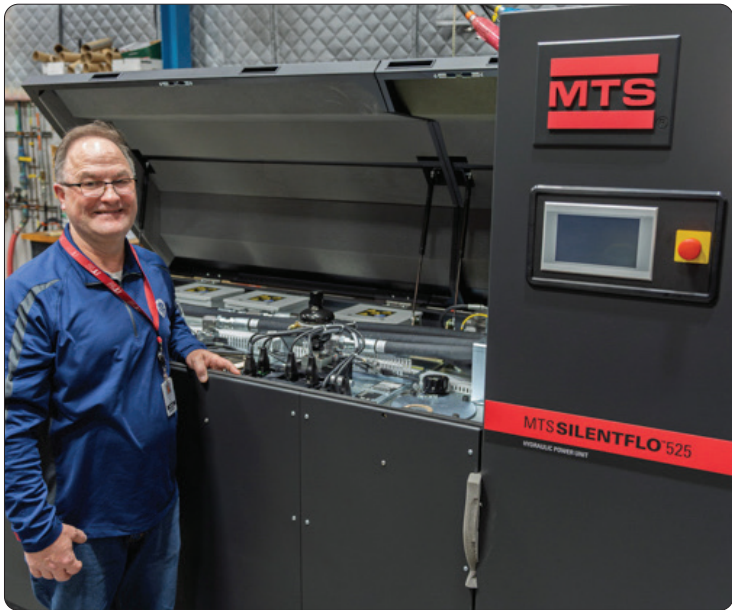
The EMA (Electro-Magnetic Actuation) product is an electrically actuated test system used for conducting damper performance characterization. It features a highly responsive linear electric actuator that delivers the accuracy and data quality damper manufacturers and OEMs demand. Born of a recent value engineering initiative, EMA Gen 2 systems deliver proven EMA performance and ease-of-use, while leveraging a host of customer-driven mechanical and software innovations to enhance test integrity, expand system utility, and increase operational efficiency and safety.



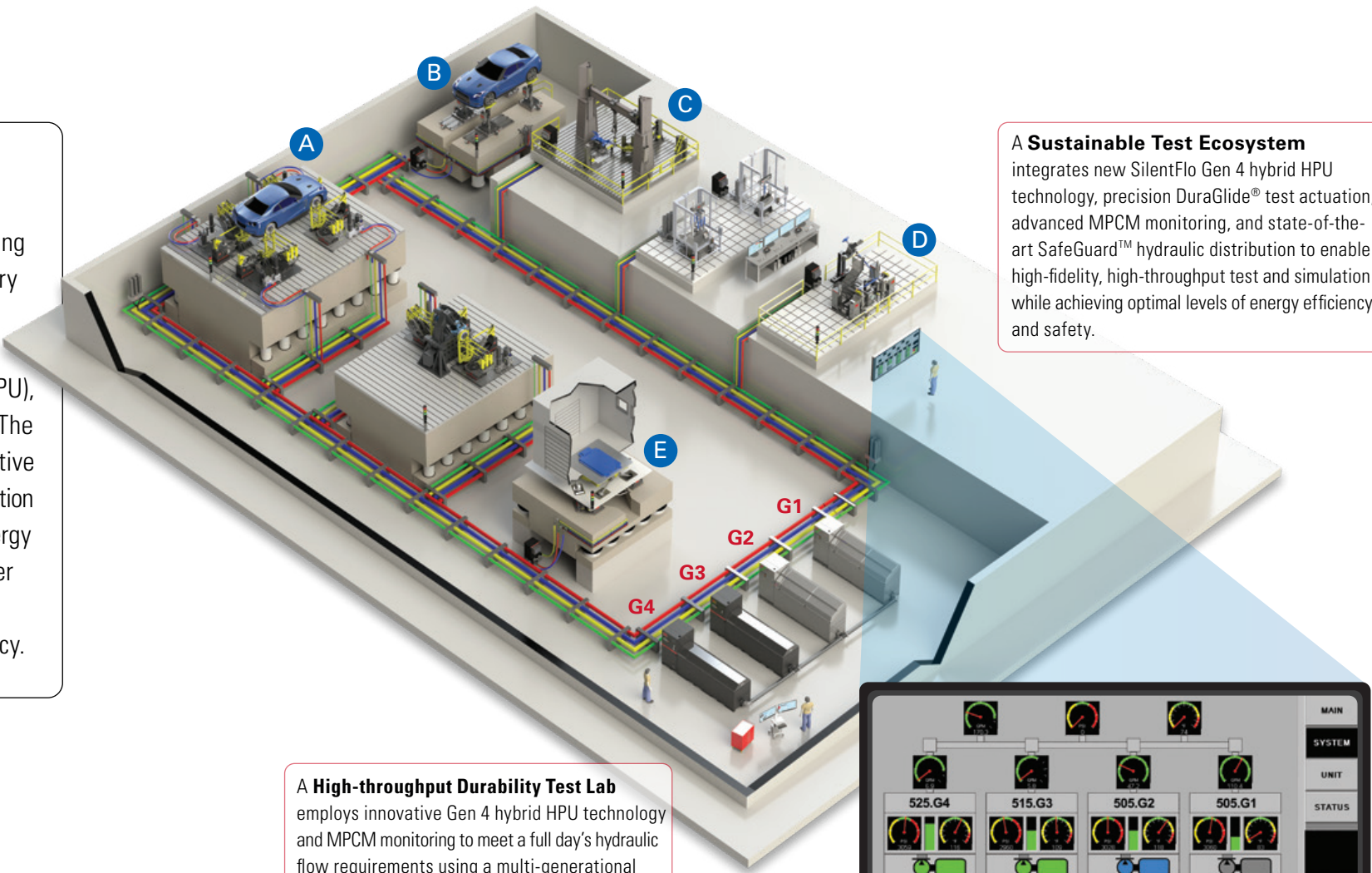
- A. Enhanced Linear Electric Load Frame
- B. Versatile FlexTest® System Controller
- C. EtherCAT Communications
- D. Full-featured MTS Damper Software
- E. Optimized Power Cabinet



Introducing SilentFlo™ Gen 4 Technology



The need to maximize energy efficiency and comply with regional and global decarbonization mandates poses daunting challenges for automotive test laboratory managers. To meet these challenges, MTS Systems has engineered the SilentFlo™ 525 Hydraulic Power Unit (HPU), our most energy-efficient HPU to date. The next generation 525 features an innovative hybrid approach to hydraulic power generation that can yield dramatic reductions in energy usage of 35% or more compared to older SilentFlo models, increase equipment uptime, and improve overall lab efficiency.

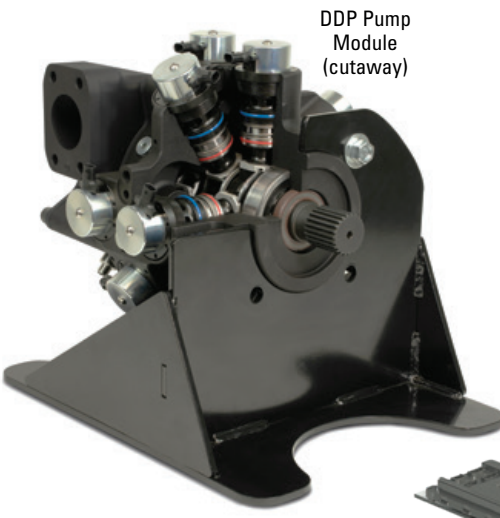


A Sustainable Test Ecosystem
integrates new SilentFlo Gen 4 hybrid HPU technology, precision DuraGlide® test actuation, advanced MPCM monitoring, and state-of-the-art SafeGuard™ hydraulic distribution to enable high-fidelity, high-throughput test and simulation while achieving optimal levels of energy efficiency and safety.

A High-throughput Durability Test Lab
employs innovative Gen 4 hybrid HPU technology and MPCM monitoring to meet a full day's hydraulic flow requirements using a multi-generational array of SilentFlo HPUs. The time history below illustrates how DDP modules (green) and swash plate modules (blue) are engaged across the four HPUs to meet 12 hours of wide ranging flow demand (red) with maximum precision and efficiency.



