



# THE POWER TO PERFORM

Wind Energy Solutions

# LEADING-EDGE MOTION SOLUTIONS FOR RELIABILITY AND HIGH PERFORMANCE

As countries and energy companies around the globe struggle to leverage environmentally-friendly energy sources, they look to the most technologically-advanced wind turbines to lead the way. And that means the pressure has never been greater for engineers worldwide to keep pace. Trends such as the push for larger, more powerful turbines, installations in offshore locations and the need for better efficiencies are all changing the business.

The rapid growth in the industry also suggests challenges as OEMs must find a way to accommodate park locations with lower or unsteady wind, and ensure reliability and operator safety in all installations. Testing of these high-performance systems is becoming a key to continued growth for wind power producers. Finally, the push for new technologies is changing the way turbines are designed in many countries. Fortunately, you're not alone.

Moog has been a leader in providing the latest motion control solutions to the power generation industry for more than 20 years. With proven expertise in both electric and hydraulic technologies and the vast global resources of a nearly two billion-dollar corporation, Moog's depth of expertise and collaborative approach make us the ideal partner to help solve your toughest challenges in this rapidly-emerging industry.

We invite you to see for yourself what Moog technologies, resources and innovation can bring to your wind power applications, wherever they may be.

# MEETING TODAY'S ENERGY CHALLENGES ON A GLOBAL LEVEL

In more than 26 countries worldwide, Moog teams work proactively with customers to take ideas further, incorporate higher performance, reduce operating costs and facilitate the development of next generation machine design. The motion control challenges for wind turbines are particularly complex, ranging from assuring efficiency to increasing reliability and safety.

Moog offers high-performance solutions across four key application areas: blade pitch control, slip ring solutions, rotor monitoring and rotor blade testing. Here is a brief look at how we meet the needs of the world's most respected energy providers.

## Higher reliability

High investment costs and operational inefficiencies have been associated with wind turbines for years due to continuous 24/7 operation in harsh, rugged environments and irregular wind conditions. By focusing on the requirements of hydraulic and electric systems, Moog is setting a new standard for smooth, reliable performance. And that translates into more uptime and significantly reduced maintenance costs.

## Safe operation

The sheer size and height of wind turbines mean that safety is a key factor. Moog solutions offer remote operation and diagnostics, and greater fail-safe functionality for a higher degree of safety in any environment.

## Enhanced efficiency

Today's fastest growing applications for wind turbines involve offshore locations, providing access to stronger winds. Moog's innovative pitch control technology helps protect the blades from environmental hazards, while delivering clean, efficient power. Our solutions also enhance the energy efficiency of blades in wind park locations with lower or unsteady wind speed.

## Remote operation and diagnostics

The location and height of wind turbines mean that all aspects of commissioning, set-up, troubleshooting and maintenance are costly and challenging. Innovations such as remote diagnostics in our systems are critical to reliable 24/7 operation of such advanced technology.

## Application know-how

Another trend is toward larger, more powerful turbines. The motion control technologies of even a few years ago are being pushed to their limits by these new designs, which is why Moog experts are focused on new solutions that let you keep pace with the emerging changes in turbine design.

## Worldwide service

Around the world, Moog Global Support™ ensures that our trained service technicians are on call for timely and precise repair and maintenance of Moog systems.



From installation and troubleshooting to product upgrades, we're there for you, making sure your critical wind turbine installations are well managed and expertly maintained.

## MAKING THE SMART CHOICE

With so much riding on your wind turbine investment, choosing a strong technology partner is critical. Here are just a few reasons to consider Moog:

- ✓ Trusted provider of electric and hydraulic pitch control solutions, rotor monitoring and slip ring systems
- ✓ Proven supplier to the world's top ten wind turbine manufacturers; more than 10,000 units in operation worldwide utilize Moog solutions
- ✓ Global supply chain for production, sales and on-site technical service anywhere in the world
- ✓ Solutions that help you reduce the cost of ownership, extend life of products and systems, and minimize your maintenance requirements
- ✓ Unsurpassed technical expertise to simplify installation and troubleshoot potential problems



# AN INNOVATIVE, SOLUTIONS-BASED APPROACH

## BLADE PITCH CONTROL

Accurately controlling the pitch of a turbine's blades is essential to the overall performance of a wind turbine. During operation each blade is subjected to instantaneously changing loads and forces. Based on the rotor position and wind conditions, a pitch system actively works to manage these changes.

