



MTS Damper Testing Solutions

A complete portfolio of systems for quality assurance, performance, NVH and durability testing

be certain.

THE **MTS DAMPER TESTING PORTFOLIO** COMPRISES A PROVEN ARRAY OF ELECTRIC AND SERVOHYDRAULIC TESTING SOLUTIONS FOR CONDUCTING ACCURATE AND REPEATABLE DAMPER QUALITY ASSURANCE, PERFORMANCE, NVH AND DURABILITY TESTING ACROSS A DIVERSE RANGE OF VEHICLES, INCLUDING MOTORCYCLES, ALL-TERRAIN VEHICLES, PASSENGER CARS, RACING CARS AND TRUCKS.

TEST APPLICATIONS:

- » Quality
- » Characterization
- » Friction force
- » Noise, Vibration & Harshness (NVH)
- » Durability

DAMPER TYPES:

- » Motorcycle
- » All-Terrain Vehicle (ATV)
- » Passenger car
- » Racing car
- » Light & heavy truck
- » Off-road vehicle - agriculture, construction, mining, forestry



Quality Assurance Testing: LEMA System



Performance Testing: EMA System



Durability Testing: Model 852 System

The Evolving MTS Damper Testing Portfolio

The MTS damper testing portfolio has evolved dramatically in recent years, adapting to meet increasingly complex test challenges posed by the rise of active and semi-active vehicle suspensions, the advent of electric and autonomous vehicles, and growing demands for improved test system efficiency.

Once exclusively servohydraulic, the redefined MTS damper portfolio now comprises a full complement of high-performance electric and servohydraulic load frames to address a complete spectrum of test applications across a diverse range of damper types in a variety of test environments, including manufacturing facilities, test laboratories, proving grounds and race tracks.

The MTS damper portfolio employs versatile FlexTest® digital controls and easy-to-use, full-featured MTS Damper Software, providing the versatility needed to adapt readily to changing test requirements.

The portfolio also features a host of ancillary hardware, including innovative add-on environments to enhance test fidelity, multi-specimen fixtures to boost system productivity and safety enclosures to protect personnel. Additionally, advanced MTS hybrid simulation techniques can extend system utility into the early stages of vehicle development, while custom solutions can be engineered to meet unique, non-standard testing needs.

All MTS damper testing solutions are backed by the unmatched MTS global service and support organization, dedicated to maximizing test system uptime and efficiency with local technical support, calibration services, rebuild and repair services, and spare parts.

Contact MTS today to learn how the diverse MTS damper testing portfolio can help you meet your unique quality, performance and durability testing requirements with ease, efficiency and confidence.



The MTS damper portfolio comprises a full complement of high-performance load frames to address a complete spectrum of test applications.

Performance Testing

The MTS damper testing portfolio features a selection of compact and portable electric and hydraulic solutions that are ideal for evaluating the vehicle dynamics of prototypes at the proving ground or tuning racecar dampers at the track. MTS solutions provide the quick, precise and repeatable single specimen performance characterization required in both environments. To optimize test environment efficiency, MTS can also provide custom designed trailer-mounted solutions upon request.

EMA (Electro-Magnetic Actuation) System

MTS EMA Damper Test Systems comprise a complete family of compact, cost-effective linear electric load frames for performing a broad range of single specimen damper testing applications. These high-performance systems are deployed worldwide for damper characterization and in-line production quality testing, as well as custom applications such as NVH, high-velocity testing and road profile playback. EMA systems are renowned among product R&D engineers, leading damper manufacturers and race team engineers alike for their high frequency response, programmability and unmatched operational efficiency. Electrically actuated EMA systems also deliver clean and quiet operation, easy setup and relatively simple maintenance and repair.

Actuation	Linear Electric (Aircore)
Application(s)	Performance Characterization (Programmable)
Force (kN)	8.9 – 26.7
Specimens	Single
Software	Shock 6 (STD) or MTS Damper

Refer to page 16 for complete performance specifications

SYD (Scotch Yoke Dyno) System

MTS offers a complete family of electro-mechanical crank dynos for performing single-specimen sinusoidal damper testing. Portable, easy-to-use and quick, MTS SYD (Scotch Yoke Dynamometer) systems are the damper characterization tools of choice for automotive racing teams, delivering the fast, accurate test results needed to re-valve and tune shocks based on subjective driver input. MTS crank dynos are also used by many of the world's leading Tier 1 suppliers and automotive OEMs to support damper production and vehicle ride and handling activities, respectively. Featuring a simple scotch-yoke and belt-drive system, MTS crank dynos are economically priced and easy to maintain.

