

WIND TURBINE SLIP RING AND FIBER OPTIC SOLUTIONS

High performance rotary and fiber optic products for onshore and offshore wind turbines



Wind turbines require delivery of power and data signals to the rotating hub by a reliable rotary assembly. These high performance components must operate continuously in harsh environments, often in remote locations, where regular maintenance and monitoring are difficult and cost-intensive. Moog provides rotary products that are designed to operate efficiently in these rugged environments.

Moog's rotary and fiber optic products incorporate the latest design technology. Product features are based on years of proven performance in numerous aerospace and demanding industrial applications. Our wind power products have standard configurations that are flexible and allow us to quickly tailor a product to meet each customer's unique set of requirements.

Slip rings are commonly used in wind turbines to provide electrical signals and power for pitch control systems. For hydraulic pitch, Moog supplies integrated fluid rotary unions that carry hydraulic fluids across the rotary joint. Moog has innovative solutions in both of these applications.

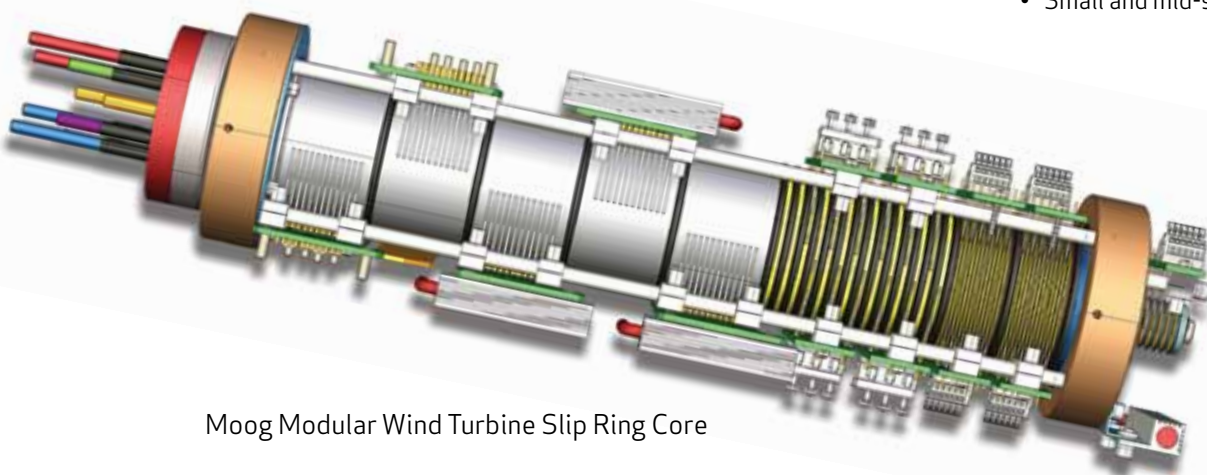
Moog's no maintenance slip rings utilize fiber brush contact technology and eliminates the need for frequent slip ring maintenance procedures — no vacuuming of brush debris, no lubrication, no regular inspection for brush wear and no brush replacement.

ADVANTAGES

- High reliability — slip rings with 100+ million revolutions
- No maintenance slip rings utilizing fiber brush technology
- Flexible design with modular slip ring configuration
- Proven and tested models
- A complete solution for wind applications by integrating fiber optic components

