

# HYDRAULIC SIMULATION TABLES NEXT GENERATION TESTING



Rev. I, August 2024

DESIGNED FOR DURABILITY TESTING  
APPLICATIONS REQUIRING HIGH  
PERFORMANCE AND RELIABILITY

# MOOG SIMULATION TABLES SET A NEW STANDARD IN AUTOMOTIVE TESTING

Unsurpassed innovation and technological expertise combined with close customer collaboration make Moog a leader in the design and development of high-performance 6 Degree-of-Freedom (DOF) electric and hydraulic motion platforms. Over the years we have installed more than 1,500 systems.

The proven technology expertise of Moog combined with the world class performance of Moog Actuators, Servo Valves and Digital Controllers deliver 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 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.

Wherever test and development engineers are pushing the limits of automotive design, the Moog Simulation Table is an indispensable tool throughout the vehicle development process.



## PRODUCT OVERVIEW

The hexapod configuration used by Moog Hydraulic Simulation Tables is the optimum design to achieve simulation and test capability using acceleration, force and displacement inputs, and to reproduce data collected on proving grounds regardless of your test type, method or specimen. By understanding today's test trends and challenges, and listening closely to the needs of customers around the world, we developed different types of Hydraulic Simulation Tables for specific applications.

The standard Hydraulic Simulation Table can accommodate loads up to 680 kg and frequencies over 100 Hz. The High Frequency Hydraulic Simulation Table is specially designed to reach higher frequencies, up to 200 Hz. The Light Payload Hydraulic Simulation Table is designed for smaller and lower weight payloads, up to 300 kg. The High Payload Hydraulic Simulation Table has a higher payload capacity, up to 2,000 kg, for large-scale article testing applications.



## KEY FEATURES

### Recommended tests

Vibration, durability, squeak and rattle, noise and harshness.

### 6 Degree of Freedom motion

Translations: vertical, lateral, and longitudinal  
Rotations: pitch, yaw, and roll

### Working in synchronization

Six identical actuators performing synchronously for each motion resulting in higher forces and accelerations.

### Degree-of-Freedom Control

DOF control allows you to simply put in the frequency and amplitude for a desired direction then the controller and software take over to achieve the expected movement result.

### Performance

The industry's most innovative engineering design incorporates proprietary software and digital control, along with the highest quality components to ensure optimal performance.

## USER BENEFITS

### High performance and versatility

Specific architecture and the exclusion of traditional bell cranks and connecting rods offer greater structural rigidity resulting in higher frequency response / bandwidth.

### User-friendly

Minimal moving parts make the Simulation Table quick to install, commission and easy to maintain. The geometry of the assembly of actuators offers a convenient working height for the operator to mount and inspect the test specimen.

### Extremely small footprint

Using only one third of the space required by classic systems, this small footprint makes it an integrated solution that is easy to position, run and control anywhere in your test lab.

### Maximum flexibility

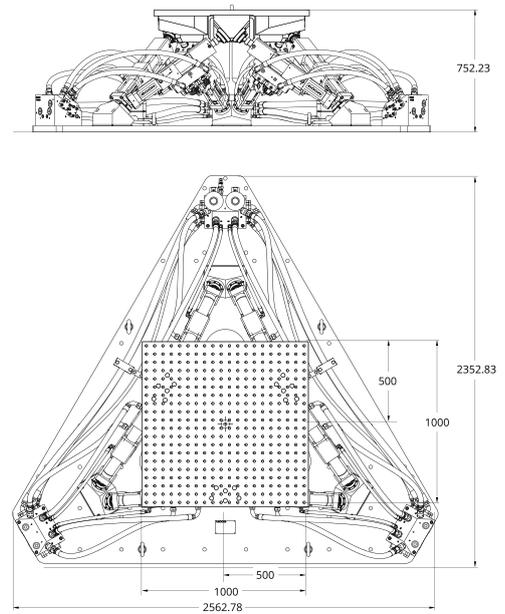
Accommodates integration of environmental chambers for temperature and humidity testing in connection with vibration testing.

