

# Oilfield and Downhole

*Market Guide*



A complete product line of rotary and electro-optic solutions for the oil and gas downhole market:

- Electrical Slip Rings
- Fiber Optic Rotary Joints
- Fluid Rotary Unions
- Complete Rotary Interface
- Multiplexers, Media Converters and Switches

# MOOG

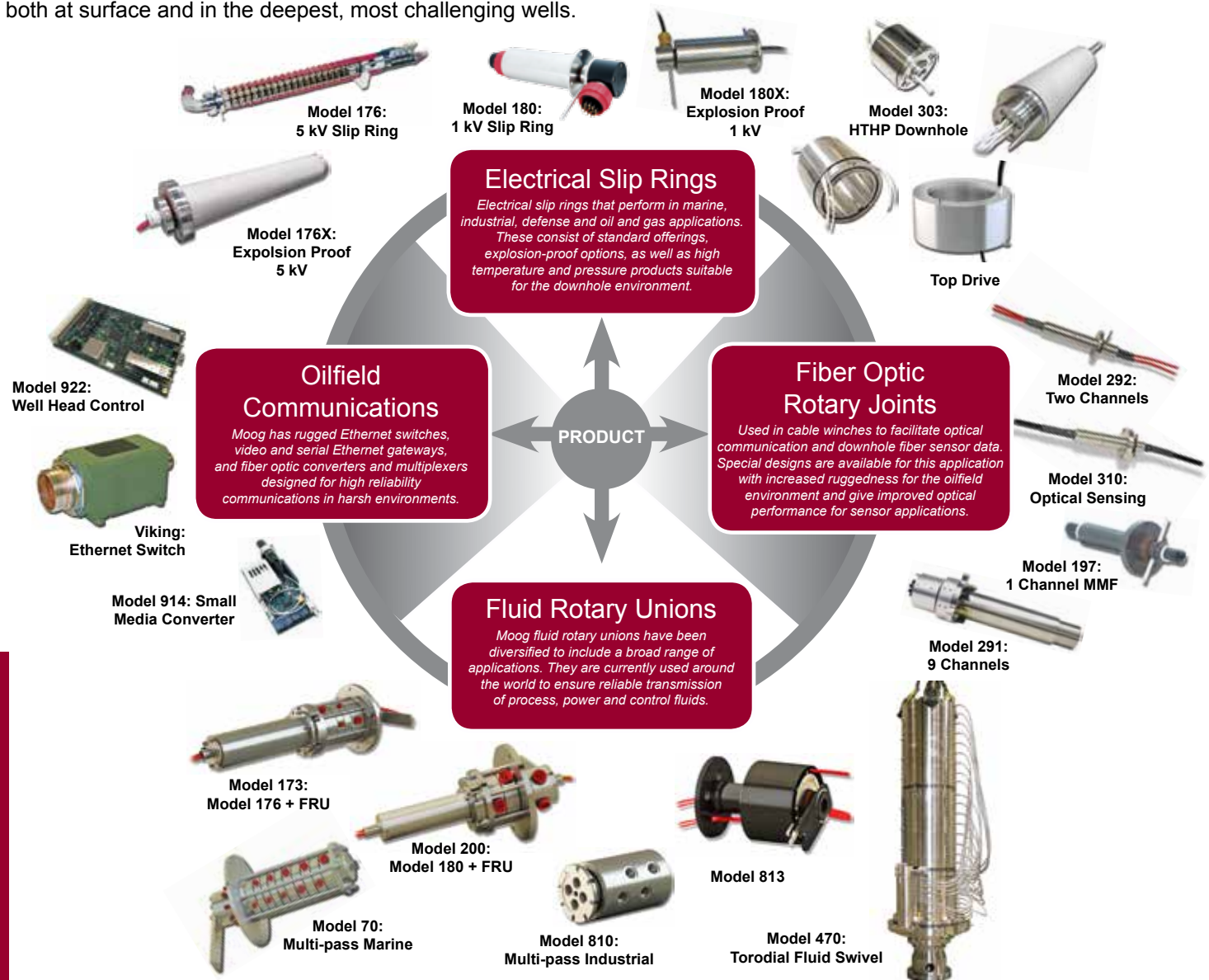
# Oilfield and Downhole

Exploration and production of oil and gas is becoming more difficult. The easy reserves have already been found and new ones are deeper or in more difficult formations. Drilling can now extend to depths of 10 km and can be multi-directional or horizontal. Temperatures and pressures can be up to 260°C and 2000 bar (29,000 psi). As a result, the cost to recover these reserves is very high – making efficiency even more important.