Multi-Pump Control Manager (MPCM)

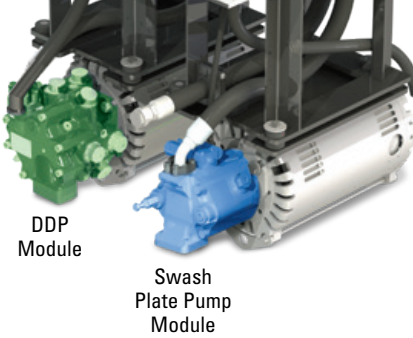


DDP Pump Module (cutaway)

Digital Displacement® Pump (DDP)
radial flow technology optimizes energy efficiency by digitally controlling individual pump pistons. Each piston's motion is precisely adjusted, allowing the pump to adapt to changing flow demands. This highly responsive, dynamic operation dramatically reduces energy wastage associated with traditional fixed-speed, swash plate (axial flow) pumps. By eliminating inefficient throttling valves and reducing pressure losses, digital displacement pumps achieve precision flow control and maximum efficiency.



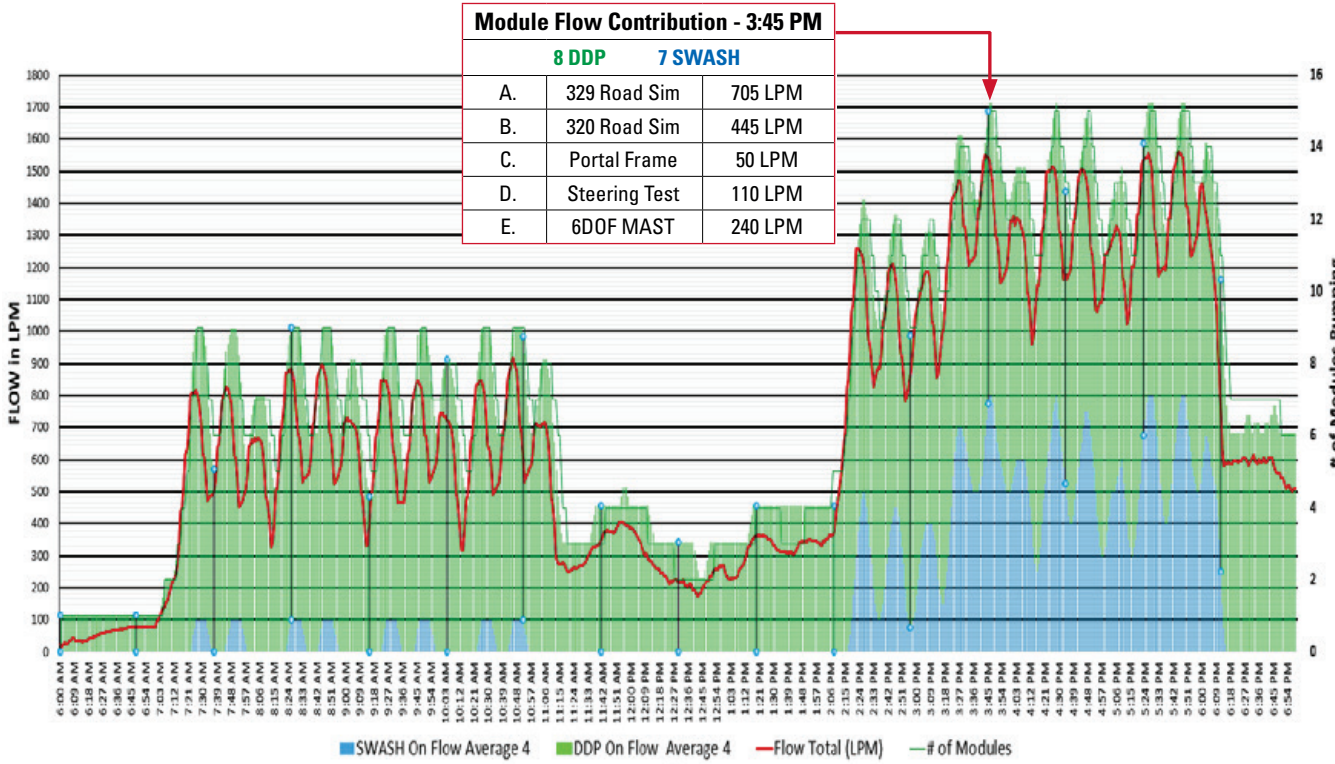
SilentFlo Gen 4 HPU



DDP Module

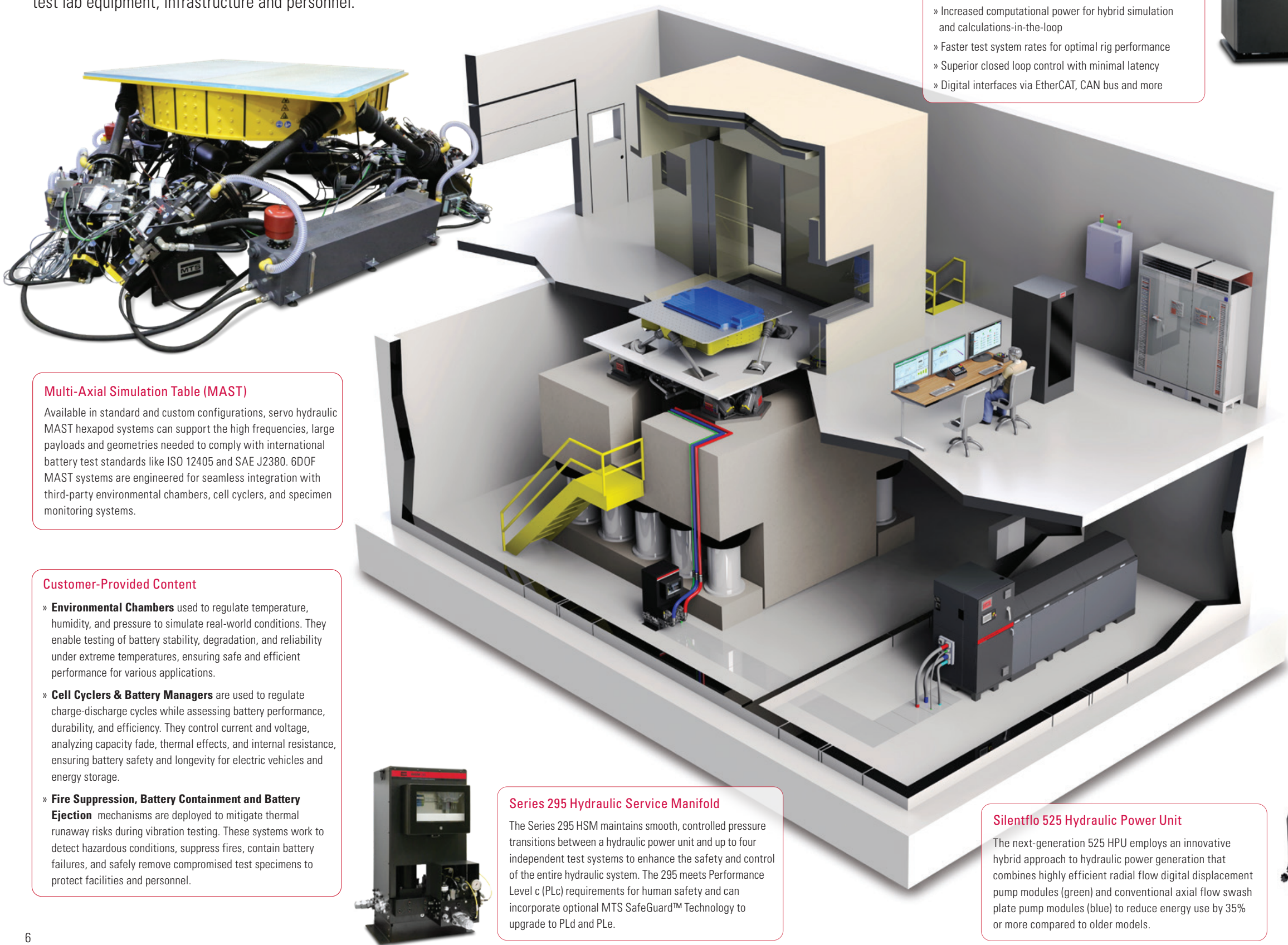
Swash Plate Pump Module

SilentFlo Gen 4 HPUs will feature an innovative hybrid approach to hydraulic power generation that employs highly efficient radial flow digital displacement pump modules (green) to modulate flow during typical demand, while engaging conventional axial flow swash plate pump modules (blue) as needed to achieve maximum energy efficiency during peak use.



Integrated EV Battery Test Cell

Testing electric vehicle Li-Ion battery packs requires an array of separate, but tightly integrated systems to apply multi-axial vibration, cycle current, simulate environmental conditions, and ensure the safety of test lab equipment, infrastructure and personnel.