Actuation	Rotary Servoelectric
Application(s)	Performance Characterization (Sinusoidal)
Force (kN)	15.5 -20.0
Specimens	Single
Software	Shock 6

Refer to page 15 for complete performance specifications



Low-Noise EMA System

MTS also offers a low-noise version of its electric EMA system to measure air- and structure-born damper noises in quieter electric and hybrid vehicles. Like standard EMA damper test systems, the low-noise solution features linear electromagnetic actuation technology, which provides clean sinusoidal input and low total harmonic distortion. Low-Noise EMA systems, however, employ higher resolution encoders than the standard EMA, further minimizing signal noise and enhancing damper test performance and repeatability. Other Low-Noise EMA options include sound dampening insulation, as well as a more massive load frame with larger columns to increase frame resonance.

Actuation	Linear Electric (Aircore)
Application(s)	» NVH » Performance Characterization
Force (kN)	8.9 – 26.7
Specimens	Single
Software	Shock 6 (SID) or MTS Damper

Refer to page 16 for complete performance specifications

* System noise level is dependent on a variety of factors. Consult with MTS applications Engineer to identify noise levels for specific applications.



Model 849 System

One of the original MTS damper test systems, the servohydraulic Model 849 is engineered to measure the damping characteristics and service life of a broad range of test specimens with unsurpassed accuracy and consistency. The system features a stiff, self-supporting base for long life and a selectable servo valve for delivering a high level of single specimen performance and durability testing flexibility.

Actuation	Linear Servohydraulic
Application(s)	» Performance Characterization (Programmable) » Durability
Force (kN)	15.0 – 25.0
Specimens	Single
Software	MTS Damper

Refer to page 17 for complete performance specifications



Durability Testing

To meet a full spectrum of damper durability testing requirements, the MTS portfolio features a selection of high-force test platforms. These solutions combine a large, self-supporting base mass to withstand high inertial loading and a selectable three-stage servovalve to perform high velocity durability testing on even the largest dampers and struts. Highly reliable and robust, these systems are engineered to subject single or multiple specimens to millions of durability cycles, or run short bursts of high-performing cycles to measure damping characteristics.

Model 850 System

MTS' original high-force damper testing platform, the model 850 was purpose built for conducting durability testing on a broad range of dampers. The MTS Model 850 can accommodate multiple specimen damper testing or single specimen performance characterization when higher forces and velocities are required for larger vehicles.

Actuation	Linear Servohydraulic
Application(s)	» Durability » Performance Characterization
Force (kN)	25.0 – 67.0
Specimens	Multiple (1 - 6)
Software	MTS Damper

