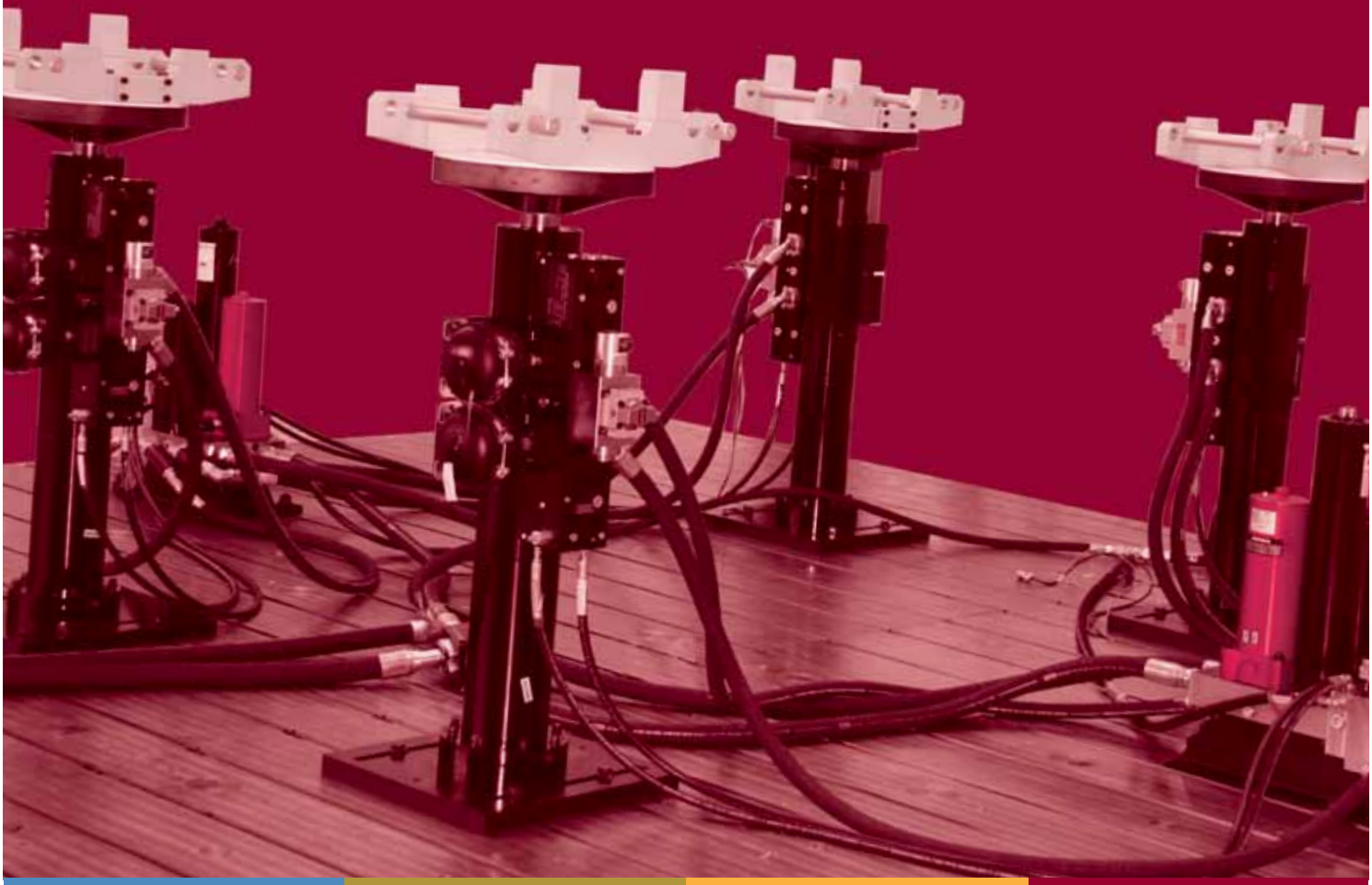
TIRE COUPLED SIMULATION SYSTEM



DESIGNED FOR STRUCTURAL, DURABILITY AND PERFORMANCE TESTING APPLICATIONS

Squeak, Rattle, Noise and Vibration

WHAT MOVES YOUR WORLD

MOOG

STATE-OF-THE-ART TIRE COUPLED SIMULATION SYSTEM DESIGNED FOR TEST APPLICATIONS AROUND THE WORLD

The application of the latest testing techniques has become a cornerstone for creating successful new designs, ensuring shorter vehicle time-to-market, managing increased regulatory pressures and maintaining cost efficiencies.