Since 1998, Moog has worked with the major oilfield service companies and equipment manufacturers to solve demanding and unique problems for the difficult downhole environment.

The need to maximize output from new reserves (as well as existing reserves) requires the need for higher performance equipment and better information from the well. To answer the demand, Moog has developed a line of oilfield and downhole equipment and technology that meets the challenge.

We didn't stop at design – Moog has also developed processes and test equipment to ensure that our products will perform both at surface and in the deepest, most challenging wells.





## ADVANCING TECHNOLOGY

From design to deployment, our experienced team of professionals specializes in providing custom electrical slip rings, fiber optic rotary joints, fluid rotary unions, motors, fiber optic multiplexers and other electronic solutions for the worldwide oil and gas industry. Product features include hybrid packages that combine fiber, electrical and fluid rotary joints, packaging for harsh environments, explosion-proof / flame-proof for hazardous locations and adaptation to customer's size and mounting constraints. From our ability and willingness to customize products, to our ISO 9001:2008 Certification, to our unmatched global capacity, we are defining and delivering custom integrated and proven products.

Our high temperature and pressure simulator allows Moog to test electrical and optical equipment in a full depth environment. The simulator also contains a downhole motor to turn rotating products during test. Products are also subjected to shock and vibration simulation as part of our testing.

Moog continues to advance its fluid rotary union technology with continued research and development. The main objective is to create a product with improved efficiency, long life, and meet the demanding requirements of the oil and gas environment. Using a state of the art test facility, various seal recipes are continuously being evaluated. The tests are closely monitored to record even the most miniscule leakage, change in pressure, temperature or torque. This information is helping Moog become an industry leader in fluid rotary union technology. As the first and only stop for the design, manufacturing and project management of oil and gas integrated power, data, and fluid rotary solutions.


Electronic and optical equipment can also meet the demanding environment. Moog are continuously striving to expand the temperature and range of multiplexers, media converters, and Ethernet switches.

# Electrical Slip Rings

Moog's Halifax operations is fully certified to North American, ATEX, and IECEx standards for hazardous area qualification. Designs are available for harsh oilfield conditions that are configured for electrical power, signals, or both. These designs can be integrated with other products such as fiber optical rotary joints, fluid rotary unions.

Some downhole tools and surface winches require an electrical rotary interface. A number of designs are available to work in the harshest conditions. These designs also fit into well diameters typical of the industry, work at 1700 bar (25,000 psi) and 230°C and are able to carry electrical power and signals.

## Certifications

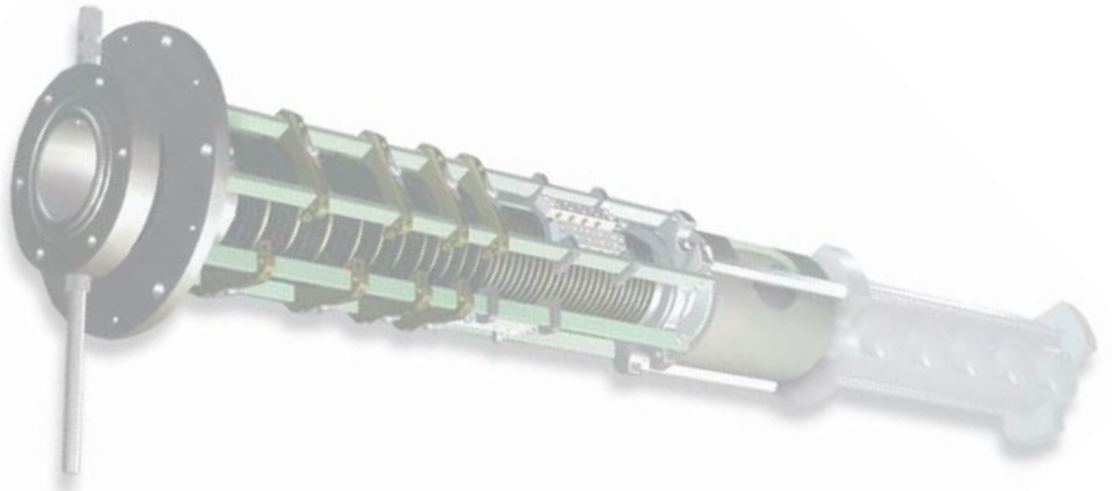
ETL:	Class I, Division 1, Group C&D T5 Class I, Zone 1, AEx d IIB T5
CSA:	Class I, Division 1, Group C&D T5 Class I, Zone 1, Ex d IIB T5
ATEX:	CE 0344  II 2 G Ex & IIB T5 Gb
IECEx:	Ex d IIB T5 Gb