Refer to page 18 for complete performance specifications

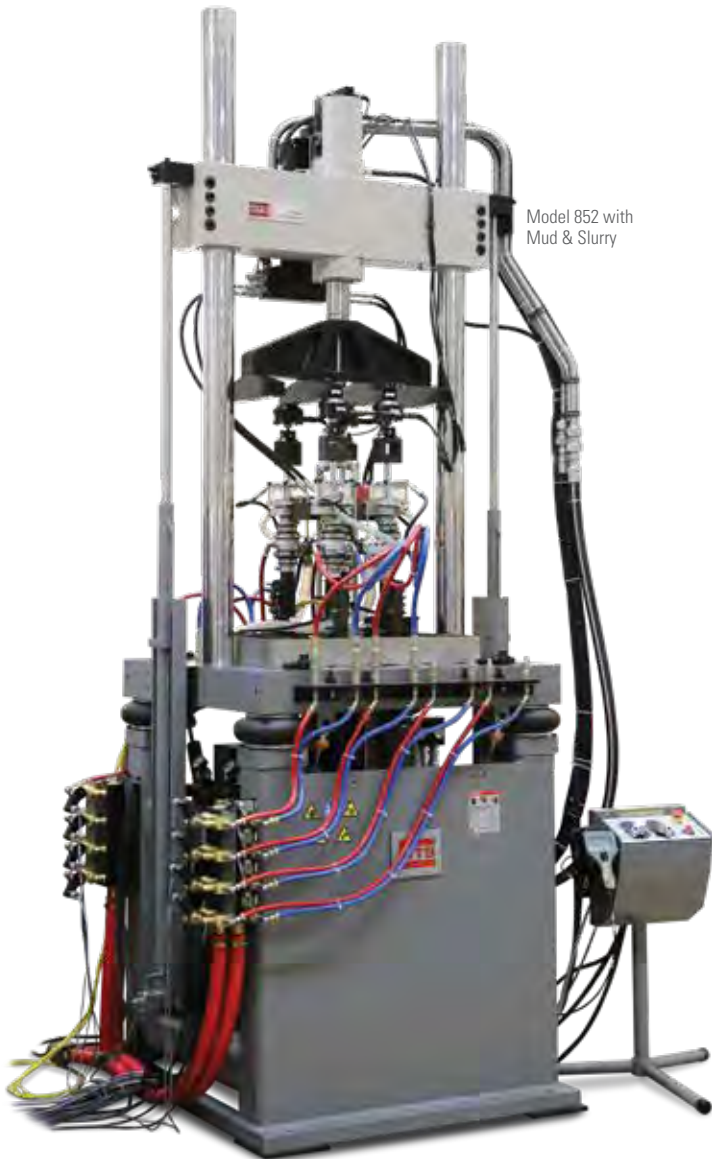


Model 852 System

Engineered for optimal damper testing flexibility, the highly capable Model 852 delivers the force required for multi-specimen durability testing while supporting an array of optional hardware for conducting a wide variety of performance testing. The standard Model 852 system is capable of applying up to 150 kN on up to eight dampers simultaneously. To support testing of independent specimens and small subassemblies, the system features a standard T-slot table for mounting the fixtures and reaction brackets needed to support a variety of optional hardware. Additionally, the system's columns, crosshead and actuator can be positioned at the table's end or center point, further enhancing test flexibility.

Actuation	Linear Servohydraulic
Application(s)	» Durability » Performance Characterization
Force (kN)	25.0 – 150.0
Specimens	Multiple (1 - 8)
Software	MTS Damper

Refer to page 19 for complete performance specifications



Hardware Options



Servovalves (high, medium or low-velocity)



Custom Accumulation



Side-loading



Multi-specimen Fixtures



Environmental Simulation



Water-cooling

Quality Testing

LEMA (Line Electromagnetic Actuator) Systems

Ease of use and low maintenance are especially valued for production quality testing in manufacturing environments, where maintaining high rates of throughput and uptime are critical. The LEMA Damper test systems is tailored specifically for such environments and are available in an H-frame configuration for standalone use or as a C-frame configuration for integration into automated production lines. These adapted, production line systems feature an open architecture that can be integrated into a line to or enabled for automation through a facility's existing robotics. Their programmability, ease-of-use and range of force capacities make them ideal for maintaining damper production quality at high rates of throughput.

Actuation	Linear Electric (Aircore)
Application(s)	Quality Assurance/Control
Force (kN)	8.9
Specimens	Single
Software	Line Test

Refer to page 16 for complete performance specifications



Custom Solutions

MTS has the custom engineering capabilities and expertise to pursue the development of systems for unique or highly specific damper testing applications. Over the years, MTS has designed and built or upgraded numerous damper testing solutions for a wide range of custom applications, including production quality testing, high-velocity testing, testing in the presence of mud and slurry contaminants, magneto-rheological (MR) damper testing, testing of inverted or angled specimens, and more.

High Velocity Systems

MTS damper systems can be equipped with custom valving to achieve speeds ranging from 6-9 m/s for meeting emerging OEM and manufacturer demands for higher velocity damper testing. These demands are prompted by industry needs to accurately replicate duty cycles for motorcycles off-road vehicles, simulate more extreme vehicle maneuvers, perform more rigorous durability testing and accommodate evolving tire geometries.



