Quantum leap in micromachining with open, high speed CNC

12 | products
Successful energy management based on integrated energy measurement

16 | interview
Industry 4.0: PC-based control concept as the core technology for the Smart Factory
10
CP32xx Panel PC for mounting arm installation supplements comprehensive multi-touch portfolio

12
Scientific Automation: Successful energy management based on integrated energy measurement

20
Industry 4.0: Interview with Andreas Thome about the convergence of mobile technologies and automation – Google Glass for industrial automation

40
Park Hotel Vitznau, Switzerland: PC- and BACnet-based building automation boosts efficiency and comfort behind historic walls
4 | news
Hannover Messe 2014:
The evolution of Industry 4.0

8 | products
CX5100 Embedded PC series: Fanless compact controller with single, dual or quad-core Atom™ CPU

9 | interview
Open control technology: IO-Link, an international communication standard according to IEC

10 | products
CP32xx Panel PC for mounting arm installation supplements comprehensive multi-touch portfolio

12 | Scientific Automation: Successful energy management based on integrated energy measurement

16 | interview
Industry 4.0: PC-based control concept as the core technology for the Smart Factory

20 | Convergence of mobile technologies and automation: Google Glass for industrial automation

24 | Fieldbus systems versus Industrial Ethernet

26 | cover
Willemin Macodel, Switzerland: PC-based CNC solution for machining and handling small parts

30 | worldwide
KUKA, Germany: KR C4 robot controller uses EtherCAT

34 | building automation
Interview: More efficiency, more comfort, more safety

38 | Light + Building 2014: Increased efficiency for engineering and building

39 | SMI master terminal integrates light and shading solutions into building automation

40 | Park Hotel Vitznau, Switzerland: PC- and BACnet-based building automation boosts efficiency and comfort behind historic walls

44 | Miele, Germany: BACnet, EnOcean and DALI communication for higher implementation flexibility and easier operation

48 | Sensirion, Switzerland: Innovative building services optimize the use of renewable energy resources

51 | worldwide
Topocare, Germany: Innovative dike building machine revolutionizes flood protection

54 | ETG
News and activities of the EtherCAT Technology Group

56 | events
Record number of visitors at SPS IPC DRIVES 2013

57 | Trade shows spring 2014: Interpack, Sensor + Test, Automatica

58 | Trade shows and events 2014

imprint
With its international sales team, Beckhoff will show its complete range of solutions and its latest innovations in the areas of IPCs, I/O, Motion and automation on over 1,000 square meters.

More performance with new multi-core CPUs
In the IPC Forum, the main focus will be on the special “Multi-Touch Integrated” presentation with its scalable spectrum of active and passive panels. Among the innovations is the CP32xx Panel PC series with all-around IP 65 protection and high performance processors ranging up the Intel® Core™ i7.

Hannover Messe: PC-based control as the technological foundation for Smart Factory applications

By making “Integrated Industry – Next Steps” its motto, Hannover Messe 2014 is signaling that Industry 4.0 continues to be the main topic at the world’s leading industrial trade show. With its implementation of Industry 4.0, PC-based control technology from Beckhoff provides the ideal toolbox for these concepts. Even today, many users are integrating Beckhoff controllers into their production networks to let them communicate with databases, perform remote maintenance over the Internet or request cloud-based services. Beckhoff will demonstrate these and other technologies, functions and services live at its main booth this year at Hannover Messe.

As a matter of fact, a broad spectrum of Beckhoff Industrial PCs now features the 4th generation of Intel® Core™ i3, i5 and i7 processors. Compared with the 2nd and 3rd generation, the new multi-core CPUs deliver more performance for PC-based controllers thanks to their higher cycle rate and an improved graphics processor. And the introduction of the latest Intel® Atom™ CPUs now makes multi-core technology available in midrange controllers as well. All devices of the new CX5100 Embedded PC series are fanless and feature low power consumption and a compact design.
More engineering efficiency with TwinCAT 3

TwinCAT 3 is optimized for more efficient engineering with its integration into Visual Studio®, its choice of programming language and its modular software creation environment. Innovations being shown by Beckhoff at this year’s Hannover Messe include the TwinCAT PLC HMI and TwinCAT PLC HMI Web visualization systems. TwinCAT Automation Interface provides an interface for automatic code generation and the TwinCAT ECAD Import Tool offers additional support for a more efficient engineering.

Servo drives in a Bus Terminal up to 4 A RMS

The servo terminals in the EL72xx series of the EtherCAT Terminal system feature a complete servo drive in a standard terminal housing. The new EL7211 model is designed for small high-performance servo drives with up to 4 A RMS at 50 V DC.

Servo drives for low power ranges

The new AM811x and AM801x servo motors feature absolute encoders with 15-bit resolution and One Cable technology for areas with very limited space. The scalable performance ranges from 50 to 250 watts. Three available lengths and a backlash-free permanent-magnet holding brake cover all requirements. In combination with the EL7201/EL7211 EtherCAT Terminals, they provide a cost-effective servo system for any application.

Main information at a glance:
- Hannover Messe 2014, Germany
- April 7 to 11, 2014
- Opening hours: Monday to Friday, 9:00 am to 6:00 pm
- Main Beckhoff booth: Hall 9, Booth F06

Beckhoff at partner booths:
- EtherCAT Technology Group: Hall 9, Booth D18
- EPLAN: Hall 7, Booth D18
- OPC Foundation: Hall 9, Booth A11
- it’s OWL: Hall 16, Booth A04
- PROFIBUS Nutzerorganisation: Hall 9, Booth D68
Within a special Industry 4.0 forum at its booth, Beckhoff will also demonstrate that all basic technologies, functions and services for Industry 4.0 are already available today. New products and advances will continue to support this development over the coming years. The forum focuses on PC-based Control as the technological foundation for the Smart Factory. And with the PC as the generally accepted platform in combination with the Automation Device Specification (ADS), EtherCAT Automation Protocol (EAP) and OPC Unified Architecture (OPC UA), Beckhoff offers everything a user needs to implement the vertical and horizontal integration as the key requirement for Industry 4.0. The technology demonstration from Beckhoff will cover various sub-processes of a Smart Factory:

- Consistent communication from the sensor to the cloud
- M2M communication via the “Internet of Things”
- New operating and diagnostic concepts in the form of web-based operating consoles and Google Glass
- Ensuring process reliability via integrated measurement technology and Condition Monitoring
- Sustainable production with power monitoring and power management
- RFID as the basis for parts tracking and “intelligent products”

- Integration of robotics and innovative drive technologies
- Flexible and efficient production of lot sizes ranging from 1 to n through highly dynamic positioning with the XTS linear transport system
- Integration of safety and security
- Consistent engineering
- Reduced commissioning times through real-time simulation
- Remote production facility maintenance worldwide

Dr. Ursula Frank, Project Manager R&D Cooperations at Beckhoff, says about the basic concept of the Industry 4.0 forum: “We want to demonstrate at this year’s Hannover Messe that our open PC-based control technology makes it possible even today to seamlessly integrate production systems and modules into existing or new systems so that they can communicate with each other, as well as with higher-level production planning and control levels. Any changes in the job schedule or the current production run can thus have an immediate impact on the production flow. All of this already functions in practical applications. To fully implement Industry 4.0, however, additional research and development is still needed over the coming years.”

Further Information:
www.beckhoff.com/hmi
Further Information:
www.hannovermesse.com

As industrial manufacturing advances with breathtaking speed, today’s enterprises face huge challenges. These manufacturers must continuously improve efficiency, respond instantly to changing markets, and satisfy the demand for ever more customized products. The factory of the future must be even more flexible and smarter than it already is. The key to mastering these challenges lies in automation. At the 2014 Hannover Messe, the leading suppliers of automation technologies and software show the way forward.

Consequently, the world’s most important industrial trade fair is also the platform where decision-makers from the manufacturing industries will determine the future. The strongest ideas and best solutions compete directly against each other on the highest level in Hannover.

With “Integrated Industry – Next Steps” as its motto, this year’s Hannover Messe highlights the central issues shaping the future of manufacturing and demonstrates what the next steps will be toward Smart Factories. In the “Industrial Automation and IT” segment, exhibitors will show the complete spectrum of innovations in manufacturing and process automation, as well as industrial IT solutions.

After all, enabling advanced communication among machines, systems and even products is the central prerequisite for flexible and intelligent factories of the future. Many new solutions have been developed in this area in recent years. Control technology from Beckhoff, for example, offers an ideal toolbox for Industry 4.0 concepts and is already available today. This means Beckhoff provides exciting answers to the most important question being asked in Hannover: What steps can manufacturers take today in order to turn their vision of a Smart Factory into the reality of a fully-networked Industry 4.0 factory?

If you want to keep your business competitive for the future, you can’t pass this event by. The next milestone in the roadmap to the factory of the future is in Hannover. I look forward to seeing you there.

Dr. Jochen Köckler, Member of the Board of Management, Deutsche Messe AG
With the introduction of the CX5100 Embedded PC series based on the latest Intel® Atom™ CPUs, multi-core technology is now also available for controllers in the medium performance class. The 22 nm technology with the new Atom™ processors results in higher performance while maintaining the same exceptional thermal balance. All devices from the CX5100 series are fanless and are characterized by low power consumption and a compact housing format.

The DIN rail-mountable CX5100 controllers use processors of the latest Intel® Atom™ generation (“Bay Trail”). The CX5100 series features three different types of devices with different processors and housing sizes:

- CX5120: Intel® Atom™ CPU, 1.46 GHz, single-core
- CX5130: Intel® Atom™ CPU, 1.75 GHz, dual-core
- CX5140: Intel® Atom™ CPU, 1.91 GHz, quad-core

The CX5100 devices supplement the existing CX5010 and CX5020 series of devices which are based on processors of the first generation of Intel® Atom™ CPUs. By comparison, these new processors offer significantly higher performance, since they feature out-of-order command execution. This means that users who have also implemented the TwinCAT 3 automation software suite can now benefit from the full availability of multi-core processors and from the optimized distribution of different program sections to individual cores, even with Intel® Atom™-based devices.

The basic interface equipment corresponds to that of the popular CX5000 devices: automatic recognition of K-Bus or EtherCAT Terminals, two independent Gigabit-capable Ethernet interfaces, four USB 2.0 ports, a DVI-I interface and a “multi-option” interface that can be equipped to support a great variety of fieldbus systems. The extended operating temperature range from -25 to +60 °C enables the use of the CX5100 Embedded PCs in climatically demanding environments.

The new CX5100 controllers are positioned in terms of both price and performance between the devices from the CX5000 series and the modular CX2000 series.

Further Information:
www.beckhoff.com/CX5100
IO-Link, an international communication standard according to IEC

The IO-Link communication system has been available worldwide since October 2013 as an international standard (IS) according to IEC 61131-9. IO-Link is thus the first worldwide standardized technology for communication with sensors and actuators below the fieldbus level. Although numerous manufacturers of automation equipment already offer an impressive variety of devices, IO-Link is set to move even more into the awareness of potential users in the future for good reason. Beckhoff supports all common fieldbuses and Industrial Ethernet systems with its open I/O systems. Elektrotechnik editor Ines Näther spoke to Torsten Budde, Fieldbus Systems Product Manager at Beckhoff, about the implementation of IO-Link into the EtherCAT Terminal system.

What technical and economic benefits does IO-Link offer users as an open technology for the lower field device level? What added value is gained and what new solutions can be created with it?

Torsten Budde: A uniform interface with simple wiring at the sensor/actuator level has been created in IO-Link, which simplifies the commissioning and integration of complex sensors into all common fieldbus systems. Beckhoff supplies an extensive range of fieldbus components that permits the connection of all common I/Os and fieldbus systems to the IO-Link interface and thus to the sensor/actuator level. Any desired combination of IO-Link devices and sensors/actuators without an IO-Link interface is possible on the IO-Link master. The connected IO-Link devices can be universally identified, diagnosed and simply replaced if necessary without having to carry out parameterization again. These advantages lead to faster project planning, a reduction in troubleshooting work, a reduction in downtime when changing products - all of which adds up to impressive cost-saving benefits.

In addition to the process data, parameter and diagnostic data are also transmitted with IO-Link. How is the intensified demand for simple operability fulfilled?

Torsten Budde: The IO-Link configuration tool is directly integrated into the TwinCAT software system. Apart from the programming of the control system, the cyclic data from various fieldbuses are collected in process images in TwinCAT, including the data from the IO-Link devices, for which reason no separate configuration tool is required. With TwinCAT, higher-level fieldbuses such as EtherCAT can be connected conveniently to the sensor/actuator level and configured simply in one software platform. Additionally, the scan function of the IO-Link devices facilitates their easy integration. In connection with the import of the device description file IODD (IO Device Description), the parameters and diagnostic data can be accessed directly via the configuration tool. The IO-Link parameters and diagnostic data can also be accessed simply and conveniently from a user program with the TwinCAT software system.

How can users select products that are suitable for them and what specifically does your company offer?

Torsten Budde: For IO-Link solutions in the “fieldbus-neutral” I/O system, Beckhoff has developed compact, 12-mm-wide IO-Link master terminals that can be seamlessly integrated into the Bus Terminal system. The IO-Link master can thus be operated in a terminal rack with a multitude of signal types and enables the user to construct a topology that is ideal for the respective application. Apart from the IO-Link terminals with IP 20 protection there is also an IO-Link master with IP 67 protection. Thanks to the robust design, use is possible directly on the machine in wet, dirty or dusty environmental conditions without a control cabinet or terminal box. All Beckhoff IO-Link masters support the IO-Link specification V1.1.