Our expertise in both electric and hydraulic technology coupled with our long experience in power generation make us the ideal partner for developing customized blade pitch control solutions designed for increased availability of your wind turbine, regardless of the technology.

## ELECTRIC BLADE PITCH CONTROL

Moog offers customized solutions that save space in the hub, while ensuring safe and reliable performance.

### Servodrives



Our family of PITCHmaster Servodrives was developed for the harsh conditions in the rotating hub and operates reliably under constant internal switchgear cabinet temperatures from -30 to +70°C (-22 to 158° F). Its flexible design provides selectable installation positions and is resistant to vibration, shock and permanent shock.

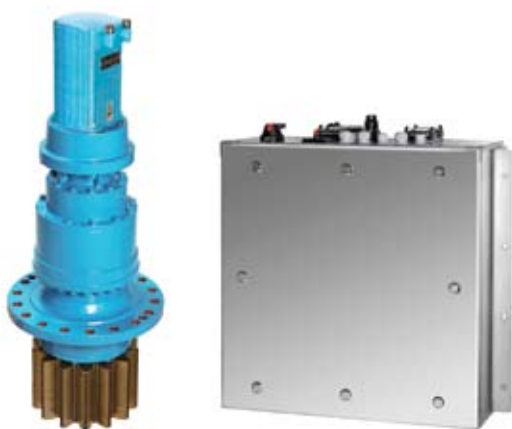
### Pitch actuators



The Pitch Actuator Unit consists of the gearbox and a motor. Moog offers both AC and DC motors, depending on the safety concept of the pitch system.

### Electric pitch system

The system cabinets are designed to meet your specifications and accommodate hub space. Our backup systems feature acid lead batteries, lithium ion batteries, or capacitors, and are independent and not interconnected to ensure redundancy.



## HYDRAULIC BLADE PITCH CONTROL

In cooperation with system integrators, we offer a unique hydraulic blade pitch control systems with integrated fail-safe functionality.

### Servovalves



Our Servo Valve features microprocessor-based electronics and CANopen, Profibus DP or Real-Time Ethernet fieldbus interfaces. This enables fully digital communication for improved performance, enhanced remote diagnostics and greater process control.

### Radial piston pumps



Moog delivers the Radial Piston Pump (RKP-II) as part of the Hydraulic Power Unit. The pump features low noise and provides longer service life. It is available with digital onboard electronics for remote maintenance and condition monitoring.

### Hydraulic pitch system

The complete system consisting of Moog's Servo Valve, advanced configuration software, reliable actuators and our RKP-II Pumps offers precise control of each blade position. The low friction actuators with Moog's Digital Servo Valve allows the pitch angle to be changed with high resolution better than +/-0.1 degree intervals at a response time of less than 50 ms. The integrated fail-safe system moves the blades to a safety position in case of any fault for safer operation.

All of our electric and hydraulic pitch systems can be integrated with a Moog slip ring solution for complete control.

## BLADE LOAD SENSING



Moog's blade load sensing dynamically adjusts the pitch of each blade in real time to optimize the loading on the rotor. The blade load measurement system supplies accurate, real-time information to

the turbine's pitch control system or main controller, enabling the turbine to dynamically respond and



