

A large offshore oil rig is shown at sea, with a crane and various structures. The image is overlaid with a blue tint. The text is white and positioned on the left side of the rig.

A DEEPER LEVEL OF PERFORMANCE

Motion control solutions
for oil and gas exploration and production

SOLUTIONS FOR THE WORLD'S TOUGHEST ENVIRONMENTS

To help meet the world's increasing demand for energy, Moog offers innovative high-performance motion control solutions designed for today's critical applications.

Our motion control solutions improve the performance of downhole tools, rig and subsea equipment in a range of applications in the oil and gas exploration and production industry. We help professionals meet key challenges including:

- Oil exploration in off-shore and other hostile environments with increased drilling depths
- Enhanced recovery from mature fields
- Improving the return on investment for exploration and production
- Extended drilling times between trips

As the industry responds to such challenges with solutions that emphasize faster drilling, improved accuracy and quicker completion rates, Moog is there. We improve the reliability and performance of downhole tools such as Rotary Steering Systems (RSS), Measurement While Drilling (MWD), Logging While Drilling (LWD), completion tools, production testing and more. We also provide precision automation for rig equipment and add productivity in subsea applications. Whatever your application, our array of high-performance products and industry expertise gives you the edge.

Today, the global resources of a two billion-dollar corporation help our team deliver solutions to customers in more than 26 countries worldwide. With expertise in areas ranging from heavy industry to space and defense, we also have a long history in severe duty applications.

Simply put, our mission is to deliver the flexibility, innovation and collaborative expertise you need for a smart approach to your most difficult engineering challenges.

MEETING TODAY'S INDUSTRY CHALLENGES

In some of the harshest environments on earth, you'll find Moog motion control solutions that increase productivity, minimize downtime and provide better ways of getting the job done.

Rather than relying on off-the-shelf systems, we collaborate with you to create the best solution for your unique application—and then deliver a turnkey solution that incorporates high-performance components—like brushless servo motors, alternators electro-mechanical actuators and motion controllers—that are tailored to meet your needs. It's a flexible approach that puts your ideas, input and requirements up front.

Here are a few of the key industry challenges that our global teams are working to meet:

Maximizing tool time on bottom

Our expertise in the design and manufacture of premium quality brushless servo motors, alternators, motor control electronics and electro-mechanical actuators are combined to create motion control solutions that are ideal for severe duty applications. These Moog 'building blocks' provide high reliability at the high temperatures of downhole applications.

Positive impact on Rate of Penetration (ROP)

Moog solutions enable improved performance of directional drilling tools for higher efficiency in reaching pay zones. We provide application-specific solutions for RSS, tractors, and wireline as well as MWD, LWD and telemetry tools that enhance data transmission speed and reliability.

Delivering higher precision for rig equipment

Our automation solutions cover pipe handling equipment, power tongs, rotary tables and brake control systems. In addition, Moog Servo Valves provide safe, reliable performance in exploration applications as well as on Vibroseis vehicles and subsea equipment like Remotely Operated Vehicles (ROVs).

Attaining a higher level of engineering and design

Moog's specialized design, project management and production support result in better solutions for customers—and better performing tools as well. Our flexible technology services are well-suited for severe duty applications in the oil and gas industry. We approach every application:

- Using proven design techniques
- Employing pre-engineered or custom solutions
- Providing high-grade magnetic designs using advanced software tools
- Delivering robust mechanical designs using FEA/FEM analysis
- Offering full service turnkey engineering from prototypes to aftermarket requirements

SUCCESS THROUGH COLLABORATION



A leading energy company sought to maximize productivity, increase operational hours and significantly reduce downtime related to equipment maintenance in an extremely harsh operating environment. Through close collaboration with the company's engineers, Moog tailored a solution that provides optimal performance in some of the world's most severe ambient conditions.

The request

Provide fully assembled and tested servo motors and alternators that meet strict performance specifications, deliver continuous power for higher output and work flawlessly despite tight space constraints.

The solution

Using a variety of Moog building block components, we designed a rugged servo motor within a unique package constraint that achieved the desired application's speed and torque requirements. We also delivered a robust alternator for a given voltage per RPM range and load.

The result

A solution that exceeds the customer's expectations for productivity and performance in some of the world's most unforgiving environments.

TOTAL PERFORMANCE IN YOUR CRITICAL APPLICATIONS

Around the globe, Moog solutions can be found in downhole, surface and subsea applications. We provide solutions for rotary steerable tools, MWD and LWD applications, tractor tools and completion services.

