



Wind turbine reliability and safety –
even under severe wind conditions

CX9020 Embedded PC for extreme temperatures controls pitch system



Headquartered in Chengdu, the capital city of the Chinese province of Sichuan, Dongfang Electric Corporation (DEW) is a leading company in the fields of energy, electrified railways, environmental technology and heavy industry. DEW has been involved in wind turbine manufacturing since 2004 and is one of the driving forces toward sustainable power generation in China. The company has since delivered more than 7,000 wind turbines – both directly driven and double-fed plants – for Chinese and foreign customers, clearly setting itself apart from its competitors through the use of state-of-the-art PC-based control technology in its wind turbine pitch systems.

The pitch system is particularly important for the control and regulation of wind turbines, as it sets the optimum pitch of the rotor blades for every operating state of the plant. In the partial load area, i.e. at wind velocities below nominal velocity, the blade angle can be adjusted very precisely within a small range, enabling plant operation with optimum aerodynamic efficiency, even during very unsteady wind conditions. At wind velocities above the nominal speed, the blade angle is adjusted over a wider range to ensure that the power output of the plant is restricted to a narrow range close to its nominal power. In extreme cases, e.g. serious malfunctions, the pitch system drives the rotor blades back to the so-called flag position, thus stopping the plant. The reliability of the pitch system is a critical requirement for the safety of the wind turbine: It must guarantee high availability and robustness, in particular when the plant is operated under extreme environmental conditions.

CX9020 Embedded PC as the core of the pitch control system

DEW has leveraged experience gained from the installation of over 7,000 wind turbines and the development of its own pitch system. After careful analysis, DEW opted to use AC servo drives and AC servomotors. These are distinguished by their simple design, high reliability, low costs and easy maintenance. The system architecture of the pitch system developed by DEW essentially consists of three identical axis units: For each of the three blade axes, there is an axis control cabinet, a backup power supply cabinet, a pitch motor, two redundant blade angle encoders, two limit switches and further accessories. The core of the pitch system is a central control unit, which provides overall control of the three axis units. The control platform used here is a CX9020 Embedded PC with inline connected EtherCAT Terminals, all from Beckhoff. Servo drives and servomotors specially developed for use in wind turbines are employed. In addition, the pitch system features a redundant safety chain, which guarantees the optimization and reliability of the safety solution.

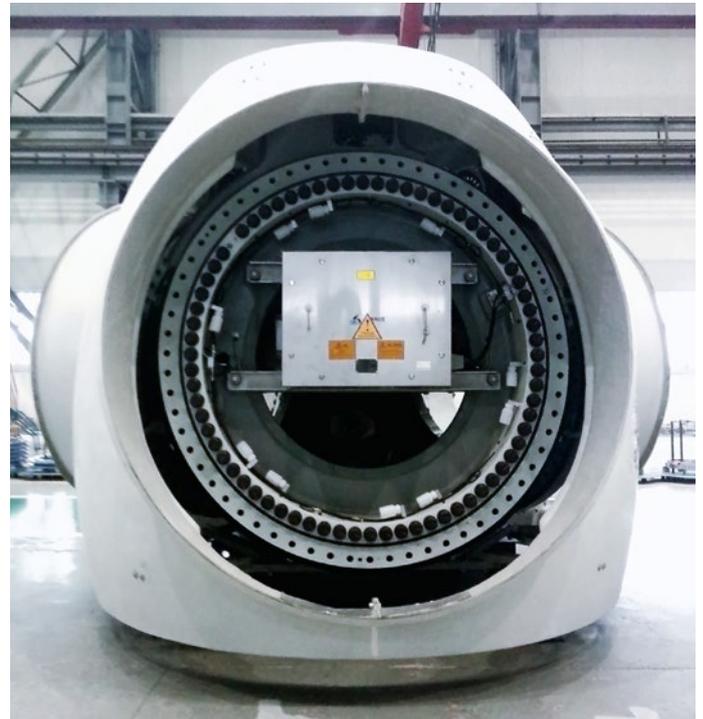
The CX9020 Embedded PC is characterized by its extremely compact size. Also, its operating temperature range extends from -25 to +60 °C, making it compatible with extremely harsh environmental conditions. DEW's self-developed user program runs on the controller, directing and regulating the pitch of the rotor blades, monitoring the complete pitch system in real-time and taking care of error management. EtherCAT Terminals are used for the I/O system, offering fast reaction times, robust diagnostics and flexible communication interfaces.

Specifically, a EL6751 CANopen slave terminal is used in the pitch system for communication between the central CX9020 of the pitch system and the main controller of the wind turbine. The connection between the central CX9020 and the three axis controllers is established via a EL6751 master terminal directly connected to the CX9020, as well as a CANopen slave each within the I/O system of the proprietary axis controllers. The RS485 interface integrated in the CX9020 is used for monitoring the status information of the backup battery chargers. Online access, e.g. for software updates and error analysis in case of pitch system problems, can be implemented via the network interface on the Embedded PCs.

Easy programming with TwinCAT

As a universal development environment and control platform, TwinCAT supports the high-level programming languages Structured Text (ST) and Ladder Diagram (LD), as well as all IEC 61131-3 languages, making programming pro-

cesses easy. "During the development of the pitch system, the engineers from DEW were assisted by the Beckhoff wind industry experts, making it possible for DEW to expedite completion of software development," comments Li Bo, development engineer at Dongfang Electric Corporation and responsible for this project. The next generation pitch system from DEW reflects the spirit of continuous technical innovation. Li Bo is convinced that the two companies' cooperation, which is advantageous for both sides, will accelerate the development of sustainable power generation in China and represent a significant step forward.



Dongfang Electric Corporation has delivered more than 7,000 wind turbines for Chinese and foreign customers. The company sets itself apart from its competitors through the use of state-of-the-art PC-based control technology in its pitch systems.

Further information:

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