APPLICATIONS

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



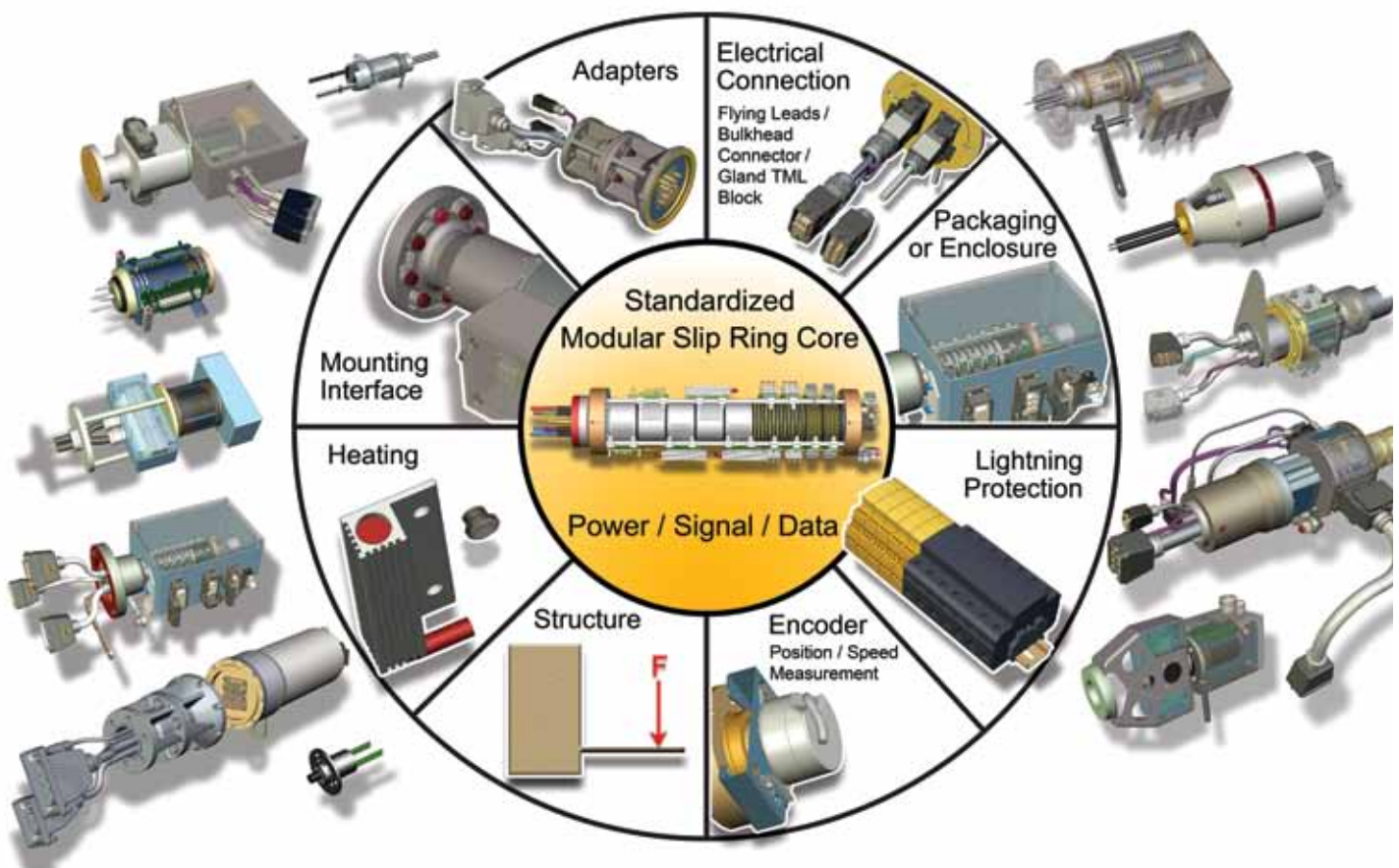
Moog Modular Wind Turbine Slip Ring Core

MOOG SLIP RING AND FIBER OPTIC SOLUTIONS FOR WIND TURBINES

Flexibility

Moog has established a modular system for developing and manufacturing its slip rings. Our building-block configuration is precisely matched to meet each customer's specifications. This business model offers faster delivery and cost effective solutions.

- Up to 500 A continuous current capability
- Discrete signal circuits, Ethernet, RS serial buses, CANbus and CANopen options available
- Fiber Optic Rotary Joint (FORJ), Fluid Rotary Unions (FRU) and encoders can be integrated
- Silver fiber brush technology
- No routine maintenance or lubrication required
- 100+ million revolutions expected life
- Other elements can be integrated as required (example lightning protection)

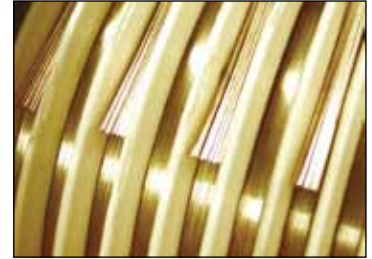


Moog Modular Wind Turbine Slip Ring

Fiber Brush Advantages

Moog developed the fiber brush technology in the early 1970s and became the first company to use this patented design in its slip rings. Fiber brush technology enables a maintenance-free slip ring design. The advantage of the fiber brush technology is its ability to achieve remarkable life without lubrication over a wide range of temperature, humidity and rotational speeds. Moog understood the value of this unique design for long life, space efficient slip rings and used its expertise to develop hundreds of different slip ring models for challenging applications, including helicopter rotor blade de-icing, satellite solar array drive power transfer, industrial packaging equipment, radar pedestals and wind turbines. Today, Moog's proven fiber brush technology has become synonymous with high performance slip rings around the world.

- Maintenance free for 100+ million revolutions
- Minimal wear debris generated
- No lubrication required
- Wide operating temperature range
- Lower life-cycle cost



Moog Fiber Brush Technology

Contactless Technology

Moog engineers spend significant time investing in research and developing new technologies. One example of this is the contactless slip ring that offers the transfer of electrical power across a continuously rotating interface without electrical contact.