## TYPICAL USES

- Wire lining
- Top drives
- Coil tubing
- Measuring / logging while drilling
- Winches
- Downhole tools

## OPTIONS

- Operates in oil
- Hazardous area versions available where necessary
- High temperature versions for downhole



### Model 180 Explosion-Proof Electrical Slip Ring

Ideal for small systems, the Model 180-X is a compact, rugged slip ring designed for harsh operating conditions. The 180-X is a fully certified flame-proof enclosure for the hazardous area environment. Please see the Model 180 data sheet for further details.

- Voltage maximum 1000 VAC
- Current maximum 7 A per pass
- Maximum 100 A total current



### Model 176 Explosion-Proof Electrical Slip Ring

For higher power applications, the Model 176-X is available for your rotary solutions. Both slip rings can accommodate a Fiber Optic Rotary Joint (FORJ). The Model 176 electrical slip rings perform in marine, industrial and defense applications. Comprised of power and signal electrical passes, the Model 176 provides superior performance and reliability in demanding operational environments. The Model 176 can be configured to meet specific customer needs. Please see the Model 176 data sheet for further details.

- Voltage maximum 5000 VAC
- Current maximum 20 A per pass
- Maximum 720 A total current



When compared to the existing non-contacting technologies, the Moog ring / brush contacting technology has the following advantages;

- Allow for higher power / voltage / current
- Does not require high temperature / pressure downhole electronics for power conversion
- Will allow higher data rates

These slip rings can be combined with Moog motors for use in applications such as Top Drives.

Moog also manufactures a number of non-explosion-proof ruggedized standard slip rings which can be manufactured with through-bore options configured to meet a given application.

### Design Parameters for Slip Rings

The points outlined below will help identify an appropriate slip ring for a given application:

- Description of the application
- Specifications and standards
- Is there a design envelope restriction, specify maximum OD (mm)
- Does the slip ring need a hollow bore, specify the ID (mm)
- Duty cycle – continuous or intermittent
- Pressure rating
- Temperature rating
- Rotational speed
- Number of electrical passes
- Voltage level (volts) for each pass
- Current level (amps) for each pass
- Details of the pressure compensation fluid
- Maximum torque



*Top Drive Slip Ring*



*Oilfield Slip Ring*

### Model 303 Downhole High Temperature And High Pressure

The Model 303 is a family of electrical slip ring products designed specifically for the extremely harsh high temperature and high pressure (HTHP) downhole environment. These products are designed and tested to operate at temperatures of up to 230°C and pressures of 25,000 psi (1700 bar), and are generally configured for an oil-filled environment. They can be combined with high temperature and high pressure resolvers and motors for position and speed feedback and motive power.

- Inner bore and outer diameter can be customized for specific downhole tooling envelopes
- Low electrical contact resistance
- Pressure and temperature compensation



# Fiber Optic Rotary Joints

Fiber Optic Rotary Joints (FORJs) are used in cable winches to facilitate optical communication and fiber sensor data downhole. Special designs are available for this application with increased ruggedness for the oilfield environment and give improved optical performance for sensor applications.

Our FORJs are capable of working with all fiber types, sizes, and wavelengths that can meet insertion loss performance typical of customer requirements. In addition to FORJs operating at standard wavelengths for data communication, FORJ versions have been developed to work with optical sensors with enhanced optical loss and return loss over a broader range of wavelengths. Moog has been the leading supplier of FORJ products to the marine industry for over 20 years with many thousands of products delivered to the oil and gas markets. For the oilfield market, products are designed to be robust and weatherproof with all models being shock and vibration tested and most models are capable of operating fluid-filled and pressure compensated.

