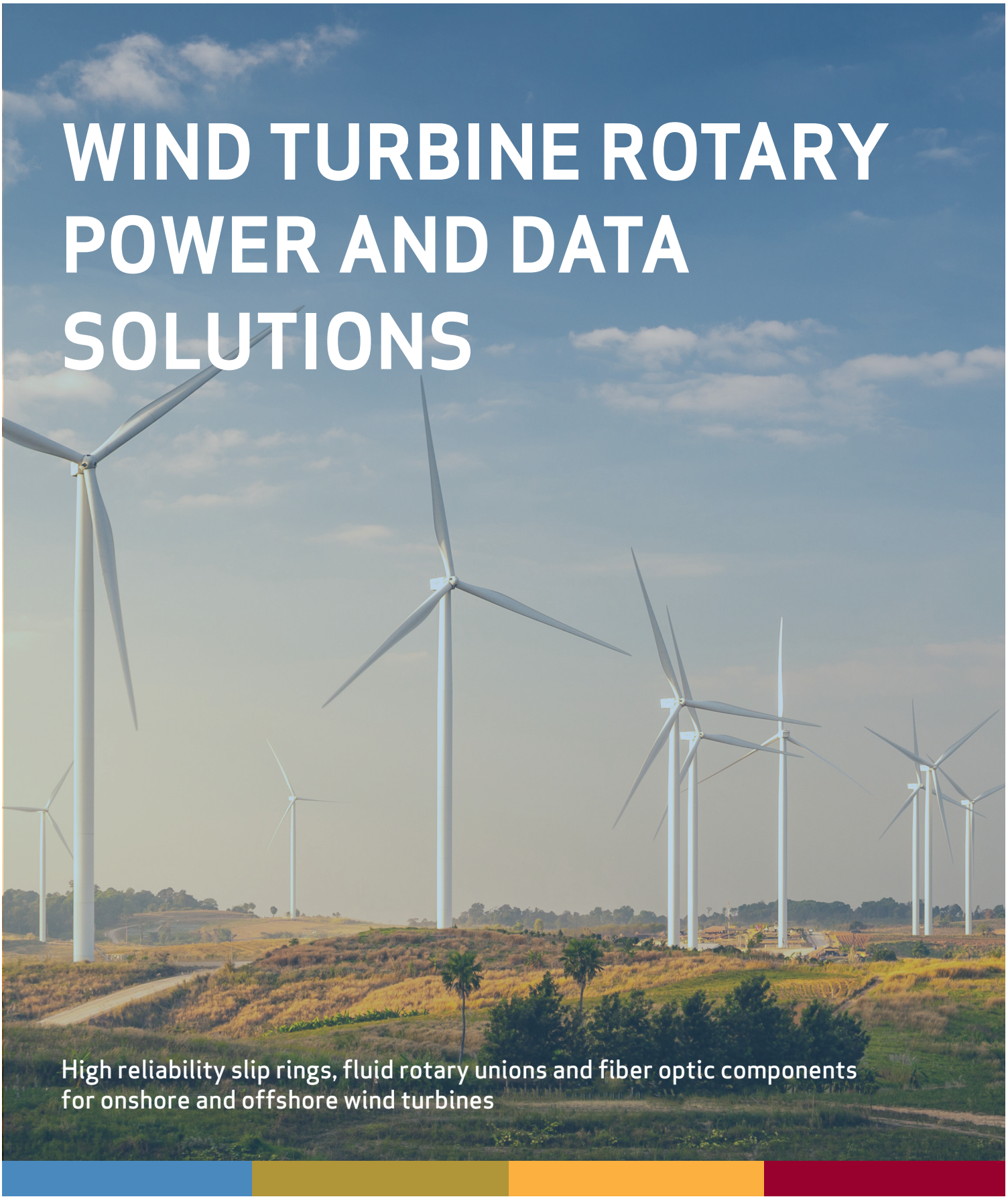
WIND TURBINE ROTARY POWER AND DATA SOLUTIONS



High reliability slip rings, fluid rotary unions and fiber optic components for onshore and offshore wind turbines

MOOG

ROTARY SOLUTIONS FOR YOUR WIND POWER GENERATION CHALLENGES

Wind turbine technology is rapidly evolving as wind energy becomes a critical part in providing an environmentally friendly source of electricity. As a leading provider of advanced slip ring and rotary transmission technologies, Moog plays a key role in wind power generation, helping turbine OEMs and operators achieve continuous power production. With our long history of providing rotary components for harsh environments, our slip rings, fluid rotary unions and fiber optic components set the standard for reliability in power and data transfer.

Moog's low maintenance slip rings utilize several contact material technologies, allowing our engineers to select the optimum material combination for every application. Our reliable slip ring assemblies deliver robust power capabilities and low noise data transfer.

Typical Applications:

- Onshore and offshore wind turbines
- Floating offshore platforms
- Small and mid-size wind turbines

Moog's global brands allow us to integrate a broad range of rotary data and power transfer technologies to achieve the best possible solution for your requirements.

