

Rotor Ice Control

Safety shutdown and automatic restart of your wind turbine in case of ice events with Rotor Ice Control. Optimize your rotor blade heating with precise ice detection.

The comprehensive performance spectrum of the Rotor Ice Control software offers both turbine manufacturers and operators relevant added benefits:

The ice detection prevents possible ice shedding by switching off the turbine in a timely manner. However, the mass signal is also increasingly used for controlling de-icing systems in order to keep the blades ice-free efficiently and safely. After the ice has melted, the ice detection system can also restart the system automatically.



Turbine Load Control

Protect your turbines from overloads, optimize energy yield while staying inside your load design envelope and estimate the fatigue life of your turbine with Turbine Load Control.

With longer rotor blades, active load reduction mechanisms are becoming increasingly important. Using an existing turbine design for new locations is often the first step.

With reliable blade load measurements, critical system loads can also be minimized and new systems can be designed cost-effectively. In addition, the knowledge of the exact load and the fatigue life of the system allows optimized turbine operation and a prolonged service life of the turbine.



Turbine Integrity Control

Structural damage is a threat to your turbine investment and the profitability of a wind park. Turbine Integrity Control helps you to identify damage early and minimize its financial impact.

This allows minor repairs to be postponed and also serious impacts on energy yield and turbine integrity can be averted.

The system monitors the condition of the rotor blades and other turbine components. Based on this, for example, warning signals can be set via a field bus if blade damage occurs.



fos4Blade R&D

The extension of the serial hardware for the collection of additional measurement variables for extensive prototype tests as well as IEC certifications.

The fos4Blade R&D measurement system is successfully utilized by several blade manufacturers. The system is usually optimized according to the customer's needs in order to gather essential information about existing as well as newly designed rotor blades.

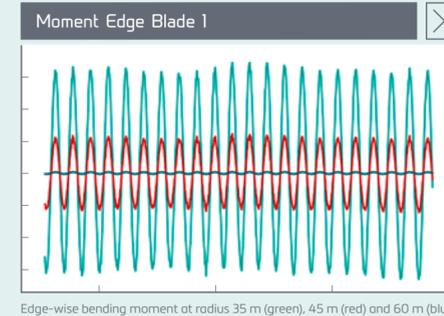
Measurement of Bending Moments

In order to enable the measurement of bending moments at several cross section of a rotor blade, four strain sensors fos4Strain expert are applied at every desired radius.

The calibration can either be conducted at a test facility or later at the turbine. The fiber optic working principle allows to reliably determine flap and edgewise bending moments over the blade's entire lifetime.

The gathered data is used for:

- + Validation of theoretical models
- + Evaluation of bending characteristics
- + Flutter and imbalance recognition
- + Continuous data analysis over the blade's entire lifetime

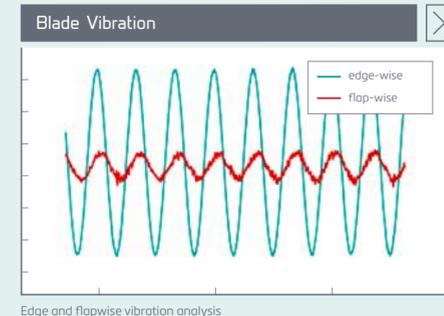


Vibration Analysis

The vibration analysis of a rotor blade is done using fiber optic acceleration sensors fos4Acc at different positions within the blade. Valuable information about the blade's mechanical performance can be derived from the gathered data and a subsequent eigenfrequency analysis. This enables several interesting applications like ice detection, health monitoring and many more.

The gathered data is used for:

- + Validation of the vibration characteristics
- + Determination of eigenfrequencies
- + Continuous data analysis over the blade's entire lifetime



Dynamic Torsion

The torsion sensor fos4Twist is able to measure the torsion angle at several cross sections of a rotor blade. Innovative fiber optic technology enables lightning-resistant twist measurements up to the tip of the blade.

The gathered data is used for:

- + Validation of theoretical models
- + Improved control of pitch angle
- + Gathering data of correlated bending and torsion effects

Surface flush pressure measurement

The pressure sensor fos4Pressure allows quasi-static and non-stationary pressure measurements on the surface of the rotor blade. The innovative sensor impresses with its high overload capacity and with its unique robustness in the field.

The gathered data is used for:

- + Distribution of pressure
- + Laminar-turbulent envelope
- + Aeroacoustics

fos4X is enthusiastic about wind energy applications and is eager to support you with the setup, integration, installation and commissioning of your fos4Blade Research&Development system.

"Exact and extensive data collection with intensive joint planning in order to solve an unsolvable problem – this is fos4Blade R&D."

Innovative Fiber Bragg Grating (FBG) measurement technology

Sensor technology

The advantages of fos4X sensor technology based on the fiber optic principle are:

- + Insensitivity to lightning and electromagnetic interference
- + Large measuring range
- + Long transmission distances and high continuous load resistance

Proprietary demodulation

We are revolutionizing fiber-optic measurement thanks to innovative signal demodulation technology, which enables a lifelong measurement in the industrial environment.

