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It goes without saying that all of the innovations that Beckhoff presents during the course of the year at trade fairs are intended for the practical side of automation. The company’s last new products brochure was 80 pages long and included many of the new products shown at Hannover Messe 2013, covering all areas of the Beckhoff product range – from Industrial PCs, through Embedded PCs to I/O modules, drive technology, safety and, last but not least, TwinCAT as a software suite. With all the new technologies to learn about, it’s no wonder that a new connection technology between an Industrial PC and its display(s) could go relatively unnoticed by some. Certain individuals might even think sarcastically: “Here we go again, yet another Ethernet cable. You use it to connect the display, the USB and the power supply if you need it… very interesting.”

As someone who works on the PC hardware development side, I must protest in the strongest possible terms about being overlooked in this way (tongue-in-cheek, of course). CP-Link 4, the new one-cable transmission technology between an IPC and its display(s), is a truly innovative development by Beckhoff. This is certainly not on account of its highly imaginative name (we have already had CP-Link 1, 2, and 3 for a number of years – see “Beckhoff – the pioneer in display connection technology” in the other article on CP-Link 4 in this issue), but due to the practical relevance of this technology. This development saves time and money, which will benefit most of our customers. Here are the benefits that CP-Link 4 has to offer in detail:

- Low-cost Ethernet cable which is easy to install because of its small cross section
- Uncompressed data transmission resulting in perfect, high-resolution images
- Dedicated hardware solution, no software drivers needed, no settings or configuration steps
- You can see the IPC even during boot-up
- PC and display can be located up to 100 m away from each other
- USB data for multi-touch, buttons, mass storage etc. is also transferred
- Even the power supply for the display can be provided using the same Ethernet cable (optional)

Other than the cabling, CP-Link 4 has nothing to do with Ethernet or even TCP/IP. Instead it uses special signal encoding and the Ethernet cable is merely used as a high-frequency transmission medium.

CP-Link 4 is the result of a painstaking, protracted development process, in which a wide range of concepts were considered. Among the options considered were compression algorithms – which would again have required some intelligence in the display and would have had an adverse effect on compression. Another possibility was special high-speed logic in combination with fiber optic transmission – flexible, but ultimately too complex and difficult to use in the field. Apart from the benefits explained earlier, the immediate usability of CP-Link 4 with all Beckhoff IPCs that have a DVI output is a decisive advantage.

In the consumer electronics sector, we have long since become used to HDMI and DisplayPort, and I see CP-Link 4 doing the same thing in the industrial world – Plug, Play and Enjoy. That said, I hope you’ll take the time to read the article on CP-Link 4 on page 14 – a technology that asks you to do nothing more than connect an Ethernet cable between the PC and the display.
Compact Embedded PC CX8093 with PROFINET interface

Small local controller integrates virtual device

The CX8093 Embedded PC from Beckhoff is equipped with a PROFINET RT device interface designed as a 2-port switch for daisy-chain cabling. A special feature is the added functionality of a virtual device which can be used to double the process data size or to connect a second controller.

When the optional virtual device (slave interface) is activated, the CX8093 Embedded PC behaves like two PROFINET devices. Accordingly, twice the maximum input/output data volume can be processed – with PROFINET approx. 1000 bytes, i.e. the CX8093 can process twice the number of PROFINET process data. The network name of the “two" devices can be set via the address switch or the TwinCAT System Manager. The IP settings are allocated by the PROFINET controller.

A further benefit of the virtual device is the ability to communicate with a second PROFINET controller, which is a simple way to increase system availability. On the one hand, the CX8093 (as a local controller) can verify the two incoming master signals by means of a plausibility check to monitor the function of the cabling, for example. On the other hand, failure of one of the masters can be detected and the second master can respond accordingly.

The space-saving CX8093 Embedded PC measures only 65 x 100 x 80 mm. It runs Windows CE 6.0 and features a 400 MHz ARM9 CPU, 64 MB RAM and a MicroSD card with up to 4 GB storage capacity. In addition to Bus Terminals, EtherCAT Terminals can also be connected directly to the CX8093. During start-up, the CX8093 automatically detects which of these I/O systems is connected. Another special feature is a capacitive 1-second UPS that enables persistent data to be saved in the event of a supply voltage failure. The controller is programmed via the TwinCAT PLC automation software. The CX80xx series is also available for other bus systems such as Ethernet, EtherNet/IP, PROFIBUS, BACnet/IP, CANopen or OPC UA.

Further Information:
www.beckhoff.com/CX8093
The EL6090 EtherCAT display terminal from Beckhoff features an illuminated, anti-glare LC display and a non-resettable operating hours counter. For the first time it offers a display option, e.g. for status messages or diagnostic information, that can be directly integrated into the EtherCAT I/O system without additional installation or interfacing efforts. Furthermore, the display can optionally be positioned separate from a controller anywhere on the DIN rail, as required by the application.

The EL6090 display terminal can simply be attached to the DIN rail in the terminal node to offer a display element in the control cabinet that can be easily controlled via EtherCAT in the familiar way. Additional display interfaces such as RS232 and mounting elements such as frames or brackets are no longer required, significantly reducing installation time and costs. In addition, it is possible to position a parameterization and diagnostic display at the ideal location in the control cabinet according to application-specific requirements.

The parameters that can be shown on the two-line display with 16 characters each include status and diagnostic data. The anti-glare display features switchable illumination. It can be used from within the application program to visualize application-specific static and dynamic texts, such as production counters, for example. A non-resettable operating hours counter is integrated in the EL6090 display terminal for recording the system operating time. The value, which is guaranteed to be stored safely for more than 20 years, can be displayed or read via the controller.

Two special features make the display highly versatile: via a 5 x 8 pixel matrix two special characters, such as “μ” or “Ω”, can be defined by the user. If the 16-character text limit per line is exceeded, the display terminal automatically switches to scrolling text mode. The navigation button with the functions “up”, “down”, “left”, “right” and “Enter” offers a high level of operator comfort. The status of these five buttons is transferred to the controller as a binary variable and can thus control the display. In this way, it is possible to navigate through a user-created menu or change production counters and parameters.

Further Information:
www.beckhoff.com/EL6090
Compact and flexible I/O solution for EtherCAT-controlled equipment

The EP8309 EtherCAT Box is equipped with a wealth of I/O technology, including: eight digital inputs and outputs, two digital tachometer inputs, two analog inputs, one analog output and one current-controlled 1.2 A PWMi output. With this wide range of interfaces, Beckhoff offers a compact IP 67 solution that is ideal for controlling various equipment via EtherCAT. The user benefits not only from low space requirements, but also from simplified wiring and installation outside of protective cabinets in the field.

The EP8309 EtherCAT Box, which measures only 60 x 16 x 26.5 mm, offers system manufacturers I/O diversity and high functionality with compact design, significantly reducing installation effort. Eight freely selectable digital inputs or outputs offer high application flexibility. Special features of the box include the two digital tachometer inputs with 2.5 kHz limit frequency. They can be used to monitor two different speeds on two different shafts, or – with simple digital sensors – speed and direction of rotation on one shaft. Optional features include monitoring of the shaft rotation and standstill warning.

These digital I/Os are complemented by two analog inputs and an analog output, each single-ended and with 12 bit resolution as well as a PWMi output. The current-controlled outputs can be used for direct control of simple proportional valves with up to 1.2 A, for example. Intelligent valves are controlled via the analog output.

With its combination of inputs and outputs, the EP8309 offers a compact solution for interfacing a wide range of equipment via EtherCAT. The pre-wired, easy to integrate I/O box features an IP 67 plastic housing, protecting the device from the effects of harsh environments such as moisture and extreme temperatures. It is therefore ideally suited for distributed applications such as controlling brake systems in wind turbines, for example. Adapted versions of the EP8309 for application in hydraulic systems, gearboxes and generators are in preparation.

Further Information:
www.beckhoff.com/EP8309
Beckhoff achieves worldwide turnover of 408 million euros in 2012

In 2012 Beckhoff Automation achieved worldwide turnover of 408 million euros. That corresponds to a reduction in turnover of 12% compared with the previous year, in which the Verl, Germany-based company achieved a turnover of 465 million euros. Nevertheless, the company is satisfied with this business development, as a correction was expected following two boom years characterized with a steep increase in turnover of almost 100%. The number of Beckhoff employees has risen by 5% to 2,200 worldwide. Apart from the continuous increase in personnel, the expansion of administration and production facilities as well as the consolidation of the national and international sales network, Managing Director Hans Beckhoff relies above all on a technological lead through innovation. Therefore, the fields of research and development in particular have grown and will expand further still in 2013.

"As expected, we were unable in 2012 to continue the rapid growth in turnover of almost 100% in 2010 and 2011," says Hans Beckhoff, Managing Director of Beckhoff Automation GmbH, commenting on the balance for 2012. Following turnover of 465 million euros in 2011, Beckhoff achieved a result of 408 million Euros in 2012. "Despite the drop in turnover of 12% – which is unusual for Beckhoff – we are quite satisfied with the overall course of business. A correction was to be expected after two exorbitant boom years and this was already apparent in 2011," says the entrepreneur. Primarily responsible for this development was the structural crisis in the renewable energy industries which had largely fuelled the growth in the previous years. "The global solar industry practically collapsed to zero in 2012, and Chinese wind turbine manufacturing has fallen to a fraction of the level seen in 2011," explains Hans Beckhoff. However, the company currently sees a strong upward trend beginning once again in the Chinese wind turbine industry. Beckhoff is optimistic about the overall prospects for 2013: "Depending on the general conditions of the global economy, we expect an increase in turnover of between 5% and 15% this year." The export share was about 55% of the total turnover; of that, 27% was attributed to Europe (excluding Germany), 16% to Asia, 10% to North America and 2% to the remaining countries worldwide in which Beckhoff operates.

National and international expansion
Beckhoff is currently represented in 62 countries worldwide by 30 subsidiary companies and sales partners; the expansion of the sales network is currently driven forward by opening new branch offices. In Germany, the Baden-Württemberg region will acquire a further office in Crailsheim to achieve even better proximity to customers in the region (see page 11). Additional regional sales offices are planned as well. Export activities are being driven forward intensively by strengthening and extending national branch offices. Following the opening of Beckhoff subsidiary companies in Hungary and New Zealand in 2012, two new locations are planned for 2013 in Egypt and Saudi Arabia.
Site expansion and extension of production capacities

Beckhoff also expanded its facilities in different locations in 2012. An additional administration building with floor space of 12,000 m² opened at the company’s global headquarters in Verl. Moreover, a new training and education center was opened. A new laboratory building for EMC tests and equipment certification is due to open in 2013. The Beckhoff drive technology division is expanding at the Marktheidenfeld, Germany production site where the production and administration areas are being doubled with the opening of a new building (see page 10). Also, with the completion of a new office building in Savage, Minnesota near Minneapolis, the course has been set for increased sales growth at the company headquarters of Beckhoff USA (see page 12).

Increasing the technological lead: investments in research and development

In parallel with the expansion of sales and office space, Beckhoff is also expanding its research and development capacities. Out of a total of 2,200 employees working for the company, over 750 are engineers. Leveraging this valuable pool of talent, Beckhoff has made it a goal to substantially expand R&D activities once again in 2013.

To avoid a lack of junior employees, Beckhoff dedicates itself strongly to training new employees. At present there are 98 apprentices and 66 students at the company. “We invest about 2.5 million euros annually into the education of young, talented people,” says managing director Hans Beckhoff.
Beckhoff Drive Technology division relocates to bigger production site in Marktheidenfeld

On March 1st, Fertig Motors, a division of the Beckhoff Group, moved into a new production building in Marktheidenfeld, a city in southern Germany. The building is in a conveniently-located industrial estate near the widely-used A3 motorway. The new facility offers an area of 2000 m² for motor production and 800 m² of office space.

With the move, the warehousing and production capacities of Fertig Motors were increased by 100%. Compared with the previous year, the motor production output is expected to triple in 2013. The relocation to the new building set the course for a further expansion of personnel and expertise. The goal is to establish a new center of excellence for drives in Marktheidenfeld focused on the development of mechatronic systems for servomotors.