Published in Elektrotechnik 11/2013, Vogel Business Media, www.vogel.de
Multi-touch functionality and high-end computing power all in one dynamic machine controller

With the new CP32xx Panel PC series, industrial multi-touch displays can now also be used as an all-in-one, high performance device directly in the field. These powerful devices for mounting arm installation feature all-round IP 65 protection and integrate best-in-class multi-touch Control Panel technology with a high-performance add-on IPC, all in one compact housing.
The area at the rear of the CP32xx Panel PC, which is required for swivelling and tilting the connected mounting arm, is also efficiently used to accommodate the added IPC components using little space. The components in this solution are thermally decoupled from each other: to save space, the computer is built around the integrated mounting arm in a u-shaped housing with cooling fins for passive cooling.

Despite its compact design the CP32xx offers excellent heat dissipation characteristics which are achieved using internal fans. This ensures even heat distribution to all walls of the housing. This results in a Panel PC operating temperature range from 0 to 45 °C. Moreover, all components are easily accessible, which is convenient when using storage media such as a CFast card or SSD. The connecting cables are laid through the support arm into the connection compartment for up to six IP 65 connectors. In the basic configuration, two of the connection points are configured with an Ethernet interface or power supply; the remainder are optionally available for a further Ethernet, USB or serial interface or for a Mini-PCI fieldbus. The cylindrical connector hood in the centre of the device is easy to remove. This enables convenient access to the connection compartment and also facilitates the cleaning of the cooling fins if necessary.

For maximum computing power beyond the standard 1.6 GHz Intel® Celeron® CPU with two cores, the CP32xx Panel PCs also offer the option to use Intel® Core™ i series processors of the second, third and fourth generations. Two cores can be used with Intel® Core™ i3 and i5 processors and four cores with the i7 processor. Panel PC displays are available in 12 to 24-inch sizes, in both 4:3 and widescreen formats as well as in landscape and portrait modes. Further features include a free Mini-PCI slot for factory-installed cards, 2 GB DDR3-RAM (extendable to 16 GB), hard disk, CFast card or SSD, on-board dual Ethernet adapter with 10/100/1000 Base-T connection and an on-board SATA RAID-1 controller (Intel® Rapid Storage Technology).

The aluminium housing design means the Panels are exceptionally robust and ideally suited for industrial applications. A narrow, circumferential metal impact protector reliably protects the touchscreen surface, including the display against mechanical destruction. The all-glass surface is chemically hardened, has an anti-reflection coating and offers maximum resistance to environmental influences.

The multi-touch panels with projective capacitive touchscreen (PCT) technology feature a high touch-point density enabling accurate, safe and jerk-free operation even in minute steps. The panels can also be operated with thin latex working gloves. Five-finger touch and automation solutions with 2-hand operation are equally possible.

Further Information:
www.beckhoff.com/CP32xx
Beckhoff offers a broad portfolio of solutions from energy measurement to grid analysis for a wide range of applications, including machines and production equipment, factories and buildings, as well as wind and hydroelectric plants. The product range includes a stand-alone energy meter as a cost-effective solution configured from standard industrial components. Yet on the other hand, the Beckhoff Bus Terminal system offers ample scope to meet a wide range of requirements, both for individual applications as well as for integrated energy measurement.

Through continuous and intensive efforts, industrial productivity has already increased to a level where the potential for further improvements is limited, at least for the time being. In contrast, energy efficiency still offers immense potential for improvements. Without requiring major financial investments, cost savings can be achieved simply by making energy consumption more transparent and by optimizing production processes: a reduction in peak loads and corresponding agreements with the energy supplier can be sufficient to make substantial progress.

In addition, most companies in industrialized nations are coming under increasing political pressure to reduce their energy consumption and CO2 emissions. For example, future repayments of the levy that resulted from the German Renewable Energy Act will be linked to the introduction of an energy management system (EnMS). A basic prerequisite for this is reliable and detailed data logging of energy, which is why monitoring, measurement and analysis is defined in the EnMS model of the corresponding DIN EN ISO 50001 standard. Beckhoff solutions with integrated measurement functionality are ideal for implementing this. The solution consists of a modular I/O terminal system, TwinCAT automation software and open communication, e.g. via EtherCAT and OPC UA.

**Successful energy management based on integrated energy measurement**

**Stand-alone and integrated energy measurement made easy**

The Beckhoff solution, in the form of stand-alone energy meters, already offers advantages over conventional devices: The modular configuration, consisting, for example, of the compact CX8090 Embedded PC (with standard Ethernet connectivity) and the EL3403 power measurement terminal results in a highly customizable solution. The user benefits from reliable, cost-effective and standard industrial components (see figure 1).
The integrated approach, however, opens up significantly larger potential for efficiency improvements: The open and integrated Bus Terminal I/O and software system from Beckhoff enables simple and cost-effective energy measurement that is fully integrated in the system. The energy consumption of all consumers can be measured anywhere in a plant or building and at any number of locations. The benefit of this integration is that the power measurements are available directly in the I/O system, without the need for a separate automation system. The corresponding Bus Terminals and software modules can simply be added to the control system as required. On the one hand this reduces the efforts to implement comprehensive monitoring of energy consumption, and on the other hand it makes total consumption data available as well as the data for all sub-processes.

**Modular and integrated measurement of energy data**

The solution is based on a large number of I/O modules for energy data acquisition. For example, commonly used gas, water and heat meters can be integrated very easily via the KL6781 and KL6401 Bus Terminals and the M-Bus or LON interface. In addition, the compressed air supply can be monitored directly with the KM37xx differential pressure measuring terminal and the IP 67-rated EP3744 differential pressure measurement box, which can be deployed locally. In this way, the system can be monitored for energy-wasting leaks, for example. Electrical parameters can be monitored conveniently via the KL/EL3403 power measurement terminals. The EL3413 and EL3433 power measurement terminals and the EL3773 mains monitoring terminal offer further analysis functionality.

The different Bus Terminals can be used locally in the areas where they are required for precise measurements. This minimizes the wiring effort for measured data acquisition. A single EtherCAT cable (standard Ethernet media) can connect the individual stations, so that all data can be collected and analyzed in a central PC controller. In this way the energy consumption of individual components, sections or the whole plant can be fully monitored. The energy consumption data for the entire factory, offices and other buildings are also available.

**Analyzing and utilizing consumption data via software**

The logged energy consumption data are available in an open, PC-based system at all software levels via EtherCAT – or via any other fieldbuses as required. The TwinCAT automation suite can be directly deployed at the control system level, both for control parameter use and for condition monitoring and energy consumption analysis. Thanks to the system openness, connectivity to a higher-level energy management system can be provided via any of the established and open software standards such as OPC UA.

TwinCAT PLC software makes consumption data available directly for correcting control algorithms, in order to improve the energy balance of the machine, system or production process. The automation suite also offers useful tools for monitoring and analysis: The Beckhoff TwinCAT CMS Condition Monitoring library offers a modular system of mathematical algorithms for analyzing measurement readings, so that energy monitoring of machines and systems can be realized efficiently. The user can select components from this modular system...
as required for the respective application to develop solutions that are scalable for different platforms. The library’s primary functions include: analysis, statistics and classification.

Comprehensive monitoring of energy data is also possible with the TwinCAT Scope software oscilloscope, which combines fast data logging with a powerful graphic display tool. The logger can process long-term recordings as well as very fast cycles in the μs range, e.g. from EtherCAT measuring terminals such as the EL3773 with oversampling function. The results are then displayed in the viewer section of the Scope. The viewer can display virtually any number of curves with high temporal resolution. In this way the user can reliably detect whether the voltage is sinusoidal or subject to harmonics. Thanks to the high temporal resolution, it is possible to analyze very short-term peaks, which are difficult to handle with conventional EMS/SCADA systems.

The versatility of integrated energy measurement technology

Energy costs are rising worldwide, which means that energy data logging is becoming more important in all industrial sectors. This puts monitoring and analysis in the spotlight and opens up the potential for savings in many areas. The EtherCAT power measurement terminals from Beckhoff with their different voltage ranges and optional features are suitable for a wide range of applications. They are ideally-suited to achieve cost-effective and efficient power data acquisition and analysis, enabling better system productivity through integrated measurement of current and voltage. The modular and distributed configuration enables the measurement of energy at any location in the system. The RMS value can be logged either directly by an EtherCAT Terminal or – in the case of the EL3773 – by a higher-level controller.

In this way it is possible to stabilize production processes, avoid production losses, detect stray couplings and identify power waste in areas such as machine construction and plant engineering, the process industries, renewables as well as building and home automation. Other options include correct cost center allocation, supply monitoring, mains synchronization and current quality monitoring. The benefits of the holistic, integrated Beckhoff solution become particularly apparent if you look at a complete production hall, for example: Energy data for machines and systems, right down to individual motors and building services such as lighting and HVAC, can be logged in an integrated manner. These comprehensive data enable truly holistic energy management across the enterprise.

The KL/EL3403 "energy meter"
The KL3403 and EL3403 3-phase power measurement terminals enable the measurement of all relevant electrical data of the mains supply with a measuring voltage of up to 500 V AC. The mains voltage can be connected directly. The current measurement takes place via simple current transformers. The measurement readings for all currents and voltages are available as effective values directly in the terminal. For each phase the effective power, apparent power, reactive power, energy, frequency and phase shift angle $\cos \phi$ are all calculated.

The KL3403/EL3403 terminals provide reliable data for grid analysis and energy management. Thus they are ideal for distributed monitoring and logging of energy consumption in a production plant, for example. By identifying “power guzzlers” in the process cycle it contributes to reducing electricity costs and enables precise allocation of the respective electricity costs to the corresponding cost center. Detailed measured energy consumption data can also be used for control purposes, for increasing the stability of the production processes or avoiding production downtime, for example.

EL3413, the "feature-filled energy meter"
The EL3413 three-phase power measurement terminal, with a test voltage of up to 690 V AC (3-phase, 5 A), has electrically isolated current inputs. Thanks to
the integrated calculation of harmonic oscillations, simple grid analysis up to the 21\textsuperscript{st} harmonic can be carried out (see figure 2). With a higher test voltage of 690 V which is common in wind turbine applications the EL3403 is suitable for a feed-in monitoring of wind turbine generators, for example.

Harmonic analysis with the EL3413 is particularly advantageous with regard to the 3\textsuperscript{rd} harmonic. Due to the increased deployment of non-linear electronic devices such as discharge lamps, computers and UPS systems, the stability of the mains can be affected, resulting in increased electrical losses in electric motors, for example. The corresponding 150 Hz currents of the individual phases add up in the neutral conductor and can result in a higher current than in the phase line. If the neutral conductor is dimensioned insufficiently, this may even result in increased fire hazard.

**EL3773, the “power oscilloscope”**

The EL3773 mains monitoring terminal logs the actual values of current and voltage with very short sample times and is therefore ideally suited for high-end grid analysis and state monitoring of a 3-phase AC power supply system (see figure 3). For each of the phase voltages, up to 288 V\textsubscript{eff}/410 V DC and currents up to 1 A\textsubscript{eff}/1.5 A DC are sampled as instantaneous values with a resolution of 16 bit. The six channels are simultaneously sampled based on the EtherCAT oversampling principle with a temporal resolution of up to 100 μs, i.e. with a temporal resolution that is significantly higher than the communication cycle time.

These parameters are passed to the associated controller. With the high computing power of PC-based controls, the parameters can be used for true RMS or power calculation, and for processing complex user-specific algorithms. This enables the user to perform detailed calculations or analyses and to display the actual current and voltage curves using TwinCAT Scope software. These benefits are particularly significant for grid synchronization in hydroelectric plants, for example.

**Seamless integration of measurement technology even permits use in smart grid applications**

With Scientific Automation, Beckhoff seamlessly combines the functionality of conventional control technology such as PLC, motion control and automation technology, with precise and fast measurement technology and engineering algorithms. The solution can be implemented on a standard, integrated platform and, thanks to the modularity of the systems, optimally adapted to the respective application and easily expanded at a later stage. It provides users with a compact and cost-effective alternative to make energy consumption highly transparent. This in turn is a prerequisite for maximizing energy efficiency and can serve as the basis for future smart-grid applications.

The stations become devices in the data network of a smart grid through the flexible expandability of the PC-based control technology from Beckhoff. It enables users to extend energy and state monitoring with remote control protocols. The systems, in office buildings, factories, substations in a distribution grid, windfarms, cogeneration or biogas plants, can be made “smart” with retrofits. In this way, an office building can generate negative balancing energy by means of a heat pump “charging” a heat store, for example. Positive balancing energy could be generated via a stand-by unit that is activated by the grid operator. Beckhoff technology is already capable of realizing this kind of balancing energy at sites that are configured as virtual power stations and equipped with Embedded PCs.

Figure 3: Through the use of oversampling technology, the EL3773 mains monitoring terminal enables actual value acquisition with a much higher resolution in relation to the communication cycle time.

Further Information:

[www.beckhoff.com/power-measurement](http://www.beckhoff.com/power-measurement)
[www.beckhoff.com/TwinCAT](http://www.beckhoff.com/TwinCAT)
The purpose of Germany’s “Industry 4.0” initiative is to strengthen the competitiveness of the country’s industries by improving flexibility, efficiency and sustainability in manufacturing through communication and intelligent controls. How can PC-based control technology contribute to this effort?

Dr. Josef Papenfort: At the core of Industry 4.0 is the convergence of information (IT) and automation technologies (AT), for which Beckhoff set the foundation over 25 years ago and continues to offer the best solution for future concepts. By employing global IT standards, we enrich automation technology with the best solutions the IT world has to offer. This also applies to our TwinCAT 3 automation software, which features the modularity and object orientation needed to realize Industry 4.0 concepts. In addition, the integration of TwinCAT 3 into Microsoft Visual Studio® provides the ideal basis for consistent engineering across the entire product lifecycle with the latest software engineering tools from the IT world. With the PC as the accepted platform in combination with the Automation Device Specification (ADS), the EtherCAT Automation Protocol (EAP) and the OPC Unified Architecture (OPC UA), Beckhoff has all the tools users need for implementing the vertical and horizontal integration required for Industry 4.0.