Reliability

Many centuries of cumulated operating lifetime on wind turbines all over the world prove the reliability of

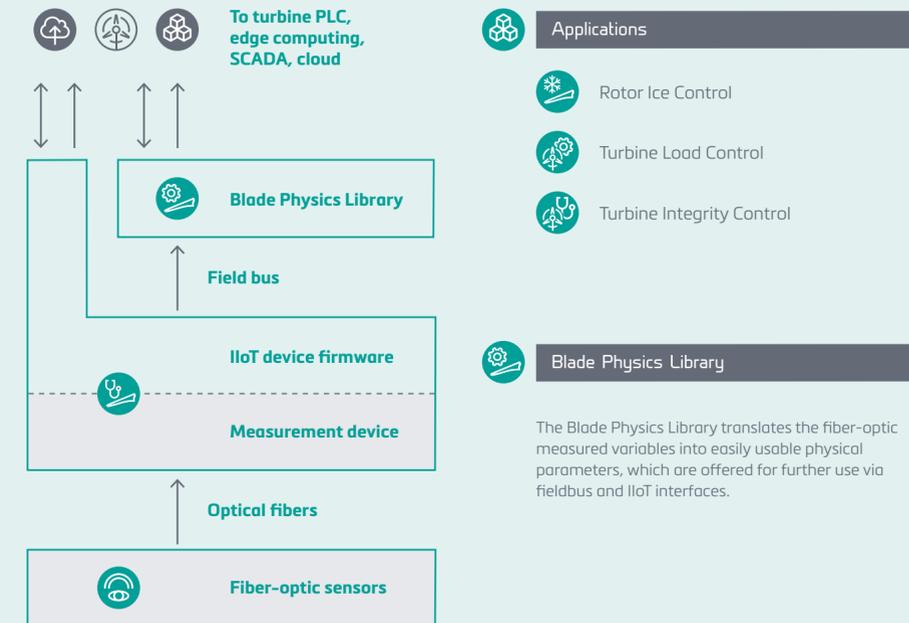


our fiber-optic sensors and technology for rotor blades, which can withstand 1000 times more load reversals at up to 10 times higher amplitudes when compared to electrical measurement technology.

Fiber-optic measuring systems and sensors offer optimal solutions for many areas and applications such as process control, test stands (automotive), infrastructure monitoring, prototype testing and much more...

fos4Blade sensor platform

The fos4Blade sensor platform is designed as the new standard for rotor blade measurements. It consists of several strain and acceleration sensors per blade. The sensors are monitored by a fiber-optic measurement device developed specifically for wind turbines placed in the rotor hub. The fiber-optic measured variables are finally translated by the Blade Physics Library into easy-to-use parameters of the rotor and are provided by fieldbus or IIoT interfaces.



fos4X
rotor blade sensing

Fiber-optic sensors
in every rotor blade

We provide sensors and solutions
to drive smart wind energy

fos4Blade sensor platform

Our fos4Blade sensor platform is a modular system of hardware components with open interfaces as the basis for various solutions for yield optimization.



fos4Strain

- + Fiber-optic strain sensors not affected by electromagnetic interference
- + Longer life-cycles and larger measurement range than conventional strain sensors
- + Temperature compensating design



fos4Acc

- + Fiber-optic acceleration sensors not affected by electromagnetic interference
- + Enables acceleration measurements at the tip of the blade
- + Does not affect the blade lightning protection system



Blackbird OECD

- + Fiber-optic measurement device for dynamic measurements
- + 1 kHz sampling rate – 1 sensor per channel, up to 16 measurement channels
- + Standardized measurement in accordance with IEC 61400-13

fos4Blade equipment

We support the development of customer-specific equipment such as control cabinets, optical cables or blade hub connections as well as data processing.



Data processing capabilities

- + Realtime data processing (for control systems)
- + Framework for customer specific algorithms
- + Webserver for configuration and visualization
- + Internal SSD storage (up to 1TB)



Possible interfaces

- + Ethernet, CAN & CANopen, PROFINET, Modbus TCP/IP
- + Fast implementation of customer specific interfaces
- + Supports standard IIoT protocols



Mechanical equipment

- + Cabinet
- + Blade hub connection
- + Optical cables

fos4Blade R&D

As an extension to the standard platform for the measurement of mechanical loads, strains and vibrations of a rotor blade, there is also the possibility of individual design of the measuring system according to the customer specific requirements.



fos4Twist

- + Fiber-optic torsion sensors not affected by electromagnetic interference
- + Relative measurement of the torsion angle
- + Measurement at any radius and along the entire blade length possible



fos4Temp

- + Fiber-optic temperature sensors not affected by electromagnetic interference
- + Longer service life
- + High signal to noise ratio



fos4Pressure

- + Fiber-optic pressure sensors not affected by electromagnetic interference
- + Robust for measuring on surfaces
- + Quasi-static & dynamic

Applications - software

Our series solutions for yield optimization, cost reduction and increased safety standards at turbine level, as well as park level and cloud level.



Rotor Ice Control

- + Optimizes the operation of wind turbines
- + With safety-relevant stop and certified, automatic re-start, additional income of more than € 10,000 per winter is generated.
- + Control of blade anti ice heating is optimized



Turbine Load Control

- + Protects your wind turbine against overloads
- + Optimizes the energy yield within the load envelope
- + Determines the fatigue life of your system



Turbine Integrity Control

- + Detect damage early with Turbine Integrity Control
- + Avoid catastrophic damage events
- + Schedule maintenance work