## SELECT YOUR HYDRAULIC SIMULATION TABLE

Moog's wide array of technologies and design expertise mean you can choose the Simulation Table that meets your specific performance needs. Our solutions address your specific requirements whether it is higher frequency, payload, footprint, performance, climatic chamber, acoustic chamber, hydrostatic ball joints or fixed based actuator design.

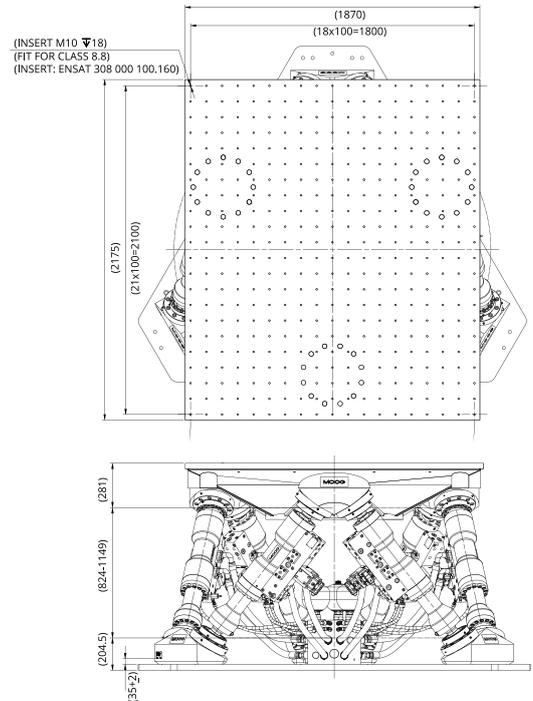
### LIGHT PAYLOAD HYDRAULIC SIMULATION TABLE

A cost-effective, stiff, and versatile test system, engineered for payloads of up to 300 kg and test frequencies of up to 60 Hz.



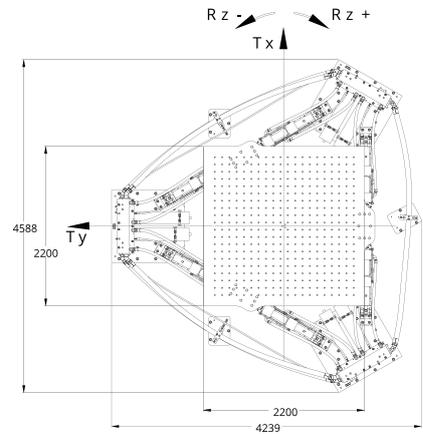
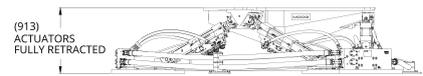
### HYDRAULIC SIMULATION TABLE

A multi-functional test system, designed for a wide range of test applications with payloads of up to 680 kg and test frequencies over 100 Hz.



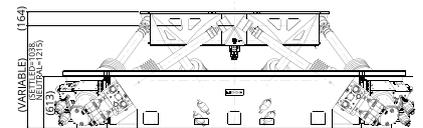
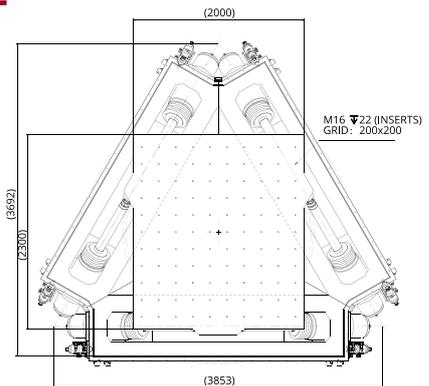
## HIGH PAYLOAD HYDRAULIC SIMULATION TABLE

A durable test system, that can simulate dynamic scenarios, suitable for testing and analyzing large-scale assemblies weighting up to 2,000 kg and test frequencies of up to 100 Hz.



## HIGH FREQUENCY HYDRAULIC SIMULATION TABLE

An extremely low-noise test system reaching frequencies of up to 200 Hz with specimens of up to 600 kg.