Multi-Axial Simulation Table (MAST)

Available in standard and custom configurations, servo hydraulic MAST hexapod systems can support the high frequencies, large payloads and geometries needed to comply with international battery test standards like ISO 12405 and SAE J2380. 6DOF MAST systems are engineered for seamless integration with third-party environmental chambers, cell cyclers, and specimen monitoring systems.

Customer-Provided Content

- » **Environmental Chambers** used to regulate temperature, humidity, and pressure to simulate real-world conditions. They enable testing of battery stability, degradation, and reliability under extreme temperatures, ensuring safe and efficient performance for various applications.
- » **Cell Cyclers & Battery Managers** are used to regulate charge-discharge cycles while assessing battery performance, durability, and efficiency. They control current and voltage, analyzing capacity fade, thermal effects, and internal resistance, ensuring battery safety and longevity for electric vehicles and energy storage.
- » **Fire Suppression, Battery Containment and Battery Ejection** mechanisms are deployed to mitigate thermal runaway risks during vibration testing. These systems work to detect hazardous conditions, suppress fires, contain battery failures, and safely remove compromised test specimens to protect facilities and personnel.

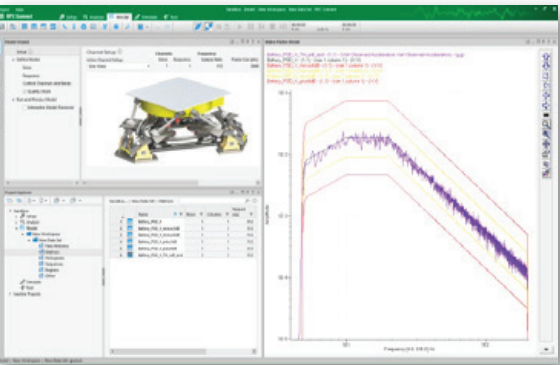
Series 295 Hydraulic Service Manifold

The Series 295 HSM maintains smooth, controlled pressure transitions between a hydraulic power unit and up to four independent test systems to enhance the safety and control of the entire hydraulic system. The 295 meets Performance Level c (PLc) requirements for human safety and can incorporate optional MTS SafeGuard™ Technology to upgrade to PLd and PLe.

FlexTest® Elite Performance Controllers

The FlexTest EP is equipped with significantly increased processing power to address evolving test and simulation requirements. It provides:

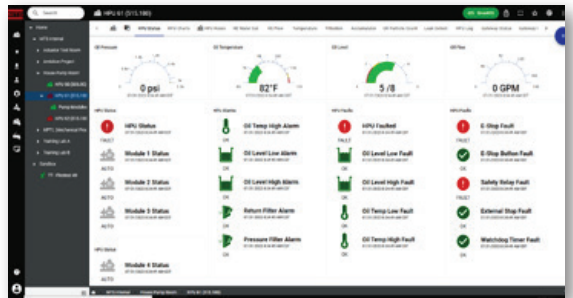
- » Higher channel counts for more DAC and monitoring
- » Increased computational power for hybrid simulation and calculations-in-the-loop
- » Faster test system rates for optimal rig performance
- » Superior closed loop control with minimal latency
- » Digital interfaces via EtherCAT, CAN bus and more



RPC Connect Software

RPC Connect software is architected to optimize durability test accuracy, efficiency and productivity. It features:

- » An intuitive, productivity-enhancing user interface
- » A high-throughput Test Stage
- » Support for advanced iteration methods and hybrid simulation



Condition-Based Monitoring

MTS Echo® Software enables real-time, remote monitoring of test status and equipment health via web-enabled smartphone, laptop, or tablet. It features tools to capture diagnostic data for predictive maintenance and failure prevention, identify threats to hydraulic system health and keep test systems in optimum condition.

Silentflo 525 Hydraulic Power Unit

The next-generation 525 HPU employs an innovative hybrid approach to hydraulic power generation that combines highly efficient radial flow digital displacement pump modules (green) and conventional axial flow swash plate pump modules (blue) to reduce energy use by 35% or more compared to older models.



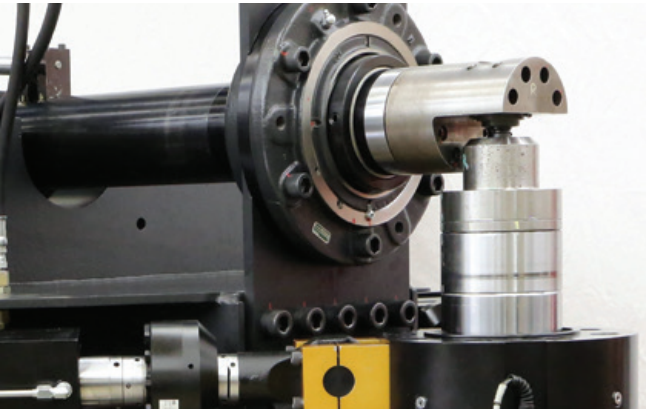
Durability Solutions

Proven, Reliable Lab-based Assessment Solutions

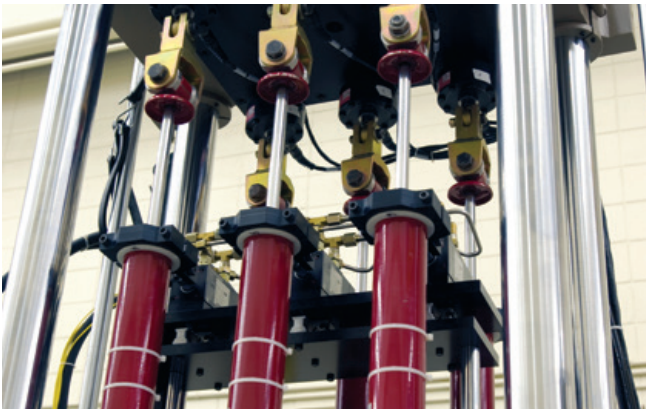
MTS sets the standard for providing highly accurate and repeatable correlation between the proving ground and the lab with a broad array of proven durability testing solutions. Comprising a variety of robust, multi-degree-of-freedom test rigs and industry-renowned RPC® Connect software, the MTS portfolio includes all the tools you'll need to accurately evaluate the durability of components, subsystems and full-vehicles, ranging from motorcycles to passenger cars to heavy trucks and agricultural equipment.

The MTS durability portfolio features:

- » Model 329i Spindle-Coupled Road Simulators that provide up to six degrees of measurement and control at each of the vehicle spindles to deliver the most efficient, accurate and repeatable reproduction of even the most challenging proving ground road surfaces, maneuvers and events.
- » Model 320 Tire-Coupled Road Simulators for both early stage testing and full vehicle assessment
- » Versatile multiaxial simulation table (MAST™) systems for general component and subsystem testing
- » Numerous subsystem-specific testing solutions
- » A variety of elastomer, damper, bushing and materials test solutions
- » Leading-edge hybrid simulation solutions



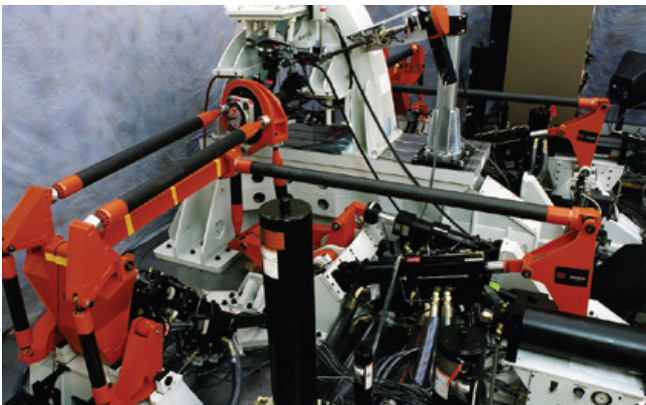
Ball Joint Test System



Damper Test Systems



Multiaxial Simulation Table (MAST) Systems



Axle Test Systems



Tire-coupled Road Simulators



Spindle-coupled Road Simulators

Expanding MAST Capabilities

High Frequencies - Models 353.20, 353.50 & 354.20

Address emerging electric vehicle battery testing needs and comply with various international standards.

