PC-based Control: The universal hardware and software platform …

Based on PC and EtherCAT technologies, Beckhoff supplies a complete system solution for the demanding control requirements of the wind industry. An Embedded PC with line-connected I/O modules and the TwinCAT automation software functions as a universal software and engineering platform. EtherCAT, as the industrial strength communication system, offers full Ethernet compatibility and outstanding real-time characteristics. Robust, industry-proven components, libraries specially developed for the wind energy industry, as well as commissioning support and services for control cabinet construction make Beckhoff a competent and reliable partner. A team of experts with vast wind industry experience supports Beckhoff customers worldwide.
... makes wind turbines sustainable.

Automation technology from Beckhoff is used worldwide, providing control for over 30,000 wind turbines, each up to 5 MW in size – both onshore and offshore. All functions can be controlled using a central Embedded PC, from operational management to pitch control and from the control of converters, gearboxes and brakes, to remote access and wind farm networking. The PC-based system collects and processes all the data, checks the feed-in, and communicates with the control room. Safety and measurement technology, as well as Condition Monitoring, are integrated seamlessly into the controller via feature-filled I/O modules. Open hardware and software interfaces permit integrated communication from the sensor to the Cloud.
Open, scalable, modular: Beckhoff control technology …

PC- and EtherCAT-based control technology is characterised by its wide variety of standard hardware and software interfaces. Openness is the basis of the system architecture at Beckhoff which streamlines the integration of functions such as visualisation, safety and measurement technology, as well as third-party software. For all product groups, from the Industrial PCs (IPCs) and Embedded PCs, Control Panels and I/O components to the automation software, Beckhoff offers modular solutions with precisely scalable performance. Interfaces for all common fieldbuses and the large signal variety in Beckhoff I/O modules cover all types of signals and fieldbus systems that are relevant to wind power. In addition, the seamless integration of Beckhoff technology with industrial communication standards such as IEC 61400-25, Ethernet TCP/IP and OPC assures high investment security for the user.
The Beckhoff control architecture is ideally suited to the requirements of the wind energy industry: openness and scalability, flexibility in the design of the controller, and a high degree of integration. The user can configure a performance-scaled controller for a wind turbine from standard Beckhoff components as if from a well-stocked toolkit. Subsequent extensions and modifications are also possible at reduced cost through the modularity of this solution. The integrated PC control platform eliminates the "black boxes" of hardware-based safety or monitoring solutions, ensuring the efficient interaction of all system components. The advantages for the user are the increased availability and, thus, higher efficiency of the wind turbine, as well as a reduction in hardware and engineering costs.
Controller: Universal PC- and EtherCAT-based control platforms

**Pitch control**

Beckhoff offers a complete control solution for pitch systems: The DIN rail-mountable Beckhoff Embedded PCs, with line-connected EtherCAT I/O Terminals or Box modules, are ideally suited to the collective or individual adjustment of the rotor blades. Encoders terminals for all types of blade pitch encoders are available as a standard offering. Intelligent control routines in the single-blade controller enable the reduction of loads that act on the system.

**Operational management**

PC control provides a complete hardware and software solution for operational management in the tower base and nacelle. It is programmed with TwinCAT software under IEC 61131-3. Interfacing with higher-level control systems is based on internationally standardised telecontrol protocols. A webserver for remote user access is integrated into the PC, permitting remote access to the controller. TwinSAFE handles the integration of the traditionally hard-wired, higher-level safety infrastructure into the automation system. In addition, TwinCAT offers comprehensive libraries for control and filter algorithms. Communication between the tower base and nacelle takes place flexibly and inexpensively via fibre-optic cables using EtherCAT.

