PC-based Control for Photovoltaic Production
PC-based Control from Beckhoff …

Beckhoff realises automation systems on the basis of PC-based control technology, which are characterised by openness, flexibility, modularity and scalability and have proven themselves worldwide in the most diverse industries. Industrial PCs, Control Panels, I/O components and Drive Technology offer a complete solution for all photovoltaic production requirements on the basis of the TwinCAT automation software and EtherCAT, the fast Ethernet fieldbus.

PC-based Control from Beckhoff uses the high-performance of modern processors for the integration of PLC, visualisation, Motion Control, robotics, safety technology, Condition Monitoring and measuring technology on a single control platform. The uniform hardware platform, based on PC and IT technology, eliminates the friction losses between different hardware controllers. TwinCAT provides the universal engineering platform for programming, configuration and diagnosis. In PC-based Control, an extremely fast control solution is available that increases the performance and efficiency of machines and thus contributes to both ecological and economic benefits.
... redefines future chances for photovoltaics.

In order for the photovoltaic sector to continue to grow, manufacturing costs must be lowered whilst maintaining the same high quality. Innovative and efficient automation solutions are therefore in demand more than ever. PC-based control from Beckhoff increases the productivity and efficiency of your plant through fast, precise control and regulation technology: from the sawing and inspection of the wafer, the various etching and coating processes as well as classification, through to the stringer and lamination lines.

The production of solar cells requires high-precision handling with fast cycle times, dynamic Drive Technology and pinpoint positioning accuracy, with a tolerance of ≤ 0.5 mm. The high-speed machine controller from Beckhoff with I/O response times of < 100 μs offers the ideal solution for this: the cell handling is controlled not only fast and with high-precision, but at the same time decentralised and system-synchronous. Over and above that, sufficient power reserves guarantee high protection of investment for the user.

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Scalable performance permits tailor-made solutions …

Beckhoff offers its complete control system finely scaled in all performance classes: from compact Embedded PCs with integrated I/O interface to Industrial PCs with multi-core processors. From the servo- and stepper motor connection in the format of a standard Bus Terminal to the EtherCAT drive series for the mid and upper performance range, together with the associated motors. A wide range of Control Panels is available for operation and monitoring.

The large variety of signals and fine granularity of the I/O components and the modular structure of the TwinCAT automation software for PLC and motion functions represent an ‘automation toolkit’ for the machine manufacturer. The integrated TwinSAFE safety solution extends from the safety I/O terminals to the complex PC-based safety controller for I/O and motion applications.
... and optimises your key position in the photovoltaic industry.

Scalability and modularity are the prerequisites for automation solutions which, with regard to computing power, performance, complexity and costs, are precisely tailored to your application. PC-based control technology from Beckhoff is thus ideally suited for use in networked, modular photovoltaic production with its different performance requirements. For instance, the EtherCAT servo terminal, together with the appropriate motors, offers precisely the performance necessary for the movement of small loads, as in the case of cell transport between the individual process steps. The high-performance EtherCAT drives are used for wafer production, which requires high dynamics. For the PC hardware, too, the user can choose between different performance classes from the Embedded and Industrial PC product portfolio, so that the available performance is used efficiently.
Universal system solution enables …

The universality of a PC- and EtherCAT-based control solution from Beckhoff provides for the efficient interaction of all system components. An ever increasing number of functions, such as safety technology, Condition Monitoring or measurement technology, are being imaged in software and integrated into the controller. The basis for this is the computing power of modern processors, the high communication speed of EtherCAT and TwinCAT 3, the multi-core-capable automation software. EtherCAT, the Ethernet-based fieldbus system, takes over the entire process communication. On the hardware side, the EtherCAT technology, from I/O systems and Industrial PCs to Drive Technology, is universally available. The TwinCAT automation software is the uniform engineering and runtime environment for all common programming languages from IEC 61131-3 to the high-level languages C/C++. Safety technology is integrated seamlessly into the PC control platform with TwinSAFE, the safety solution from Beckhoff.
process optimisation and reduction in costs.

On account of its universality and high level of integration, the Beckhoff automation solution is ideally suited for the optimisation of all manufacturing steps in the production of wafers, cells and modules and thus for the lowering of costs. For instance, the flexible topology of EtherCAT allows the connection of any number of classification stations within a plant, each of which can be individually switched off without impairing the operation of the plant. Fast communication between the I/O signals and the controller opens up the possibility for the machine manufacturer – without special hardware – to realise Motion Control with a large number of axes, synchronised through the EtherCAT distributed clocks function, with an accuracy of the order of nanoseconds. The use of standard components such as measuring terminals or the integration of robot kinematics in the software allows expensive special hardware to be dispensed with. Hence, hardware costs are reduced, as are the costs for wiring and engineering. Last but not least, the universality of the Beckhoff system solution simplifies operation and reduces training requirements.
PC Control for photovoltaic production

**Wafer production**

- TwinCAT PLC/NC
- Panel PC
- Ethernet
- EtherCAT Terminals
- Emergency Stop
- EtherCAT

**Cell production**

- TwinCAT PLC
- Control Panel
- Ethernet
- DVI/USB
- EtherCAT Terminals
- CANopen

**Module production**

- TwinCAT PLC/NC
- Control Panel
- Ethernet
- DVI/USB
- EtherCAT Terminals
- Servomotor

We reserve the right to make technical changes.
Wafer production
The slicing of the ingots into thin silicon wafers by means of a sawing wire requires a highly dynamic drive solution with synchronous axis movement. Together with the Panel PCs for the control of the high-performance EtherCAT drives and servomotors, the scalability of the Beckhoff system offers a control solution adapted precisely to the requirements. TwinSAFE terminals conveniently integrate the safety technology in the Beckhoff I/O system.