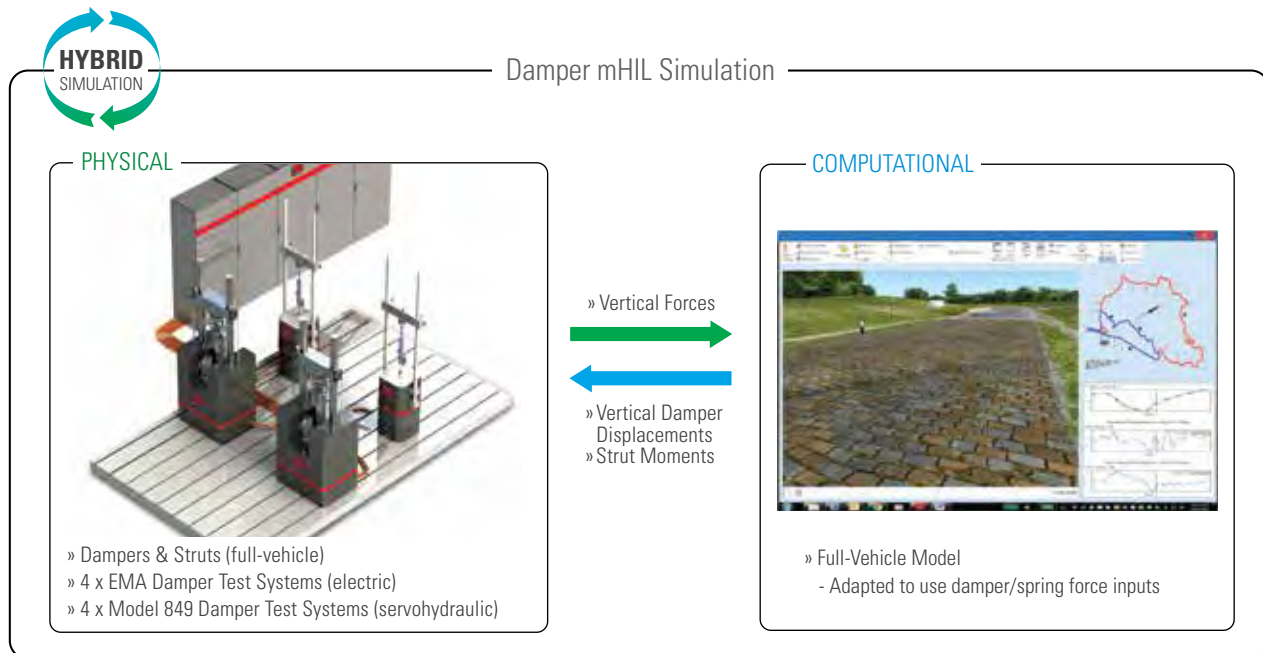
Advanced Simulation

Mechanical Hardware-in-the-Loop (mHIL™)

MTS is pioneering the use of advanced simulation methods and technologies throughout vehicle development to realize new efficiencies and reduce costs and time to market. An industry leader in hybrid simulation, MTS continues to explore new ways of integrating physical components and virtual models to streamline and accelerate analysis and testing. MTS has proven both iterative and real-time hybrid simulation techniques for use in vehicle development simulation.

Mechanical Hardware-in-the-Loop (mHIL) employs a real-time, closed loop process to introduce physical components under test into a virtual simulation; for example, using actual vehicle dampers as part of a virtual handling simulation. This approach replaces a vehicle model's virtual dampers with four real ones in test rigs. As the virtual handling simulation plays out, data is exchanged in real-time. The vehicle model and the damper rigs act on new data with each clock tick, with the physical response of the dampers affecting the behavior of the model and vice versa.

For manufacturers under pressure to bring new products to market faster, mHIL delivers important advantages. By allowing physical inputs from hard-to-model damper systems and the subsequent simulation of their complex interactions with other vehicle systems, it generates high-fidelity vehicle, system and component behavior data much faster and more cost-effectively than physical testing or computational analysis alone. Validation and optimization of designs can occur earlier in the development process – with fewer and faster iterations – well before the first prototype hits the track.



Full-featured MTS Damper Testing Software

Full-featured MTS Damper Software is engineered to fulfill all your damper performance, durability and quality assurance testing needs. Working in concert with FlexTest controllers, it provides capabilities for testing up to four user-programmable channels simultaneously, including axial, lateral, rotational/torsional, and active damper. It is deployed on MTS Models 849, 850 and 852, as well as EMA systems with FlexTest controls.

The software can be used to conduct temperature-dependent performance tests, position-dependent gas force evaluation, noise characterization (NVH),

and friction force testing.

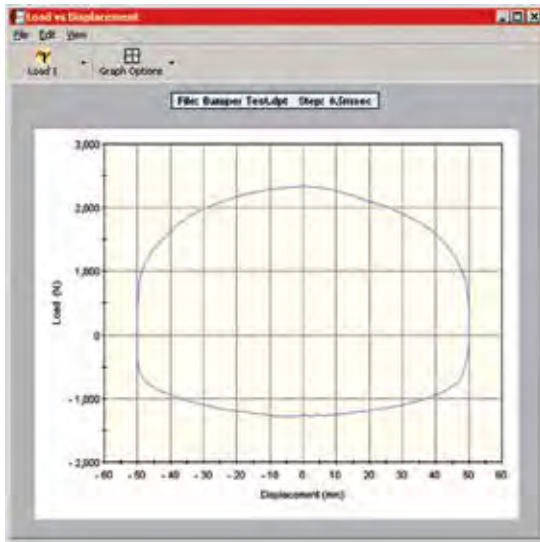
Scalable durability test capabilities enable users to create simple predefined cycle counts that ensure components meet their required fatigue life, as well as more complex specimen-failure characterizations.

Quality assurance tasks are made simple with easy-to-understand graphics displaying specimen information and pass/fail data.