- » Test up to 200 Hz when performing Power Spectral Density (PSD) tests and Time History (TH) replication
- » Apply force and motion in full six-degrees-of-freedom
- » Streamlined integration with third-party environmental chambers, battery cyclers - or battery management systems - and specimen monitoring systems
- » Functional safety per ISO 13849-1:2015 (Safety of machinery – Safety related parts of control systems)

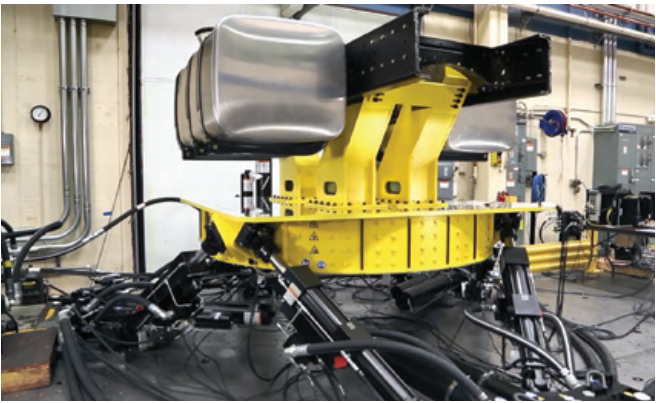


Model 353.20

High Payloads - Models 353.50 & 354.20

Test larger, heavier electric vehicle, commercial truck and agricultural vehicle components, assemblies, and subsystems.

- » Test specimens up to 3000 kg (353.50) and 2000 kg (354.20)
- » Choose from a variety of standard and custom table sizes/ configurations (largest: 2.5 x 2.5-meter square)



Model 354.20

Large Geometry Specimens - Model 354 LG

Conduct vibration tests on large battery packs used in next-generation commercial and off-highway electric vehicles.

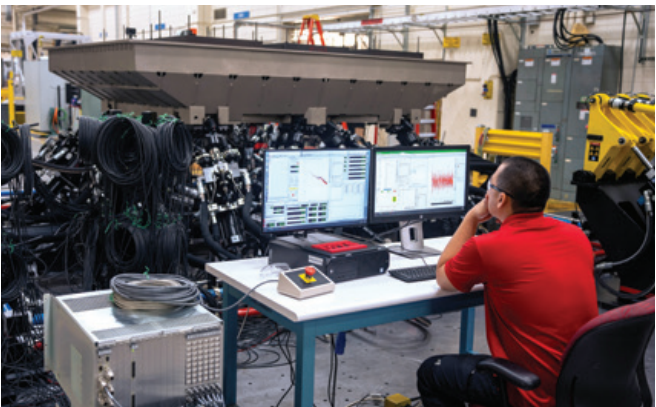
- » Accommodate large lithium-ion battery packs on a 2.5 x 3.5 meter table
- » 6DOF 12-actuator (dodecapod) configuration
- » Test specimens up to 2000 kg at 200 Hz
- » Meet ISO 12405, UN R100, UN R136, and UN 38.3 requirements
- » Compatible with third-party environmental chambers, battery management systems, and specimen monitoring systems



Advanced Compensation Tools - FlexTest Software (793)

Achieve the highest levels of MAST system controllability and fidelity to accelerate RPC drive file convergence.

- » Degree of Freedom Control establishes a coordinate space where actuators work in 6DOF concert
- » Three-Variable Control enables simultaneous control of displacement, velocity, and acceleration variables
- » Amplitude Phase Control (APC) compensates for errors between command and feedback sine waves
- » Adaptive Harmonic Cancellation (AHC) removes distortion and generates clean sinusoidal inputs in conjunction with APC



Modular TestLine™ Component Test Solutions

Precision-engineered components for building your test solution right the first time



Photo courtesy of CTAG

TestLine Solutions comprise a versatile and reliable set of modular test components and standard hardware and software tools that enable you to create cost-effective test systems that can be reconfigured as your needs change. You supply the in-house design capability and imagination, MTS provides the premium-quality products and components to help build your test solution right the first time.

Precision-engineered to the highest quality and designed for seamless integration, the modular components and the standard hardware and software used in TestLine Solutions are the same as those integrated into the most advanced MTS custom test systems.

MTS Standard Products

MTS DuraGlide® Linear Actuators

MTS Application Software

MTS DuraGlide® Rotary Actuators

MTS 252 Servovalves

Load Cells

MTS 293 Hydraulic Service Manifold (HSM)

MTS 295 Isolation Hydraulic Service Manifold (IHSM)

SilentFlo™ Hydraulic Power Units (HPU)

FlexTest® Controllers

MTS TestLine Components

Universal Struts

Rod End Spacer Assemblies

Bell Crank Assemblies

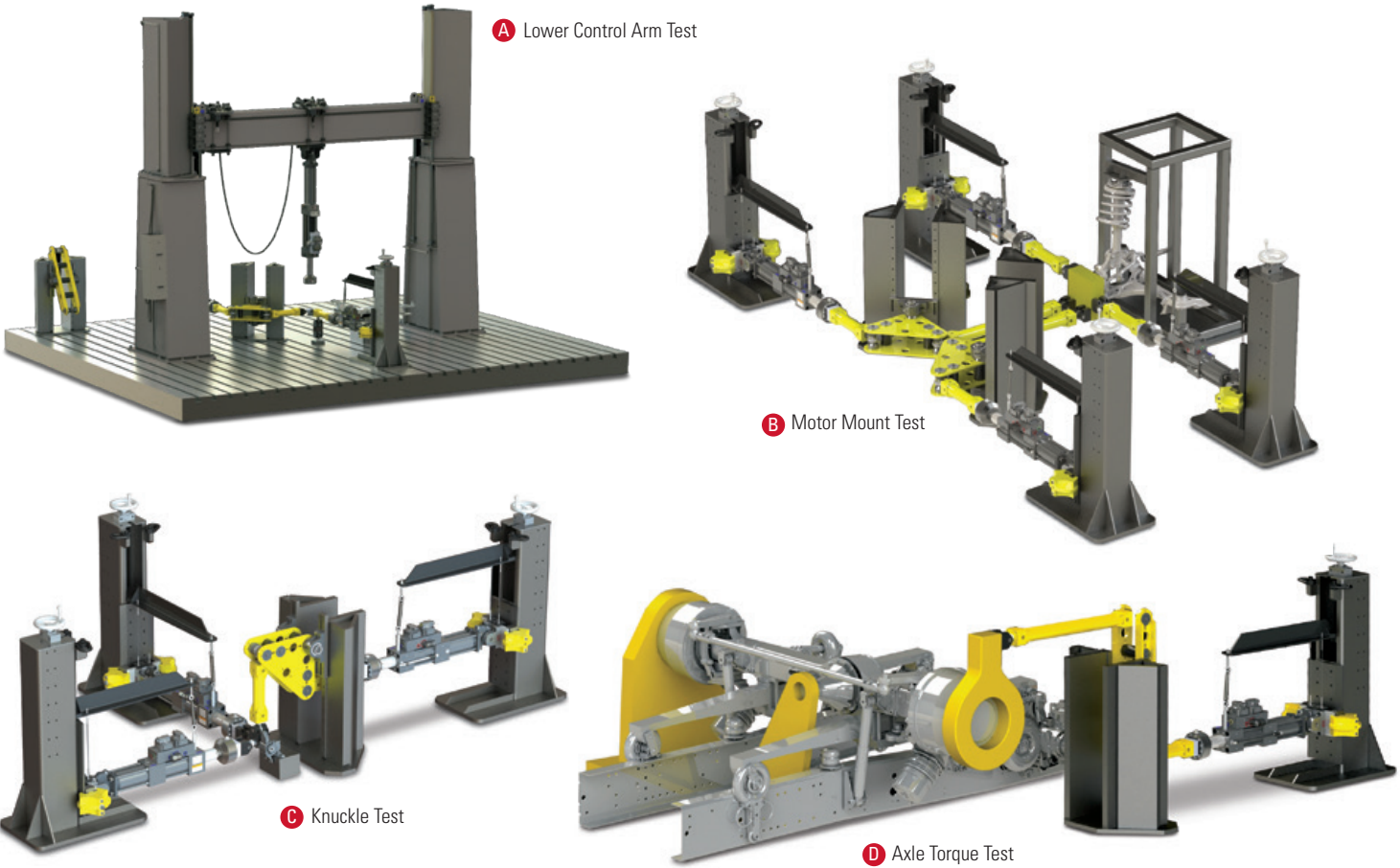
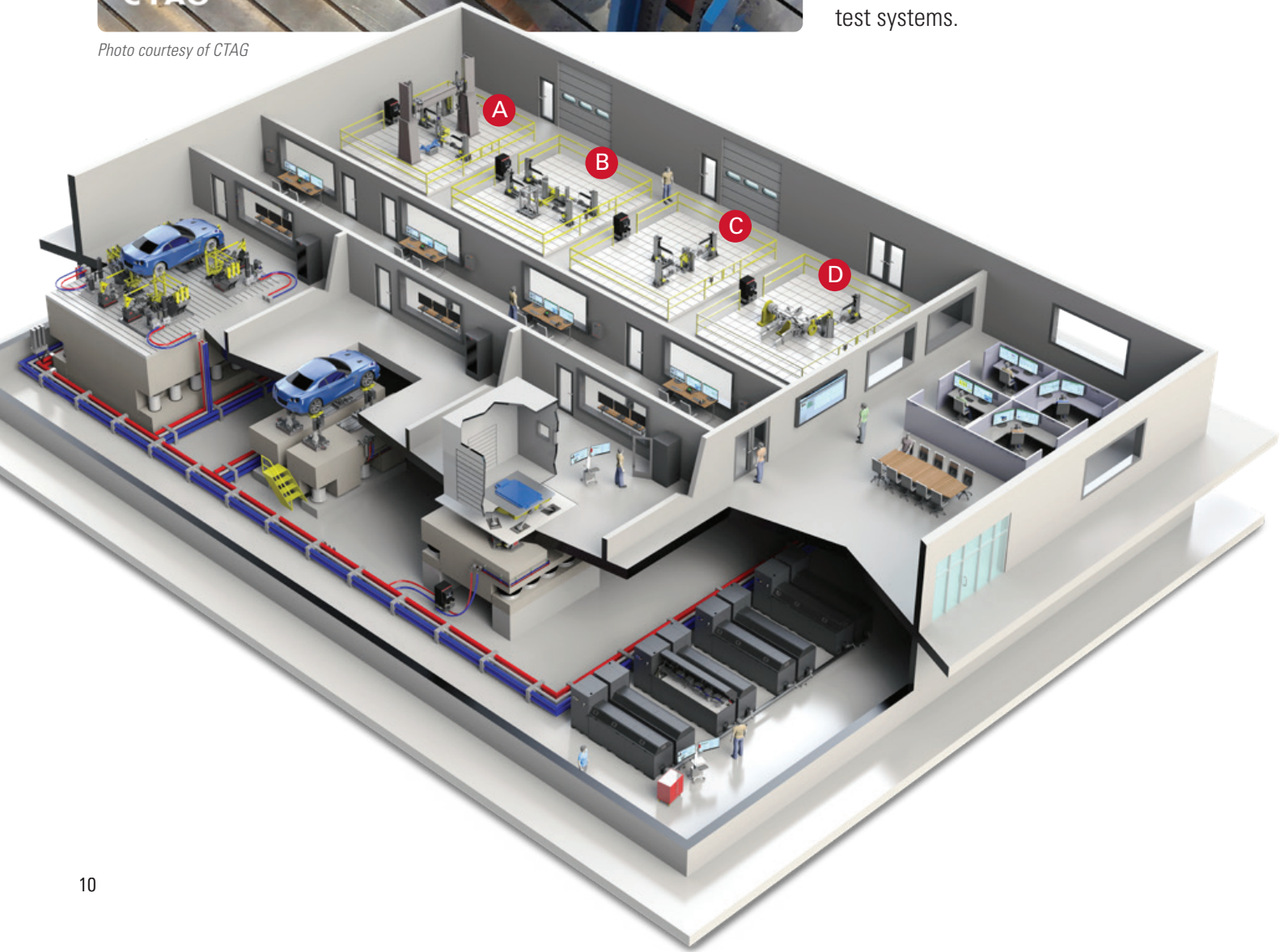
Rod End Block Assemblies