Unsurpassed innovation and technological expertise combined with close customer collaboration make Moog a leader in the design and development of hydraulic motion test systems.

The proven technology expertise of Moog combined with the world class performance of Moog Actuators, Servovalves, Test Controllers and Automotive Software delivers long-lasting solutions to meet your challenges today and tomorrow.

Our total focus on meeting your unique test requirements means you can rest assured you're using the most flexible, highest performance test equipment available anywhere.

The Moog Tire Coupled Simulation System is indispensable in evaluating a wide variety of vehicles through structural, durability and performance testing.

ANSWER THE CHALLENGE OF STRUCTURAL, DURABILITY AND PERFORMANCE TESTING WITH MAXIMUM VERSATILITY

The Moog Tire Coupled Simulation System provides vertical inertial loads through the vehicle's tire patch. Simulating vertical acceleration or displacement inputs of the wheel from data collected on the proving ground road, the system is used throughout the vehicle development process.

From ride quality evaluations to noise and vibration assessments of design candidates and prototypes, the Tire Coupled Simulation System has become an invaluable asset for the product development engineer in their research labs.

The system is also deployed in durability test labs to prove out selected structural, chassis, and suspension designs. Production and assembly facilities use it to assess squeak and rattle concerns at end of line tests.

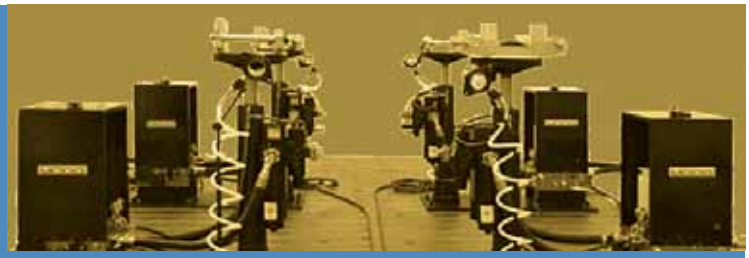
AVAILABLE SYSTEM FEATURES AND OPTIONS

- Fatigue-rated hydrostatic servo hydraulic actuators
- Vehicle loads up to 10,000 kg (22,000 lbs)
- Provides strokes, speeds, accelerations and bandwidth needed for high performance
- Manual or automatic track and wheelbase positioning
- Stiff wheel pans with low-friction tire patch
- Integrated control hardware and software
- Touchscreen tablet or handheld remote
- Acoustic environment
- Climatic chamber
- Integrated safety devices and procedures to protect test specimen and operators

GENERAL TECHNICAL DATA

PERFORMANCE	LD - Light Duty	MD - Medium Duty	SR - Squeak and Rattle
System Payload gross vehicle weight	5,000 kg (11,000 lbs)	10,000 kg (22,000 lbs)	2,500 kg (5,500 lbs)
Actuator Payload unsprung mass (to specified performance)	114 kg (250 lbs)	114 kg (250 lbs)	114 kg (250 lbs)
Actuator Size	50 kN (11 kip)	100 kN (22 kip)	28 kN (6.3 kip)
Stroke	± 152 mm (6 in)	± 152 mm (6 in)	± 76 mm (3 in)
Peak Velocity	6.4 m/s (250 in/s)	3.2 m/s (125 in/s)	1.4 m/s (55 in/s)
Peak Acceleration	45 g (vertical)	45 g (vertical)	25 g (vertical)
Bandwidth	0 - 60 Hz	0 - 60 Hz	0 - 200 Hz

TAILORED TO MEET YOUR TEST REQUIREMENTS



Our wide array of technologies means your Moog Tire Coupled Simulation System can be tailored to meet your specific performance needs. Our solutions address your requirements whether they be higher frequency, payloads, durability and performance, or adding climatic or acoustic chambers.

Detailed engineering, stress and model analyses are used to ensure that your specifications are realized in the final design.

The system incorporates fatigue-rated hydrostatic servo hydraulic actuators for specified vertical accelerations up to 45 g.

As a result, the system can accommodate the evaluation of a wide variety of vehicles including the heavy demands of structural durability and the delicate performance requirements of squeak, rattle, noise and vibration.