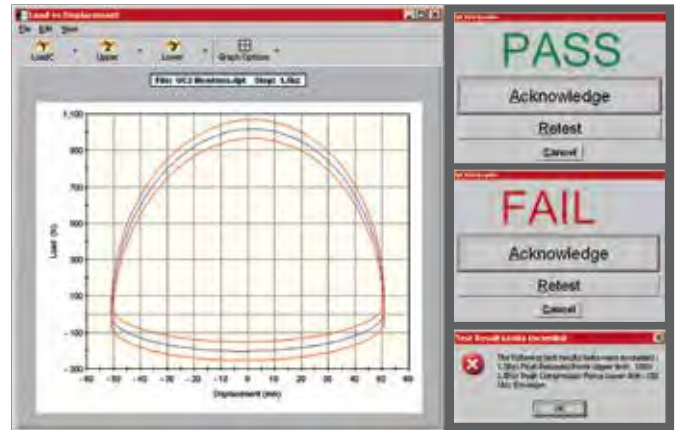
The software's standard waveform generation capabilities include sine, ramp, square, sine-on-sine, sine sweep, dual rate sine, dual rate ramp, arbitrary

(profile), and more. The arbitrary, or profile, command waveform enables the generation of user-defined block cyclic waveforms. Optional RPC Time History Playback is also available.

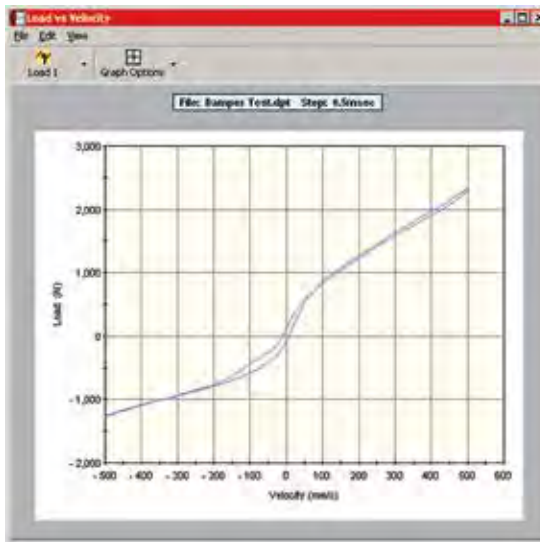
With MTS damper software, tests can be set up easily and stored for use at any time. Data acquisition is flexible and comprehensive, and test data reports can be automated and include standard force-displacement and force-velocity curves, as well as numerous other methods of presentation and analysis.



Force vs. Displacement



Pass/Fail Quality Auditing



Force vs. Velocity

Peak Hysteresis Force (N)	
Specimen	Value
Specimen 1	24.78
Specimen 2	7.86
Specimen 3	3.52
Specimen 4	18.08
Specimen 5	8.87
Mean	13.48
Stdev	8.49
Min Value	24.78
Max Value	3.52
Mean - Stdev	-19.39
Mean + Stdev	21.97
Characteristics	24.35

Peak Damp. Force (N)	
Specimen	Value
Specimen 1	-824.81
Specimen 2	-858.65
Specimen 3	-884.29
Specimen 4	-865.93
Specimen 5	-853.94
Mean	-853.94
Stdev	16.51
Min Value	-824.81
Max Value	-884.29
Mean - Stdev	-870.45
Mean + Stdev	-837.43
Characteristics	-853.94

Automated Test Data Report

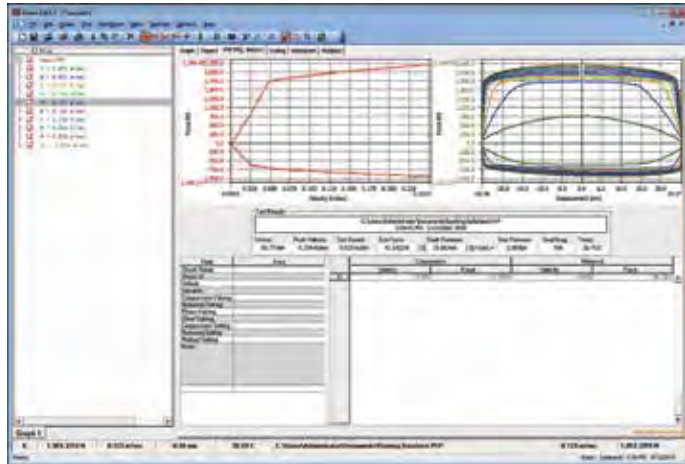
MTS Damper Software

Shock 6 Software

Designed primarily for damper performance testing, easy-to-use Shock 6 Software offers an array of pre-programmed test options and a wizard-based interface with integrated analysis tools. It is typically deployed on SYD (Crank Dyno) and EMA systems.

