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The purpose of Germany’s “Industry 4.0” concept is to strengthen the competitiveness of the country’s industry by improving flexibility, efficiency and sustainability in manufacturing through communication and intelligent systems. Control technology plays a key role in this endeavor and the potential of control technology is still far from exhausted. Advanced communication capabilities and the increasing convergence of information and automation technologies will generate significant progress.

Beckhoff has already been implementing this approach for many years with its PC-based control technology and advanced fieldbus communication equipment. At the core, all systems from Beckhoff feature the convergence of information and automation technologies, which the company introduced with PC-based control over 25 years ago and still provides the best architecture for future concepts.

With PC-based Control, Beckhoff offers an ideal control platform for “Industry 4.0” solutions. With the PC as a widely accepted platform, in combination with the Automation Device Specification (ADS), the EtherCAT Automation Protocol (EAP) and the OPC Unified Architecture (OPC UA), users are ready to implement the vertical and horizontal integration which is one of the critical requirements of “Industry 4.0”. In addition, TwinCAT 3 automation software delivers the necessary modularity and object orientation to support the programming of Industry 4.0 engineering concepts. In addition, the automation software’s integration into Microsoft Visual Studio® provides the ideal basis for consistent engineering across the entire production lifecycle by making modern software engineering tools from the IT world available to the automation engineer.

Due to the openness of PC-based control technology, production systems and modules can be seamlessly integrated into existing as well as new production systems, while communicating with these and also higher-level production management and control systems. As a result, changes in the job schedule or the running operation can be instantly reflected in the current production step.

While these considerations will be important well into the future, all the necessary capabilities are already available today. Partly because of such powerful automation technology, Germany has successfully reclaimed its reputation as an excellent manufacturing location despite being a high-wage country. German manufacturers along with the associated machine-building industry and their suppliers are clearly focused on higher-tech solutions. Kitchen manufacturer Nobilia, having an output of roughly 2,200 kitchens every day, provides a prime example of what PC-based control can deliver. Thanks to its consistent, IT-integrated production on all levels – the company began to link its production floor to an Oracle database as early as 1990 – Nobilia managed to become the No. 1 kitchen manufacturer in Europe despite Germany’s high labor costs.

As part of the “it’s OWL” (Intelligent Technical Systems OstWestfalenLippe) technology network, which was named a top cluster by the German Federal Ministry of Education and Research in 2012 and was the first major project supported within the ministry’s high-tech strategy “Industry 4.0”, Beckhoff leads the “ScAut” (Scientific Automation) project which explores the integration of engineering knowledge from various disciplines into automation technology in order to make technical systems more intelligent. In the EFA (Extremely Fast Automation) innovation project Beckhoff is researching the possibilities of further performance increases of PC-based control technology in a more in-depth way at the process communication level.

The ScAut project focuses on developing a Scientific Automation platform for the development and the operation of machines and plants. The aim is the implementation of intelligent, reusable automation solutions on the basis of modular software solutions or intelligent Bus Terminals, e.g. Developments like these are intended to enable production systems to automatically recognize wear, reduce emissions, optimize their energy use and help avoid production errors. This will reduce scrap, pollutants and downtime while increasing the durability and sustainability of the systems without adding significant costs in terms of automation technology.
Tire Technology Expo 2014: PC-based automation for the tire industry

From 11 to 13 February 2014 at Tire Technology Expo in Cologne, Germany, Beckhoff will exhibit its open PC-based automation solution for the tire-making industry. The automotive industry’s growing demands on tires as an end product necessitate faster and more precise tire-making machines, vulcanisation with the most stable process possible and extremely accurate testing machines. Increasingly high demands are placed on the process quality, the logging of production data and the plant flexibility. At the same time the enormous cost pressure in the international competition has to be countered with innovative concepts.

PC-based control technology meets these requirements with an open, high-performance hardware and software platform. Communication options from the shop floor up to the MES level are automatically integrated, thus reducing hardware costs. State-of-the-art processor generations enable ultra-fast, high-precision process control.

Further Information:
www.beckhoff.com/tiretech

Prolight + Sound 2014: PC Control – the universal platform for all systems

At Prolight + Sound in Frankfurt a cross-section of the latest product offer for show technology is regularly shown: From 12 to 15 March 2014 lighting, audio and stage technology as well as solutions for system integration will be presented to an international audience.

The PC- and EtherCAT-based control platform from Beckhoff is used to control all kinds of systems in stage and show technology: lighting, sound systems, stage technology, show elements and building automation. The key to the universal application lies in the openness of the control technology, i.e. the support of all relevant fieldbus systems and protocols.

Further Information:
www.beckhoff.com/prolight-sound

Fensterbau Frontale 2014: PC-based control for window production machines

Fensterbau Frontale, the world’s leading trade show for windows, doors and facades, will present the latest products and solutions from the industry to international visitors from 26 to 29 March 2014 in Nuremberg, Germany. The highest requirements apply to process automation in this industry. On the one hand, it is necessary to control the processing of such different materials as wood, plastic, aluminum as well as different combinations to make complex end products. On the other hand, a high individuality of the manufacturing processes must be ensured – lot sizes of 1 are the rule. The open PC- and EtherCAT-based control technology from Beckhoff meets these requirements with maximum flexibility. The scalable range of products ensures the development of cost and performance-optimised automation solutions – from the control of individual machines up to complete production lines.

Further Information:
www.beckhoff.com/fensterbau
“Social automation” for Industry 4.0

The concept of Industry 4.0 requires close interaction between IT systems and automation technology – something that Beckhoff has focused on for 30 years. In this interview, Managing Director Hans Beckhoff gives a business update and tells Open Automation Editor-in-chief Ronald Heinze about how Industry 4.0 is already being implemented and how the underlying principles can lead to concepts of the future such as “social automation”.

“We are quite pleased with the business results of 2013 thus far and overall turnover will most likely grow by 5 to 10 percent,” says Hans Beckhoff, Managing Director of Beckhoff Automation, putting the revenue target for the year around 440 million euros. In the previous year, the company had suffered some sales declines caused by macroeconomic slumps in the solar and wind energy industries. The Managing Director views the results of the past two years also as a “return to normal” after several years of above-average growth. After all, Beckhoff has experienced an average annual growth rate of 16 percent since 2000.

Much of the current growth comes from the export side of the business: “China in particular stands out with increases between 15 and 20 percent,” says Hans Beckhoff. Other countries with above-average growth include Turkey and a few European countries such as Austria and Finland.

Beckhoff views the global economic situation as very stable, with a tendency towards moderate growth. “Next year we will aim for double-digit growth again,” says the entrepreneur. He is also optimistic as far as overall business development is concerned: “Automation is a cross-functional technology used in almost all areas. Not just in machine-building and systems engineering, but also in areas such as building automation, medical technology and the entertainment industry. Wherever you see economic growth, automation plays a critical part.” For the automation industry, this means successful companies must recognize new trends early and identify growth areas in terms of technology and geography alike. “At this time, the US economy is growing again, and the southern European countries have bottomed out and will soon join their northern European neighbors on the path towards renewed growth,” says Hans Beckhoff.

Accordingly, Beckhoff is continuing its international expansion. The company is currently setting up offices in Saudi Arabia and Egypt. However, expanding the existing Beckhoff network is just as important, says the Managing Director, particularly in important markets like Southeast Asia and China. Hans Beckhoff is convinced: “There are also excellent growth opportunities in our traditional markets like Germany, Europe and the US. PC-Control has been proven as a powerful control philosophy and is the obvious and attractive technological platform for “Smart Factories” and “Smart Control”, which are part of the Industry 4.0 concept.

The demand for high-performance automation systems has spread all over the globe. “Companies that lead technologically all over the world are interested in our entire portfolio of solutions which is based on PC-Control and EtherCAT,” continues Hans Beckhoff. “The technology divide we saw in the past has essentially disappeared.”

Automation helps solve sociopolitical problems

“Automation is the answer to numerous great challenges facing mankind around the world,” Hans Beckhoff says about the sociopolitical aspects confronting his company. As the Earth’s population increases from 7 billion people in 2010 to approximately 8.3 billion people in 2030, “we forecast that prosperity will grow threefold by 2030, which translates to three times the demand for goods. This requires that products be made using less energy and with fewer natural resources. To master this kind of challenge, you need great ideas.” Beckhoff believes that this development provides the business and science communities with great opportunities to both participate and profit: “Our automation technology is called upon to create great solutions, and this technology is up to the task.”

The concept of Industry 4.0 resulted from the search for general development trends in implementing these giant tasks. “The German federal government, under the leadership of Chancellor Angela Merkel, has been working together with Acatech, the German National Academy of Science and Engineering, in recognizing the potential advances that could result from the continued development of our production technologies,” explains Hans Beckhoff. After some initial doubts about whether the term “Industry 4.0” is merely “old wine in new bottles,” Beckhoff considers Industry 4.0 to be a “good umbrella term...
are durable and reliable technologies, system operators enjoy lower life cycle costs,”
He believes that optimizing the interaction between all these technologies will
lead to a new level of quality and result in higher levels of productivity and
efficiency in manufacturing.