AUTHENTIC PRODUCTS ENSURE BEST PERFORMANCE

Each Moog Tire Coupled Simulation System incorporates the world-class performance of Moog products along with proprietary software and test controllers. Every element of the Tire Coupled Simulation System is thoughtfully integrated in the engineering design to offer unsurpassed performance, reliability and longevity.

HIGH PERFORMANCE ACTUATORS

The Moog model LH11RS series or the Moog Hydraulic Actuators with hydrostatic bearings are employed in the Tire Coupled Simulation Systems. Hydrostatic bearings allow for higher side loading capability without damage to rod or bearing end cap surfaces. Up to 12 inches of travel accommodate a broader range of vehicle applications from compact vehicles to light duty trucks.

Linear Variable Displacement Transducer (LVDT) position transducers are integrated into the actuators to allow for accurate position measurement and control. Industry standard wiring configurations ease integration with most servocontrollers. The LVDTs are precision wound with insulation between each wire layer and feature constant control of wire tension and spacing. This ensures protection against dielectric breakdown and improves stability under the effects of vibration, acceleration, mechanical and thermal shock, ensuring unit-to-unit consistency.

The result? A consistent performance, high reliability, and long life solution that is vital to today's customer.

WHEEL PAN AND RESTRAINTS

Moog aluminum wheel pans have a Teflon tire patch contact area. Wheel restraint bars are provided on all actuator assemblies when adjustability is required. The bars will be positioned at two locations and are adjustable to accommodate various tire diameters and tire widths. Additionally, longitudinal restraints are provided at two wheels to prevent fore and aft vehicle movement. Cast aluminium wheel pans with fixed lateral restraint increase stiffness needed for squeak and rattle applications. Positioning of the restraints (both lateral and longitudinal) is manual and does not interfere with the usable tire contact patch area.

X-Y POSITIONERS

Moog provides positioner base plates to adjust the actuators for varying track widths and wheelbases. Moog employs our own and commercially available X-Y positioners. Options for automated repositioning via gear motors and trapezoid spindles quickly position the actuators to your desired movements. Hydraulic spring clamps are available to release/tighten the moving plates. Automated control is available with PC and remote control options.

PORTABLE TEST CONTROLLER

The Moog Portable Test Controller includes up to 4 servo control channels and is recommended for 4 post test systems. The engineer can operate from an LCD front panel or external PC screen. It includes Moog's unique control loop technology for force, displacement and acceleration control with bumpless transition. The Portable Test Controller runs on Moog Application Software and supports Software Development Kits (SDK) for connections to other programming environments such as Matlab®, LabVIEW® and others.

AUTOMOTIVE TEST CONTROLLER

The Moog Tire Coupled Simulation Systems utilizes the same Automotive Test Controller as other Moog solutions.

- Advanced control loop technology
- Unique control algorithm
- Function generator–plays out cyclic commands including sine, triangle, square wave and more
- Random Wave–creates random waveform that allows variable Power Spectral Density (PSD) with multiple break points across the frequency spectrum
- Sweep function generator–sweeps through a sine function with closed-loop control of defined amplitudes at various frequencies
- Random time history iteration and durability test playback

SERVOVALVES

Moog Servovalves are known for their exact tolerances, high performance and durability. Our Servovalves are the preferred choice of leading test engineers and set the world standard for hydraulic servovalve performance.

GENERAL TECHNICAL DATA

Channels	• Expandable up to 32 channels
Housing	• 19 inch cabinet 1.8 m (70.9 in) high or lower • Integrated 17" full VGA color display • Climate controlled cabinet
Servocontroller	• Up to 2.5 kHz control loop (software selectable) • Integrated DOF control • Delta P compensation included • Features Moog's unique control loop • Three variable control possibilities (Velocity, Position, Acceleration)
Function Generator	• Frequency range 0.01 to 500 Hz • Waveforms: sine, sawtooth, block/square, ramp, rounded ramp, exponential • Analog input can be used as command • Complex simulation spectrum support including spectral density (PSD frequency definition) • Constant amplitude and phase matching
Standard Inputs (Per Channel)	• 2x high resolution (0.03 %) with selectable gain and bridge excitation • Pot meter input (0.03 %) (+/- 5 V 5 mA) or LVDT input (0.03 %) with LVDT excitation (5 V RMS @ 3.5 kHz) • Encoder, absolute (SSI) maximum 32 bit or relative 10 bit • 16 bit input (+/- 10 V)
Standard Outputs (Per Channel)	• 16 bits ± 100 mA valve driver output, with a limit in software from 0 to 100% or (hardware selectable) +/- 10 V output • 2 x 16 bit D/A converters, +/- 10 V
Optional Items	• Digital I/O board containing 8 inputs and 8 outputs • Analog input board containing 16 inputs • Strain amplifier board (6 channels, 1/4, 1/2 and full bridge 120/350 ohm) • Add onboard for 3-stage servovalve • Accelerometer input board 6 channels • Uninterruptible Power Supply (UPS)