SHOCK 6 CAPABILITIES:

- » Temperature or time-based warm-up
- » Static gas tests
- » Friction testing
- » Velocity Plots (constant, peak velocity, multiple constant)
- » Pass/Fail validation
- » Variable wave form generation for conducting square wave, sine on sine, variable sine, triangle and frequency sweeps with EMA Systems
- » The ability to import custom waveforms or playback track data to simulate real world conditions with EMA Systems

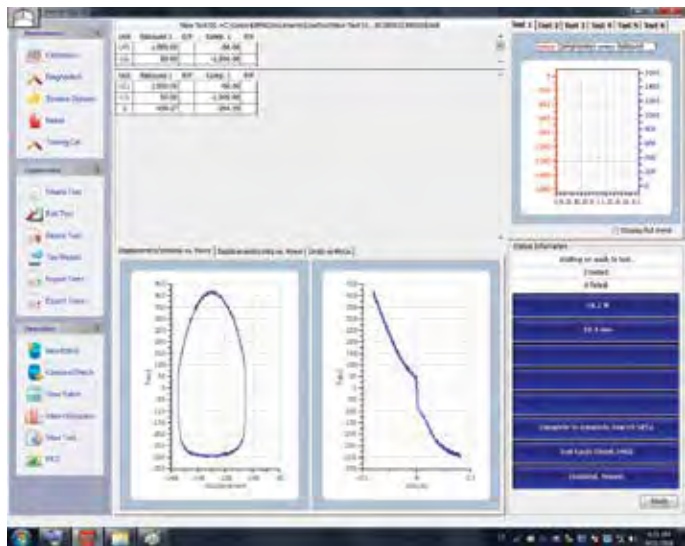


Line Test Software

Developed for damper production environments, LineTest software provides efficient velocity-based test setup and run-time, easy identification of specimen failures and a variety of methods for graphing and reporting results. It is typically deployed on LEMA systems.

LINE TEST CAPABILITIES

- » Set park, test, and pickup positions and define custom pre-cycles and speed
- » Conduct Gas Force testing (including user-configurable upper/lower limits and waveform points)
- » Define up to three different test speeds at various cyclic amplitudes
- » Pre-define operating limits or calculate them from the statistical mean of parts in a new batch run
- » Display diagnostic data on a user-configurable screen with failure indication
- » Append data to existing batches or collect and analyze in new batch files
- » Perform statistical analysis at the end of each batch file



Damper System Safety

To help ensure the safety human operators, MTS damper test systems are engineered to comply with ISO 13849, which defines performance levels in terms of the probability of a dangerous specimen failure per hour. While levels PLc or PLd are widely accepted for most mechanical test systems, MTS damper systems have the potential to require the highest safety level (PLe) due to the frequency of operator intervention required to install and test multiple damper specimens within short timeframes. To adhere to these requirements, MTS damper

systems employ a certified, safety-rated Programmable Logic Controller (PLC) to arbitrate system controller requests and manage safety functions and subsystems, including:

- » Safe Speed
- » Safe Isolation / Safe Power Off
- » Three-position mode switch (Off / Low / High)
- » Safety-rated valves
- » Test Area Enclosures
- » E-stops & Station stops



Versatile System Controls



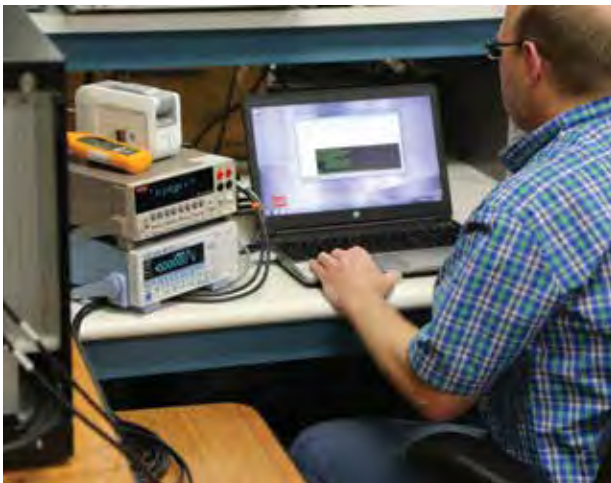
MTS damper testing solutions are supported by a selection of versatile system servo controllers to provide the flexibility you need to address a full spectrum of testing needs and adapt readily to evolving standards. The standard system servo controller has a sample rate of 8 kHz; while an alternative servo controller with a 20 kHz sample rate is also available.


Scalable and easy-to-use, FlexTest controllers provide the high-speed closed-loop control, data acquisition, function generation and transducer conditioning required to conduct reliable single and multi-channel testing. These controllers integrate seamlessly with MTS Damper software to generate a wide variety of control waveforms.

FlexTest digital controllers provide higher channel densities and capacities, greater configurability and more setup options than previous platforms. They are based on a modular architecture that features uniquely field-upgradable processors. The ability to upgrade these processors makes it easy to scale testing activities up or down, adapt to future test requirements and accommodate lab expansion and updates. FlexTest controllers share common sets of hardware boards and user interface tools, which simplifies testing standardization and optimization. An optional, compact handset facilitates convenient specimen installation and test setup.

