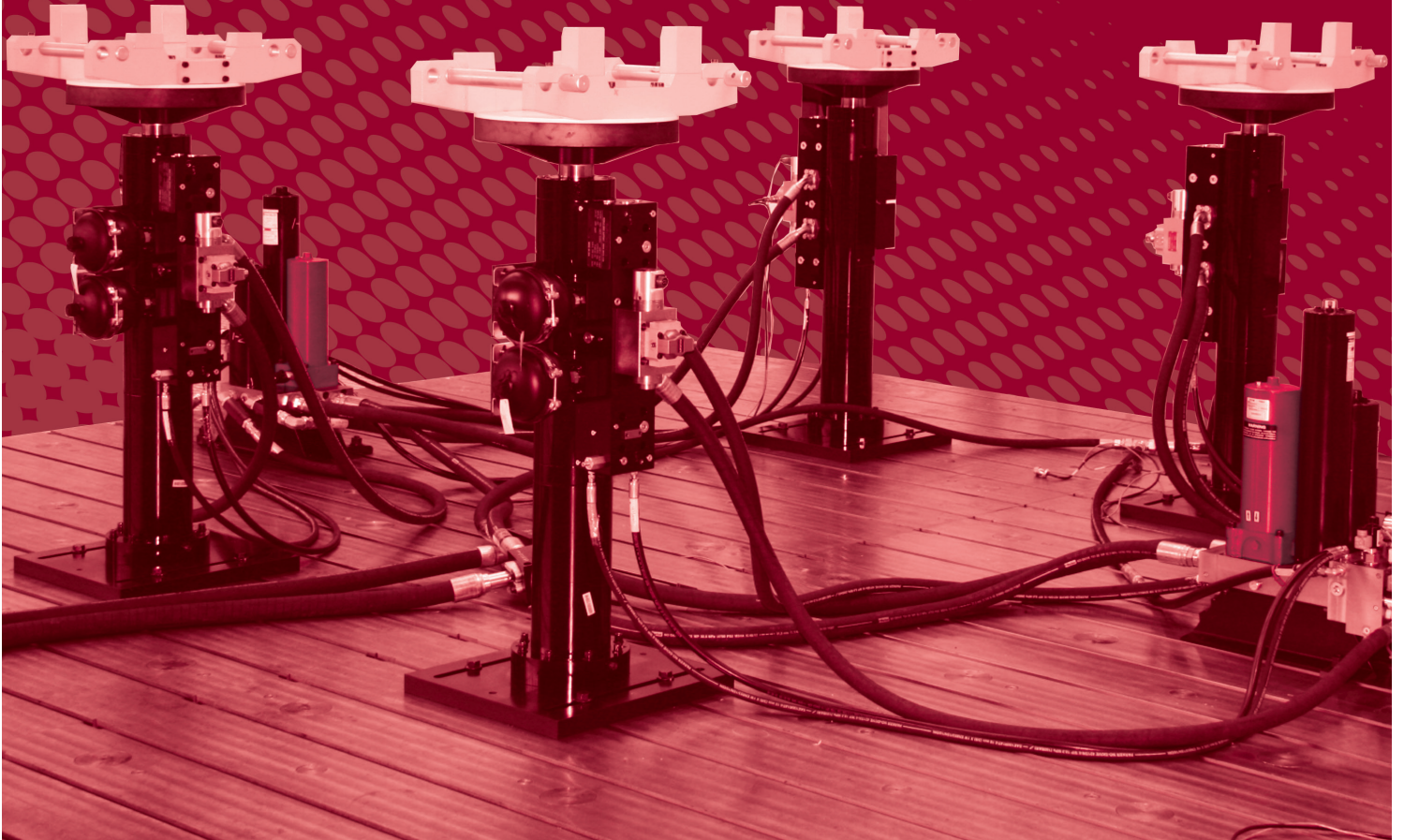


TIRE COUPLED SIMULATION SYSTEM

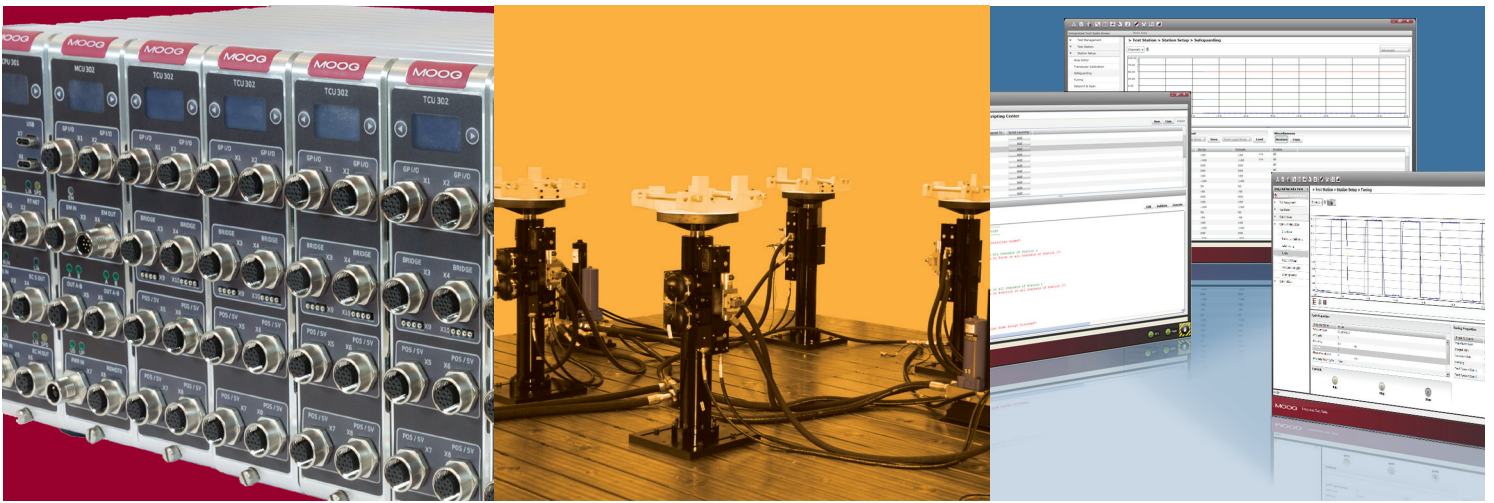


Rev.D, October 2022

DESIGNED FOR STRUCTURAL DURABILITY
AND PERFORMANCE TESTING APPLICATIONS

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,

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.

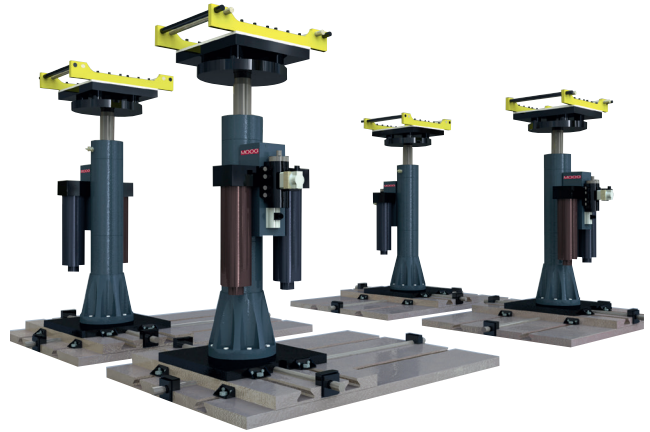
The Moog Tire Coupled Simulation System is indispensable in evaluating a wide variety of vehicles through structural, durability and performance testing.