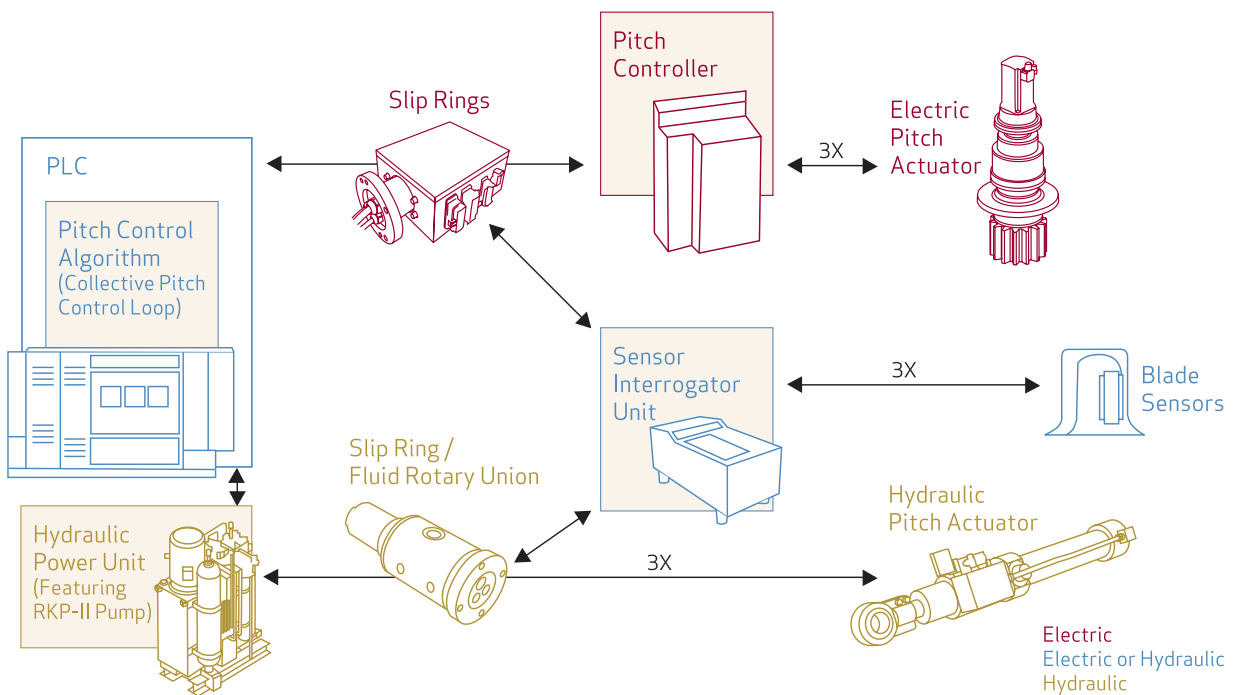
intelligently manage loads during operation through control algorithms. By managing loads, it reduces wear on components, minimizes downtime and maintenance costs. It also increases efficiency through improved turbine operation, reduced friction and better wind utilization.

## COMPLETE PITCH CONTROL SOLUTIONS

### NACELLE/TOWER BASE

### HUB

### ROTOR/BLADE



Moog Pitch Control Solutions are designed for both electric and hydraulic systems. Our solutions can be seamlessly incorporated at the nacelle and tower base, and in the hub, significantly improving rotor and blade performance.

## SLIP RING SOLUTIONS



In harsh conditions and offshore environments, Moog Slip Rings, Fluid Rotary Unions and Fiber Optic Rotary Joints set the standard for reliable power and data transmission in electric and hydraulic systems.

Moog Slip Rings feature a rugged enclosure, connection options on both rotor and stator, and a wide operating temperature and speed range. Our Slip Rings are designed to integrate our low-leak Fluid Rotary Unions in hydraulic systems. The modular design configurations adapt to unique mounting configurations quickly and effectively.



Our Slip Ring Products utilize fiber brush technology to offer extremely long brush and ring life, minimal wear debris generation, lower lifecycle costs and no lubrication for low maintenance.

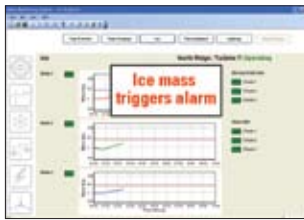


Moog Fiber Optic Rotary Joints and Multiplexers are ideal for transferring high data rates over longer distances. Our innovative contactless technologies are also included in our family of slip rings.

# ROTOR MONITORING AND TEST SOLUTIONS

## ROTOR MONITORING

The Rotor Monitoring System (RMS) is a proven, robust, load measuring system specifically for installation in the turbine hub. The system can be designed-in during manufacture or retrofitted to existing operational turbines. The RMS system allows cost-effective remote monitoring of turbines for the early detection of operational and maintenance issues such as:



**Ice detection**—the system enables operators to accurately predict when they need to shut down turbines in sites where potential ice throw is a problem. The system's capability to indicate when

the ice has been shed from each individual blade also allows the operator to restart earlier and with confidence.

**Yaw misalignment**—the RMS provides instant feedback on misalignment. A 10° yaw misalignment reduces the effective rotor swept area and reduces power by approximately 5% when running below rated power.