Our solutions improve the performance of the tools that increase ROP and drive the reliability, accuracy and efficiency of downhole tools. Moog servo technology enhances signal strength for reliable data transmission in difficult drilling

DOWNHOLE SOLUTIONS AND PRODUCTS

ELECTRO-MECHANICAL ACTUATORS



Moog Electro-mechanical Actuators (EMAs) provide precision actuation with compact packaging. They're ideal for applications such as completion, formation testing and inspection tools.

In addition, the use of EMAs reduces the hazards and inaccuracies from other technologies, including explosives and other hydraulics.

Moog EMAs offer superior dependability and performance. Each model is designed to meet customer-specific speed and force requirements.

Specifications and design

- **Integrated motor, gearing and ball screw** for compact design
- **Brushless servo motor** designed to meet proper speed/force performance
- **Screw technology:** choose ballscrews or rollerscrews based on application requirements
- **Gearing** as application requires (compound planetary, planetary gear set)
- **Resolver feedback**

Characteristics

- Force range: capabilities over 45,000 kg (100,000 lb) peak
- Speed range: Up to 30 IPS
- Stroke: Up to 1.5m (60 in)
- Motor voltage range from 24 to 1,000 V_{DC}
- Optimum design for available physical limits
- Packaging and system components designed for application
- Customized for application and specific envelope

conditions. In addition, it dramatically improves reliability for directional drilling and completion tools. Our alternators provide a much needed reliable, continuous power supply in critical downhole tools.

Here are just a few of the building blocks from our range of turnkey solutions—providing world-class performance in today's oil and gas exploration applications.

DOWNHOLE MOTOR CONTROLLER

The Moog Downhole Motor Controller is the industry's only true closed loop control solution. Designed to complement our brushless motors and actuators, and expedite the design and test cycle for the entire system, the single-axis digital motion controller provides superior position control and a range of efficiency improvements.

Specifications and design

- **Rugged construction** for increased reliability and uptime in hostile downhole environments
- **Reduced liability**
- **Flexible hardware/software** for application customization
- Intuitive GUI for faster assembly/configuration
- **PC commissioning tool** for function generation, position and velocity control
- **Thermal management** provides ability to run to end of life and deliver fault codes for maximum longevity
- **N-stop protection**
- **Velocity limits**

Characteristics

- Ambient operating temperature: -25 to 175 °C (-13 to +347 °F)
- Maximum survival temperature: +200 °C (+392 °F)
- MTBF: 3,000 hours
- Vibration: 20G rms Random, 50 to 500Hz
- Interchangeable software modules per application requirements
- Field upgradable software
- Parameter database
- EIA-232 development/commissioning interface
- Customer interface options: I2C, SPI, CanOpen
- Power range: 20 to 250 V; up to 5 Amps nominal to 10 Amps peak
- Position control feedback



BRUSHLESS SERVO MOTORS



Moog Brushless Servo Motors are custom designed for demanding downhole drilling applications. They offer high performance, reliability and a long service life. In addition, our manufacturing group

uses proprietary processes and rigorous quality controls to ensure compliance and product integrity. Special assembly tools and testing equipment have been developed strictly for use in this market.

Specifications and design

- Designed to meet speed/torque requirements for specific application
- Designed for optimal efficiency—greater battery life, less power usage
- Custom designs available
- Framed or frameless versions
- Hollow or solid rotor shafts (gear, spline, keyed)
- Based on standard laminations or custom-designed lams

Characteristics

- Optimum design for available physical limits
- Voltages from 24 to 1,000 V_{DC}
- Existing sizes: <25 to 250 mm (<1 to 10 in) outside diameter
- Torque: Up to 170 Nm (1,500 lbf in)
- Speed range: Up to 10,000 r/min
- Power range: 7.5 kW
- Resolver or HED feedback available

Environment-HTHP

- Over 220 °C (430 °F)
- Over 30K psi, high shock and vibration
- Oil-filled environment

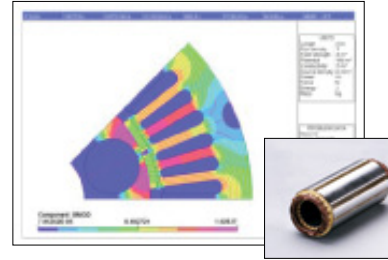
RIG EQUIPMENT



Moog provides high-performance, intrinsically safe explosion-proof servo valves for handling of drill pipe, power tongs and controlling torque.