According to Hans Beckhoff, the basic technologies required for Industry 4.0
include automation technology along with the required sensors and actuators,
information technology with its networking, server and database technologies
(“Big Data”), as well as Internet technologies with web-based communication
and web-based services such as cloud computing. “The Industry 4.0 initiative
courages us to analyze each aspect of automation for new innovations,”
the visionary continues. “Every engineer and scientist is called upon to take
part in this effort with his or her concepts.” Beckhoff is also analyzing how
new concepts can be created in the context of Industry 4.0: “We reconsider all
production and associated automation aspects and their potential for Industry
4.0. As a matter of fact, our PC-based control technology provides the perfect
toolbox to truly implement Industry 4.0. Virtually all of our control systems
enable network and web connectivity while using Windows as their operating
system.” As a result, today’s users don’t think twice about integrating Beckhoff
controllers into their production network, linking them to databases, performing
remote maintenance over the Internet and, if desired, even request services via the cloud.

Maximum flexibility and deep integration into existing IT architectures are standard features that users of the open PC-Control platform from Beckhoff have enjoyed since 1986, the year in which we delivered our first PC-based controller,” says Hans Beckhoff. “The capabilities described in Industry 4.0 have been part of our control philosophy from the start. In other words, we have ‘lived’ Industry 4.0 from day one. Many functions and services are already available and more will follow.”

Long-term stability and scalability
PC-Control has another important benefit: “Since both hardware and software are durable and reliable technologies, system operators enjoy lower life cycle costs,” states Hans Beckhoff. Yet another benefit: besides being long-lived, the ability of IPC technology to handle high computing requirements and storage capacities makes it suitable for analyzing the large data volume captured by condition monitoring components or for signaling critical data to higher-level monitoring systems. This data can then be used to analyze machine condition, for example. “This is where traditional PLCs quickly encounter their limits, because they do not provide sufficient processing capacity for such tasks, which are not directly control-related, but more future-oriented,” explains Hans Beckhoff.

In addition to performance and stability, the PC-Control architecture features exceptional scalability with regard to Bus Terminals, software and CPUs, which Beckhoff considers to be “one of the great strengths of the Beckhoff system architecture for everything from very small applications to the largest systems.” The uniform system architecture covers all aspects of automation.

The same applies to hardware, for example, the IP 20-rated I/O modules: “We are proud that Beckhoff introduced the electronic bus terminal device category together with Wago at the 1995 Hannover Fair,” recounts Hans Beckhoff. “This development surprised visitors, competitors and the entire industry at the time. The ground-breaking solution was widely accepted, used – and ultimately copied. Needless to say, we kept improving our Bus Terminals over the years. For example, for 10 years we have built our E-Series bus terminals, which use EtherCAT as the internal as well as higher-level bus and, as a result, can implement the fastest, deterministic response times. “Since EtherCAT Terminals don’t require an additional sub-bus, the resulting system architecture is very powerful,” says the Managing Partner. Beckhoff Bus Terminals feature “the widest selection of signal types, integrated measurement technology functions to support the Scientific Automation concept, as well as the eXtreme Fast Control (XFC) architecture. “From the 400 available signal types, machine builders can select the 10 to 15 that are usually needed for each application and cover all requirements perfectly,” adds Beckhoff. The Bus Terminal series also has solutions with integrated drive technology functions. Hans Beckhoff is convinced that “Bus Terminals will continue to be a core component of the automation architecture for many years, if not decades, to come. Also, we will keep advancing this architecture in a strategic and systematic manner.”

EtherCAT represents another successful core element of the Beckhoff system architecture: “We are proud that with EtherCAT we introduced a network technology 10 years ago that makes automation easier, more powerful and, last but not least, more affordable,” says Hans Beckhoff. “EtherCAT has become a global standard that serves in many companies and industries as the foundation for their respective system architectures. Over 2,500 companies support EtherCAT today!”

Customer benefits + new developments = innovations
“Listening to your customers and understanding them is critically important,” says the General Manager. “As an industrial equipment manufacturer, it is also our duty to keep an eye on general technology trends in general and understand them, and, of course, to use a good amount of creative thinking in the process. The next requirement involves development expertise. ‘Total customer orientation’ by itself is not enough. It is the mix of potential customer benefits and new technologies that leads to fresh ideas and innovations that generate evolutionary and sometimes even revolutionary progress,” Hans Beckhoff summarizes. “We sell hardware and software in the form of products, but the things we actually deliver to our customers are creativity and trust.” All of this works only in close cooperation with machine manufacturers and end users, says Beckhoff. “As a platform supplier we carry a responsibility that we take very seriously,” he adds. Using the same approach, the company currently assesses all aspects

“The capabilities described in Industry 4.0 have been part of our control philosophy from the start. In other words, we have ‘lived’ Industry 4.0 from day one.”
of Industry 4.0 in collaboration with customers, generating new ideas that
the parties implement together.

Whether centralized or decentralized automation concepts are being used as
a result depends on the particular application. According to Hans Beckhoff,
individual machines operate more effectively if they are controlled centrally,
which is why there will be no major changes in the automation architecture
of the machines themselves. "The debate about whether ‘centralized or de-
centralized’ is better is at least as old as our company," recalls Hans Beckhoff.
There is no clear answer. "Processing machines are more likely run with cen-
tral automation concepts, while segmented, but
cooperating assembly lines are more likely run
with decentralized solutions." For both options
the physicist sees parallels in nature, which he
divides into two levels: "Among mammals, which
include humans, biological evolution has selected a mostly centralized control
architecture as effective and viable. On the other hand, humans live together as
individuals based on social rules, which is more akin to a decentralized architec-
ture." Hans Beckhoff is convinced that Industry 4.0 will mostly affect the area of
social structures, i.e. the upper part of the automation pyramid: "The machine
sends information upward and in return gains benefits from this in the form of
services." This development will have little impact on the machine’s traditional
automation structure, however, in his opinion.

New services for “social automation”

"As an Internet-capable communication platform, our TwinCAT automation
software is completely ready for Industry 4.0," says Hans Beckhoff. The company
also plans to add standardized interfaces to Industry 4.0 services in the future.

Particularly, the definition of new automation services will provide opportunities
for further developments, Beckhoff believes. After all, why shouldn’t there be a
Facebook for machine automation? What useful features can be implemented
in this context? Hans Beckhoff finds it exciting to contemplate such concepts,
which is why he coined the term social automation in the style of social media.

"PC-Control provides the ideal basis for such an approach, because it can ena-
ble machines with interfaces to cloud-based services," explains Hans Beckhoff.
With such an interface, the machine would deliver data “upward” for analysis,
which would in turn generate new benefits. As examples he mentions the traffic
services provided by Google and Tom-Tom, which
use mobile phone density to predict traffic jams
more accurately. For automation, such new servi-
ces could generate a new quality of knowledge,
which could then be used to enhance the flexibi-

ly and efficiency of production processes and to support Industry 4.0 concepts
more actively. Without a doubt, automation will continue to evolve in ways that
mirror other technologies of our time – such as social media – and change life
as we know it for the better.

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“We sell hardware and software in the form
of products, but the things we actually deliver
to our customers are creativity and trust.”
.NET
Powershell
C/C++
...
Automatic code generation
I/O
C++
More efficient engineering with TwinCAT 3

Automation Interface – the open interface for automatic code generation

The automation Interface within TwinCAT 3 automation software enables complete remote control of the TwinCAT engineering system and automatic generation of programs and configurations. Depending on the degree of automation, manual handling of control projects and any associated errors that go along with it can be reduced or eliminated. The quality of software engineering is increased by automating the project generation, while at the same time saving time and cost.

The automation of machines and plants is becoming increasingly complex and time-consuming. Engineering expenditures are growing in proportion to this, which is reflected, among other things, by the increased costs for the development, configuration and programming a PLC. These costs can be reduced if either the complete software application or parts of it are generated automatically. On top of that, errors in the configuration can be reduced by automated code generation. This is precisely where the TwinCAT Automation Interface makes a dramatic impact: it provides a programming interface using the complete TwinCAT system and virtually all offline and online functions can be remotely-controlled. The error-prone and (in terms of personnel costs) expensive generation of I/O configurations and programs is thus simpler to accomplish.

The TwinCAT Automation Interface

Various interfaces to different tools that simplify the engineering process have already been available for many years in TwinCAT 2. The TwinCAT Automation Interface is one of these disclosed interfaces that is based on the Component Object Model (COM) from Microsoft and – in addition to the standard Microsoft .NET programming languages – also supports modern script languages such as Windows Powershell. This opens up new areas of application and usage scenarios for the TwinCAT Automation Interface.

The TwinCAT Automation Interface is made up of a large number of programming routines that are available to the user in the form of classes and methods. Among other things they enable the loading of TwinCAT projects from a source code database such as the Team Foundation Server. The projects can be modified afterwards and activated on the runtime system. Navigation through a project is intuitive, because the underlying tree structure is the same as in the TwinCAT engineering environment, which facilitates faster familiarization with the Automation Interface.

Configuration nodes can be added, deleted and modified within a project. Appropriate routines are available for this, irrespective of the type of node (PLC,
I/O or Motion). The modification of parameters on a node is simple, since almost all the settings are provided in a generic XML format. The configuration of a node is loaded by means of methods available in the Automation Interface; it can be modified by means of standard XML mechanisms such as those provided, for example, by the .NET framework and saved once again in the TwinCAT configuration. I/O nodes can contain, for example, node addresses or baud rates as parameters, while a PLC node in PLCopen-XML provides the source code (e.g. of a function block) in the corresponding IEC 61131-3 language. Here, too, the source code can be loaded, modified and saved again.

