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PCcontrol

The New Automation Technology Magazine

www.beckhoff.com/pc-control

38 | worldwide

Increased production efficiency for chassis-by-wire technology

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22 | interview

Decades of experience incorporated into the new generation of PLC technology

PLC++

TwinCAT

52 | worldwide

Keeping the limits of space and time in view using large telescopes

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Beckhoff at Hannover Messe 2025

From May 31 to April 04, 2025, Hannover Messe will open its doors with all its international charisma. As a technology leader and PC-based control pioneer, Beckhoff will again be present this year with numerous new products and innovations – to see in Hall 9, Booth F06, including in spontaneously bookable highlight tours "Beckhoff in a nutshell" – that will help to further increase the flexibility and productivity of machines and processes. The event will also be covered by the popular Beckhoff Live + Interactive livestream, which will be broadcast daily from 10:00 a.m. right from our booth.

More information, tickets, live TV:
www.beckhoff.com/hannover-messe

The decentralized MX-System is the first to achieve completely control cabinet-free automation of machines and systems with PC-based control.

As the new generation of PLC technology, TwinCAT PLC++ offers a real leap in automation technology performance. Both engineering and runtime can be accelerated.

The AX1000 economy servo drive sets new standards in the cost-sensitive servo applications, while the AF1000 economy variable frequency drive opens up a new market segment for Beckhoff.

Intelligent product transport from Beckhoff can be used even more cost-effectice with the new XTS EcoLine motor module, which can also be used in combination with the previous versions.

Hans Beckhoff is now a member
of the German Hall of Fame for Family Businesses

A billion-dollar company powered by a pioneering spirit and technological innovation

Since he founded Beckhoff Automation in 1980, Hans Beckhoff (71), Managing Director, has consistently focused on innovation in the automation of machines, buildings, and energy supply, among other elements. On January 29, 2025, he was honored for his entrepreneurial achievements by Handelsblatt (a German business newspaper), KPMG, and the Stiftung Familienunternehmen (the Foundation for Family Business) and inducted into the Hall of Fame for Family Businesses.

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An influential entrepreneur with numerous inventions that have revolutionized the automation market, Hans Beckhoff (shown here with Kay-Sölve Richter, journalist and TV presenter) was inducted into the Hall of Fame for Family Businesses on January 29, 2025.

At the ceremony in Munich, Hans Beckhoff was honored in front of more than 170 family entrepreneurs. He has kept the rate of innovations at his technology company high for 45 years, which is not easy to do. He is driving the digital transformation, rather than being driven by it. Nor has he lost sight of the global challenges of our time, such as climate change. Hans Beckhoff has seen that advanced automation technology is hugely significant here; it lays the foundations for improving sustainability, along with energy and resource efficiency, in line with Beckhoff's motto: "Engineers must save the world!".

The company's claim to be a technology leader is consistently reflected in its technical innovations, which have even proved revolutionary – many have become global market standards in automation. A prime example of this is the fundamental Beckhoff philosophy of PC-based control technology, which harnesses the enormous developmental power of the IT world for industrial applications. Automation and IT converge in PC-based control, which Beckhoff launched on the market back in 1986 and is now indispensable in a wide range of industries, such as the packaging, semiconductor, and automotive industries, and is specifically implemented for high-performance applications. Another milestone is the bus terminal, fieldbus technology in terminal block format, which was introduced in 1995. This basic building block of automation made it possible to implement powerful compact, modular, and finely granular control solutions tailored to individual requirements. In 2003, Beckhoff launched the ultra-fast EtherCAT communication system, which has developed into a pivotal world standard for high-performance automation. Today, over 8,000 companies from around the globe belong to the EtherCAT

Technology Group and support this fascinating technology. Though Beckhoff is renowned for its innovations and revolutions, its system concept remains ingrained. Control tasks are solved end-to-end with Beckhoff technology today: from the modular TwinCAT control software including artificial intelligence functions, powerful industrial PCs, and EtherCAT, to modular I/O components, flexible drive technology, and intelligent product transport, through to machine vision and control cabinet-free automation.

Hans Beckhoff has also passed on his enthusiasm for automation and innovation on to the next generation: his children, Frederike and Johannes Beckhoff, have held leading positions in the company for several years. 45 years after its foundation, Beckhoff Automation thus remains a family business and will continue to be so into the future.

More information:
www.beckhoff.com
www.handelsblatt.com/hall-of-fame
(website only in German)

Dr. Wilfried Plaß active from the start in 'Motion rules for cam mechanisms and motion control systems'

Beckhoff expertise helps shape new VDI guideline

Development of VDI Guideline 2143 Part 1 – 'Motion rules for cam mechanisms and motion control systems – Theoretical principles' – began in March 2017. Dr. Wilfried Plaß from Beckhoff Automation's software development department was among the experts involved from day one. When the guideline was finally published as a white paper in November 2024, the Association of German Engineers (VDI) acknowledged his invaluable voluntary contributions.

Screenshot of the TwinCAT 3 Cam Design Tool

VDI guidelines define recognized technical standards, providing a reliable framework for implementing automation solutions. The development of VDI 2143 Part 1 was prompted by two factors: the impending expiration of the original guideline and the growing importance of electronic cam plates, which differ in some respects from their mechanical counterparts. The new guideline is therefore a completely revised edition of the well-established VDI Guideline 2143, which has been a trusted resource for over 40 years. To ensure the guideline reflected the latest technological standards, the committee made a conscious decision to broaden the scope of cam mechanism motion design to cover motion control systems. The central content of the new guideline is the section-by-section definition of cam plates, as implemented in the TwinCAT 3 Cam Design Tool (TE1510). This allowed for the incorporation of extensive Beckhoff motion control expertise, along with Dr. Wilfried Plaß's considerable experience in motion design, motion control systems, and particularly cubic splines.

The TwinCAT 3 Cam Design Tool and TwinCAT 3 NC Camming (TF5050) comply with both the original and new versions of VDI 2143. Both tools also offer additional capabilities, including the Peisekah profiles and the seventh-order polynomials that account for jerk values at start and end points to prevent vibration excitation; however, a guideline can only address part of the problem. TwinCAT goes beyond the standard with its ability to generate cam plates directly from the PLC while receiving key parameters from the NC. It also enables online modification of cam plates during engagement, which is another functionality not covered by the guideline.
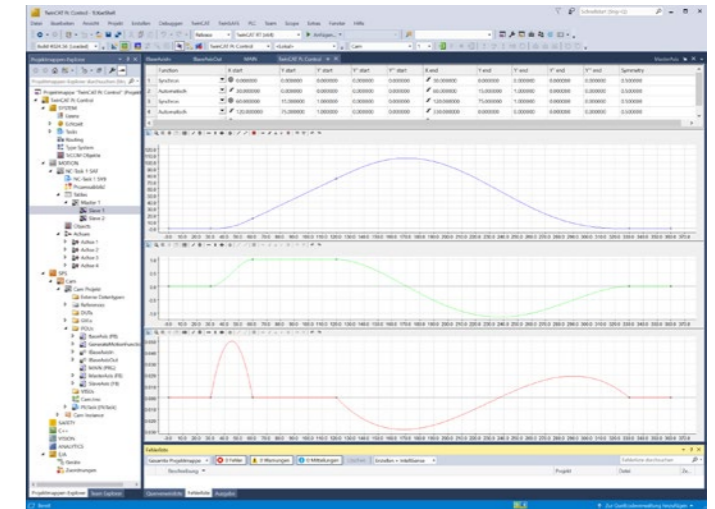
The TwinCAT 3 Cam Design Tool offers comprehensive support for designing electronic cam plates. Using VDI Guideline 2143 as a reference, users can interactively develop or modify cam plates through a graphical interface. The cam plates are composed of sections based on motion laws, such as modified sine waves, harmonic combinations, or several polynomial functions. TwinCAT 3 NC Camming is used to map a non-linear relationship between a master and a slave axis. The camming package offers various options for storing cam plates.
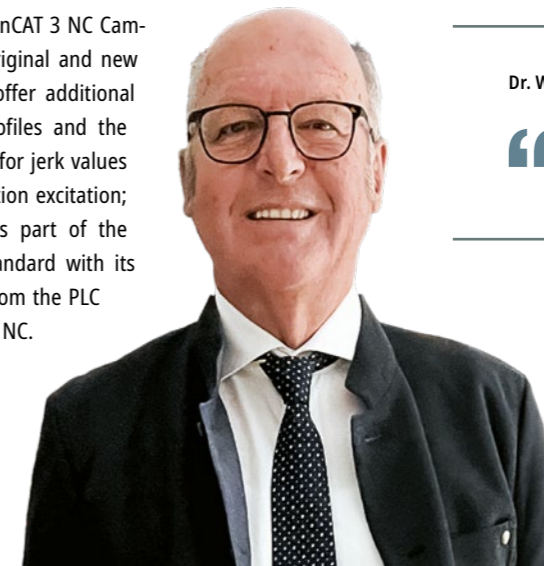

Dr. Wilfried Plaß, Software Development at Beckhoff:

" The collaboration within the committee was extremely constructive."

More information:
www.beckhoff.com/te1510
www.beckhoff.com/tf5050

Beckhoff Automation supports newly founded furniture industry training factory

Advanced Beckhoff laboratory workstation in the furniture industry training factory – and digital model of the Beckhoff demonstrator – to help apprentices learn about sequence and motion control, energy monitoring, and horizontal and vertical networking of control systems

control technology. These components are also used in the machines on the production line in the training factory. This gives apprentices the opportunity to transfer the knowledge acquired in the laboratory environment to a real production environment. The production line in the training factory realistically reproduces all the key steps in furniture production – from incoming goods and cutting the individual parts to edge processing and assembly and right through to quality control, packaging, and shipping of the finished furniture or furniture parts. The great advantage of the training factory is its practical orientation, which allows the apprentices to familiarize themselves quickly and easily with their company's production processes.

Alongside the advanced PC-based control technology, a demonstrator for conveying and sorting forms the core of the laboratory workstation. It is equipped with, among other things, an electric motor, an electric cylinder, and a pneumatic cylinder. In addition to the equipment at the laboratory workstations, various learning situations are provided for the apprentices to work on – from basic commissioning of the control systems and activation of electric motors or pneumatic cylinders to integrating several control systems in order to create a smart factory. Either OPC UA or MQTT are used as communication protocols for networking. In addition to the real-life demonstrator, a digital model is also available. This makes it possible to prepare and test control programs independently of the actual hardware and then transfer them to the real hardware used. The control programs are initially programmed using function block language (FBD), followed by programming in Structured Text (ST).

More information:
www.lehrfabrikmoebel.de
www.bang-netzwerke.de

November 5, 2024 marked the official opening of a new BANG® network (BANG® = "Berufliches Ausbildungs-netzwerk im Gewerbebereich" – a vocational training network in the commercial sector) in the form of the furniture industry training factory in Löhne in the Ostwestfalen-Lippe region of Germany. This advanced training center sets new standards in vocational training and provides sustainable support for the furniture industry by offering highly advanced training facilities and enabling apprentices to learn about the latest technologies and processes.

Beckhoff sees the furniture industry training factory as a valuable addition to the existing training opportunities in the region and is looking forward to the new possibilities it will open up – for example, practice-based teaching of programming skills. Beckhoff is supporting this initiative and is also stepping up its cooperation with the BANG® networks in order to promote practice-oriented training for the next generation of automation technology specialists on a sustained basis.

Within this cooperation framework, Beckhoff provides the BANG® networks with extensive training material, ranging from demo and teaching material to product samples. "Our automation products are used by many companies in the region. If young people get to know these technologies during their training, they will be ideally prepared for their future career," explains Sebastian Strughold, Project Management R&D Cooperations at Beckhoff Automation.

Training factory for the furniture industry
The furniture industry is an important industry in the Ostwestfalen-Lippe region and is also of particular importance to Beckhoff. Since the company was founded in 1980, Beckhoff has become an important automation technology manufacturer for woodworking machines in the furniture industry. Supporting the

professional development of skilled workers in this industry is therefore a priority for the company – especially when it comes to training on and with Beckhoff technologies.

Dr. Ursula Frank, Project Manager R&D Cooperations at Beckhoff Automation, explains: "For Beckhoff, the promotion of young talent is an integral part of our company philosophy. A good education opens up opportunities and possibilities for young people to shape their own future. It is a key to the personal success of each individual – and, viewed holistically, to a society worth living in. For us it is important that young people receive practical training. They are therefore involved in projects from the very beginning so they can put their theoretical knowledge into practice."

Control technology in laboratory and production environments
In the laboratories of the training factory, apprentices are taught how to control electric motors and pneumatic cylinders using equipment provided by Beckhoff based on PC-based

Dr. Ursula Frank,
Project Manager
R&D Cooperations
at Beckhoff Automation

Sebastian Strughold,
Project Management
R&D Cooperations
at Beckhoff Automation

Furniture industry training factory in Löhne on its opening day in November 2024

New economy drive system designed
for cost-sensitive applications

High functionality with cost efficiency and reduced complexity

The new AX1000 servo drives (left) and AF1000 variable frequency drives (right), both fully integrated into the TwinCAT system, are particularly suitable for cost-sensitive applications and can be used together in seamless side-by-side installations.

Beckhoff has developed two new drive series on a shared platform, incorporating a host of innovative ideas: the AX1000 economy servo drives and the AF1000 economy variable frequency drive. These new additions complement the existing portfolio perfectly, particularly by expanding coverage for cost-sensitive applications. To that end, the development focused heavily on ensuring high cost efficiency and minimizing complexity.

Before the start of development, intensive discussions were held with customers to define their needs and the most important product features of a new drive. These insights provided a solid foundation for clear design specifications. The aim of this new device generation was to deliver core servo functionality without adding features for niche applications. This strategy made it possible to create extremely cost-effective, streamlined devices with fewer components, resulting in significantly faster assembly times and more efficient production processes. Additional benefits for users include the excellent serviceability and fast, simple, and intuitive commissioning.

Development of the AX1000 series included both single-phase, compact devices and three-phase servo drives running in parallel. Building on this foundation, Beckhoff quickly launched another device series in the form of the AF1000 variable frequency drives. The AX1000 platform is also ideally suited for the development of a series of variable frequency drives – a new product range for Beckhoff targeting a market segment under even greater price pressure. As with previous Beckhoff series, the AX1000 servo drives are available in both single-axis and dual-axis versions, which is by no means standard for variable frequency drives. Beckhoff always incorporates new and innovative features

when developing a product. In this case, a dual-axis version of the variable frequency drives was introduced. To our knowledge, this is a worldwide first and enables a significantly higher maximum packing density in the control cabinet. The dual-axis device also delivers substantial cost savings by allowing key components to be used for two variable frequency drives.

AX1000: optimized, efficient servo drive for low power requirements
The AX1000 servo drive is available with a rated current range of 1.65 to 6.9 A and is fully integrated into TwinCAT. It is available in two different connection versions: for lower power ratings up to 2.2 kW with single-phase 1 x 230 V AC

input, and for higher power ratings from 1.1 kW to 4.5 kW with three-phase 3 x 400 V AC input. Despite its compact dimensions, it features an integrated power supply, DC link capacitors, and a ballast circuit.

The cost-optimized plastic housing of the AX1000 is immediately noticeable. Its intelligent PCB design eliminates the need for a stainless steel housing to reduce electromagnetic emissions. Despite being designed for maximum efficiency and compactness, the devices can be mounted side by side in the control cabinet without spacing. With the exception of optional safety inputs, all connections are accessible from the front, which not only makes wiring the devices easier but also improves control cabinet organization.

The AX1000 eliminates the need for an external 24 V DC power supply, as the drive generates the control voltage for I/Os and the holding brake supply directly from the DC link. This saves considerable space and provides the added benefit of the 24 V DC generation continuously lowering the DC link voltage, providing a greater energy reserve for dynamic braking operations. The AX1000 is also equipped with a very high-capacity design to efficiently store as much energy as possible for braking processes without having to activate the internal braking resistor. This reduces additional heat generation in the control cabinet. For applications with extremely high kinetic energy, an external braking resistor can be connected to each device.

The ultra-compact design of the AX1000 and seamless side-by-side mounting of multiple devices ensure minimal space requirements.

expansion of an AX1000 system with the AF1000, particularly when certain axes in an application do not require servo control. As a result, users can benefit from significant cost savings.

The AF1000 uses an unshielded motor cable and supports the connection of motor temperature sensors such as PT1000, KTY, or LPTC600, with evaluation performed directly within the device. Although holding brakes are rarely used with asynchronous motors, some motors equipped with brakes may require higher voltages. As a result, the device does not include a direct holding brake connection. If required, a digital output is available for controlling an external relay.

The AF1000 supports asynchronous motors, reluctance motors, and servomotors with sensorless operation – i.e., without position encoders – via U/f characteristic curve or vector control. This variant can be used to create a cost-effective drive system for simple applications such as belt drives, pumps, and fans. For dual-axis devices, two different motor modules can be selected independently for each axis.