The new facility enables “One Piece Flow” production of Beckhoff servomotors, which are available in a wide range of models and in small to large batch sizes. A new CNC machining center facilitates in-house prototype production, permitting Fertig Motors to respond more quickly to customer requirements.
The new sales office is a further step towards providing the best possible customer proximity and territorial coverage in Baden-Württemberg, Germany, as the manager of the Beckhoff branch office in Balingen, Frank Saueressig, explains: "In addition to the main branch office in Balingen, two local sales offices now offer expert advice in the direct vicinity – the already established Ravensburg sales office in the southeast of Baden-Württemberg and the new Crailsheim office in the northeast."

A total of 150 m² of office space is available for sales and application support in the new office building which features building automation from Beckhoff. The local contacts are office manager Ulrich Vogel and Ulrich Stürzl, business management packaging. They will shortly be joined by an application engineer.

Further Information:
www.beckhoff.com/balingen

Beckhoff opens sales office in Crailsheim, Germany

Increased presence in Baden-Württemberg

With the opening of the Crailsheim sales office on 2 May 2013, Beckhoff has reinforced its sales network in Germany. Situated northeast of Stuttgart near Hohenlohe, Germany, it is well within reach of the large number of medium-sized companies of the industrial sector and the companies of the “Packaging Valley” traditionally based in Baden-Württemberg.

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Further Information:
www.beckhoff.com/balingen
New 4000 m² building sets the course for further growth

North American Beckhoff subsidiary moves into new headquarters

Beckhoff Automation LLC has experienced strong growth in North America over recent years. In 2012 Beckhoff USA generated sales of $50 million. With the construction of a new head office in Savage, a suburb of Minneapolis in Minnesota, the North American Beckhoff division now has a state-of-the-art building complex with more than 4,000 m² office and storage space available.
Beckhoff Automation LLC moved into this new building in April 2013 and held a grand office opening reception on May 30 in conjunction with the subsidiary’s national sales meeting. At the office opening, numerous guests including Beckhoff customers, trade media editors, local politicians and business leaders, college/university leaders and others were in attendance to celebrate the occasion. Beckhoff Automation LLC president, Graham Harris served as the emcee of the night’s festivities.

The new US head office in Savage is characterized by large glass elements and a limestone façade. The two-storey building offers around three times as much space as the previous head office, including around 2,400 m² of office space, 1,400 m² of warehouse space and an advanced, ESD-protected service center.

“Beckhoff Automation LLC has been active in the North American market since 1999, with annual revenue growth averaging around 20 percent,” said Graham Harris. “With the construction of our state-of-the-art subsidiary headquarters in Savage, Beckhoff has set the course for further growth in the North American market. In addition, we will continue to strive to expand the status of the Minneapolis area, with focus on Savage, as a renowned location for the automation and high-tech industries in the US.”

Further Information:
www.beckhoffautomation.com

At the office opening, hundreds of guests were in attendance to celebrate the occasion.
Thanks to CP-Link 4, the CP29xx-0010 built-in Control Panel with multi-touch and the CP39xx-0010 Control Panel with multi-touch for mounting-arm installation can be operated at distances of up to 100 m away from the PC via a standard CAT-7 cable.
One Cable Display Link — simple, efficient, flexible

Beckhoff has bundled more than 15 years of know-how in the area of flexible visualisation and control concepts in order to develop the new CP-Link 4 solution. This innovative connection technology can be used installing multi-touch Control Panels up to 100 m away from the Industrial PC. The one-cable solution of CP-Link 4 enables the transmission of video signals, USB 2.0 and power via a single, standard CAT-7 cable, reducing cable and installation costs as a result. Another benefit is the use of purely passive displays instead of requiring panels with an integrated CPU.

The new Beckhoff panel series with industrially compatible multi-touch technology — the CP29xx-0010 “built-in” version and the CP39xx-0010 mounting arm version — offers an impressive variety of display sizes and connection technologies. CP-Link 4 extends the multi-touch portfolio with a standard-based connection technology, supplementing the current CP29xx and CP39xx Control Panel ranges with DVI/USB-Extended connection functionality.

Flexibility and simplicity for maximum user benefit
CP-Link 4 represents the consistent further development of Control Panel connection technology from Beckhoff which has been established on the market for more than 15 years. One of the special features of CP-Link 4 is high flexibility for connecting a panel according to individual needs and the user-friendly plug-and-play capability. All that is required is a standard CAT-7 cable for the simultaneous transmission of video signals (uncompressed DVI) and USB-2.0 data, plus the power supply (if desired).
CP-Link 4 is used with the Beckhoff Control Panel families of the multi-touch generation. Encompassing the CP2xxx and CP3xxx Control Panel and Panel PC series, the multi-touch panels are characterized by a contemporary, elegant device design and a modern operating concept. Widescreen panels in various sizes and resolutions are available in addition to the classic display sizes in 4:3 format. The new panel generation even offers numerous advantages to single-touch users, such as an optimized price-to-performance ratio with savings of up to 28% compared to previous devices.

The CP-Link 4 connection technology is directly integrated into the CP29xx-0010 and CP39xx-0010 passive panels, regardless of applications, cable lengths, whether a PCI express (PCIe) module or an external transmitter box is used for connection to the PC, or whether an integrated or a separate power supply is used. Not only that, no special software or driver is required in order to use CP-Link 4.

A further big advantage of this transmission technology is the use of standard commercial CAT-7 cables. These are less expensive than special DVI cables, uncomplicated to install and are optionally available in drag-chain-compatible versions. The standard plug connectors are field-configurable; alternatively, pre-assembled cables are available as accessories.

**Reliable and economical panel connections**

Whether integrated via a CAT-7 cable or a separate power cord — the 24 V voltage supply of the Control Panel can be connected to the UPS output of the connected Industrial PC (IPC). This provides particularly reliable operation, since even in UPS mode the display is able to indicate when, for example, the PC reports that data can still be saved for a few seconds before shutdown. If required, the power supply to the panel can also be completely separate from the IPC. The same Control Panel can be used with all supply variations; with an integrated supply, the power input socket on the panel simply remains free.

CP-Link 4 also offers advantages from the cost point of view: Simplified mounting and cable installation alone, especially over long distances, taps into considerable savings potential. In addition, the standard CAT-7 cables are less expensive than special DVI cables. CP-Link 4 also compares well to the previ-
The CP-Link 3 concept first presented in 2008 is a pure software solution based on standard technologies for the flexible connection of Panel PCs to an Industrial PC located up to 100 m from the Industrial PC. It permits the connection of up to 255 Ethernet panels, or as an "extended version," up to eight client displays showing different screens. Panel PCs are necessary here as operating units; passive panels are insufficient as displays. Very inexpensive standard Ethernet cables (CAT 5) can be used for the connection. However, consideration must be given here to the costs of the intelligent components required in the Control Panel as well as the performance of the software solution which in some cases is lower than a pure hardware solution.

The optimum convergence of all the experiences gained in the past several years is now realized in CP-Link 4 which is based on one-cable technology. Thus, a pure hardware solution is once again available which, consisting of innovative displays as well as state-of-the-art and very simple connection technology, enables installation at a maximum distance and represents the ideal basis for remote multi-touch control operating elements.

Beckhoff – the pioneer of connection technology for industrial displays

As a pioneer in industrial display connection technology, Beckhoff introduced a transmission technology onto the market as early as 1998 with the first version of CP-Link, which for the first time allowed separate installation of a control panel and PC – at that time a 2-cable technology. Distances up to 100 m between the PC and operating unit could be bridged using two standard coaxial cables, although the cables were rather rigid over long distances. This pure hardware solution was one of the first systems that permitted the separation of the display from the Industrial PC using fast serial data communication and was thus ahead of its time.

In 2006, Beckhoff presented the second generation of its display connection technology as another innovation: In contrast to the 5 m DVI/USB standard distance, the DVI/USB Extended technology, which is based on standard cables, enables distances of up to 50 m between the Industrial PC and the operating panel. DVI/USB Extended 2.0 technology is offered with the new multi-touch Panel series.

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One Cable Display Link

With the "One Cable Display Link," i.e. the "pure" single-cable solution, the DVI and USB-2.0 signals as well as the 24 V power supply are carried by the standard CAT-7 cable. For this the CU8803 transmitter box is required which can be connected to any Beckhoff Industrial PC with a DVI and a USB cable and requires a 24 V power supply itself. As mentioned above, the power supply socket on the panel remains unconnected (see diagram 1). This connection variant is particularly suitable for building automation applications as well as for complex mounting-arm installations, as it eliminates three connectors by only one.

Two Cable Display Link

In the case of the "Two Cable Display Link," which can be achieved in two versions, the DVI and USB-2.0 signals are also transmitted via just one CAT-7 cable. For this, any Industrial PC is connected by DVI and USB via the CU8802 transmitter box (see diagram 2), or else the C9900-E276 PCIe module can be integrated directly into certain Beckhoff IPCs – C6930, C65xx, C5201, CP22xx or CP62xx (see diagram 3). The external transmitter box lends itself above all if the connected PC does not have a PCIe module slot. The separate power supply used in both cases is particularly suitable for emergency stop concepts with parallel wiring or for customer-specific Control Panels with additional electromechanical buttons.

Further Information:
www.beckhoff.com/CP-Link4
www.beckhoff.com/CP29xx
www.beckhoff.com/CP39xx
Customer-specific Control Panels offer outstanding added value

Three development levels for customized operator interface panels

As “the face” of a machine, the operator interface is one of the most important areas where machine builders can differentiate from their competitors. With this in mind, customer-specified panel designs from Beckhoff are available based on the company’s extensive range of standard Control Panels and a wide selection of accessories. The broad product range offers outstanding scalability in any case, but it can also be modified extensively, for example, by adding electromechanical function keys, and tailoring them to any machine operation need. In particular, the user benefits from three optional development levels for customized Control Panels, all of them offering the high quality standards set by Beckhoff as well as minimized development costs and effort.

How much users appreciate the added value of individualized control panels is shown by the fact alone that they make up between 45 and 50 % of all Control Panels that Beckhoff delivers. Although standard devices as a rule are less expensive than custom-made products, with Beckhoff it is not true that there are always immense additional costs and long development times involved. Thanks to the diversity of standard devices and extensive manufacturing know-how, the development costs remain comparatively low – and the same applies to delivery times: simple requests, where, for example, only the front laminate is to be changed, can usually be completed in a maximum of seven working days. Even more elaborate projects, involving a modified housing design, require little time, with eight to ten weeks from customer inquiry to delivery.

Three levels – from customer logos to special housing designs

The first development level of a customer-specific panel application merely involves visual modifications. This starts with a slide-in logo which the customer can either insert directly on-site in the insertion slit in the front laminate or have it inserted by Beckhoff as a service with a small surcharge. This category also includes adapted laminate designs – i.e. a completely customer-specific printed panel – according to the user’s specifications or supported by an industrial designer if necessary. Thanks to close co-operation with Beckhoff experts, this is a successful way to create an application-specific operator interface panel very quickly.

The second level of customer-specific development uses the extensive Beckhoff kit of panel components. This means that the needs-based integration of various buttons, switches and circuit boards can be implemented in an existing standard housing with unchanged dimensions. There are, for example, circuit boards in different shapes for building individual buttons, which are always used in several customer-specific devices to minimize engineering costs. These short-stroke or ring-illuminated buttons are designed and developed by Beckhoff. Since all inputs and outputs are available as digital I/Os, they can be connected to the outside very flexibly using bus communication. Frequently, the high-performance EtherCAT fieldbus is used, but connection to other networks such as PROFIBUS, PROFINET and CANopen is also possible. The second development level is still characterized by an extremely modular design – and a robust, integrated device at that – without requiring error-prone electrical and mechanical interfaces. The alternative would be to extend operator interface panels by means of plug-in button modules on the left or right; this did not prove successful in practice according to any of Beckhoff’s market findings. The main reasons for this are the additional interfaces mentioned and the lack of a requirement for extension modules, since the user is in any case already precisely aware of the desired operating elements from the outset.

