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

Your Partner in Pitch Control
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)
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

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.

<table>
<thead>
<tr>
<th>Micro-Generation Wind</th>
<th>Aftermarket / Retrofit Wind</th>
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<tbody>
<tr>
<td>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.</td>
<td>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.</td>
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<tr>
<td>- Slip rings up to 15 kW turbine designs</td>
<td>- Direct form, fit, function replacement</td>
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<tr>
<td>- Conventional brush slip ring solution for 1.5 kW generator</td>
<td>- Easy installation</td>
</tr>
<tr>
<td>- Alternators available up to 150 kW</td>
<td>- Maintenance free</td>
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## MOOG WIND TURBINE PRODUCT MATRIX

<table>
<thead>
<tr>
<th>Product</th>
<th>Model</th>
<th>Features / Advantages</th>
</tr>
</thead>
</table>
| Pitch Actuation Slip Ring    |                   | - Modular design adds flexibility  
- 100+ million revolutions for high reliability  
- No maintenance; lower operating costs |
| Wind Turbine Slip Ring WP58484 |                   | - Compact size  
- Stainless steel housing  
- IP65 sealing |
| Wind Turbine Slip Ring AC7008 |                   | - GE 1.5 MW direct replacement  
- High power capacity  
- Heavy duty bearing  
- No maintenance |
| Wind Turbine Slip Ring WP7129 |                   | - NEG Micon NM72 / 82 replacement  
- Sealed  
- No maintenance |
| Fiber Optic Rotary Joint 1975 |                   | - Single-pass, multimode FORJ  
- Fully sealed  
- Allows transfer of optical signals |
| Fiber Optic Rotary Joint 285 / 286 |           | - Single-pass, singlemode (285) / multimode (286)  
- Optimally suited for integration inside slip ring  
- Allows transfer of optical signals |
| Fiber Optic Rotary Joint 292 |                   | - 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          |                   | - 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           |                   | - Low leak rates  
- Can be integrated with slip ring and fiber optic rotary joint  
- Offers a total rotary system solution |
| Wind Turbine Alternator      |                   | - Direct drive power generating device  
- Available up to 150 kW  
- Housed and frameless designs available |

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Wind Energy Solutions Brochure  
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