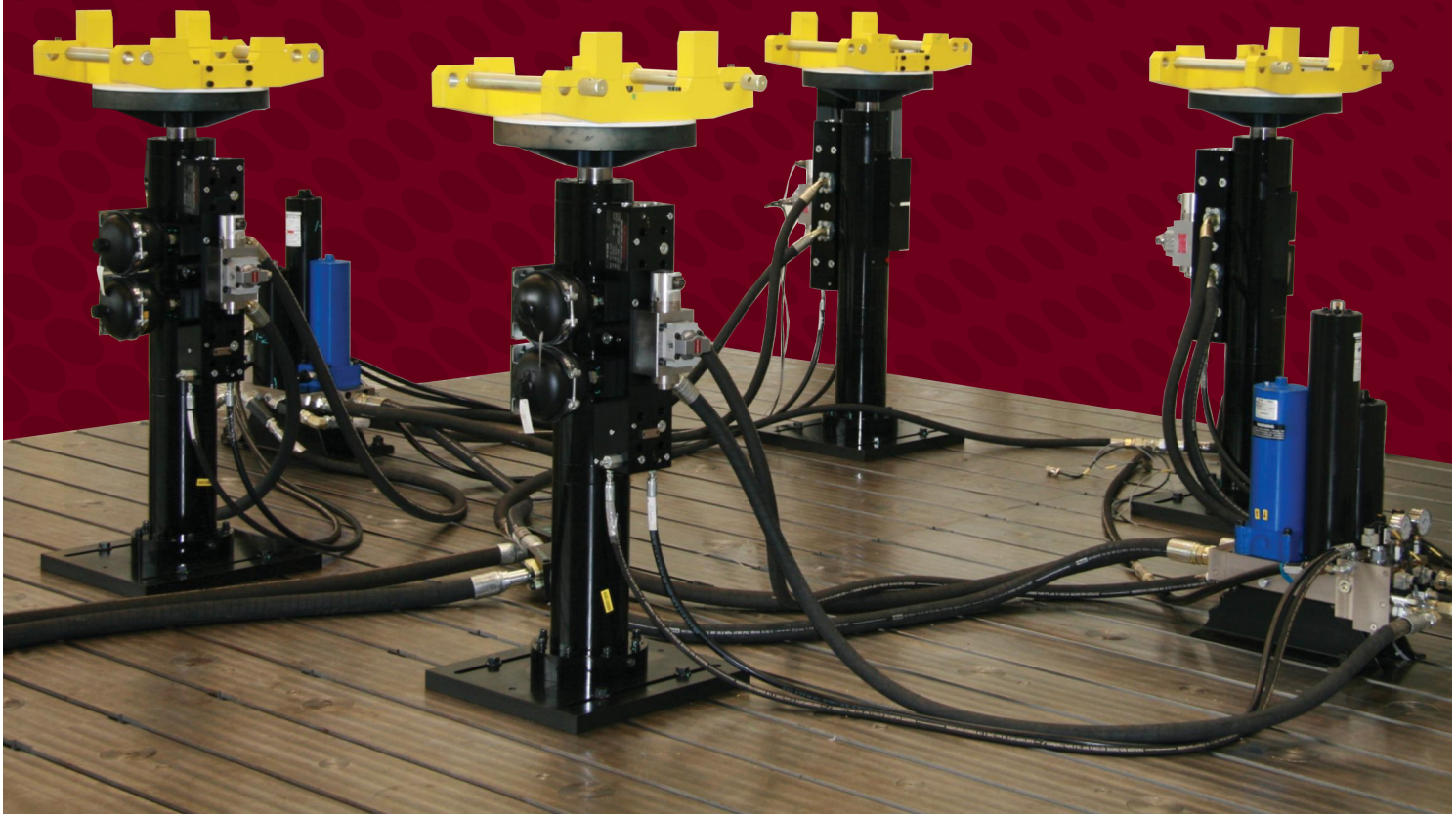
TIRE COUPLED SIMULATION SYSTEM



Rev. E, July 2025

DESIGNED FOR STRUCTURAL DURABILITY AND PERFORMANCE TESTING APPLICATIONS

MOOG | Shaping the way our world moves™

ADVANCED TIRE COUPLED SIMULATION SYSTEMS ENGINEERED FOR GLOBAL TESTING APPLICATIONS

Accelerate vehicle development and ensure durability with Moog's advanced Tire Coupled Simulation Systems – engineered to deliver high-performance testing for structural, durability, and NVH requirements.

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, Servo Valves, 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.