GAT® REKOFA FOCAL™

TECHNOLOGIES AND CAPABILITIES

The reliability of Moog's slip ring assemblies starts with the optimization of contact materials and the design strategy of the power and data modules. Building on that foundation, bearing selection, sealing, housing construction and internal wiring all contribute to the final, optimal solution for your application.

Power Transfer

The most common challenge slip ring assemblies face in wind turbine applications is power transfer capability. Poor selection of contact materials and inappropriate design parameters often result in accelerated wear and debris generation in the power section. This results in a breakdown in dielectric isolation between phases, circuits or circuits and ground, leading to short circuits. Moog contact technologies and matching design parameters provide several options for long-lived, reliable power transfer, including a patented fiber brush technology and a carbon/metal composite brush custom designed for wind turbine power transfer requirements.

Data Transfer

Contacting: There are several sound options for reliable data transfer in wind turbine slip rings. Contacting signal and data slip rings normally incorporate noble metals for the contacts themselves. Gold and silver are the most common contact materials, but there are other noble metals that provide advantages in some environments. Moog designs incorporate the right material to meet the most demanding bit error rate (BER) requirements for communication data.

Non-contacting: Another option for electrical signal transfer is contactless data transmission using Moog's High Speed Data Link (HSDL) technology. This technology uses capacitive coupling or near field RF coupled designs to couple data from rotor to stator without sliding contacts. These designs can handle data up to 1 Gbps and can be configured to provide multiple data channels.

Fiber optic data transmission is available to increase data reliability. Optical data transmission is available using a complete line of Fiber Optic Rotary Joints (FORJ), which are integrated into the final rotary union solution. The high bandwidth capability of fiber provides an opportunity to reduce the number of circuits and minimize the number and size of signal cables, thus reducing cost and weight and improving reliability and EMI performance.

Media Transfer

Moog's rotary unions are used for the transfer of media between stationary and rotating machine parts in almost all branches of the industry to ensure reliable transmission of media, such as oil, water, grease, emulsion as well as (compressed) air, gas and vacuum. A wide range of speeds and pressures are offered.

FLEXIBLE SOLUTIONS

Special techniques are required in rotary assemblies to ensure the reliable operation of each of the specific functional components, including multiplexer and media conversion electronics. Moog delivers a fully tested and qualified assembly.

AFTERMARKET SOLUTIONS

Moog's aftermarket slip rings offer long life and low maintenance high reliability performance. They utilize several reliable contacting materials and technologies, allowing our engineers to select the optimum material combination for every application. Robust power and low noise data transfer are features of our slip ring assemblies.

Moog's slip ring solutions are designed for demanding wind turbine environments and incorporate the latest design technology. Product features are based on years of proven performance across numerous applications. Our wind power solutions include standard, flexible designs that allow quick configuration to meet each customer's unique set of requirements. Our standard pre-engineered modules deliver cost effective, field-proven and customizable solutions.

FEATURES

- Direct bolt-in replacement
- Handle for easier lift and install
- IP65 sealed enclosure
- Heater for cold weather installations
- Adjustable terminal block locations in rotor junction box for flexibility with umbilical cable length
- Key diagnostics can be integrated to ensure reliable operation
- Up to 500 A continuous current capability
- Discrete signal circuits, EtherNet/IP™, RS serial buses, CAN bus and CANopen® options *
- Optimum electrical contact material options
- Customized mechanical and electrical interface features

ADVANTAGES

- No maintenance required
- High reliability slip rings with 100+ million revolution life
- Minimal wear debris generation
- Designed for harsh environments (temperature, humidity, vibration)
- Various technologies for customizable and flexible solutions
- No lubrication required
- Lower cost per life cycle
- Flexible design with modular slip ring configuration
- Thoroughly tested, field-proven performance

Direct Replacement Wind Turbine Pitch Control Slip Rings

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OFFSHORE CAPABILITIES

Offshore wind turbines are now an accepted part of our coastal scene. As these turbines grow, they will move further offshore and into deeper water to benefit from the better wind conditions. Many of these turbines will require a floating platform rather than being fixed to the seabed.

As a result, Moog has created a wide range of standard products for this deep-water development:

- **Electrical and optical swivels** that allow the platform to rotate and take a favorable orientation to wind and waves, reducing the forces exerted on the platform. The swivels transmit electrical power at 66,000 Volts and higher from the tidal energy device, across the mooring system rotational interface to the export cable on the seabed.

- A series of **health monitoring products** for critical breakdown areas of the platform and turbine design. These products result in lower operating costs, as platforms can be monitored from a long distance from shore.

- **Communication systems** for complete fields including both electrical and optical systems. Moog's rotary joints transfer power and signals between the pitch control systems located in the rotating blades to the nacelle.

Moog is committed to developing equipment for offshore and harsh environments that meet the high reliability standards required to minimize servicing needs. Our certified field team is ready to ensure successful onshore and offshore installation, commissioning and planned maintenance. Should the need for unplanned service arise, we provide a quick response to all inquiries and rapid mobilization worldwide.