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 (35,200 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
- Table PC or Touchscreen PC for remote operation
- Acoustic environment
- Climatic chamber integration
- Integrated safety devices and procedures to protect test specimen and operators

GENERAL TECHNICAL DATA

	Squeak and Rattle - SR	Light Duty - LD	Medium Duty - MD	Heavy Duty - HD
Actuator size	38 kN (8.5 kip)	38 kN (8.5 kip)	50 kN (11.2 kip)	100 kN (22 kip) [F] 160 kN (35 kip) [R]
Actuator Stroke	254 mm (10 in)	253 mm (10 in)	254 mm (10 in)	254 mm (10 in)
System Payload (gross vehicle weight)	2,500 kg (5,500 lbs)	3,500 kg (7,700 lbm)	5,500 kg (11,000 lbm)	16,000 kg (35,200 lbm)
Actuator Payload (unsprung mass)	40 kg (88 lbm)	60 kg (132 lbm)	100 kg (220 lbm)	180 kg (397 lb) [F] 350 kg (772 lb) [R]
Peak Velocity	1.2 m/s (47 in/s)	3.5 m/s (137 in/s)	5.5 m/s (216 in/s)	3 m/s (118 in/s) [F] 2.5 m/s (98 in/s) [R]
Peak Acceleration	25 g	20 g	20 g	25 g

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.

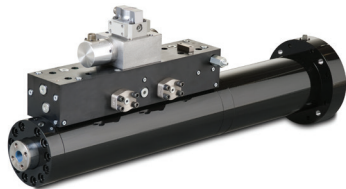


AUTHENTIC PRODUCTS ENSURE THE BEST IN PERFORMANCE

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

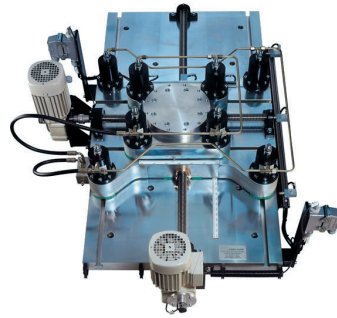
The Moog Hydraulic Actuators with hydrostatic bearings are employed in the Tire Coupled Simulation Systems. Hydrostatic bearings allow for higher side loading capability without damage to rod or bearing end cap surfaces. Up to 12 inches of travel accommodate a broader range of vehicle applications from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



Linear Variable Displacement Transducers (LVDT) are integrated into the actuators to allow for accurate position measurement and control. 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.

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 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.



MOOG TEST CONTROLLER

The Moog Test Controller is a 1 to 32 channel 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
1 to 32 channel expansion easier	Low cost controller expansion with space saving channel or data acquisition modules avoiding expensive racks with limited slots
Better 24-bit signal resolution	32 times improvement in signal resolution over 19-bit, giving better precision to control or recorded data

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.

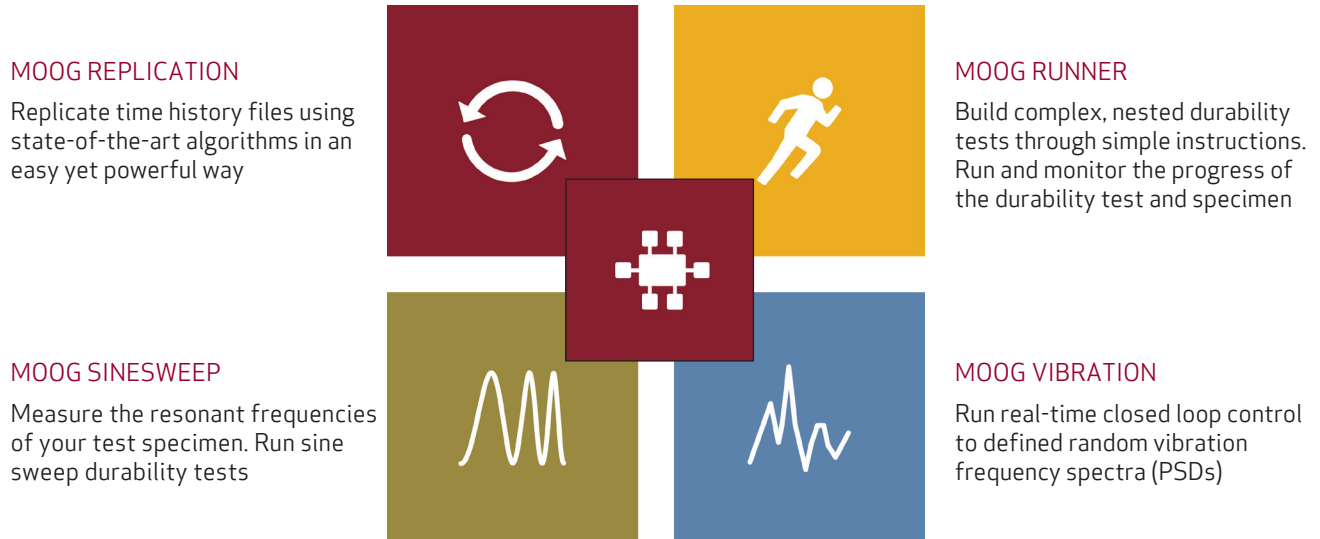
Our commitment to you goes beyond the initial collaboration. In fact, Moog Global Support™ is as reliable and flexible as our products. Our service technicians worldwide ensure timely and precise repair of your Moog products should service be required.