The third and most elaborate development level encompasses a new housing construction, in order to implement the customer’s own design or special...
The new multi-touch panels can also be customized, for example, using electromechanical function keys and with standard push-button extensions.

ergonomic adaptations, for example. Virtually no limits are imposed on the housing design, the color or the choice of materials. Looking at the resulting panels, the standard devices on which they are based are usually no longer recognizable so the "Beckhoff panel" is quite literally transformed into "the customer's panel." In addition to Beckhoff’s many years of experience, the know-how of industrial designers often contributes to highly customized designs. They can either be experts from Beckhoff or the customer’s own designers who implement the end user’s requirements and subsequently work hand-in-hand with the Beckhoff specialists on the solution.

Over 20 years of know-how and commitment to quality
Beckhoff brought the company’s first operator interface devices onto the market more than 20 years ago. Even these early Control Panels were milled from a solid aluminium block which at the time was a completely new approach, but then and now it offers many advantages. For example, the housings can be designed extremely flexibly without having to fundamentally change the shape. In addition, the aluminum housing is very sturdy and has outstanding capacity for heat dissipation so that the electronics are efficiently cooled. The need for sustainability is also a strong argument for such an easily recycled raw material.

Another advantage of the customer-specific display solutions is the high quality standards of the entire Control Panel product family, because the individual devices are not produced apart from the standard line, but are integrated into the manufacturing process of the standard products. Accordingly, the same stringent requirements for testing under the same laboratory conditions apply to all product groups, whether standard or customer-specific. This also holds for new components to be installed according to customer specifications: they are tested extensively with regard to EMC, thermal resilience, shock and vibration, validating their suitability. An additional quality characteristic is the extensive hardware know-how which in the case of the Industrial PC products even extends to in-house development, design and assembly of the main boards.

Endless application possibilities
The wealth of experience in Beckhoff’s team of experts is as extensive as the customer requirements are different. At the end of the day it is precisely in this variety that the advantage of a customer-specific control solutions lies. For instance, a “built-in,” cabinet-mounted Control Panel with a width of 1.20 m was designed for a machine manufacturer – without doubt a technical challenge, but still a request that could be successfully answered. After all, the housings could even be milled out of aluminum blocks up to 4 m in length if necessary. A further good example is the retrofitting of an RFID reader: the user can open the device or a corresponding bay directly on site and flexibly and simply retrofit modules like the RFID reader – which is usually very expensive – if this is necessary in the application. Aggressive environmental conditions also frequently represent big challenges. Therefore, operator interfaces, for example, had to be designed with extreme robustness in order to work reliably even in aggressive environmental conditions.

With an eye for detail, customers can opt for special surfaces on stainless steel operator interface devices. In this case Beckhoff performs a special mechanical surface treatment, carrying out not the usual standard lengthwise grinding, but a specific “cloudy” grinding in order to adapt to the finish of the end customer’s
Based on the broad range of standard Control Panels from Beckhoff, company know-how and the variety of customization options, an ideal solution is available for virtually any application.

Further Information:
www.beckhoff.com/ControlPanel

Multi-touch panels go beyond simple software adaptations
The new CP2xxx and CP3xxx multi-touch panel series offer an increased range of possible applications and enhance operating convenience. This technology also has implications for customer-specific solutions. On the one hand, technical progress is reflected in the display or touch requirements, while on the other the new devices also have to be adapted to various machine applications. Therefore, some key customer accounts have already switched from the previously used resistive touch technology to the more robust Projective Capacitive Touchscreen (PCT) technology used in multi-touch devices. Their high touch-point density permits exact and reliable operation with short reaction times and, thanks to Beckhoff’s own touch controller and the individually programmable touchscreen sensitivity, operation is allowed while users wear thin work gloves (e.g. made of latex) if necessary.

Despite the many possibilities of the multi-touch operation, the devices can be adapted in many areas beyond the visualization software. Many panels are equipped with PTC and a supplementary customer-specific push-button extension. Even though a membrane keyboard around the edge of the display is rarely requested today, experience shows that customer-specific printing of the PTC glass pane and additional electromechanical buttons continue to be necessary. Such push-button extensions, e.g. underneath or to the side of the display, prove to be particularly important if they enable the previously used resistive touch panel of an existing machine to be replaced simply and without great effort using a modern multi-touch device.

Author: Klaus Niewöhner, Product Manager, Industrial PCs, Beckhoff
PC-based control – the ideal technology platform for the “Internet of Things”

Industry 4.0: Realization today with proven control architectures
A revolution is by definition a radical change of existing conditions. As history classes stress, certain points in time are strongly associated with revolutions; however, close examination often reveals more subtle, evolutionary developments. This particularly applies to the ongoing industrial revolution as currently discussed in its fourth embodiment: Industry 4.0. At the core of this development is the convergence of information and automation technology, a phenomenon for which Beckhoff has already laid the foundation more than 25 years ago with PC-based control – which still offers the optimum control architecture for the concepts of the future.

Following the introduction of mechanical production systems at the end of the 18th century, the work-sharing mass production started at the turn of the 20th century and the automation of production processes beginning in the mid-1970s, a fourth industrial revolution is now on the horizon. The term introduced for this phenomenon – Industry 4.0 – already points toward intelligent, networked systems: Information Technology (IT) and Automation Technology (AT) combine traditionally separate production environments to produce universal production worlds which are partly physical in nature, yet they attain new functionality in the cyber space of web connectivity.

It is no coincidence that the term "Industry 4.0" was coined in Germany, since the conditions are ideal for such a (r)evolutionary development in this part of the world. Despite the business challenges inherent to high-wage countries, Germany has maintained its excellent reputation as a manufacturing nation thanks to high quality and efficiency and, last but not least, high-performance automation technology. It is exactly this combination that gives Germany a unique, globally competitive advantage: this is not due only to the manufacturer companies themselves, but also the associated machine builder companies and their suppliers, the automation specialists. This synergy and focus on high-tech solutions create ideal conditions for the development and implementation of trend-setting concepts such as Industry 4.0. The German government has recognized this and is funding the interdisciplinary future project Industry 4.0 within the context of the High-Tech Strategy 2020.

Industry 4.0 – defining a vision
But what does Industry 4.0 really mean? One clear definition can be found in the funding guidelines of the BMBF (Bundesministerium für Bildung und Forschung), which is the German Federal Ministry of Education and Research: "The flexibility that exists in value-creating networks is increased by the application of cyber-physical production systems (CPPS). This enables machines and plants to adapt their behavior to changing orders and operating conditions through self-optimization and reconfiguration. This interaction between the real and digital world in a modern factory creates the basis for an "Internet of Things." The main focus is on the ability of the systems to perceive information, to derive findings from it and to change their behavior accordingly, and to store knowledge gained from experience. Intelligent production systems and processes as well as suitable engineering methods and tools will be a key factor to successfully implement distributed and interconnected production facilities in future ‘Smart Factories’.

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The fourth industrial revolution on the basis of cyber-physical systems enables the consistent convergence of automation and information technology.

First industrial revolution through the introduction of mechanical production machines driven by water and steam power
First mechanical loom, 1784

Second industrial revolution through the introduction of work-sharing mass production with the aid of electricity
First conveyor belt, slaughterhouses of Cincinnati, 1870

Third industrial revolution through the use of electronics and IT for the further automation of production
First programmable logic controller (PLC), Modicon 084, 1969

Fourth industrial revolution on the basis of cyber-physical systems

Source: DFKI 2011 (German Research Center for Artificial Intelligence)
The underlying concept for Smart Factories is the "Internet of Things," a phrase coined in 1999 in conjunction with RFID and sensor technologies describing the networking of and with everyday objects. The prerequisites for a consistent implementation are the cyber-physical systems (CPS) which were first described in 2006. This means cyber components are closely intermeshed at all levels – for discrete processing of information and communication – as well as physical components. The BMBF funding guidelines also reflect this where they explain: "Cyber-physical systems – as an extension of today’s mechatronic systems – are equipped with intelligent sensors for perceiving their environment and actuators for influencing it. They differ from existing technical systems by their ability to interact with their environment, to plan and adapt their own behavior in relation to this environment and to learn new modes of behavior and strategies, optimizing themselves as a result."

**Flexible centralized control architectures are future-proof**

Granted, the CPS definition is open to wide interpretation. It extends as far as workpieces or blanks which, thanks to their own intelligence, move independently through the production process, specifying processing parameters to the production units. Since as far back as the 1980s, when for example, the idea of self-configuring multi-processor systems was born, such autonomous subsystems have proven to be intellectually inspiring concepts that, however, do not translate into working practical solutions.

In principle, PC-based control offers enough flexibility to implement both centralized and decentralized control architectures. Within the field of automation, however, a hierarchical organisation will remain the first choice for some time to come, as will I/O systems with reduced intelligence. This concept relies on clearly defined levels as well as the interfaces between them. With Industry 4.0, it is just the universality of communication that will be emphasized more strongly, for example, by assigning an IP address of its own to a limit switch. An automation device will have to provide direct access to devices in order to enable such an "Internet of Things."

Ultimately, in order to realize Industry 4.0 following a genuinely holistic approach, three aspects must be implemented: horizontal integration across value creation networks – i.e. beyond the limits of individual companies – vertical integration or networked production systems and the universality of engineering over the entire product life cycle. In close connection with appropriate business management application software this approach should enable companies to tap into significant optimization potential as well as additional business models – e.g. via an "Internet of Services." PC-based control offers a future-proof basic structure for all of this, especially since it can be adapted very flexibly to varying application requirements: intelligence can be arranged in a hierarchically modular fashion under the central controller, but also decentralized, i.e. with equal rights if need be. It is with good reason that the traditional automation pyramid is already used very successfully everywhere, and the analogy with biological evolution, for example, shows that precisely this hierarchical structure is a guarantee of success. It has produced largely centralized concepts – in the case of man and animals with a central brain and decentral sensors and actuators. The brain as the center for data processing enables optimized movement and control sequences in nature as well. Beyond that there are social concepts, as in an ant colony, in order to coordinate centrally controlled individuals.

Accordingly, managing director Hans Beckhoff sees excellent opportunities worldwide for further growth with PC-based control technology in mechanical engineering and plant construction as well as in building automation and process technology: "With our PC-based control technology both we and our customers are ideally positioned for exactly the kind of high-tech strategy pursued by the German government under the designation of “Industry 4.0”. The convergence of IT and automation technology in particular is the core principle underlying both Industry 4.0 and PC Control. We are pleased that this concept is now making further inroads into the awareness of the general public and, in particular, of the technical public. We are sure that Germany as a manufacturing nation as well as the international automation community

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<th>Automation Technology (AT) + Information Technology (IT)</th>
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<td>Control CPU + General Purpose Computer (PC)</td>
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The advantages from the convergence of IT and AT (automation technology) were made possible for industrial applications by PC-based control from the very beginning.
Gerd Hoppe, Corporate Management, illustrates that the idea behind Industry 4.0 has a long history at Beckhoff.

PC Control: How long has Beckhoff been focused on the ideas surrounding Industry 4.0?

Gerd Hoppe: The general strategy behind Industry 4.0 is the fusion of standard IT with other technical domains, including the manufacturing industry. Beckhoff has been pursuing this idea for over 25 years with the use of standard PC technology for machine control. A good example of the holistic approach from the early beginnings is the 4-year EU research project, Eupass which started in 2004 and where Beckhoff was in charge of the control technology working group. The goal was to achieve a flexibly adaptable manufacturing environment without high mechanical engineering expenses – the approach that we call “zero engineering.” This was realized using standardized machine modules that each had an assigned set of tools and corresponding software support. With this component family it was possible – with software support – to automatically assemble a control solution for a manufacturing plant by intelligently combining units, supplies, materials and tools. At the same time, entirely in keeping with the concept of Industry 4.0, an Internet-supported database or “repository” provided support with descriptions of the modules, tools and their capabilities as well as libraries with software function blocks for the respective skills of the machines, i.e. the production characteristics and manufacturing relationships.

With respect to Industry 4.0, Beckhoff has shown an outstanding clarity of vision, not only in terms of technology but also in terms of philosophy, i.e. with the introduction of the Industrial PC and thus the convergence of IT and AT. In addition to that, the company took part in research projects with comparable approaches to Industry 4.0 – long before the term was even defined (see box text, “History of the vision”).