**Rotor imbalance**—provides information on both mass and aerodynamic imbalances, enabling early remedial action to maximize generation capacity and avoid costly damage.

**Blade damage**—provides real-time notification of damage impacting the structural or aerodynamic performance of the blade, enabling early remedial action and avoiding costly damage.

## WIND TURBINE TEST AND MEASUREMENT SYSTEMS



Larger blade sizes, new materials and changing designs make structural testing more critical than ever. Moog offers static and fatigue blade testing using electric or optical sensing technologies.

We offer a flexible approach to testing that can grow and change with your designs.

### Test controllers



The Moog Test Controller affords straightforward test set up and user-friendly analysis of the measured data based on a real-time loop spectrum for faster and more efficient static and fatigue testing.

### Fiber optic sensors

The Fiber Optic Test and Measurement system is a highly configurable, easy to use, load measurement system designed for stand-alone operation or easy integration with existing measurement equipment during testing for blade load verification and regulatory certification.

## PROVIDING THE TOTAL SOLUTION

When a customer came to Moog seeking a better approach to pitch control, we delivered the most flexible and reliable solution to meet their stringent requirements.

### The request

Provide a total pitch control solution—including electric actuator, slip ring, controller and software—that is rated for typhoons, will operate in virtually any climate condition, and will ensure cost-effective operation. What's more, the customer wanted a true global partner who spoke their language and could respond quickly to their needs.

### The solution

Moog's team of experts designed and delivered a total pitch control solution to meet their specific request. The electric solution is fully customized to suit wind conditions at the installation site. It operates in temperatures ranging from

-40 to +60° C (-40 to +140° F). And it is designed for low maintenance and proven reliability with safety check functionality, fail-safe software and monitoring functions for force, voltage, current and temperature.

In addition, the Moog design features individual blade control, giving the customer the option of improving power efficiency by applying a difference in pitch at the top and bottom of the blade's rotation. This improves the customer's degree of design freedom.

### The result

The Moog pitch control solution provides reduced operating costs, low downtime and long service life.



# TAKE A CLOSER LOOK.

Moog solutions for wind energy are only a click away. Visit our worldwide Web site for more information and the Moog facility nearest you.

Argentina  
+54 11 4326 5916  
wind.argentina@moog.com

Hong Kong  
+852 2 635 3200  
wind.hongkong@moog.com

Russia  
+7 83171 31811  
wind.russia@moog.com

Australia  
+61 3 9561 6044  
wind.australia@moog.com

India  
+91 80 4057 6605  
wind.india@moog.com

Singapore  
+65 6773 6238  
wind.singapore@moog.com

Austria  
+43 664 144 65 80  
wind.austria@moog.com

Ireland  
+353 21 451 9000  
wind.ireland@moog.com

South Africa  
+27 12 653 6768  
wind.southafrica@moog.com

Brazil  
+55 11 5523 8011  
wind.brazil@moog.com

Italy  
+39 0332 421111  
wind.italy@moog.com

Spain  
+34 902 133 240  
wind.spain@moog.com

Canada  
+1 716 652 2000  
wind.canada@moog.com

Japan  
+81 463 55 3767  
wind.japan@moog.com

Sweden  
+46 31 680 060  
wind.sweden@moog.com

China  
+86 21 2893 1600  
wind.china@moog.com

Korea  
+82 31 764 6711  
wind.korea@moog.com

Switzerland  
+41 71 394 5010  
wind.switzerland@moog.com

Finland  
+358 10 422 1840  
wind.finland@moog.com

Luxembourg  
+352 40 46 401  
wind.luxembourg@moog.com

United Kingdom  
+44 1684 296600  
wind.uk@moog.com

France  
+33 1 4560 7000  
wind.france@moog.com

Netherlands  
+31 252 462 000  
wind.netherlands@moog.com

USA  
+1 716 652 2000  
wind.usa@moog.com

Germany  
+49 2303 77910  
wind.germany@moog.com

Norway  
+47 64 94 19 48  
wind.norway@moog.com

**[www.moog.com/wind](http://www.moog.com/wind)**

Moog is a registered trademark of Moog Inc. All trademarks as indicated herein are the property of Moog Inc. and its subsidiaries. All rights reserved.  
©2009 Moog, Inc.

Moog Wind Energy Solutions  
Mobium/PDF/0609