Is Industry 4.0 already being implemented in real-life applications? What additional developments are needed, if any?

Dr. Ursula Frank: There are already many end users such as large kitchen manufacturers who automate entire systems from receiving to shipping with Beckhoff technology, including their integration into their ERP systems. Some initial solutions are definitely in line with the Industry 4.0 concept, for example, by providing continuous communication across all levels with some approaches to an intelligent production environment. It goes without saying that we will continue developing our products and our portfolio in this direction over the coming years.

Dr. Josef Papenfort: As part of TwinCAT 3, for example, we are working on improved engineering functions by providing additional features like easier communication capabilities and configurations. Also important in this context is the continuing development of universal communication standards such as those with its integrated measurement technology and Condition Monitoring up to the monitoring of complex production systems. To explain, Scientific Automation involves the integration of scientific findings from various disciplines into automation technology so that we can build more reliable and energy-efficient production systems with inherently intelligent features. This will also require new, intuitive operator interface concepts that make it easier for humans to perform their everyday work and interact more effectively with intelligent machines. After all, Industry 4.0 is not intended to push the human element aside. Our multi-touch-capable industrial panels make these new operating concepts possible.

Industry 4.0: PC-based control concept as the core technology for the Smart Factory

PC Control has always been based on the convergence of information and automation technologies

PC-based control technology from Beckhoff offers the ideal toolbox for Industry 4.0 concepts. It opens the door to new ways of implementing visionary ideas ranging from cloud computing to social automation today. In this interview, Dr. Ursula Frank and Dr. Josef Papenfort explain which basic technologies, functions and services are already available and where additional developments are still needed.
being defined by the OPC Foundation and the PLCopen Association. Beckhoff is actively involved in both of these standardization efforts. One of the goals is to not only exchange data with the ERP system via OPC UA or ADS, but to also be able to call up and execute methods directly in the PLC. This would be the next step in the evolution of communication.

**How important is the openness of PC Control for the “Internet of Things”?**

**Dr. Ursula Frank:** It is very important. Put in very abstract terms, the Internet of Things implies that products as well as systems and their modules can communicate openly with each other. This is precisely what the open control technology from Beckhoff makes possible by allowing the developer to design the system with the ability to function and communicate intelligently.

**Dr. Josef Papenfort:** The open interfaces represent a significant advantage of PC Control. This applies to engineering applications and as to the fieldbus technology being used as well as to the components being integrated such as RFID chips or intelligent sensors.

**Does this openness also apply to the automation architecture as a centralized or decentralized system?**

**Dr. Josef Papenfort:** Of course it does. As a rule, we prefer the centralized approach, because it has advantages in the areas of engineering, data administration and diagnostics. But there are also certain systems such as assembly machines where a decentralized approach may work better. For example, such a solution makes it easy to replace individual modules, because the central control components must only be adapted to the new work station. In addition, systems or machines on the production floor don’t operate as islands, but are usually networked – a trend that will accelerate significantly in connection with Industry 4.0. Accordingly, each machine is controlled locally in a larger system or an Industry 4.0 concept. A very important factor in this approach is the implementation on the software side, which we support with modular programming via TwinCAT. After all, it doesn’t matter whether 10 software modules run on a central CPU or individually on 10 different controllers. How the data traffic is executed between the modules – whether on a local PC or via EAP which is equally deterministic and fast – also doesn’t matter. PC Control makes it easy to implement either version depending on the application requirements.

**The vision of Industry 4.0 even extends to something referred to as the “Facebook of machines” or “social automation.” What does this actually mean?**

**Dr. Ursula Frank:** The vision of social automation involves transferring the new developments in information and communication technology to industrial applications. As we mentioned earlier, linking information and automation technologies with PC-based control technology is at the core of technology from Beckhoff. Accordingly, Beckhoff will always take a close look at the latest developments in information technology with regard to their use in automation technology. Trends like social media, for example, may offer new communication capabilities. We must check what potential benefits may arise from using these communication capabilities in the automation field. The “Facebook of machines” is one such scenario. For example, users can create individual
Dr. Ursula Frank: “At this year’s Hannover Messe we will show as part of our Industry 4.0 Forum that open, PC-based control technology from Beckhoff already makes it possible today to seamlessly integrate production systems and modules into existing and new production systems – and have them communicate with higher-level production scheduling and control levels. To fully support the Industry 4.0 concept, however, a lot of research and development will still be needed over the coming years.”

profiles on Facebook, describe their lives on the “timeline” and offer information or services on their “wall.” Transferred to industrial applications, this would mean, for example, that a machine may post its current utilization or offer its services on a similar wall. If it does not have the requested capacity, it could refer the interested party to a “friend” in the corresponding “Facebook machine group.” Another option would be to adapt the traffic backup information on Internet services like Google Maps or TomTom to the world of industrial production. This would enable you to monitor a factory’s machine utilization rates or even generate duty rosters for machines via a Doodle survey.

Dr. Josef Papenfort: We are again coming back to the convergence of information and automation technology within the framework of PC Control. Just as we combined our automation know-how with the Visual Studio® IT engineering tool to create TwinCAT 3, the next step might involve enriching Internet services like Facebook, Doodle or WhatsApp with automation features. Another approach has already been implemented by Beckhoff with a technology study that proved that Google Glass as a “wearable device” can significantly simplify human-machine interaction, for activities involving commissioning and fault diagnostics, for example. Functions like the retrieval of online support information or troubleshooting with a specialist via video-based live chat make Google Glass an enabling technology for social automation.

What roles do hot current IT topics like cloud computing and big data play?

Dr. Ursula Frank: We will see more and more solutions in the future where data and parameters reside in the cloud. At the end of the day, it doesn’t really matter where the information is stored. Today and in the coming years, however, most of the data will still be processed in the machine or system. On the other hand, things like measurement data are already being stored in the cloud and analyzed offline in many cases. We will definitely see an increasing shift towards cloud computing. Over the long term there will surely be some Internet services that affect automation technology, for example, as a machine monitoring app.

Dr. Josef Papenfort: With regard to big data, i.e. large amounts of data from a wide range of sources, the focus is predominantly on the subject of data storage at this time. And the amount of data will surely increase even further, as a result of images and videos being stored for more thorough tracking-and-tracing applications, for example. On top of this we will see more offline analytics, and these will be performed increasingly as a cloud-based service. In the wind energy field, this approach has already been practiced for years. The service providers don’t access the data on the turbine itself, but take it from the cloud to be analyzed offline.

Will we see more real-time services in this context?

Dr. Josef Papenfort: With more and more data being stored in the cloud, we will also see more real-time – or rather, deterministic – processing. With the IEEE 1588 protocol, such real-time services for machine synchronization are already being implemented. This synchronized collection of distributed data will become more and more prevalent, particularly in the area of measurement technology, but it will not replace the local control intelligence in the machine. Another aspect is more important: We already have technologies for analyzing data in real time, i.e. on its path to the cloud. These techniques might become widely accepted over the medium term in order to filter out the large amount of unimportant information before it gets stored.

Are such complex Industry 4.0 engineering concepts still manageable?

Dr. Josef Papenfort: Modern systems are becoming more and more complex, and the Industry 4.0 concept will only accelerate this trend. That’s why we will have to pay more attention to efficient and reliable engineering in the future. We have already taken a great step in this direction with TwinCAT 3, which reduces the engineering effort with features like source code control and automatic code generation. Where I still see potential for improvement is in the efficiency of the data management, for example, by transferring the motor design data directly into the engineering system and making it available there without any additional effort.
Dr. Josef Papenfort: “At the core of Industry 4.0 is the convergence of information and automation technologies, for which Beckhoff set the foundation over 25 years ago and continues to offer the best solution for future concepts.”

Dr. Ursula Frank: This is an area where a lot still needs to be done. From the engineering perspective, the data transmission between the various development domains, such between the control technology and E-CAD or M-CAD, is still not completely error-free and seamless. There are some approaches and solutions such as the AutomationML standard, but we don’t have a standardized data pool at this time. TwinCAT has featured many open data export and import interfaces for some years now. The TwinCAT E-CAD import program makes use of these interfaces and can communicate directly with various E-CAD programs on the market. However, additional tools are still needed. For example, order data from an ERP system must be able to flow into the engineering level. What’s most important, however, is that the data can be shared on all levels so that effective and synchronized engineering becomes possible across the entire life cycle.

Will simulation play a larger role in the engineering field as a result of Industry 4.0?

Dr. Ursula Frank: Industry 4.0 will make the systems more complex and more intelligent, but also less predictable. When machines are allowed to react on their own and negotiate with other machines, the human brain is no longer capable of predicting the overall behavior. That’s why powerful simulation tools will be indispensable. This is a truly long-term vision, but ideally we would have tools that simulate not only the development concept but can drive simulations on their own.

Dr. Josef Papenfort: Such systems would reduce not only the commissioning time and costs. Simulation can support all areas such as the machine design process, electrical engineering and software development, because it will make it possible to test any changes quickly via the control technology and the software without having to make hardware modifications. Naturally, the corresponding interfaces for importing simulation models and providing the relevant data must be available. Today, TwinCAT 3 already offers features such as the integration of Matlab®/Simulink® models in real-time as well as the TwinCAT Simulation Manager for the easy configuration of a simulation environment.

What concrete results of the research activities for Industry 4.0 are already visible?

Dr. Ursula Frank: We are, for example, actively involved in the “it’s OWL” (Intelligent Technical Systems OstWestfalenLippe) network, which the German Federal Ministry for Education and Research named a “Leading-Edge Cluster” in 2012 and is the first large Industry 4.0 project. We are working, among other things, on reference models, i.e. automation solutions for various classes of production systems that can be transferred to similar systems. In addition, the ScAut project, which focuses on a Scientific Automation platform for the development and operation of intelligent, self-optimizing machines and systems, is already bringing forth some concrete economic benefits. Depending on the application, Scientific Automation functions such as condition and power monitoring may produce energy savings of roughly 20 percent, productivity improvements of 10 percent and maintenance cost reductions of 50 percent.

Author: Stefan Ziegler, Marketing Communications, Beckhoff

Further Information:
www.beckhoff.com/industry40
At last year’s SPS IPC Drives trade show in Nuremberg, Germany, Beckhoff introduced a new concept for operating machinery via a technology study that focused on Google Glass. With Google’s web-enabled glasses, status or dialog messages can be projected via a head-up display directly into a person’s field of vision. Online information and communication is also possible with this innovative device, and error messages can be acknowledged using a touchpad. Andreas Thome, Product Manager of PC Control at Beckhoff, firmly believes that Google Glass is a prime example of the convergence of Internet and automation technologies as an enabler of Industry 4.0.
What makes these “augmented-reality glasses” from Google stand out for use as a control element in industrial environments?

Andreas Thome: Google Glass is equipped with a head-up display, camera, microphone and bone-conduction audio transducer serving as a loudspeaker – it also has vibration sensors and a touchpad integrated in the side pieces of the headset. With these features Google Glass is well-suited for visualization, diagnostics and service purposes, as well as for technical interventions and person-to-person communication. Unlike conventional control concepts, this device belongs to a class of innovative technology known as “wearable computing” – a group of devices that can be worn daily by users to dramatically increase their connectedness. In fact, many of these devices today already have all of the functions of a modern smartphone. What’s more, Google Glass-type devices are convenient to use thanks to the overall ergonomics of a semi-transparent visor and the largely hands-free operation. The great advantage here – also with an eye toward industrial automation – is that existing mobile computing technology can be used without any limitations to our sensory perception or our physical movements – and there are no wires or cables to contend with.

How can Google Glass be integrated with PC Control?

Andreas Thome: Google Glass can be easily integrated with control technology using TwinCAT automation software from Beckhoff. The glasses communicate with a web server which provides the status of the machine controlled by TwinCAT. The glasses receive this status information and express it in the form of signals or error messages, perhaps even indicating the exact location of any problems. Confirmation and resetting of the machine status can also be done on the spot with Google Glass.

In what kinds of scenarios can this concept be applied?

Andreas Thome: Potential application scenarios can be classified as either “direct or indirect.” For example, an operator can use the glasses to “directly” monitor the machine or even take action to change or correct the machine status directly, without always having to be on-site. With large machines and production facilities, the operator needs to walk around the equipment and check the process status values at specific critical points while watching how the machine is functioning at the same time. If necessary, the operator can take manual action because both hands are free. The “indirect” options are related to gathering and saving information that is not fully dependent on the processes being run. These options include, for example, studying the manufacturer’s documentation about specific machine components, searching for information on the Internet and engaging in person-to-person interaction through e-mails and chats with video support. However, the combination of direct and indirect applications is also possible. Even while a machine is running, the operator can contact an expert for advice about a specific problem by using the glasses to send a video of the machine in action. The expert can then give the operator support – in the form of a video or voice message – so that corrective measures can be taken. This is an example of how the IT concept known as “What You See Is What I See” (WYSIWIS) can also be applied in an industrial environment.
display with keyboard, cannot be replaced entirely – simply because of its higher resolution, better readability and the electromechanical integration of critical control elements, such as an emergency switch or joystick. The same can be said regarding the vision of realizing complete “no-touch control” based on Google Glass. In real-world scenarios of the future, it is most likely that we will find a mix of traditional touch and innovative no-touch approaches. Remember that touching the side of the augmented-reality glasses is much faster than giving a voice command. Of course, the glasses do function in the hands-free mode: They are turned on with a simple upward nod of the head. Browsing through menu items is possible by gently nodding the head up and down, and a particular item can be activated with a voice command. Launching functions shown on the so-called slides would also be possible through voice control. However, to achieve this, special programming is required and the ergonomics of the software must be precisely designed to accommodate voice control.

Does the use of Google Glass as an operating device increase security risks related to data and the machine itself?