Lever Assemblies

Rod End Spacers

Reaction Stand

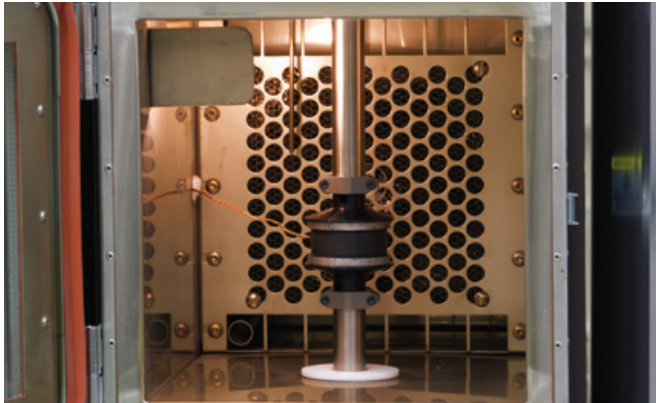
Pillow Block Bearings



Vehicle Dynamics Solutions

MTS offers a broad selection of test & simulation solutions designed to help you gain precise measurements earlier in the development cycle, enabling more efficient optimization of component, system and full-vehicle performance. The MTS vehicle dynamics portfolio features:

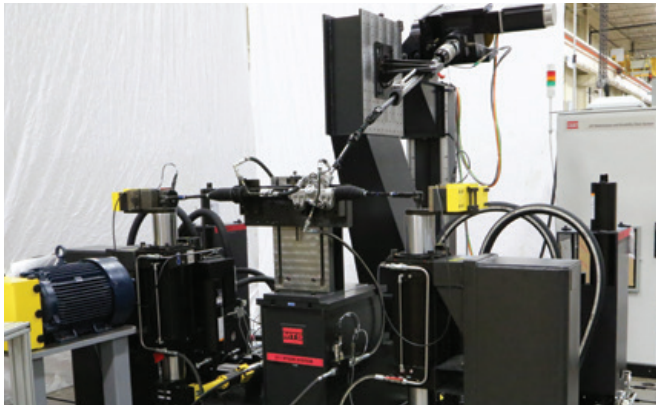
- » Flat-Trac® Roadways, which combine tire-coupled road simulation and flat-belt roadway technology to create a realistic laboratory environment for evaluating noise, vibration transmissibility, suspension performance, and fuel economy
- » MTS Kinematic & Compliance (K&C) systems for quickly and efficiently measuring key suspension parameters
- » Dynamic Kinematic & Compliance (DK&C) systems for simulating rough road inputs and transient maneuvers
- » State-of-the-art single and multi-belt wind tunnel rolling road systems for evaluating vehicle aerodynamics
- » Numerous subsystem-specific testing solutions
- » Robust and efficient tire force and moment measurement, rolling resistance measurement and tread wear simulation systems
- » A variety of elastomer, damper and materials characterization solutions
- » Leading-edge hybrid simulation solutions



Elastomer Test Systems



Tire Force & Moment Measurement Systems



Steering Test Systems



Multi-axial Simulation Table (MAST) Systems



Dynamic Kinematic & Compliance (K&C) Systems



Dynamic Flat-Belt Roadways

Expanding MAST Capabilities: Dual-Mode MAST System

Electric and autonomous vehicles are driving an intensified focus on occupant ride comfort, prompting increased need for human-rated, 6DOF vibration simulation capabilities. To help meet these demands, the new Model 353.20 DM (Dual Mode) MAST delivers an expanded application range that includes both durability and NVH testing, and occupants-on-the-table ride comfort evaluation.

Driven by ISO 13849-1:2015 (Safety of machinery – Safety related parts of control systems), the 353.20DM integrates advanced MTS Safety PLC technology, new hydromechanical manifolds, an array of human interfaces and test space monitoring devices to ensure safe and efficient switching between full-performance durability testing and reduced-performance ride comfort evaluation.

Available via turnkey system or 353.20 field upgrade, MTS Dual Mode MAST technology is purpose-engineered for conducting human-rated vibration simulation that complies fully with ISO 13090-1 and ISO 2631-1.