FEATURES

- Medium to high voltage slip rings operating between 3.6 kV - 145 kV
- Up to 52 singlemode or multimode optical channels
- Transfer of high pressure fluids with leakage collection option
- Ingress protected for surface or subsea applications
- Condition monitoring systems available
- Multiplexing and media conversion available

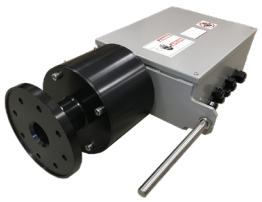
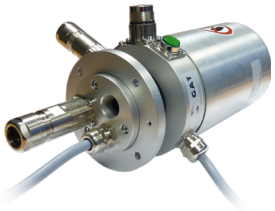
ADVANTAGES

- Designs to meet application and classification requirements, including marine certifications
- Front end engineering design support
- Long life, low maintenance
- Supplier of swivels for harsh environment applications for over 30 years

WIND TURBINE PRODUCTS

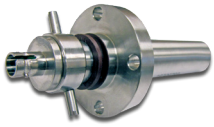
The chart below shows some of Moog's products for wind turbine power generation applications and is intended to show the range of solution offerings. With our modular construction approach we can easily configure individual and integrated solutions for the most challenging power or data rotary transfer requirements.

We offer direct replacement options for major OEM turbine suppliers. Contact us for more information.

Slip Rings	Model	Features / Advantages
	**WP7286 Series** Slip Ring	- No maintenance - Available with "oil seal" ingress protection for -2N and -ESS slip rings - Custom terminal block orientation options - Fiber brush or carbon brush design available - Direct replacement models available - High power capacity - Heavy duty bearing
	**ROTOFLUX** Slip Ring	- OEM direct replacement options available - Highest contact quality with reliable transmission of power, signal, and data via gold / gold technology - Very low contact resistance - Vibration and temperature resistant - Available with quick connectors - UL / CSA certification available
	**ROTOCAP** Non-Contacting Capacitive Data Transmission	- Reliable real-time data transmission - Process safe - Maintenance-free - Transmission rates of 100 Mbit/s up to 2.5 Gbit/s - Compatible with industry standards
	**High Speed Data Link** Technology	- Non-contacting, electrical data transfer - Capacitively coupled - Low noise, high life, high reliability
	**High Current Brush Holder**	- Used for lightning protection - High power capacity up to 1,000 A

Rotary Unions	Model	Features / Advantages
	**ROTOSTAT E** Rotary Union	- Non-contacting sealing system with very low friction - Maintenance free - Designed for idle-mode operation - Cold weather versions available as low as -40° C - Field proven for decades

Combined Systems	Model	Features / Advantages
	**ROTOKOMBI** Rotary Union and Slip Ring	- Customized combination of different transmission technologies in one housing - Integration of encoder or fluid rotary union possible - IP 65 protection - Robust housing design - Two ball bearings integrated - Resistant against humidity and vibration - Hot and cold climate versions available
	**De-icing / Anti-icing** Power Slip Ring for Blade Heating, Signal Slip Ring and Hydraulic Rotary Union	- Operation in temperatures as low as -40° C - Blade heating retrofit for numerous OEM wind turbine models - Improve performance and reliability - Customized solutions for hydraulic and electrical pitch control - Optimizes performance for more power during cold weather periods - Increases availability by reducing downtime

Rotary Joints	Model	Features / Advantages
	**F0197S** Fiber Optic Rotary Joint	- Single pass, multimode fiber optic rotary joint - Ruggedized for harsh environments - Low insertion loss and low back reflection - Common wavelengths (850 / 1310, 1310 / 1550 nm) - Sealed design (IP67) - Bulkhead ST connectors - 316 stainless steel
	**F0286** Fiber Optic Rotary Joint	- Combines multiple channels in single interface box to single bi-directional fiber - Reduces system cost and space - Low and deterministic latency for real-time Ethernet applications - Link condition monitoring using open standard Ethernet based protocols
	**F0292** Fiber Optic Rotary Joint	- Provides rotary coupling for two multimode fibers - Passive bidirectional optical transmission - Customized mounting flanges available - Stainless steel housing - Optional 90° cable exits at either end

Multiplexers	Model	Features / Advantages
	**920-EDM** Ethernet and Data Multiplexer	- Combines multiple channels in single interface box to single bidirectional fiber - Reduces system cost and space - Low and deterministic latency for real-time Ethernet applications - Link condition monitoring using open standard Ethernet based protocols
	**923-EDL** Condition Monitoring	- Real-time health monitoring of temperature, humidity, shock / vibration, rotations - On-board logging and programmable intervals - Expandable external sensor interface - Mounted in surface and oil-filled subsea slip rings and junction boxes

TAKE A CLOSER LOOK

Moog experts offer decades of trusted engineering experience and reliable solutions for all your product design and development needs. Contact us today.

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For market information, visit
www.moog.com/markets/energy

Moog Wind Turbine Rotary Power and Data Solutions Brochure
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This technical data is based on current available information and is subject to change at any time. Specifications for specific systems or applications may vary.