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.



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. Configure, calibrate and tune equipment with easy-to-use setup screens and then build and play simple to complex test sequences for durability tests. Complementing the Integrated Test Suite software are several optional application packages to expand control, capability and test performance.



FEATURES	BENEFITS
<p>Supports multiple test systems</p> <ul style="list-style-type: none"> Single and multi-axis hydraulic or electric test systems, Hydraulic Simulation Tables, Electric Simulation Tables, Tire Coupled Simulation Systems 	<p>One controller platform for many uses</p> <ul style="list-style-type: none"> User interface includes configuration, calibration, tuning and test players for strength, fatigue or vibration tests
<p>Integrated suite</p> <ul style="list-style-type: none"> Utilize a variety of functions for simple or complex tasks 	<p>User friendly and intuitive</p> <ul style="list-style-type: none"> 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
<p>Real time motion control</p> <ul style="list-style-type: none"> Multiple control loops, amplitude and phase matching, bumpless control switching, data acquisition 	<p>Test accuracy and efficiency</p> <ul style="list-style-type: none"> Optimal control and data recording across all channels minimizes setup and run time
<p>Maximum access to configurable hardware</p> <ul style="list-style-type: none"> Bind the high density I/O needed to the test station, easily calibrate sensors 	<p>Cost effective hardware and software combination</p> <ul style="list-style-type: none"> High utilization of available I/O Quick setup leads to more testing uptime
<p>Customize your user interface</p> <ul style="list-style-type: none"> Multi-language support (9 languages including English, German, and Chinese) Save/load user interface layouts (scopes/meters) User authentication (levels of access) 	<p>Efficient localization</p> <ul style="list-style-type: none"> Preferred language Time saving monitor sets Control access to key information
<p>Several players built-in to run your test</p> <ul style="list-style-type: none"> 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 	<p>One software package to run simple or advanced tests</p> <ul style="list-style-type: none"> 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