The AF1000 is available with optional TwinSAFE STO/SS1 safety functions, with or without I/Os. Parameterization is carried out via FSoE, as with the servo drives, and activation is possible via either FSoE or the optional safety I/Os. The I/Os provided with the safety option feature the same clocked implementation as that described for the AX1000.

The AF1000 is seamlessly integrated into the TwinCAT system via EtherCAT, providing full convenience for design, commissioning, operation, and diagnostics. Just like the other Beckhoff servo drives, the AF1000 variable frequency drive is also commissioned using TwinCAT 3 Drive Manager 2, meaning users do not need to familiarize themselves with a separate dedicated tool.

Compliance with EMC directives requires an external mains filter, which, together with the device's integrated interference suppression, ensures that EMC limits are not exceeded. A key advantage is that a single filter can be used for collective interference suppression of multiple devices, and suitable filters are available for different current ratings. With their very low leakage current, the devices are easier to use with residual current circuit breakers. The AX1000 servo drives also support Beckhoff's established One Cable Technology (OCT). Partially shielded motor cables for the AX1000 further reduce sheath diameters and bending radii while lowering costs for components such as drag chains, cable channels, and fixings.

The AX1000 supports various motor types, including AM8000 synchronous servomotors with OCT, asynchronous motors, and reluctance motors, each with or without feedback. In applications where maximum dynamics are not

The economy drive amplifiers AX1000 and AF1000: two new drive series based on a shared platform, incorporating a host of innovative ideas

required, reluctance motors offer an efficient and cost-effective solution. Setting up the AX1000 to operate these motors requires minimal effort. For dual-axis devices, two different motor types can be selected independently for each axis.

The AX1000 is equipped with the TwinSAFE STO/SS1 function as standard. Parameterization is carried out via FSoE, with activation possible via either FSoE or the optional safety I/Os. A key advantage is the clocked implementation of the safety I/Os, which eliminates the need to exclude wiring faults, allowing for direct connection of an emergency stop switch. Additional safety functions are available with the TwinSAFE Safe Motion option.

The AX1000 is integrated into the TwinCAT system via EtherCAT, providing full convenience for commissioning, operation, and diagnostics. All tools available for the larger AX5000 and AX8000 drives, such as TwinCAT 3 Drive

Manager 2, TwinCAT 3 Autotuning, TwinCAT 3 Bode Plot, and TwinCAT 3 Cogging Compensation, can also be used with the AX1000 servo drive. Integration into the Motion Designer makes it easier to tailor the drive axes to suit individual requirements.

AF1000: universal variable frequency drive for low power requirements

Like the AX1000 servo drive, the AF1000 variable frequency drive is fully integrated into TwinCAT and is available in two different connection versions: for lower power ratings up to 2.2 kW with single-phase 1 x 230 V AC, and for higher power ratings from 1.1 kW to 4.5 kW with three-phase 3 x 400 V AC. The power ratings within the series are based on the general standard range for asynchronous motors. The dual-axis version of the AF1000 makes the device even more compact and cost-effective, as essential components such as the EtherCAT interface, microcontroller, power supply, and housing are used for both axes.

The AF1000 shares many properties with the AX1000, which was developed based on the same platform. These include the plastic housing, high DC link capacitance, internal 24 V control voltage supply, and the connection via external interference suppression filters. The AF1000 is the ideal complement to the servo drive, as it also shares the same dimensions. This allows for easy

Andreas Golf (left) and Dirk Hansen (right),
both Senior Product Manager Drive Technology, Beckhoff Automation

More information:
www.beckhoff.com/ax1000
www.beckhoff.com/af1000

Linux®-based real-time control – now also available as a virtual PLC

Working on the basis of TwinCAT for Linux®, Beckhoff is opening up more application possibilities that enable resource-efficient, virtualized distribution of TwinCAT applications. Both the TwinCAT PLC runtime and TwinCAT functions in the form of containers can be operated not only locally on the controller, but also in a data center. Communication with decentralized I/Os can take place via the EK1000 EtherCAT Coupler in this case.

Thanks to the modular structure of TwinCAT, the individual TwinCAT applications can also be distributed across several containers. ADS-over-MQTT technology, which has been established on the market for many years and is familiar to users, is available for cross-network communication and can also be used for integrating a virtualized engineering system.

This implementation of a virtual PLC means that the application options can be extended to the local data center as well, allowing certain control or simulation and test tasks to be outsourced from the machine or its control PC. This operating mode holds particular appeal for applications with lower real-time requirements. The advantages of virtual control technology with TwinCAT and Beckhoff hardware:

– increased flexibility: virtual control systems can be easily scaled and adapted to different requirements
– lower costs: there is less need for physical hardware in the field, reducing the associated costs
– simplified maintenance: maintenance and software upgrades are easier to carry out as no physical hardware is affected

More information:
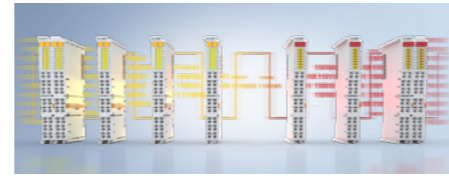www.beckhoff.com/linux
www.beckhoff.com/virtualplc

CX7000: Devices for BACnet/IP and PROFINET RT Device
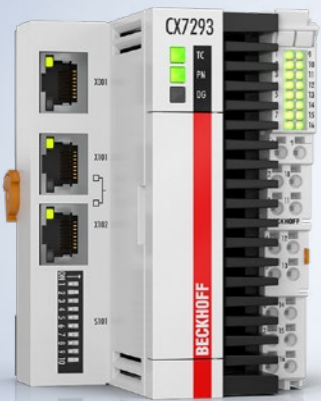
Two devices featuring the Arm® Cortex®-A9 processor (720 MHz) have been added to the CX7000 series from Beckhoff. The basic equipment includes a slot for a microSD card, an Ethernet interface as well as eight integrated multifunctional inputs and four integrated multifunctional outputs.

The CX7291 Embedded PC is suitable for BACnet/IP and is therefore ideal for applications in the fields of HVAC, lighting controllers, and security and fire alarm technology. The CX7293 Embedded PC, on the other hand, has a PROFINET RT Device interface. E-bus or K-bus terminals can be attached to both devices as required; the embedded PC automatically recognizes which system is connected during the start-up phase. The controller is programmed with TwinCAT 3 via the Ethernet interface. The devices in the CX72xx series have a higher CPU performance compared to the basic CX7000 series and integrate a capacitive 1-second UPS.

The CX7000 Embedded PCs open up the TwinCAT 3 world to small controllers too, providing a high level of computing power for the small controller sector. The extremely compact design – with dimensions of just 71 mm x 100 mm x 73 mm for the new devices – offers optimum scalability of PC-based control for typical small controller applications with a minimal footprint.

More information:
www.beckhoff.com/cx7291
www.beckhoff.com/cx7293

New EtherCAT digital input and output terminals

The new EL14xx and EL24xx EtherCAT Terminals complement Beckhoff's existing broad portfolio in the area of digital input/output and combine proven functions with an optimized circuit architecture.

Implementation of advanced components ensures future-proofing and guarantees long-term availability. These product families – now with up to 32 channels – offer maximum flexibility for standard applications with basic functionality. The following I/Os are initially available in the EL14xx and EL24xx EtherCAT Terminal series:

16-channel digital input, 24 V DC, 3 ms input filter:
EL1409: positive switching,
EL1489: ground switching,
EL1429: positive/ground switching
16-channel digital output, 24 V DC, 0.5 A:
EL2409: positive switching,
EL2489: ground switching
32-channel digital input, 24 V DC:
EL1417: adjustable, positive switching
32-channel digital output, 24 V DC, 0.5 A:
EL2407: positive switching

More information:
www.beckhoff.com/el1xxx
www.beckhoff.com/el2xxx

XTS EcoLine motor module: Proven benefits, full compatibility, lower costs

The new XTS EcoLine motor module allows for even more cost-effective use of intelligent product transport systems from Beckhoff. It offers 95% of the technical properties of the well-known motor modules at just 55% of the cost for the same distance. The motor module is also designed to be seamlessly compatible, allowing it to be used together with previous versions if required.

Right from the outset, the XTS EcoLine motor module stands out due to its length: at 500 mm, it is twice as long as the standard straight modules, yet still fits within the same grid dimensions. The familiar reliability and robustness of XTS are guaranteed, as are the specifications for travel speed (up to 4 m/s) and acceleration (up to 10 g).

The XTS EcoLine module type differs slightly with regard to the following technical properties:
– 0.70 mm absolute accuracy and 0.075 mm repeatability
– 70 mm minimum product distance
– up to 30 N nominal force initially and up to 80 N peak force per mover

The XTS EcoLine motor module is fully compatible with standard motor modules, making it highly versatile for a variety of applications:
– for processes that do not require extremely low values in terms of accuracy or product distance
– in combination with high-precision motor modules (e.g. for creating dedicated transport routes without process stations)

More information:
www.beckhoff.com/xts-ecoline
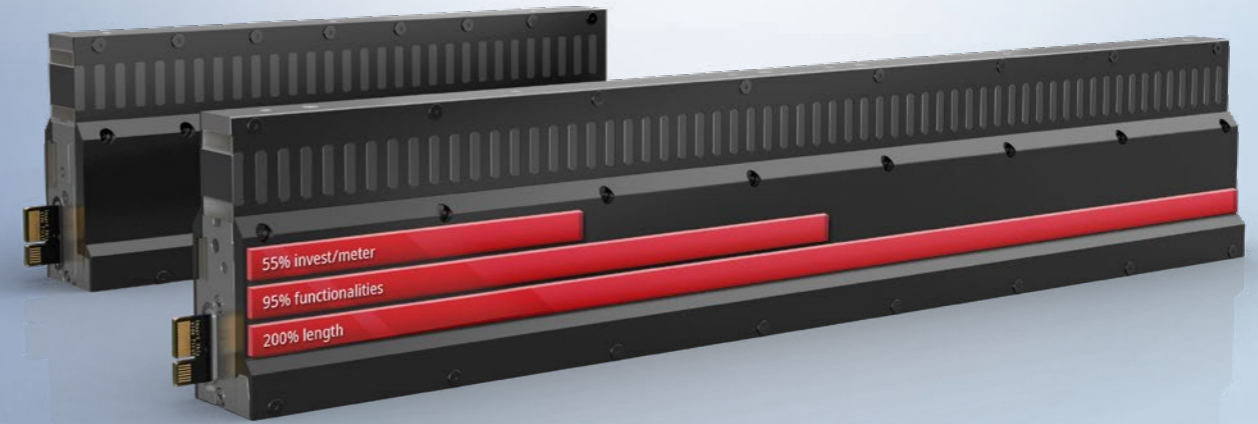
IP67 I/Os with simple identification and addressing via ID switch

Beckhoff brings out new EtherCAT and EtherCAT P Box modules with additional hexadecimal addressing rotary selector switches. This means that these IP67 I/Os can be clearly identified regardless of their installation position.

In modular systems, individual devices must be uniquely addressed within an EtherCAT network with its variable topology. Products with rotary selector switches enable quick and easy assignment of the corresponding addresses. The new EtherCAT Box and EtherCAT P Box modules feature three additional hexadecimal rotary addressing switches. An individual address from 0 to 4,095 can thus be set and a unique, position-independent identification can be given; this is required for some device profiles for certain industries, e.g. in the semiconductor industry.

Three I/O Box modules are initially planned. Each one is available as a version for EtherCAT (EP) and for the EtherCAT P one cable solution (EPP):
– EP/EPP1816-0703: 16-channel digital input, 24 V DC, 10 µs, IP20 connector
– EP/EPP2339-0703: 16-channel digital combi, 24 V DC, 3 ms, 0.5 A, IP20 connector
– EP/EPP3754-0702: 4-channel analog input, multi-functional, M12

More information:
www.beckhoff.com/ep-id-switch
www.beckhoff.com/epp-id-switch

AMP8000: Extended voltage range and additional braking option

More information:
www.beckhoff.com/amp8000
www.beckhoff.com/amp8620
www.beckhoff.com/amp8805

The AMP8620 supply module and the AMP8805 distribution module are now also available with an extended voltage range for the AMP8000 distributed servo drive system from Beckhoff. There is also an additional option for controlling the holding brake for the AMP80xx distributed servo drive.

The AMP8620-2005-0x10 supply module is suitable for single-phase or three-phase voltage connection at 1 x 120...240 V AC and up to 8 A DC link output current or at 3 x 200...480 V AC and a maximum of 20 A DC link output current. The AMP8805-1010-0000 distribution module, which matches all AMP8620 supply modules, now offers an input voltage range of 155 to 848 V DC. The AMP80xx-xxx2 distributed servo drive is equipped with a holding brake and an M8 connection for manual control. This allows the holding brake to be controlled during mechanical installation or for service purposes if this cannot be performed by the main controller.

TwinCAT 3 Motion Designer: Version update with new functions and device options

The TwinCAT 3 Motion Designer is a powerful tool for optimally designing Beckhoff Drive Technology to fit individual requirements. Even more functions and device options are now available in the latest update.

The design of the drive, particularly the dimensioning of drive axes, in conjunction with optimal selection of the motor, gear unit, drive controllers, and accessories, is the foundation for efficient machine design. The TwinCAT 3 Motion Designer tool has been created for this purpose and can be integrated in the TwinCAT automation platform or used as a stand-alone project engineering tool for drive design. The following new functions can be used with the update:
– file import for linear and rotary motors including motor inertia compensation
– triangular load case for linear applications
– implementation of variables for quick and easy parameter changes
Other Beckhoff products are also integrated in the TwinCAT 3 Motion Designer. In terms of the AMP8000 distributed servo drive system, these include the AMP8620 supply module and the

AMP8805 distribution module with their extended voltage ranges. The AX8128 single-axis module and the AX8820 universal regenerative unit are also integrated.

More information:
www.beckhoff.com/te5910

Millivolt measurement at high voltage level

High-level voltage measurement is an important topic in the field of electromobility, for example. The ELM3002-0205 EtherCAT measurement terminal from Beckhoff, which is well-suited to this field with a measuring range of up to ±1,200 V, is now supplemented by the two new ELM3002-0305 and ELM3002-0405 terminals, which can measure an mV voltage drop – e.g., on shunt resistors – in order to determine the current.

With the new ELM3002-0305/0405, accurate mV measurements are available at high voltage levels up to 1,000 V. Seven voltage measurement ranges from ±5 V to ±60 mV are supported, suitable for single cell measurement and shunts. Both EtherCAT measurement terminals offer a voltage range of ±2.5 and ±5 V, 24 bit resolution, and 50 ksps per channel as well as ±200 ppm accuracy. The -0305 version has two galvanically isolated analog input channels for mV measurements in two different current branches. With version -0405, on the other hand, the voltage can be measured in the range up to ±1200 V via channel 1 and the mV voltage drop across the shunt resistor via channel 2.

More information:
www.beckhoff.com/elm3002-0305
www.beckhoff.com/elm3002-0405
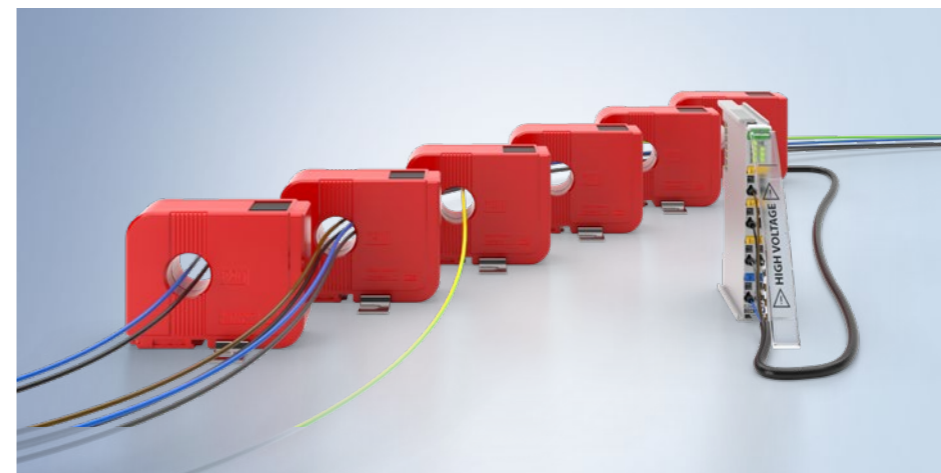
Precise measurement of differential currents for comprehensive grid analyses

Together, the new SCT4xxx differential current transformers and the new EL3446-0011 power measurement terminal enable continuous monitoring and condition-based maintenance, saving operators the increased costs of fixed, predetermined maintenance intervals.

The EL3446-0011 power measurement terminal enables comprehensive grid analysis and supports energy management by measuring all relevant electrical data of the supply grid and performing simple pre-evaluation. With 100 mA inputs, it is also particularly suitable for differential current transformers such as the SCT4xxx, which detect even low differential currents as well as leakage currents (type A). The SCT4xxx ring-type CTs for 25 A AC and type A differential current are available in four sizes for 20 to 120 mm round conductors. Combining the two offers particular advantages: The integrated harmonic analysis of the power measurement terminal allows any differential currents to be examined in detail for possible origins immediately and without additional measuring equipment.