Andreas Thome: Again, the answer here is no. There is a general misconception that Google as a business enterprise or the Google Cloud is always party to all of the communication conducted with the augmented-reality glasses. This is not the case. As the Beckhoff technology study has shown, Google Glass can be easily encapsulated and embedded in the WLAN intranet of a business enterprise, where it is safeguarded by standard IT procedures in effect there. And when it comes to machine operation, the functions of Google Glass are – in principle – the same ones found on the machine’s control panel or display screen. What’s more, any actions that would prove dangerous must be prevent-
ed using effective and approved security technologies (such as an emergency stop concept). According to data protection experts, Google Glass is just as safe as any cell phone. Both devices are suited for taking photos of machinery and people. This aspect is not new and has been part of the mass proliferation of smartphones. Furthermore, wearing the augmented-reality glasses can hardly go unnoticed, so it is highly unlikely that anyone would use them secretly for unlawful purposes. In sum, it means that Google Glass is subject to the same rules and code of conduct that apply to the smartphone – in other words, the device will not be approved for use in highly sensitive areas of business.

How quickly will Google Glass penetrate the market, especially when it comes to machine operation?

Andreas Thome: Today it is already clear that augmented-reality glasses like Google Glass are becoming a trend in the commercial market. However, it is difficult to forecast when these devices will become mainstream items. On the one hand, vendors such as Meta Pro, Samsung and Epson have already announced that they are developing similar hardware. Yet on the other hand, just like smartphones, augmented-reality glasses will undergo a continuing development process as more sensors and higher processor performance can be integrated into the devices. That’s why Beckhoff is studying the acceptance of these devices in industrial environments based on existing software that is of benefit to users – and during the course of 2014, a field test will be conducted in cooperation with interested users. However, machines and production facilities already equipped with Beckhoff controllers and TwinCAT software already offer all of the communication interfaces required to effectively use Google Glass or other augmented-reality glasses today.

Is this development supported by the latest Industry 4.0 and Smart Factory concepts?

Andreas Thome: Augmented-reality glasses will contribute to more efficiency when it comes to visualization, diagnostics and service in the future. Thus, they are predestined to play a significant role in Industry 4.0 concepts, because a Smart Factory represents a networked form of manufacturing with data transparency. Google Glass and similar devices add mobility to this transparency; in other words, the user in a Smart Factory has the option of seeing the status and performance data of all components in the facility – anytime, anywhere – from access control to heating/air conditioning/ventilation and including all or just individual machines, even down to an individual sensor on a machine.

Further Information: 
www.beckhoff.com/GoogleGlass
Fieldbus systems versus Industrial Ethernet

Industrial Ethernet is without a doubt very well established in automation technology, although traditional fieldbus technology still has a long way to go before reaching retirement. Since modern machines and systems must perform increasingly complex tasks, data networks are growing ever larger. This is where real-time capable Ethernet networks come into play, because they provide a consistent flow of data from the control level down to the field level. While all established systems offer this basic set of benefits, users who want to switch nevertheless face a variety of Ethernet-based models and options which can be difficult to understand or is even confusing. Also, other aspects such as functional safety are becoming increasingly important. To shine more light on the “Ethernet jungle,” electrical engineering editor, Ines Näther spoke with Martin Rostan, who heads the technology marketing department at Beckhoff.

How do you assess Beckhoff market share in the area of fieldbus I/O, and what future developments do you foresee with regard to the replacement of the traditional fieldbus systems by Industrial Ethernet?

Martin Rostan: As a pioneer in the field of modular I/O components for fieldbus systems, Beckhoff is undoubtedly one of the world’s largest manufacturers of fieldbus I/O systems. The millions of I/O Bus Terminals we have sold since 1995 have contributed significantly to our exceptional growth as a company. Since Beckhoff stands for open control and communication technologies, we support over 20 fieldbus systems with our product lineup. Although EtherCAT accounts by far for the largest share of our sales these days, we continue to support all relevant fieldbus technologies. For new projects, however, our customers decide almost exclusively in favor of EtherCAT. One of the reasons: Even if EtherCAT is your system bus, you can still integrate other buses via one of our gateways without losing performance. Since numerous machines and systems are built for many years without any modifications, traditional fieldbus technology will, of course, be around for many more years. For that reason, the associated modules will keep accounting for a good part of our sales as well. In addition, many of our components are used with third-party controllers. While most controllers may “speak” EtherCAT by now, there are still others around that don’t.

What are the user’s general benefits from switching to Ethernet-based communication, and which points are particularly important when making such a change?

Martin Rostan: The benefits clearly depend on the selected version of Industrial Ethernet. EtherCAT users benefit from significantly higher performance and more efficient machines, all while reducing equipment costs. They also enjoy faster commissioning which takes less time than it does with legacy fieldbus technology. For example, users don’t have to set device addresses, and the diagnostic capabilities of EtherCAT make the process of finding the sources of
malfunions and troubleshooting substantially easier. Switching to Ethernet per se does not necessarily mean that everything will automatically work better, though. Depending on the specific technology selected, you might have to deal with more complexity and higher costs that may not be balanced out by application benefits. For example, if complex IT expertise is required on the field level to configure managed switches, or if the network topology adversely affects its performance, switching to that "brand" of Ethernet might not be advisable.

Where do you still see problems with regard to Ethernet for safety technology? According to a recent study, 33 percent of machine manufacturers use Ethernet for safety, but only on six percent of their machines. What is the current status, and how do you assess its future development?

The sales of Beckhoff TwinSAFE products with the Safety over EtherCAT protocol indicate that our customers are more advanced than this. The benefits of our integrated safety solution seem to make the difference for users: safe access to secure I/Os even with a standard controller, easy configuration instead of complex programming, and all of this with the flexibility of a modular approach and lower costs. Keep in mind, though, that just like how fieldbus technology with its local I/O modules took many years to replace parallel wiring, integrated safety Ethernet technology will also take a while to become ubiquitous. I don’t see any "pressing problems" at this time, however.

Published in Elektrotechnik 01/2014, Vogel Business Media, www.vogel.de
Quantum leap in micromachining with open, high speed CNC

With the 701S machining center, Willemin-Macodel has introduced a quantum leap in the machining of small parts by fully exploiting the dynamics and rigidity of the delta kinematic for the first time. This was achieved through the reduction of moved masses and by leveraging powerful PC-based CNC technology from Beckhoff. This has enabled a 90% reduction in energy consumption and a reduction in the machining time by as much as a factor of ten, depending on the workpiece.
The Delémont, Switzerland-based Willemin-Macodel company specializes in machines for small part machining. The systems are used in the watch making industry, medical technology and the aerospace industry, among others. Technical director Denis Jeannerat explains: “Our core competency is in high-precision machines for full-process machining. Because fixing small workpieces has always represented a challenge, the same machine now performs all machining steps – without the traditional division of processes into turning, milling and grinding. The machine also takes care of the parts handling, i.e. the careful insertion and removal of the workpieces. A prime example of this is the 701S machining center, which was introduced at the EMO 2013 trade fair.”

A simple idea revolutionizes micromachining

On the face of it, the idea behind the new machine sounds simple: The 701S micromachining center features a delta robot that has been inverted – placed “upside down”, so to speak. This robot moves the workpiece – a task usually handled by the tool carriage. Denis Jeannerat explains the thinking behind this concept as follows: “There is a strong tendency toward component miniaturization in our markets. Therefore, we sought to design a machine with an enhanced ratio of parts size to machine size, because when you’re machining a 2 g or 20 g part, it makes no sense to move a tool carriage weighing 100 kg in a 3 m long machine that weighs 12 metric tons. It is much better to move the small mass of the workpiece instead of the tool. In this way, the mass that must be moved is reduced immensely, from perhaps 500 to 800 kg for a conventional shaft to only around 2 kg. These low moments of inertia can also be mastered using a delta robot.”

Accordingly, the basic concept of the new machine is based on parallel kinematics with a delta structure, and has been implemented in form of a workpiece carrier connected by three arms. The machining strategy of the 701S, which is designed for machining small workpieces (Ø 52 x 32 mm), focuses on compu-
tationally intensive “circular interpolation”. The key characteristics include path accuracy better than 0.2 μm, low sensitivity to temperature fluctuations as well as very high precision and repeatability. A specially designed high-performance motor spindle, with a maximum speed of 80,000 rpm and without tool holders, additionally provides increased static and dynamic rigidity, very high balancing quality and a low radial runout (less than 1 μm at the tool tip).

PC-based control technology masters machine kinematics

Achieving what sounds so simple, however, requires a great deal of engineering effort and know-how with regard to both design and control technology, as Denis Jeannerat explains: “It was a very long project for us, having started over five years ago. Above all, the mechanical systems and drive technology required a great deal of development effort so that we could enhance and finally master the dynamic behavior.”

The decision to use PC-based control technology was taken right at the beginning of the project, because it was clear from the outset that this would be the only way to sufficiently realize the complex circular interpolation and fast control loops. Denis Jeannerat says: “After all, the goal was to develop an extremely dynamic machine. The highly dynamic rigidity needed from the system can be only achieved with a powerful Industrial PC that can calculate the control loop parameters extremely quickly. This is especially significant considering the reduced masses that must be moved.”

PC Control: powerful, proven and open

Following the decision in favor of efficient PC-based control technology, a fitting supplier was also found quickly. Denis Jeannerat says: “We evaluated various industrial control architectures and were immediately impressed by PC Control. This was not just because of the technology, it was also important to us that Beckhoff has a great deal of know-how and industrial expertise in applications like ours.”

According to Denis Jeannerat, Willemim-Macodel attaches particular importance to high flexibility in machine design: “To make our machine design as flexible as possible, we need a system that is open in every respect – with a multifaceted I/O solution, connectivity to various communications subsystems and software versatility. Communication with the necessary handling or robot systems, for example, is very important. On the one hand, we benefit from the kinematics that are already integrated in the TwinCAT software, while on the other we can also integrate our own solutions very easily if necessary.” Not only that, each individual machine is adapted precisely to the application, which would be virtually impossible without an open control system. In addition to a modular toolkit of automation hardware that enables flexible machine configurations, dynamic control software – like TwinCAT in this case – must also be modularly structured and offer a great deal of programming freedom.

In the 701S machining center, the openness of PC control has also proven helpful in the simple connection of a special vision-based tool measuring system. With its help, the tools can be measured at full speed, including radial runout. The measuring system can be integrated into the Beckhoff control computer simply by using appropriate PCI plug-in cards, thus providing the computer with large quantities of data directly and very quickly. In addition to its high computing power, the C6920 Control Cabinet Industrial PC (IPC) with 1.9 GHz Intel® Celeron® processor employed in the machine offers a further important advan-
In Denis Jeannerat’s view: “The C6920 Industrial PC from Beckhoff is very compact and therefore requires little space in the machine’s control cabinet.”

CNC-specific software and operator interface
Apart from complex path calculations, the tasks of PC control also include controlling the speed and position of the high-performance spindle. A total of four axes – the delta robot and the spindle as an additional axis – are controlled extremely quickly. This makes it possible to perform special machining operations with the spindle, such as planing or deburring. This is implemented using TwinCAT CNC, i.e. by means of a pure software solution running on an IPC with complete CNC functionality. TwinCAT CNC can operate with up to 64 axes/controlled spindles, which can be distributed to up to 12 CNC channels. In a CNC channel, up to 32 axes can be interpolated simultaneously, solving even the most difficult motion tasks.

With TwinCAT CNC, users also benefit from the openness to the I/O periphery and to the drive system, which is unusual in the traditional CNC world. The most diverse I/O assemblies can be connected via all common fieldbus systems. The drive systems can be connected with the CNC entirely in accordance with application needs via an analog/encoder interface and directly via a digital drive interface. The I/O system of the 701S machining center consists of 44 EtherCAT terminals, the information of which is transferred to the control system via two EK1100 EtherCAT couplers. The data are primarily acquired via EL1124 or EL1008 digital input terminals, EL2008 digital output terminals, EL3064 or EL3202 analog input terminals, EL4002 analog output terminals and via EL5101 incremental encoder interfaces.

For a CNC operator interface, the 701S features a customized CP7912 “Economy” Control Panel with a 15-inch touch screen as well as integrated DVI/USB-Extended technology which allows separation from the IPC by up to 50 m. In a sturdy aluminum housing with IP 65 protection, the panel for mounting arm installation features an added keyboard shelf and offers 12 function keys and 10 LED-illuminated special PLC keys. In addition, there is a key extension with emergency stop button, six illuminated pushbuttons, gray code switch (23 positions) and incremental encoder. Denis Jeannerat concludes: “The Control Panel makes the operation of the machine extremely convenient. Numerous functions are directly integrated, for example, via the electromechanical pushbuttons, which enables intuitive and very simple operation.”

Highly efficient micromachining solution
The combination of intelligent design and efficient automation has resulted not only in a particularly compact machine with a footprint of only around 1 m², but also in a highly efficient machine. Due to the reduced moved masses, it requires only 2 kW of power to machine a small part. A conventional machine requires 20 kW or more for this. Denis Jeannerat adds: “With very high path accuracy within 0.2 µm – even at full speed – the 701S also achieves a value that is better than conventional machining centers by a factor of 10. A further advantage is the immense time savings in parts machining. Depending on the complexity of the workpiece, the machining time is reduced by a factor between 3 and 10. The machining of a copper electrode, for example, now takes only eight minutes instead of over an hour previously.”
KUKA KR C4 robot controller uses EtherCAT

Since 2010 KUKA has relied on EtherCAT technology as a system bus in all KUKA robot controllers. The compact controller for the new KR AGILUS robot and the LBR iiwa lightweight robots is also implemented on the basis of EtherCAT. Industrial Ethernet-based EtherCAT from Beckhoff is thus universally integrated as a foundational technology throughout the current KUKA controller range.