Moog Servo Valves with analog and digital interfaces afford the automation of manual operations resulting in higher speed, greater precision and better repeatability. This results in reduced drilling time by automating and improving drilling efficiency.

ALTERNATORS



A reliable power supply to the electronics of downhole tools is necessary to minimize time-consuming trips. The hostile environmental conditions encountered in

deep drilling applications greatly limit the capabilities of traditional power sources like batteries.

Moog application-specific alternators provide reliable power to critical downhole tools. They're designed to customer specifications for speed range, voltage and load, and based on standard laminations or custom configurations. The units can be used as a constant source of power or to replace batteries.

Specifications and design

- Optimum design for available physical limits
- Designed to meet voltage/RPM requirements within specific envelope
- Flexible designs to meet your voltage and load requirements
- Proven construction techniques for severe environments
- Custom designs based on application requirements
- Framed or frameless versions

Characteristics

- Voltage range: 24 to 600 V_{DC}
- Speed range: Up to 8,000 r/min
- Power: 50 to 50K watts
- Size: 25 to 250 mm (1 to 10 in) outside diameter

SUBSEA EQUIPMENT

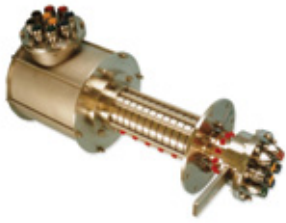


Moog motion control solutions play a key role in electrical or hydraulic control of ROV thrusters and manipulators as well as on ancillary equipment such as cameras and sonar.

Moog Servo Valves—including the Ultra Series 4693 and 4657, and Moog Atchley Valves 211 and 218—are widely used in ROV thruster valve packs for accurate directional and lift control of the ROV during

underwater maneuvering. The miniature size of other servo valves—including the 30 Series and Ultra 4633 Series—make them the preferred choice for the valve pack of the manipulator, performing robotic tasks with precision while keeping weight to a minimum.

THE RIGHT COMPONENTS. THE RIGHT SUPPORT.



Working with Moog means access to experts with a long and rich heritage in the oil and gas industry. Experts who understand the critical difference the right components can make and who are committed to the highest level of customer support.

Moog Focal: Components that give you the edge

Specialized applications require specialized solutions. Moog Focal (a Moog company) is a well-known brand in the industry that provides an array of key components for our solutions including:

- Slip rings and telemetry systems for ROVs
- Geophysical or seismic streamer slip rings
- Floating Production Storage and Off-Loading Swivels (FPSO) including power and signal swivels
- Fiber Optic Rotary Joints (FORJ) and optical converters
- Hydraulic utility swivels
- Cables
- Junction boxes
- Fiber optic modems for subsea controls

All components have EEX d Certification.
For more information on Moog Focal, visit www.moogpowerdata.com/marine_energy.html.

A long-term partner in your success

In addition to specialized components, Moog experts deliver a unique level of hands-on customer service. Our engineers are on call across the globe, ready to respond quickly and professionally to help you get the most from your investment. From helping you minimize downtime to keeping your systems working at peak effectiveness, Moog specialists understand the special demands of oil and gas exploration and production. We're there when you need us.

In addition, we provide full mechanical and electrical inspection/evaluation services including access to a full metallurgy laboratory.

Take the next step

Isn't it time you worked with a partner who understands what makes your oil and gas exploration applications more productive? Who offers world-class products, a solutions-centered approach and the collaborative expertise you need to reach the next level of performance? And who is committed to this industry for the long run?

Contact us today. And see for yourself the difference the right partner can make.

UNIQUE SOLUTIONS FOR UNIQUE CHALLENGES



A leading energy company wanted to incorporate a customized motion control solution that could provide a high force limit, yet withstand the rigors of a hostile operating environment.

The request

Provide a fully integrated electro-mechanical actuator incorporating a motor, resolver, custom gearing and ball screw all contained in a unique housing that fits the customer's requirements.

The solution

A unique solution designed to ensure high productivity in this unforgiving environment by employing specialized high-strength alloys for durability, custom construction techniques for protection against high heat and vibration, a unique ball screw to meet the application's unique force characteristics, and a custom compound planetary gearbox for long-lasting operation.

The result

A reliable, high-performance solution capable of unsurpassed productivity in a range of demanding oil exploration applications.

TAKE A CLOSER LOOK.

Moog solutions for oil and gas exploration and production are only a click away. Visit our Web site for more information and the Moog facility nearest you.

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