**PC- and EtherCAT-based control: the complete system**

PC control is the best-in-class technology for efficient control of wind turbines, including safety systems, condition monitoring, remote access, and intelligent wind farm networking. The converter in the base of the tower, the I/O system for operational management in the nacelle, and the pitch controller in the hub are connected to the master controller via EtherCAT. If desired, lower-level fieldbuses such as CANopen, PROFIBUS, and Ethernet TCP/IP can be relocated to the field via fieldbus master or slave terminals for the control of subsystems. The universal use of EtherCAT accelerates communication; the project planning, programming and cabling of the wind turbine are simplified.
Fast wind farm networking based on EtherCAT …

Wind farm networking with EtherCAT is not only faster compared to conventional IP solutions, but also offers substantial cost benefits by eliminating the need for costly switches or hubs. With the EtherCAT power measurement terminal integrated into the automation system, momentary current and voltage values can be measured at high frequencies at up to 10,000 samples/s. With EtherCAT “Distributed Clock” functionality, the measured values of all wind turbines and the measurement at the feed-in point of a farm can be synchronised to a timeframe smaller than 1 μs. TwinCAT supports the standardised IEC 61400-25 communication protocol for wind turbines, which simplifies the monitoring and control of heterogeneous wind farms, including the connection to electric utilities.
… turns the wind farm into a grid-supporting power station.

The producers of renewable energies are faced with the challenge to support grids in the case of voltage drops (Low Voltage Ride Through or LVRT). Wind farm networking with EtherCAT sets new benchmarks here due to its high speed: in case of an LVRT, the setpoint values can be specified for all wind turbines in the entire farm network in less than 1 ms and the control of current, voltage, and frequency can be adapted efficiently. The existing fibre-optic-based Ethernet infrastructure can be used for this up to distances of 20 km without a loss of speed. Even the synchronisation of the IGBTs of converters within a wind farm can be realised with this technology.
TwinCAT, the universal control platform and development environment …

TwinCAT consists of runtime systems for real-time execution of control programs and development environments for programming, diagnostics and configuration. TwinCAT programming, in accordance with the international IEC 61131-3 standard, guarantees high investment security for wind turbine manufacturers. Through support for multi-core technology, computationally-intensive tasks can be executed on a separate core of the central CPU without loss of controller performance. Open interfaces, as well as the use of the latest technological standards based on Windows operating systems, facilitate various extension options and allow the easy integration of third-party software. With regard to the programming language for real-time applications, the TwinCAT 3 user can freely select between IEC 61131-3, C/C++ and MATLAB®/Simulink®.
... simplifies the wind turbine engineering.

With TwinCAT, the wind turbine manufacturer needs only one tool for programming and configuration. The integration of MATLAB®/Simulink® into the development environment of TwinCAT 3 means that a convenient, optional tool is also available for wind turbine simulation, such as for load calculation. Wind-specific experience Beckhoff has gained from many years of success in the industry is bundled into corresponding software libraries. These libraries encompass the flexible modification of brake programs and operational states of the wind turbine, visualisation and parameterisation, as well as simple simulation of operation, including the subsystems and internal communication, logging of events, trends and performance curves, event and alarm handling, and online modifications via remote user access.
The integration of Condition Monitoring into the control platform...

The high-performance processors of modern IPCs and Embedded PCs with multi-core technology, employing EtherCAT as the fast communication system, provide the conditions necessary for the control platform to be capable in performing measuring tasks – virtually “on the side”. Standard EtherCAT Terminals for 3-phase power measurement, oscilloscope functions and PWM offer inexpensive solutions, for example, for network analysis or for monitoring the rechargeable batteries in the pitch system. In this way, Condition Monitoring (CM) can be seamlessly integrated into the existing automation system and the complex integration of traditional hardware-based CM systems with the plant controller is eliminated. Configuration, programming, and diagnostics now take place in one dynamic system using TwinCAT.

www.beckhoff.com/Condition-Monitoring
increases wind turbine availability and prolongs service life.