In 1996 KUKA Roboter GmbH became the first robot manufacturer to introduce a robot controller exclusively based on Windows PCs. The success of this first generation of controllers can be largely attributed to the intuitive operator guidance using Windows technology as it is familiar from the office world and accepted by customers, and to the high performance of PC technology. Leveraging IT products from consumer markets enables a high degree of innovation and high performance at low cost. When it came to planning a new generation of KUKA robot controllers, it was an obvious progression to adopt further matured technologies from the IT world in addition to Windows and PCs – namely universal communication via Ethernet. A very powerful, fast and deterministic bus system is required for the internal communication inside the controller. For this reason KUKA has relied on EtherCAT since 2010 as the system bus for the KR C4 controller series to ensure high-performance and open standards.

A standardized fieldbus is generally used for the outward communication of the robot controller into the I/O, cell and plant levels in order to fully integrate the robot into an automation system. The fieldbus system is usually specified by the customer and the robot controller must be able to connect to the selected technology.

However, complex data traffic between the different components such as drives and position encoders is also necessary inside a robot controller so that control and regulation tasks with high requirements for real-time performance can be implemented. Furthermore, internal devices must exchange information for the safety technology and control infrastructure, not to mention display and operation. Different communication technologies were used for this in the previous version of the KR C4 robot controller, resulting in a large number of different plugs and cables.

In the planning phase of the current KUKA controller this issue was considered in great detail, taking also into account the ability of current Ethernet technologies to support real-time and safety requirements with very high data rates, all with the characteristics familiar from IT. In addition, Ethernet has the advantage that different protocols can be transmitted over a single line, which contributes enormously towards the reduction of cables in the system.

With the aid of the fully integrated “KUKA.VisionTech” vision system, robots can also be used flexibly in unstructured environments.
One important goal of the project development was to use the fewest possible number of different communication technologies, both outwards to the fieldbus level and inwards, in order to achieve a more streamlined design. KUKA’s aim was to avoid the use of proprietary technologies in favor of the most accepted and open industry standards possible. In addition, performance-limiting hardware was to be replaced by intelligent software functions, and this was made possible due to the high computing performance of modern multi-core PCs. Less hardware meant an improved MTBF (mean time between failures) as well as lower development costs, price per unit and logistic costs. These standardizations led to a reduction in the number of required hardware assemblies by 33 % and in the case of plug connectors and cables by as much as 50 %.

Communication to the field level: software stacks or gateways?
With the pre-existing Ethernet equipment in the PC, the fieldbus connections to Ethernet-based fieldbuses such as PROFINET or EtherNet/IP could be entirely realized in software instead of using more expensive, specialized hardware. Thus, connections to conventional fieldbuses such as PROFIBUS or DeviceNet are not integrated by installing plug-in cards in the controller, but rather via EtherCAT communication gateways in the I/O system.

Ethernet and EtherCAT for internal communication and communication with sensors, actuators and I/O
All internal communication and the communication to the lower-level I/O level take place via standard Ethernet or EtherCAT. Therefore, only two different, yet standard communication protocols are used in the universal bus physics (cables, plugs and Ethernet controller chips) in the KR C4 robot controller.

Standard Ethernet is used internally for addressing the KUKA hand-held controller, for connecting and synchronizing several robot controllers within a KUKA RoboTeam group or for connecting an engineering laptop, for example.
The use of EtherCAT communication technology in addition to standard Ethernet was necessary because standard Ethernet technology cannot meet the requirements to deliver real-time capability and support of industrial safety protocols. EtherCAT functions as an internal drive bus for controlling and monitoring the drives of the robot and the position encoders. In addition, EtherCAT is used to control the internal safety assemblies for robot safety or for the safety-relevant operating elements of the SmartPad. Furthermore, an EtherCAT master interface to conventional fieldbuses is integrated for the user to address local I/O modules or gateways.

Why EtherCAT?
EtherCAT, as a real-time Industrial Ethernet and safety communication technology, was chosen because in comparison with other real-time Ethernet technologies it offers a series of benefits that were ideally suited to KUKA’s development goals. For example, EtherCAT requires no special hardware connection in the master, but only in the slaves. In the master, a standard Ethernet controller suffices, which is present in large numbers in the PC of the KR C4. The plugs and cables required are also identical to standard Ethernet, which lowers costs and increases simplicity.

Thanks to its special “processing on-the-fly” technique, EtherCAT enables very high data throughput rates, which can almost completely utilize the maximum possible net Ethernet data rate of 100 Mbits/s. That made it possible to execute many functions in software on the control PC that otherwise would have had to be outsourced to expensive proprietary hardware assemblies.

The EtherCAT-specific safety protocol, Safety over EtherCAT (FSoE) can be communicated over both EtherCAT and Ethernet. FSoE enables the PC-based and centralized KR C4 safety controller, which is similarly executed exclusively in software, to control all safety-related peripheral devices such as local safety modules for robot safety or the safety-relevant operating elements of the SmartPad.

Along with PROFINET and EtherNet/IP fieldbuses, EtherCAT is the among the most widely used Ethernet-based industrial communication technologies in the world with a large community of users. Accordingly, it is possible to use the numerous EtherCAT slave devices that are available on the market from EtherCAT Technology Group (ETG) members. This makes countless new EtherCAT-based automation solutions possible that use high performance devices from a great many vendors. Continuity is also an argument in favor of EtherCAT, since no “version changes” have been made to the standards, protocols or ASICs since the system was established.
Buildings account for 41% of the world’s total energy use. Of that enormous figure, around 85% is used for heating and cooling and 15% for lighting. As energy resources become ever scarcer, the focus must be on optimizing energy efficiency in new buildings and on modernization projects for older buildings. In addition, demands for comfort and safety must continue to be satisfied.

Examples of an intelligent building include: adaptable “color temperature” of the lighting, wind- and light-dependent control of shading systems, individually adaptable room automation, needs-based control of temperature and supply of fresh air. In medium-sized and large projects in particular, the focus is also on low investment and operating costs to provide a fast return on investment (ROI).

Synergies via integrated solution
These demands concern a variety of systems in the building and until now each system has brought along its own control and regulating system. The result: efficiency, safety and comfort were partly achieved; synergies, however, were not fully realized. “Despairing” technicians must also be considered: those who must deal with different programming environments and technologies. The expense for installation and maintenance is high and a patchwork of systems is inflexible when the building owner and tenants request changes.

Building automation can be implemented much better when a universal, coordinated control system is deployed for the automation of all technical building services. The integrated building automation solution from Beckhoff thus achieves system-spanning synergy. The solution is by definition uncomplicated — no matter how complex the building is and no matter how many building systems need to be centrally controlled and synchronized. The software-based control system can be implemented inexpensively. The use of open standards enables many efficiencies, for example, commissioning via Internet. “The system integrator can assemble the control cabinet in their own workshop and no longer has to travel to the customer’s premises for commissioning. Remote programming, parameterization and diagnostics via Internet drastically reduce the need for on-site commissioning,” says Georg Schemmann.

The integrated system gathers all information from every device at all times and uses this information purposefully for optimizing efficiency. “Integrated building automation for us means that all systems in the building can be controlled and regulated by way of our overall system and the individual components,” explains Georg Schemmann. “All building functions can be integrated ‘from top to bottom,’ regardless of whether sun protection, heating or lighting control is required, for example.”

The possibilities for energy savings are particularly impressive: integrated building automation opens up energy-saving potential of up to 30%, which creates impressive justification for the investment. Georg Schemmann is certain that
“With system-spanning building automation, the idea of the ‘Green Building’ – of sustainable, energy-efficient building and living – is easily attainable. The acquisition of the operating data for heating, ventilation, air conditioning and lighting enables the appropriate regulation and control to ultimately save energy.” All energy efficiency classes can be fulfilled with the solutions. In addition, they are well-prepared for Smart Grid functions.

In the construction of new commercial properties, this perception has already led to the use of integrated building automation across the board. In the private sector, where large savings potential could similarly be found, there is still some catching-up to do as clients often don’t have the necessary budgets. Georg Schemmann is aware of the problem: “If you’re expecting an automated solution for the price of a low-tech, legacy installation, it is of course impossible. Automation creates added value toward the total cost of ownership, however, which is what we must help the customers better understand.”

Simple and efficient engineering lowers overall costs

Efficient engineering represents a key enabler for a fast ROI. In the case of complex projects, engineering makes up a significant portion of the total cost of the overall building system technology. This is where a particular strength of the complete solution from Beckhoff becomes apparent: the standards-based control that takes place via a central PC. The software and hardware are optimally matched to one another. All systems in the building are programmed or parameterized in accordance with IEC 61131-3 as established by PLCopen using TwinCAT as the automation software platform. “All code can be programmed in the same language and is available as function blocks in building libraries,” says the building automation specialist. Lifecycle costs are thus reduced, because the expense for maintenance is concentrated on one software platform. “TwinCAT Building Automation is optimized for modern, system-spanning building automation and enables efficient engineering,” he adds.

With the TwinCAT BA PLC libraries the system integrator has at their disposal the established and tested basic functions from the fields of control and signal processing as well as special mathematical functions, error message processing and general system functions. The TwinCAT BA PLC templates consist of ready-to-use TwinCAT program blocks for sensors and actuators, complete assemblies for system parts and complete systems for heating, air conditioning and ventilation. As opposed to a “regular” PLC library, TwinCAT BA PLC templates are imported as program blocks into the PLC programs. The integrator can carry out any necessary adaptations independently. All of this makes highly efficient and fast implementation of projects possible.

The universal structure of the TwinCAT project files forms the basis for simple maintenance. “The system identification feature assigns a name to each data point and each program block according to fixed rules,” explains Georg Schemmann. “The TwinCAT BA Project Builder defines the system components and
assigns them to the individual templates. The project files for TwinCAT PLC Control and the System Manager are generated for each controller from this information.”

Scalable performance and a large range of functions for BACnet
Apart from the open control philosophy that is typical of Beckhoff, particular importance was attached during the design of TwinCAT Building Automation to the transparent integration of BACnet in accordance with EN ISO 16484-5 [3]. Georg Schemmann: “We have integrated extensive functions for BACnet in TwinCAT.” He continues: “Since a great many data points must usually be acquired in the simplest possible manner in the BACnet system, we have tailored our libraries to suit that.” The latest version of BACnet (version 12) is supported.

Together with the corresponding hardware, a complete product line is available for BACnet which is characterized by its high scalability: from the compact ARM-based CK90xxx controller, which supports up to a thousand data points, to the CX5020, on which several thousand data points can be centrally collected and processed. These devices are usable without restriction as BACnet Building Controllers (BBC). The DIN rail-mountable Embedded PCs from the CX series integrate an interface for the direct serial connection of the Bus Terminal I/O system. “The integration of BACnet into TwinCAT also enables the use of integrated automation from Beckhoff without having to use multiple automation platforms,” Georg Schemmann adds. This is particularly compelling for modernization projects: sustainability is one of the strengths of the Beckhoff portfolio.

Beyond the core functions for classic HVAC applications, TwinCAT Building Automation also includes room automation in accordance with VDI 3813 [2] for lighting, air conditioning and shading systems. The foundation has thus been created for the installation of systems that comply with the EN 15232 [3] standard for energy efficiency in buildings.

New components for integrated building automation
No two buildings are identical: it is therefore advantageous if a broadly diversified range of products is available for integrated building automation solutions so that all requirements can be met. The building blocks for intelligent building automation from Beckhoff include the Bus Terminal I/O system, scalable control technology with Industrial PCs and Embedded PCs, open communication systems as well as software-based control technology based on TwinCAT. Using the I/O modules from the Bus Terminal system, it is easy to integrate all essential sub-bus systems and protocols such as DALI for lighting, SMI for blind drives, MP-bus for regulating flap drives in ventilation systems, M-bus for energy data acquisition as well as LON, EIB/KNX and EnOcean. Expensive gateway solutions are not necessary. Connection to hotel management systems such as Fidelio as well as to Crestron media controllers is equally possible with Beckhoff automation solutions.

“All components can be integrated seamlessly into the Beckhoff automation solution. “In highlighting a new technology at Light + Building 2014, we will present our Standard Motor Interface (SMI) Bus Terminals for blind control as an extension to our building automation system — in a 24 V indoor version and in a 230 V version for outdoor use,” Georg Schemmann continues. The KL6831 and KL6841 SMI master terminals, which connect the Bus Terminal system with the SMI bus, integrate light and shading solutions into the building automation platform. Each terminal can control up to 16 SMI-compliant drives for roller shutters and sun protection. The energy consumption for heating/cooling and lighting is reduced by intelligently controlling the blinds or roller shutters according to the position of the sun."

Published in Building & Automation 02/2014, VDE-Verlag, www.vde-verlag.de

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
</table>

Further Information: www.beckhoff.com/building
Light + Building 2014: Increased efficiency for engineering and building

At Light + Building from 30 March to 4 April 2014 in Frankfurt am Main, Germany, Beckhoff will present its PC- and Ethernet-based control technology for building automation applications. The focus will be on solutions for optimizing energy efficiency based on integrated, software-based building control. The new "TwinCAT Building Automation" software suite provides integrated engineering efficiency: from the simple import of planning data to the project generation with predefined PLC libraries and function templates for all building systems.

TwinCAT Building Automation essentially encompasses three basic functions:
- TwinCAT BA PLC Libraries: basic functions for all building systems
- TwinCAT BA PLC Templates: function templates for all building systems
- TwinCAT BA Project Builder: a configuration tool that links templates, hardware and BACnet objects.

For all Beckhoff controllers, the Project Builder tool automatically generates project files for TwinCAT PLC Control and the TwinCAT System Manager. The Project Builder can be extended by customer-specific PLC templates and thus offers full engineering flexibility. Add-ins offer the option of integrating planning documents such as Excel lists as a basis for project planning and support connectivity for visualisation systems.