MOOG TOTAL SUPPORT

Our trained engineers, based in more than 26 countries around the world, bring a dynamic and collaborative approach to helping you solve your automotive testing challenges. Rather than starting with a product, we start with a thorough understanding of your application, your technical needs, and your overall objectives. By focusing on your specific requirements, we are able to provide high-performance solutions that realize your test objectives.

Our commitment to you goes beyond the initial collaboration. In fact, Moog Global Support™ is as reliable and flexible as our products. Our service technicians worldwide ensure timely and precise repair of your Moog products should service be required. And we can tailor a maintenance program that is ideal for your particular needs.

Contact your nearest Moog representative to see how our world-class solutions, technical expertise and proactive support can help you take your tests further.

MOOG GLOBAL SUPPORT™

LEADING-EDGE TEST SOFTWARE

High-level test sessions can be set up quickly and easily using the test software applications. Store or retrieve test configurations including identification, iteration, sequence editing and more. These features facilitate quick user feedback, total test flexibility and comprehensive test monitoring. Dedicated algorithms allow you to create drive files from road surface files that can be downloaded and played out.

Our Moog test software is totally compatible with common data formats on the market today. In addition, our application-specific and PC-based test software solutions use standard TCP/IP hardware to connect to our test controllers.

As part of the Moog Test Software, the replication and sinesweep functions are specifically designed for Tire Coupled Simulation Systems.

MOOG REPLICATION SOFTWARE

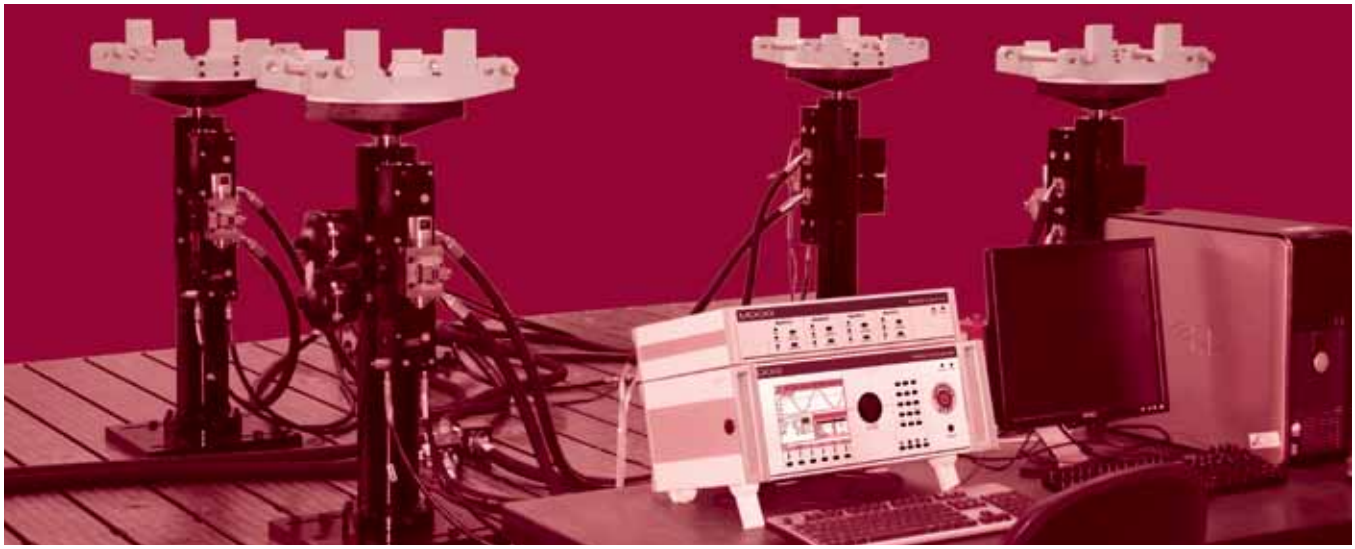
The easy-to-use graphical interface, state-of-the-art algorithms and powerful feature set make Moog Replication Module the perfect application software for tire coupled testing. Replication is continuously improved to reflect each customer's requirements.