MTS Global Service & Support

MTS fields the most experienced service, support and consulting staff of any testing solution provider. This global team provides local technical support, calibration services, rebuild & repair services and spare parts to maximize the uptime and efficiency of your MTS damper testing investment and help you meet your exact test requirements as quickly as possible.





The Model 852 mud/slurry add-on provides a precise, clean and efficient means for conducting damper seal tests in the presence of dry powders, particulate/liquid volumes or particulate/liquid sprays.

SYD System Specifications

SYD Specification¹

Description	Units	SYD-10VS	SYD-10VS HV	SYD-20VS	SYD-20VS HV
Peak Force	kN	15.5	15.5	20	20
	lbf	3500	3500	4500	4500
Maximum Displacement	mm	150	150	150	150
	in	6	6	6	6
Maximum Velocity	m/sec	2	2.5	2	2.5
	in/sec	78	98	78	98
Stated Performance	m/sec @ kN force	2.0 @ 3.8	2.5 @ 6.0	2.0 @ 7.5	2.5 @ 6.0

¹ Specifications subject to change

Power Supplies²

Model	Voltage	Phase	A in	A out
SYD-10VS	200-240	3	46.1	33
	380-500	3	26.6	17
SYD-20VS	380-500	3	41	28

² Assumes 90° C insulation on all cables



EMA System Performance Specifications

EMA Specification ¹	Units	EMA-2K	EMA-4K	EMA-6K
Dynamic Force	kN	8.9	17.8	26.7
	lbf	2000	4000	6000
Static Force	kN	2.1	4.2	6.2
	lbf	475	950	1400
Static Force with Static Load Compensation	kN	7	13	20
	lbf	1475	2950	4400
Peak Velocity	m/sec	4	4	4
	in/sec	157	157	157
Velocity at Peak Force	m/sec	2.5	2.5	2.5
	in/sec	98	98	98
Actuator Rod Diameter	mm	25.4	31.75	31.75
	in	1.0	1.25	1.25
Stroke	mm	203	203	203
	in	8	8	8
Frequency Response	Hz	100	100	100
Temperature Monitoring	Specimen Motor	Non-contacting IR with software monitoring Non-contacting IR with process meter monitoring		
Digital Encoder Accuracy	μ	1	1	1
Noise Level – Typical	dbA	<60	<60	<60
Load Cell	lbf	2000	5000	10000
	Type	Interface		
Waveforms Supported	Type Software	Sine, Triangle, Square, Frequency Sweep, Custom Profile SHOCK™ Test Control and Damper Analysis Software		
Bearing Material	Type	Dry Linear Bearing – Maintenance Free Replacement Interval: 2-5 yrs		
Facility Requirements ²	V	220	220	220
	A	30	60	100
Air Supply	PSI	100	100	100
	BAR	7	7	7
	CFM	35	35	35

¹ Specifications subject to change

² MTS can supply transformers for voltages other than 220V III-Phase



MTS 849 System Specifications

Description	Model 849.15		Model 849.25	
Actuator Maximum Dynamic Force	15 kN (3.3 kip)		25 kN (5.5 kip)	
Actuator Rod Diameter	70 mm			
Actuator Stroke	250 mm			
Actuator Hydrostatic Bearing	Standard			
Actuator Anti-Rotate	Standard			
Servo valve	126 lpm (33 gpm)		188 lpm (50 gpm)	
Friction Force Servo valve	3.8 lpm (1 gpm)		Not available	
Servo valve Shutoff	Manual			
Hydraulic Low Flow	Standard, limits actuator to 10 mm/s			
Friction Force Load Cell	7 kN (1500 lbs.)			
Sideload	Hydraulic, dynamic (optional) Pneumatic, static (optional)			
Accumulators	8 liters		15 liters	
Test Space	1200 mm			
HSM	Integral to accumulator manifold			
Performance:	3.2 m/s	0 kN	2.9 m/s	0 kN
<i>For 3 cycles at 100 mm stroke sine wave command</i>	2.3	5	2.5	5
	0.7	10	2.0	10
			1.4	15
			0.6	18

MTS 850 Specifications

MTS Model 850.xx Damper Test Machine Specifications

Description	
Actuator Rod Diameter	80 mm (3.15 in.)
Test Space, Actuator Face to Load Cell	850.25 max. 1560 mm min. 160 mm
	850.50 max. 1540 mm min. 132 mm
Frame Dynamic Load Rating	50 kN (11 kip)
Floor Mount	Frame Bolted to Concrete (optional vibration isolation system available)
HSM	Integral to Accumulator manifold, 300 lpm max
Actuator Hydrostatic Bearing	Yes
Actuator Stroke	250 mm (10 in.)
Heavy Duty Anti-Rotate	Yes
Safety Low Flow	Yes
Accumulator	19 Liter Pressure and Return