After the Industry 4.0 project was conceived from the perspective of the information and communication technologies and adopted into the German government’s High-Tech Strategy, a working group, “Industry 4.0” was established in late 2011 on the initiative of the Business & Science Research Union. This working group was chaired among others by Prof. Dr. Henning Kagermann from the German Academy of Technical Sciences (Acatech). Accordingly in April 2012, Acatech published a research agenda on CPS, to which Beckhoff, among other companies, had contributed in co-operation with Prof. Dr. Birgit Vogel-Heuser from the Technical University of Munich. The research was conducted from the point of view of production technology and automation for the “Smart Factory” scenario.

Moreover, Beckhoff is one of the core companies of the technology network “it’s OWL” (intelligent technical systems Ostwestfalen-Lippe, or East-Westphalia-Lippe) which was distinguished in 2012 by the BMBF as a “Leading-Edge Cluster” and represents the first large-scale project supported in the context of Industry 4.0. On the way from mechanical systems or mechatronics to intelligent technical systems in the sense of Industry 4.0, Beckhoff is heading two important innovation projects as the consortium leader: “ScAut” – short for Scientific Automation – deals with the integration of findings from engineering science into standard automation, while the idea behind “efa” – Extreme Fast
Automation – is to leverage the performance potential of multi-core processors for standard processing machines (see box text “Leading-Edge Cluster for intelligent systems”).

**PC plus Ethernet equals a globally-accepted platform**

Today there is hardly a technical system that cannot be operated by PC or at least connected to a PC via software. If you consider the great variety of system environments and technologies that are used in industrial enterprises, the role of PC technology as an open platform and de facto industry standard for automation becomes quite obvious. Future Industry 4.0 concepts will strongly benefit from the variety of communication systems and architectures supported by the PC world. It is the openness which will enable the easy implementation of innovative concepts.

This applies in equal measure to Ethernet as an industrial communication standard. Owing to the extremely high — and still by no means exhausted — data transmission rates, Ethernet is now widely accepted throughout the manufacturing industry. A contribution to this has certainly been made by the advanced Ethernet-based industrial protocols, EtherCAT and Safety over EtherCAT which meet the toughest industry-specific demands for short cycle times, determinism and efficient safe data communication.

The development of data communication with ever more complex contents and increasing usability requirements is leading in the same direction: Modern communication is Ethernet-based and is able to meet all requirements created by vertical integration. PC-based control from Beckhoff is also optimally suited to this development because, with the company’s Automation Device Specification (ADS), the EtherCAT Automation Protocol (EAP) and the OPC Unified Architecture (OPC UA) standard, it already offers excellent options today to cost-effectively implement a communication solution that extends all the way “from the sensor into the cloud”:

- ADS is a message-based, routing-capable transport layer within the TwinCAT software system. It enables acyclic communication with other tools from any point in TwinCAT. In a networked system, all data can be accessed from any point.
- The real-time protocol EAP can transmit process data between EtherCAT masters at speeds in the μs range using the publisher-subscriber mechanism.
- OPC UA is a manufacturer-independent, Ethernet- and Web service-based communication standard which can be seamlessly integrated into MES and ERP systems.

**Universal engineering for integrated production**

With the PC as a globally accepted platform and the support of the ADS, EAP and OPC UA protocols mentioned above, the prerequisites for the universal vertical and horizontal integration demanded by Industry 4.0 already exist. This setup will be essential, at the latest when the cyber-physical systems of the future are actually able to organize production processes automatically, autonomously and via Internet – all with minimized engineering effort.

The required modularity and object-orientation for Industry 4.0 must be reflected in the associated software tools. TwinCAT 3 automation software enables an application to be executed by a single-core CPU just as easily as it can allocate individual application tasks to different cores of a multi-core processor in order to optimize the control of modular production machinery. Moreover, the integration of TwinCAT 3 into Microsoft Visual Studio® serves as the ideal basis for a universal engineering environment over the entire product life cycle, providing the automation specialist with access to the modern software engineering tools of the IT world. Furthermore, additional languages such as C/C++ and Matlab®/Simulink® can be used efficiently and be fully integrated with classic IEC 61131-3 programming languages which are now extended by object-orientation. So for each automation task, the programming language that is best suited to the application at hand can be used.
Dr. Ursula Frank from Beckhoff Project Management R&D explains how strongly Beckhoff is involved as a core participating company in the Leading-Edge Cluster "it's OWL".

**PC Control: How active is the participation of Beckhoff in "it's OWL" and how is the research work structured?**

Dr. Ursula Frank: Beckhoff was involved from the very start as a key company in the Leading-Edge Cluster "it's OWL" (intelligent technical systems Ostwestfalen-Lippe, or East-Westphalia-Lippe), the first large-scale project to be supported within the context of the Industry 4.0 future project. The research work into networked and intelligent systems is structured, among other things, into five university-driven interdisciplinary projects for self-optimization, human-to-machine interaction, intelligent networking, energy efficiency and systems engineering. These are intended to provide a technology platform for the innovation projects – 34 in all – of the cluster's core companies. In addition there are eight so-called sustainability measures, for example, for technology transfer. Funding for five years of work has been provided, amounting to a total of 40 million euros.

**PC Control: Which are the most important research projects for Beckhoff?**

Dr. Ursula Frank: As consortium leader, Beckhoff is in charge of two innovation projects. With the main project, ScAut, the intention is to integrate findings from engineering science more closely into standard automation technology. The goal is a Scientific Automation platform for the development and real-time-capable operation of technical systems that possess inherent partial intelligence and the following characteristics: ability to adapt with situation-based autonomous adjustments of the plant operation in order to reduce energy consumption; robustness for bridging a defective sensor by interpolating data from other functioning sensors; proactivity via condition monitoring to identify the first signs of wear, among other concerns. The goal of the innovation project "efa" (Extreme Fast Automation) – essentially on one level below – is to increase the performance of control technology. There are plans to implement eXtreme Fast Control (XFC) technology from Beckhoff in large and complex projects extending up to complete factories. Important topics include optimizing cycle times and determining the highest possible performance of multi-core processors in automation devices.

First evolutionary steps have already been taken successfully

In practice, production systems, especially those implemented in Germany, are already connected to each other, even if they evolve further toward better networking and connectivity in a horizontal and vertical direction. If you look at it this way, modern production facilities which are connected to just-in-time suppliers or distributors and are capable of producing lot sizes of one, are in many cases the first existing examples of Industry 4.0.

An example for PC-based control showing its full potential is kitchen manufacturer Nobilia which incredibly manufactures around 2200 kitchens per day. Only thanks to consistent, computer-integrated production at all levels – starting as early as 1990 by linking the production to an Oracle database – the company has been able to advance to its industry’s number one position in Europe and do it in the high-wage country of Germany. In the sense of Industry 4.0, the closest possible linkage of manufacturing and IT systems has facilitated the success of Nobilia. This linkage consists of the integration of the PC controller into the overall manufacturing process as well as binding production to the inhouse system for complex production data acquisition and to the higher-level ERP system. In the context of Scientific Automation, the main project “ScAut“ of the Leading-Edge Cluster "it's OWL", the constantly growing power reserves of PC technology can now be used for the additional implementation of scientific findings in standard machine controllers. A specific example of this is process-optimized drilling, where spindle current and power, feed current and power, vibration of spindle and workpiece as well as drill-hole temperature, chip formation and drill hole-pattern are recorded and used as control parameters for optimizing the manufacturing process.
Building automation in the “Zukunftsmeile Fürstenallee” research and development cluster

Future-proof technology for the “Future Mile”

In the building project “Zukunftsmeile Fürstenallee” (Fürstenallee “Future Mile”) in Paderborn, Germany, a research and development cluster is being created for regional mid-sized companies. In the nation-wide competition “365 Landmarks in the Land of Ideas,” the project has already won a prize when the first building was completed in 2012. The automation technology implemented in the building complex in Paderborn is just as innovative and future-proof as the project idea itself. On the one hand, Beckhoff and system integrator HGI were able to create a system that can be flexibly adapted to the office users’ needs and to do it inexpensively at the same time. In addition, it was possible to implement a concept that is very open and flexible by accommodating future requirements and extensions.

The initiative “Germany – Land of Ideas” has awarded prizes since 2006 to ideas and projects that make a lasting contribution to the future economic viability of Germany. The Zukunftsmeile (future mile) Fürstenallee, which is supported by industry and science in the region of East-Westphalia (Ostwestfalen-Lippe, OWL), was honored for creating a cluster focused on product and manufacturing innovation in the fields of mechanical engineering, vehicle construction and information technologies as well as for the interfaces between them. It began with the “Intelligent Technical Systems” complex focussing on mechatronics, software quality, virtual prototyping/simulation and system integration. According to the development plan, there is still room for four further buildings in the first stage.

Flexible, functional and inexpensive

On a floor area of approximately 5000 m², building 1 of the Future Mile offers 3200 m² of rentable area. It is currently used by the University of Paderborn for the special fields of software technology, database and information systems and swarm intelligence, as well as by the Software Quality Lab (s-lab), the Paderborn Institute for Advanced Studies ( Pace), the Fraunhofer Mechatronic Design Technology project group, the excellence networks InnoZent OWL e.V. and OWL Maschinenbau e.V., MLAP GmbH (University of Applied Sciences) and the it’s owl GmbH Cluster Management. The large number of tenants in itself suggests one of the three most important requirements on the building automation, as Simone Probst, Managing Director of Zukunftsmeile Fürstenallee Infrastruktur GmbH, explains: "The largest challenge was that the building services had to be adaptable to various types of users with very different needs. Therefore, a great deal of flexibility was required.”

The second aspect that Simone Probst attached a great deal of importance to involved building services “that we can develop further ourselves.” After all, during the bidding and construction phase no-one could have known what the future tenant community would be like. And the third key requirement concerned the cost-benefit aspect: “The building itself and the initial technical building equipment were financed with a total of 11.5 million euros from public funds and, therefore, it was open to bids from the entire EU. Therefore,
One of the most important requirements for the building automation to be used was high flexibility. For example, the system had to provide user-friendly control of over 300 lights.

The systems realized by Beckhoff in Building 1 of Zukunftsmeile Fürstenallee comprises numerous automation components – e.g. 31 Ethernet TCP/IP Bus Couplers, eight Ethernet switches and approx. 450 Bus Terminals – installed in over 35 control cabinets to provide the control for blinds and a total of 314 lights, among other things:

- TwinCAT: Automation software with Building Automation and DALI libraries
- CP6607: 5.7-inch built-in Control Panel
- CX1010: Embedded PC with Windows CE and TwinCAT PLC runtime
- Bus Terminals with Ethernet TCP/IP Bus Coupler
- CU2008: 8-port Ethernet switch

Access to the building can be controlled centrally and conveniently via the Beckhoff Control Panel for door control.

Beckhoff Building Automation components are used in over 35 control cabinets such as the CX1010 Embedded PC with numerous I/O terminals.

Zukunftsmeile Fürstenallee Managing Director Simone Probst (on the right) is pleased with the smooth and productive cooperation with Elektro Beckhoff project manager Ingo Wagner.
the solution not only had to be functional, but also markedly inexpensive. Both requirements have been fulfilled in an outstanding manner."

**A universal and easy-to-handle solution**

Beckhoff components serve as a universal basis for building control across all systems. Ingo Wagner, Project Manager at the contracting installation company Elektro Beckhoff, explains: "On our side, we handled the complete electrical installation in the Zukunftsmile Fürstenallee. This includes the control of the interior and exterior lighting via DALI interfaces, the connection of I&C technology and multimedia, the acquisition of energy data in the main distribution system as well as the control of blinds and the central locking system." Heger Gebäudeautomation Ingenieurgesellschaft (HGI), on the other hand, was responsible for heating, ventilation and air-conditioning technology, which was no problem to integrate, as Ingo Wagner continues: "HGI also uses Beckhoff components such as the Bus Terminal I/O system and a standard Ethernet network in its solutions. In this way the data required in one system can be seamlessly exchanged with the other systems." HGI departmental manager Burkhard Brüning adds: "Our network checks the entire energy flow in the building from energy generation to distribution and storage to the loads. Of course, no building can be competitive today without a powerful and reliable IP network. This is where our Building Automation 2.0 system comes into play; it integrates building automation and IT."

