

RACE WINNING MOTION CONTROL

Motorsport solutions

WHY THE WORLD OF MOTORSPORT TRUSTS MOOG



MEETING YOUR CHALLENGES

Motorsport presents a number of unique challenges to motion control suppliers. Whereas Formula 1 looks for low weight, small size and performance, rallying looks for ruggedness and the ability to perform reliably in fairly brutal conditions such as extreme temperatures, adverse weather and demanding time constraints. Moog has been at the forefront of sub miniature actuation systems in motorsport since 1982, initially supplying active ride height equipment to Team Lotus for use on their Lotus 92 Formula 1 car. Over the intervening years, Moog has continuously developed a range of products and systems for actuation in many types of motorsport including Formula 1, World Rally Championship (WRC), Moto GP, Touring Cars, and Le Mans prototypes.

PRODUCT HOMOLOGATION

All Moog electro-hydraulic products used in Formula 1 are homologated by the FIA, this indicates they are approved for use with the standard Formula 1 Electronic Control Unit (ECU).



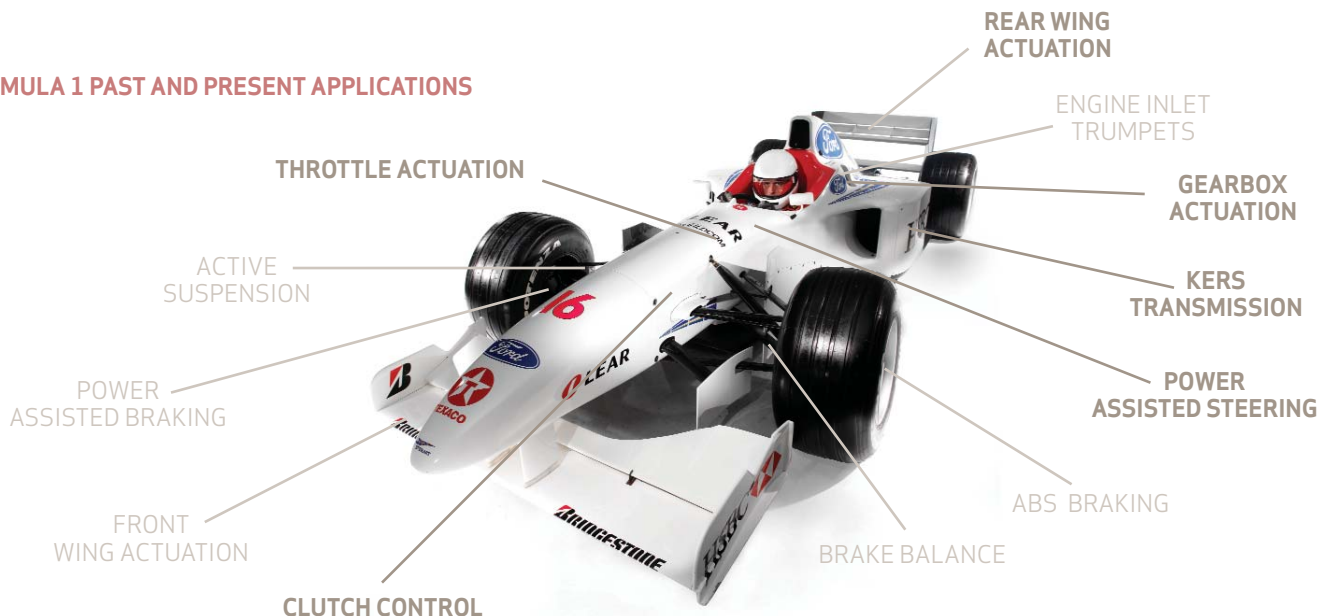
CAPABILITY

Moog has a dedicated global motorsport design, development, manufacture and service center based at its Tewkesbury facility in the UK. This center has a specialist team of engineers, designers and product managers working on motorsport product development and custom systems. Moog's application engineers stay abreast of the latest motorsport regulations, and offer expert advice on the design of systems. Moog also specializes in simulation and modelling consultancy.