TwinCAT BACnet/IP – extended scope of performance with latest revision

With a large range of BACnet controllers, Beckhoff provides solutions that are precisely scalable in terms of performance for all applications. Particularly suitable are the CX90xx and CX50xx Embedded PC series, which directly integrate the modular I/O level. The implementation of BACnet revision 12 in TwinCAT, enabling extended services and additional object types, has increased the execution performance and offers numerous advantages for building automation. For example, BACnet objects can be generated and configured directly from the PLC.
SMI master terminal flexibly integrates light and shading solutions into building automation

Beckhoff has extended its range of sub-bus systems for building automation via two SMI master terminals, the KL6831 and the KL6841, which connect the Bus Terminal system with the SMI (Standard Motor Interface) bus. Each terminal can control up to 16 SMI-compliant roller shutter and sunblind drives. The energy consumption for heating/cooling and lighting is reduced by intelligently controlling the blinds or roller shutters according to the position of the sun.

The SMI command set, which is completely supported by the Beckhoff Bus Terminals, not only allows SMI drives to perform up and down movements, but also enables them to move to defined roller shutter positions and precise louvre angles. This is exactly where the greatest advantage lies: in conjunction with intelligent energy and lighting management, the louvres are positioned or tracked according to the position of the sun. This results in a reduction of the heating and/or cooling power consumption on the one hand and, on the other, optimises light regulation to ensure glare-free living and working areas. The feedback signals supplied by the SMI drives for the current position of the motor/blind can be forwarded to the higher-level building automation system and to the management and operation levels.

According to the different designs of roller shutters and blinds, the KL6831 is designed for LoVo SMI drives (24 V DC) and the KL6841 for 230 V AC SMI drives. Both SMI master terminals have two digital inputs, to which freely definable SMI movement commands can be assigned. External sensors such as weather stations or manual operation modules with an override function over the automatic controller are thus easy to integrate. In addition, commissioning is facilitated simply by actuating the two inputs, since the connected SMI drives can be driven upwards and downwards without a control program.

Preconfigured PLC function blocks from the TwinCAT PLC SMI library cover the complete range of SMI functions. Thus, control functions are very easy to implement, and external signals or central commands from other building bus systems, such as BACnet, EIB/KNX, LON, Ethernet or Modbus/TCP, will be forwarded to the SMI drives via the TwinCAT controller.

Further Information:
www.beckhoff.com/KL6831
Intelligent building controls in the Park Hotel Vitznau

PC- and -BACnet-based building automation boosts efficiency and comfort behind historic walls

Housed in a 110-year-old building complex situated directly on the shore of Lake Lucerne in Switzerland, the Park Hotel Vitznau combines a historic setting with the equipment and range of services offered by a modern 5-star luxury hotel. The advanced building automation from Beckhoff, with over 100 Embedded PCs networked by BACnet, is largely responsible for the ability to efficiently configure the complex building operation with maximum comfort for the hotel and event guests.
Following three and a half years of extensive renovation work, during which the technical building infrastructure was also brought up to the latest standards, the Park Hotel Vitznau opened its doors again in March 2013. The complexity of the property (which is subdivided into four “houses”) and the building automation, is shown by the wide range of services alone: 47 suites in six different topical “galleries”, which include the music, theater and finance galleries, are supplemented among other things by two restaurants, six wine cellars with over 30,000 bottles of wine and a large spa area as well as numerous event rooms. Even a doctor’s practice is integrated into the facility.

Versatile functions of room and building automation
PC-based control from Beckhoff is the basis for all functions in the secondary area of the technical building infrastructure implemented by the Swiss system integrator, Panthek. Connected to the primary systems for heating and ventilation as well as to the higher-level building management system, 108 CX5010 Embedded PCs with Intel® Atom™ processors (1.1 GHz) operating as BACnet/IP servers and clients provide the necessary data communication and control for the automation tasks, which include, but are not limited to the individual suites, the two hotel restaurants and the spa/medical area as well as in the floor distributors and for the two weather stations.

Within the scope of room automation, the lighting, blinds, air conditioning and suite controllers can be adapted individually. In addition, there is the switching on and off of under-floor and mirror heating, especially in the bathrooms. Primarily, four lighting effects – i.e. the lighting scenarios “dark”, “medium”, “bright” and “off” – can be selected in the rooms. Additional special and color effects are used, for example, in the bar or in the relaxation room of the spa area. The lighting is controlled using the DALI standard via the KL6811 Bus Terminal which is connected to the PC-based control system.

Higher-level reactions are possible via the hotel reservation system. Thus, 24 hours before the guest arrives, the room is raised from the energy-free mode to the comfort mode, for example, a pleasant temperature is set and the valves for the water supply are opened. The booking system, which is linked to the control technology via the TwinCAT Database Server and TwinCAT FIAS Server running on a C6920 Control cabinet Industrial PC, also enables the pooling of several suites. For this, connecting doors are automatically unlocked and telephone, doorbell and master switch are forwarded accordingly.

Similarly, the information from the two weather stations is evaluated centrally. The information is, used among other things, to retract the sun awnings in case of strong wind gusts and to close the windows in case of rain. Nevertheless, sufficient leeway remains for individuality: even if the horizontal awnings are retracted for safety reasons, the additional vertical blinds can still be operated via the room automation. The automatic shading of the individual facade sides is an additional function of the weather stations equipped with Embedded PCs.
Openness and flexibility thanks to modular I/O system

Over 100 Embedded PCs and around 90 BK9100 Ethernet TCP/IP Bus Couplers acquire approximately 10,000 I/O data points in the Park Hotel Vitznau. A total of more than 1,600 Bus Terminals are connected to them. These include numerous:

- KL1408 or KL2408 8-channel digital input and output Terminals (24 V DC),
- KL2761 1-channel universal dimmer terminals (230 V AC, 600 VA),
- KL3208 8-channel HD analog input terminals for resistance sensors,
- KL3464 or KL4408 8-channel analog input and output terminals (0–10 V) as well as a total of
- 121 KL6041 Serial RS485 interfaces for Modbus room sensors among others,
- 112 KL6301 EIB/KNX Bus Terminals for control elements and
- 202 KL6811 DALI/DSI master and power supply terminals.

All of this information comes together in the respective floor distributors and is processed there by the Embedded PCs. Thus, a CX5010 controls all functions in one corridor, such as the pasteurization function for thermal water disinfection, as well as the distribution of the hot water supplied by a heat pump, which provides air conditioning for the rooms via the ceiling, the base and an additional fan convector (fan coil).

The openness and flexibility of PC-based control is also shown by the simple integration of several subsystems into the BACnet-networked control technology. For example, it was possible to integrate all control buttons simply using KNX. The room sensors specified by the Park Hotel Vitznau – for temperature and humidity as well as for the adjustment of the ventilation – are connected via Modbus RTU. Conversely, the audio/video systems employed communicate with their environment via Modbus TCP/IP. It was possible to implement all of this on the software side as well without a great deal of expense using the TwinCAT automation suite and the appropriate supplements. The same applies to the hotel reservation system, which is an integral component of the holistic building automation via TwinCAT FIAS Server and TwinCAT Database Server.

Simple control of a complex system with TwinCAT BACnet/IP

The Embedded PCs with TwinCAT BACnet/IP fulfill all requirements of the BACnet standard ISO 16484-5:2010 and thus offer a scalable control platform...
for system and vendor-spanning automation of buildings. Numerous additional functions have been implemented that extend beyond the requirements for BACnet building controllers. With the integration of the BACnet protocol in the TwinCAT System Manager it is possible to efficiently configure the I/O Bus Terminals and the BACnet devices with a single tool. The "auto-mapping" function additionally reduces programming efforts and shortens the development time.

Extensive additional functions supplement the required interoperability function blocks of the Beckhoff BACnet Building Control (BBC) devices. Timer switch schedules and trend objects among other things can thus be created and configured even later on by the dynamic generation of BACnet objects. Distributed clocks can be synchronized with the aid of the supported Client and Master functions. BBMD (BACnet Broadcast Management Device) services have been integrated into TwinCAT BACnet/IP for use in widely distributed networks. The integration of spatially remote and third-party devices is particularly convenient within the framework of the Client functionality.

It was possible to implement this functionality in the Park Hotel Vitznau with great efficiency, particularly since the building management system and the primary system from Sauter also use the BACnet standard for their communication. According to Andreas Hutter, Project Manager from Panthek, the connection of the automation technology was very simple and the connectivity via BACnet/IP was much clearer and self-descriptive than a conventional Modbus TCP/IP coupling. The fact that each individual CX5010 is already inherently BACnet-capable also simplifies matters.

**Comfortable BACnet solution with auto-mapping**

The simplification of the project implementation is due in no small part to the auto-mapping function: In a BACnet environment data are always represented via objects and their properties. This applies equally to memory states (variables) and to hardware input/outputs and PLC variables. In the end this means that all hardware terminals in the I/O system as well as all PLC states of the PLC runtime, which should be visible in BACnet, must be mapped by means of BACnet objects. With TwinCAT BACnet/IP this is done conveniently by the automatic mapping, which considerably reduces the work required for linking the BACnet objects. Andreas Hutter explains: "We wrote reusable programs for this complex project. Thus the approximately 60 suites are all controlled by the same program and we therefore benefit a great deal from the fact that BACnet can be configured directly in the respective program and not just centrally in the TwinCAT System Manager. In the System Manager only the individual device is created; everything else takes place via the individual control program."

Daniel Rothenberger, Building Automation Sales Manager at Beckhoff Switzerland mentions a further consideration: "It is particularly important that TwinCAT BACnet/IP facilitates the engineering with numerous functions and templates, since BACnet requires a somewhat changed philosophy or perception. Whereas real variables are used in traditional controller programming, there are additional properties in a BACnet object with its 'Present Value', such as min/max values. The system integrator first has to get used to this and TwinCAT BACnet/IP offers optimum support here."

Further Information:
- www.parkhotel-vitznau.ch
- www.panthek.com
- www.beckhoff.com/building
BACnet, EnOcean and DALI communication for higher implementation flexibility and easier operation

The German appliance manufacturer Miele is building a new office complex in four construction stages at the company headquarters in Gütersloh. The importance of choosing the right building automation solution for a fast and flexible implementation of the project as well as optimized operation is shown in the first completed building. This new facility was automated using PC control from Beckhoff and supported by BACnet, EnOcean and DALI communication.
The first of the four new administration buildings has a total of four office floors, each with an area of 1000 m². Concrete core activation for the basic heating/cooling load, floating ceiling panels and a ventilation system for implementing the change of air have been implemented. In addition to the classic automation of the heating, ventilation and air conditioning systems, the entire room automation is integrated into the automation system, including sun protection with exterior louvered blinds and the lighting. The technical building infrastructure was planned by the Bielefeld-based engineering firm Schröder & Partner and implemented by system integrator Brüggemann from Versmold.

**Automation stations control HVAC and room functions**

Located in the basement of the building is a central air conditioning plant for the supply of fresh air to all four office floors. The cold water requirement for the air conditioning system, the concrete core activation and the floating ceiling panels is met by the factory’s own cold water supply network. The heating energy is similarly provided by a local heating supply. The concrete core activation and the floating ceiling panels are connected via a two-pipe system to the hot and cold water distributors.

An automation station is responsible for controlling and regulating the complete HVAC plant in the basement. In order to optimize the efficiency of the energy generation and distribution, the control of all generation and distribution systems is optimized to suit needs through communication with the automation stations for room automation on the floors of the building. For a proactive control of the concrete core activation, the forecasts from the online service wetter.com were integrated in addition to the current weather information.

On each office floor there is an automation station in the form of a CX2020 Embedded PC, to which the room climate, lighting and sun protection systems are connected. The utilization times of the office floors are specified by timer schedules. Outside of the regular utilization times the building is switched to an economy mode; i.e. the ventilation and air conditioning system is switched off and the room temperatures are reduced to a low energy level. Within the utilization times the room temperature setpoint values are raised to the Comfort energy level.

**Simple wireless networking of control elements and sensors**

The users of the open space work areas can lower or raise the room temperature of individual zones within a small range using EnOcean room control units. The air volume in the floors is controlled by means of flow rate regulators, depending on the air quality. All the windows on a floor are provided with EnOcean window contacts. If the windows are open the entire open space area is switched to the “Protection” operating mode. When Protection mode is active the room
temperature setpoint values are lowered to 6 °C for the heating operation and raised to 35 °C for the cooling operation. By means of the flow rate regulators the air volume is reduced to a minimum in Protection mode.

The communication range of EnOcean wireless signals is at least 30 m, which can considerably reduce the cabling in a building. This has resulted in positive effects in many respects according to Jürgen Meierarnd: “In order to successfully accomplish Miele’s new open-space concept (instead of conventional office and workplace structures), the concrete floor plan of the individual floors had to be finalized at a very late stage. For reasons of time, therefore, a wire-connected installation of light switches, sensors, etc. would have been very difficult. The EnOcean wireless technology offered us maximum flexibility here. Further advantages are the reduction in costs due to the reduced cabling and the correspondingly lower fire loads.”

Energy-efficient building operation
In case of strong sunshine outside of the regular utilization times the blinds are lowered by the automatic thermal control. This reduces the cooling load of the building and saves energy for the generation of cooling water. If the room temperature drops below the setpoint value of the Comfort level, the automatic thermal control automatically raises the blinds in order to use the energy input from the sun to heat the rooms. The sun thus makes a contribution towards the heating of the building whenever possible and necessary.

In order to create optimum working conditions for the PC workstations in the offices, the “Sun protection” program is activated when the room is in use. The sun protection lowers the blinds to a defined position. The louver angle is aligned in relation to the position of the sun so that glare is prevented whilst still allowing the maximum amount of natural daylight to enter. There is thus no unnecessary increase in the power requirement for the artificial lighting of the office workstations. Another function that has been implemented is the automatic twilight function. It automatically closes the blinds when it gets dark and prevents views inside the building from the outside, thus contributing towards the comfort of the employees.

