

DOWNHOLE SOLUTIONS



Rev. A, October 2013

MOTION CONTROL SOLUTIONS TAILORED TO
YOUR CRITICAL DOWNHOLE APPLICATIONS

WHAT MOVES YOUR WORLD

MOOG

IMPROVE PERFORMANCE FOR YOUR DOWNHOLE TOOLS

To succeed today, oil and gas services companies must explore in some of the earth's most hostile environments with unprecedented drilling depths and an array of other critical challenges.

Downhole challenges include high temperature, high pressure environments, tight space constraints and the need for ever-increasing efficiency. This leads engineers to look for trusted products capable of seamless integration into their tools.

Moog designs and manufactures customized oil and gas motion control solutions to meet today's most rigorous application requirements.

Drawing from the technical resources of a \$2.4+ billion corporation operating in over 25 countries worldwide with over

11,000 employees, Moog engineers leverage our deep portfolio of proven motion control building blocks including electro-mechanical linear servo actuators, brushless servo motors, downhole motor controllers, alternators and servo valves. In addition, our world-class aftermarket support network ensures productivity over the lifecycle of your equipment.

Our mission is to collaborate with customers to customize and integrate high performance motion systems that meet your unique performance and packaging requirements. Simply put, we're there for you with the right technologies and the right answers.

SUPPORTING YOUR APPLICATIONS, MEETING YOUR CHALLENGES

When it comes to downhole applications, Moog engineers leverage extensive experience in other severe duty applications ranging from heavy industry to space to defense. This proven know-how means you'll always work with professionals who understand the hostile environments in which you operate.

Well Drilling

Moog motion control solutions help facilitate MWD, LWD and Directional Drilling/Rotary Steerable Systems.

Formation Evaluation

Moog offers linear and rotary motion capabilities, enabling customers to build reservoir sampling and coring tools that minimize power consumption while increasing sample rates.

Well Completion

Moog delivers technologies that help maximize functionality within envelope restrictions. In wellbore isolation, our electric linear and rotary systems deliver extremely high force density with position and force feedback.

Well Intervention

To increase the rate of deployment, Moog solutions improve functionality despite constricted envelope space to increase usable time in well.

Oil and Gas Production

Moog motion control technologies play a key role in downhole production systems. For example, our low-powered electric actuators are suitable for long-term deployment.



Our specialized design, project management and production support ensure we meet your toughest challenges including:

SURVIVING IN HTHP ENVIRONMENTS

For over 25 years, Moog has strived to define downhole materials and processes that will endure the industry's HTHP needs, including survival at over 240 °C and 30,000 psi.

DECREASING NPT & INCREASING RELIABILITY

According to one estimate, nonproductive time (NPT) accounts for approximately 20% of all rig time and can be even higher in difficult fields. By increasing your reliability and optimizing operations, it's possible to realize major cost savings even in demanding conditions.

MAINTAINING OPTIMUM CONTROL

Moog solutions seamlessly integrate into your specialized downhole tools, for a higher level of motion control despite space constraints and package interface requirements.

COLLABORATIVE ENGINEERING, INDUSTRY EXPERTISE AND WORLD-CLASS TECHNOLOGIES TAILORED TO YOUR UNIQUE APPLICATIONS

A flexible and collaborative approach brings expertise and accountability to the delivery of motion control solutions. Your ideas, input and requirements come first, while Moog delivers a higher level of motion control design and support through five key project steps:

1 REQUIREMENTS DEVELOPMENT

Project scope and technical requirements are established between you and a dedicated Moog team.

1

A dedicated Moog project team works closely with you to define the application requirements and project scope. Moog believes joint requirements definition increases the accuracy and speed of solution development.

2 SYSTEM DESIGN

Moog brings extensive engineering capabilities to address your application requirements.

2

A structured development process ensures the technical solution meets your design, quality and reliability requirements. Moog engineers utilize a comprehensive analysis tool kit, including 2D and 3D FEA for magnetic, mechanical, thermal and CFD. Transmission elements are optimized using gearing and ball screw analysis tools. Product reliability is ensured using modeling and prediction methods.

3 SYSTEM QUALIFICATION

Design verification and system qualification testing using mutually agreed requirements enable you to have confidence in the solution.

3

Moog performs all necessary design verification and qualification testing in a representative environment. All qualification data is shared with you to ensure confidence in the solution. Internal test capabilities include shock vibration, thermal and load/life/endurance.

4 PRODUCTION

Robust supply chains and qualified manufacturing processes ensure you can trust Moog to deliver. The partnership extends beyond the development phase to help you bring your tool to the commercialization phase faster.

4

In an uncertain world, supply chain flexibility is a must. Moog understands that you need a product delivered on time. We have established robust supply chains and constantly monitor them for risk and quality.

5 SUPPORT

Total support is provided through the product's life cycle, including repair services or detailed failure analysis if necessary.