The monitoring of gearboxes and generators is particularly important for wind turbines in remote regions or offshore. However, the integrated solution from Beckhoff turns even general monitoring, including the foundation monitoring, into an economically sustainable solution. Wind farm failures are thus avoided and the service life of wind turbines is optimised. The sensors measure the vibrations of a bearing or motor and transmit them over EtherCAT to the controller, where signal analysis takes place. This way damage is detected and suitable preventive actions can be initiated before plant downtime occurs. All current status information, for example the rotor speed, is available to the controller with time synchronisation, and as a result, false alarms can be avoided.
Xinjiang Goldwind Science & Technology Co., Ltd., Urumqi, China

PC-based control of 1.5, 2.5 and 3 MW wind turbines without gearboxes

Industrial PC: Embedded PC CX1020
I/O system: EtherCAT/PROFIBUS
  PROFIBUS Bus Coupler BK3150,
  PROFIBUS Bus Terminal Controller BC3150, BX3100
  Bus Terminals
  EtherCAT Terminals
Software: TwinCAT PLC

www.goldwind.com.cn
Guandong Mingyang Wind Power Technology Co. Ltd, China

PC- and EtherCAT-based control platform for 1.5 and 2 MW wind turbines

Industrial PC: Embedded PC CX1020
  built-in Control Panel CP6901
I/O system: EtherCAT Terminals, Bus Terminals
  TwinSAFE Terminals
Software: TwinCAT PLC

Further references
- Zhejiang Windey Co. Ltd., Hangzhou, Zhejiang, China
- Guodian United Power Technology Co., Ltd, Jiangsu Province, China
Areva Wind GmbH, Bremerhaven, Germany

PC- and EtherCAT-based control platform of the M5000 5 MW wind turbine and wind farm networking for the first German offshore wind farm (Alpha Ventus)

Industrial PC: Control cabinet PC C6515
Embedded PC CX9020
built-in Control Panel CP6832
I/O system: EtherCAT Bus Coupler
Bus Terminals
Software: TwinCAT PLC

www.areva-wind.com
Further references
- DeWind Europe GmbH, Lübeck, Germany
- Vensys Energy AG, Neunkirchen, Germany
- Alstom Group, Levallois-Perret Cedex, France
- Mervento Ltd, Vaasa, Finland
- LEITWIND AG/SPA, Sterzing, Italy
- Renewtech LLC, Elbow Lake, MN, USA

Pitch
- Atech Antriebstechnik GmbH, Mehring, Germany
- Moog GmbH, Unna, Germany

Brakes
- Svendborg Brakes A/S, Vejstrup, Denmark

Converters
- TheSwitch, Vantaa, Finland
- Vensys Elektrik, Diepholz, Germany

Obstacle light
- Enertrag AG, Dauerthal, Germany

Condition monitoring
- 8.2 Monitoring GmbH, Hamburg, Germany
- DMT GmbH & Co. KG, Essen, Germany
- Ortosense Wind Power, Birkerød, Denmark
- Končar Inc., Zagreb, Croatia

We reserve the right to make technical changes.
Beckhoff – New Automation Technology

Beckhoff has been implementing open automation systems on the principle of PC-based control technology for over 30 years. The Beckhoff product portfolio covers the main areas of Industrial PC, I/O and fieldbus components, drive technology, and automation software. Product lines are available for all application areas and are used as individual components or as complete system solutions. „New Automatio Technology“ from Beckhoff stands for innovative and industry-independent control and automation solutions that are used worldwide in a wide variety applications, ranging from CNC-controlled machine tools, to wind turbines, to intelligent building control.

Beckhoff at a glance

- Headquarters Verl, Germany
- Turnover 2013: € 435 million
- Staff worldwide: 2,510
- Branch offices in Germany: 11
- Subsidiary companies/representatives worldwide: 33
- Distributors worldwide: more than 60
  (as of 04/2014)

www.beckhoff.com

We reserve the right to make technical changes.
Worldwide presence on all continents

The company headquarters of Beckhoff Automation GmbH in Verl, Germany is the location of the central departments for Product Development, Production, Administration, Sales, Marketing, Support and Service. A strong presence on the international marketplace is ensured by 33 subsidiary companies and cooperative partners in over 60 countries.

Further informationen

The web pages “PC-based Control for Wind Turbines” offer further information, e.g. application reports or industry-specific solutions. ► www.beckhoff.com/wind

The Beckhoff catalogs and flyers are available for download on the Internet. ► www.beckhoff.com/media

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