All elements of the TwinCAT configuration are made available to the outside with fine granularity via the Automation Interface. This provides a high degree of flexibility for the customer application, since the Automation Interface – as opposed to the step-by-step generation of the configuration "node for node" – also enables the generation of configurations on the basis of templates. For this, the application could access a template pool, e.g. a source control system, and successively build up the configuration. Templates can be defined in a range from complete projects right down to the node level; i.e. an EtherCAT device from the I/O area, once configured, could be saved in a template file, imported later via the Automation Interface and added to a new configuration.

The generation of a configuration – especially in the case of I/O configurations – is based among other things on hardware addresses, which are of course only available if access to the corresponding I/O device is possible. The Automation Interface provides the option to prepare a configuration offline, i.e. without connected I/O devices, and to add the parameters later on when the I/Os are present. Alternatively, a configuration can also be accomplished with connected I/O devices using the "Scan function" that is familiar from TwinCAT XAE.

**Applications of the TwinCAT Automation Interface**

With the aid of the TwinCAT Automation Interface, complete projects can be generated or changed in a standard and flexible way. The application possibilities that result for the customer are extremely varied: They can range from a simple application for the automated addition of version information to PLC function blocks to complex user-defined engineering tools, which only use the regular TwinCAT configuration environment in the background. However, officially available TwinCAT supplement/function products also make use of the Automation Interface: for instance, the TwinCAT ECAD import tool, which uses the Automation Interface internally in order to generate a project from an XML file coming from an ECAD tool.

Users can find a detailed description of the Automation Interface, many solution examples and best practice articles in the Beckhoff Information System. Among other things a downloadable application example is provided that offers the customer a starting point for their own application and thus promises an initial sense of achievement in handling the Automation Interface. The application provides a certain number of different TwinCAT configurations on a graphic interface written in C# using WPF. These can be specified in detail in an XML file. The corresponding configuration is then automatically generated in the background at the push of a button and activated when necessary. The time required for this is just a few seconds – depending on the scope of the configuration to be generated. Such an application offers very high optimization potential for ap-
Applications where the configuration of a machine must be changed several times a day, for example because tools are to be activated with other I/O systems. A machine operator can then activate the different configurations as required without TwinCAT know-how.

A further demo application shows the possible use of the Automation Interface from a Visual Studio® add-in. The application can be started when a TwinCAT project has been opened. It automatically adds version information (author, version) to all PLC function blocks in the project in the form of constants that can be read later on. Such an application underlines once more the usage possibilities and the flexibility in the integration of applications into the Visual Studio® development environment.

Further Information:
www.beckhoff.com/TwinCAT3
http://infosys.beckhoff.com

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Universal multi-touch ...

... as a built-in Panel ...

... as a built-in Panel PC ...

... with DVI/USB Extended ...

... or CP-Link 4 interface.

... with ARM Cortex™ A8 ...

... or Intel® Core™ i3/i5/i7.
The CP2xxx and CP3xxx Control Panel and Panel PC series constitute a highly flexible and modular system that gives machine builders immense potential for innovation through modern operating philosophies. They can rely on an identical panel appearance from any part of the machine while retaining complete freedom of design. In addition to the numerous housing options – built-in or mounted on a support arm, for 7 to 24" screens with aspect ratios 16:9, 5:4 and 4:3, plus landscape and portrait mode – there is also a wide and finely scalable range of CPU classes, including Intel® Celeron® and Core™ i3, i5 or i7 processors, plus ARM Cortex™ A8 CPUs.

The scalability goes even beyond choosing the optimal screen size and CPU class, because the HMI can be implemented either as an active Panel PC or as a remote, purely passive Control Panel, as required – and the option is there to integrate directly in a cabinet or mount on a support arm. There is even more flexibility in the Control Panel’s possible connection options: a USB 3.0 input allows direct connection to any of the standard USB outputs on an IPC at distances up to 3 m; DVI/USB extension technology allows panels to be placed up to 50 m away; when connected via CP-Link 4 with standard CAT 7 cables, they can be up to 100 m away. Altogether this amounts to an ideally tailored HMI solution both in terms of functionality and cost.

Built-in Panel family for all HMI tasks
Using the versatile multi-touch Panel family is an excellent way to achieve a consistent look and feel for your machine’s front end and improve general appearance. For example, the CP2xxx series – designed with IP 65 at the front and IP 20 at the back – it offers all the scaling options of the multi-touch portfolio from Beckhoff, all with the same elegant panel appearance. The built-in panel family includes:

- CP22xx: high-performance Panel PC series with Intel® Celeron® or Core™ i3, i5, i7 processors
- CP26xx: compact Panel PC series with ARM Cortex™ A8 processor
- CP29xx-0000: Control Panel with DVI/USB Extended interface (up to 50 m from the PC)
- CP29xx-0010: Control Panel with CP Link 4 interface (up to 100 m from the PC)

CP22xx: Multi-touch convenience plus maximum processor performance
The built-in Panel PCs from the CP22xx series equipped with multi-core CPUs – Intel® Celeron®, Core™ i3, i5 (all with two cores) and i7 (four cores) – combine multi-touch technology with maximum computing power.
This makes it possible to solve even the most demanding control and HMI tasks very flexibly, and, with screen sizes from 12 to 24", to tailor them precisely to the requirements of the specific application.

The performance features offered by the CP22xx series include a Mini PCI slot available for cards installed at the factory, 2 GB DDR3 RAM (expandable to 16 GB), hard drive, CFast card or SSD, on-board dual Ethernet adapter supporting 10/100/1000Base-T and an on-board SATA RAID 1 controller (Intel® Rapid Storage Technology). A serial RS232 port and four USB 2.0 ports are also included.

In contrast to the previously used ARM9 architecture, the ARM Cortex™ A8 processor hardware features a floating point unit, enabling floating point operations (real, LReal) to be processed much faster. This means that the CP26xx can also be used to implement motion control applications. This compact Panel PC is thus a lower cost alternative to the higher performance CP22xx Panel PCs for applications that only require low to medium computing power.

The built-in CP22xx Panel PC features the very latest generation of Intel® Core™ i processors, making it ideal for applications that demand a high level of computing power.

CP26xx: Compact and fanless multi-touch Panel PCs
The extremely compact and fanless Panel PCs in the CP26xx series feature 7 to 24" screens and ARM Cortex™ A8 processors. They are designed for universal use in PLC and motion control applications, such as in small and medium-sized machines and plants. They can be used for implementing both decentralized and centralized control systems, such as for process monitoring tasks.
The new Beckhoff connection technology CP-Link 4 transmits video signals (uncompressed DVI), USB 2.0 and optionally also power supply via a standard CAT 7 cable, significantly reducing cabling and installation costs. Another advantage is the use of purely passive displays: CP29xx-0010 (built-in Panel) and CP39xx-0010 (mounting arm version) with 7 to 24" screens. Using CP-Link 4, no special software or drivers are required. In addition, ordinary commercial CAT 7 cables are easy to install, less expensive than special DVI cables, and are also available for use in drag chains (see PC Control 02/2013, p. 14).

The compact CP26xx Panel PC with a 1 GHz ARM Cortex™ A8 CPU is ideal for small and medium-sized PLC and motion applications.
Local acquisition of measured data in machines and systems offers many benefits, such as reduced effort in terms of engineering, installation and commissioning along with shorter response times for process events. The key is a wide range of measurement modules, which also cover complex signal types and seamless integration in the control system. EtherCAT Box modules from Beckhoff are ideal for implementing such a system. They open up all the options offered by high-performance EtherCAT technology for the IP-67 world outside of electrical cabinets.

Scientific Automation enables local acquisition of measured data with robust IP 67 modules

**EtherCAT Box – System-integrated measurement technology for harsh environments**

The new EP1816-3008 EtherCAT Box has two integrated 3-axis acceleration sensors and 16 digital inputs.
PC Control 04 | 2013

PC-based control and EtherCAT communication provide a high-performance platform, and not only for traditional control tasks such as PLC, Motion Control and control technology. The holistic Scientific Automation approach that Beckhoff pursues seamlessly integrates additional technology areas such as robotics, sophisticated measurement and data processing, as well as Condition Monitoring and energy monitoring. Rather than utilizing a “black box” solution that is complicated to integrate, measurement technology can be implemented and also retrofitted easily using standard I/O components and standard engineering processes. The main advantage lies in the basic system structure: The measured data are logged in a simple, cost-effective and highly scalable manner by EtherCAT terminals or IP 67 modules and are then transferred via very fast EtherCAT communication to a high-performance Industrial PC for processing.

**Robust housings ensure reliable use in the field**
To complement the wide range of IP 20-rated measurement terminals, Beckhoff started at an early stage to map corresponding functions for solutions in protection class IP 67. The result is a comprehensive EtherCAT Box family, which is still being expanded continuously with new variants. These modules from the IP 67 series integrate direct EtherCAT interfaces, so that high performance is retained right down to each module. This enables new technologies in the IP 67 world: fast process data communication with eXtreme Fast Control (XFC), integrated drive functions and high-precision measurement technology directly in the field.