- 5 kW solutions available, 12 kW in development
- Inductive transformer to achieve power transfer with > 90 % efficiency
- Associated electronics can be designed to suit your application requirements
- Contactless data channel can be provided by a fiber optic rotary joint

Fiber Optic Data Transmission

Optical data transmission is available using a complete line of Fiber Optic Rotary Joints (FORJ) integrated into the rotary unions. The very high bandwidth capability of fiber provides tremendous opportunity to reduce the number of lighting protection circuits and minimize the number and size of signal cables — reducing cost and weight, improving reliability and EMI performance.

Fiber optic communication electronics are used to multiplex multiple signals onto a single optical fiber. Optical fiber is used to transmit many high bandwidth bidirectional communication signals throughout the turbine using various standard protocols. A non-contacting fiber optic rotary joint (FORJ) is used to transmit optical signals over the rotary interface between the hub and nacelle, and fiber optic electronics are used to combine multiple signals onto a single fiber and provide link monitoring.

Fluid Rotary Unions

Hydraulic pitch actuation systems require both electrical and fluid transfer to and from the turbine blades. While slip rings provide the electrical transmission across the rotary interface, fluid transfer is accomplished through fluid rotary unions (FRU). Typically, two fluid channels are required to provide supply and return hydraulic power to the blade actuators. Special seals and shaft coatings have been developed to ensure long life of the FRU. Seals are selected based on chemical compatibility, design pressure, design temperature, required service life and acceptable leakage rate.

Slip rings are often integrated with fluid rotary unions into rotary union assemblies. It is also common to include rotary position sensors and fiber optic rotary joints for a complete rotary interface solution. Special techniques are required in these integrated assemblies to ensure the reliable operation of each of the specific functional components.

Micro-Generation Wind	Aftermarket / Retrofit Wind
<p>Moog offers products tailored to the wind segment that includes wind-minded consumers and small and mid-size wind turbine applications. Our technology has been packaged specifically for the performance requirements and cost targets of these customers. Slip rings and alternators are available solutions.</p> <ul style="list-style-type: none"> • Slip rings up to 15 kW turbine designs • Conventional brush slip ring solution for 1.5 kW generator • Alternators available up to 150 kW 	<p>Wind turbine operators use Moog slip rings to replace low reliability, high maintenance designs in existing turbines. These models are developed as direct replacements in major wind turbine models.</p> <ul style="list-style-type: none"> • Direct form, fit, function replacement • Easy installation • Maintenance free

MOOG WIND TURBINE PRODUCT MATRIX

Product	Model	Features / Advantages
	Pitch Actuation Slip Ring	<ul style="list-style-type: none"> - Modular design adds flexibility - 100+ million revolutions for high reliability - No maintenance; lower operating costs
	Wind Turbine Slip Ring WP58484	<ul style="list-style-type: none"> - Compact size - Stainless steel housing - IP65 sealing
	Wind Turbine Slip Ring AC7008	<ul style="list-style-type: none"> - GE 1.5 MW direct replacement - High power capacity - Heavy duty bearing - No maintenance
	Wind Turbine Slip Ring WP7129	<ul style="list-style-type: none"> - NEG Micon NM72 / 82 replacement - Sealed - No maintenance
	Fiber Optic Rotary Joint 197S	<ul style="list-style-type: none"> - Single-pass, multimode FORJ - Fully sealed - Allows transfer of optical signals
	Fiber Optic Rotary Joint 285 / 286	<ul style="list-style-type: none"> - Single-pass, singlemode (285) / multimode (286) - Optimally suited for integration inside slip ring - Allows transfer of optical signals
	Fiber Optic Rotary Joint 292	<ul style="list-style-type: none"> - Ultra-compact, two pass, multimode FORJ - Enables bidirectional using separate fibers or fiber redundancy - Allows transfer of optical signals on two separate optical fibers
	Multiplexer 920-EDM	<ul style="list-style-type: none"> - Ethernet and data multiplexer - Combines multiple channels in a single interface box - Reduces system cost and space - Combines multiple channels onto a single fiber - Link monitoring using open standard Ethernet-based protocols
	Fluid Rotary Union	<ul style="list-style-type: none"> - Low leak rates - Can be integrated with slip ring and fiber optic rotary joint - Offers a total rotary system solution
	Wind Turbine Alternator	<ul style="list-style-type: none"> - Direct drive power generating device - Available up to 150 kW - Housed and frameless designs available

Moog has offices around the world. For more information or the office nearest you, contact us online.

Email wind.uk@moog.com

Moog is a registered trademark of Moog Inc. and its subsidiaries. All trademarks as indicated herein are the property of Moog Inc. and its subsidiaries. ©2012 Moog Inc. All rights reserved. All changes are reserved.

This technical data is based on current available information and is subject to change at any time by Moog. Specifications for specific systems or applications may vary.

Wind Energy Solutions Brochure
December 2012, MS3079 rev. 1