More information:
www.beckhoff.com/el3446-0011
www.beckhoff.com/sct4xxx

C6670-0020: Enormous computing power with up to 64 cores

The new C6670-0020 industrial server is equipped with two Intel® Xeon® Scalable processors from the 5th generation with up to 32 cores per CPU and a memory of 128 to 1,024 GB DDR5 RAM. This makes it ideal for machine controls with the XPlanar planar motor system from Beckhoff.

The industrial server is initially available in six CPU versions, starting with:
– two Intel® Xeon® Silver 4510 processors with 2.4 GHz clock frequency and 12 cores each, i.e., a total of 24 cores, and up to
– two Intel® Xeon® Gold 6530 processors with 2.1 GHz clock frequency and 32 cores each, i.e., a total of 64 cores.
The C6670-0020 can be equipped with M.2 NVMe SSDs up to 640 GB and up to two hard disks with 1, 2, or 4 TB. It also features five free PCIe slots for EtherCAT or Ethernet fieldbus cards or similar. All the industrial server connections face upward so that the connection cables can be fed directly into a wiring duct. The side panels are completely passive and allow the industrial server to be fitted directly next to other control cabinet devices.

More information:
www.beckhoff.com/c6670-0020

25 years of EtherCAT Box modules

Users of EtherCAT and EtherCAT P Box modules from Beckhoff's EP and EPP series benefit from 25 years of IP67 expertise in the I/O sector. The broad product range for decentralized distribution of the I/O level directly at the machine or system has been continuously expanded and further developed during this time – and this is set to continue, as proven by numerous new modules.

Two of the new products – the EP3048-0002 and EPP3048-002 analog input modules for ±20 mA – provide eight channels combined with a small width of just 30 mm for the first time, making them ideal for use in particularly confined spaces. The 2-channel IO-Link master EP6222-0002 for fine-granular adaptation to applications that only require a small number of channels is also new. The IO-Link channel can be used as a digital input/output here. Furthermore, the range of motor controllers for roller conveyor systems has been expanded to include

the EP7402-0067 EtherCAT Box, which can now be used to supply 24 and 48 V motors. The EP7402-0067 also has an EtherCAT expansion port, which makes it easy to integrate any additional EtherCAT devices into the roller conveyor system. As a 4-channel analog input, the EPX3184-0092 EtherCAT Box enables the direct connection of intrinsically safe HART-capable field devices from hazardous areas in zones 0/20 and 1/21 and also offers TwinSAFE SC functionality,

which means that the 4...20 mA signal can also be used for safety applications. All 30 mm wide EtherCAT and EtherCAT P Box modules are also optionally available with three addressing rotary selector switches. This means that these I/O modules can be clearly identified regardless of their installation position.

More information:
www.beckhoff.com/ethercat-box

TwinSAFE: Portfolio expansion and safety controller in the industrial PC

With TwinSAFE, Beckhoff offers an extensive portfolio of software and hardware components for functional safety. This range is continuously being expanded and developed, as demonstrated by numerous new safety I/Os and the TwinCAT Safety PLC with EL6910 functionality.

The EL1957 TwinSAFE EtherCAT Terminal is a digital input and output terminal for sensors with potential-free contacts for 24 V DC. It has eight fail-safe inputs and four fail-safe outputs (up to 2 A). The EL1957 also integrates a programmable Twin-SAFE Logic and thus enables direct implementation of the safety application in the terminal. With this TwinSAFE Terminal, users can design their safety applications cost-effectively and with fine granularity, as a complete safety loop solution based on the local inputs and outputs can be created using a single safety component. Other new products include the EL2962 TwinSAFE EtherCAT Terminal

with two safe relay contacts and safe analog inputs, initially for 4...20 mA, which are available in the two SIL3-capable versions EL3952 and ELX3952. In addition, the TwinSAFE modules EJ6910, EJ1957, and EJ1918 are now also available in version -0001 without a housing and can therefore be integrated into any device.

The functionality of the dedicated EL6910 TwinSAFE Logic has also been transferred to the industrial PC. This makes the TwinCAT Safety PLC the framework for the EL6910 runtime. The solution remains binary-compatible with the hardware variant, allowing the same tooling to be used (TE9000 for engineering and TwinSAFE Loader/User for TwinCAT 3-independent interaction). In contrast to the hardware solution, however, faster response times and higher configuration limits are achieved in this case due to the use of advanced processor architectures: 4,096 instead of 512 FBs,

1,024 instead of 128 TwinSAFE groups, 2,014 instead of 212 TwinSAFE connections, and 8 µs to 7 ms instead of 1 ms to 15 ms cycle times.
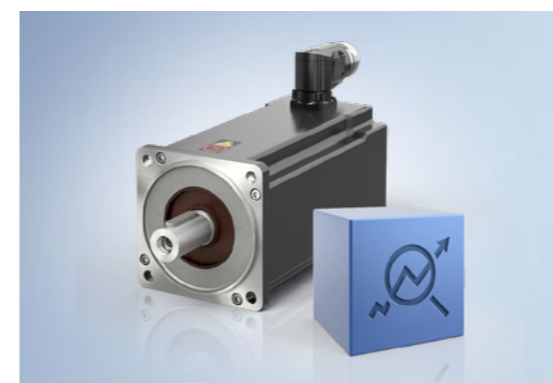
More information:
www.beckhoff.com/twinsafe

AM8000 servomotors with Beckhoff Smart System Diagnosis (B/SSD)

As an option, the AM8000, AM8300, AM8500, AM8700, and AM8800 series servomotors are available with the innovative Beckhoff Smart System Diagnosis. With B/SSD, it is possible to monitor motors and systems in real time with minimal effort and to implement effective predictive maintenance.

Precise measurement of vibrations, humidity, and temperatures directly in the motor provides the basis for statistical evaluation with TwinCAT Analytics and, hence, for effective predictive maintenance. This allows machine conditions and processes to be monitored and any necessary action to be taken in a timely manner to ensure efficient operation and maximum machine uptime. B/SSD uses the proven One Cable Technology (OCT), which eliminates the need for additional sensors and sensor cables and means that the wiring work is similar to that of a standard motor.

Thanks to full integration in TwinCAT Analytics, both live data and historical data can be recorded, clearly visualized, and processed into valuable information with B/SSD for machine optimization. Vibration measurements can be performed as an average value (RMS), with peak values, or statistically (kurtosis) up to +/-50 g.

More information:
www.beckhoff.com/b-ssd
www.beckhoff.com/twincat-analytics

Beckhoff Industrial PCs with new processor generations and Windows 11

PC-based control technology from Beckhoff has always benefited from the convergence of automation and the IT world. Current examples include the use of the latest industry-standard processor generations, high-quality and demand-optimized flash memory, and the long-term availability version of Windows 11.

The latest CPU generations include the Intel Atom® x6 processors, the 11th generation of the Intel® Core™ i and Core™ i U processors, the 12th and 13th generation of the Intel® Core™ i processors, and the 5th generation of the Intel® Xeon® processors. They result in significant performance increases and thus more powerful controllers or reduced hardware costs while maintaining the same computing power.

The new Intel® Core™ i processors, which have a structure size of 10 nm, offer particularly high innovation potential, resulting in a significant leap in performance and efficiency. Furthermore, TwinCAT Core Boost can be used. In the case of the ultra-compact C6025 and C6030 Industrial PCs with 11th generation processors, it can even be implemented in an extremely small form factor. With TwinCAT Core Boost, the clock frequency of the processor cores can be configured individually and as required, so they no longer all have to be clocked at the same rate. The clock rate can be set for each core for real-time transmission and user-mode applications. It is also possible to operate individual cores continuously and in real time in what is known as turbo mode. Applica-

tion benefits include up to 50% more computing power for one or more processor cores or the possibility of using more cost-effective CPUs. The 13th generation Intel® Core™ i processors (with up to 24 cores) used in the ATX industrial PCs offer additional benefits alongside TwinCAT Core Boost due to their hybrid architecture featuring performance and efficiency cores, which can be easily differentiated in TwinCAT.

The industrial SSDs (solid-state drives) from Beckhoff deliver excellent reliability and performance when it comes to data storage in challenging operating environments. 3D TLC flash memories are used, which are operated in pSLC mode via firmware configuration. This mode enables a long service life with over 50,000 write cycles and up to 5,200 MB/s write speed.

The crucial factor when using the latest IT developments is their long-term availability. This also applies to the Windows operating system, which is used in its LTSC version (Long-Term Servicing Channel). Windows 10 IoT Enterprise is currently, and will continue to be, available but it will be joined in the future by Windows 11 IoT Enterprise – the latest Windows platform.

More information:
www.beckhoff.com/ipc

Expansion for the complete Vision Unit Illuminated system
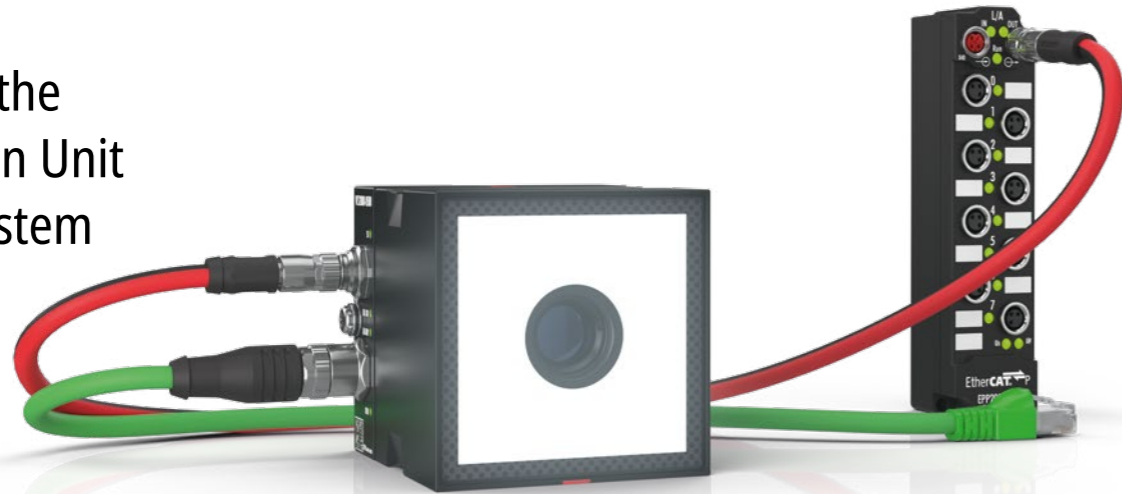
The VUI2000 series from Beckhoff is being joined by four new vision units. The Vision Unit Illuminated (VUI) is a compact unit comprising the camera, illumination, and focusable optics complete with liquid lens technology. It significantly reduces the installation and commissioning effort.

All functional components of the VUI are encapsulated in a visually appealing anodized aluminum housing in protection rating IP65/67. In addition to the existing models, the portfolio is now being expanded to include four devices featuring color

or monochrome image sensors with resolutions of 2.3 MP or 3.1 MP in a 16 mm focal length.

The liquid lens used in all VUIs does not require any mechanically moving parts. The unit is calibrated at the factory so that focus adjustment can be carried out with a high degree of accuracy using real dimensions. The optimum choice and combination of lens position, aperture, and resulting depth of field ensures that the focus can be reliably adjusted in the distance range from 10 to 2,000 mm, i.e., even beyond the optimum distance range for the illumi-

nation. Temperature-related changes in refractive power are reliably compensated for by means of continuous temperature measurement and a corresponding mathematical model.

More information:
www.beckhoff.com/vui2000-0216
www.beckhoff.com/vui2001-0216
www.beckhoff.com/vui2000-0316
www.beckhoff.com/vui2001-0316

TwinCAT Vision:
Image processing functions and options for camera integration added

The Beckhoff TwinCAT 3 Vision software portfolio offers additional image processing functions and extra options for camera integration, as detailed below.

The TwinCAT 3 Vision Beckhoff Camera Connector (TF7020) offers the option of integrating Beckhoff cameras directly into the TwinCAT architecture. The connector establishes the basis for communication and provides up to 64 camera connections.

TwinCAT 3 Vision Code Quality (TF7255) complements the basic package with functions for quality evaluation of various 1D and 2D codes. This ensures high-quality code and means that problems in code creation are detected at an early stage.

TwinCAT 3 Vision OCR (TF7260) adds optical character recognition to the basic package. The

functions identify characters in an image and return the recognized character string. Application examples include verification of best-before dates and batch numbers.

TwinCAT 3 Vision Neural Network (TF7810) adds the option to use neural networks for vision-specific applications to the basic package. With the help of these models, complex data analyses can be learned automatically. Application exam-

ples include object detection, classification and anomaly detection for quality control, and process monitoring.

More information:
www.beckhoff.com/tf7020
www.beckhoff.com/tf7255
www.beckhoff.com/tf7260
www.beckhoff.com/tf7810
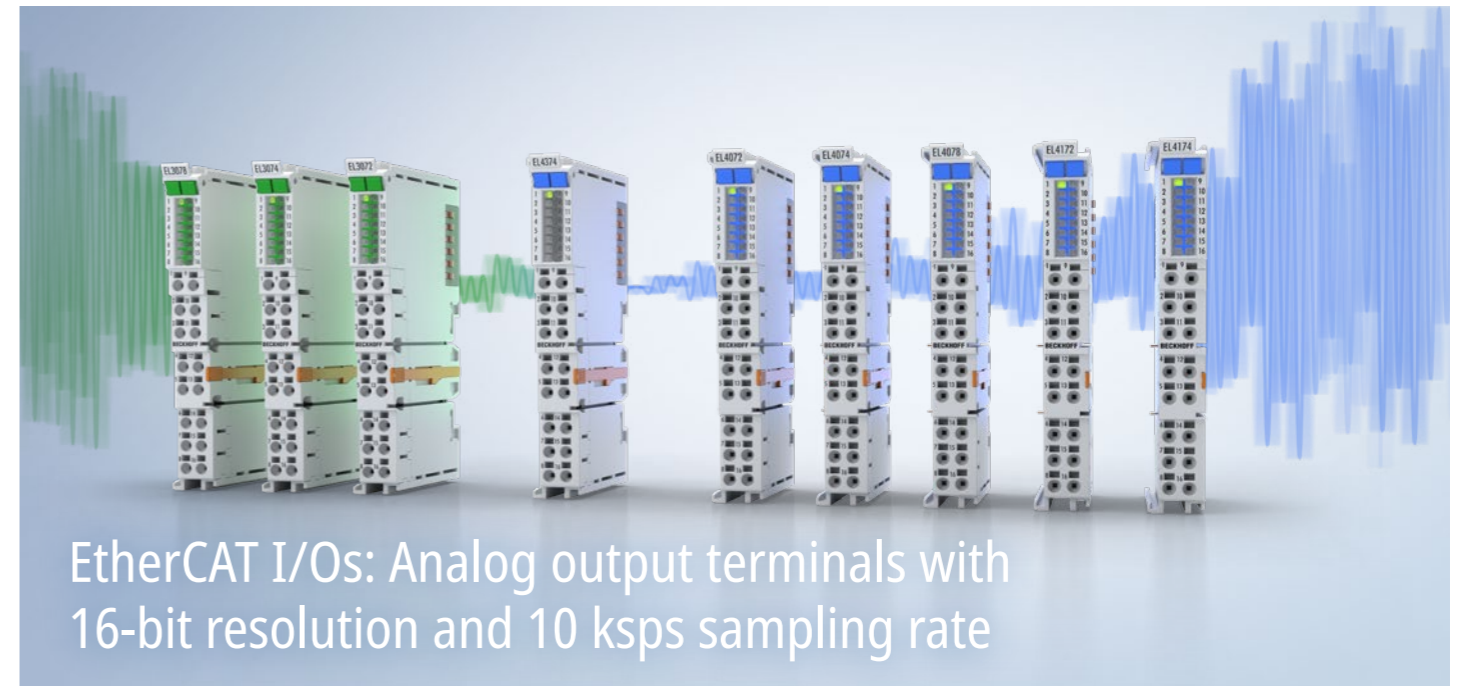
EtherCAT I/Os: Analog output terminals with 16-bit resolution and 10 ksps sampling rate

The range of high-performance EtherCAT multi-functional terminals from Beckhoff is supplemented by the EL4172 and EL4174 output terminals. In contrast to the EL4072 and EL4074, the new 2- and 4-channel terminals operate with a 10 ksps sampling rate while retaining the 16-bit resolution.

The two EL417x analog output terminals output all known standard signals in the range of ±10 V and ±20 mA, and the EL307x inputs can process these. All outputs can be parameterized individually and are

single-ended to reduce cabling work. The current outputs can have high load resistances and detect operating faults such as overload, wire breakage, or short circuiting via a diagnostic feature. The EtherCAT Terminals have an extended output range of ±107%, which can be used to pass on atypical setpoints, e.g. for transmitting error states

The new analog EL3x7x and EL4x7x family of EtherCAT multi-functional terminals offers a reliable and versatile solution for a wide range of applications

– from simple to highly demanding. With their high performance, compact design, and precise 16-bit resolution, they set new standards in the field of analog IP20 I/Os.