HGI implemented the HVAC systems as well as individual room control and energy monitoring. In addition, HGI had to allow for integration of ground source heat pumps into the overall design. The Ethernet-based communication technology provides the backbone for an integrated system enabling, for example, Thermokon room control units, various field devices from different manufacturers as well as a CP6901 12-inch touchscreen panel and CX9010 Embedded PCs from Beckhoff to seamlessly exchange data. Specifically, the CX9010s are used in connection with KL6401 LON Bus Terminals for controlling primary systems, i.e. heating, ventilation and cooling, as well as for superordinate functions for room-control.

Especially for use in buildings, Ingo Wagner sees a particular benefit in the DALI lights: "Thanks to this advanced lighting system the building is adaptable to the changing needs of the tenants, i.e. the extension or division of rooms can be accounted for by a simple program change. In this way, a single-room situation can be created from an open-plan area without great effort. Zukunftsmile Fürstenallee facilities are thus innovative and sustainably equipped." In any case, the underlying automation technology should be hidden to the users’ eye in the interests of convenient and simple building use: "Therefore the installation has a standard look and feel; that is, it was realised with what at first sight appear to be normal operating switches. The series and changeover switches we used are, of course, communication-capable, while to the user they seem to be simply switching on and off of the light. The same applies to the control technology which in this case is implemented using TwinCAT automation software." Simone Probst adds: "The room size of the offices, for example, is fairly standard in order to achieve a compromise that is acceptable to the various users. A certain degree of individualization is, however, possible in a simple manner. In the larger offices, for example, the light is directed towards the center of the room. If the tenant desires, however, it can also be directed towards the desk or the meeting area."

A password-protected CP6607 5.7-inch Control Panel in the caretaker’s room is used for this, and also to support remote VPN access and changed door-opening times when evening events are scheduled.

**Practice-proven and future-proof**

After a very short construction period of just one year, Simone Probst also draws a positive balance for the building use: "The automation technology has proven to be outstanding in daily use so far and has fulfilled all expectations with regard to functionality as well." In addition, all doors remain open for future changes, because thanks to the universal hardware architecture, the building services can be adapted and optimized by means of simple software extensions without great cost. For instance, the weather station already installed on the roof of the building could be integrated more deeply into the automation technology if need be or, where remote access is concerned, an alarm could be sent to the caretaker by SMS in case of a malfunction.

**Further Information:**
- [www.elektro-beckhoff.com](http://www.elektro-beckhoff.com)
- [www.hgi.de](http://www.hgi.de)
- [www.zukunftsmile-fuerstenallee.de](http://www.zukunftsmile-fuerstenallee.de)
- [www.beckhoff.com/building](http://www.beckhoff.com/building)
The Vaillant Group, headquartered in Remscheid, Germany, is an internationally operating heating, ventilation and air conditioning company. In order to meet the highest quality standards, all Vaillant appliances are subjected to comprehensive tests. The company specified a standardized test procedure for its worldwide production sites and uses Beckhoff control technology throughout its test bench implementations.
The screwdrivers in the assembly lines are also among the system peripherals. The set values for the screwing forces are read by the Assembly Management System from the database and written to the screwdriver controller. The actual values are written back to the database and documented.

One of the Vaillant Group’s core business areas is the production of heating appliances. The product range extends from appliances designed for conventional fuels to system solutions that use regenerative energies. The Production Test Development Department is responsible for the testing concept of the Vaillant Group and for the development of testing methods, test benches and the Assembly Management System (AMS). “The test standards developed by us are binding for nine international production sites of the Vaillant Group. Presently we attend to about 200 test and assembly management applications that are in production,” explains Christian Kron, head of the Production Test Development Department. “The philosophy of the Vaillant Group is to check our products throughout 100 percent of the process. It starts with the incoming goods, where we carry out random checks, and extends as far as the ‘shipping audit.’ In production and assembly we perform inline and end-of-line checks to test the appliances for correct assembly and functions.” The Vaillant Group’s thorough test strategy is applied to the entire product range.

Flexible and scalable test bench solutions from the Beckhoff automation toolkit

The control hardware for the test benches comes from the Beckhoff automation toolkit; i.e. the system configuration is not fixed, but is adapted modularly to the test task at hand. “We predominantly use Industrial PCs from the C5210, C6915 and C6930 series as well as Control Panels from the CP6201, CP6907, CP7201, CP7709 and CP7901 series. Moreover, we use a customized panel based on the CP7901 that was developed with Beckhoff according to our specifications,” Christian Kron reports.

Up to 300 test contents are documented

All test steps and results, including the measured values, are recorded and documented. Traceability is guaranteed for every product on the basis of the documented test report. The main measured variables recorded during the test sequences are pressure, flow, temperature, current, voltage and frequency. Sig-
A Vaillant heating appliance is pushed into the test bench.

The recorded test signals are transmitted via the EtherCAT Terminals to the PC and evaluated by the UTS software. All test benches and Assembly Management Systems from the Vaillant Group are connected to a database. Up-to-date article-specific test sequences and parameters are downloaded from there before each test. “That is in some cases involves up to 300 parameters and the associated test sequence, including the test steps,” affirms Christian Kron. These parameters are used by the UTS Software for evaluation; subsequently, the determined and qualified data from each test procedure are written back to the database.

**Standardization offers clear benefits**

The high degree of standardization of the test methods and the test benches allows them to be managed internationally by a small, central team with local support, despite the large number of applications. The employees operating locally in the respective teams are trained in the use of the checking and test facilities. Beyond that, the Remscheid team offers so-called “Second Level Support.” “This means that if the colleagues on site require assistance, we connect to the system remotely and help resolve support issues,” explains Christian Kron. He is particularly proud of an additional benefit: “The consistent reuse of our test benches following the discontinuation of a product is made possible by the high degree of standardization and also represents a significant cost-saving factor.”

**Further Information:**

www.vaillant-group.com

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**Christian Kron, Head of the Production Test Development Department, from the Vaillant Group together with Wilm Schadach, Beckhoff Sales Office, Rhine-Ruhr, Germany (from left)**

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**Vaillant Group**

The Vaillant Group, with head office in Remscheid, Germany, is an internationally operating heating, ventilation and air conditioning company. As one of the worldwide market and technology leaders, the Vaillant Group develops and produces tailor-made products, systems and services for room comfort. The product range extends from efficient heating appliances using conventional fuels to system solutions that use regenerative energies. The company, which has been family-owned since its establishment in 1874, achieved sales of around 2.3 billion euros in the 2012 financial year with more than 12,000 employees.
The 1.5 MW wind turbine from Zhejiang Windey has a classic design: a three-blade upwind rotor with horizontal main shaft and three-point bearing. The drive train consists of a three-stage planetary gear and a double-fed induction generator. As an actuator for power or speed control, the plant has an independent pitch system that also encompasses the servo drives for the blade adjustment. The plant is characterized by reliable and stable operation, high efficiency, good grid compatibility and a robust design for use under extreme environmental conditions. The automation of the plant is based on a CX1020 Embedded PC with inline-connected EtherCAT I/O terminals as well as TwinCAT automation software including the TwinCAT "wind libraries".
The automation platform of the 1.5 MW wind turbine from Zhejiang Windy consists of a CX1020 Embedded PC with inline-connected EtherCAT I/O terminals and the TwinCAT automation software, including the TwinCAT “wind libraries”.
Zhejiang Windey Wind Power Engineering Co., based in Hangzhou, China, was established in 2001. The business areas of the company, which evolved from the Wind Power Research Sub-Institute for Zhejiang Institute of Mechanical & Electrical Engineering, include the development and production of wind turbines, their connection to the grid and the operation and maintenance of wind farms. The company additionally offers engineering services for the planning and construction of wind farms.

**TwinCAT: the complete and open control solution for wind turbines**

In the TwinCAT "wind library" Zhejiang Windey has found the ideal basic construction kit for the engineering of its wind turbines, as Lou Yaolin of Zhejiang Windey stresses: “The ‘wind library’ provides a clear program structure and contains a complete set of function blocks enabling us to design the automation program flexibly.” The entire library is available in open source code, so that the user can make any desired or required adaptations and extensions autonomously.

**System management and diagnosis in one tool**

The “wind library” offers numerous management and diagnostic functions for wind turbines resp. for process monitoring and control. As a result the engineering time and costs are substantially reduced and the user can fully concentrate on the plant-specific part of the wind turbine automation tasks.

The “wind library” also provides various functions for the logging of process data and events. The user can easily adapt the type and extent of the data to be saved as well as time intervals, file names and storage paths of the files to be written (e.g. on Flash disk or hard disk). The library also contains general function blocks, for example for reading the CPU utilization rate of the controller or for the diagnosis of the EtherCAT I/O modules. These diagnostic blocks can be called up as needed and the status information can be used to form status codes, so that a smooth and reliable wind turbine operation ensured.

**Tools for code generation**

In addition to the blocks available in the source code, the TwinCAT wind library encompasses tools for the automatic code generation. With the help of these tools the I/O signals, parameters, status codes and telecontrol commands with all their individual characteristics required for the plant operation can be conveniently created and
maintained. With these tools the data entered can be stored both as an Excel file and in a format that can be directly imported by the TwinCAT programming tool (*.exp format). In this way not only is the programming speed increased and the occurrence of code errors reduced, but also the operation and maintenance of the wind turbine are made considerably more convenient.

Access management and Scada interfaces
Blocks for the management of user access are also part of the scope of delivery of the "wind library". They allow a fine graduation of the access rights for all users: a total of 100 access levels are available, where zero is the lowest level and one hundred the highest. If a user has logged in at his individual level, only the functions and information enabled are available to him. The user name and password are transmitted in encrypted form for logging in. The blocks for encryption and decryption are part of the library.

Beyond that the "wind library" also provides a visualization interface on the PLC side that makes do without any special communication interface. All process data and telecontrol commands enabled for remote access can be read or operated by external Scada systems via this interface (taking into account the access level).

Other communication protocols such as Modbus, TCP/IP or OPC can also be enabled for access. Zhejiang Windey uses Modbus TCP and a Scada remote system for data interaction.

Outlook
After the first 1.5 MW wind turbine equipped with TwinCAT was put into operation in the Zhangbei wind farm and is running stably and reliably, Zhejiang Windey is planning to use the "wind library" on a large scale for the control of its wind turbines by the end of 2013.

Further Information:
www.chinawindey.com
www.beckhoff.com.cn
With the completion of Tower 185, the skyline of Frankfurt am Main now has one more attraction: with a height of 200 meters the 50-story high-rise office building is one of the four tallest skyscrapers in Germany. The contract for the entire building automation infrastructure was awarded to Hermos AG, a specialist in IT solutions for properties and production processes. The medium-size enterprise, which has already implemented several building automation projects with Beckhoff as a technology partner, once more relied on the PC-based control platform for this building project. The FIS# building management system developed by Hermos – for use at the management and operating level – and the Beckhoff technology components together create an intelligent, highly efficient building automation system that fulfils all requirements of both the operator and occupants of Tower 185.
Tower 185, designed by the Frankfurt architectural office Prof. Christoph Mäckler Architekten, rises to its impressive height out of a horseshoe-shaped base, the so-called east and west perimeter blocks. These blocks house shops, restaurants, offices and a conference center, as well as a restaurant and daycare for children of employees. The high-rise office building offers a total floor space of 100,000 m² across 50 floors. The main tenant of Tower 185 is the auditing company PricewaterhouseCoopers (PwC) which has rented an area of 71,000 m². Further tenants of the building include the globally active law firm Mayer Brown LLP as well as Excellent Business Centers GmbH.

Building automation platform in XXL format
Hermos was commissioned by the building owner, CA Immo to implement the complete building automation of the office building – from the management and operating level to HVAC and room automation systems. With an office space of 100,000 m², both the individual room control and the dynamic room management are extraordinarily complex and represent a challenge in terms of control: On the one hand, the management and operating level must acquire and evaluate the requirement signals from the office rooms. On the other, global control functions must be executed, including changing room sizes, lighting as well as various user and shading scenarios. And finally the needs-based control for the required amount of heating, cooling and air quality must be activated and controlled.