Multi-axial Simulation Table (MAST) Systems



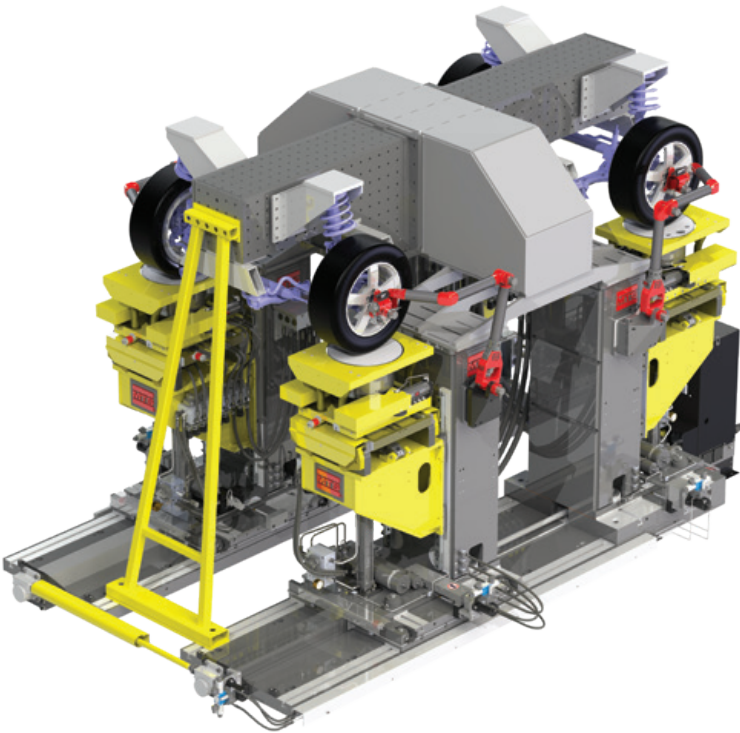
mHIL K&C Test System

Accelerate Active Chassis Development

The mHIL K&C Test System combines physical active suspension modules under test with a vehicle model adapted for suspension inputs to create a real-time, vehicle-level simulation environment for testing active suspensions and chassis in the early stages of vehicle development and at several points along the “V”.

mHIL Benefits:

- » Enhance CAE model development
- » Conduct accurate simulations earlier in vehicle development
- » Dramatically reduce proving ground dependency, validation costs and need for prototypes



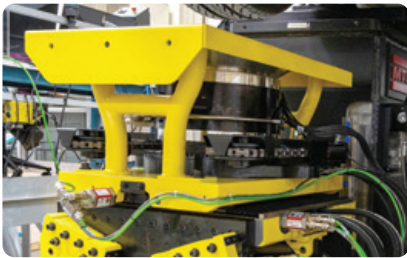
Next-Generation K&C System



High-fidelity Wheel Motion Sensors

Larger wheel motion range:

- » Longitudinal: ± 90 mm
- » Lateral: ± 90 mm
- » Vertical: ± 240 mm
- » Camber Angle: $\pm 10^\circ$
- » Spin Angle: $\pm 45^\circ$
- » Steer Angle: $\pm 45^\circ$



New Steer Input Assemblies

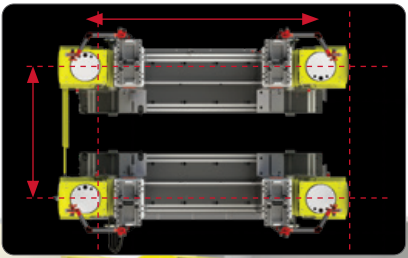
Linear-to-rotary design delivers enhanced performance for characterizing electric vehicles:

- » Increased steer angle ($\pm 50^\circ$)
- » Increased steer torque (± 1000 Newton-meters)
- » No backlash
- » Better control & safe limited speed operation



Flexible Body Clamping

- » Multiple clamp offerings with varying degrees of adjustability
- » Electric vehicle clamping featured



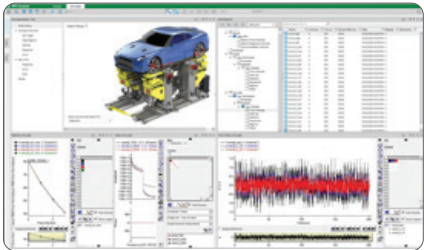
Increased Track Width & Wheelbase

- » Wheel Track: 1080 - 1830 mm (750 mm)
- » Wheel Base: 1800 - 3600 mm (1800 mm)



Full-featured K&C Application Software

- » K&C testing workflow
- » Multi-mode control
- » Flexible user programming
- » Analysis software



RPC® Connect Software

- » Dynamic operation
- » RPC time history payout
- » Payout and measurement to 10 Hz
- » Maneuver decomposition



mHIL Integration/User Interface

- » Mechanical Hardware-in-the-Loop (mHIL) integration and capability
- » CAN / dSPACE communications
- » EtherCAT communications
- » Control of ancillary devices



Hand-held Operator Pendant

- » Safety system status
- » Jog Mode to aid in spindle-coupled specimen installation
- » Specimen setup available with hydraulics on



System-level Calibration

On-system calibration for maximum accuracy:

- » 6DOF calibration @ each corner (Fx, Fy, Fz, Mx, My, Mz)
- » 4-corner system calibration
- » Fixturing provided for quickly verifying machine accuracy between formal calibration events

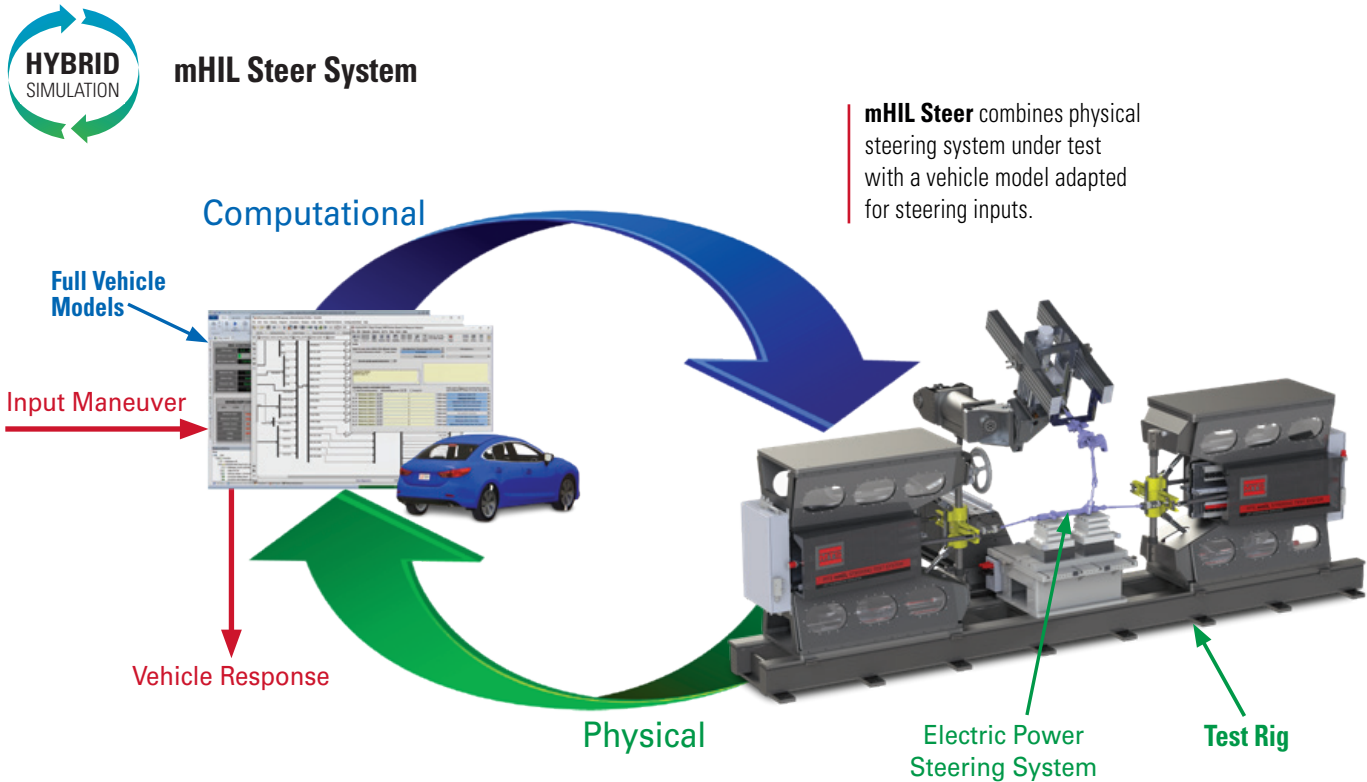
The latest addition to MTS' K&C portfolio is purpose-built for precise and repeatable passenger car and SUV suspension measurement.

Smaller, lighter and easier to install than its predecessors, this new Passenger Car K&C system performs the full spectrum of kinematics and compliance deflection measurement applications, including suspension and steering characterization, benchmarking and target setting, model verification, evaluating design changes, and diagnosing problems. As with all MTS K&C systems, system-level calibration methods are employed to ensure optimal measurement accuracy.

Ideal for characterizing fast-evolving electric vehicle designs, the next-generation Passenger Car K&C system features re-engineered steer input assemblies with increased torque and angle, new high-fidelity wheel motion sensors, new highly adjustable body lamping, increased track width and wheelbase adjustment, and a new operator's pendant for safe test vehicle installation.

State-of-the art MTS controls and software can be used to extend the utility of K&C systems to include dynamic operation, real-time hybrid simulation, and the integration of ancillary EtherCAT devices.