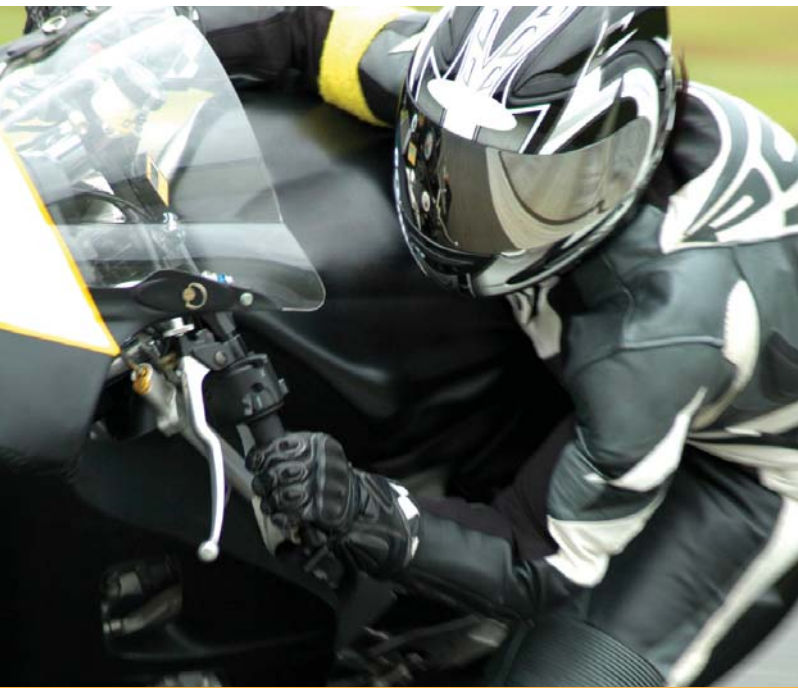
MOOG OVERVIEW

Moog has developed a reputation throughout the world as a company with employees and motion control products that are at the forefront of the aerospace and industrial industries. Moog's high-performance actuation systems and components control human-rated spacecraft, launch vehicles, satellites, missiles and aircraft. We also provide controls on a variety of industrial machines manufactured and installed all over the world – installations where flow, precision, velocity, force and acceleration are critical.

FORMULA 1 PAST AND PRESENT APPLICATIONS



Note: Applications in bold text are current for the 2011 F1 season



TEST AND SIMULATION

Applying state of the art test techniques has become essential in creating successful new high performance automotive products and sub-systems.

Moog's technological expertise and reputation for innovation, along with close customer collaboration, are key reasons we have rapidly become a leader in high performance test and simulation systems.

Creative designs and incorporation of world-class servomotors and actuators ensure that Moog's systems can reach higher levels of fidelity, efficiency and longevity.

Proven experience in flight simulation and an ability to enable human beings to participate in the testing are key advantages we offer to motorsport design and development facilities. This "human-in-the loop" technology sets us apart from other system providers and is crucial in developing tests requiring feelings of comfort and realism.

With more than 1,250 motion bases developed for leading customers around the world, Moog is a global leader in the design, development and manufacture of electric and hydraulic motion platforms that span a variety of key applications with payloads ranging from 1,000 Kg (2,200 lbs) to 14,500 Kg (32,000 lbs).

From ride and comfort testing to driving simulation, our complex test rigs can provide full evaluations for components as well as full vehicle testing to ensure quicker and better product development.

MOOG DRIVING SIMULATOR HEIGHTENS REALITY OF VIRTUAL TEST LAPS FOR FERRARI DRIVERS

Ferrari and Moog teamed up to take charge of a multi-million euro development project, which led to the creation of the Ferrari Driving Simulator. This new collaborated development simulates real race track scenarios and tests different aspects of an F1 racing car. The Driving Simulator has an integrated motion control and testing system, complete software package, cockpit and a dedicated operator workstation.

The Challenge

Ferrari required mechanical frequencies high enough to help drivers get the most accurate feel of the car. Velocity and acceleration levels had to reach a level never met before by any system.

The Solution

Moog's project management and engineering teams worked very closely with Ferrari engineers at Moog's facility during the development of this driving simulator. Moog met Ferrari's every specification and expectation for a system that can test car designs as well as deliver driver training.