A total of 700 PC-based controllers from Beckhoff are in use to implement all control and regulation tasks in Tower 185. About 60,000 data points are connected via Ethernet and a TwinCAT ADS communication interface to the FIS# management and operating level system developed by Hermos which is implemented on the central building management server. FIS# connects the room automation with the building management system and is responsible for the central operation, monitoring and control of the technical building equipment (HVAC) as well as the dynamic room management. Thomas Sturm, Hermos’ project manager for the Tower 185, adds: “The data points are connected via standard Beckhoff I/O, DALI, EIB/KNX and EnOcean terminals. A total of 170 Beckhoff Embedded PCs of the CX9010 series, 500 Embedded PCs of the CX9001 series as well as 80 C6925 Industrial PCs (PCs) take care of the data processing. On each floor, a C6925 filters or qualifies the data in order to transmit them, then structures and consolidates the information for the FIS# server. For example, it collects actual and setpoint values for the room temperature and transmits them to the management and operating level according to a defined time pattern.” All data captured by the building automation system are merged in the FIS# and represent the basis for benchmarking and controlling, for example, the energy consumption, the system availability or the operating costs, as well as for the integrated maintenance management.

Redundant Ethernet network for 24/7 availability
An autonomous Ethernet-TCP/IP-based network forms the “backbone” of the building management system. The network infrastructure of the building is divided into three areas, namely the east and west perimeter blocks and the tower itself. There is a redundant fiber-optic cable ring in each section of the building, so that the data traffic is maintained even if the network cable is interrupted. The entire management and operation level, consisting of redundant servers and
client stations, is networked by a fiber-optic cable ring and by means of Ethernet TCP/IP. The fiber-optic cable ring couples the automation devices floor by floor via switches, i.e. the lower-level Beckhoff IPCs are connected by copper-based Ethernet cables in a star topology to the control level which is networked via optical fiber.

Connected to the Industrial PCs are Bus Terminals and to these in turn the room control units, sensors and actuators. Thomas Sturm explains: "The Tower 185 building can be completely supervised and controlled via the monitor by the building operator Hochtief Solutions with the clients in the building automation control room." However, Hermos also has the possibility to access the building controller via a client station for remote maintenance.

**Designed for flexibility: individual room control**

Individual room control in Tower 185 encompasses light control with DALI as well as blind control via SMI. Room control units with EnOcean technology are used to enable flexible room usage on the basis of the small office units. These are each equipped with an occupancy sensor, a selector switch for room temperature, a temperature sensor and a pushbutton for blind operation. All signals from the room control units, such as the actual and setpoint temperature values, are sent by EnOcean wireless technology to KL6583 EnOcean Bus Terminals and transmitted to the Embedded PC.

A prerequisite for dynamic room management is adherence to predefined control variables. Thomas Sturm explains: "With regard to the usage scenarios we had to meet exact specifications, also taking the needs of tenants into account. In room automation the adherence to maximum permissible deviations is demanded. Accordingly we have defined three modes of operation for the office spaces: day, night and weekend, and comfort mode. With regard to the night and weekend mode, we must adhere to limit values of ± 3 K (Kelvin) in order to properly condition the room. The day mode is defined by timers; this means that from 7 am until 7 pm the room is maintained in such a way that it can be quickly put in comfort mode as soon as the occupancy sensor is activated."

Beside the standard office space, special and comfort rooms were set up on the 48th and 49th floors of Tower 185. Room control takes place here using operating panels that employ EIB/KNX technology. The panels encompass pushbuttons for various room functions, such as the control of the blinds and lights, as well as the digital specification of the set temperature value. Here, the tenant has the possibility, for example, to call up stored lighting scenarios and to modify them via the FIS# client. In addition, the operating panels provide status information about various room parameters, such as temperature or air quality, etc. The outside temperature is displayed, five climate elements are shown and the flow rate is controlled by means of a PWM controller. A dew-point sensor indicates the possible formation of condensation on the ceiling. The control function is implemented using a TwinCAT software module.

**Dynamic room management without hardware changes**

Since each standard office is equipped with a room control unit with EnOcean technology, the room layout can be arranged flexibly if its usage changes. If standard rooms are combined to form an open-plan office, the components
The floor computers: a total of 80 Control cabinet Industrial PCs of the type C6925 are used in the Tower 185. A C6925 is installed on each floor for the filtering or qualification of the data.

belonging to the basic units are assigned to the master controller. “The room control units are removed for this. The necessary regrouping, for example of lighting and heating elements or blinds, is defined in the FIS# system by our dynamic room management or by suitable task assignments. Modifications to the wiring or installation are not required,” explains Thomas Tröger, software expert from Hermos.

In special rooms with movable partition walls, the wall position is detected by signalling contacts in order to control the room conditioning. If two rooms are combined the operation is adapted accordingly and the control processes are aligned via both control panels. For other room changes, the tenant must make a request to building operator Hochtief Solutions who then adapts the visualization of the management and operation level or the room control in accordance with the changed floor plan.

Centralized blind control improves energy efficiency
Tower 185 uses so-called “global blind control” which is carried out centrally at the management and operation level. For this, the blinds of the entire façade of the tower and perimeter blocks are divided into segments. They are controlled in relation to the level of sunlight, light direction and temperature. A weather station installed on the 6th floor of the east perimeter block measures not only the temperature, but also the wind velocity, wind direction, rain and brightness. In order to account for the effects of the surrounding high buildings on the control parameters of Tower 185, further weather sensors were installed on the 53rd floor that measure brightness levels without impediment.

Thomas Tröger explains the concept of the shading control as follows: “An input mask was created for this in the FIS# into which the operator can enter the values. The sun protection is then operated globally in accordance with these criteria. It can quite easily be the case that the east side is shaded in the early morning while the south side is still open. If the conditions change over the course of the day, the global controller changes the blind segments. Nevertheless, each room user naturally has the possibility to operate the blind on each window individually using the room control unit. In the case of an approaching storm or rain, however, the central controller automatically takes command again.”
The data processing is carried out by a total of 670 Embedded PCs of the type CX9001 or CX9010. In the basic configuration, two RJ 45 sockets that are internally connected to an integrated switch are available as interfaces. This facilitates the wiring in a line topology.

**User-friendly operating interface**

The operating interface of the FIS#, which summarizes all information that is relevant for the operator, is arranged into two large sections. The system tree reflects the overall project structure and is subdivided into room management and technical systems. The room management encompasses the individual floors, from the ground floor to the 50th floor. The technical systems have been divided into the individual subsystems, including ventilation and cooling systems. The ventilation systems, for example, are subdivided into supply and exhaust air as well as into air-conditioning subsystems. An operator is thus able to access individual systems via the operating interface.

**Flexibility – from the management and operation level to the automation platform**

With a large building project like Tower 185 with a usable floor area of 100,000 m² it is only natural that the leases extend over a longer time period. Thus, a high degree of flexibility in the building automation system is required as well as trouble-free interaction of all systems and components employed. "Both the Hermos management and operation level and the Beckhoff automation platform are characterized by openness. They offer numerous interfaces to other communication and technology concepts. Hermos has developed its own ADS driver for coupling the control system and TwinCAT which enables universal access to the system," explains Wolfgang Negele, Beckhoff sales representative from the company's Nuremberg branch office.

Further Information:
- www.tower185.com
- www.caimmo-deutschland.com
- www.hermos.com
- www.beckhoff.com/building
Embedded PC CX5000 controls rail-guided vehicle

Huaheng Welding Co., Ltd., based in Kunshan, Jiangsu, China, specializes in the development, production and sales of welding equipment. The company’s product range extends from mechanized to intelligent robot welding solutions and automated welding plants. With the development of a new production line on the basis of a rail-guided vehicle, Huaheng has made an important contribution to automated production in the Chinese mechanical engineering industry.

Bridge cranes are still widely used for in-plant transport in the Chinese mechanical engineering industry; however, the growing production requirements create an increasing demand for automation in production. Kunshan Huaheng recognized this trend and in April 2010 introduced an RGV (rail-guided vehicle) with automatic points changer to the market which, when combined with a robot station, forms a flexible production line. The structural welding shop at the Sany Lingang Factory manufactures among other things excavator shovels and booms using this production line. Currently there are more than 20 RGV-enabled production lines in operation at Sany.

Where control is concerned, Huaheng’s architecture is based throughout on automation components from Beckhoff: the plant is well-equipped using Panel PCs and Embedded PCs with TwinCAT automation software for control, I/O components for system communications as well as highly dynamic servo drives and motors. The fully automated production line essentially consists of the rails, the RGV as the means of transport, a robot station, a decentralized control system and the higher level control system.

The compact RGV offers high speed (up to 20 meters/min), excellent stability while driving as well as a high positioning accuracy (< 1 mm) and can be loaded and unloaded fully automatically. The control level connects itself to the MES system and transfers information about the workpiece during the manufacturing process.

The fully automated production line essentially consists of five elements: the rail, the rail-guided vehicle as the means of transport, a robot station, a decentralized control system and the higher level controller.
CX5010 Embedded PC: high performance, numerous interfaces

The CX5010 Embedded PC with TwinCAT NC PTP handles all control functions of the rail-guided vehicle. “We chose the CX5010 on the one hand due to its performance and on the other due to its range of interfaces and compact design. Another advantage is that the Bus Terminal system from Beckhoff supports different fieldbuses such as CANopen and PROFIBUS and is thus compatible with our device periphery,” explains Wang Wei, head of the electrical welding automation group at Kunshan Huaheng. In addition to that, the development engineers from Huaheng value the software libraries and function blocks in TwinCAT. “Since many requirements cannot be covered by a standard controller, which makes additional programming work necessary, we save a great deal of time during project development by using the TwinCAT software modules,” emphasizes Li Fang, electrical engineer at Kunshan Huaheng.

Drive Technology: high dynamics and positioning accuracy

Kunshan Huaheng uses AX5000 servo drives and AM3000 servo motors from Beckhoff for motion control. This solution ensures the fast travel and exact positioning of the RGV on the main and branch rails as well as rotation on the Z-axis while replacing traditional positioning modules and NC controllers. “The stations that the vehicle drives to are freely selectable. They are configured in the RGV without having to modify the program,” explains Wang Wei. In addition the RGV is equipped with the EL6731 PROFIBUS master/slave terminal to which two barcode scanners are connected. They read the barcodes on the main and branch rails and enable fast changing of the points if slippage should develop between the vehicle wheels and the rails.

Embedded PC and EtherCAT are at the “heart” of the control platform

The production line is also controlled via an Embedded PC. Via the local I/Os, the control system detects the requirement signals of the robot welding positions, the execution signals of the hydraulic clamping fixtures and the “ready” signals of workpieces on the feeding platform; in addition it controls the loading and unloading of the vehicles. The CX5020 Embedded PC forms the “heart” of the control platform. The position and feeding platform signals are captured by an EtherCAT terminal. For each position, an EK1100 EtherCAT coupler is used which is connected to the CX5020 over EtherCAT. “The use of EtherCAT as the communication system has many advantages for us: Apart from faster signal detection we also have shorter cycle times. In addition wiring is simplified because we can use CAT5 cables, significantly reducing our installation costs as a result,” says Liu Xiaolan, electrical engineer at Kunshan Huaheng. “What’s more, thanks to wireless communication between the RGV controller and the CX5020 via the Beckhoff CU8890 WLAN controller, the individual production lines can communicate with one another easily.”

Further Information:
www.huahengweld.com
www.beckhoff.com.cn

The rail-guided vehicles are used among other things for the automatic production of excavator shovels and booms in the structural welding shop at the Sany Lingang Factory, a manufacturer of construction vehicles and machines.
Wellness destinations and spa centers are very popular for vacationers to get some much needed rest and relaxation. With this in mind, VAMED Vitality World, which operates a total of eight hot springs in Austria, has made a proverbial splash with the »Therme Wien« (Vienna Hot Spring), which opened in autumn 2010. As one of the most modern urban hot springs in Europe, it offers an overall water area of about 4,000 m² as well as a generously-sized sauna, plus health and fitness zones on a 75,000 square meter site. From the varying water temperatures in the individual pools to the plays of light and sound in the water, to the control of HVAC, lights and blinds – sophisticated building automation is required to suit this comprehensive spa operation.