More information:
www.beckhoff.com/multi-io

EL3453-0090:
Power measurement with safe power monitoring

The EL3453-0090 EtherCAT power measurement terminal has voltage inputs for direct monitoring of powerful generators up to 690 V AC, such as those commonly used in the wind energy industry. No upstream voltage transformer is required. TwinSAFE SC technology now also makes it easy to implement safe power monitoring.

The TwinSAFE SC technology (TwinSAFE Single Channel) facilitates the use of standard signals for safety-related tasks in any networks or fieldbuses. The EtherCAT I/Os, such as the new power measurement terminal, are expanded to include the TwinSAFE SC function, but will retain their typical signal properties and standard functionalities. The TwinSAFE SC technology facilitates communication by means of a TwinSAFE protocol. These connections can be distinguished from the usual safe communication by means of Safety over EtherCAT. The data of the TwinSAFE SC components are transferred to the TwinSAFE Logic, where they can be used in the context of safety-relevant applications, e.g., for safe power monitoring.

The four current inputs of the EL3453-0090 power measurement terminal are electrically isolated from each other and allow the terminal to be used in all common current transformer configurations such as 2- or 3-transformer configurations with star or delta connection including neutral conductor current measurement. The grid analysis is carried out up to the 63rd harmonic and also summarized in the Power Quality Factor for simplified diagnosis. Like all measured terminal data, the harmonic content can be read via the process data. In addition to the "ExtendedRange" feature, which provides the full technical measuring range (130% of the specified nominal measuring range), the EL3453-0090 now also offers TwinSAFE SC technology.

More information:
www.beckhoff.com/el3453-0090

Based on well over 40 years of experience with state-of-the-art automation technology and almost 30 years with TwinCAT software, Beckhoff has developed a new generation of PLC technology in the form of TwinCAT PLC++. In this interview, TwinCAT product managers Dr. Josef Papenfort and Béla Höfig explain the performance leap this enables in terms of both engineering and runtime.

Decades of experience incorporated into the new generation of PLC technology

TwinCAT PLC++: New PLC generation with a leap in engineering and runtime performance

"The runtime and engineering performance is improved in TwinCAT PLC++, creating significant added value, and the switch is easy to make while preserving current TwinCAT Functions – a real plus plus for the user."

Dr. Josef Papenfort,
TwinCAT Product Manager,
Beckhoff Automation

Béla Höfig,
TwinCAT Product Manager,
Beckhoff Automation

A new generation of PLC technology – what does this mean for automation engineers already working with TwinCAT?

Dr. Josef Papenfort: TwinCAT PLC++ is based on the familiar TwinCAT architecture and is fully integrated into the proven TwinCAT ecosystem. Complete compatibility with the existing TwinCAT Functions is ensured and the new PLC generation can also be used in parallel with the existing TwinCAT PLC if required. For example, existing TwinCAT Scope and TwinCAT HMI applications can continue to be used unchanged. The available PLC libraries can also be used to their full extent. On the one hand, this enables a step-by-step changeover with parallel TwinCAT PLC and TwinCAT PLC++ operation. On the other hand, an integrated converter enables the efficient transfer of existing program code, so that existing expertise is easily available in TwinCAT PLC++. Switching therefore involves little effort.

What will change with TwinCAT PLC++ in terms of technology?

Béla Höfig: TwinCAT PLC++ is a completely new development from Beckhoff, but of course it is still based on the languages described in IEC 61131-3. Due to aspects such as the modern compiler technology and the new architecture used in this context, a significant leap in engineering and runtime performance can be achieved. Beckhoff is consistently pursuing the path of converging automation and IT that it has taken from the very beginning. Although the company has retained familiar and proven features, it has redeveloped key components of the development environment such as editors and compilers based on best practices from IT. What's more, Beckhoff has placed particular emphasis on the possibility of using DevOps principles to implement continuous integration and continuous deployment, and focused

particularly on the specific needs of users. This results in a PLC that is not only extremely advanced in terms of technology but also perfectly tailored to requirements in the field.

What performance gains can be achieved in terms of runtime?

Dr. Josef Papenfort: Compared to the previous version TwinCAT PLC, the same control code can be executed up to 1.5 times faster during runtime. And as a special highlight, the new TwinCAT PLC++ compiler makes it possible to further optimize the control code in terms of execution time and thus achieve an overall performance gain of up to a factor of 3.

What are the concrete advantages for machine builders and users?

Béla Höfig: The significantly faster execution of the control code generates different advantages depending on the machine requirements. For example, an industrial PC with less computing power may be sufficient for the previous machine control application, which reduces hardware costs. If the hardware platform remains unchanged, the freed-up computer resources can be used either to implement more control functionality or to increase the productivity of the machine by minimizing cycle times.

To what extent does control engineering benefit from TwinCAT PLC++?

Dr. Josef Papenfort: From an engineering perspective, TwinCAT PLC++ achieves shorter throughput times from control software development through to commissioning and the entire machine life cycle. This is

Jakob Sagatowski,
CEO & software influencer,
Sagatowski GmbH

> " TwinCAT PLC++ makes it easier to bring good practices from the IT world into the space of industrial automation. It's an important technological leap forward, making it possible to develop high quality software faster."

© Jakob Sagatowski

> " TwinCAT PLC++ is a completely new development from Beckhoff, but of course it is still based on the languages described in IEC 61131-3."

achieved by reduced operating times through shorter project loading times and an improved compile process. The minimized project load times significantly reduce costs and also enable new machines and systems to be launched more quickly.

Béla Höfig: Furthermore, the new TwinCAT PLC++ architecture enables an even deeper integration of TwinCAT Functions. For example, TwinCAT HMI and TwinCAT Target Browser can access the PLC variables directly without the program code having to be compiled ready for execution beforehand. In addition, a programming assistant based on TwinCAT Chat can be integrated. This assistant can support the generation of both textual and graphical codes. There are also expandable code snippets, smart shortcut functionalities for guided code creation, an online-offline code comparison, and a favorites pool. In this way, the extensive potential of the TwinCAT world can be fully exploited and the entire engineering process can be made more efficient.

Dr. Josef Papenfort: In addition, the program code is stored in plain text at file level for the first time. This simplifies the use of source code management systems such as Git, as comparing different code versions is particularly easy and intuitive. What's more, the new compiler is available as a stand-alone component and can be called up automatically via a command line interface. Given that a complete engineering instance is no longer required, this allows automated processes for creating and testing program code in unit tests to be greatly optimized in terms of time.

How well does TwinCAT PLC++ perform with regard to standard conformity and code quality?

Béla Höfig: As a member of the German IEC group, Beckhoff has a direct influence on the latest developments and best practices in standardization. TwinCAT PLC++ is almost fully compliant with the fourth edition of IEC 61131-3 and meets the highest international standards.

With the resulting portability, it facilitates exchange and collaboration between different automation systems. In addition, it is possible to use standard-conforming object orientation with classes and access modification for variables, among other things. Compliance with the IEC standard offers additional safety aspects for programming, which are supplemented by extended type checks in the compiler. TwinCAT PLC++ also offers a secure online change where pointers and references are automatically adjusted. This prevents the implementation of potentially error-prone code and ensures that the application is more reliable and secure – resulting in better code quality overall.

TwinCAT PLC++ was presented at the SPS 2024 trade fair in Nuremberg. What was the feedback like and what is the roadmap for the future?

Dr. Josef Papenfort: The initial reactions and assessments from both customers and market players were extremely positive. We are now working hard on further functions and optimizations so that numerous new features will be available in time for Hannover Messe 2025. The software release is scheduled for the end of 2025.

The interview was conducted by Stefan Ziegler,
Editorial Management PR, Beckhoff Automation.

More information:
www.beckhoff.com/twincat-plcpp
www.youtube.com/jakobsagatowski

EP7402 EtherCAT Box modules in warehouse and distribution logistics

Conveyor technology retrofit reduces energy consumption and noise emission

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The approximately 250-m long central ring conveyor from Arvato SE was extensively modernized with PC-based control, One Cable Automation, and around 200 EP box modules for roller drives.

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Intralogistics systems such as the central ring conveyor at Arvato SE benefit in particular from One Cable Automation: Power and communication are efficiently distributed to the compact EP7402 MDR controllers using pre-assembled hybrid cables.

Conveyor technology is part of the critical infrastructure of every logistics company. This is why the logistics service provider Arvato SE has completely retrofitted the central conveyor line between several warehouses and the order picking area at its Harsewinkel site. With PC-based control, One Cable Automation, and around 200 EP7402 EtherCAT Box modules with integrated MDR controllers from Beckhoff, the system runs much more efficiently, quietly, and reliably.

As a global logistics company, Arvato SE, headquartered in Gütersloh, handles all B2C and B2B logistics processes for its customers, from order acceptance and value-added services to returns management. Represented at over 100 locations worldwide, Arvato maintains warehouse capacities of almost 1 million m² at 28 locations in Germany alone, including several halls with high-rack warehouses at the Harsewinkel site near Gütersloh. From here, orders are picked for customers from various industries, then the goods are packed and shipped to the recipients. The high-rack warehouses are connected to the picking area by a central circular conveyor line measuring over 250 m in length.

24-V technology for more efficient operation

The ring's previous conveyor technology was still based on roller drives with three-phase motors. "These drives were very loud, ran continuously along the entire route, and were prone to failure after around 20 years of operation," says Markus Wolharn, Senior Expert Engineering at Arvato. The conveyor technology has therefore been renewed with a mechanical and electrical alternative: 24-V roller motors have now replaced all the old drives. They are controlled via a total of 186 decentralized EP7402 EtherCAT Box modules with integrated MDR controllers (MDR = motor driven roller). At the same time, the existing control hardware was con-
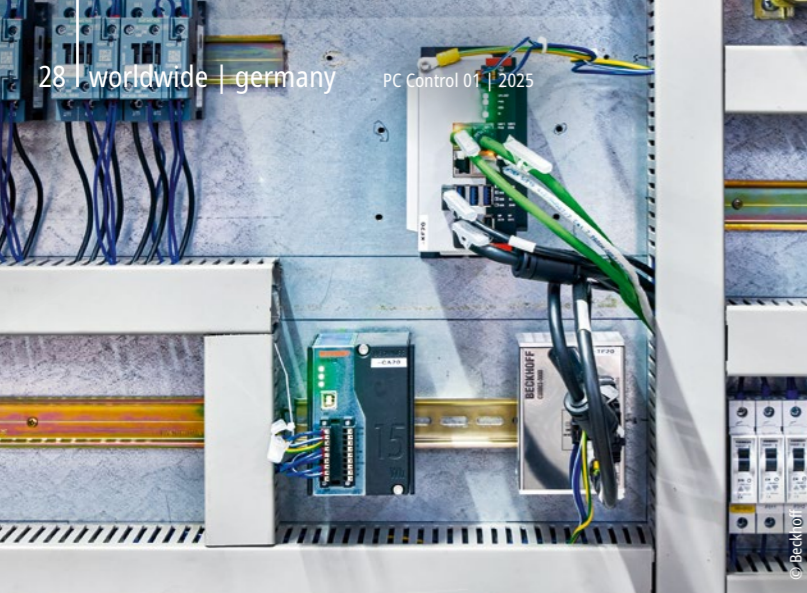
A C6030 ultra-compact Industrial PC controls all roller drives of the central ring conveyor via EtherCAT and EP7402 compact box modules.

The power supply for the EP box modules is decentralized via 27 control cabinets with Beckhoff PS3031-2440 power supply units.

Special components such as barcode scanners are integrated via the integrated EtherCAT junction of the MDR controller.

verted to a C6030 ultra-compact Industrial PC, the software was migrated from TwinCAT 2 to TwinCAT 3, and the existing system visualization was adapted.

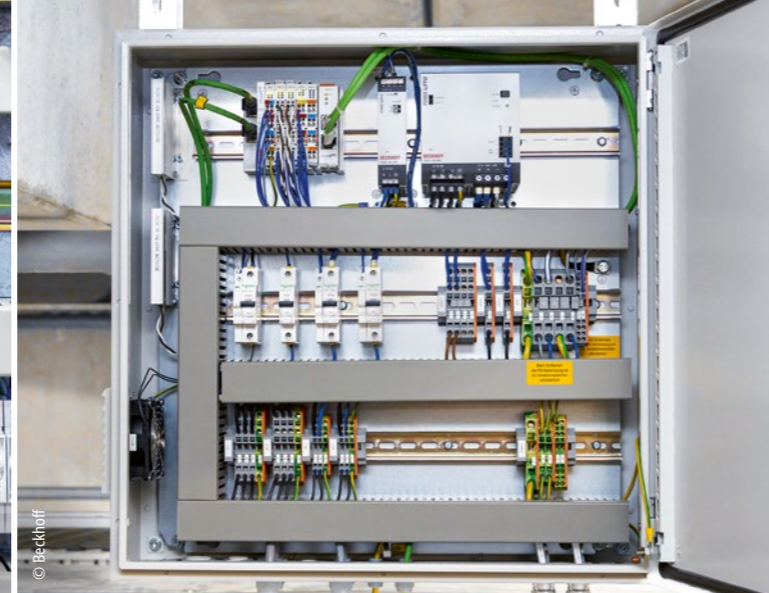The mechanical conversion of the conveyor line was designed and realized by Budde Systems in Schloss Holte-Stukenbrock. To speed up the conversion work on site, the conveyor line was divided into 125 individual segments, which were completely pre-fabricated and pre-wired at Budde Systems. "This modular production concept saved us a lot of cabling effort and time during final assembly at Arvato," explains Maximilian Budde, managing director of Budde Systems.

The advantages of One Cable Automation

The prerequisite for this modular approach is the EtherCAT Box module connection technology using M8 connectors for the sensor technology and roller drives as well as ENP hybrid connectors (B23) for connecting power and EtherCAT communication. "This enables a fast and fail-safe connection," enthuses Stefan Maßmann from Beckhoff systems engineering, emphasizing one of the advantages of One Cable Automation (OCA). The Budde Systems mechanics only had to lay the pre-assembled hybrid cables between the MDR controllers in the individual segments on site and connect them to one of the power supply control cabinets.

To keep the cable lengths to the EP box modules short, a total of 27 control cabinets are distributed throughout the system to supply power to the roller drives. "Each control cabinet supplies several segments and is positioned in the middle to keep the DC voltage drop low," emphasizes Stefan Maßmann. The input voltages on the EP box modules were evaluated during commissioning, showing that this approach works. There was only case concerning a roller drive where the output voltage of the corresponding PS3031 power supply had to be adjusted slightly.

Markus Wolharn, Senior Expert Engineering at Arvato

" One Cable Automation and the IP67 box modules offer much more flexibility in terms of future system expansions."

Each ring conveyor segment has one or two roller drives and the corresponding sensor technology to activate the drives. The switches also have a barcode scanner to identify the packages. All sensors are recorded via the EP box module I/Os. If required, additional I/O modules or other EtherCAT devices can be connected via the integrated EtherCAT junction. "This was the case, for example, with the switch supplier's roller drives and the barcode scanners," explains Stefan Maßmann.

Increased flexibility with PC-based control and OCA

"One Cable Automation and the IP67 box modules offer much more flexibility in terms of future system expansions," says Markus Wolharn, picking up on another important aspect of the cabling philosophy. If the system needs to be modified, the simple connection technology and pre-assembled cables make this just as easy in terms of control technology as the mechanical conversion. The system also demonstrates its advantages when it comes to maintenance. "The HMI shows the troubleshooting service exactly which segment is blocked and which component may need to be replaced," explains Markus Wolharn.

When transporting the packages, the individual conveyor segments are switched on or off depending on the destination and whether the next segment is occupied. "When the path is clear, the next two transport segments are always switched on to ensure smooth and fast transportation," explains Dimitri Kool from Beckhoff systems engineering. By the time the package reaches the next conveyor, it has already reached its target speed and the package moves on without losing time or jerking. In practice, each package creates a zone of active conveyors that moves through the ring.

Efficient engineering through variant management

Logistics operations had to be resumed quickly during the ten-week conversion period. This requirement was met by splitting the project into two sec-

tions. To this end, the first part of the modernized conveyor technology – which is a high priority for warehouse logistics – was put into operation with a C6030 ultra-compact Industrial PC and TwinCAT 3. At the same time, the second and larger part of the conveyor technology was automated on an old PC.

Finally, both software projects were merged on the C6030 ultra-compact Industrial PC. "With variant management in TwinCAT 3, we were able to achieve this efficiently and work permanently with an overall project in the Git repository," says Stefan Maßmann.