This helped Ferrari to realize the maximum benefit from high performance motion control systems and the design of new actuators to deliver the desired strength and stiffness at a lower weight.

The Result

- The new simulator offers test drivers a heightened sense of driving reality as well as a being highly responsive and receiving immediate feedback from their actions.
- High bandwidth and less latency makes braking and steering more responsive creating the high fidelity test drivers need to correctly feel and assess the car's behaviour.
- Test drivers can feel the difference of a modification to a part or component of the car without the risk of a high acceleration rate of real test driving.
- Current and future car designs, the training of new drivers on multiple F1 circuits, cuts track time, enabling better planned training which is not determined by the weather conditions.

HIGH PERFORMANCE MOTION SOLUTIONS

Whilst we are generally known for our servovalves, we also produce a range of other sub miniature proportional valves and actuators for use in motorsport and other applications requiring high performance solutions and minimized size and weight.

E024 MICROVALVES

The E024 Series Miniature Servovalve is available in two basic versions: a standard version with a linear flow gain characteristic and a high resolution dual gain version. The E024 Series was developed from the proven E030 Series aerospace servovalve that is widely used for control surface actuation in civil and military aircraft.

It is ideal for motorsport applications where very high levels of power density are required, that can not be achieved with electrical actuation. These include: selector drum positioning, clutch control, throttle control and torque control in limited slip differentials.



E243 ROTARY POWER ASSISTED STEERING (PAS) VALVES

The E243 Rotary Power Steering Valve was specially developed for Formula 1 steering systems which operate from the "on board" high pressure hydraulic supply. It achieves a highly repeatable and precise steering control with little compliance felt by the driver.

This is a custom product which can be designed to integrate with the customer's steering system.



E243 LINEAR POWER ASSISTED STEERING (PAS) VALVES

An alternative to the Moog Rotary PAS Valve, the linear unit is an easy to use, closed- center Power Steering Valve which can be applied to any vehicle having a high pressure hydraulic supply. The design allows easy tuning both for the level and the linearity of assistance.

These valves have been successfully applied in Formula 1, Rally Cars and Le Mans cars.



E085 MINIATURE ACTUATORS

Moog manufactures a range of miniature actuators with cylinder bores as small as 9 mm (0.35 in) in diameter. Many of the designs incorporate high precision servovalve manufacturing expertise to realize seal-less piston technology.

The seal-less design has extremely low levels of break-out friction and cross piston leakage. Systems using these actuators achieve high levels of repeatability and resolution.

Typical applications include throttle actuation, gear box indexing, clutch control and turbo charger wastegate actuation.



BRUSHED AND BRUSHLESS MOTORS

Moog offer a comprehensive range of high speed, low inertia miniature brushed and brushless motors. These products were originally developed for the space and defense industry, and are particularly suited to the harsh requirements of motorsport applications. Typical applications include front and rear wing actuation and fuel pump drive.



E050 FUEL REGULATING VALVES

The E050 Fuel Regulating Valve is a precision two-stage pressure regulator designed to be used in conjunction with a fixed displacement fuel pump. The two stage design yields a constant fuel pressure independent of pump delivery. Weighing in at just 28 gm (1 oz), it is much smaller and more accurate than a conventional diaphragm valve.



E050 OIL PRESSURE REGULATING VALVE

The E050 Oil Pressure Regulating Valve uses the established technology of the miniature fuel regulating valve. It is optimized to regulate lubricating oil at pressures of between 3 (43 psi) and 20 bar (290 psi).

Similar to the fuel regulating valve, it has very precise pressure control independent of oil pump flow, which is ideal for use in both engine and gear box lubrication systems. It can also be applied to fuel regulation systems operating at lower pressures.



E242 CARTRIDGE DIRECT DRIVE VALVE (DDV) PROPORTIONAL VALVE

The E242 Cartridge DDV Proportional Valve was developed especially to meet the demands of the rally car industry. Of cartridge construction, it uses a robust linear electric motor to actuate the flow control spool. The maximum flow capability of 18 L/min (4.8 USg/min) is able to meet the requirements of the majority of motorsport applications.

The cartridge design permits compact packaging on applications where multiple valves are required to be mounted in a single manifold.