## FRAUNHOFER LBF USES MOOG HIGH FREQUENCY HYDRAULIC SIMULATION TABLE FOR VEHICLE COMPONENT AND BATTERY TESTING

Moog supplied to Fraunhofer LBF, German Institute for Structural Durability and System Reliability Research, a complete test system to be integrated with a climatic chamber and battery-testing safety system. The test system consists of a Moog High Frequency Hydraulic Simulation Table and real-time controller, including Moog operator test and application software.

The test system is rated for frequencies up to 200 Hz and will aid Fraunhofer LBF in the evaluation of electric car battery performance in order to assist the automotive industry with research and development for batteries

and electric vehicles. During testing, the batteries will undergo drive simulation and vibration tests to measure the performance and durability aspects under 'real' circumstances. A virtual model will simulate power consumption and measure the charge and discharge of the batteries during a car ride. All power consuming car parts will be included in the test, such as the electric motor, power steering, wipers, windows, lights, audio, heating, etc.



## SPECIFICATIONS

Model	Light Payload HST	Standard HST	High Payload HST	High Frequency HST	
System Rated Payload	300 kg	680kg <sup>1)</sup>	2,000 kg	600 kg	900 kg <sup>1)</sup>
Supply Pressure	210 bar	210 bar	210 bar	210 bar	280 bar
Table Mass	220 kg	758 kg	1,000 kg	750 kg	
Table Size (L × W)	1,000 × 1,000 mm	2,175 × 1,870 mm	2,200 × 2,200 mm	2,300 × 2,000 mm <sup>2)</sup>	
Table Mounting Pattern	50 × 50 mm	150 × 150 mm	100 × 100 mm	200 × 200 mm	
Table Mounting Hole Size	M12	M16	M12	M16	
Actuator Peak Force	25 kN	54 kN	80 kN	53 kN	70 kN
Frequency	60 Hz	> 100 Hz <sup>3)</sup>	100 Hz	200 Hz	
<b>Excursion</b>					
(X) Longitudinal	-61/+57 mm	+216/-177 mm	±135 mm	±118 mm	
(Y) Lateral	±52 mm	±174 mm	±120 mm	±103 mm	
(Z) Heave (Vertical)	-64/+60 mm	±122 mm	±150 mm	-163mm /+140 mm	
Roll	±8°	±9°	±8.3°	±7.6°	
Pitch	±8°	±8.5°	-8° / +9°	-8.4° / +7.2°	
Yaw	±7°	±12°	±6.2°	±5.3°	
<b>Velocity</b>					
(X) Longitudinal	±1.3 m/s	±1.4 m/s	±1.35 m/s	±1.2 m/s	±1.3 m/s
(Y) Lateral	±1.1 m/s	±1.4 m/s	±1.30 m/s	±1.1 m/s	±1.2 m/s
(Z) Heave (Vertical)	±1.3 m/s	±1.2 m/s	±1.70 m/s	±1.5 m/s	±1.6 m/s
Roll	±200°/s	±110°/s	±80°/s	±100°/s	±110°/s
Pitch	±180°/s	±110°/s	±75°/s	±90°/s	±100°/s
Yaw	±160°/s	±120°/s	±60°/s	±58°/s	±65°/s
<b>Acceleration (with bare table/rated payload)</b>					
(X) Longitudinal	±19 g / ±10.0 g	±11 g / ±6.5 g	±11.5 g / ±5.8 g	±10.5 g / ±6.5 g	±12.2 g / ±8.8 g
(Y) Lateral	±15 g / ±9.0 g	±10 g / ±6.0 g	±11.0 g / ±5.5 g	±10 g / ±5.8 g	±12.0 g / ±8.3 g
(Z) Heave (Vertical)	±22 g / ±11 g	±14 g / ±9.0 g	±15.0 g / ±7.0 g	±12.1 g / ±8.2 g	±14.3 g / ±10.2 g

This technical data is based on currently available information and is subject to change at any time by Moog. All numbers in the table are abbreviated to improve readability. Specifications for specific systems or applications may vary.

