BLADE SENSING SYSTEMS

Proven technology for advanced turbine control

The current trend in wind turbine development is towards higher power and lower cost per MW designs. Larger swept areas and rotor diameters enable increased output but also present design challenges. Since loads increase with the cube of the rotor diameter, greater loads can impact reliability and performance.

Moog has worked with leading blade as well as turbine and pitch control designers to develop a modular blade sensing system. Our proven fiber-optic load measurement system enables the fast and reliable development of individual pitch control for your turbine, minimizing your investment and time to market.

In addition to increasing loads, the larger rotor diameter makes the turbine much more susceptible to variations in wind speed and intensity across the swept area, resulting in increased asymmetric loading on the turbine blades, main-shaft and other key structural components.

These challenges can be overcome by designing the turbine with a Blade Sensing System, which dynamically adjusts the pitch of each blade in real time. This enables turbine designers and builders to balance the loading across the rotor disc, eliminate asymmetric loading and reduce the peak loads.

Moog's Blade Sensing Systems has been proven to deliver significant benefits in design, manufacture and post-installation operation. The new MW class wind turbines from initial concept designed with the Moog Blade Sensing System for individual pitch control have experienced lower cost, higher reliability and more efficiency. The most successful systems are fully integrated and installed in the blades and control system during the manufacturing process.

ADVANTAGES

- Proven, reliable technology for wind turbine deployment
- Achieve load reductions through independent pitch control implementation
- Reduce structural materials and lower parts costs
- Proven system based on a mature fiber optic sensing platform
- Enables increased rotor diameter for higher energy yield
- Modified wind class for existing machines
- Facilitates installation on more complex terrains
- Improves reliability and MTBF
- Fast, simple, sensor integration into blade production process
- Create an accurate, reliable and cost effective signal input

APPLICATIONS

- Load measurement system specifically designed for wind turbine operation
- OEM-specific design for simple system integration
- Non-conductive system eliminates EMI and lightning issues in the blade and hub

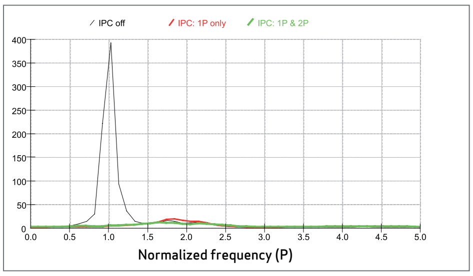
SPECIFICATIONS

Blade Load Sensors are installed in the cylindrical root section of each blade to provide edgewise and flapwise bending moment data to the individual pitch control system. The Sensor Interrogation Unit is designed for installation in the hub PLC or pitch cabinet to enable simple interfacing to the turbine's PLC.

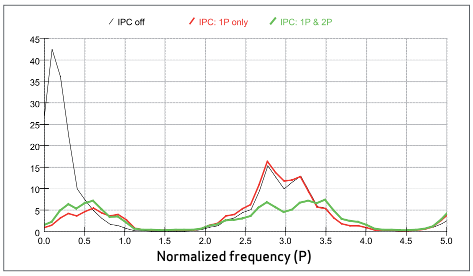
Fibre optic sensor patch

The algorithm is run in the main turbine PLC or in the master pitch controller. This utilizes the data from the blade sensors in conjunction with the turbine data to optimize the blade pitch angles in real time and provide updated pitch commands to the pitch system.

Pitch Systems utilizing electrical and hydraulic actuation mechanisms have been proven to successfully operate as part of an IPC system.



Reduction in Main Shaft Loads with IPC*



Reduction of Stationary Loads with IPC*

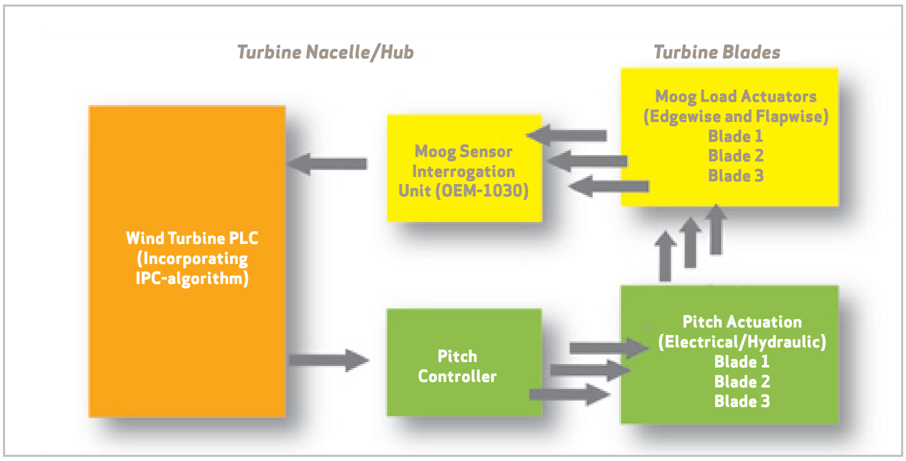
Data courtesy of Garrad Hassan and Partners

It has been demonstrated that IPC using the Moog blade sensing system can significantly reduce loads on the rotor and key structural components, providing load reductions of 10-20 % in the blades, 20-30 % in the main shaft and significantly reduced tower and yaw bearing loads.

TECHNICAL DATA

Number of blades	3
Number of sensors per blade	6 to 8
Range	±4500 microstrain (e)1)
Measurement resolution	1 microstrain (e)1)
Measurement frequency per sensor	25 Hz
Power supply	24 V_{DC}
Power consumption	< 3 W
PLC interface	RS232, RS422, RS485, CANbus, CANopen
Weight	2 kg
Dimensions W x H x D	120 x 240 x 97 mm (4.7 x 9.5 x 3.8 in)
Operating temperature range	-40 to +60 °C (-40 to +140 °F)
Degree of protection	IP40

1) Change in length in relation to source length: e = *L/L, 1 nm = 8061 e



IPC schematic diagram

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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.