Collaborative Chassis Tuning Environment



Accelerate Active Steering Development

Meaningful evaluation of interconnected active systems used in next-generation ICE, electric, and autonomous vehicles must extend from early-stage modeling through proving ground validation, which presents numerous simulation challenges for OEMs.

MTS has proven that mechanical Hardware-in-the-Loop (mHIL) techniques can be used to establish vehicle-level simulation environments where developers can evaluate, integrate, test drive, and certify active systems well in advance of

full vehicle prototypes. This enables them to enhance CAE model development, conduct accurate simulations earlier in development, and dramatically reduce proving ground dependency, validation costs and the need for prototypes.

mHIL technology can be used to create a real-time simulation environment for accelerating the development of ADAS steering functionality. The mHIL Steer solution combines physical active or semi-active power steering systems under test with a real-time vehicle model adapted

for steering inputs. The resulting vehicle-level simulation environment enables steer development engineers to benchmark, characterize, set-up, tune, and validate hydraulic, electric, or steer-by-wire power steering systems at the sub-system and vehicle levels.

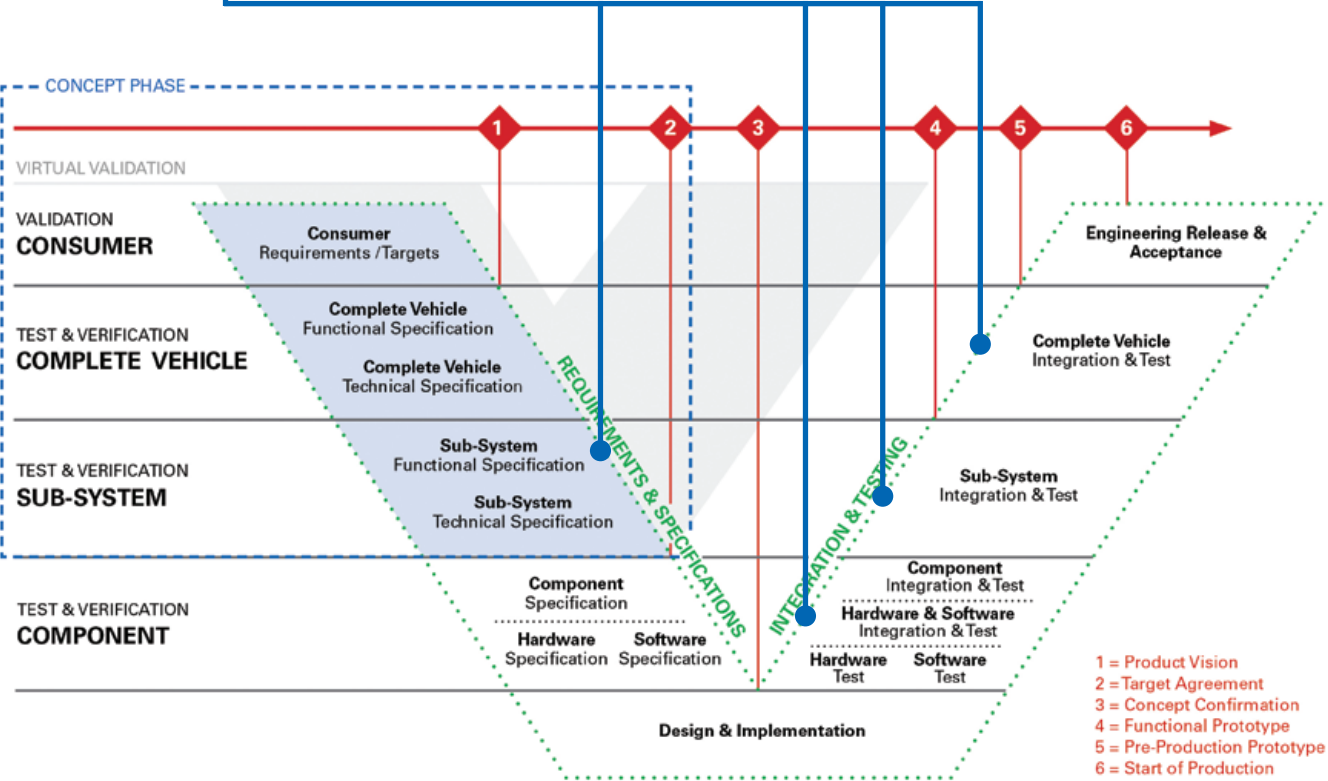
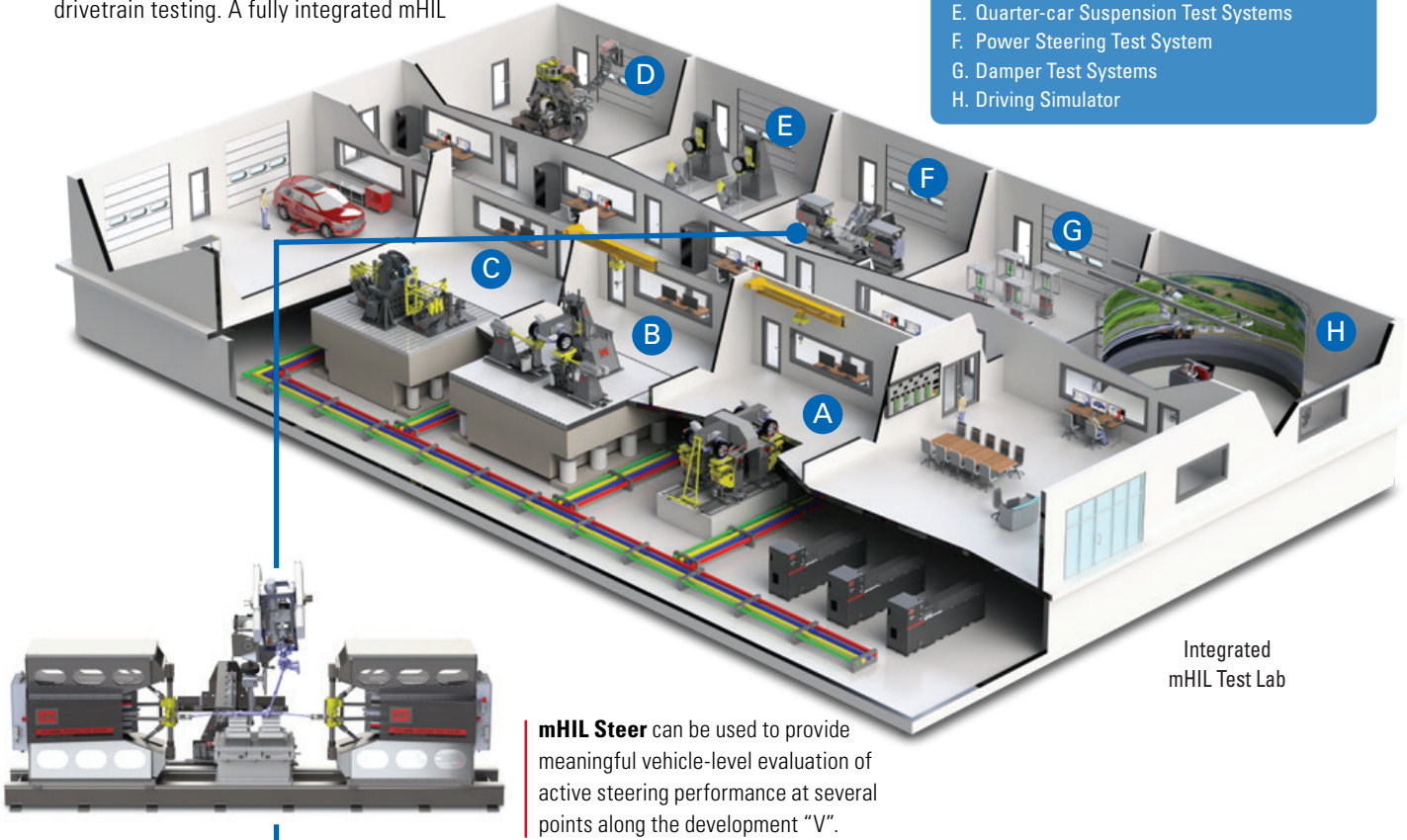
mHIL Steer can employ an MTS standard 3-5 channel multi-purpose servo hydraulic steer test system, or alternatively, a custom all-electric performance variant available in 2-3 channels.



mHIL Solutions

MTS has pursued mHIL solutions to complement a broad array of physical test systems, including those purpose-engineered for damper, tire, steering system, suspension, axle, and drivetrain testing. A fully integrated mHIL

lab with a driving simulator functions as a collaborative tuning environment to enable faster, more efficient active chassis development.