**Scientific Automation integrates measuring functions into standard control technology not only in the IP 20 world – such as temperature measurement in this example – but also in harsh IP 67 environments.**

**From digital I/Os to complex signal types**
The EtherCAT Box modules cover the typical range of requirements for IP 67 I/O signals: digital inputs with different filters (3.0 ms or 10 μs), digital outputs with 0.5 and 2 A output current, combination modules with freely selectable inputs or outputs, analog inputs and outputs with 16-bit resolution, thermocouple and RTD inputs, as well as stepper motor modules. With integrated XFC functionality, the EP1258 EtherCAT Box opens up a wide range of new applications, which in the past were not possible with an IP 67 module. With eight digital inputs it logs fast binary signals from the process level and transfers them in an electrically isolated manner to the control system. The signals are furnished with a time stamp that identifies the time of the last edge change with a resolution of 1 ns. In this way signal variations can be traced exactly over time and related to the EtherCAT distributed clocks across the system.

**Integrated acceleration and angle measurement**
This diversity enables connection of almost any sensor and actuator type and the logging of complex signal types. A good example is the new EP1816-3008 EtherCAT Box. With 16 digital inputs it logs binary control signals from the process level and features two integrated 3-axis acceleration sensors. It is easy to install and can be used to implement cost-effective vibration and shock/oscillation monitoring directly in the field. It also supports inclination measurement in X and Y directions. The acceleration sensors with 16-bit resolution in the optional ranges ±2g, ±4g, ±8g and ±16 g are realized as so-called MEMS (Micro-Electronic-Mechanical Systems). Compared with the conventional combination of sensors and separate data sampling, this solution is more cost-
effective and easier to install and integrate in the control system. Furthermore, it offers another advantage: Two sensors, which are arranged at 90° angles, make the EP1816-3008 a redundant measuring system, and moreover, the results can be reliably verified in the controller. A typical application for the 3-axis acceleration box is vibration and shock/oscillation monitoring of machines and buildings. For example, vibrations of robot arms can be monitored exactly and with no great effort via the measured accelerations. For wood sawing machines, an EP1816-3008 mounted on the work table offers reliable monitoring of the saw blade angle adjustment thanks to its fast signal acquisition, as another example.

The most efficient way to measure compressed air

The new EP3744 differential pressure measurement box is a compact and integrated solution for measuring, monitoring and analysis of compressed air supplies, which are encountered in almost all areas of industrial automation. This EtherCAT Box has six digital inputs, two digital outputs and four pressure inputs with integrated 6 mm fittings. The pressure is measured as the difference to the fifth pressure connection, which is fed via a hose into a protected environment for IP 67 conformity. This all adds up to a compact stand-alone device for the direct measurement and monitoring of pressure in the field. On the one hand, it eliminates long routes and hose connections from the process to the control cabinet, and on the other hand, it facilitates separation of electric and pneumatic systems, as stipulated for many applications. The EP3744 can be used for operating pressure monitoring, for example. In addition, the decentralized and system-integrated pressure measurement is the ideal solution for the prompt detection and localization of leaks. The EP3744 can also contribute to a trouble-free processing sequence: for example, the vacuum necessary for the gripping process in automatic pick-and-place machines can be monitored without great expense. To do this the EtherCAT Box needs only to be integrated into the compressed air supply to the suction gripper via a simple T junction.

Complete range of infrastructure components

For the consistent decentralized configuration of machine or system data acquisition, corresponding infrastructure components are required. The new EP9224 Smart Power Box even combines the infrastructure component with measurement functionality: The 4/4-channel power distribution enables the connection of four EtherCAT Box power supply branches. In each 24 V branch the current consumption for the control voltage and peripheral voltage is monitored, limited and switched off if necessary. All input voltage and output current values can be analyzed in the controller via the process data. In the event of a fault, the continuous logging of relevant data such as current values or temperature facilitates troubleshooting. The data can be retrieved from a ring buffer in order to pinpoint the causes of faults.

EtherCAT supports virtually any topology, which can also be directly branched in the field using the EtherCAT Box modules. If several junctions are required at one point in the star topology, an EtherCAT junction can be used to branch the topology further. Analogous to the infrastructure components with IP 20 protection, the EP9128 eight-way EtherCAT star hub offers the possibility to construct the branches of the topology with the smallest possible number of components in the IP 67 world as well. The EtherCAT network is connected to the input port of the star hub and can be extended via the other seven ports.

The EP9521 and EP9522 EtherCAT/Industrial Ethernet modules for fast industrial Ethernet/100 Mbaud serve as media converters from optical fiber to copper and vice versa. Both media converters are suitable for multimode fiber-optic cables. In addition to the copper branch, the 2-channel EP9522 enables further optical fiber topologies to be configured via a second optical fiber port, while the single-channel EtherCAT Box EP9521 is used for direct transfers between the two media. The CU2608 IP 67 Ethernet switch is another important infrastructure component with robust design. In a compact plastic housing it
Measurement technology integration for Industry 4.0

The ScAut innovation project is part of the Leading-Edge Cluster, “it’s OWL” (Intelligent Technical Systems OstWestfalenLippe), and is managed by Beckhoff as the consortium leader. ScAut illustrates the trend-setting nature of the holistic approach embodied by Scientific Automation. The idea is – in the spirit of Industry 4.0 – to utilize the ever-growing capacity reserves of PC technology for implementing scientific findings on standard machine controllers. A concrete example is process-optimized drilling, in which spindle current and power, feed current and power, vibration of the spindle and workpiece, drill hole temperature, chip formation and drilling pattern are all used as control parameters for optimizing production efforts.

Further Information:
www.beckhoff.com/EtherCAT-Box

The EP9224 combines a 4/4-channel power distribution for EtherCAT Box modules with comprehensive current measurement and data logging functionality.

Software optimizes measurement technology integration

The new TwinCAT 3 software generation, which is integrated in Microsoft Visual Studio®, was designed to meet the needs of Scientific Automation, i.e. the convergence of automation and advanced measurement technology. The real-time environment is designed to enable almost any number of PLCs, safety PLCs and C++ tasks to be executed on the same or on different CPU cores. The new TwinCAT 3 Condition Monitoring library enables the utilization of these options: Raw data can be logged with a fast task and processed further with a somewhat slower task. This is ideal for continuous measured data logging and independent analysis in a second task, based on a wide range of algorithms. The individual function blocks of the Condition Monitoring library store their results in a global transfer tray, a kind of memory table. From there the results can be copied to variables or processed further via other algorithms so that a customized measuring and analysis chain can be configured.

No Beckhoff-specific blocks or other modifications of the original model are required for creating Matlab®/Simulink® modules. The Matlab® and Simulink® coders generate C++ code, which is then compiled into a TwinCAT 3 module. Modules can easily be re-used through instantiation. The block diagram from Simulink® can be visualized directly in TwinCAT for setting break points, for example.

TwinCAT Scope offers display options for all relevant Scientific Automation software signals. The View component is used for visualization of signals in the form of charts, the Server component records the data on the respective target device. Scope is able to take precise measurement readings right down to the microsecond range and can visualize oversampling values from the EtherCAT measuring terminals, for example.

Accessories for efficient system configuration

The wiring for protection class IP 67 is simplified significantly thanks to pre-assembled cables for EtherCAT, power and sensors. Wiring errors are effectively prevented, reducing commissioning times as a result. In addition, field-configurable connectors and cables are available for maximum flexibility. Combination I/O modules and the high signal granularity also reduce system costs.
EL6201 AS-Interface master terminal supports specification 3.0

The EL6201 AS-Interface master terminal enables direct connection of AS-Interface slaves and facilitates the interfacing of sensors and actuators from the lower field level to the higher control level via EtherCAT. The AS-Interface-compliant interface supports digital and analog slaves according to the current AS-i specification 3.0.

The EL6201 EtherCAT Terminal is an AS-Interface master in a compact, 12 mm wide terminal housing, which seamlessly integrates into the EtherCAT system. In this way AS-Interface slaves can be operated in a terminal network with a wide range of signal types, and topologies with further subordinate fieldbuses can be implemented. The EL6201 is certified by the AS-International Association.

The configuration interface integrated in the TwinCAT System Manager enables convenient manual or automatic addressing of the integrated AS-Interface slaves. The AS-i system overview shows the addressed slaves and the project planning status. Thanks to the extended addressing mode of the 3.0 specification, up to 62 slaves can be included in an AS-i network. Extensive diagnostics options, including the display of parameterization errors, for example, minimize the likelihood of errors during the project planning stage. During operation the diagnostics system facilitates troubleshooting in the event of a voltage or slave failure, for example. The configuration is stored in the AS-Interface master terminal, so that AS-Interface slaves can be exchanged quickly.

The connected devices can be supplied from the existing 24 V DC power supply unit via the EL9520 AS-Interface potential feed terminal with integrated filter. An additional 30 V DC AS-Interface power supply unit is no longer required. The only restriction is that the topology is reduced from 100 m to 50 m. The reduction of the rated voltage to 24 V has been specified by the AS-International Association as AS-Interface Power 24. The fact that no special AS-i power supply units are required makes the system configuration more economical, particularly for smaller topologies.

Further Information:
www.beckhoff.com/EL6201
www.beckhoff.com/EL9520
www.beckhoff.com/AS-Interface
More flexibility, speed and efficiency in production – this was the aim of French manufacturer Bieber who specializes in windows and doors. To this end they commissioned Koch Maschinenfabrik to build a new production plant that would set new standards in terms of sophistication and flexibility. Based on plenty of expertise and a strong investment commitment, the aim was achieved using PC- and EtherCAT-based control technology from Beckhoff. In addition the Bieber quality windows benefited from a genuine technical evolution.