## TYPICAL USES

- Wire lining
- Coil tubing
- Winches
- Downhole tools
- Point source measurements using Fiber Bragg Grating (FBG)
- Distributed Acoustic Sensing (DAS)
- Raman-based / Brillouin-based Distributed Temperature Sensing (DTS)

## OPTIONS

- Supply and installation of customer specific connectors and fibers
- Customization of mounting configurations, housing materials and drive couplers
- Fluid filling and pressure compensation
- CSA and ATEX versions available where necessary
- High temperature versions for downhole

### Model 197 Fiber Optic Rotary Joint

The FO197 is a single-pass, multimode fiber optic rotary joint (FORJ). It is passive and bidirectional, and allows the transfer of any type of optical signal across rotational interfaces. ST or FC connector receptacles or customized pigtails. It is available with a stainless steel, aluminum or anodized aluminum housing. Fully Sealed versions (FO197S) with ingress protection ratings up to IP67 are also available.



### Model 310 Fiber Optic Rotary Joint

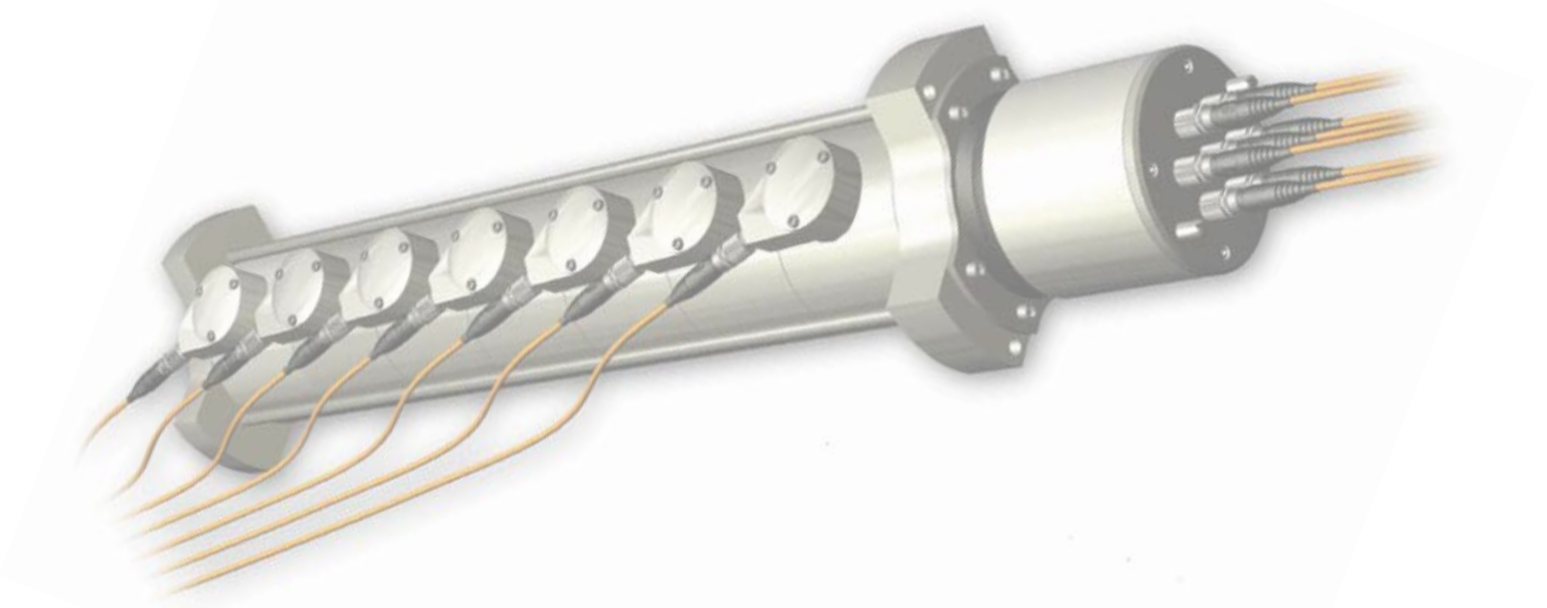
The FO310 is a sealed single-pass fiber optic rotary joint (FORJ) which is factory configured to transfer optical signals over either singlemode or multimode fiber. The FO310 supports both analog and digital optical signals, and is specially suited for sensitive single-pass optical sensing applications where optical insertion loss and back reflection must be optimized.