The Direct Drive design is extremely resistant to hydraulic contamination allowing the valve to be used in challenging environments.



E085 GEARSHIFT & THROTTLE ACTUATOR

The E085 product range was originally designed for Formula 1 throttle control. Variations on this design have been successfully applied in other Formulae for on vehicle and test lab applications. Moog miniature actuator designs are available with seal-less construction giving precise control in high temperature and high vibration installations.



E050 SERIES SERVOVALVES

This range of valves is a development of the well established 30 Series Aerospace servovalve. The motorsport version has a higher temperature capability, performing to specification at temperatures at 165 °C (329 °F). It also has improved environmental sealing using precision o-ring seals to protect the pilot stage.

These valves have been widely adopted by the rally car industry, which requires long service life in difficult environments



E081 INTEGRATED MOTORSPORT SYSTEMS

If required, we have the capability to design, manufacture and deliver complete motorsport motion control systems, utilizing either hydraulic or electrical actuation technology.

Working together with the customer, to evolve a detailed specification we can assist with the detailed design and supply a complete package. Typically, these systems are fully tested at Moog in conjunction with the customer's ancillary hardware, before delivery, enabling fast development times.



TOTAL SUPPORT

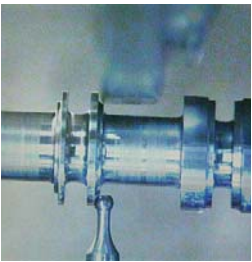


Delivering world-class motion control products and solutions means taking customer support far beyond the initial sale. It requires a dedicated approach to addressing your challenges and helping you achieve maximum productivity on a daily basis.

The Motorsport Center incorporates its own production and service facility, complying to Class 100,000 aerospace clean room standards. In addition to the UK facility, there is a dedicated team of motorsport specialists strategically placed at worldwide locations.

With rapid turn-round often required, motorsport customers benefit from a dedicated repair service, where a team of specialists provide anything from a functional test, to a complete strip down, repair and assembly, with specialist diagnostic reporting.

SPECIALIST PRODUCTION TECHNIQUES FOR MOTORSPORT APPLICATIONS



Our capability includes the ability to produce extremely precise close-fitting cylindrical components using technology developed from Moog Servovalve manufacture. Typically we can achieve diametric fit tolerances of 1.25 micron and axial tolerances of 2.00 micron using our temperature control machining and measurement facilities.

Furthermore, we have extensive expertise in the precision spark erosion of a wide range of features in a variety of materials and the manufacture of complex hydraulic manifolds.

Typical Applications include miniature manifolds, state of the art brake components, steering systems, fluid control and hydraulic and electric actuation.

MOTORSPORT TECHNOLOGY IN OTHER HIGH PERFORMANCE APPLICATIONS

A by-product of competitive international motorsport is the active fostering of engineering innovation. Many technologies first seen in Formula 1 or rallying have transferred from the race track to result in performance benefits across our industrial and aerospace product ranges. Engineering teams work across both disciplines and a cross-pollination of ideas is something Moog encourages.

SPECIAL EFFECTS



Our motion control systems are used in the film and theater industries.

The most common applications are robotics, electric/hydraulic actuation, and motion bases used for special effects, often in conjunction with Computer-Generated Imagery [CGI].

Some examples of films which have utilized Moog systems are:

Harry Potter, Sweeney Todd, Blackhawk Down, Saving Private Ryan, Judge Dredd, Casino Royale.

MEDICAL



Medical engineering often uses precise motion control systems with some similar miniaturization to those of motorsport. Moog has provided both components and systems for a diverse range of medical applications:

- Fatigue testing of artificial joints
- Sophisticated athletic training and rehabilitation machines
- Ventilation systems for sleep apnoea sufferers
- Electronic ambulatory pumps for pain management