<sup>1)</sup> A 1,000 kg payload version is also available.

<sup>2)</sup> Also available with a round table.

<sup>3)</sup> The actual frequency depends on the type of test, test amplitude and payload weight.

## 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	High resolution analog inputs providing high precision for control and data acquisition

### THULE GROUP CONTINUES TO EXPAND SAFETY AND PERFORMANCE TESTING

Thule Group invested in a Moog Hydraulic Simulation Table and expanded its testing capacity by ordering a next-generation Moog Hydraulic Simulation Table that can achieve test frequencies up to 100 Hz. Due to Thule Group’s growing product portfolio and the continuous focus on product safety testing needs have increased and so a second system was required.”

Thule Group’s decision to select Moog is based on the reliability and performance of the current hydraulic simulation table, the level of service provided over the years and Moog’s technical expertise.

Eric Gustavsson, VP Product Compliance at Thule, said the test system has proven to be very successful: “We simulate ‘time history files’ to accurately replicate any specific road conditions needed for the tests. The system itself is very compact and because of its lay-out provides excellent accessibility to our lab personnel. Our lab’s productivity is optimized by Moog’s software and the fast and simple iteration process. We use it very intensively, running it constantly, 24 hours per day. As the company’s testing know-how has increased over the years, engineers have been able to take full advantage of the test system’s potential.

Gustavsson explains: “Different customers demand different types of tests and different test profiles.

The Moog system allows us to simulate a wide range of car types and sizes in different road and terrain conditions. It really enables us to simulate the most extreme conditions with high accuracy, within a short test set-up time.

This is of vital importance to our product development and qualification process, for which Thule is so well known.”



## 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 RUNNER

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



### MOOG VIBRATION

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

### MOOG SINESWEEP

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



### MOOG REPLICATION

For a given design profile Replication generates a command signal which when sent to the system, matches the desired profile.

### INTEGRATED TEST SUITE

Configure, calibrate and tune equipment with easy-to-use setup screens and then build and play simple to complex sequences.

Features	Benefits
<b>Supports multiple test systems</b> <ul style="list-style-type: none"> <li>Single and multi-axis hydraulic or electric test systems, Hydraulic Simulation Tables, Electric Simulation Tables, Tire Coupled Simulation Systems</li> </ul>	<b>One controller platform for many uses</b> <ul style="list-style-type: none"> <li>User interface includes configuration, calibration, tuning and test players for strength, fatigue or vibration tests</li> </ul>
<b>Integrated suite</b> <ul style="list-style-type: none"> <li>Easily setup and configure test station</li> <li>Do some simple initial tuning</li> <li>Possibility to communicate with external devices</li> </ul>	<b>User friendly and intuitive</b> <ul style="list-style-type: none"> <li>Straight forward setting up tests and stations</li> <li>Also suitable for less experienced operators</li> <li>Extra functionality available in optional features</li> </ul>
<b>Real time motion control</b> <ul style="list-style-type: none"> <li>Multiple control loops, amplitude and phase matching, data acquisition</li> </ul>	<b>Test accuracy and efficiency</b> <ul style="list-style-type: none"> <li>Optimal control and data recording across all channels minimizes setup and run time</li> </ul>
<b>Data acquisition</b> <ul style="list-style-type: none"> <li>Easily create recording sets</li> <li>Block based recording</li> <li>Configurable recording instructions</li> </ul>	<b>Customize the way you record your test</b> <ul style="list-style-type: none"> <li>Record any signal you want at a desired frequency</li> <li>Prevents recording loss</li> <li>Choose when to record what</li> </ul>
<b>Customizable safeties and event actions</b> <ul style="list-style-type: none"> <li>Configurable safeties</li> <li>Event actions</li> </ul>	<b>Prevent unnecessary damage of test specimen or equipment</b> <ul style="list-style-type: none"> <li>Easily set safety critical measures</li> <li>Configure additional test specific actions</li> </ul>
<b>Maximum access to configurable hardware</b> <ul style="list-style-type: none"> <li>Configure I/O needed to the test station</li> <li>Easily calibrate sensors</li> </ul>	<b>Cost effective hardware and software combination</b> <ul style="list-style-type: none"> <li>High utilization of available I/O</li> <li>Quick setup leads to more testing uptime</li> </ul>
<b>Customize your user interface</b> <ul style="list-style-type: none"> <li>Multi-language support (9 languages including English, German, and Chinese)</li> <li>Save/load user interface layouts (scopes/meters)</li> <li>User authentication (levels of access)</li> <li>Widget bar</li> </ul>	<b>Efficient localization</b> <ul style="list-style-type: none"> <li>Preferred language</li> <li>Time saving monitor sets</li> <li>Control access to key information</li> <li>You choose who accesses what</li> <li>In any view always have frequently used tooling at hand</li> </ul>
<b>Several players built-in to run your test</b> <ul style="list-style-type: none"> <li>Cycle player- multi-axis phased operation with target matching and recording</li> <li>Sequence player- create custom tests with ramp, cycle, drive file instructions, recordings and/or triggered actions</li> </ul>	<b>One software package to run simple or advanced tests</b> <ul style="list-style-type: none"> <li>One user interface to run and monitor simple fatigue tests, or monitor complex tests with nested instructions, data recording, and dozens of triggered actions</li> </ul>