Beckhoff I/O components in ultra-modern spa help enable wellness, fun and efficient energy consumption
The Vienna Hot Spring is arranged like an elongated brook, interrupted by water cascades, small waterfalls and fountains. The heated water invites the visitor to bathe in pools with different temperatures both indoors and out. Between them, various buildings are placed like “stones” in the landscape: depending on their mood, the guest can visit the “Stone of beauty,” the “Stone of quietness” or “stones” in adventure, sauna or fitness themes. In addition, extra-wide, tube and adventure water slides, diving platforms, pools, plays of light and sound as well as underwater massage jets ensure that nothing is left to be desired for wellness seekers.

Multifaceted spa and water park experience calls for flexible technology
In close co-operation between evon GmbH and Beckhoff, a building control solution was created that fulfills all the operator’s requirements with regard to energy efficiency, integration into the IT network, increased convenience and reduced cabling expense. On the basis of the higher-level XAMControl control and visualization system developed by evon and Beckhoff I/O components, the individual room conditioning and thermal water preparation were integrated into the building automation along with typical building automation tasks such as HVAC and lighting control.

6,500 data points guarantee a “feel-good climate”
The plant room at the Vienna Hot Spring houses two large industrial servers in a redundant configuration. A total of 120 BK9100 Ethernet TCP/IP Bus Couplers with about 1000 digital and analog input and output terminals form the backbone of the building automation system for the hot spring and connected health center. Around 70 % of the entire hot-spring technology is run via two main servers. Three further servers are necessary for various subsystems, such as the lighting control and the acoustics systems of the pools. A total of 6,500 physical inputs and outputs were installed in 90 control cabinets for this project. The acquired data are evaluated and stored using a central SQL-based database. “The values are written in a one-minute cycle – even more frequently in particularly important zones. This means that it can be seen immediately at any time how the individual systems interact and what the individual temperature and flow curves look like – and all of that online, of course,” emphasizes project manager, Rene Hirschmugl from evon GmbH.

In total about 150,000 variables have to be processed in a cycle time of 80 ms at the Vienna Hot Spring; communication takes place without exception via standard TCP/IP network technology.
Efficient energy management

The natural heat of the thermal spring is also used for heating in the Vienna Hot Spring. After all, the exclusive spa consumes 15 MW – more electricity than a large shopping center. “Efficient use of energy,” says Rene Hirschmugl, “was one of the primary objectives of this project. All building systems are linked in such a way that the thermal water system interacts functionally with the heating, air conditioning and ventilation systems and energy is provided according to their requirements.” For this purpose integrated requirement chains were created, which ensure that over 50 heating circuits, 30 air conditioning systems that handle a total of 350,000 cubic meters of air per hour and the thermal water system all cooperate with one another.

“The thermal water system demanded the highest planning and programming skills of all the engineers involved in the execution,” says Christian Pillwein, Business Manager, Building Automation from Beckhoff Austria. After all, the challenge is to bring 200 tons of water per hour up to the right temperature – deviations of ± 0.2 degrees are allowed – and to guide them into the right channels or pools. In addition to the water conditioning, the process control must naturally also take into account the wastewater control as well as the so-called backwash processes in which the pumps, shut-off flaps and valves must process 700 or 800 tons of water within a few hours.

Controller exchange during operation

One of the project’s special challenges was to replace an existing controller when it has been damaged by the sulphur-laden spring water during ongoing spa operation. Since an interruption was out of the question for the hot spring operator, the entire existing control equipment was switched over in one weekend. “No easy task,” as Rene Hirschmugl says, “such an action is only conceivable with the selected Beckhoff/XAMControl platform. It is a crucial advantage of our software that every PLC program change works without interruptions. No restart is required, no configuration mode has to be switched to, nor anything else – the hardware simply goes on running.”

Further Information:

www.thermewien.at
www.evon-automation.com
www.beckhoff.at
www.beckhoff.com/building

Lighting scenes that change rhythmically in tune to the music are controlled by a Windows Media Player combined with a DMX controller and lighting consoles.
Medical technology: Precise control and alignment of electron beam technology using Embedded PCs, EtherCAT and stepper motor system

Innovative radiation therapy uses flexible PC-based control platform

Modern automation technology is playing an increasingly important role in the effective treatment of cancer. IntraOperative Electron Radiation Therapy (IOERT), which was developed in the U.S. by IntraOp Medical, has achieved excellent treatment results in practice and is now being used in hospitals around the world. This technology delivers a direct, highly concentrated and precise dose of radiation with electron beams during cancer surgery, immediately after the tumor is removed.

Mobetron® is a mobile linear accelerator for IOERT and is used globally for treating different types of cancers.
With corporate headquarters located in Sunnyvale, California, IntraOp Medical has developed a fully mobile, electronic linear accelerator for IOERT called the Mobetron®. This radiation machine is currently being used in clinics and hospitals in North America, Europe and Asia to treat various cancer cases. Mobetron® allows the tumor bed to be radiated precisely with concentrated electrons and any remaining cancerous cells to be killed off. In most cases this eliminates or at least reduces the need for post-operative, external radiation therapy. “In addition to better survival rates, shorter treatment cycles and fewer side effects, Mobetron® also helps to drive down the cost of cancer therapy,” explains Andy Merrill, VP of Engineering and Operations, IntraOp Medical.

Embedded PCs control electron radiation treatment

IntraOp Medical uses the PC-based control platform from Beckhoff to automate its 2nd generation mobile linear accelerator. “Incorporating the open PC control solution allowed us to meet our key strategic requirements in terms of electrical engineering. The CX5020 Embedded PC is a compact, high-performance and flexible controller,” says Shura Kretchetov, Physicist, IntraOp Medical. All control functions are run using the TwinCAT PLC and TwinCAT NC PTP automation software. It controls all the automated functions of Mobetron® including the small linear accelerator that is used to deliver electron beams directly to the affected areas.

“We use the enhanced processing power of the CX5020 to continuously integrate new functions in the controller, such as treatment planning tools or remote diagnostics,” explains Shura Kretchetov. The EtherCAT Terminals are connected directly to the CX while additional EtherCAT nodes use the EK1100 EtherCAT couplers to distribute additional I/Os across the system.

“The PC and EtherCAT-based control platform enables very fast control processes in the low microsecond range, which has a direct positive impact on the performance of the Mobetron® systems in the field,” explains Shura Kretchetov. All system and process data gathered by the Mobetron® can be processed quickly and efficiently as the tumor cells are being irradiated.

Complex drive-technology solution

Ensuring space-saving motion control technology on the Mobetron®, IntraOp Medical uses Beckhoff’s EL7031 and EL7041 stepper motor control terminals paired with AS1060 series stepper motors for an extremely compact stepper system that doesn’t require separate amplifiers. The stepper motor control terminals ensure precise control and alignment of the electron beam. “Naturally, ensuring precise control of machine movement and the treatment process is critical to the health and safety of patients and PC- and EtherCAT-based control help us implement that security,” explains Andy Merrill.

Flexible device connectivity via wide array of interfaces

In addition to easily integrating essentially any device with an Ethernet connection, IntraOp Medical utilizes EtherCAT Terminals to establish connectivity to other communication protocols, such as PROFIBUS or serial protocols. The EL6731 slave terminal enables full integration of PROFIBUS devices in the EtherCAT...
network without requiring the addition of PCI cards. Similarly, the EL6021 serial interface terminal enables simple connection of devices with RS422 or RS485 interfaces.

"By integrating Beckhoff’s control technology we’ve opened up our machine architecture, allowing us to go from a simple PLC controller to a powerful and open PC-based control platform, thereby affording us excellent flexibility," says Andy Merrill. With the integration of the PC-based control platform, the Mobetron® IOERT systems can be monitored and controlled with greater ease and precision, something that is hugely significant in terms of the high safety standards in cancer therapy. "The PC control solution means we can establish much better monitoring and control of various components on our machines while at the same time it helps us optimize our remote diagnostics and system efficiency," adds Andy Merrill.

Significant also is the much shorter engineering time thanks to the PC-based control platform. "Compared with first generation machines, which were equipped with a conventional PLC, use of PC-based control allows us to save around 36 hours of engineering and installation time per machine, enabling us to ship twice as many machines per month," says Shura Kretchetov. He continues on to say: "All in all, since integrating Beckhoff’s control technology, our Mobetron® cancer treatment system has become easier to manufacture, troubleshoot, and maintain; I can conservatively estimate that we have easily reduced our overall controls costs by 20 %.”

Encouraged by these excellent results, IntraOp Medical is continuing to successfully move forward with its goal of, on one hand creating more flexible, efficient, and cost-effective IOERT machines, and on the other hand bringing new machines for other medical applications to market. "In the future, we want to create a universal system that is open to all different types of medical applications such as cosmetic surgery, burn victim treatment, fighting infections and viruses, to name just a few,” explains Andy Evans. We are focusing on specialized and customized “Ready for Use” solutions to ensure that we remain at the forefront of the highly competitive medical technology market.”

The control system of the Mobetron®, comprising a CX5020 Embedded PC, TwinCAT automation software and the connected EtherCAT I/O modules, is highly efficient and flexible. It controls all automated functions of Mobetron® including the linear accelerator that is used to deliver electron beams directly to the affected areas.

IntraOp Medical uses Beckhoff’s EL7031 and EL7041 stepper motor control terminals paired with AS1060 series stepper motors for precise alignment of the electron beam.

Further Information:
www.intraopmedical.com
www.beckhoffautomation.com
This year’s Hannover Messe was no doubt a great success for all involved. Visitor numbers were up by more than 20 % compared with last year and there was keen interest in the latest trends and developments in industrial technologies.

It goes without saying that the EtherCAT Technology Group (ETG) was once again well prepared for this: The ETG partner booth featured information on master systems, servo drives, frequency converters, I/O systems, pneumatic and hydraulic valves, encoders, sensors, gateways, implementation kits and services for slave devices, software tools and Safety over EtherCAT solutions. Visitors got an excellent impression of the wide-spread use and high acceptance of EtherCAT. In total, 63 ETG member companies presented more than 360 products, a number which had increased by more than 100 compared with the previous year.

The ETG and numerous representatives of the group’s co-exhibitors welcomed guests from more than 30 countries at HMI 2013.

Visitors from more than 30 countries attend the ETG partner booth

EtherCAT Technology Group successful at HMI 2013

Safety over EtherCAT is implemented around the world in control and drive technology, robotics and sensors by well-known companies. To support certification of such devices, Beckhoff Automation now offers a special Conformance Test Tool for Safety over EtherCAT (FSoE). This tool enables the FSoE protocol functionality to be checked automatically and comprehensively, so that the compliant implementation of the specification can be verified.

The certification was preceded by the definition of the test cases implemented in the tool by the EtherCAT Technology Group (ETG). TÜV (Technischer Überwachungsverein, a German Technical Inspection Association) was involved in the whole development process, including implementation of the test environment for the tool, analysis of the results and subsequent confirmation. Dr. Guido Beckmann, safety expert at the ETG, emphasizes the considerable benefits of the tool: “The FSoE Conformance Test Tool helps manufacturers discover implementation errors at an early stage of development. Proof of conformity of an implementation is required for the official acceptance of safety-relevant devices. Without the FSoE Conformance Test Tool all device manufacturers would have to generate this proof on their own.”

The new FSoE Conformance Test Tool, in combination with a lean protocol specification, pre-certified software stacks and a wide range of support from different service providers, offers device manufacturers an all-in-one package for complete peace of mind, which significantly simplifies the integration of Safety over EtherCAT.