5

We stand behind our solutions for the life of your tool, addressing technical, supply chain or business needs. Moog engineers, operations specialists and business partners will continue to support every need to maintain a strong relationship you can trust.

EXPERTISE AND WORLD-CLASS APPLICATIONS

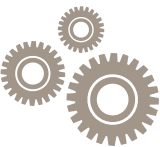
A MOOG SOLUTION UP-CLOSE

In the harshest conditions on earth, off-the-shelf systems often come up short. That's why Moog engineers work closely with you to design reliable motion control solutions.

These solutions are tailored to meet your specific requirements and maximize your productivity in a range of critical downhole applications - from well drilling to production.

M BRUSHLESS SERVO MOTOR

Customized to meet rigorous requirements (e.g. speeds up to 10,000 rpm) and torque up to 170 Nm) and deliver the long service life that meets the challenges of downhole HTHP drilling.



GEAR BOX

Moog will choose the correct integrated solution that meets the

application needs, from available designs to an array of custom-designed multistage compound and conventional planetary gearboxes.



BALL SCREW

Moog screw technologies provide high efficiency and maximum load capacity, providing the highest power density in demanding applications.

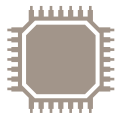
ALTERNATOR

Moog application-specific alternators deliver reliable power and are designed to customer specifications for speed, voltage and load.



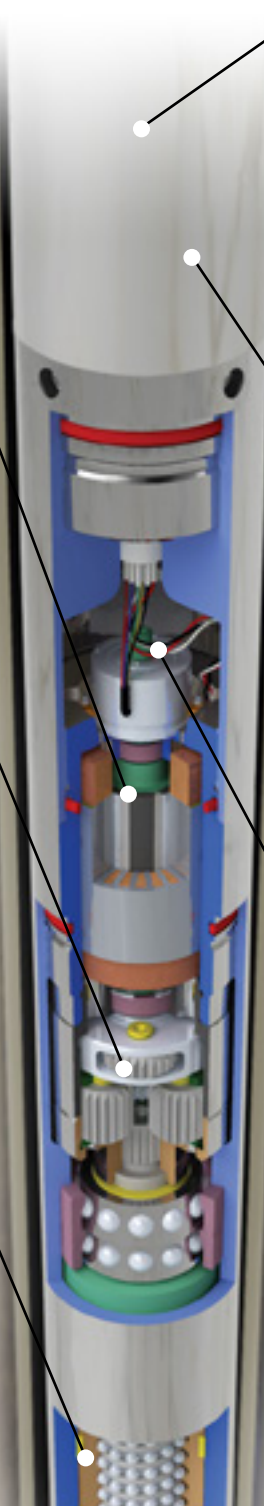
DOWNHOLE MOTOR CONTROLLER

Moog provides ruggedly designed motor controllers to operate in hostile downhole environments, capable of reliable torque, velocity or position control.



RESOLVER


Providing reliable position and velocity feedback signals critical for controlling servo motors and actuators. They contain no internal electronics or optics, and are qualified for your HTHP environments.



WORLD-CLASS PRODUCTS MAKE THE DIFFERENCE

No matter where in the world you are operating, you'll find that all Moog solutions have one thing in common. They all rely on the leading-edge performance of our building block products. Whether we design the full system for you, or you require

specific components, these products are engineered to improve the reliability, accuracy and efficiency of downhole tools while giving you the confidence to overcome any environmental challenge.

BRUSHLESS SERVO MOTOR		<ul style="list-style-type: none"> • Diameters: 12 to 250 mm (<1 to 10 in) outside diameter • Output torque: Up to 170 Nm (1,500 lbf in) • Voltages from 24 to 1,000 VDC • Speed: Up to 10,000 rpm • Power Range: Up to 7.5 kW
GEARING		<ul style="list-style-type: none"> • Diameters: <25 to 250 mm (<1 to 10 in) outside diameter • Output torque: Up to 800 Nm (7,080 lbf in) • Ratios up to 1400:1 for power transmission • Simple and compound planetary gearing
BALL SCREW AND ROLLER SCREW		<ul style="list-style-type: none"> • Output force: Up to 450 kN (100,000 lbf) • Screw sizes from 11 to 80 mm (0.47 to 3.15 in) • Leads ranging from 5 to 40 mm (0.197 to 1.575 in)
FEEDBACK DEVICE		<ul style="list-style-type: none"> • Resolver frame sizes from size 8 to 64 • Outside diameter: 20 to 163 mm (0.8 to 6.4 in) • Hall effect feedback • Qualified for HTHP environments
MOTOR CONTROLLER		<ul style="list-style-type: none"> • Power range: 20 to 250 V; up to 5 Amps nominal to 10 Amps peak • Ambient operating temperature: -25 to 175 °C (-13 to +347 °F) • Maximum survival temperature: +200 °C (+392 °F) • Width starting at 19 mm (0.75 in)
ALTERNATOR		<ul style="list-style-type: none"> • Diameters: 25 to 250 mm (1 to 10 in) outside diameter • Power: 50 to 50,000 W • Speed range: Up to 8,000 rpm • Voltage range: 24 to 600 VDC