## COMPONENTS TO ENSURE BEST PRECISION

Each Moog Simulation Table incorporates world class performance of Moog components . Every element of the Simulation Table is thoughtfully integrated in the engineering design to offer unsurpassed performance, reliability and longevity.

### SERVO VALVES

Moog Hydraulic Simulation Tables incorporate our well known Servo Valves. Moog Servo Valves are known for their exact tolerances, high performance and durability. They are the preferred choice of leading test engineers and set the world standard for hydraulic Servo Valve performance.



### TEST ACTUATORS

Our Hydraulic Simulation Tables use six hydrostatic or polymer bearing actuators. They are engineered to deliver consistent performance over hundreds of millions of cycles. They provide increased reliability, stiffness and increased side load capabilities. They have a robust design which offers low maintenance due to improved seal life, and improved cushion design (improved energy dissipation).

Moog has vast experience developing actuators for some of the world's most demanding applications and building high performance motion control components is one of our strengths. Actuators are key to high performance test solutions and our customers have expressed a need for more reliable, high performance components than they can find in the marketplace.

### Hydrostatic Bearing Test Actuator

- Used in the Standard Hydraulic Simulation Table
- Innovative 6 pocket hydrostatic bearing increases side load capacity to 40% of stall output and reduces energy requirements
- Higher level of dynamic performance, reliability, and longevity
- Advanced coating used on the rod significantly improves seal wear for long life and less maintenance
- Fully integrated manifold eliminates the need for any external piping



### Test Actuator Polymer Bearing :

- Used in the Light Payload and High Payload Hydraulic Simulation Table
- Oil-cooled polymer bearing improves side load capacity to 15% of stall output, compared to 10% with traditional polymer bearing design
- Advanced cushion design for higher reliability and safety
- Higher level of dynamic performance, reliability, and longevity
- Advanced coating used on the rod significantly improves seal wear for long life and less maintenance
- No external piping



## HYDRAULIC INTERFACES

### TEST DISTRIBUTION MANIFOLD

The Distribution Manifold is fully integrated into the simulation table assembly and creates an optimum configuration for the layout of the hoses to the actuators. Optional items can be connected to this Distribution Manifold for convenience and options are flexibility.



### TEST SERVICE MANIFOLD

The Hydraulic Service Manifold used on the simulation table is capable of a peak of from 400 l/min to 1,000 l/min for the smallest size model to the largest flow demand model. It contains a 3 micron filter in the pilot line, and 20 micron filters for the pressureline. Accumulators installed in the Pilot, Return and, Return and Supply lines serve to dampen unwanted pulsations. Control valves are used to control pressure and flow to ensure the system meets all safety requirements.