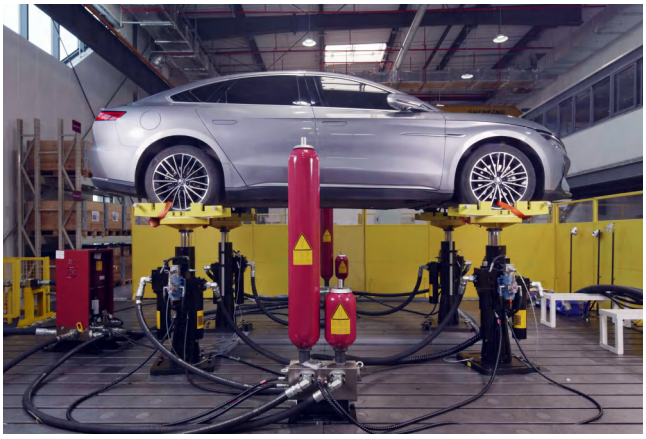
The Moog Tire Coupled Simulation System is indispensable in evaluating a wide variety of vehicles through structural, durability and performance testing.

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 16,000 kg
- ✓ 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
- ✓ Table PC or Touchscreen PC for remote operation
- ✓ Acoustic environment
- ✓ Climatic chamber integration
- ✓ Integrated safety devices and procedures to protect test specimens and operators

GENERAL TECHNICAL DATA

	Light Duty - LD		Medium Duty - MD		Heavy Duty - HD	
Actuator Size (kN)	40		50		100 [F] * 160 [R]	
Actuator Stroke (mm)	150	250	250	300	250	300
Unsprung mass (kg)	60		100		180 [F] 350 [R]	
Sprung Mass (kg)	875		1,250		4,000 [F] 6,000 [R]	
Acceleration (g)	33	30	29	28	18.5 [F] 20.5 [R]	18 [F] 20 [R]
Velocity (m/s)	4.5	4.5	5	5	3.2 [F] 2.1 [R]	3.2 [F] 2.1 [R]

* [F]: Forward, [R]: Reverse direction

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 are 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.

To meet the most demanding extreme environment testing challenges, Moog introduces Sandstorm Resistant and Low Pressure Tire coupled Simulation Systems. Sandstorm Resistant System features a multi-layer sand and dust protection enclosure, enabling testing of vehicles in simulated sandstorm conditions without causing equipment damage. Low Pressure System adapts to temperature, humidity, and altitude variations, ensuring that the test can truly replicate road vibrations in high-altitude, low-pressure, extreme temperature and humidity environments.

Building on our simulation expertise, Moog also launches the mechanical Hardware-in-the-Loop (mHiL) Tire Coupled Simulation System. It replicates diverse road conditions and emergencies in a controlled laboratory setting. It is ideal for R&D testing of semi-active and active suspension systems, and fully addressing the most demanding mHil test requirements.

AUTHENTIC PRODUCTS ENSURE THE BEST IN 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 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 300 mm of travel accommodates a broader range of vehicle applications from compact vehicles to light duty trucks.

Linear Variable Displacement Transducers (LVDT) are integrated into the actuators to allow for accurate position measurement and control. Industrys tandard wiring configurations ease integration with most servo controllers. 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.

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 springs and clamps are available to release/tighten the moving plates. Automated control is available with PC and remote control options.

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 aluminum 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.

MOOG TEST CONTROLLER

The Moog Test Controller is a real-time modular control system that can control or collect data from any hydraulic or electric test system. The robust and compact modules have a wide range of transducer inputs and control outputs that can be easily configured for optimum use. The Moog test software allows the end user to control and record all of these signals in an easy-to-use format providing maximum value for many years of reliable usage.

FEATURES	BENEFITS
Familiar feature-rich software: configurable hardware bindings, wizard for calibration, powerful control loops	No new training for current users; new users will appreciate the simplified interfaces that allow complex tasks with minimal training
Easier 1 piece modules	With less parts to manage, moving hardware between controllers is safe
Easier upgrades in future with CPU module and Manifold Control Unit	Modular design permits low cost upgrades to take advantage of rapidly improving technology or controller expansion
Higher density I/O per module	Lower cost per connection with more I/O packed into less space
Flexible I/O - Configurable Digital Input, Digital Output, Analog Input or Accelerometer (ICP)	One connection can be used to serve different functions giving you no added cost options as your test needs change
Easy channel expansion	Low cost controller expansion with space saving channel or data acquisition modules avoiding expensive racks with limited slots
Better 24-bit signal resolution	High resolution analog inputs providing high precision for control and data acquisition

MOOG GLOBAL SUPPORT

Our trained engineers, based in various 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. This customer-centric approach enables us to deliver high-performance, application-specific solutions that help you achieve your testing goals with precision and efficiency.

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.

MOOG GLOBAL SUPPORT®

THINKING ABOUT AN UPGRADE?

To keep your systems running at peak performance or upgraded with the latest technology, we offer comprehensive servo valve services – including cleaning, repair, and trade-in programs.

The software maintenance agreements keep you up-to-date with the latest features, stabilizing updates and ease-of-use improvements.