MOTION CONTROL FOR THE UPSTREAM OIL AND GAS MARKET

SEGMENTS

DOWNHOLE

Offering high torque/force density HTHP solutions for downhole tools

TOPSIDE

Meeting your demanding application needs, even in explosion-proof environments

SUBSEA

Designed and qualified to specifically meet your long-life requirements

MARINE

Supporting marine and ROV applications with precision solutions

TECHNOLOGIES

ELECTROMECHANICAL

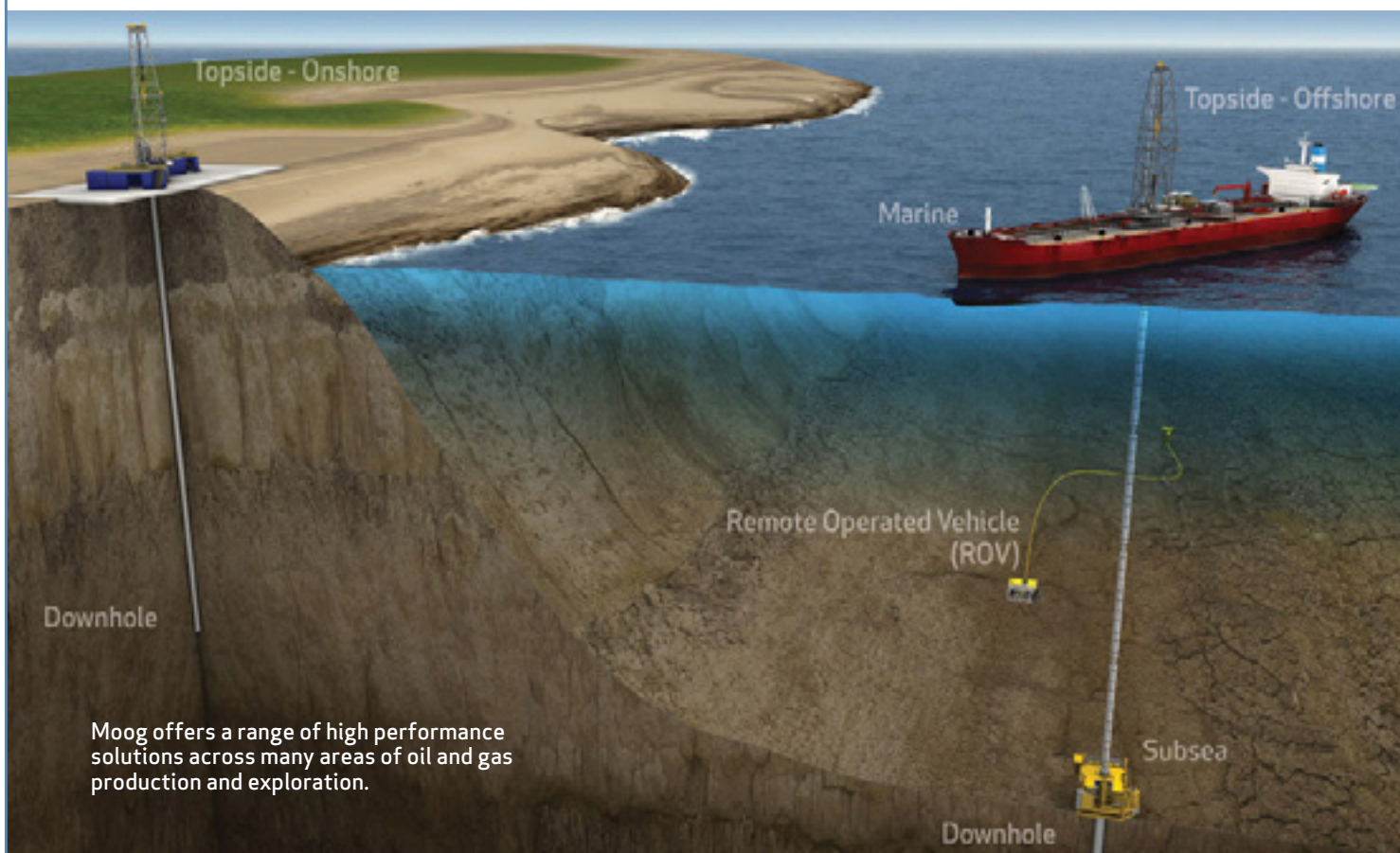
Extensive portfolio of electric motors, linear actuators and alternators

HYDRAULIC

Leader in industrial hydraulic servo controls, including servo valves, pumps, actuators and complex manifolds

ELECTRICAL CONTROL SYSTEMS

Field-proven motion controllers and drives that support an array of industry-standard fieldbus technologies



TAKE A CLOSER LOOK.

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

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Moog Oil and Gas Downhole Solutions
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