Hydraulic Distribution System	
Hydraulic System Fluid	Mobil DTE-24 (-25), Shell Tellus 32 (46), or equivalent
Filtration Requirements	To prolong the operational life of active hydraulic components, the hydraulic fluid should be maintained at a cleanliness level of ISO 4406 (SAE J1165) 16/14/11 (NAS 5) or better.
Operating Pressure	210 bar (3,000 psi) and/or 280 bar (4,000 psi) for the High Frequency Hydraulic Simulation Table
Maximum Return Pressure	14 bar (200 psi)
Maximum Drain Pressure	3.5 bar (50 psi)
Operating Temperature	Hydraulic oil temperature should be maintained between 24 °C (75 °F) and 57 °C (135 °F)

## MOOG HYDRAULIC SIMULATION TABLE ALLOWS EXOVA TO ACHIEVE MORE REALISTIC AUTOMOTIVE TESTING

Steve Panter, operation manager of global automotive testing provider Exova, purchased the standard Moog Hydraulic Simulation Table and states, "A lot of damage occurs within the range from 50 to 80 Hz when a company does testing analysis. With a lower performance simulation table, results are often filtered down to 40 Hz, so any damaging events beyond that point are not captured." Panter adds, "The Moog Hydraulic Simulation Table allows those events to be included in the scope of testing, and broadens the value of the testing process." The Moog Hydraulic Simulation Table gives users a frequency of response up to 100 Hz and can handle payloads up to 680 kg (1,500 lbs).



## SERVICE AND SUPPORT

### Five Point Inspection Process

Our number one goal is to eliminate downtime and make repairs that will deliver reliability and cost savings for years to come. When you send in your repair, it must work like new when you get it back. This is the Moog Global Support® promise.

- Incoming inspection will provide the customer details on the performance of the assembly. For actuators it could be leakage or response. For electronic modules it could be a non-functional connection. The inspection will also provide details to our technicians in regards to critical performance specs that need to be addressed.
- Technicians will then review engineering notes for any design improvements that may have been initiated since inception.
- Servo valves are removed and sent through the same rigorous evaluation, disassembly and test.
- Finally, the individual component or assembly will be tested to original specs to ensure the overhauled unit meets all design and performance criteria as if it were new.

### Moog Engineering On Call For You

In today's competitive manufacturing environment, machine performance plays a significant role in determining your bottom line. Moog Global Support® is key to achieving cost-effective machine operation, day in and day out.

We are committed to providing world-class motion control products and solutions, taking customer support far beyond the initial sale. Our dedicated approach solves your problems, addresses your machine challenges, and allows you to achieve maximum productivity on a daily basis.

### Repair Capabilities

Moog Global Support® is designed to keep your critical machines up and running at peak performance with only 100% genuine Moog replacement parts. Only Moog replacement parts can deliver the reliability, versatility and long life that you would expect from a world leader in motion control solutions. Each Moog part delivers essential components with precise dimensions, close tolerances and specifications. Because we understand the key role our parts play in the overall operation of your machine, we carefully inspect and test each repair to identify only those components that need replacement.

### The Moog Difference

It's time you worked with a partner who can offer both the world-class products you desire and collaborative expertise you need to reach the next level of performance. Contact us today to see the difference Moog can make.



# MORE PRODUCTS. MORE SUPPORT.

Moog designs a range of motion control products to complement those featured in this document. Moog also provides service and support for all of our products. For more information, contact the Moog facility closest to you.

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

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

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

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

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

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

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

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

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

China  
+86 512 5350 3600  
info.china@moog.com

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

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

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

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

United Kingdom  
+44 (0) 1684 858000  
info.uk@moog.com

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

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

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

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

The Netherlands  
+31 252 462 000  
info.thenetherlands@moog.com

**For more information, visit:  
[www.moog.com/industrial](http://www.moog.com/industrial)  
[www.moogtest.com](http://www.moogtest.com)**

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