## Design Parameters for Fiber Optic Rotary Joint (FORJ)

The points outlined below will help identify an appropriate FORJ for a given application:

- Description of the application
- Duty cycle – continuous or intermittent
- Pressure rating
- Temperature rating
- Rotational RPM
- Number of fiber passes
- Is it multimode or singlemode (or both)
- Does the unit need to be sealed and pressure compensated
- Maximum torque
- Wavelength range of operation
- Insertion loss target, maximum and rotational variation
- Back reflection requirements



### Model 300 Fiber Optic Rotary Joint

The FO300 is a multi-pass fiber optic rotary joint (FORJ). It allows the transfer of optical signals across a rotational interface and is passive and bidirectional. The unit can be configured with a mix of singlemode or multimode passes and is available in 3 versions supporting channel counts up to 17 (version "A"), 31 (version "B"), and 52 (version "C") separate channels. Pressure compensated units are also available.



### Model 291 Fiber Optic Rotary Joint

The FO291 is a multi-pass, singlemode fiber optic rotary joint (FORJ). It is passive and bidirectional, and allows the transfer of optical signals across a rotational interface on 2 to 9 separate singlemode optical fibers. Fluid-filled versions are available.



# Fluid Rotary Unions

Our Fluid Rotary Unions (FRUs) have been diversified to include a broad range of applications. Moog fluid rotary unions are currently used around the world to ensure reliable transmission of process, power and control fluids. Currently, fluid rotary unions rated for pressures up to 15,000 psi (1000 bar) are available. Seals are selected based on chemical compatibility, design pressure, design temperature, required service life and acceptable leakage rate. Leak collection can be supplied when required for environmental or personnel safety. Fluid rotary unions can be combined with our electrical slip rings and fiber optic rotary joints.

## Design Parameters for Fluid Rotary Union (FRU)

The points outlined below will help identify an appropriate FRU for a given application:

- Description of the application
- Are there any space limitations
- Is a through bore required on the FRU (for electrical slip ring wiring, etc)
- Number of fluid ports required and port size
- Preferred connections, thread type
- Fluid type
- Fluid pressure
- Duty cycle
- What is the RPM
- Continuous or intermittent rotation
- Fluid temperature
- Flow rate of the fluid
- Ambient temperature
- What is the maintenance interval and life requirement
- What is the environment
- Does the unit require any special environmental sealing
- Is leak collection required
- Maximum torque

### Model 810 Fluid Rotary Union

The Model 810 fluid rotary union is designed for industrial applications where multiple fluid passes need to be transferred across a rotational interface. There are various standard designs, depending on the application. Can be used to transfer air, oil, hydraulic fluid, water or various other fluids. It is available as a standalone FRU or can be combined with an electrical slip ring or a fiber optic rotary joint. The Model 810 FRU has a large variety of designs, with many different configurations and sizes.



## TYPICAL USES

- Coiled tubing trucks
- Heavy equipment turrets
- Cable reels
- Top drives
- Automated handling
- Palletizing machines

## OPTIONS

- Customized mounting and drive configurations
- Customized materials to satisfy weight, chemical compatibility and other requirements
- Customized port configurations
- Hard coating, standard on high pressure FRU, can be selected for improved abrasion resistance and extended seal life
- Leakage detection and collection ports (drain to tank)
- Optional hollow bore

### Model 200 Hybrid Fluid Rotary Union

The Model 200 is a multi-pass fluid rotary union combined with an electric slip ring and can also include a Moog fiber optic rotary joint. The FRU portion is typically configured with up to 13 passes, inter-port mixing is prevented through the use of double seals and an intermediate vent between passes. It is available in several standard port configurations or types. It is available with the standard seal technology or with a low leakage seal option.





# Complete Rotary Interface

Moog can use existing commercial off-the-shelf products to deliver a complete rotary interface. Often, a more comprehensive rotary interface is required, consisting of an electrical slip ring, fiber optic rotary joint, resolver, motor, servo drive electronics, RF joint and multiplexers. These rotary interface solutions can be provided to meet unique environmental requirements, from deep space to kilometers below the ocean surface. Integration of the complete rotary interface assemblies allows optimum performance at the lowest cost to the customer.

## Custom Designs

Often, a standard off-the-shelf unit does not perfectly match the requirements of an application. In these situations, a custom design must be used. Moog is an ISO 9001:2008 Certification registered facility with a strong multidisciplinary engineering group. For this reason, non-standard assemblies can be created for very challenging applications.