- Signal viewer with statistical information, fatigue parameters, single and multiplots, FFT and PSD analysis
- Signal editing functionalities like cut/copy/paste, filtering, remove offset and custom scripts
- Import and export of various file format such as MATLAB® and others
- Hardware control function to remotely operate a test rig
- Real-time signal monitoring and oscilloscope
- System identification and iteration using state-of-the-art algorithms for quick and easy drivefile development
- Batch iteration to simplify test processes
- Sequence building using the setpoint, cycles, drivefile, recording, scripts and other instructions to create a sequence
- Sequence playing via the controller

MOOG SINESWEEP SOFTWARE

Moog Sinesweep is used for sinesweep testing in open or closed-loop operation. The Moog Sinesweep Software is used to investigate the resonance frequencies of a test specimen or to run sine sweep durability tests. The application has an intuitive interface that makes it user-friendly.

- Open and closed-loop sinesweep control
- No iteration needed using closed-loop algorithms
- Resonance finding in manual mode
- Automatic mode for durability testing for number of cycles or time
- Built-in data acquisition functionality



TECHNICAL DATA

EQUIPMENT SPECIFICATIONS	LD - Light Duty	MD - Medium Duty	SR - Squeak and Rattle
Actuator (4 per system)			
Actuator	± 50 kN (11 kip) equal area	± 100 kN (22 kip) equal area	± 28 kN (6.3 kip) equal area
Bearing type	Hydrostatic	Hydrostatic	Hydrostatic
Manifold	Pilot pressure available cross-port bleed valve and/ or delta-p	Pilot pressure available cross-port bleed valve and/ or delta-p	Pilot pressure available cross-port bleed valve and/ or delta-p / safety valve and flow limiting available
Accumulators - close coupled	Available	Available	Available
Valves	Moog 79-200 series 3-stage Servovalve with G761 3.8 lpm (1 gpm) 2-stage pilot valve	Moog 79-200 series 3-stage Servovalve with G761 3.8 lpm (1 gpm) 2-stage pilot valve	Moog D762 Servovalve 62.5 lpm (16.5 gpm) (2 per actuator)
Hydraulic Control Manifolds (2 per system)			
Flow	944 lpm (250 gpm)	(2) 944 lpm (250 gpm)	(2) 189 lpm (50 gpm)
Off/Low/High pressure	Yes	Yes	Yes
Control voltage	24 VDC	24 VDC	24 VDC
Pressure and return ports (with check valves)	2 each	2 each	2 each
Pilot pressure ports	Yes	Yes	Yes
Supply filter	3 Micron	3 Micron	3 Micron
Accumulation	3.8 l (1 gal) pressure 1.9 l (0.5 gal) return 0.47 l (1 pt) pilot	3.8 l (1 gal) pressure 1.9 l (0.5) gal return 0.47 l (1 pt) pilot	3.8 l (1 gal) pressure 1.9 l (0.5) gal return
Hydraulic Hoses (from manifold to actuator)	Code 61 on -24 and -32	Code 61 on -24 and -32	Code 61 on -24 and -32
Hydraulic fluid	Mobil DTE 25 or Shell Tellus 46	Mobil DTE 25 or Shell Tellus 46	Mobil DTE 25 or Shell Tellus 46
X-Y Positioning			
Track width	± 300 mm (12 in)	± 480 mm (19 in)	± 300 mm (12 in)
Wheel base	± 750 mm (29.5 in)	± 910 mm (36 in)	± 750 mm (29.5 in)
Powered option	Manual or automatic	Manual or automatic	Manual or automatic
Clamping option	Bolted or hydraulic	Bolted or hydraulic	Bolted or hydraulic
Wheel Pans			
Type	Durability	Durability	NVH
Shape, material	Round, aluminium	Round, aluminium	Rectangular, aluminium (cast)
Size	457 mm (18 inch) diameter	635 mm (25 inch) diameter	660 x 450 mm (26 x 17.75 inch)
Stiffness	200 Hz	200 Hz	200 Hz
Adjustable bar option	Bars for lateral and longitudinal	Bars for lateral and longitudinal	Non-adjustable
Low friction tire patch option	Teflon® interface	Teflon® interface	Teflon® interface

TAKE A CLOSER LOOK.

Moog designs a range of products that complement the performance of those featured in this catalog. Visit our Web site for more information and the Moog facility nearest you.

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