Performance Testing Specifications

Maximum peak velocity for 3 cycles of 100 mm stroke (peak to peak), sine wave command

Model 850.25		Model 850.50	
4 m/s	No Load	5 m/s	No Load
3.5 m/s	5 000 N Load	4.5 m/s	5 000 N Load
2.8 m/s	10 000 N Load	4.0 m/s	10 000 N Load
1.8 m/s	15 000 N Load	3.0 m/s	20 000 N Load
1.0 m/s	18 000 N Load	1.2 m/s	30 000 N Load

Durability Testing Specifications

Maximum continuous peak velocity of 100 mm stroke (peak to peak) and 12.5 kN load sine wave command

Maximum continuous peak velocity of 100 mm stroke (peak to peak) and 25 kN load sine wave command

Model 850.25			Model 850.50		
HPU	HZ POWER	M/S	HPU	HZ POWER	M/S
505.20	60	0.9	505.20	60	0.4
505.20	50	0.7	505.20	50	0.3
505.30	60	1.5	505.30	60	0.8
505.30	50	1.2	505.30	50	0.6
505.60	60	3.5	505.60	60	1.9
505.60	50	2.8	505.60	50	1.6
505.90*	60	3.6	505.90	60	3
505.90	50	3.6	505.90	50	2.4
			505.180*	60	4
			505.180*	50	4

*HSM on frame limits flow to 300 Lpm (80 gpm). Add MTS Model 293 HSM for HPUs with output greater than 300 Lpm.

MTS 852 Specifications

MTS Model 852.xx Damper Test Machine Specifications

Description	
Actuator Rod Diameter	80 mm (3.15 in.)
Test Space, Actuator Face to Load Cell	1575 mm maximum 180 mm maximum
Frame Dynamic Load Rating	67 kN (15 kip)
Floor Mount	Frame Bolted to Concrete (optional vibration isolation system available)
HSM	Integral to Accumulator Manifold, 284 lpm max
Actuator Hydrostatic Bearing	Yes
Actuator Stroke	250 mm (10 in.)
Heavy Duty Anti-Rotate	Yes
Safety Low Flow	Yes
Accumulation	852.25 & 852.50 19 Liter Pressure and Return 852.67 38 Liter Pressure and Return

Performance Testing Specifications

Maximum velocity, sine wave, for 3 cycles of 100 mm stroke (peak to peak), 45 kg moving mass, sine wave command

Model 852.25		Model 852.50		Model 852.67	
4.0 m/s	no load	5.0 m/s	no load	3.8 m/s	no load
3.6 m/s	5 000 N load	4.5 m/s	5 000 N load	3.6 m/s	10 kN load
3.0 m/s	10 000 N load	4.0 m/s	10 000 N load	3.1 m/s	20 kN load
2.2 m/s	15 000 N load	3.0 m/s	20 000 N load	2.5 m/s	30 kN load
1.5 m/s	18 000 N load	1.2 m/s	30 000 N load	1.7 m/s	40 kN load

Durability Testing Specifications

Maximum sine wave continuous peak velocity for durability testin

Model 852.25			Model 852.50			Model 852.67		
HPU	HZ POWER	M/S	HPU	HZ POWER	M/S	HPU	HZ POWER	M/S
505.20	60	0.9	505.20	60	0.5	505.20, 60 Hz	60	0.3 (33.5 kN of load)
505.20	50	0.7	505.20	50	0.4	505.20, 50 Hz	60	0.2 (33.5 kN of load)
505.30	60	1.6	505.30	60	0.9	505.30	60	0.6 (33.5 kN of load)
505.30	50	1.3	505.30	50	0.7	505.30	50	0.4 (33.5 kN of load)
505.60	60	3.2	505.60	60	2	505.60	60	1.4 (33.5 kN of load)
505.60	50	2.9	505.60	50	1.7	505.60	50	1.1 (33.5 kN of load)
505.90*, #	60	3.2	505.90*	60	3.2	505.90*	60	2.2 (33.5 kN of load)
505.90*, #	50	3.2	505.90	50	2.6	505.90	50	1.7 (33.5 kN of load)
			505.180*, #	60	3.6	505.180*, #	60	2.9 (33.5 kN of load)
			505.180*, #	50	3.6	505.180*, #	50	2.9 (33.5 kN of load)

* Due to a flow limit of 284 lpm with the standard on/off HSM, an optional 293 HSM is required to meet this performance.

Maximum velocity limited at this specimen load.

Regional Business Centers

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