Cell production
In the diffusion furnace an n-type surface layer is applied to the p-type wafers using a phosphorous gas. Phosphorous diffusion results in an electric field in the wafer, which generates electricity when light falls onto the finished solar cell. Together with the CX Embedded PC and the stepper motor terminals, the scalability of the Beckhoff system offers an efficient control solution for the loading and unloading of the diffusion furnace.

Module production
During stringing, individual solar cells are strung together and electrically connected to form solar modules. High-precision Beckhoff drive systems and measuring technology integrated seamlessly into the I/O terminal system are used for this. The strings must be positioned with a tolerance of ≤ 0.5 mm to ensure that the module matrix can be transported to the next station, the fully automated welding station.
TwinCAT, the universal software solution for all control requirements

TwinCAT, the universal automation platform …

TwinCAT, the open, scalable Beckhoff automation software on the basis of Windows operating systems, forms the heart of the PC-based controller. It replaces conventional PLCs and motion controllers and transforms almost any compatible PC into a real-time controller with multi-PLC system, NC axis control, programming environment and operation station. Connectivity to all popular fieldbuses and PC interfaces is supported. Various software function blocks and libraries facilitate the engineering.

By integration in Microsoft Visual Studio®, TwinCAT 3 offers a greater degree of freedom in programming: in addition to the object-orientated extensions of IEC 61131-3, C and C++ are now also available as programming languages for real-time applications. Thanks to the multi-core capability of TwinCAT 3, there are virtually no limits to the further extension of the automation functions of PC Control.

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In TwinCAT, machine manufacturers have a universal development environment and programming standard at their disposal with which they can solve all control tasks, from the smallest Bus Controller to the computer network of a complex photovoltaic manufacturing plant. TwinCAT controls the individual process steps precisely and very productively. Extensive TwinCAT libraries simplify programming and integrate special functions such as robotics. Hence, the TwinCAT Kinematic library allows the execution of pick-and-place tasks such as those required for the loading and unloading of the solar cells.

The use of the C and C++ programming languages in TwinCAT 3 enables the modularisation of the programming code and the encapsulation of machine functions in the software as well as improved legibility, simpler maintenance, reusability and expandability. The integration of Matlab®/Simulink® supports developers in the simulation of elaborate control problem formulations.
Over recent years the demands on communication systems for production facilities have increased significantly. While in the past a wide range of different, more or less special fieldbuses were used, these are now being replaced with a single, significantly more powerful system: EtherCAT, the real-time Ethernet system from Beckhoff, integrates the functional areas I/O, motion and safety and makes control and regulation concepts possible that were previously unrealisable. Classic fieldbus and Industrial Ethernet systems such as PROFIBUS or PROFINET and the corresponding peripherals are easy to integrate via gateways. EtherCAT is characterised by full Ethernet compatibility, maximum utilisation of the Ethernet bandwidth, outstanding real-time characteristics, flexible topology, almost unrestricted network expansion and openness, and simple handling. Thanks to Ethernet and Internet technologies, EtherCAT also offers optimal vertical integration of the controller into the factory automation market.
... for the fastest controller, based on standard XFC components.

With XFC technology (eXtreme Fast Control) Beckhoff offers a new, fast control solution: the optimised control and communication architecture is based on a modern Industrial PC, ultra-fast I/O terminals with extended real-time characteristics, the EtherCAT high-speed Ethernet system and the TwinCAT automation software. With XFC it is possible to realise I/O response times of < 100 µs and thus to considerably increase the performance of machines. XFC increases the process and energy efficiency of all manufacturing steps in the value creation chain of photovoltaic production. The design effort is reduced; if necessary special local, intelligent control components are replaced with simple inputs and outputs, and the system can be extended as required almost without restriction or loss of performance.

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Beckhoff – New Automation Technology

Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff “New Automation Technology” philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

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Beckhoff at a glance

- Headquarters Verl, Germany
- Sales 2010: 346 million €
- Staff worldwide: 2.130
- Sales/Technical Offices: 11
- Subsidiaries/Branch Offices worldwide: 30
- Distributors worldwide: in more than 60 countries (as of 11/2011)
Further information

The web pages „PC-based Control for photovoltaic production“ offer further information, e. g. application reports or industry-specific solutions.

➤www.beckhoff.com/photovoltaic

The Beckhoff catalogs and flyers are available for download on the Internet.

➤www.beckhoff.com/media

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