Our control hardware includes updates to processors, storage space, and multi-range conditioners as changes occur to useful life to your initial purchase.

Do you have an analog test controller? Moog can provide a digital controller to provide commands to the existing controller as a transition to full digital or a drop-in replacement in one step. Why not take advantage of the many features digital controls can bring to your tests like advanced control loops and sequenced tests, built-in data acquisition, and settings that can be saved for future use. Contact Moog for more details!

SOFTWARE TO MEET YOUR NEEDS

The Moog Test Controller includes the Moog Integrated Test Suite as the core to operating complex tasks in easy-to-use ways. Complementing the Integrated Test Suite software are several optional application packages to expand control, capability and test performance.

MOOG REPLICATION

Replicate time history files using state-of-the-art algorithms in an easy yet powerful way

MOOG RUNNER

Build complex, nested durability tests through simple instructions. Run and monitor the progress of the durability test and specimen

MOOG SINESWEEP

Measure the resonant frequencies of your test specimen. Run sine sweep durability tests

MOOG VIBRATION

Run real-time closed loop control to defined random vibration frequency spectra (PSDs)

FEATURES	BENEFITS
Supports multiple test systems • Single and multi-axis hydraulic or electric test systems, Hydraulic Simulation Tables, Electric Simulation Tables, Tire Coupled Simulation Systems	**One controller platform for many uses** • User interface includes configuration, calibration, tuning and test players for strength, fatigue or vibration tests
Integrated suite • Utilize a variety of functions for simple or complex tasks	**User friendly and intuitive** • One learning curve for operating different test rigs • Supports less experienced operators or total control for advanced users • High value software without hidden extras • Additional capability with optional application software
Real time motion control • Multiple control loops, amplitude and phase matching, bumpless control switching, data acquisition	**Test accuracy and efficiency** • Optimal control and data recording across all channels minimizes setup and run time
Maximum access to configurable hardware • Bind the high density I/O needed to the test station, easily calibrate sensors	**Cost effective hardware and software combination** • High utilization of available I/O • Quick setup leads to more testing uptime
Customize your user interface • Multi-language support (9 languages including English, German, and Chinese) • Save/load user interface layouts (scopes/meters) • User authentication (levels of access)	**Efficient localization** • Preferred language • Time saving monitor sets • Control access to key information
Several players built-in to run your test • Cycle player- multi-axis phased operation with target matching and recording • Sequence player- create custom tests with ramp, cycle, drive file instructions, recordings and/or triggered actions	**One software package to run simple or advanced tests** • One user interface to run and monitor simple fatigue tests, or monitor complex tests with nested instructions, data recording, and dozens of triggered actions

TECHNICAL DATA

	Light Duty - LD		Medium Duty - MD		Heavy Duty - HD	
Actuation						
Actuator Rated Force (kN)	40		50		100 [F] 160 [R]	
Actuator Stroke (mm)	150	250	250	300	250	300
Servo Valve Rated flow @ Δp_N 70 bar (l/min)	400		800		1,000	
Performance at Wheel Pan [1]						
Typical Gross Vehicle Weight (kg)	3,500		5,500		16,000	
Unsprung Dynamic Mass (kg)	60		100		180 [F] 350 [R]	
Sprung Static Mass (kg)	875		1,250		4,000 [F] 6,000 [R]	
Maximum Acceleration – Sinusoidal (g)	33	30	29	28	18.5 [F] 20.5 [R]	18 [F] 20 [R]
Maximum Velocity (m/s)	4.5	4.5	5	5	3.2 [F] 2.1 [R]	3.2 [F] 2.1 [R]
HPU Requirement						
Flow (l/min)	460		600		1,140	
Operating Pressure (bar)	210		210		210	
Fluid	Hydraulic oil as per DIN 51524 Part 1 to Part 3 and ISO VG32, 46 or equivalent					
Wheel Pans [2]						
Flat Wheel Pan Diameter (mm)	425		425		630	
Dished Wheel Pan Diameter (mm)	480		480		NA	
Restraints	Lateral / Longitudinal		Lateral / Longitudinal		Lateral / Longitudinal	
X-Y Positioning						
Track Width (mm)	±300		±480		Per vehicle	
Wheel Base (mm)	±750		±910		Per vehicle	
Options						
Positioning Method	Manual or Automatic					
Clamping	Bolted or Hydraulic					

1) Performance is measured at the wheel pan. Performance is not representative of spindle motion. For performance estimations at the spindle see below tire magnification factors (valid near wheelhop frequency):
- LD and MD: 2.0 to 2.5
- HD: 1.25 to 1.5

2) Custom wheel pans available on request

TAKE A CLOSER LOOK

Motion System Solutions from Moog are available around the world. For more information, visit our web site or contact one of the locations below.

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