### ISO 9001: 2008 Certification

### Strong Multidisciplinary Engineering Group

#### Mechanical Design

3D modeling — Pro / ENGINEER®  
AutoCAD®  
FEA Stress Analysis

#### Electronics Design

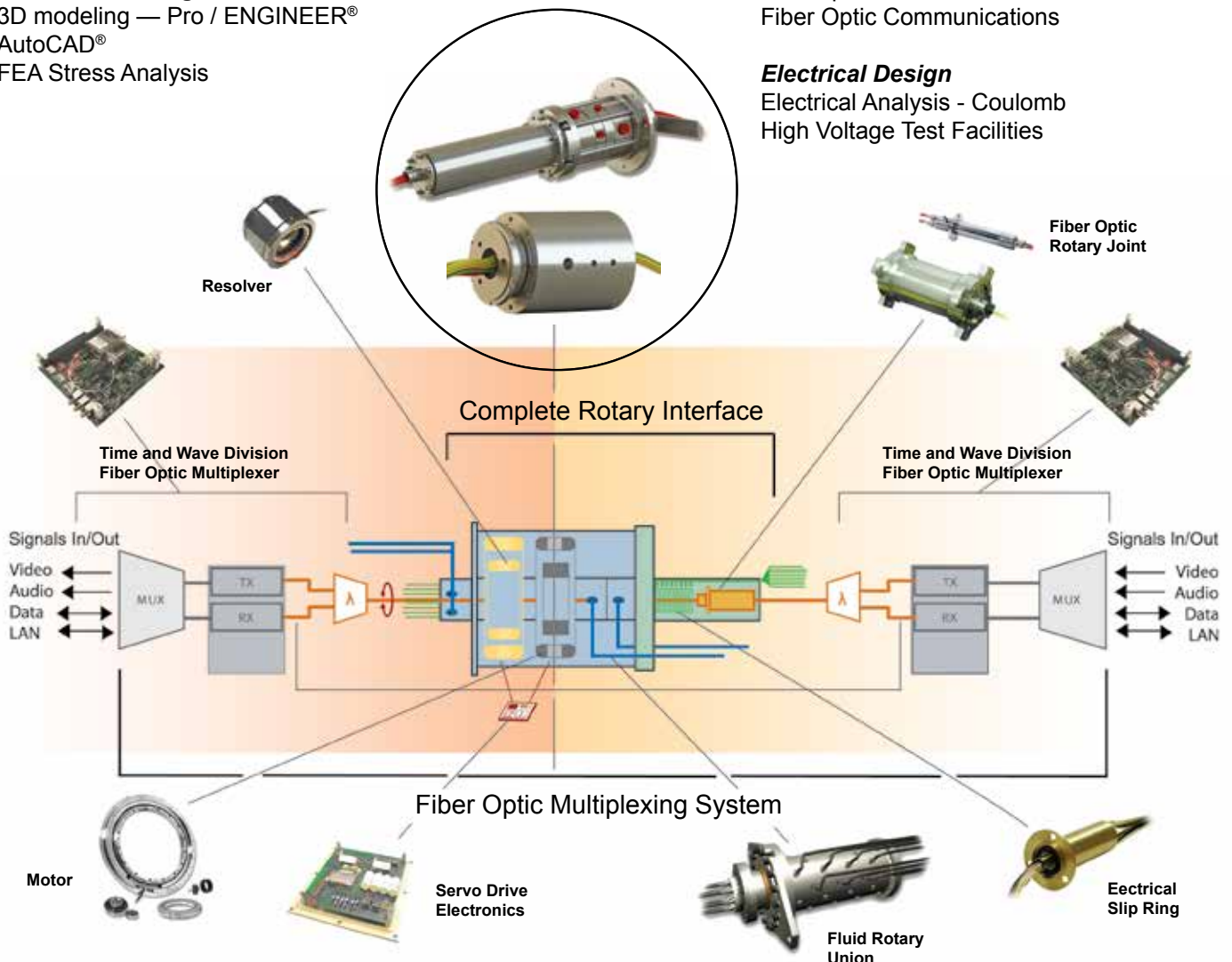
Analog and digital including high-speed

#### Optical Design

Free Space  
Fiber Optic Communications

#### Electrical Design

Electrical Analysis - Coulomb  
High Voltage Test Facilities



# Fiber Optic Multiplexers and Media Converters

Our multiplexers and Ethernet switches were developed to provide reliable fiber optic transmission of video and data signals in the demanding oil and gas applications, robust defense systems, and other platforms operating in harsh environments around the world. Solutions are available for fluid filled environments up to 400 bar (6000 psi), and up to +85°C.