	Squeak and Rattle - SR	Light Duty - LD	Medium Duty - MD	Heavy Duty - HD
Actuation				
Actuator Rated Force	38 kN (8.5 kip)	38 kN (8.5 kip)	50 kN (11.2 kip)	100 kN (22 kip) [F] 160 kN (35 kip) [R]
Actuator Stroke	254 mm (10 in)	253 mm (10 in)	254 mm (10 in)	254 mm (10 in)
Servo Valve	2 x 57 lpm (2 x 15 gpm)	378 lpm (100 gpm)	787 lpm (208 gpm)	984 lpm (260 gpm) [F] / [R]
Performance at Wheel Pan¹				
Typical Gross Vehicle Weight	2,500 kg (5,500 lbs)	3,500 kg (7,700 lbm)	5,500 kg (11,000 lbm)	16,000 kg (35,200 lbm)
Maximum Velocity	1.2 m/s (47 in/s)	3.5 m/s (137 in/s)	5.5 m/s (216 in/s)	3 m/s (118 in/s) [F] 2.5 m/s (98 in/s) [R]
Maximum Acceleration (Sinusoidal)	25 g	20 g	20 g	25 g [F] / [R]
Unsprung Dynamic Mass	40 kg (88 lbm)	60 kg (132 lbm)	100 kg (220 lbm)	180 kg (397 lb) [F] 350 kg (772 lb) [R]
Sprung Static Mass	750 kg (1653 lbm)	750 kg (1,650 lbm)	1,500 kg (3,307 lbm)	3,500 kg (7716 lb) [F] 5,000 kg (11,023 lb) [R]
HPU Requirement				
Flow	460 lpm (120 gpm)	460 lpm (120 gpm)	600 lpm (150 gpm)	1,140 lpm (300 gpm)
Operating Pressure	210 bar (3,000 psi)	210 bar (3,000 psi)	210 bar (3,000 psi)	210 bar (3,000 psi)
Fluid	Mobile DTE 25 or Shell Tellus 46 or Equivalent			
Wheel Pans²				
Flat Wheel Pan Diameter	425 mm (16.7 in)	425 mm (16.7 in)	425 mm (16.7 in)	630 mm (24.8 in)
Dished Wheel Pan Diameter	480 mm (18.9 in)	480 mm (18.9 in)	480 mm (18.9 in)	NA
Restraints	Lateral / Longitudinal	Lateral / Longitudinal	Lateral / Longitudinal	Lateral / Longitudinal
X-Y Positioning				
Track width	±300 mm (12 in)	±300 mm (12 in)	±480 mm (19 in)	Per vehicle
Wheel base	±750 mm (29.5 in)	±750 mm (29.5 in)	±910 mm (36 in)	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):
S&R to Medium Duty: 2.0 to 2.5
Heavy Duty: 1.25 to 1.5

- 2) Custom wheel pans available on request

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.

Australia
+61 3 9561 6044
info.australia@moog.com

Ireland
+353 21 451 9000
info.ireland@moog.com

Spain
+34 902 133 240
info.spain@moog.com

Brazil
+55 11 3572 0400
info.brazil@moog.com

Italy
+39 0332 421 111
info.italy@moog.com

Sweden
+46 31 680 060
info.sweden@moog.com

Canada
+1 716 652 2000
info.canada@moog.com

Japan
+81 46 355 3767
info.japan@moog.com

Turkey
+90 216 663 6020
info.turkey@moog.com

China
+86 21 2893 1600
info.china@moog.com

Korea
+82 31 764 6711
info.korea@moog.com

United Kingdom
+44 168 485 8000
info.uk@moog.com

France
+33 1 4560 7000
info.france@moog.com

Luxembourg
+352 40 46 401
info.luxembourg@moog.com

USA
+1 716 652 2000
info.usa@moog.com

Germany
+49 7031 622 0
info.germany@moog.com

The Netherlands
+31 252 462 000
test@moog.com

Hong Kong
+852 2 635 3200
info.hongkong@moog.com

Singapore
+65 677 36238
info.singapore@moog.com

India
+91 80 4057 6666
info.india@moog.com

South Africa
+27 12 653 6768
info.southafrica@moog.com

www.moog.com/industrial

Moog is registered trademarks of Moog Inc. and its subsidiaries. All trademarks as indicated herein are the property of Moog Inc. and its subsidiaries. MATLAB® is a registered trademark of The MathWorks Inc. LabVIEW® is a registered trademark of National Instruments Inc. Teflon® is a registered trademark of DuPont Inc. ©2022 Moog Inc. All rights reserved. All changes are reserved.

Tire Coupled Simulation System
SMM/Rev. D, October 2022, Id. CDL28938-en