Dr. Guido Beckmann, Chairman of the Technical Committee at ETG
2013 Spring European EtherCAT Plug Fest a success in Tettnang, Germany

The annual Spring European EtherCAT Plug Fest, organized by the EtherCAT Technology Group (ETG), took place from May 14 – 15 at the wenglor sensoric site in Tettnang, Germany. The event was attended by a total of 27 manufacturers from 9 countries who brought along EtherCAT devices for interoperability testing. Florian Häfele, who attended the event as onsite ETG expert, finds that the strong interest confirms the value of such events: “The benefits of our Plug Fests are increasingly recognized by participants from Europe and indeed worldwide. The fact that the event in Tettnang was fully booked in a very short time was once again impressive proof of this.”

Manuel Gärtner, developer at wenglor sensoric, who helped organize the Plug Fest in Tettnang, was also very satisfied: “EtherCAT is increasingly important. This makes an event such as the Plug Fest a critical part of our strategy regarding EtherCAT technology.” This statement was confirmed by the active participation in the Plug Fest: The attending manufacturers had brought along more than 40 EtherCAT devices. A particularly significant factor was the high number of masters among the devices. Ten such implementations were tested for interoperability. As usual, the EtherCAT Conformance Test Tool was in action, which can be used to thoroughly test EtherCAT products during the development stage and make them ready for introduction in the market.

EtherCAT Plug Fests are regularly held in Europe, Asia and North America. Event details can be found on the EtherCAT Technology Group website at www.ethercat.org.

EtherCAT Technology Group welcomes its 100th Korean member

With the declaration of EtherCAT as a national standard for Korea in 2012, the course was set for the further development of EtherCAT. Key Yoo, manager of the EtherCAT Technology Group (ETG) office in Korea and a driving force in the standardization process, realized this at the time: “The fact that EtherCAT is now a national standard makes it even easier for Korean manufacturers and users to utilize the technology.”

Just over a year later, the ETG has now welcomed its 100th Korean member. Martin Rostan, Executive Director of the ETG, is pleased about this result, not least in view of the significance of the Korean market for EtherCAT: “Clearly, Korea is home to companies of high economic significance. For example, the world’s four largest shipyards are based here – and all four are ETG members.” The three largest Korean companies, generating almost a third of the Korean gross domestic product, are also members of the ETG, which is further proof of the key role EtherCAT is already playing in the Korean market.
Within the framework of the Beckhoff Technology Days around 320 international customers visited the booth in Hanover and the company's headquarters in Verl, Germany.

The main booth in Hall 9:
New Automation Technology on over 1000 m².

The new, compact Panel PC series: CP26xx with ARM Cortex™-A8 processor with integrated display sizes from 7 to 24 inch.

The trade show highlight: CP-Link 4 – the new connection technology for operating panels separated from the Industrial PC by up to 100 m.

TwinCAT enables the optimum interaction and synchronisation between pick-and-place applications and the eXtended Transport System on a single PC.
Beckhoff: 10 x the representation at Hannover Messe 2013

With about 225,000 visitors, Hannover Messe 2013 reached the high level of the last "big" Hannover Messe in 2011. All in all, the trade show was a resounding success for Beckhoff. With three trade show booths of its own and seven further appearances in partner booths, it was possible to increase the number of visitor contacts compared to the previous year. In particular, the number of international guests increased. The subject of Industry 4.0 was present everywhere at Hannover Messe as the guiding theme of "Integrated Industry."

Beckhoff also exhibited the extended Transport System (XTS) at the booth of the German Federal Ministry of Education and Research (BMBF) in Hall 2 as well as at the booth of the Leading-Edge Cluster, "it's OWL" in Hall 16.

Beckhoff Trade Show TV at Hannover Messe 2013: www.beckhoff.com/hmi
Ligna 2013, which took place between 8th and 12th May in Hanover, Germany, impressively confirmed its position as the leading international trade fair for the timber and woodworking industries. Under the lead theme of "Making more out of wood", 1637 suppliers from 47 countries presented innovative solutions for improving efficiency and therefore competitiveness in the wood industry. Exhibitors and organizer alike expressed full satisfaction with the 20th Ligna show and praised the high quality and increasing internationality of the event: 40 percent of the 90,000 visitors came from 100 different countries around the world.

At a 170 m² booth, Beckhoff presented its whole range of solutions for resource and cost-efficient woodworking. Stefan Sieber, Business Management Woodworking at Beckhoff, was very content with this year's show: "Compared with Ligna 2011, the number of contacts has increased, and more than half of them were visitors from abroad. We can only underline the positive assessment of the organizers. There is another point we can confirm: In Hanover we had a number of concrete discussions relating to several automation projects in the furniture industry. Here, each plant is different, and machine manufacturers value us as technology partners, because they know that due to our long-standing experience, we offer optimum support for the design of tailor-made solutions for a wide range of end customers. There was also demand for our scalable drive technology including self-produced motors, especially in conjunction with the integrated TwinSAFE safety solution. On the whole, however, we find that our customers are mostly interested in the overall package of control technology and the comprehensive industry expertise of our engineering specialists."

Further Information:

www.beckhoff.com/ligna
Beckhoff at Prolight + Sound 2013

Prolight + Sound, the leading international trade fair for the entertainment and event technology industry took place from April 10 to 13, 2013 in Frankfurt am Main, Germany, and once again offered a comprehensive overview of products and services for theater, studio, show and stage technology as well as system integration. The music trade fair that took place in parallel rounded off the event and contributed to the success of the Prolight + Sound: this included 113,000 visitors from 142 countries and 2,285 exhibitors from 54 countries. With PC- and EtherCAT-based control, Beckhoff presented the universal platform to control a wide range of systems in stage and show technology. The Beckhoff appearance at Prolight + Sound 2013 was centered on the presentation of the new communication solutions SMPTE Timecode and Streaming ACN as well as the multi-touch panel series and the EK1960 compact safety controller.

Michel Matuschke, Vertical Market Manager Stage and Show Technology at Beckhoff, sums it up: “The industry is in good economic shape and we are seeing a growing market. Our expectations for this trade show were fulfilled in every respect.”

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

ISH 2013: Optimizing energy efficiency with integrated building automation

ISH 2013, the world’s leading trade fair for building, energy and air conditioning technology, ended on March 16 after five days in Frankfurt, Germany, with its most successful results ever, despite a late onset of winter weather: around 190,000 visitors – of whom about one third came from foreign countries – gathered information from 2,434 exhibitors on trend-setting solutions for building services. The 27th ISH was very much focused on the efficient handling of energy and water resources.

George Schemmann, Business Management, Building Automation, commented on how the trade show went: “Considering it was the first time we have participated at the ISH, the Beckhoff presence was a complete success. Not only the quantity, but also the quality of the contacts confirmed our belief that the universality of PC-based control technology provides the decisive advantage for the ideal interaction of all systems. Beckhoff building automation offers a solid basis for the needs-based regulation of all building services and for the optimization of energy efficiency.”

Further Information:
www.beckhoff.com/ish

Sensor + Test 2013: PC Control – The high-precision platform for high-precision testing and measurement technology

Sensor + Test 2013 in Nuremberg, Germany, serves as a meeting place for manufacturers and users of sensors as well as testing and measurement technology. From 14 to 16 May 2013, nearly 8,000 visitors from Germany and abroad took an interest in the trade-show appearances of the 543 exhibitors. Organizers and exhibitors unanimously judged the success of the leading measurement technology trade show as good and spoke of a positive investment climate.

Michael Jost, Product Manager Fieldbus Systems and EtherCAT at Beckhoff, was pleased with the optimistic mood at this year’s Sensor + Test: “Although we have only been participating in this trade show for four years, the number of contacts has once again increased significantly and half of the discussions were about concrete enquiries. EtherCAT is an industry standard and the demand for our precise terminal-based measuring technology was very high, particularly in the analog technology segment. Many enquiries were directed towards Condition Monitoring, but power monitoring was also a topic. We will be extending our I/O system by further measuring terminals, because the need is obvious.”

Michael Jost goes on to analyze: “One of the reasons for our increasing success in this high-tech market is the high performance of the IPCs, because they offer sufficient capacity to support processor-intensive signal analysis procedures and the integration of the most diverse algorithms. Moreover, this type of user feels comfortable within the engineering environment of TwinCAT 3 and appreciates new features such as the convenient integration of Matlab®/Simulink® which is widely used in this industry.”

Further Information:
www.beckhoff.com/sensor-test
Trade shows and events 2013

**Europe**

**Germany**

EMO
September 16–21, 2013
Hanover
Hall 25, Booth F33
[www.emo-hannover.de](http://www.emo-hannover.de)

FachPack
September 24–26, 2013
Nuremberg
Hall 4A, Booth 417
[www.fachpack.de](http://www.fachpack.de)

Motek
October 07–10, 2013
Stuttgart
[www.motek-messe.de](http://www.motek-messe.de)

K
October 16–23, 2013
Düsseldorf
Hall 11, Booth G21
[www.k-online.de](http://www.k-online.de)

EWEA Offshore
November 19–21, 2013
Frankfurt
Hall 3.0, Booth F70
[www.ewea.org/events/ewea-offshore](http://www.ewea.org/events/ewea-offshore)

**SPS IPC Drives**
November 26–28, 2013
Nuremberg
Hall 7, Booth 406
[www.mesago.de/sp](http://www.mesago.de/sp)

**Austria**

Smart Automation
October 01–03, 2013
Linz
Booth 235
[www.smart-automation.at](http://www.smart-automation.at)

**Denmark**

hi[13]
September 03–06, 2013
Herning
Hall E, Booth 4120
[www.hi13.dk](http://www.hi13.dk)

**Finland**

Automaatio
October 01–03, 2013
Helsinki
Hall 6, Booth 6899
[www.automaatiomessut.fi](http://www.automaatiomessut.fi)

**France**

Interclima + Elec
November 04–08, 2013
Paris
[www.interclimaelec.com](http://www.interclimaelec.com)

**Switzerland**

Ineltec
September 10–13, 2013
Basel
Hall 1.1, Booth C135
[www.ineltec.ch](http://www.ineltec.ch)

**Turkey**

Eurasia Packaging Istanbul
September 12–15, 2013
Istanbul
Hall 10, Booth 1013
[www.packagingfair.com](http://www.packagingfair.com)

Plast Eurasia Istanbul
December 05–08, 2013
Istanbul
Hall 10, Booth 517B

**Asia**

**China**

Propak China
July 17–19, 2013
Shanghai
[www.propakchina.com](http://www.propakchina.com)

Miconex
August 27–30, 2013
Beijing

China Wind Power
October 16–18, 2013
Beijing
[www.chinawind.org.cn](http://www.chinawind.org.cn)

Industrial Automation Show China
November 05–09, 2013
Shanghai
[www.industrial-automation-show.com](http://www.industrial-automation-show.com)

Marintec
December 03–06, 2013
Shanghai
[www.marintecchina.com](http://www.marintecchina.com)
India
Engimach
November 27–December 01, 2013
Ahmedabad
Hall 1, Booth P3
www.engimach.com

Plastivision
December 12–16, 2013
Mumbai
Hall 2, Booth 15
www.plastivision.org/pvi2013

Industrial Automation India
December 17–20, 2013
New Delhi
www.ia-india.com

South Korea
Kormarine
October 22–25, 2013
Busan
Hall 4, Booth N10
www.kormarine.net

South Africa
KZN Industrial Technology Exhibition
July 23–26, 2013
Durban
Hall 2, Booth 822
www.kznindustrial.co.za

North America
USA
CPP EXPO
September 08–12, 2013
Chicago
Hall North, Booth 6915
www.cppexpo.com

Pack Expo
September 23–25, 2013
Las Vegas
Hall South, Booth 5633
www.packexpo.com

ATX Texas
October 15–16, 2013
Houston
Booth 630
www.atxtexas.com

Process Expo
November 03–06, 2013
Chicago
Hall North, Booth 2225
www.myprocessexpo.com

Fabtech
November 18–21, 2013
Chicago
Hall South, Booth 3414
www.fabtechexpo.com

Canada
CMTS
September 30–October 03, 2013
Mississauga
Hall 4, Booth 7408
www.cmts.ca

Japan
Techno-Frontier
July 17–19, 2013
Tokyo
www.jma.or.jp

System Control Fair
November 06–08, 2013
Tokyo
www.scf.jp

Africa

Canada

South Korea

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