The TwinCAT 2 controllers that are still in operation in the connected warehouses presented a challenge. TwinCAT 3 contains prepared data structures that map an EP box module with all variables and significantly speed up configuration. To be able to use this in the configuration of the modernized system parts under TwinCAT 2, this data structure was implemented as a function block for TwinCAT 2 and then migrated back to TwinCAT 3. "This had the advantage of working with identical variable names everywhere and ex-

changing the program parts between new and existing controllers as required when updating," emphasizes Stefan Maßmann. "These global data types for TwinCAT 2 and TwinCAT 3 have significantly accelerated the project planning of the approximately 200 MDR controllers with around 50 signals each," says Jürgen Bolte from Beckhoff systems engineering.

More packages, less energy consumption

The retrofit has not only increased reliability, but also the possible throughput from 2,000 to 3,000 packages or transport containers per hour – with significantly quieter operation and lower energy consumption to boot. "The 24-V technology also ensures greater safety if manual intervention is necessary in the event of a jam," says Markus Wolharn. As a reference project, the ring conveyor conversion is attracting interest in other Arvato departments and locations due to its energy efficiency and lower noise emissions during operation. For Markus Wolharn, however, the advantages of One Cable Automation and the EP box modules when adapting the conveyor technology and installation are equally valid arguments.

Stefan Maßmann, Jürgen Bolte, and Dimitri Kool (all Beckhoff systems engineering), Maximilian Budde (seated) and Tristan Rodewald (both Budde Systems), and Markus Wolharn (Arvato SE) – from left to right – in front of the ring conveyor mounted under the ceiling with one of the 27 control cabinets for supplying the EP7402.

More information:
www.arvato.com
www.budde-systems.com
www.beckhoff.com/intralogistics
www.beckhoff.com/ep7402

Trend reversal in homebuilding with next-generation control technology

Automatic preassembly speeds up prefabricated homebuilding

Promise Robotics offer the most intelligent, flexible, and compact industrial robotic systems for building component prefabrication on the market, according to their own account.

Imagine a world where affordable, sustainable housing isn't a dream, but a reality. This vision faces two significant hurdles: skyrocketing construction costs and a shortage of skilled labor. Enter Promise Robotics, a Canadian startup reinventing prefabrication as they say: Advanced automation technology from Beckhoff and artificial intelligence (AI) control a robotic solution for efficient prefabrication. As a result, on-site assembly becomes up to 70% faster.

Edmonton, Alberta-based Promise Robotics is bringing the most intelligent, flexible, and compact industrial robotic systems to the construction industry. The industrial solution is powered by a cloud-based software platform that manages the entire production lifecycle from planning to factory floor operations, scheduling, and logistics. With the Homebuilding Factory-as-a-Service™ concept, homebuilders can expect to dramatically reduce final on-site assembly of homes by up to 70% compared to traditional methods. For example, a single-family home could be assembled in about five hours and a 64-unit, three-story apartment building in two weeks.

By using automated pre-assembly, homebuilders can expect, for example, a single-family home to be assembled in as short as five hours, from foundation to roof.

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"Automation is not very common in the construction industry, which remains heavily labor-intensive," said Ramtin Attar, CEO and co-founder of Promise Robotics. "Our goal is to build foundational technology – an automation system with a tangible return on investment and without limits for wide market adoption."

Challenges in robotic homebuilding

Developing Promise Robotics' innovative construction systems presented unique challenges. A primary hurdle was the need for a robust, high-performance control system. Specifically, real-time processing was crucial for precise robot control with position feedback.

"One of the key lessons we've learned is how to use perception to handle material variations that can occur during production," explains Farid Mobasser, Director of Software at Promise Robotics. "We have to provide feedback to the robots and adapt to unique scenarios that might disrupt the process. It's a continuous learning curve – we test and build different structures, shapes, and handle edge cases to improve our systems."

Another key challenge was ensuring a compact, integrated system design. Minimizing wiring and complexity was essential for facilitating quick deployment in a dynamic construction environment with limited space.

A solid foundation using EtherCAT and PC-based control

To address these challenges, Promise Robotics leveraged several Beckhoff products, including TwinCAT 3 automation software and EtherCAT for data transmission between controllers, drives and I/O components. TwinCAT offers an end-to-end engineering and runtime platform for all automation functionality, from machine control logic and motion control to safety and HMI. The TwinCAT development environment allows Promise's engineers to leverage a wide range of programming languages, including structured text, ladder logic, and C++ to rapidly build robust applications.

EtherCAT can handle real-time communication with minimal latency – a critical requirement for precise robotic control. The high-performance fieldbus seamlessly integrates motion control, safety functions, and other machine components with high data rates, enabling the complex construction systems to operate smoothly in dynamic operation. "The flexibility and scalability of EtherCAT was a big factor. It's the fastest industrial Ethernet communication protocol, and Beckhoff also offers a wide complement of hardware. This includes everything from the CX2043 Embedded PC to I/O components and all drive technology, including motors, drives, cables," says Darren Brix, Director of Hardware at Promise Robotics. "It's a turnkey package that streamlines process and system design. EtherCAT really makes it simple and efficient to complete a harmonized, consistent industrial solution at a high standard."

The CX2043 Embedded PC from Beckhoff, featuring a quad-core AMD Ryzen™ CPU with a clock speed of 3.35 GHz, is the powerful backbone of the control system allowing seamless integration with all Beckhoff I/O components. Paired with TwinCAT automation software, the CX2043 becomes a high-performance PLC and motion control system, supporting both 32-bit and 64-bit modes, and providing high processing power with the short cycle times needed for precise, deterministic control in this dynamic environment. A CP3924 multi-touch Control Panel, leveraging the one cable technology CP-Link 4 for connection to the PC, serves as the main interface for operators to control the robotic systems.

Dynamic motion with distributed drive systems

Precise control of the robotic arms and actuators is achieved using the compact, integrated Beckhoff AMI8122 servo drives, which combine the servomotor, output stage, and fieldbus connection in a space-saving design. Promise Robotics leveraged the integrated servo drive to build a custom end effector paired with a KUKA robot to achieve the precision alignment required to build different structures, shapes and sizes. The AMI8122 is part of Beckhoff's distributed drive solutions, which bring drive technology out of the control cabinet and place it directly on the machine. This design significantly reduces the control cabinet size, overall machine footprint, and cable length, making it ideal for dynamic construction environments.
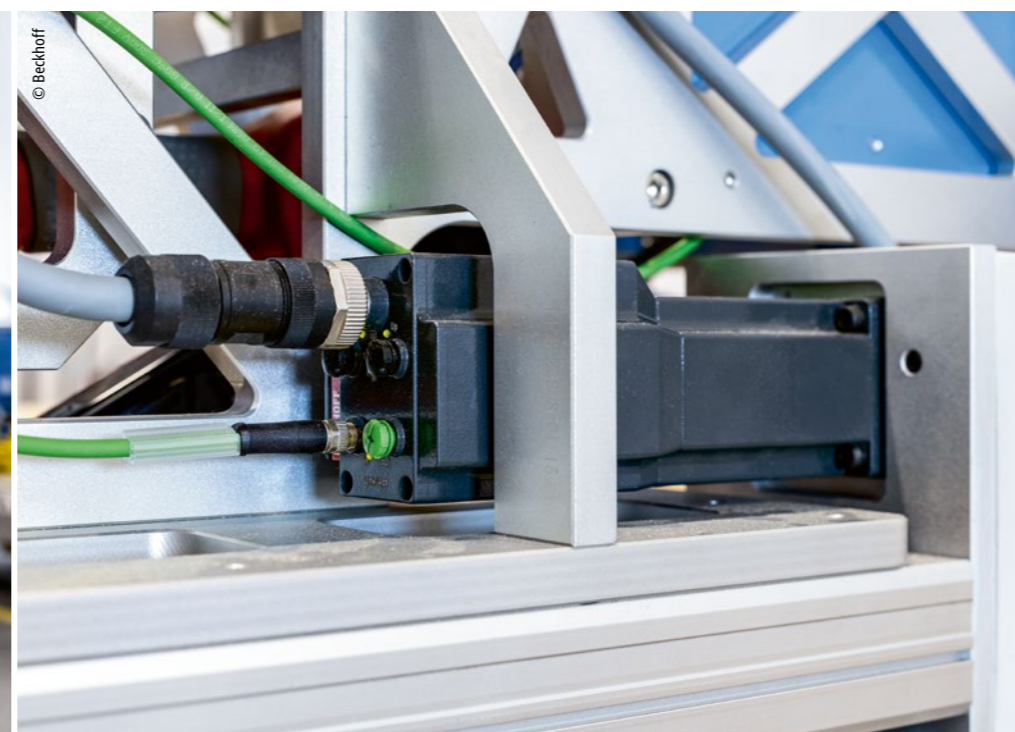
The high-speed EtherCAT communication protocol and TwinCAT 3 Drive Manager 2 also simplify implementation and commissioning in real-world construction scenarios. Because safety is paramount, the EL6900 TwinSAFE component ensures the safe operation of all machines. This system-integrated EtherCAT Terminal with TwinSAFE Logic handles safety-oriented applications based on Boolean values, with function blocks for processing safe input signals and generating safe output signals. Additionally, it supports up to 128 safe connections and includes a backup and restore function for easy controller exchange, contributing to the reliability and safety of the solution.

A blueprint for the future

By standardizing their control system on automation technology from Beckhoff and relying on the flexible and open EtherCAT fieldbus system, Promise Robotics has significantly accelerated research and development cycles and reduced commissioning times. The standardized approach simplifies maintenance, ensures consistent operation across all machines, and allows seamless integration of new innovations – reducing downtime and increasing productivity. "Right now, we're focused on wood frame construction, which is about 80% of

> **Darren Brix, Director of Hardware at Promise Robotics:**
>
> " **EtherCAT really makes it simple and efficient to complete a harmonized, consistent industrial solution at a high standard."**

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The Promise Robotics team together at the facility in Edmonton, Alberta:
(from left) Jeffrey Kervin, Robert Johnston, Darren Brix and Mark Vermeiren.

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residential construction in the U.S. and Canada. But essentially, we are building the largest AI library for robotic assembly tasks that could be extended to all kinds of building assemblies," Ramtin Attar says, explaining the challenges involved in attempting to transform an entire industry. "There's a reason why automation has not scaled in this massive, multi-trillion-dollar industry. While there have been some successful custom implementations, scalability and rapid deployment have been rather limited. Our goal is to deploy these systems very rapidly in non-custom factories, where you can take over a warehouse, turn on the lights, and start returning profit on your capital."

Left: A CP3924 multi-touch Control Panel serves as a convenient interface for operating the robotic systems.

Right: The AMI8122 compact servo drives integrate the servomotor, output stage and fieldbus connection into a compact design and enable precise control of robotic arms and actuators.

More information:
www.promiserobotics.com
www.beckhoff.com/ami8100
www.beckhoff.com/ethercat

From film to finished mailer bags in record time

To ensure that an online order arrives in perfect condition, the parcel must be well protected during shipping. CMD Corp. from Appleton, Wisconsin, developed a system producing mailing bags for the fast-paced e-commerce business. Control technology from Beckhoff integrates all stations along the line – regardless of whether for intermittent or continuous operation – into an optimized workflow.

CMD understands that flexible automation and repeatable results are essential in the packaging industry. So the OEM provider strives to meet these requirements by continuously exploring new technologies for use in their highly customized plastic converting solutions. CMD thus lives up to its name, which is an acronym for Custom Machinery Design.

For a contract manufacturer in the e-commerce sector, the company started designing a new mailer packaging machine. A high throughput machine with an intuitive operator interface was a top priority, according to Scott Fuller, Product Line Manager, Intermittent Motion Products at CMD. "This new ma-

chine is much faster and more automated, which was key for our end user customer," says Fuller. The end customer will produce bags for online retailers primarily to ship e-commerce items in plastic bags. Another customer need: bags that would work with automated product loading.

Next-level automation
In the new streamlined converting process, the 1400-GEC machine unspools two rolls of film, registers the print on those two rolls and applies a continuous longitudinal seal. Then it runs the rolls through a series of cross-directional punches and seals, slits the material in up to five individual lanes of bags

The new 1400-GEC mailer packaging machine from CMD incorporates a complete Beckhoff control system, offering enhanced flexibility and performance capabilities.

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Space-saving EtherCAT Terminals and bus couplers, including the EK1914 coupler with TwinSAFE functionality, combine high-speed real-time communication with functional safety.

The Beckhoff CX2033 Embedded PC functions as the sole machine controller for the 1400-GEC mailer packaging machine and contributes to boosting scan times.

depending on order specifications, and adds perforation for easy separation. Before loading the finished bags into cases, ready for use as specified by the customer, the system performs a vision test while blowing air into the open end of the bag and measuring its shape profile.

"This machine incorporates entirely new automation processes. It transitions from continuous motion to intermittent motion and back to continuous in the outfeed, while handling various tasks in each phase," Scott Fuller explains. "That makes it distinct from the machines we've designed before."

The support of all this functionality in real time required a control system with significant processing power. In addition, the development team faced tight lead times on this project. It was essential to finish on schedule while also delivering a smoothly working, reliable solution.

Powerful programming tools
As an end-to-end engineering and runtime platform, TwinCAT automation software combines everything from PLC and motion control to integrated safety and IoT. When programming the new operator interface, TwinCAT HMI allowed CMD to leverage modern web design standards, such as HTML5, JavaScript and CSS. The resulting responsive interface increases user-friendliness with a more intuitive HMI.

When programming the machine control with TwinCAT, CMD benefited from close cooperation with the software experts in Beckhoff's Special Projects Team (SPT). The SPT framework builds on industry standards such as ISA-TR88 and PackML and the associated libraries in TwinCAT. It simplifies the programming of communication between individual machines within a production line. The advantage for programmers is that they do not have to start from scratch

Beckhoff AM8000 servomotors, including large, air-cooled motors, provide reliable performance for both continuous and intermittent motion axes.

for every project, but can reuse existing code or easily customize it to new requirements.

Efficiency throughout the line
A CX2033 Embedded PC serves as the sole machine controller for the entire line. A dual-core AMD Ryzen™ processor supplies extensive performance capabilities to the DIN rail-mounted controller from Beckhoff with room to grow in the future. "If you're working with a resource-constrained system, your HMI will be laggy to the touch. So, putting the HMI server on a CX2033, which offers ample computing resources, enables the touch panel to operate very responsively," explains Software Engineer Adam Benson from CMD.

EK1914 EtherCAT couplers integrate communication along the entire line with their digital standard and safety I/Os. Besides EtherCAT Terminals for standard signals, the I/O segments of the various stations also include TwinSAFE terminals for functional safety. This allows CMD to conveniently allocate safety functions, such as an e-stop, to each tool in the machine line.

The high level of synchronization provided by EtherCAT also enhanced the powerful drive technology from Beckhoff in CMD's motion-intensive application. The machine features the AX8000 multi-axis servo system and AM8000 servomotors controlling fourteen axes. "The AX8000 drives are very compact for the power they provide," CMD Electrical Engineer Jason Plutz says. "And by using the integrated Safe Torque Off functionality, we eliminated two large contactors, saving significant panel space."

CMD leveraged camming motion control in TwinCAT 3 software with two of the axes on the bag packaging machine. The bag opener, initially positioned

in the intermittent movement section, was relocated downstream to enhance efficiency through the camming functionality. Using an extrapolation of continuous web processing, the bag opener is precisely cammed to achieve the desired motion at just the right moment.

Well-positioned for the future
By harnessing the software framework from Beckhoff, CMD boosted their code reusability to 90%. Employing TwinCAT HMI also helped the team create a more intuitive operator interface in a way that supports outstanding customization. "The new operator interface resembles our legacy HMI, but has a much cleaner, more user-friendly design," says Software Engineer Adam Benson.

Running the entire machine with an EtherCAT-networked CX2033 Embedded PC accelerated CMD's cycle times. "Having everything scan at one high speed is a huge benefit. You don't have to worry about communicating between process stations that function at different speeds because everything updates at the same time," Jason Plutz explains. This enabled the CMD team to reach their target throughput rate of 200 feet or approximately 60 m of plastic sheet per minute. This translates to 100 bags per minute per lane, resulting in an impressive total of 300 to 500 bags produced every minute.

Looking ahead, the CMD team intends to scale up to the CX2043 with a quad-core AMD Ryzen™ CPU for even greater machine control horsepower. Beckhoff's nearly endless Industrial PC portfolio is built for scalability, enabling performance adjustments without requiring reengineering.

Automation and converting experts combine forces at the CMD Technology Center in Appleton, Wisconsin (from left to right): Mark Lewis (Special Projects Manager at Beckhoff USA) with CMD's Doug Main (R&D Test Technician); Scott Fuller (Product Line Manager, Intermittent Motion Products); Jason Plutz (Electrical Engineer); Nicole Onesti (Corporate Market Manager) and Adam Benson (Software Engineer)

More information:
www.cmd-corp.com
www.beckhoff.com/twincat
www.beckhoff.com/ethercat

The XTS intelligent transport system from Beckhoff has made a significant contribution to increased production efficiency at ZF in China.