Moog multiplexers use both time division multiplexing (TDM) and wavelength division multiplexing (WDM) technology to exploit the high bandwidth, long distance, and excellent thermal performance properties of fiber optic cables in downhole applications. Multiple unidirectional and bidirectional channels of sensor and control signals can be combined into a single optical fiber. Signals supported include RS-232, RS-422, RS-485, CAN Bus, 4 - 20 mA, Ethernet, real-time control physical-layer Ethernet protocols such as EtherCAT, PROFINET, EtherNET/IP and much more. Having pioneered features like embedded remotely accessible fiber optic diagnostics and automatic fiber optic switching for redundancy, today we offer a full range of custom and off-the-shelf multiplexer systems with more than 2000 fielded systems. Using careful component selection and screening, wide temperature ranges can be offered in a highly reliable and compact form-factor. Internal processes have been refined for managing obsolescence, maintaining quality, and provided extensive design testing, analysis, qualification, environmental stress screening (ESS) and factory acceptance testing. Furthermore, Accelerated Life Testing (ALT) and other customer specific high temperature life tests can be provided as required.

- CAN Bus (repeater and bridge)
- Serial (RS-232, RS-422, RS-485)
- 10/100/1000 Base-T(X) Ethernet
- Real-time physical layer Ethernet including link failure pass-through capability (EtherCAT, PROFINET, EtherNET/IP, etc.)
- Many other data and video formats.
- Embedded diagnostics and controls
- Single or multi fiber, SMF/MMF, wide range of wavelengths and optical budgets available



## Model 907 Multiplexer

Time division and wavelength division multiplexing to support any number of sensor and control signals within a robust board-level PC / 104 form factor card. A full line of expansion cards provides supports a wide range of signals.









## Viking Ethernet Switch

Highly reliable and compact rugged Ethernet switches, fiber transceivers and Ethernet gateways.



# Additional Moog Product Offerings

No matter where in the world you are operating, you will find that all Moog solutions have one thing in common – they all rely on leading-edge performance of our building block products. These products are engineered to improve the reliability, accuracy and efficiency of oil and gas tools while giving you the confidence to overcome any environmental challenge.

<p><b>Brushless Servo Motor</b></p>		<ul style="list-style-type: none"> <li>• Diameters: 12 to 250 mm (&lt;1 to 10 in) outside diameter</li> <li>• Output torque: Up to 170 Nm (1,500 lbf in)</li> <li>• Voltage from 24 to 1,000 V<sub>DC</sub></li> <li>• Speed: Up to 10,000 rpm</li> <li>• Power range: Up to 7.5 kW</li> </ul>
<p><b>Gearing</b></p>		<ul style="list-style-type: none"> <li>• Diameters: &lt;25 to 250 mm (&lt;1 to 10 in) outside diameter</li> <li>• Output torque: Up to 800 Nm (7,080 lbf-in)</li> <li>• Ratios up to 1400:1 for power transmission</li> <li>• Simple and compound planetary gearing</li> </ul>
<p><b>Ball Screw And Roller Screw</b></p>		<ul style="list-style-type: none"> <li>• Output force: Up to 450 kN (100,000 lbf)</li> <li>• Screw sizes from 11 to 80 mm (0.47 to 3.15 in)</li> <li>• Leads ranging from 5 to 40 mm (0.197 to 1.575 in)</li> </ul>
<p><b>Resolver</b></p>		<ul style="list-style-type: none"> <li>• Resolver frame sizes from size 8 to 64</li> <li>• Outside diameter: 20 to 163 mm (0.8 to 6.4 in)</li> <li>• Hall effect feedback</li> <li>• Qualified for HTHP environments</li> </ul>
<p><b>Motor Controller</b></p>		<ul style="list-style-type: none"> <li>• Power range: 20 to 250 V; up to 5 Amps nominal to 10 amps peak</li> <li>• Ambient operating temperature: -25 to 175°C (-13 to +347°F)</li> <li>• Maximum survival temperature: +200°C (+392°F)</li> <li>• Width starting at 19 mm (0.75 in)</li> </ul>
<p><b>Alternator</b></p>		<ul style="list-style-type: none"> <li>• Diameter: 25 to 250 mm (1 to 10 in) outside diameter</li> <li>• Power: 50 to 50,000 W</li> <li>• Speed range: Up to 8,000 rpm</li> <li>• Voltage range: 24 to 600 V<sub>DC</sub></li> </ul>

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