MTS Elastomer Testing Portfolio

Uniaxial

MTS Acumen System

MTS Landmark System

MTS Landmark System

High-Frequency Torsional

Model 831 System

Model 834 System

Multiaxial

Model 832 System

Model 831 Biaxial System

Model 833 System

Model 836 System

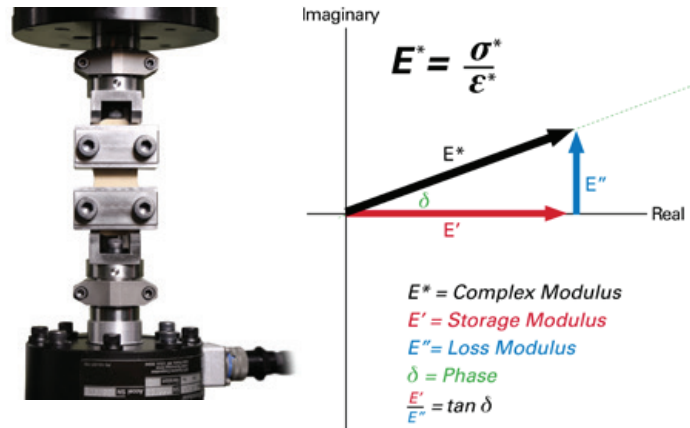
MTS Acumen® Test Systems

Ideal for automotive elastomer characterization and materials lightweighting, MTS Acumen Electrodynamic Test Systems deliver superior precision and ease of use for dynamic and static testing. Energy-efficient electrodynamic actuation enables these flexible systems to be installed quickly with minimal impact in your facility.



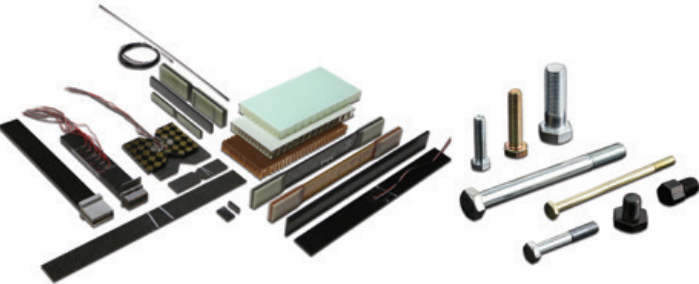
ELASTOMER CHARACTERIZATION

Measure the static and dynamic behaviors of tire materials, suspension components, and engine and exhaust mounts.



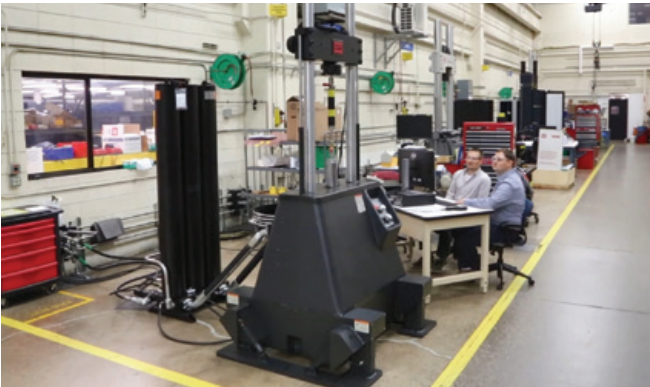
LIGHTWEIGHTING

Determine the static and dynamic properties of plastics, composites, metals, fasteners and adhesives.



The Evolving MTS Damper Portfolio

The MTS damper testing portfolio continues to evolve, adapting to meet more challenging test requirements and growing demands for improved test system efficiency. Once exclusively servohydraulic, this expanded portfolio now features both high-performance electric and servohydraulic systems to fulfill a complete range of test applications, spanning quality, characterization, friction force, noise and durability.



853 EMA

NVH PERFORMANCE

849 850 852

DURABILITY

ELECTRIC SERVOHYDRAULIC



mHIL Damper Test System

Accelerate Active & Semi-active Damper Development

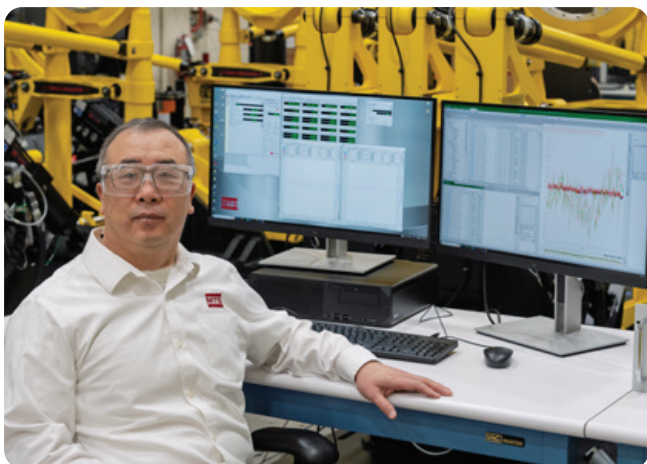
The mHIL Damper Test System combines a physical damper sub-system under test with a vehicle model adapted for damper and spring inputs to create a real-time, vehicle-level simulation environment for testing semi-active or active damper, suspension, and body control systems in the early stages of vehicle development and at several points along the “V”.

mHIL Benefits:

- » Enhance CAE model development
- » Conduct accurate simulations earlier in vehicle development
- » Dramatically reduce proving ground dependency, validation costs and need for prototypes



Live RPC® Connect Demonstrations



Dr. Shawn You, Business Development Manager

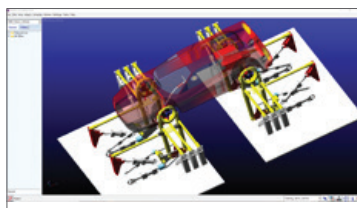
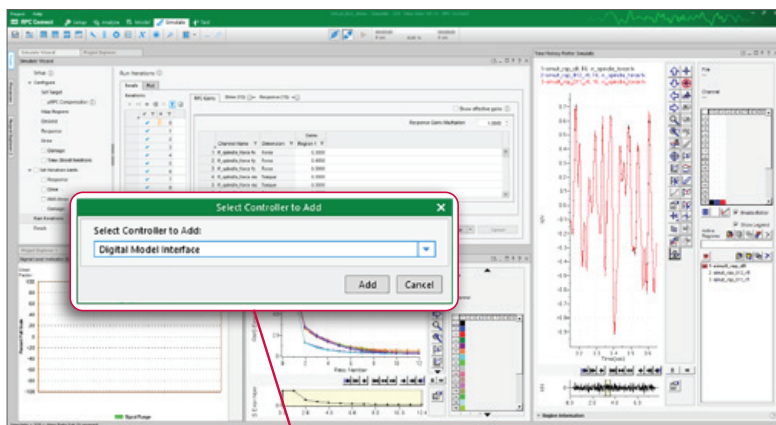


Hans-Peter Beggel, Senior Systems Engineer

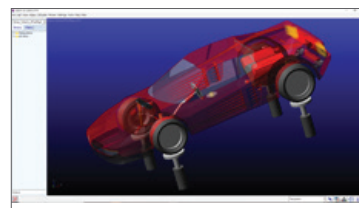
Join our durability testing experts in Booth 8515 to gain insight into the enhanced capabilities and efficiencies of RPC Connect software. Dr. Shawn You and Hans-Peter Beggel will be demonstrating the powerful arsenal of next-generation RPC Connect simulation tools, including Digital Model Interface (DMI), which allows test engineers to engage computational models of system controllers, test rigs, and specimens to perform an array of valuable pre-test operations:

- » Evaluate specimen designs
- » Rehearse test sequences
- » Verify test rig capabilities
- » Predict required hydraulic flow
- » Optimize timing to maximize energy efficiency
- » Tune vehicle models
- » Calculate drive files

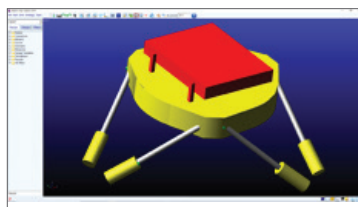
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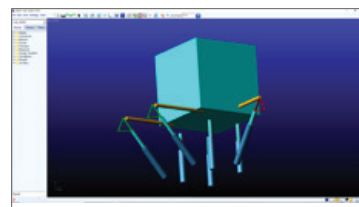
6DOF Road Simulator



4-Poster



6DOF MAST



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