PC-based Control for Robotics in Handling, Production and Assembly
Open automation solutions for robotics

For over 30 years Beckhoff has been realising automation solutions on the basis of PC-based control technology, which have proven themselves in the most diverse industries and applications on account of their openness and high performance. The globally operative company, whose headquarters and production sites are in Verl, Germany, is represented by 30* subsidiaries and distributors in over 60 countries and employs around 2100* people worldwide. Beckhoff achieved a total turnover of 465 million Euros in 2011. The constant technological development, economic growth, high depth of production and production capacities of Beckhoff guarantee long-term availability and delivery reliability of PC-based control technology.

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... as a uniform control platform for all types of robots.

PC-based control technology from Beckhoff enables the whole process chain for individual processing machines and complete production lines to be controlled and monitored: feeding, joining (welding, gluing etc.), assembly, checking, handling and palletising can be implemented universally with Beckhoff Industrial PCs as hardware platform and TwinCAT as automation software. Beckhoff uses the high performance and multi-core architecture of modern PCs to integrate robotics into the machine controller.

Whether gantry robot, SCARA, articulated robot or parallel kinematics – regardless of the type of robot you use for your processing step – with PC Control solutions from Beckhoff you opt for a universal automation platform. As a result, you not only save hardware costs for an additional robot CPU, you also reduce your engineering expenditure and optimise your production process.

www.beckhoff.com/robotics
The integration of robotics into the control solution ... 

Beckhoff offers products and basic technologies for dynamic handling processes and assembly automation: high-performance IPCs and Embedded PCs with motherboards specially developed for industrial applications, Control Panels as control and display elements, fast and compact I/O components in IP 20 or IP 67, EtherCAT as open and ultra-fast communication system, versatile, dynamic Servo Drive technology and the TwinCAT PLC and Motion Control software. Modern processor architectures and their high performance as well as a fast communication system in EtherCAT are the basis for an extended automation concept, which Beckhoff has brought onto the market under the name of “Scientific Automation”. Scientific Automation allows the full exploitation of processor performance and multi-core support. In addition to measuring technology and Condition Monitoring, robotics also can be integrated seamlessly into the standard controller.
… optimises the manufacturing process and reduces costs.

On the basis of Scientific Automation robotics and Motion Control functions can be optimally combined and synchronised on a single platform. Friction losses or latency times, such as those that occur in communication between different systems, are thus avoided and the manufacturing process is optimised. The high dynamics and repeatability demanded in handling processes can thus be easily achieved. Over and above that, the seamless integration of the robotics into the automation platform makes a separate robot CPU superfluous. This reduces hardware costs and the “Black Box” of the robot controller can be dispensed with. Programming using TwinCAT as a uniform software tool considerably simplifies engineering – without the use of special robotic tools and languages – and the expenditure of time and costs is reduced.
PC-based control for robotics

Feeding

- TwinCAT
  - PLC
  - NC/CNC
  - Libraries
  - Control Panel

- Ethernet
- Connects to other fieldbus systems
- Safety monitoring of the workroom
- Flexible acquisition of I/O signals
- TwinCAT
  - PLC
  - NC/CNC
  - Libraries

Assembly

- TwinCAT
  - PLC
  - NC/CNC
  - Libraries
  - Control Panel

- DVI/USB
- Rapid tool change due to Hot Connect functionality
- Ethernet

Checking

- TwinCAT
  - PLC
  - NC/CNC
  - Libraries
  - Control Panel

- USB
- DVI
- Machine visualisation and control via touch screen
- TwinCAT
  - PLC
  - NC/CNC
  - Libraries

Handling

- TwinCAT
  - PLC
  - NC PTP
  - XTS
  - Industrial PC

- Ethernet

We reserve the right to make technical changes.
Handling
The eXtended Transport System XTS is ideal for individual product transport applications with a continuous flow of material. The motor is completely integrated together with power electronics and displacement measurement. One or more wireless movers can be controlled with high dynamics at up to 4 m/s on an almost arbitrary and flexible path. The compact size can significantly increase the energy efficiency and reduce the footprint of a machine.

Checking
Prerequisite for constant production quality is the connection of suitable auxiliary systems to the controller. On account of its wide variety of interfaces, TwinCAT allows the connection of devices with any desired fieldbus interface. The monitoring of the condition of machines and plants is integrated into the controller – without the use of additional hardware modules – via Condition Monitoring terminals.

Assembly
Gantry robots or articulated robots are frequently used for assembly steps such as joining, gluing, screwing, welding, etc. PC-based control, with multiple parallel tasks and extremely short cycle times, has the performance necessary to simultaneously control many axes. The EtherCAT Hot Connect functionality enables fast tool changes.

Feeding
TwinCAT automation software realises the precise guidance of multiple coupled axes. For example, the four axes of a gantry robot can be realised in a space-saving manner with two 2-channel Servo Drives. The integrated Beckhoff safety solution, TwinSAFE, is available both for safe inputs and outputs and for safe drive technology.

We reserve the right to make technical changes.
TwinCAT, the open Beckhoff automation software ...