CNC machining center: with a single system to the individual finished product
With more than 50 years of experience, Gerhard Koch Maschinenfabrik GmbH & Co. KG, based in Leopoldshöhe, Germany, has become a leading supplier of top-quality machines for the production of furniture, doors and timber windows. The plant manufacturer specializes in machines for sawing, milling, drilling and, especially, for gluing and dowelling. This extensive know-how is what attracted the window and door specialist Bieber SA, based in the Alsatian town of Waldhambach, when the time came to modernize their production facilities with a new main production system.

Quality and flexibility as key requirements

Koch's main requirements for the new CNC machining center Winline-6 were safeguarding and possibly even increasing the high product quality and maximum flexibility right down to lot size 1. Both are key success factors in the market for wooden windows and doors. After all, the company even deals with private customers demanding custom products in small series or individual pieces.

The result is a unique, modular woodworking machine, which, notwithstanding its size and complexity, only requires two operators. It handles all parts of a wooden window right up to the individual finished product – for wood/metal windows including the application of brackets for aluminum panels – so that the window is ready for coating. Although the new production plant for Bieber is based on the tried and tested modular Koch system, it was tailored to meet the requirements of the window specialists, which included the in-house development of software for the PC Control master computer.

A complete machining center from one source

The machine manufacturer Koch developed the Bieber production plant completely in-house. Only the upstream planer, which was also automated with TwinCAT as requested by Koch, was sourced externally and then seamlessly integrated in the system. Koch’s actual Winline-6 plant consists of five modules: the intermediate parts store, the three processing modules – Winline-600, Windoor-LU und Winline-6000 – arranged in a U-shaped configuration, and the tool changer with shuttle system located in between.

Koch uses EtherCAT and TwinCAT NC I software for transferring and processing control data within the individual machine modules. This was a prerequisite to meet the high requirements for axis synchronization of the servo-controlled and independently operating tension jacks in the Winline-600 processing module, for example. Oliver Bexte, software Development Manager at Koch, explains: “Each of the two Winline-600 processing sections may contain up to six individual components, i.e. twelve parts in total, at any one time. The high processing performance and short cycle times require very fast control technology. We therefore operate the NC with a task with 2 ms speed and precision, the
Based on the proven track record over many years, Koch uses Beckhoff automation technology for all its NC-controlled machines. The different machine modules exchange higher-level data via real-time Ethernet. The communication with the master computer – which is used for the calculation and allocation of the production data, parts tracking and tool management – is based on TwinCAT ADS.

The high complexity of the plant is reflected in the key data of the automation system: C6140 control cabinet Industrial PCs with RAID system from Beckhoff are used as control computers in all modules and as master computer. They are operated via customized Beckhoff touch panels with push-button extension. Including the upstream planer, a total of 102 servo axes have to be controlled. In addition, the EtherCAT system has 1804 digital inputs and 1516 digital outputs, numerous analog I/Os and TwinSAFE terminals – for realization of a start-up lock and a global emergency stop – and several other terminals, such as the EL6001 for connecting RS232 devices.

Five modules for the production process
The first module of the Bieber production plant is the intermediate parts store with shelf trolleys from which the plant is automatically supplied with raw ma-
terial in the form of timber beams that are up to 6 m long. In order to minimize waste, the material supply is organized based on the overall order, rather than in relation to individual timber beams. An order can comprise of up to 196 individual components, which are allocated from the intermediate store on a frame-by-frame basis. The complex process is controlled via four AX51xx servo drives, four EK1100 EtherCAT couplers, 28 digital EL1004 input terminals and 37 digital EL2004 output terminals, plus a total of 30 I/Os in protection class IP 67, in the form of EP1008, EP2008 and EP2028 EtherCAT Box modules.

The subsequent Winline-600 module has three processing stations, so that up to six workpieces, which are transported through the plant on two conveyor sections, can be processed independently and simultaneously. The process steps include saw cutting with waste wood disposal, horizontal drilling for dowel joints, drilling for installation holes and corner hinges, strike plate installation and milling of face profiles. The module is controlled and monitored by 13 AX51xx and 11 AX52xx servo drives, 12 EK1100 EtherCAT couplers, 106 digital EL1004 input terminals and 127 digital EL2004 output terminals.

The third Windoor-LU module is the processing unit for length-independent drilling and dowelling. Two AX51xx and AX52xx servo drives, four EK1100 EtherCAT couplers, 39 EL1004 EtherCAT Terminals and 43 EL2004 EtherCAT Terminals ensure precise workpiece positioning and therefore exact drilling and dowelling. The maintenance-free monitoring system for correct glue application developed by Koch ensures high manufacturing quality when the dowels are applied.

The last processing module before the workpieces are queued or fed directly to the frame press is a Winline-6000 unit, where the workpieces are profiled longitudinally; first inside then outside. Up to four processing motors per side are used, depending on how the tools are allocated. A special feature is that all four motors can plunge and emerge on the fly, as required, thanks to TwinCAT cam plates, independently of each other and very dynamically, so that profile changes are smooth and fast, without the need to stop the main axis. The control system for the module comprises 20 AX51xx servo drives, 14 AX52xx servo drives, four EK1100 EtherCAT couplers, 238 EL1004 EtherCAT Terminals and 152 EL2004 EtherCAT Terminals.

The fifth module, the tool change system, sits between the Winline-600 and Winline-6000 processing units. Via a shuttle it supplies the ten plate changers for the processing units with the tools required for the next processing step, controlled via the master computer based on look-ahead functionality. In this way downtimes are eliminated, further reducing the processing times. The devices used in this module include 23 AX5xxx servo drives.

Customer requirements optimally implemented
The customer requirements in the market for high-quality wooden windows are the yardstick based on which the new production plant is measured. Bieber’s Managing Director Philippe Beyer explains: “We cover the whole range from standard windows to individual products. We are renowned for high quality, particularly in the important and demanding US-American market, where Bill Gates is one of our customers, for example. Key aims were therefore increased flexibility, higher productivity and improved product quality, which is why we were looking for a new, innovative plant from Koch. In the meantime it has become evident that our products have experienced technical evolution thanks to the Koch plant.” Yves Kuhl, Plant Designer at Bieber, said: “The high requirements resulting from short production times are optimally satisfied thanks to the high performance and positioning speed within the plant. On average we achieve a throughput of two workpieces per minute and therefore an output of around 800 window components per shift. Moreover, the Koch plant offers many innovative functions, such as profile changes, that were not possible with the previously used individual systems. Above all, the end product is a finished product with all the required holes and dowels that simply has to be pressed.”

PC-based Control technology from Beckhoff has already been tried and tested in everyday practice at Bieber for a long time, as Ralf Steube, Chief Designer for window and door production machines at Koch, explains: “Two of our machines that are controlled with Beckhoff technology were installed at Bieber over ten years ago and are still operating extremely reliably. PLC-controlled machines therefore became a thing of the past quite some time ago. With the new plant, Bieber once again benefits from comprehensive PC Control expertise.” Oliver Bexte, Software Expert at Koch, added: “With our new plant Bieber covers around 80 % of their production. A quick response in the event of a system shutdown is therefore crucial. This is one of the reasons why we use Beckhoff control technology throughout. The same PCs, EtherCAT couplers and I/Os are used anywhere in the system, so that in the event of a fault components can be replaced quickly and easily, quite often even without having to call in a service technician.” Philippe Beyer sees another benefit: “The PC technology also sim-
Key requirements for the production of top-quality wooden windows at French specialist company Bieber are precision and flexibility.

Simplifies interfacing with the ERP level. All production data are transferred from the ERP system directly to the Koch master computer, i.e. the plant is optimally integrated in our company network. This coming year we intend to rebuild our production EDP, which thanks to the process and material flow optimization offered by the new plant, will also become much simpler.*
TwinCAT 3 unites PC Control and science for simplified cable robot operation

High-bay warehouses with conventional automated storage and retrieval machines are in widespread use and firmly established. However, the payload in relation to the total mass that has to be moved is very small. Within the scope of a project sponsored by the German Federal Ministry of Education and Research (BMBF), “EffizienzCluster LogistikRuhr”, researchers at the University of Duisburg-Essen have now eliminated this disparity with the help of parallel cable robots. In doing so they benefitted from the inexpensive and flexible control technology enabled by PC-based Control. Furthermore, the scientific know-how existing in Matlab®/Simulink® models can be integrated into the controller in the simplest way using TwinCAT 3 software.
Automated storage and retrieval machines (SRM) are used today in intralogistics. By means of a rail-mounted drive unit and a lifting unit, a storage/retrieval device is positioned in front of the high rack, which puts goods into storage or removes them again in a targeted manner. In the process, current SRMs move the large mass of 1 to 2 tonnes of drive unit, mast and lifting unit in order to transport small parts with a payload of only 20 to 50 kg. In order to avoid this, a light-weight platform with an integrated storage/retrieval device now replaces the complete drive and lifting unit. This platform is moved in front of the high rack as a so-called cable robot with eight tensioned cables. The result is a mechanically simple and extremely light-weight system, which on top of that can be constructed in the most diverse sizes without the mass-related height limits that need to be observed with traditional high-bay warehouses.