PC-based control and EtherCAT for a new era of chassis-by-wire technology

Rapid data communication, easy diagnostics, and a significant increase in production efficiency

As a global leader in automotive components, ZF is at the forefront of the mobility transformation with its innovative and sustainable technologies. A pioneer in chassis-by-wire systems, ZF also requires advanced manufacturing technology for its brake-by-wire products to achieve faster, more efficient production with higher quality. The production line in China comprises numerous assembly lines with sophisticated core processes. A comprehensive range of Beckhoff components and solutions were used to overcome the associated challenges.

The Beckhoff automation solution for the new production line uses the high-performance C6675 control cabinet Industrial PC with TwinCAT software, along with EtherCAT I/Os featuring XFC technology, AX5000 and AX8000 series servo drives, and the XTS intelligent transport system. Bu Yuli, responsible for Advanced Manufacturing Engineering in the solenoid valve cartridge division at ZF in China, confirms the efficiency of this seamless, PC-based control technology: "The first thing we noticed after implementing the Beckhoff solution was a remarkable reduction in the production cycle time for solenoid valve cartridges, from 2.6 to just 2.4 seconds per unit. This improvement represents a significant increase in productivity that was achieved simply by switching to a Beckhoff controller and EtherCAT."

PC-based control technology from Beckhoff is industrial-grade, utilizing standard PC hardware such as multi-core processors and, in this instance, the high-performance x86 architecture to deliver exceptional computing power. This enables the system to manage sophisticated control tasks and large data sets while meeting the high performance requirements of advanced industrial automation. In combination with EtherCAT's ultra-fast real-time

The numerous servo axes implemented in addition to XTS are controlled by AX5203 servo drives, among others.

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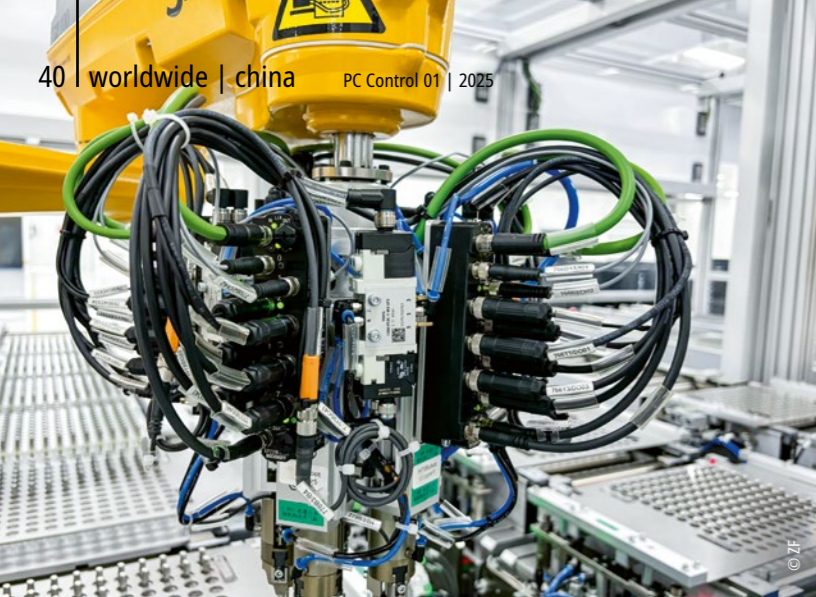
The wide range of EtherCAT I/Os from Beckhoff also includes
IP67 Box modules that can be mounted directly on site.

The high-performance C6675 control cabinet Industrial PC
forms the core of the control system for the new ZF production line.

The Beckhoff AM8000 servomotors with One Cable Technology (OCT) also ensure highly dynamic movements.

response and high-speed data transmission, previous delays caused by signal interactions are also significantly minimized. What's more, the oversampling technology and the TwinCAT 3 Scope software oscilloscope would help to quickly identify potential optimizations and effectively shorten bottleneck processes during programming.

Platform integration and cost savings
"The PC-based control platform not only enables the seamless integration of Manufacturing Execution Systems (MES) and IoT applications, but also works seamlessly with the ZF testing systems. This platform-based solution simplifies system setup and maintenance, delivers significant cost savings, and improves overall operational efficiency," explains Shi Wenjie, responsible for testing in ZF's Advanced Manufacturing Engineering division.

ZF chose the C6675 control cabinet Industrial PC for this production line due to its standardized and modular hardware design, which allows for flexible and demand-oriented configuration and upgrades. The high performance also meant that previously separate software systems for data acquisition, analysis, and motion control could be integrated into the C6675, thereby reducing overall costs. Beyond that, tasks that previously required other control platforms are enabled through TwinCAT Interface for LabVIEW™ or the Beckhoff I/Os and servo drives. Going forward, AI-based quality tools will also be integrated via TwinCAT 3 Machine Learning to increase productivity further still.

Efficient multi-user commissioning
With an increasing number of machine and device functions being implemented via software, it is now standard for multiple programming teams to work on the control code and commissioning. This can lead to challenges during the commissioning process, such as limited access to the version control system, discrepancies between the current status of the software on the

machine and the local system, and errors resulting from irreversible changes. "Our extensive production line often requires integration and commissioning by multiple engineers, which has led to collaboration issues in the past," adds Tian Xiaofei, responsible for Advanced Manufacturing Engineering in production line development.

TwinCAT's multi-user commissioning function now allows multiple engineers to work on the same project at the same time, without requiring specific knowledge of version control. Version control is built into the standard workflow and automatically transfers the current project status to the target system, while creating a history of all changes – including user names, timestamps, and comments on each change. "With the multi-user function, we have achieved both efficiency and time savings during commissioning. The history function also helps us to track changes throughout the program," confirms Tian Xiaofei.

Li Xiao, Advanced Manufacturing Manager at ZF:

" The use of XTS in our assembly line has made production considerably more flexible."

Flexible and efficient installation with XTS
"We have implemented Beckhoff's XTS intelligent transport system on several production lines to assemble critical parts while ensuring flexibility and efficiency," says Shi Anton, Advanced Manufacturing Manager at ZF. "The XTS movers, which are independently, precisely, and quickly positionable, allow us to achieve high-quality assembly of parts. What's more, the individually controllable movers allow for dynamic configurations of the production lines. By loading different recipes, the movers can remain in predetermined positions to enable one-touch product transfer in the production line. In addition, the special topology support of the XTS facilitates a compact line design and maximizes space on the production floor."

In the assembly process, where a small percentage of products may be defective, real-time inspection is crucial to ensure the reliability of brake control systems. XTS improves inspection efficiency by enabling fast and
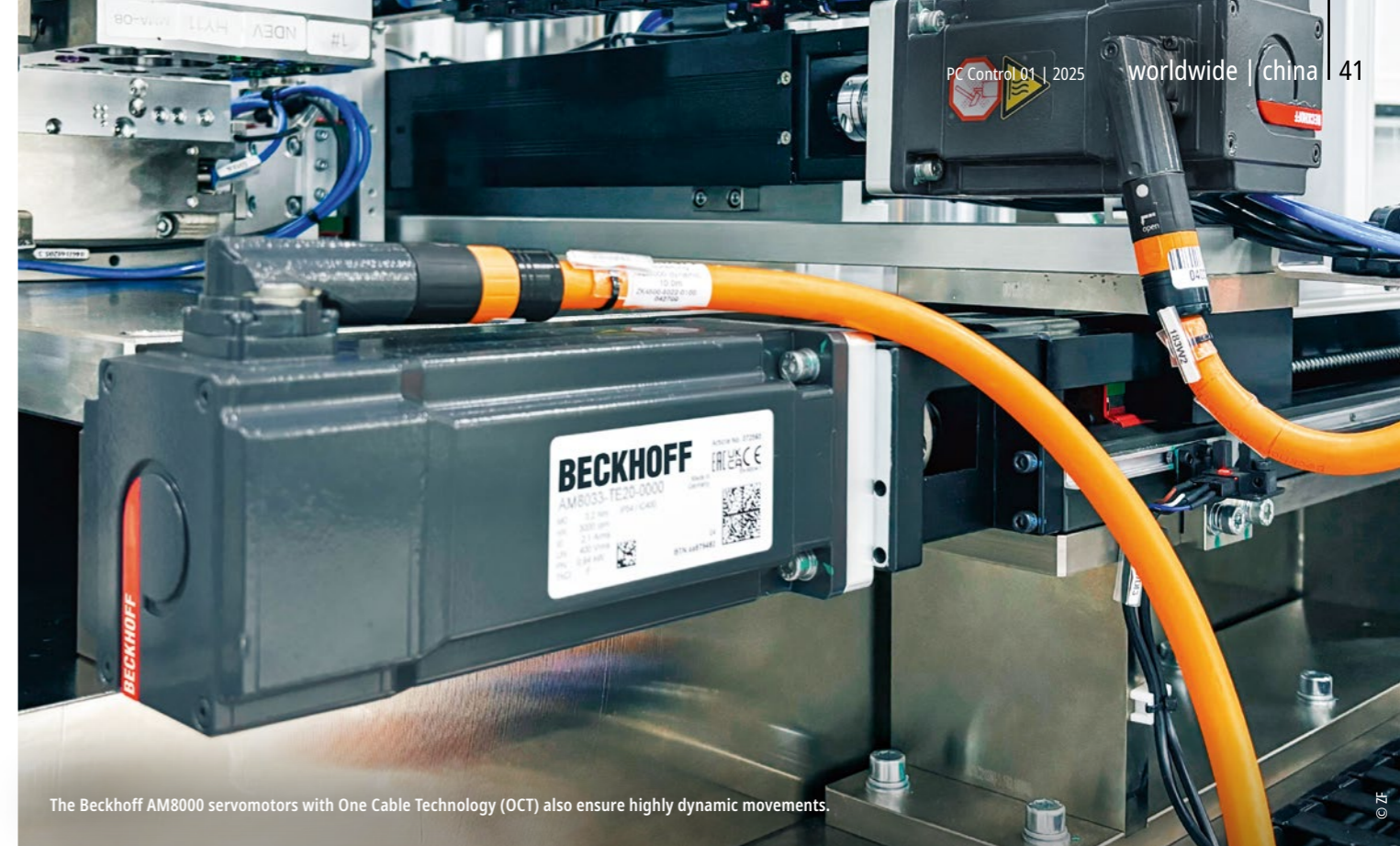
precise control of the mover position and speed. The flexible mover movements allow defective products to be diverted to an analysis station for manual inspection – a benefit that is difficult to achieve with conventional transport systems. "The use of XTS in our assembly line has made production considerably more flexible. The motion control allows us to achieve faster cycle times, while the programmable flexibility ensures smooth transitions between different positions. The generous loading space and versatile layout of XTS also allows us to test more sophisticated production processes without having to remove products from their pallets," explains Li Xiao, Advanced Manufacturing Manager at ZF. "We also see further potential for the future in using the XPlanar planar motor system to improve existing assembly and manufacturing processes. That said, we still need more time to validate it for specific applications."

Conclusions
Beckhoff's PC-based control system, particularly XTS, has demonstrated exceptional performance and adaptability in chassis-by-wire production lines, according to ZF. With faster cycle times, efficient platform integration, multi-user commissioning, and advanced control functions, ZF has been able to achieve significant improvements in both productivity and product quality. "ZF is committed to continuous innovation to increase the competitiveness and adaptability of future production lines by integrating new technologies such as XPlanar, TwinCAT Vision, MX-System, and XFC," summarizes Li Xiao.

The team from ZF China and Beckhoff
China next to Tilman Plaß, Automotive
Industry Manager at Beckhoff Automation,
on the right.

More information:
www.zf.com
www.beckhoff.com/automotive

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Moser-Baer AG in Switzerland is streamlining the production process for its world-famous railroad clocks with a new type of profile bending machine: With four bending rollers instead of the usual three, the Mobamatic MPB23 profile bending machine, with the mechanical platform developed and built by Moser-Baer, can bend a wide variety of profiles without straight end pieces. The automation specialist Pneutronic AG implemented the complete drive and control technology. PC-based control and the AX8000 multi-axis servo system with TwinSAFE ensure a compact design, precision, and safe operation without safety guards and laser scanners.

PC-based control and safe drive technology for profile bending

Closed profile rings – the advantage of the fourth bending roller

The protagonists behind the Mobamatic MPB23 profile bending machine, which does not require an enclosure, light grid, or laser scanner (from left to right): Andreas Iseli, head of Beckhoff Lyssach office, Remo Kissling, managing director at Pneutronic AG, Thomas Steffen, head of mechanical development and equipment manufacturing at Moser-Baer, Eric Schaller, Area Sales Manager Beckhoff Lyssach, and Marcel Gloor, technical manager at Pneutronic AG

Moser-Baer AG, founded in 1938 with its headquarters and production facilities in Sumiswald, has been manufacturing clock and timing systems under the MOBATIME brand for over 80 years. Everyone has come across this famous product: the round clocks that hang on countless train platforms, in station concourses, airports, universities, schools, and public buildings.

The clock cases are based on aluminum or sheet steel profiles that are bent into a ring. Depending on the type of clock, the profiles are made of aluminum up to 3 mm thick or thin angled steel profiles up to 200 mm high. To date, the cases have been manufactured by skilled workers on manually adjusted bending machines. This requires a great deal of experience, as many factors influence the precision of the finished component during the plastic forming of sheet metal, starting with changing resistance moments and different material behavior due to ageing or batch-related factors.

"We have developed the bending machine for our standard portfolio of station clocks with a diameter ranging between 40 and 120 cm – but we also want to be able to bend special constructions with a diameter of several meters," explains Thomas Steffen, head of mechanical development and equipment manufacturing at Moser-Baer. Such large cases are assembled from several profiles. Roundness and adhering to the radius are therefore essential quality criteria for the profile bending process.

Fourth bending roller replaces process step

Moser-Baer's primary motivation for the development was to be able to completely bend the profiles without straight end pieces. "This is impossible in kinematic terms with conventional three-roll bending," explains Marcel Gloor, CTO at Pneutronic AG. The solution: a fourth, independently adjustable roller. This is the only way to achieve the required reversal of the bending direction and bend the profiles completely with the defined radius – without creating a straight section at the end of the profile. This part previously had to be sawn off in a further work step. Thomas Steffen explains: "Curved profiles are always difficult to clamp and saw. This also produces chips and sharp burrs." By avoiding the straight end pieces, 15–20% material savings can be achieved on the case for each clock produced. This represents both a significant gain in

economic efficiency and a contribution to sustainable, resource-saving production – something that Moser-Baer always strives for. In addition, 50% of time savings can be achieved in case ring production by eliminating the separation process after bending.

Safe drive technology reduces the footprint

"Bending processes always involve the risk of trapping and crushing fingers or hands," emphasizes Remo Kissling, managing director of Pneutronic AG, with regard to the safety requirements to be met by the bending machine. Nevertheless, the bending machine was designed without an enclosure, light grid, or laser scanner. This was made possible by a sophisticated safety concept based on the AX8000 multi-axis servo system with TwinSAFE and the AM8000 servomotors from Beckhoff. "We use almost all safe drive functions, such as

The profile bending machine's nine axes are precisely positioned using the AX8000 multi-axis servo system.

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safety limited speed (SLS) in connection with an enabling switch for set-up mode," says Marcel Gloor. Once again, operators need to use both hands to insert and clamp the profile. To prevent injuries, the clamping stroke, which is only a few millimeters, can only be triggered from a safe distance using a foot switch. The foot switch is positioned close to the machine so that the profile can be inserted accurately.

The automatic bending process is started using two-hand buttons, which must be permanently actuated. If the operator releases one of the buttons, e.g., to check something or because another person steps up to the machine, the process stops immediately. The axes are brought to a safe operating stop (SOS). However, the control remains active and continues the bending process as soon as both buttons are pressed again. "Without the wide range of functions such as SLS, SLI, SOS, STO, and the safe drive technology from Beckhoff, this machine could not have been designed without a safety fence or laser scanner," confirms Remo Kissling.

Nine axes in a confined space
A total of nine axes have to be controlled during the process: In addition to the four independent drives for the bending rollers and the three linear infeed and clamping axes, the height adjustment of the two work tables is also controlled. There is also an axis for the hand wheel which is used to set up the processes as well as the virtual X-axis for the feed of the synchronized and linearly trans-

formed bending roller drives. The virtual X-axis represents the straight metal profile, which is used to control all real movements of the bending rollers. "The TwinCAT 3 Motion Designer gave us the flexibility to design the ideal drive system", explains Marcel Gloor.

The machine design is extremely compact – in particular thanks to the small dimensions of the AX8000 multi-axis servo system, the space-saving One Cable Technology (OCT) for connecting the AM8000 servomotors, and the flexible installation options offered by EtherCAT. Eric Schaller, sales at Beckhoff Switzerland: "Pneutronic was able to install the compact drive amplifiers in a second control cabinet and connect them to the CX5240 Embedded PC in the control cabinet via EtherCAT." Marcel Gloor adds: "Without using One Cable Technology as the connection technology for the servomotors, we would have needed additional cables for the safe encoders and would not have been able to design the roller adjusters under the work table in such a compact way."