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, Motion Control, programming environment and operation station. A connection to all common fieldbuses is integrated. TwinCAT version 3 includes – alongside IEC 61131-3 – C/C++ and Matlab®/Simulink® as programming languages for real-time applications. Numerous PLC libraries with function blocks according to the PLCopen Motion Control standard facilitate programming. Due to the multi-core capability of TwinCAT 3 all cores can be used to the optimum, leading to a significant increase in performance.

www.beckhoff.com/TwinCAT
that provides for a leap in efficiency even during the engineering.

TwinCAT provides the user with a uniform tool for universal configuration, programming and diagnostics. Robotic and Motion Control functions can be synchronised optimally using TwinCAT NC PTP (point-to-point axis positioning) or NC I (axis interpolation in three dimensions). All NC characteristics such as “cam plate” or “flying saw” can be combined as desired on a common hardware and software platform.

Using TwinCAT almost all robot kinematics can be programmed in normal PLC programming language – without special robotic tools and languages. This guarantees efficient engineering and the engineering costs can be considerably lowered. TwinCAT 3 enables the integration of C or C++ code. This way, you can simply continue to use existing robot kinematics. In addition to C/C++, existing models can also be integrated into Matlab®/Simulink® models. These can be used for controllers or for simulations.
The "TwinCAT Kinematic Transformation" software library integrates the robot controller into TwinCAT, so that PLC, Motion Control, HMI and robotics are now integrated on one Industrial PC. The following kinematics have been implemented so far: Cartesian gantry, shear kinematics, roller kinematics (H-Bot), SCARA, 2-D kinematics, 2-D parallel kinematics and 3-D delta-kinematics. Further kinematics are planned. The respective kinematics can be selected and parameterised conveniently in the TwinCAT System Manager. The kinematic channel is used to parameterise the type (e.g. delta or SCARA) and the bar lengths and offsets. Mass and mass inertia values can be specified for dynamic pre-control. In addition, TwinCAT Kinematic Transformation offers tracking functions. This means that the robot is synchronised with a moving object, so that it can pick up workpieces from conveyor belts or inclined turntables, for example.

www.beckhoff.com/kinematics
... for the integration of robot kinematics into a standard controller.

Using “TwinCAT Kinematic Transformation”, various parallel and serial kinematics such as those used, for example, for pick-and-place tasks can be realised. The seamless integration of the robot kinematics into the controller allows not only an additional robot CPU to be dispensed with, but also provides for optimal interaction and synchronisation with the PLC and the existing Motion Control functions. Direct interfaces take the place of complex communication between different controllers and systems. This results in high performance and improved accuracy. The universality of the solution provides the user with a number of further benefits: configuration, programming and diagnostics take place with TwinCAT in a single system or with uniform tools, so that the engineering is considerably simplified.
EtherCAT – Ethernet for Control Automation Technology

EtherCAT (Ethernet for Control Automation Technology) is the real-time Ethernet solution from Beckhoff for industrial automation. It is characterised by outstanding performance, with 1000 distributed I/Os in 30 μs, almost unlimited network expansion, flexible topology and, thanks to Ethernet and Internet technologies, optimal vertical integration of the controller into the factory automation. All I/O components can be integrated directly into the EtherCAT communication, so that lower-level communication systems can be completely dispensed with. Synchronised by the EtherCAT distributed clocks, Motion Control applications with multiple axes and an accuracy of the order of nanoseconds can be controlled precisely and with exact repeatability. Safe transmission of data is possible with the Safety over EtherCAT protocol up to SIL 3 of IEC 61508.
The use of EtherCAT in the field of robotics offers numerous benefits, such as maximum performance, extremely short update times for the process image (to less than 50 μs), flexible topology, simple configuration and unrestricted Ethernet compatibility. Even control loops (up to the current controller) can be closed via EtherCAT. Control of the axes can thus take place centrally in the controller – including the coupled motion functions. EtherCAT provides the user with maximum flexibility in choosing between a line, star or tree structure for the control topology. Addresses are assigned automatically. Since the EtherCAT protocol is retained into each device, lower-level bus systems can be dispensed with, allowing extremely short reaction times.

www.beckhoff.com/XFC
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.

Beckhoff at a glance

- Headquarters Verl, Germany
- Sales 2011: 465 million €
- Staff worldwide: over 2,100
- Branch Offices Germany: 11
- Subsidiaries/Branch Offices worldwide: 30
- Distributors worldwide: in more than 60 countries (as of 03/2012)

www.beckhoff.com

Turnover development

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

The central divisions of Beckhoff, such as development, production, administration, distribution, marketing, support and service are located at the Beckhoff Automation GmbH headquarters in Verl, Germany. Rapidly growing presence in the international market is taking place through 30 subsidiaries. Through worldwide co-operation with partners, Beckhoff is represented in more than 60 countries.

Further information

The web pages “PC-based Control for Robotics in Handling, Production and Assembly” offer further information. 

www.beckhoff.com/robotics

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

www.beckhoff.com/media

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