New concept with energy-saving and performance potential

The enormous reduction in mass of the cable robot technology, which amounts to over 90 % compared with conventional technology, leads to enormous increases in performance and a very good energy balance at the same time. The concept has already been implemented in 2012 at the University of Duisburg-Essen with a 6-m high, 12-m wide and 1-m deep prototype. It was realized by the two departments of Mechatronics and Transport Systems/Logistics as well as the department of Computer Application in Design. Dr. Tobias Bruckmann from the Faculty of Mechatronics summarizes the result as follows: “We have achieved an extremely improved mass ratio, because the end effector which has to be moved – the light-weight platform with the storage/retrieval device – weighs only 80 kg and can take a payload of up to 20 kg. A model calculation, based on a simple model and idealized assumptions, resulted in a reduction in energy consumption of about 70 % compared to a conventional storage and retrieval machine.”

Regarding the attainable storage/retrieval performance, there is similarly a high optimization potential. Typical SRM values, i.e. a platform speed of 6 m/s and a platform acceleration of 5 m/s², were taken as design specifications at the start of the project. Christian Sturm, also from the Faculty of Mechatronics, adds: “Winch drives with a rating of 7 kW are required in order to attain these values. In our prototype we even use 14 kW drives, enabling considerably higher speeds and acceleration, especially since the more powerful and thus heavier drives don’t have to be moved as they do in the classic storage and retrieval machine, so their higher mass has no impact.”

High-performance, industrially compatible control technology as the basis

In order to ensure a safe system operation at all times, highest demands are placed on the control system. In addition to that, eight servo drives have to be driven synchronously, and force sensors and angle encoder for all eight cables have to be read simultaneously. These measured values supply the data for a model-based controller that demands a high-performance real-time platform. Dr. Tobias Bruckmann adds: “Since this controller was implemented in Matlab®/Simulink®, the TwinCAT 3 automation suite from Beckhoff represented an ideal,
powerful and affordable solution. Instead of prototype control systems for academic use, it was thus possible to make use of proven standard components.

The C6640 Control Cabinet PC provides more than enough computing performance for the entire control technology. It communicates by EtherCAT with sensors and drives as well as with components of the light-weight platform, such as the storage/retrieval device and the laser scanner for fine positioning. Since the cable robot operation requires extremely reliable measurements of the cable forces, the researchers use the EL3356-0010 Analog Input Terminal with eXtreme Fast Control (XFC), as Christian Sturm explains: “In order to be able to move the light-weight platform precisely and with as little vibration as possible, the cable tensions are measured by load cells and EL3356-0010 EtherCAT Terminals. These values are then processed by the control algorithms implemented in Matlab®/Simulink®. In this way the signals can be processed in the controllers without any further pre-processing. Furthermore, parameterization and connection are very simple and also the terminals are very cost-efficient.”

A critical advantage of the control system is its industrial compatibility. It therefore represents the ideal basis for further work on the actual main thrust of the research – the control algorithms. Dr. Tobias Bruckmann confirms this: “Instead of decentralized controllers for drives and platform, we need only one central real-time PC with a wide data bus and it doesn’t matter whether we have to transmit measured values over just one metre or over twenty metres to the platform. In earlier prototypes data acquisition and, in particular, motor control over large distances were rather complex. We were surprised at how simple the commissioning of our new, large prototype was.” And there is another benefit-factor: “The Beckhoff technology also offers a great advantage with regard to practical use, in other words series production, because on the one hand we can use the familiar Matlab®/Simulink® world and on the other the user can make unlimited use of common IEC 61131-3 languages. Thanks to this universality it is not necessary to integrate a second control system , for example for the addition of safety functionality – PC Control is ready to provide everything which is required for industrial use on a single platform.”

The openness of TwinCAT 3 as a milestone for developing future-proof systems

The researchers view the simple interfacing of Matlab®/Simulink® with TwinCAT 3 as a true milestone, because only that enables them to access an industrially compatible system in a simple manner from their scientific field of work. In addition, the entire hardware level can be structured very simply and modularly using TwinCAT 3 and EtherCAT. Christian Sturm explains: “All components connected to the EtherCAT system are represented as a hardware image under TwinCAT 3, so that all devices can be linked to the controller with ease via communication with our software module. In addition the system
TwinCAT 3 similarly offers potential for future developments. Its support for multi-core technology, for instance, is of particular importance, especially with regard to industrial use, since the tasks necessary for this such as warehouse management and safety concepts can be outsourced to their own processor cores if necessary. In addition there is the openness through integration into Visual Studio®, which according to Dr. Tobias Bruckmann is a very attractive feature. The academic users would be only too willing to use this new programming technology to create a complete project, from real-time programming to the visualization in Visual Studio®. The next step for the cable robot project is to integrate software blocks written in C/C++ as well and in this way to be able to access other hardware interfaces, for example a camera system.
Turning waste into a “green” energy source

The Dutch engineering firm Gastreatment Services (GtS) specializes in the creation and distribution of biogas. The Gastreatment Power Package® developed by GtS can be used to convert biogas from landfills, wastewater treatment plants or farms into fuel with the quality level of natural gas. This biogas can be used to power machines and automobiles or as an environmentally-friendly household energy source. On November 1, 2012, GtS put its first green gas plant into operation on the site of a former landfill at Schoteroog, near Haarlem in the Netherlands.

“We have already constructed four such plants internationally, but this one in Haarlem, on the site of the former Schoteroog landfill and next to the wastewater treatment plant of the Hoogheemraadschap Rijnland water authority, is the first green gas system we have built in the Netherlands,” explains Mathieu de Bas, Director and Co-Founder of Gas Treatment Services. The plant employs a complex process to convert biogas given off by the decommissioned landfill into fuel gas of natural gas quality, plus liquid CO₂ as a by-product.

Converting landfill gases to fuel gas with natural gas quality

In the mid-seventies and eighties, Schoteroog had a 22,000 m² waste dump. In 1992, when it became apparent that the landfill had been contaminating the groundwater, it was sealed to then state-of-the-art standards. As was usual at the time, the methane and other gases given off by the biological degradation of garbage were captured and flared off together with the biogas from the wastewater treatment plant – much to the annoyance of the province of North Holland and the municipality of Haarlem. Local officials wanted to use the gas to generate energy under their sustainability programs.

In 2009, GtS and the energy supply company Essent took the initiative and joined forces with the province of North Holland, the municipality of Haarlem, the waste management company Afvalzorg and the water authority Hoogheemraadschap Rijnland to develop a treatment plant that would clean and upgrade biogas from the former landfill and wastewater plant in order to produce biogas of natural gas quality. This purified gas can be used for cooking appliances and
heating as well as for fuel. A further advantage of this process is that greenhouse gases will no longer escape into the atmosphere. “The former landfill at Schoteroog will supply sufficient landfill gas until 2035. Initially there will be about 800,000 m³ per year, falling to an estimated 600,000 m³ after 2025,” explains Mathieu de Bas. The system can take in up to 280 standard cubic meters of gas per hour and use it to produce 190 cubic meters of natural gas equivalent, satisfying the natural gas consumption of about 500 households. “We deliver this natural gas to the energy supplier Essent, who sells it to the municipality of Haarlem,” says Mathieu de Bas.

Compressors maintain a constant 2 mbar underpressure to prevent landfill gas from escaping into the atmosphere. Gas from the 16 gas wells distributed over the area is regulated by valves and piped into the green gas plant.

The biogas plant is designed on the basis of a separation process in which excess CO₂ is removed from the gas mixture and conveyed in liquid form to a number of customers, or used as a coolant in the GtS treatment plant itself. Landfill gas contains water vapor, CO₂, nitrogen, methane, and various impurities. The plant first cools the gas down to 5 °C at a pressure of 30 mbar to remove water vapor. The water condenses and is drained away to the neighboring wastewater treatment plant. Compressing the gas mixture and cooling it to -25 °C removes the volatile organic compounds (VOCs) and siloxanes. Finally, the gas is filtered to remove any remaining impurities and is then passed over a catalyst.

In the next step, the gas is cooled down to -60 °C, which separates off liquid CO₂. Cooling still further, down to -80 °C, produces solid CO₂, which is then melted again and stored in liquid form in a cryotank (at 20 bar and -30 °C). The liquid CO₂ is ultimately used, for instance, by transportation companies in refrigerated trucks and by metal processing facilities for welding or shrink joints. The green gas produced is either fed into the natural gas distribution network or subjected to a further liquefaction process and then stored. This means that in the event of a system failure, GtS can continue to supply gas for a further 14 days.

PC-based control system fulfills high computing-power requirements

To control its green gas plant, GtS decided on a PC-based control platform from Beckhoff, comprising a C6930 Industrial PC, real-time TwinCAT PLC software and Bus Terminal I/O modules. “The great advantage of this Industrial PC is that it delivers the high level of CPU power needed by the sophisticated control processes – for cooling and rewarthing, increasing and decreasing the pressure, regulating the replacement of pressure drums, continuous measurement of pressures and temperatures – plus controlling the overall process,” says Jurjen Verhoeff, office and Marketing Manager of the Dutch distribution partner Beckhoff Industrial Automation Link, based in Haarlem. “In addition, the computing power of the Industrial PC is sufficient to support SCADA software packages for trend analysis and the storage of historical data, giving the operator a better overview and more convenient operation,” adds Jurjen Verhoeff.

“The wide range of available Beckhoff I/O modules guarantees us a customiz-able solution that is able to communicate with all the sensor types involved in the process,” explains Mathieu de Bas. All temperatures are measured using the KLL314 measurement terminal while pressures are measured with the KM3702. Temperatures are recorded at a total of 162 points, and pressures and flow rates at a further 67 points. “Another advantage of the I/O modules used is their Ex certification, enabling us to use them in rooms subject to explosion hazards up to Zone 2,” concludes the GtS Managing Director.