The automatic functions of the sun protection system can be manually overridden by the building users by means of EnOcean buttons. Following the manual actuation of an EnOcean button, the blind controller switches back to automatic mode on the expiry of a time parameterized by the operator.

The automation station on the fourth floor is connected by a serial communication terminal to a weather station via the Modbus-RTU protocol. The weather data is transmitted via BACnet/IP to the other BACnet stations. By means of the weather information for wind force, precipitation and outside temperature, the blinds are protected against storm and icing damage and are automatically raised in case of danger.

The open space areas are lit by standard lamps at the workplace. The lighting is switched on by an occupancy sensor integrated in the lamps. The standard lamps are also capable of EnOcean communication and are integrated into the building automation system.

In order to minimize the energy consumption for lighting the corridors, the lighting systems there are integrated into the automation system by means of a KL6811 DALI interface from Beckhoff. EnOcean brightness sensors measure the light intensity. The presence of people in the corridors is likewise detected by an EnOcean sensor. The lights are thus switched on only when required. By means of the light sensors in the corridors the lights are dimmed to a constant setpoint value, independent of the external brightness.

Simple control and flexible design of a complex system
In addition to the EnOcean room control units, the rooms can also be controlled on the floor level by a touch panel (15-inch CP2916 Control Panel). The touch panel offers an overview of the floor with status information for all sensors and actuators.

The automation stations on the floors consolidate the data from the DALI, EnOcean and Modbus-RTU devices. There are a total of 15,000 BACnet objects within the five BACnet servers for the room and plant automation. A new BACnet management and control level (MCL) for the entire Miele works in Gütersloh is currently under construction. In the programming of the BACnet servers, however, care was taken in advance to ensure that the future connection of further office buildings to the new MCL at Miele will go without a hitch. All relevant data and parameters are made available with TwinCAT BACnet/IP via BACnet objects, so that needs-based, stress-free operational management and system optimization will be possible via the new management and control level system. Also, energy meters are integrated via the KL6781 M-bus terminal from Beckhoff for energy optimization.

For the implementation of the project, the room automation functions were programmed in accordance with the new VDI 3813 directive. TwinCAT libraries and program templates from Beckhoff, including the required BACnet objects, facilitate the engineering even of complex systems and room automation func-
tions. The use of the compact Beckhoff automation stations and Bus Terminals, in combination with the EnOcean technology, enables an extremely space-saving construction of the control cabinets.

On the basis of the flexible EnOcean technology, future modifications in case of a change of use of one of the four office floors are easily possible without changing the cabling. Programs can be modified within the automation stations during operation thanks to “online change”. The Beckhoff solution offers the advantage of system openness, due to the versatile range of Bus Terminals for the integration of subsystems in combination with the vendor-neutral communication protocol BACnet/IP. Furthermore, the Brüggemann experts Rolf Eikelmann, Project Manager Electrical Engineering, MSR, Industrial and Building Automation, and programmer Daniel Malkusch benefit from the flexible and open TwinCAT software: “Our extensive industry know-how has been incorporated via our own library in addition to the new TwinCAT BACnet library. This integration is optimally supported by TwinCAT, especially since we already have many years of experience with this tool and can implement our own approaches very quickly. In this case only the implementation of the BACnet standard was new to us.” It all adds up to a sustainable, flexible and energy-efficient building automation with protection of investment for the building owner.

Further Information:
www.miele.com
www.technik-im-haus.de
www.ib-schroeder.de
www.beckhoff.com/building

A CX2020 Embedded PC with Intel® Celeron® CPU and a 1.4 GHz clock frequency controls an entire office floor.

Overview of the office space on the second floor of the new Miele administration building.

Detailed trend display of the HVAC system data.
In summer 2011, Sensirion moved into a new production building at its main site in Stäfa, near Zurich, which was designed according to the latest standards.

Innovative building services optimize the use of renewable energy resources

Optimum climate in the cleanroom

Sensor components and solutions from the Swiss company, Sensirion AG are in use in the millions, among others in the automotive industry, medical technology, building technology, industrial processes and in consumer goods. Since its establishment in 1998, the company has achieved impressive financial and technological success. In order to keep step with these developments, Sensirion has moved into a new production building at its main site in Stäfa, near Zurich, which adheres to the latest standards. The complex building services were implemented by the Swiss company, Bühler+Scherler AG with the use of Beckhoff automation components.
Sensirion manufactures sensors for the measurement of humidity, temperature, differential pressure as well as gas and liquid flow rates. Manufacturing is handled by highly automated production lines in cleanrooms with a total floor area of 10,000 m² distributed over three floors.

The core of the production building’s innovative air conditioning system consists of geothermal probes and heat pumps as well as its own cooling system with heat recovery, enabling enormous energy savings. Bühler+Scherler AG from St. Gallen, a solution partner of Beckhoff Switzerland, was commissioned to plan and implement the building automation system.

The control architecture for the building services encompasses four Embedded PCs from the CX5010 series, to which over 1,000 hardware data points are connected. “The majority of the I/Os are required for the cooling plants,” explains Bühler+Scherler project manager Martin Müller, who is responsible for the system technology. Analog temperature, humidity and other sensors as well as signal transducers are connected to the signal inputs. Numerous frequency converters are coupled at the output level for the control of the pump motors. “The specified setpoints are analog voltage signals from 0 to 10 V. The frequency converter forms the frequency value from these; for example, a setpoint of 5 V could lead to a frequency of 30 Hz inside the frequency converter,” explains Martin Müller. If the associated sensor of a frequency convertor now signals that the control process is successful, or that the intended effect is not achieved, then the specified setpoint is corrected. This process is controlled in the CX5010 with TwinCAT PLC. Bus Terminals are installed in the control cabinets for the I/O infrastructure. All Beckhoff controllers are networked via Ethernet and communicate via Modbus TCP/IP.

Use of renewable energy resources with intelligent technology

For climatic control there are two water reservoirs each with a volume of 60,000 liters for heating and cooling. In order to ensure process reliability, the water is buffered there and only pumped into the air heater or cooler when needed. Despite these gigantic volumes, a dedicated controller is in use – with precise monitoring of pressure, temperature and further process variables.

The “exterior” air conditioning system, which consists of geothermal probes and heat pumps, is also controlled by a CX5010. “This technology must be seen in context with the two water reservoirs,” stresses Martin Müller. Cold and heat are created on the one hand by the geothermal probes which, in connection with the four heat pumps, supply energy for heating and cooling. “In the winter we get heat from the ground and in the summer, cooling. A heat exchanger is used for this that produces cold water on the one side and hot water on the other, which is transferred by means of the pumps into the respective reservoir. The hot and cold water loads are regulated with the reservoirs; that means the...
Currently the world’s smallest (according to Sensirion) humidity and temperature sensor, the SHTC1 was specially designed for mobile terminals in which the product size plays a decisive role. It measures the relative humidity over a measuring range from 0 to 100 % RH and the temperature from -30 to 100 °C with a typical accuracy of +/-3 % RH.

cooling requirement is covered in the summer and the heating requirement in the winter,” says Martin Müller, describing the process. Sensors for pressure measurement are in use in the heat pump area; these are necessary for the precise regulation of the system pressure setpoint.

The temperature measured at the geothermal probes is used to control the heating and cooling management. This depends on the one hand on the actual temperatures and on the other on the fill level of the reservoirs. Naturally, there are also marginal areas that represent a challenge in terms of control. That is the case, for example, if cold water is produced even though the temperature in the cold water reservoir is already low enough. “In such a case, we cannot allow heating pumps to run any longer because they produce both cold and hot water at the same time,” says Martin Müller. “This situation is covered by the control system – an alarm is triggered if limit values are exceeded. All single technical systems are monitored for quality and process reasons. For example, if a frequency converter fails, the controller sends a message to the higher-level control system. Depending on the priority, it will then send an alarm by text message or email so that an appropriate action can be initiated.”

A higher-level control system logs each alarm, including the acknowledgement and rectification. However, the entire building controller works even if the control system is not available. “The control system is actually a visualization that has no controlling access to processes or systems,” explains Martin Müller, “and that also corresponds to the usual demands on the building automation. The visualization supplies information about the status of the system; the specification or changing of setpoints and parameters, on the other hand, requires expert knowledge.”
Wrapping technology instead of human chain

The flooding disaster that devastated entire regions in southern and eastern portions of Germany in June 2013 caused economic losses reaching a double-digit sum of billions of euros. Experts assume it to be the most costly natural disaster in German history. Of course, this is reason enough to consider new strategies for more reliable flood protection. As a result, the Gütersloh, Germany-based start-up enterprise Topocare GmbH has introduced an innovative solution with its Topomover 3.5 dike building machine. With this technology, endless geotextile tubes produced by means of a special “wrapping” technology can be used in a variety of ways for dam and dike construction and promise effective flood protection.

The development of the dike building machine, which was ready for series production in late July 2013, was supported as an innovative co-operative project through financial assistance from the German Federal Ministry of Industry and Technology. The solution is the result of close co-operation between the Draier engineering firm, Löseke & Marx Maschinen- und Anlagenbau GmbH (mechanical and plant engineering) and Beckhoff as the automation partner. The core of the invention is the geotextile wrapping technology which allows endless tubes – so-called topotubes – to be manufactured and laid on-site. “The use of topotubes could revolutionize dike building in the future,” says Roland Draier, managing director of Topocare, presenting his invention.

Effective flood protection with textile tubes

Granted, using sand-filled tubes to create protective embankments on large-scale sites is nothing new. From the technical point of view the challenge was to design a robust machine that would permit an economical and fast implementation of this method. The method developed by Topocare for the
The picture shows the starting procedure when laying a second tube. Subsequently, a third hose is added in pyramid fashion. In this way, protective dams of a considerable size can be manufactured quickly using the Topomover 3.5.

The manufacturing of seamless and endless tubes made of a sturdy, water-permeable material fits the bill perfectly. It is outstandingly well suited for use in temporary flood protection to quickly stabilize and increase the height of dikes. “In the case of floods success or failure often depends on just a few hours,” explains Simon Jegelka, who is also a member of the Topocare management team. “According to one study, six helpers from THW, a German disaster relief organization, need 70 hours to erect a barrier 75 cm high and 100 meters long from 10,000 sand bags. The Topomover manages that same barrier in just one hour with one person to operate the machine. The dike building machine can produce or process up to 200 m of endless tubing and up to 80 tons of sand per hour. “The method we developed is not only fast, but also less expensive compared to conventional methods,” stresses Roland Draier. The Topomover can be installed and moved on any traction system such as a tractor with a trailer.

CX2030 Embedded PC ensures a trouble-free process

The dike building machine consists of the conveying equipment, which transports the sand to the filling point via two corrugated-edge belts, the boom, which has every degree of freedom due to height adjustment, tilting and a positioning platform, and the wrapping technology, which consists of the filler pipe and the turntable for mounting three textile bobbins. The feeding of the filler pipe is controlled by a level sensor, which is attached to the hopper at the end of the boom. After filling the hopper, the wrapping equipment starts by wrapping the textile belt around the downpipe. At the same time the boom moves upwards along the z-axis so that the wrapped geotextile is continuously pulled off the pipe, creating a sort of sand column. This is continuously set down by the feed of the machine, which is synchronized with the wrapping speed. In order to lay the hose, the boom can be rotated in the x and y planes; it can also be moved in the y direction by means of the cross carriage.
The PLC and motion control is handled by a CX2030 Embedded PC running TwinCAT NC I automation software. All sensors and actuators as well as the encoders are connected via EtherCAT Terminals. The drive components employed are Beckhoff AX5000 servo drives with the corresponding servomotors. A CAN-bus interface connects the “base station” of the manual control unit with the controller; communication between the manual control unit and the base station is wireless. Following the start-up procedure, the installation of the sand-filled endless tubes is performed automatically. The controller is monitored from the driver’s cab.

“In addition to supplying the controller solution, we received great support from Beckhoff application engineering in the development of the Topomover: from planning to the construction of the control cabinet to assembly and commissioning,” explains Roland Draier. The company aims to make the geotextile wrapping technology usable on a large scale for onshore and offshore areas. For example, the tubes can be used as the stable core of a dike and could replace the method of washing sand into the interior of a dike. “The geotextile tubes, which have a diameter of between 60 and 100 cm, provide the grains of sand or gravel maximum positional stability, thus preventing erosion. Dikes manufactured in this way can also withstand overtopping and wave loads, so the danger of a dike breaking is several times lower,” stresses Simon Jegelka.
This year’s appearance of the EtherCAT Technology Group (ETG) at the leading industrial trade show Hannover Messe Industrie (HMI) 2014 in Germany will still be influenced by the 10-year anniversary of EtherCAT technology and of the ETG. Accompanied by a total of 59 partner exhibitors from all over the world, the ETG will exhibit an impressive variety of EtherCAT products at its trade show booth # D18 in Hall 9. Interested visitors can gather information in one convenient spot about EtherCAT technology as well as the combined work of the EtherCAT Technology Group – the world’s largest fieldbus user organization.

The ETG will display its functional safety demo as well as the extremely impressive EtherCAT motion demo, which shows a KUKA robot interacting with two Beckhoff XTS systems. The EtherCAT experts from the ETG as well as numerous knowledgeable representatives of member companies will also be on hand to answer questions and discuss topics concerning EtherCAT. Newly designed information walls will give further insight into the work of the ETG and the wide variety of applications that EtherCAT can modernize.

In addition to its appearance at Hannover Messe the EtherCAT Technology Group will exhibit at a total of 13 trade shows worldwide in 2014. All dates can be found online at www.ethercat.org/events.

In order to cover the need for official EtherCAT conformance tests even better, the EtherCAT Technology Group has extended its lineup of official testing facilities. The accreditation of the first U.S. Test Center in Savage, Minnesota (Minneapolis area), supplements the existing EtherCAT Test Centers (ETC) in Germany, Japan and China. It also meets the sharply increasing need for official EtherCAT device tests in North America.