Teach-in programming
The experts at Moser-Baer teach the movement sequences for a profile using the hand wheel. The employees move all axes to the position in question and save the position values of each axis at the touch of a button. These motion profiles are then stored in the TwinCAT HMI recipe management system and can be called up at any time via the customer-specific CP3918 Control Panel and modified as required. During automatic bending, TwinCAT 3 NC PTP takes

over sequence control and moves all axes synchronously from teach point to teach point.

The machine is currently being used to bend rings for clock cases, but the control technology and mechanics were deliberately designed to enable the production of all parts in the same way as on a conventional 3-roller bending machine. If required, it can also be used to produce design elements with curves, free-form arches, and straight intermediate pieces. "There are no limits in terms of control thanks to TwinCAT 3 and the powerful CX5240 Embedded PC," enthuses Marcel Gloor.

Pneutronic has been realizing a wide range of projects with PC-based control from Beckhoff since 2010. Remo Kissling cites the excellent hardware and software performance, the broad product portfolio, and the scalability of the automation system as reasons for this. The use of TwinCAT as the engineering software and its modular design help to create tailor-made solutions. "My colleagues and I wouldn't want to go back to a time where we didn't integrate GitHub for source code

management," says Marcel Gloor, highlighting one feature in particular. What's more, Beckhoff is always at hand to provide support with its expertise. "Manufacturers like Pneutronic that automate innovative machine concepts will, at times, require a little support. We get this from Beckhoff whenever necessary," says Remo Kissling.

Marcel Gloor, CTO at Pneutronic AG:

> " There are no limits in terms of control thanks to TwinCAT 3 and the powerful CX5240 Embedded PC."

As a Beckhoff Solution Provider that automates many different machines, Pneutronic consistently relies on standardization in terms of the technologies, software, and methods used. That explains why it works exclusively with TwinCAT 3 – in particular the TwinCAT 3 Motion Designer – and Beckhoff components. "We always try to solve the basic tasks in the same way and gain efficiency through standardization in all project phases – from project planning to programming and wiring," says Remo Kissling. In terms of I/Os, for example, Pneutronic has specified twelve EtherCAT I/O Terminals from the wide range that are used to automate projects as standard. "For special functions, Pneutronic can still use the entire range of EtherCAT Terminals at any time," emphasizes Eric Schaller.

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The customer-specific CP3918 Control Panel with two-hand buttons for the automatic bending process
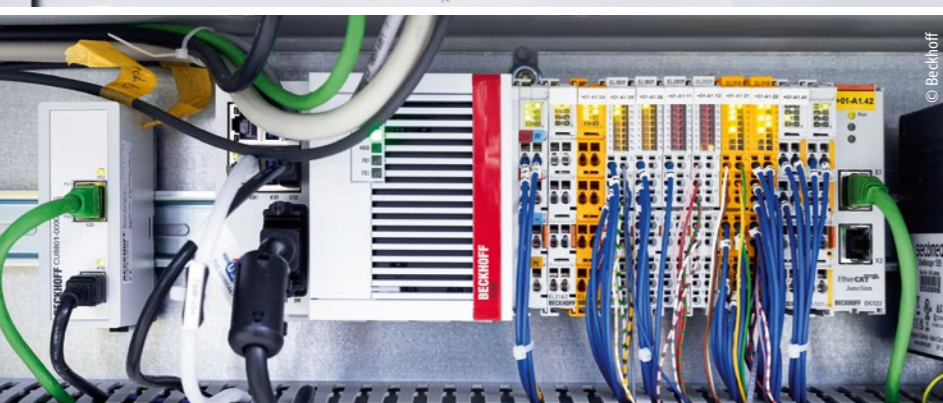
TwinCAT 3 NC PTP and TwinCAT HMI are installed on a CX5240 Embedded PC.

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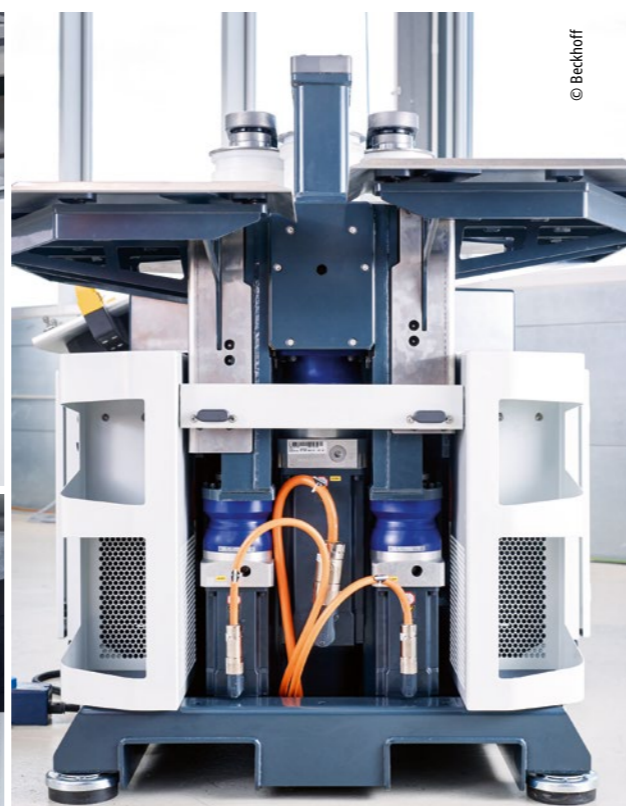
Without the space-saving AM8000 servomotors and One Cable Technology as the connection technology, it would not have been possible to design such a compact roller bending machine.
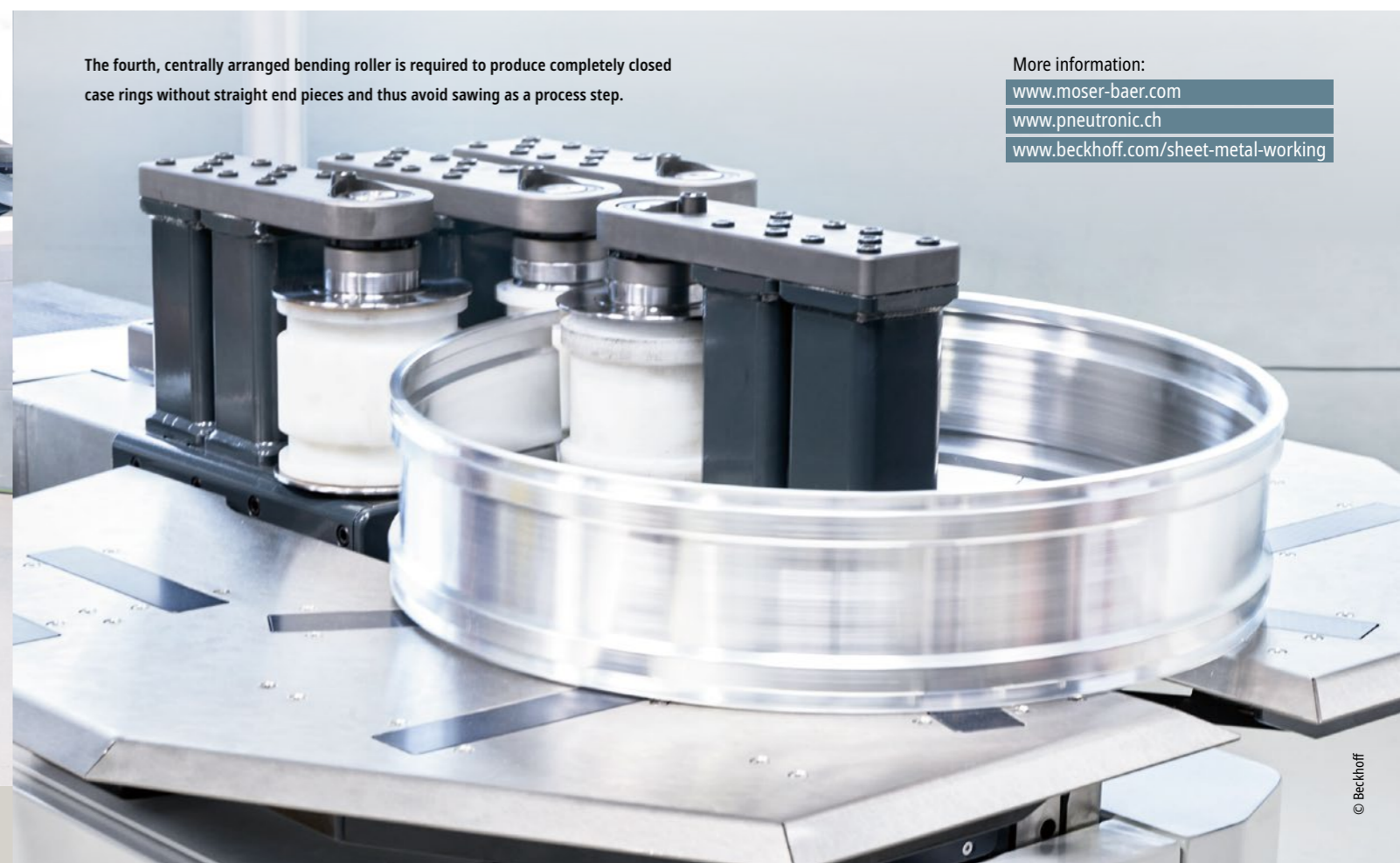
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The fourth, centrally arranged bending roller is required to produce completely closed case rings without straight end pieces and thus avoid sawing as a process step.

More information:
www.moser-baer.com
www.pneutronic.ch
www.beckhoff.com/sheet-metal-working

EtherCAT
in boost mode

EtherCAT is by far the fastest Industrial Ethernet technology. Nevertheless, the data acquisition process at Kraus & Naimer's cam controller test benches called for an even shorter bus cycle. To achieve the required performance, Beckhoff specialists reduced the previous cycle time from 100 µs to 20 µs.
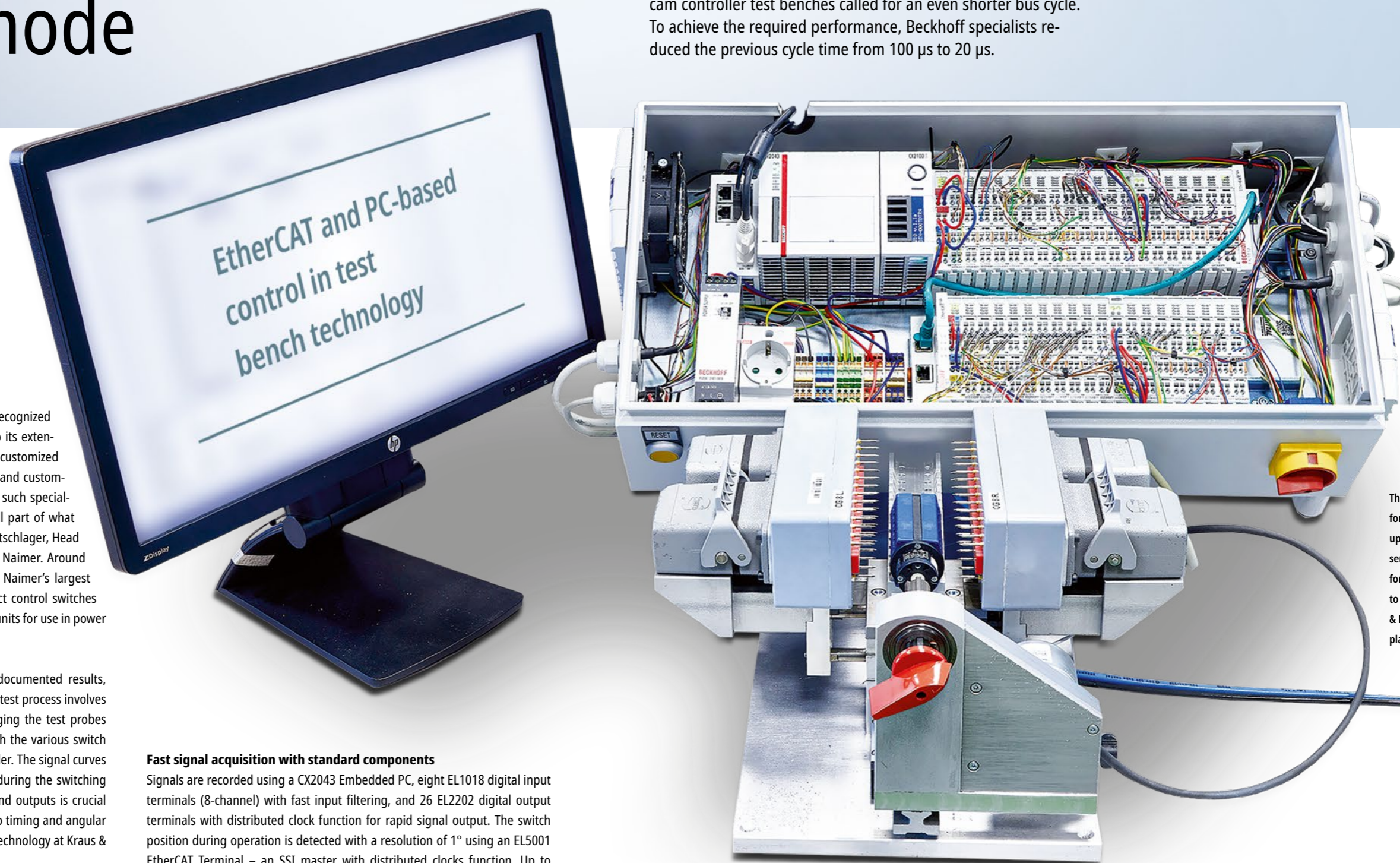
With over 118 years of experience, Kraus & Naimer is a recognized specialist in switches and cam controllers. In addition to its extensive range of standard switches, the company provides customized solutions for various applications with up to 96 contacts and customer-specific contact configurations. "Our ability to deliver such specialized cam controllers starting from a lot size of one is all part of what sets Kraus & Naimer apart," emphasizes Christoph Halbertschlager, Head of Product Data Management and Marketing at Kraus & Naimer. Around 8,000 switches are manufactured every day at Kraus & Naimer's largest production facility in Weikersdorf, ranging from compact control switches and load-break switches with dozens of contacts to large units for use in power plants and energy distribution systems.
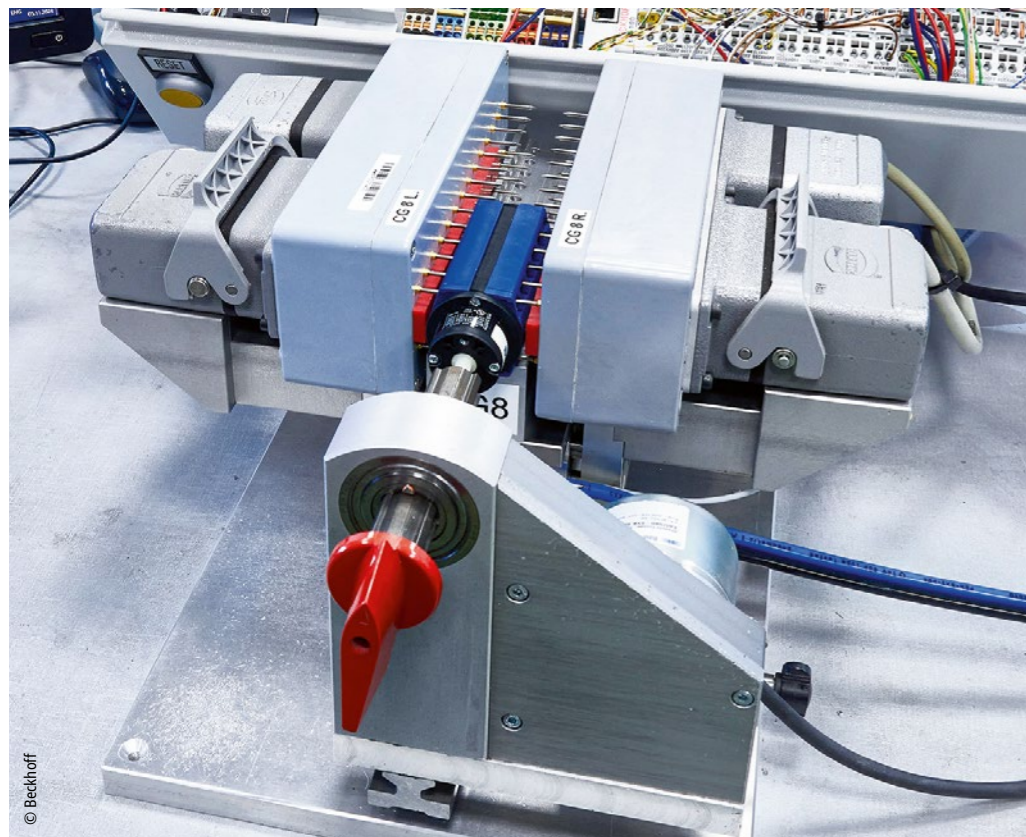
Every single switch undergoes thorough testing with documented results, and that includes the many custom variants on offer. The test process involves placing the switch into the fixture, pneumatically engaging the test probes onto the contacts with a foot pedal, and moving through the various switch positions via a handle equipped with an integrated encoder. The signal curves and rotational angles are recorded with high precision during the switching process. "High-resolution recording of multiple inputs and outputs is crucial for precise testing of switching operations with respect to timing and angular position," notes Ibrahim Podrimja, Head of Automation Technology at Kraus & Naimer in Weikersdorf.