Further Information:
www.gtsbv.com
www.beckhoff.nl
CRS Máquinas, which is headquartered in Mirassol, Brazil, has produced machines for the furniture industry for over 10 years. “We developed the Logic-II woodworking center to differentiate ourselves from conventional offerings in the Brazilian machine-building market,” explains Célio Renato Silva, the CEO of CRS Máquinas. “With its quick tool changes and easy reconfiguration capabilities to accommodate frequently changing production lots, Logic-II enables users to manufacture a wide range of components very efficiently. Reliability, high speed and exceptional productivity are just some of the advantages we offer our customers.”

PC-based control provides more performance and faster engineering
CRS Máquinas has been using PC-based control technology from Beckhoff since 2009. “We picked PC-based control because all machine functions such as PLC, HMI and CNC can be run on the same hardware and software platform. Another reason for investing in this technology, which was new for us at the time, was the excellent relationship with Beckhoff’s technical support in Brazil,” says the CEO.

Today CRS Máquinas uses the C6920 control cabinet PC with TwinCAT NC PTP automation software. The user interface for the CNC was implemented in a C#
application, which sends the X-, Y- and Z-target positions to TwinCAT – a solution that is only made possible by the open design of the Beckhoff technology.

"With the TwinCAT motion control libraries, which offer a multitude of time-saving function blocks, our developers have a very flexible tool for generating control software that speeds up the engineering process significantly," says Célio Renato Silva. The data traffic between the TwinCAT control software and the user interface developed by CRS Máquinas is handled via TwinCAT ADS.

Drive innovation with One Cable Technology:
Compact and cost-cutting solution
The Logic-II woodworking center uses a total of 47 Beckhoff servo motors from the AM8000 series with One Cable Technology (OCT). "By employing OCT we were able to reduce our drive technology costs since the required cabling was reduced by 50 percent," says Célio Renato Silva. Because the Beckhoff AXS2xx-series servo drives support simultaneous control of two motors with multi-channel versions, the machine is also very compact.

Positive outlook
As far as the national market is concerned, CRS Máquinas forecasts a growth rate of roughly 50 percent for 2013, which is even greater than the Brazilian furniture industry's 2012 growth rate of 48.2 percent. "The machine-building market will benefit from further improvements in our CNC technology, which means that the production of conventional machines will decline," says Célio Renato Silva.
Beckhoff Turkey: PC-based Control for the fast-growing machine-building industry

In March of 2008, Beckhoff established a subsidiary in Turkey that has been established with great success and continues to grow ever since. PC Control talked with Cem Ayday, General Manager of Beckhoff Turkey, about this success story and the specific requirements of the Turkish market.

How well has Beckhoff Turkey been developing since its foundation?

Cem Ayday: When we started out, we focused primarily on setting up the company and raising awareness of the Beckhoff brand in Turkey. The following years saw significant growth in terms of both headcount and sales, due largely to the close partnerships we established with leading OEMs. From 2010 to 2011 we grew by approximately 100 percent, and from 2011 to 2012 by roughly 50 percent. In 2013 we expect to grow by another 50 percent. The number of employees grew accordingly to our current headcount of 23 people, 16 of whom are engineers.

To what extent is this reflected in the development of your sales and support activities?

Cem Ayday: To improve our sales and support activities and get closer to our customers, we decided to set up branch offices in Izmir and Bursa in April 2011 and July 2012, respectively – both are areas with a dynamic market development and great customer demand. As a result, our service quality has improved considerably. One of our major goals for the future is to add more people to our sales and support teams. We want to reach more customers with our current product and solution offer and at the same time develop new distribution channels for the latest products like XTS and TwinCAT 3.

What characterizes the Turkish market?

Cem Ayday: Our core market is the Turkish machine manufacturing industry, which enjoys an average annual growth rate of 20 percent thanks to its adaptation to technological advances and its production of high-quality machinery. Our PC- and EtherCAT-based control solutions meet the price and performance expectations of the Turkish machine building industry perfectly, which is why Beckhoff has received a great deal of interest in this market, and enjoys high demand. That’s why we plan to further expand our sales and technical support activities for the machine building market. On the other hand, however, we also want to establish Beckhoff in other markets such as building automation and energy automation. We also have customers in the market segments testing and measurement, water processing and warehouse automation.

Are there any country-specific requirements?

Cem Ayday: The Turkish market places great importance on trust in the products and the people who sell them, which is why having a good relationship with the customer matters a lot. The “made in Germany” image is also a factor that helps in becoming accepted. As a Beckhoff company we combine German quality and solution expertise with sales and support services that are based on the same high standards. To stay in contact with our customers, we regularly visit them and hold special events for them.
In which areas of the machine manufacturing industry is Beckhoff particularly active?

Cem Ayday: Sheet metal working, profile processing, food processing, packaging and CNC applications account for an ever-growing share in Turkish machine manufacturing. The major machine builders are active in these fields, and Beckhoff has succeeded in establishing close contact with almost all of them. Ermaksan and Murat Machinery, two of the largest machine manufacturers in Turkey, are our key customers in these areas. Their products are used for CNC and NC-I applications and employ the complete range of Beckhoff solutions. All in all, there are many key players in this field who produce predominantly high-end machines. Our CNC controls, drive solutions and XTS meet their high requirements perfectly.

Further Information:

www.beckhoff.com.tr

Kenan Aktas, Area Sales Manager, talks about the market development in Turkey:

“When we made the decision five years ago to set up a subsidiary in Turkey, we did not expect the development to be this rapid. Although the Turkish machine building market was already quite large at the time, it was however dominated by low-cost solutions and established systems vendors. The industry has changed and advanced a lot in recent years. It now produces much more complex systems and machines, which has increased the demand for modern and high-performing automation technology significantly. This is where our “New Automation Technology” with its state-of-the-art features really delivers. The second major factor is the development of Beckhoff Turkey itself. Cem Ayday has built in the shortest period of time a team of young engineers who provide the best possible support for our customers with their highly complex applications. Particularly in Turkey, customers place great emphasis on getting the perfect combination of powerful technology and a high level of technical expertise.”

The Fibermak Momentum Gen-2, Ermaksan’s newest fiber-cutting machine, features the following: 15-inch control panel with alphanumeric keyboard, customer-specific CNC extension keypad, TwinCAT 3 and EtherCAT I/Os, AX5000 servo amplifiers, AM80xx OCT servo motors or AL28xx linear servo motors.
Further Information:
www.ethercat.org

SPS IPC Drives in Nuremberg, Germany, is one of the most important trade fairs in the automation industry and is especially important for the EtherCAT Technology Group (ETG) this year.

Apart from the regular trade fair presence at the ETG organization booth, where visitors can marvel at the enormous variety of EtherCAT devices, the world’s largest fieldbus user organization is also celebrating its very own milestone. After EtherCAT technology itself was presented for the first time at Hannover Fair in 2003, the EtherCAT Technology Group was founded the following November and has promoted the advancement of EtherCAT technology from the outset in its role as a user and manufacturer association: Everyone should be able to use and implement EtherCAT.

The ETG started off with 33 member companies at SPS IPC Drives 2003; in time for this year’s fair, the organization has announced that there are now in excess of 2,500 members. There is no end in sight in terms of the ETG’s growth, as Executive Director of the ETG, Martin Rostan, can confirm: “The staff and members of the EtherCAT Technology Group are looking forward to guiding the technology successfully through the next 10 years as well.”

2013 EtherCAT seminars in Taiwan and South Korea

The EtherCAT Technology Group (ETG) conducted its series of Industrial Ethernet seminars in Taiwan and South Korea in September 2013. “We received very positive feedback from the 300 plus participants in Taipei, Tainan and Taichung, who all showed great general interest in EtherCAT as well as in the individual seminar topics,” explains Beryl Fan, Manager of the ETG office in China. In South Korea, the EtherCAT Roadshow stopped off for the first time in Seoul and Daejeon and was very well attended with some 120 participants in total.

The seminars, which were free of charge for all participants, offered valuable and timely information on the use of EtherCAT as an Ethernet-based real-time communication system. The attendees learned details about EtherCAT technology and were given an insight into the variety of applications of EtherCAT as well as the numerous advantages and challenges arising from the use of Industrial Ethernet.

As usual, the EtherCAT seminars in Taiwan and South Korea were also supported by various ETG member companies who sponsored the event and introduced their EtherCAT implementations in real world-oriented project presentations.

Impressions of the Industrial Ethernet seminars hosted by the ETG in Taiwan (left) and South Korea (right)
The annual North American EtherCAT Plug Fest of the EtherCAT Technology Group (ETG) took place in the US in September 2013 – this time at the company headquarters of Advanced Motion Controls in Camarillo, California. Over the two day event, 33 participants from 16 different ETG member companies attended in order to test six master and 18 slave devices with respect to interoperability. As with the recent EtherCAT Plug Fest in Japan, the semiconductor-specific devices the participants brought along attracted particular attention at the North American EtherCAT Plug Fest. According to Florian Hammel, who was in attendance as one of the ETG’s EtherCAT experts providing support to participants at the event: “Although we only recently released the newly developed device profiles for the semiconductor industry, corresponding devices are already represented at our EtherCAT Plug Fests taking place around the globe. In North America especially, we are experiencing particularly strong interest in this area.”