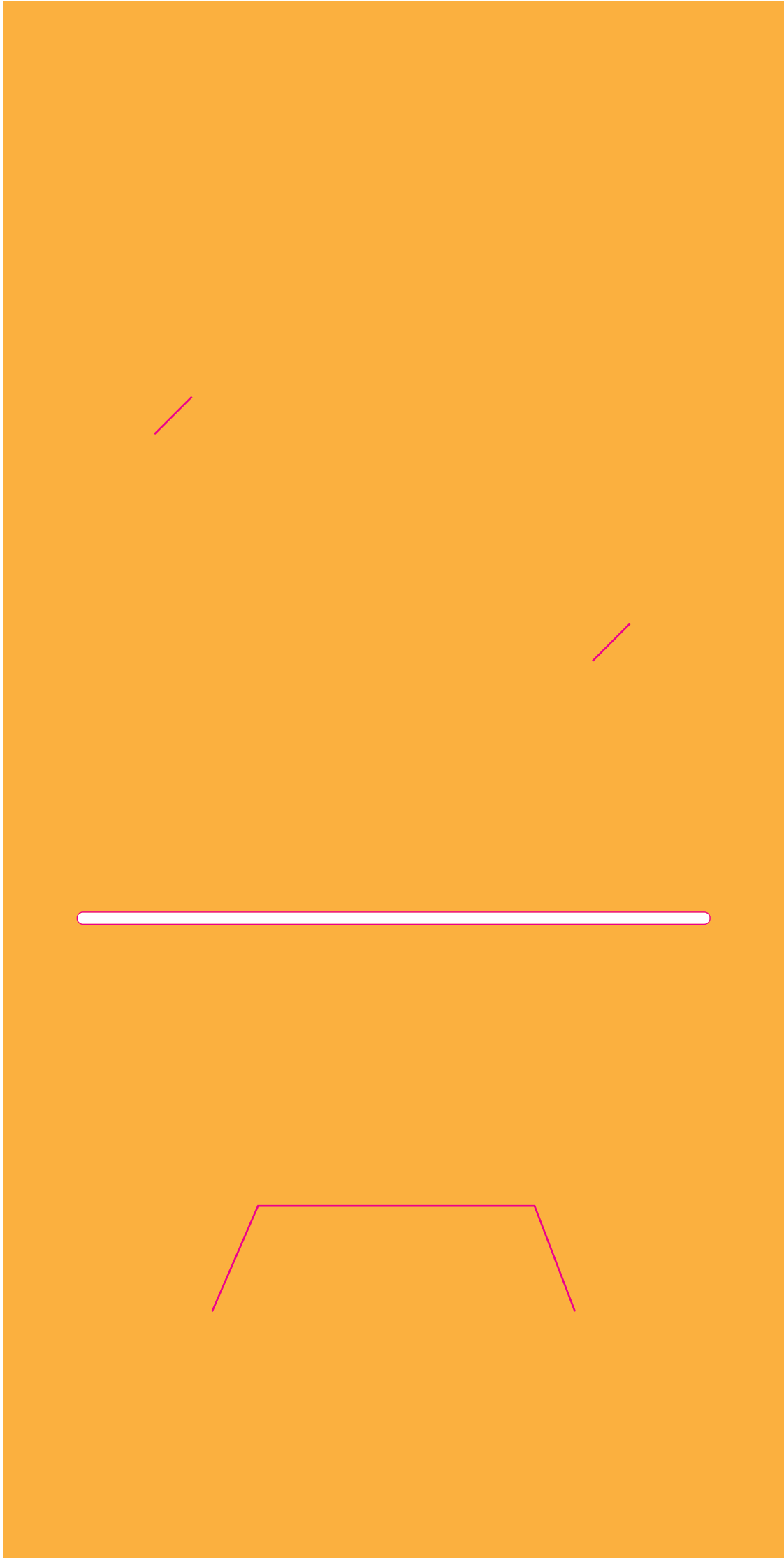
OIL AND GAS



The demanding environment of sub-sea engineering is a significant market for Moog. Our products and systems are used on Remotely Operated Vehicles (ROV), used for subsea, construction, maintenance and cable laying, where space is at a premium.

Typical applications are:

- Propulsion thruster speed control on autonomous vehicles
- The remote operation of robotic manipulator arms
- Transmission control for tracked vehicles on the seabed
- Steering controls and power generation for Measurement While Drilling (MWD), Logging While Drilling (LWD), and Tractor downhole tools



TAKE A CLOSER LOOK.

International motorsport solutions are available around the world.
For more information visit our web site or contact one of the locations below.

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