Since the Semiconductor Technical Working Group (SEMI TWG) of the ETG only recently published an extensive device standard especially for the semiconductor manufacturing industry, the services of the North American EtherCAT Test Center are of particular importance not least to the manufacturers of semiconductor-specific EtherCAT devices. The development of the profile-specific tests is in full swing within the SEMI TWG, which applies to both the automated and the manually-executed tests.

There is great demand on the part of the manufacturers for certified devices: An official certificate, which can be only be achieved through a successful test at the ETC, is considered to be a crucial selection criterion for meeting the industry’s high quality demands. Florian Häfele, who provides technical support to the SEMI TWG from the ETG side, explains: “We are expecting a further increase in worldwide requests as soon as the profile-specific test specifications are implemented in the ETCs. Because numerous big players in the semiconductor manufacturing industry are based in North America, having a new EtherCAT Test Center in their home country will play a very important role in future developments.”
The recently concluded SPS IPC Drives 2013 in Nuremberg, Germany was of particular importance to the EtherCAT Technology Group (ETG), which presented at the trade show with a total of 58 partner exhibitors and more than 330 EtherCAT products: it was 10 years before that the ETG was launched at this same trade show with 33 founding members. Today the ETG has more than 2,700 member companies that continuously support, promote and develop EtherCAT technology within the organization.

To mark this milestone occasion, the ETG presented an application that highlighted mechatronic and robotic concepts in its trade show booth that attracted countless visitors: "Two XTS systems from Beckhoff interact with a KUKA robot," as Thomas Rettig, Senior System Expert at ETG, explained: "The Beckhoff EtherCAT master controls two XTS systems with a cycle time of 250 μs and about 2 kilobytes of data every 250 μs per XTS. We integrated safety over EtherCAT throughout the demo for the safety technology. The KUKA robot, which is integrated as a slave, has its own internal EtherCAT master with a safety controller. The demo brilliantly shows how different advanced motion systems can be combined today, universally and without gateways."

Bernd Fiebiger, Senior Developer System Engineering at Kuka Roboter GmbH, added: "Here at the trade show we are showing the integration of the Kuka robots into the EtherCAT PLC control world, which means that we are now also acting as an EtherCAT slave. The fact that there are currently over 25,000 successful Kuka systems with EtherCAT technology in use worldwide proves that EtherCAT was the right choice for our controllers. We appreciate the high availability, the high bandwidth and the extremely fast communication that EtherCAT gives us."
Record number of visitors at SPS IPC Drives 2013

With 60,027 trade visitors a successful SPS IPC Drives 2013 achieved a new record number of visitors. All in all, the positive mood in the automation industry was reflected by the trade show. Busy halls and booths could be seen throughout the event. Beckhoff presented its range of solutions and innovations at the customary location in hall 7: The Beckhoff trade show TV sums up the latest product news in interviews and impressions: www.beckhoff.com/sps.
Outdoor area FG 15-1

Interpack 2014: Automation and motion solutions in the “Solution Forum”

Interpack, the leading global trade show for the packaging industry and all related process technologies, will take place between 8th and 14th May 2014. Beckhoff will present its PC and EtherCAT-based automation and motion solutions in a special “Solution Forum” in the Interpack outdoor exhibition area. The red “Beckhoff Cube” is located at the center of the fairgrounds and focuses on the following subjects and more: Increased flexibility through the eXtended Transport System and efficient engineering with TwinCAT 3. Besides product innovations such as the new multi-touch Panel generation and CP-Link 4, Beckhoff will present a concept for packaging machines in the context of Industry 4.0 production environments.

Further Information:
www.beckhoff.com/interpack

Hall B5, Booth 309

Automatica 2014: PLC, Motion Control and robotics on a single platform

Automatica, the trade fair for automation and robotics, will take place between 3rd and 6th June 2014 in Munich, Germany. Here, Beckhoff will present its comprehensive range of solutions for robotics, assembly, handling, control, safety and drive technology. In addition to IEC 61131-3, TwinCAT 3 also supports the use of C/C++ and Matlab®/Simulink® as programming languages, greatly facilitating the integration of special robot kinematics. In cases where special controllers have to be used, they can simply be integrated as Matlab®/Simulink® models.

Further Information:
www.beckhoff.com/automatica

Hall 11, Booth 127

Sensor + Test 2014: System-integrated measurement technology

Sensor + Test, the meeting place for the measurement and testing technology sector, will take place between 3rd and 5th June 2014 in Nuremberg, Germany. Beckhoff integrates measurement technology into the standard I/O system with a wide range of specific EtherCAT Terminals – with high precision, high speed and high bandwidth. The signals acquired in temperature, power, current, voltage and complex grid monitoring or Condition Monitoring are provided to the control system as raw data. Special software libraries ensure an efficient engineering.

Further Information:
www.beckhoff.com/sensor-test
Trade shows and events 2014

Europe

Germany
Light + Building
March 30 – April 04, 2014
Frankfurt a. M.
Hall 11.0, Booth C56
www.lightbuilding.de
Hannover Messe
April 07 – 11, 2014
Hanover
Hall 9, Booth F06
www.hannover-messe.de
AALE
May 08 – 09, 2014
Regensburg
www.hs-regensburg.de/fakultaeten/maschinenbau/aale-2014.html
Interpack
May 08 – 14, 2014
Düsseldorf
Outdoor area FG 15-1
www.interpack.de
Sensor + Test
June 03 – 05, 2014
Nuremberg
Hall 11, Booth 127
www.sensor-test.de
Automatica
June 03 – 06, 2014
Munich
Hall B5, Booth 309
www.automatica-munich.com
SMM
September 09 – 12, 2014
Hamburg
Hall B6, Booth 216
www.hamburg-messe.de/smm
WindEnergy Hamburg
September 23 – 26, 2014
Hamburg
Hall B6, Booth 309
www.windenergyhamburg.com
Motek
October 06 – 09, 2014
Stuttgart
www.motek-messe.de
EuroBLECH
October 21 – 25, 2014
Hanover
Hall 27, Booth C41
www.euroblech.de
Vision
November 04 – 06, 2014
Stuttgart
Booth 1807.1
www.vision-messe.de
FMB
November 05 – 07, 2014
Bad Salzuflen
Hall 20, Booth E14
www.forum-maschinenbau.com
SPS IPC Drives
November 25 – 27, 2014
Nuremberg
Hall 7, Booth 406
www.messe.de/spc
Austria
Smart Automation
May 06 – 08, 2014
Vienna
Hall A, Booth A0420
www.wien.smart-automation.at

Belgium
Indumation Network Event
September 18, 2014
Leuven
Hall Brabanthal, Booth RED-12
www.indumation.be/networkevent

Denmark
Robo Business Europe
May 26 – 27, 2014
Billund
www.robobusiness.eu
Automatik
September 09 – 11, 2014
Brondby
www.automatik2014.dk
FoodTech
October 28 – 30, 2014
Herning
www.foodtech.dk

Finland
ICTexpo
May 07 – 08, 2014
Helsinki
Hall 5, Booth 5G3
www.easyfairs.com
Suomen Asuntomessut
July 11 – August 10, 2014
Jyväskylä
www.asuntomessut.fi
Teknikka
September 03 – 05, 2014
Jyväskylä
Hall D, Booth D206
www.teknikkamessut.fi
Prosessiteollisuus
October 08 – 09, 2014
Helsinki
Hall C, Stad C39
www.easyfairs.com

France
SEPEM
May 20 – 22, 2014
Colmar
Hall 3, Booth F26
www.sepem-industries.com/colmar

Great Britain
Drives and Controls
April 08 – 10, 2014
Birmingham
Hall 3, Booth D210
www.drives-expo.com

Hungary
IndustriAutomation
May 27 – 30, 2014
Budapest
www.industriautomation.hu

Italy
SPS IPC Drives Italia
May 20 – 22, 2014
Parma
www.sps-italia.net

Netherlands
High-Tech Systems
May 07 – 08, 2014
s-Hertogenbosch
www.hightechsystems.nl

Norway
ONS
August 25 – 28, 2014
Stavanger
www.ons.no

Austria
Smart Automation
May 06 – 08, 2014
Vienna
Hall A, Booth A0420
www.wien.smart-automation.at

Belgium
Indumation Network Event
September 18, 2014
Leuven
Hall Brabanthal, Booth RED-12
www.indumation.be/networkevent

Denmark
Robo Business Europe
May 26 – 27, 2014
Billund
www.robobusiness.eu
Automatik
September 09 – 11, 2014
Brondby
www.automatik2014.dk
FoodTech
October 28 – 30, 2014
Herning
www.foodtech.dk

Finland
ICTexpo
May 07 – 08, 2014
Helsinki
Hall 5, Booth 5G3
www.easyfairs.com
Suomen Asuntomessut
July 11 – August 10, 2014
Jyväskylä
www.asuntomessut.fi
Teknikka
September 03 – 05, 2014
Jyväskylä
Hall D, Booth D206
www.teknikkamessut.fi
Prosessiteollisuus
October 08 – 09, 2014
Helsinki
Hall C, Stad C39
www.easyfairs.com

France
SEPEM
May 20 – 22, 2014
Colmar
Hall 3, Booth F26
www.sepem-industries.com/colmar

Great Britain
Drives and Controls
April 08 – 10, 2014
Birmingham
Hall 3, Booth D210
www.drives-expo.com

Hungary
IndustriAutomation
May 27 – 30, 2014
Budapest
www.industriautomation.hu

Italy
SPS IPC Drives Italia
May 20 – 22, 2014
Parma
www.sps-italia.net

Netherlands
High-Tech Systems
May 07 – 08, 2014
s-Hertogenbosch
www.hightechsystems.nl

Norway
ONS
August 25 – 28, 2014
Stavanger
www.ons.no
Russia
Hi-Tech Building
October 29 – 31, 2014
Moscow
Hall 2-2, Booth 2-122
www.hthb.ru

Spain
BIEMH
June 02 – 07, 2014
Bilbao
www.biemh.com

Sweden
Nordbygg
April 01 – 04, 2014
Stockholm
Hall A, Booth A33:21
www.nordbygg.se

Elmia Automation
May 06 – 09, 2014
Jönköping
www.elmia.se/de/automation

Trä & Teknik
September 02 – 05, 2014
Gothenburg
www.svenskamassan.se/sites/tra-teknik

Scanautomatic
October 07 – 09, 2014
Gothenburg
www.scanautomatic.se

Switzerland
EPHJ-EPMT-SMT
June 17 – 20, 2014
Geneva
www.ephj.ch

Sindex
September 02 – 04, 2014
Bern
www.sindex.ch

Turkey
Eurasia Packaging Istanbul
September 18 – 21, 2014
Istanbul
www.packagingfair.com/en

Africa
South Africa
The Control Roadshow Port Elizabeth
August 21, 2014
Port Elizabeth
www.whatsnewinprocessing.co.za
Electra Mining Africa
September 15 – 19, 2014
Johannesburg
www.electramining.co.za
The Control Roadshow Vanderbijlpark
October 09, 2014
Vanderbijlpark
www.whatsnewinprocessing.co.za

Asia
China
WWW
April 07 – 09, 2014
Shanghai
www.wwwc2014.net
Chinaplas
April 23 – 26, 2014
Shanghai
www.chinaplasonline.com
Ciros
July 09 – 11, 2014
Shanghai
www.ciros.com.cn
Automotive Testing Expo China
September 15 – 17, 2014
Shanghai
www.testing-expo.com/china
China Brew & Beverage
October 13 – 16, 2014
Beijing
www.chinabrew-beverage.com
China Wind Power
October 22 – 24, 2014
Beijing
www.chinawind.org.cn
Industrial Automation Show
November 04 – 08, 2014
Shanghai
www.industrial-automation-show.com
All in Print
November 14 – 17, 2014
Shanghai
www.allinprint.com

India
Pharma Pro&Pack Expo
April 24 – 26, 2014
Mumbai
Hall 6, Booth H18
www.pharmapropack.com
ACMEE
June 19 – 23, 2014
Chennai
Booth B79a
www.acmee.in

Kazakhstan
Expo-Russia Kazakhstan
June 11 – 13, 2014
Almaty
Booth B9-810
http://eng.zarubezhexpo.ru/expokaz2014

United Arab Emirates
Wetex
April 14 – 16, 2014
Dubai
Hall Zabeel, Booth PSP-7
www.wetex-uae.com

North America
Canada
MMTS
May 12 – 14, 2014
Montreal
Booth 464
www.mmts.ca
ATX Montreal
November 19 – 20, 2014
Montreal
Booth 1415
www.atxmontreal.com

USA
International Cheese Technology Expo
April 22 – 24, 2014
Milwaukee
www.cheeseexpo.org
Offshore Technology Conference
May 05 – 08, 2014
Houston
Booth 10065 & 4527
www.otcnet.org/2014

Windpower Expo
May 05 – 08, 2014
Las Vegas
Booth 2256
www.windpowerexpo.org
Pace Americas
June 03 – 05, 2014
Miami
www.arena-international.com/paceamericas
ATX East
June 10 – 12, 2014
New York
Booth 2827
www.atxeast.com
Semicon West
July 08 – 10, 2014
San Francisco
Hall South, Booth 2410
www.semiconwest.org
Industrial Automation North America
September 08 – 13, 2014
Chicago
Hall East, Booth 4905
www.imts.com/iana
Pack Expo
November 02 – 05, 2014
Chicago
Hall North, Booth 4740
www.packexpo.com
Fabtech
November 11 – 13, 2014
Atlanta
Hall B, Booth 2151
www.fabtechexpo.com

For additional information on our worldwide subsidiaries’ and partner companies’ trade show schedules please check:
www.beckhoff.com/trade_shows