Aside from North America, the EtherCAT Plug Fests also take place several times each year in Europe and Asia. The events at which the ETG’s EtherCAT Conformance Test Tool is used offer manufacturers of EtherCAT devices of all types the possibility to test the interoperability of their products with third-party devices at an early stage of development. As a result, any potentially defective device properties can be identified early on and resolved so that the products are ready for their launch on the market as efficiently as possible.

Furthermore, the participants benefit from the personal atmosphere that prevails at the EtherCAT Plug Fests: Open questions can be clarified directly through exchanges of expertise with the other participants and in discussions with the EtherCAT experts on-site.

Numerous master and slave devices from different manufacturers were tested for interoperability at the North American EtherCAT Plug Fest 2013.

**North American EtherCAT Plug Fest 2013**

This year’s visit by the EtherCAT Technology Group (ETG) to Yokohama in Japan was very well received – just like last year. The event kicked off with the annual EtherCAT Technology Update, where the visitors – mainly developers and product managers of EtherCAT devices – were informed about developments in the individual ETG working groups and learned about the latest happenings in the area of EtherCAT technology. "Of particular interest this year were the results of the SEMI TWG, the EtherCAT Technology Working Group, which recently attracted attention for its specification of new device profiles for the semiconductor industry," reports Dr. Guido Beckmann, Chairman of the ETG Technical Committee and Event Director. In total, 45 participants attended and received information on the topic of "EtherCAT in Mobile Applications" as well as on the ETG’s Safety-over-EtherCAT (FSoE) Conformance Test Tool, which was recently certified by the German certification organization, TÜV.

Following the Technology Update, the ETG issued an invitation to the Japanese EtherCAT Plug Fest 2013, which was held at the Japanese subsidiary headquarters of Beckhoff in Yokohama. The two-day event attracted 32 participants from 14 companies who were able to test the 5 master and 18 slave devices they brought along for interoperability evaluation using the ETG’s Conformance Test Tool. The above-mentioned device profiles of the ETG’s SEMI TWG also played an important role at this event: Although these profiles were only introduced in July of this year, semiconductor devices based on these profiles have already been successfully tested in Japan.

Some 45 participants gathered at this year’s EtherCAT Technology Update in Yokohama to get information on EtherCAT and the ETG.

**EtherCAT Technology Update and Japanese EtherCAT Plug Fest 2013 in Yokohama**

Success of EtherCAT in Japan continues unabated
EMO 2013:
PC- and EtherCAT-based control meets increasing requirements in the metalworking industry

EMO Hanover 2013, the world’s leading trade show for metalworking, came to an end on 21 September 2013 after six days. Over 2100 exhibitors from 43 countries and around 145,000 visitors from more than 100 nations heeded the call for “Intelligence in Production”. Both exhibitors and organisers spoke of a positive trade show and an economic recovery in the machine tool industry.

Among the current trends in metalworking, apart from high dynamics and accuracy, is greater flexibility in production. Beckhoff is meeting this increasing requirement complexity with the flexibility and openness of its PC- and EtherCAT-based CNC solution. PC control offers sufficient performance reserves for complex algorithms for the optimisation of machining processes, such as high-speed cutting, and beyond that for modern operating interfaces and Condition Monitoring.

“The EMO 2013 was a good trade show for us”, says CNC Product Manager Frank Saueressig in summary. “That is reflected in the increased number of visitors compared to the previous event as well as in the number of customers who exhibited machines with Beckhoff control technology. Through numerous customer acquisitions we have been able to strengthen our position in the field of classic machine tools.”

FachPack 2013:
The universal control solution for packaging machines

1,440 exhibitors provided an up-to-date overview of the packaging market for about 35,000 visitors from Germany and abroad at FachPack, which took place from 24 to 26 September 2013 in Nuremberg, Germany. Frank Würthner, Business Management Packaging at Beckhoff, summarises: “The high speed and precision of PC control enables optimisations and cost savings within the entire process chain, and thus meets the urgent demand for more resource efficiency in the face of increasing prices for raw materials and energy. Apart from our innovative drive products, our multi-touch Control Panels and Panel PCs for attractive and user-friendly operator interfaces were also in demand.”
Motek 2013: Modular control concepts for modular assembly lines

Motek, the international trade fair for production and assembly automation, closed its doors on 10th October 2013 in Stuttgart, Germany, reporting a growth in visitor numbers: 1,056 exhibitors presented a wide range of products and solutions related to assembly technology, robots and robot system integration, feeding and joining solutions as well as drive, control, and motion solutions to 36,967 visitors from 101 countries.

Frank Saueressig, director of the Beckhoff branch in Balingen, Germany, gave his impressions of the fair: “Visitors who come to this industry fair usually have fairly concrete projects in mind and look for specific information. Time and again, one of the main arguments for the control solution from Beckhoff is its openness and modularity. Based on the wide range components from our automation toolkit as well as integrated solutions for complete production and assembly lines, this enables us to cover virtually all demands of machine builder and to realise a great variety of system concepts.”

Further Information: www.beckhoff.com/motek

K 2013: Xmold – the new system solution for precision manufacturing in injection molding

K 2013, globally leading trade show for the plastics and rubber industries, came to an end on 23 October 2013 after eight successful days. According to the organizers, the high expectations of the K 2013 have been exceeded. 3,200 exhibitors showed innovations from all sectors of the plastics processing industry. 218,000 trade visitors from over 120 countries, with an increasing numbers of visitors from foreign countries and overseas, came to Düsseldorf, Germany, to get an overview of the current market.

Beckhoff can look back on a successful event: among the highlights at the Beckhoff trade show booth was the new XMold control solution for injection molding machines. Also in focus were the turnkey solutions from Beckhoff for blow molding machines. The increasing market acceptance of Beckhoff’s open automation solution was also reflected in the trade show appearances of other exhibitors who exhibited blow and injection molding machines with integrated control technology from Beckhoff.

Thomas Kosthorst, Business Management Plastic Processing Machines, adds: “Apart from the system solutions for plastics processing, components such as our servo motors with One Cable Technology were also in demand. And the manufacturers of high-end machines value our large-size multi-touch panels for sophisticated HMIs in plastics processing.”

Further Information: www.beckhoff.com/k2013
Trade shows and events 2013/2014

**Europe**

**Germany**
Automatisierungstage
February 05 – 06, 2014
Emden
www.automatisierungstage.de

E-World
February 11 – 13, 2014
Essen
www.e-world-essen.com

Tire Technology Expo
February 11 – 13, 2014
Cologne
Booth 3040
www.tiretechnology-expo.com

Prolight + Sound
March 12 – 15, 2014
Frankfurt
Hall 9.0, Booth E84
www.prolight-sound.com

Fensterbau Frontale
March 26 – 29, 2014
Nuremberg
Hall 3A, Booth 113
www.frontale.de

Light + Building
March 30 – April 4, 2014
Frankfurt
Hall 11.0, Booth C56
www.lightbuilding.de

Hannover Messe
April 07 – 11, 2014
Hanover
www.hannovermesse.de

Interpack
May 08 – 14, 2014
Düsseldorf
www.interpack.de

Sensor + Test
June 03 – 05, 2014
Nuremberg
www.sensor-test.de

Automatica
June 03 – 06, 2014
Munich
www.automatica-munich.com

SMM
September 09 – 12, 2014
Hamburg
www.hamburg-messe.de/smm

WindEnergy Hamburg
September 23 – 26, 2014
Hamburg
www.windenergyhamburg.com

EuroBLECH
October 21 – 25, 2014
Hanover
www.eurolblech.de

**Austria**

Smart Automation
May 06 – 08, 2014
Vienna
www.wien.smart-automation.at

**Switzerland**

Swissbau
January 21 – 25, 2014
Basel
www.swissbau.ch

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

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

**Great Britain**

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

**Italy**

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

**Norway**

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

**Poland**

Automaticon
March 25 – 28, 2014
Warsaw
Hall 1, Booth B-18C-17
www.automaticon.pl

**France**

CFIA
February 11 – 13, 2014
Rennes
Hall 9
www.cfiaexpo.com

SEPEM
May 20 – 22, 2014
Colmar
Hall 3, Booth F26
www.sepem-industries.com/colmar
Sweden
Fastighetsmässan Öresund
February 05 – 06, 2014
Malmö
www.easyfairs.com

Nordbygg
April 01 – 04, 2014
Stockholm
www.nordbygg.se

Elmia Automation
May 06 – 09, 2014
Jönköping
www.elsmia.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

Slovenia
IFAM
January 29 – 31, 2014
Celje
www.ifam.si

Spain
EWEA Annual Event
March 10 – 13, 2014
Barcelona
Hall 7, Booth 7F62
www.ewea.org/annual2014

Turkey
Plast Eurasia Istanbul
December 05 – 08, 2013
Istanbul
Hall 5, Booth 517B
www.plasteurasia.com

Asia
India
Engimach
November 27 – December 01, 2013
Ahmedabad
Hall 1, Booth P3
www.engimach.com

Plastivision
December 12 – 16, 2013
Mumbai
Hall 3, Booth D03
www.plastivision.org

Industrial Automation India
December 17 – 20, 2013
New Delhi
Hall 18, Booth B-32b
www.ia-india.com

Israel
Motion Control & Power Solutions
January 07, 2014
Tel Aviv
www.new-techevents.com/events/motion

Japan
Semicon Japan
December 04 – 06, 2013
Tokyo
www.semiconjapan.org

North America
USA
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

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