The manual test station for cam switches with up to 24 contact pairs serves as the blueprint for further test facilities to be installed in Kraus & Naimer production plants worldwide.

Fast signal acquisition with standard components

Signals are recorded using a CX2043 Embedded PC, eight EL1018 digital input terminals (8-channel) with fast input filtering, and 26 EL2202 digital output terminals with distributed clock function for rapid signal output. The switch position during operation is detected with a resolution of 1° using an EL5001 EtherCAT Terminal – an SSI master with distributed clocks function. Up to

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Left: Reducing the EtherCAT cycle to 20 µs enables rapid transmission of the 830,000 input and output values recorded during the test.

Bottom: (From left to right) Ibrahim Podrimja (Head of Automation Technology, Kraus & Naimer), David Kittl (Sales, Beckhoff Austria) together with Gerald Platzkammer (Electrical Design and Software Development, Kraus & Naimer) and Rainer Fraunschiel (Developer – specializing in software implementations for automation solutions; Kraus & Naimer) pictured with part of the product range.

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24 switch positions are possible depending on the switch configuration. With the current configuration, Kraus & Naimer can test up to 48 contacts (24 contact pairs).

The challenge during the test was to record the switching pattern quickly and accurately during actuation. "We set very tight tolerance ranges in which a contact must open or close," explains Gerald Platzkammer, Electrical Design and Software Development at Kraus & Naimer. To achieve the high temporal resolution required, the team worked on exploring solutions together with the specialists at Beckhoff.

eXtreme Fast Control or faster bus cycle?

At the beginning of the project, the team considered implementing the high temporal resolution requirements with eXtreme Fast Control Technology (XFC). While assigning inputs and outputs via precise timestamps was technically feasible, it would have added complexity to the evaluation process in this case. "It was much more effective to reduce the EtherCAT cycle time to 20 µs," explains David Kittl, sales representative, Beckhoff Austria. Two bus cycles were used to set the outputs and read back the inputs. "Reducing the cycle time further would have made it impossible to clearly assign inputs and outputs," adds Gerald Platzkammer.

In its current configuration, the CX2043 Embedded PC records around 830,000 bits for 48 contacts via EtherCAT during each test. In the fully expanded configuration for 92 contacts, this figure rises to around 3,000,000 bits. The data is transferred as an array to the evaluation program, where it is compared with the target switching program and switching sequence. The C#-based evaluation program retrieves data from the control program via ADS and accesses order-specific switching programs from the ERP system and various databases through web services. "A major advantage of PC-based control is that we can continue to run our software on the Beckhoff control system with minimal adaptation effort," says Rainer Fraunschiel, a developer specializing in software implementations for automation solutions. This enabled Kraus & Naimer to eliminate the need for an additional PC as an interface between the ERP system and the controller. "Thanks to the fast bus cycles and PC-based control, the entire electrical test still takes no longer than 2 seconds," adds Ibrahim Podrimja. At the end of the process, a test report is stored in a database together with the target/actual comparison of the switching patterns for each individual switch.

PC-based control replaces separate measurement technology

Before switching to Beckhoff as its automation supplier, Kraus & Naimer used a separate measurement technology computer with custom-designed plug-in cards. The move to PC-based control technology allowed the company to cut down on equipment significantly. "Eliminating the need for an additional PC has allowed us to save both space and costs," explains Ibrahim Podrimja. "We've also become more independent by using Beckhoff's standard components." He goes on to highlight the comprehensive product portfolio, strong support, and solution-oriented approach of the sales team, which continues to provide valuable assistance for future projects.

The switch to TwinCAT 3 and Structured Text as the programming language provided further advantages. "We were able to make the control program

more intelligent and add features that would have been very difficult to implement before," notes Gerald Platzkammer. The open architecture of PC-based control allows for the use of any visualization solution when needed, alongside TwinCAT HMI. Another major advantage of TwinCAT, according to Ibrahim Podrimja, is the widespread use of TwinCAT 3, "Many vocational students learn to program with TwinCAT 3 during their training and are already familiar with PC-based control when we hire them as control engineers." He also points out that having software documentation and functional descriptions available in German is another significant benefit.

More projects in the pipeline

Parallel to the ongoing projects in assembly automation, cooperation in the testing technology sector is starting with the manual high-end test bench. Plans are in place for additional test stations to be used at Kraus & Naimer's production facilities around the world, while existing fully automated test benches are set to receive Beckhoff control system upgrades. Since the start of the collaboration in fall 2023, four other projects have been implemented in parallel to the test stations, with a new assembly automation system currently in the planning stage. "Beckhoff's approach and company size make it the perfect fit for us," concludes Ibrahim Podrimja.

© Beckhoff

Every cam switch at Kraus & Naimer undergoes thorough testing of its switching patterns and functionality on a range of test benches.

More information:
www.krausnaimer.com
www.beckhoff.com/measurement

eXtreme Fast Control (XFC) and EtherCAT
in semiconductor manufacturing

Advanced packaging for 3D structures in the micrometer range

The printer is controlled by a C6017
ultra-compact Industrial PC (left);
the energy required for the very
high and short current pulses is
provided by compact PS2001 power
supply units (top).

Fonontech's Impulse Printing™
technology enables fast and
non-contact 3D printing of wafers
and printed circuit boards with
conductive ink in the µm range.

© Beckhoff

ules could then be combined to form a large print head that uses the distributed clocks of EtherCAT and XFC to print larger structures with higher precision.

Fonontech is currently using a C6017 ultra-compact Industrial PC that runs TwinCAT 3 PLC/NC PTP, TwinCAT 3 Target for Simulink®, and TwinCAT 3 HMI. The image processing application is currently run on a 19-inch C5240 slide-in Industrial PC. Fabien Bruning comments: "We could probably also run the algorithm on the C6017, but it's more convenient for it to be installed on a separate industrial PC during development."

The goal: 5 µm resolution
The prototype is currently printing multiple patterns measuring 10 µm in width on the substrates. "Structures as fine as these are beyond the abilities of most printing techniques," explains Rob Hendriks. Fonontech wants to go further than this, however, with the aim of producing lines measuring 5 µm wide with a sub-micrometer overlay error range. The exact timing of the processes required for printing with this high level of precision is based on eXtreme Fast Control Technology from Beckhoff. It is also necessary to migrate the current motion concept to an air-bearing sub-micrometer platform. "Thanks to the openness and flexibility of PC-based control, this works with the same hardware and control philosophy," states Stijn de Bruin.
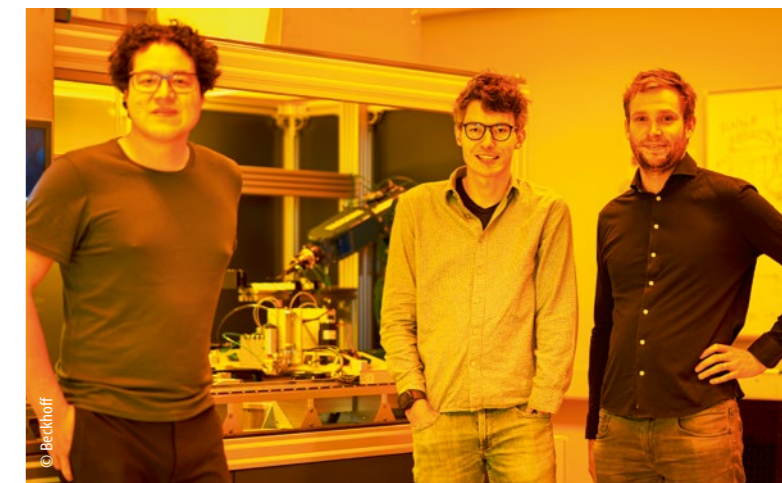
In the beta version of the system, various motor variants and a handling platform are integrated alongside the air-bearing system. The compact drive technology for the low-voltage range up to 48 V – the EL72xx EtherCAT Servomotor Terminals and AM8100 Servomotors – has the potential to save additional space and outlay during installation and commissioning in this case. Fabien Bruning sees the integration of distributed controllers and EtherCAT functionality as another interesting option: "There are not actually many alternatives to PC-based control on the market if you want to develop and market functional units with their own high-performance slave controller and integrated motion."

More information:
www.fonontech.com
www.beckhoff.com/semiconductor-industry

CTO Fabien Bruning (left) and CEO Rob Hendriks (right, both from Fonontech)
with Stijn de Bruin (center, from Beckhoff Sales in the Netherlands), in front of
the proof of concept for the technology.

Electronic components and their structures are becoming smaller and smaller, making it all the more difficult to bond them. Conventional processes have long since reached the limits of what they can do in this area, but the Impulse Printing™ process developed by Dutch start-up Fonontech is bringing something new. It enables advanced packaging of semiconductors in 3D structures in the micrometer range. XFC technology components from Beckhoff and EtherCAT are key in this process.

The miniaturization of electronic components is making it increasingly difficult for conventional lithography-based processes to produce the bonding structures between components economically and reliably. "Conventional manufacturing techniques are reaching the limits of what they can do. With our Impulse Printing™ technology, we are taking things to the next level," says Fabien Bruning, CTO of Dutch start-up Fonontech B.V., based in Eindhoven.

The most important components in the process are silicon printing plates with micron-sized structures etched into them. These structures absorb the ink, which is applied to the substrates (printed circuit boards) during the next step. In addition to the etched conductor tracks, a heating structure is incorporated into the printing plates. Fabien Bruning explains: "A very high, short current pulse causes a tiny amount of the ink solvent to evaporate suddenly at the

interface with the wafer. This blasts the ink off the wafer and onto the circuit board." Rob Hendriks, CEO of Fonontech, adds: "This process works really well even at a distance of over 60 cm, albeit with less accuracy at that point."

It is important that the printing process is contactless and fast. With a single current pulse, thousands of lines can be printed on a circuit board or other substrate in less than 1 ms. In addition, selective heating of the heating structures enables local alignment between the structure being printed and the substrate. The print head developed by Fonontech covers an area of 128 x 128 mm and can process all common inks. "This allows 300 mm wafers or areas of 600 x 600 mm to be printed in a short space of time, a format that is currently finding its way into back-end semiconductor assembly," says Fabien Bruning. With a flat heating plate and a stencil printing process, even

larger structures can be produced in the same machine – for flat screens, as an example. Several print heads can be easily mounted next to each other for this purpose.

Fast and precise with PC-based control
The process is automated with PC-based control from Beckhoff. "Working with EtherCAT and XFC technology, Fonontech can synchronize and position the various modules of the machine in real time and with the necessary precision," explains Stijn de Bruin, sales engineer at Beckhoff Netherlands. When building the prototype, Fabien Bruning decided from the outset to use as many standard components as possible. As he explains, Beckhoff was chosen partly because of the flexibility that the TwinCAT 3 control software offers: "For example, we created algorithms in Simulink® that we execute in real time in TwinCAT." He also adds that there are many third-party suppliers who offer components with an EtherCAT interface. EtherCAT is also accepted by SEMI™ (Semiconductor Equipment and Materials International) as a communication standard (E54.20). For that reason, Fabien Bruning is also working on offering the print head as a separate module with an EtherCAT interface: "This would make it much easier for other companies in the semiconductor industry to integrate our technology into their machines." In addition, several print mod-

© Beckhoff

PC-based control technology in large telescopes

Keeping the limits of space and time in view

The Instituto de Astrofisica de Canarias (IAC – Institute of Astrophysics of the Canary Islands), a research institute at the University of La Laguna, Spain, operates two astronomical observatories on the Canary Islands: the Roque de los Muchachos Observatory on La Palma and the Teide Observatory on Tenerife. PC-based control and motion control from Beckhoff enable astrophysicists to explore the limits of space.

The partnership between IAC and Beckhoff began with the first telescope for the Q-U-I Joint Tenerife Experiment (QUIJOTE I) over twelve years ago. Its aim was to characterize the polarization of the cosmic microwave background (CMB) and other galactic and extragalactic emission processes in frequency ranges from 10 to 42 GHz, and to discover traces of the Big Bang in this way. Beckhoff Automation was chosen as the partner for the telescope's control technology – and is still a valued partner today.

Precision with motion control and EtherCAT
The telescope's control system is based on TwinCAT 2 NC PTP and a C5102 19-inch slide-in Industrial PC which precisely controls the azimuth and elevation of the

telescope. In addition to the digital and analog inputs and outputs required to control the telescope, the EL6688 (IEEE 1588/PTP) communication interface facilitated the programming and implementation of the Precision Time Protocol. This EtherCAT Terminal supports PTPv1 (IEEE 1588-2002) and PTPv2 (IEEE 1588-2008) as a device in the IEEE 1588 synchronization system. "Clock synchronization is crucial for synchronizing telescopes very precisely with the movements of the stars and galaxies being observed," states Jose Miguel Herreros, Engineering Director of IAC. Another major challenge was moving the axes with exceptional precision at both very slow speeds and

PC-based control is used to automate the telescopes and other instruments at the Roque de los Muchachos observatory on La Palma and the IAC Teide on Tenerife (pictured).

The QUIJOTE I telescope with the axes for vertical alignment (elevation) and instrument cabinets.

(From left to right): Daniel Casco (Beckhoff Automation), Saúl Menendez (IAC), Roberto Iraola (Beckhoff Automation), Panchi Gomez (IAC), and Jose Miguel Herreros (IAC) migrating the QUIJOTE I telescope from TwinCAT 2 to TwinCAT 3 at the end of 2022.

Different site, same technology

The Roque de los Muchachos Observatory (ORM) on the edge of the Caldera de Taburiente National Park, sitting at an altitude of 2,396 m in the municipality of Garafía (La Palma), boasts one of the most comprehensive telescope technologies in the world. Thanks to the clear atmosphere and its location far away from disruptive light waves, the observatory offers ideal conditions for astronomical research. This is why the location has been home to some of the largest-ever telescope projects – as well as the new generation of Cherenkov telescopes for exploring the universe using very high-energy gamma rays.

The observatory operates what is currently the world's largest optical and infrared telescope, the Gran Telescopio de Canarias (GTC), alongside twenty other telescopes and astronomical instruments for applications such as nocturnal, robotic, solar, and astrophysical observations involving high energy. These telescopes have already made significant progress in exploring the universe: for example, identifying the most distant galaxy or confirming the existence of black holes and the accelerated expansion of the universe.

A superlative telescope

With a mirror diameter spanning 10.4 m, the GTC is the largest telescope at this observatory. Its planning phase began in 1994 and the GTC was put into scientific operation around 15 years later in 2009. As the technology of the control system specified at the time eventually became outdated, it has since been replaced by PC-based control. This occasion also enabled subsystems such as building automation and lighting systems to be integrated. "We have been able to implement these subsystems thanks to Beckhoff's open PC-based technology and its experience in building automation," explains Roberto Iraola.

The close cooperation between Beckhoff and GTC extends not only to modernization, but also to the development of new technologies such as instrument calibration modules (ICMs). It is common practice to use an ICM to calibrate scientific instruments. In the GTC, this system consists of a series of lamps with defined wavelengths and a mechanism for positioning a parabolic mirror that reflects the light onto the telescope mirror. PC-based control is used to control and dim the ICM's spectral and incandescent lamps. A CANopen interface (master) for operation with the existing CANopen infrastructure was also implemented.

This was followed in 2018 by another calibration module: the ICM-FC. TwinSAFE was used in this project to prevent the mirror from moving and to control the intensity of the illumination when people are in the vicinity. Additionally, this ICM is in charge of controlling the power supply for hollow cathode lamps. Beckhoff technology has also played a role in other projects, such as monitoring and controlling the helium tank compressors and their refrigerants.
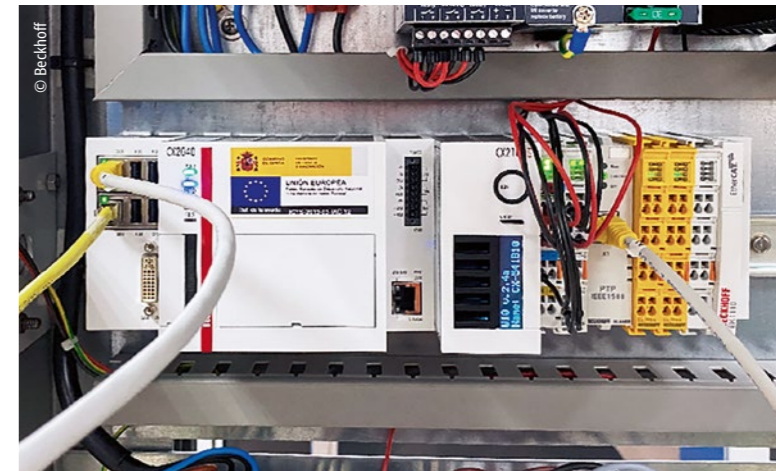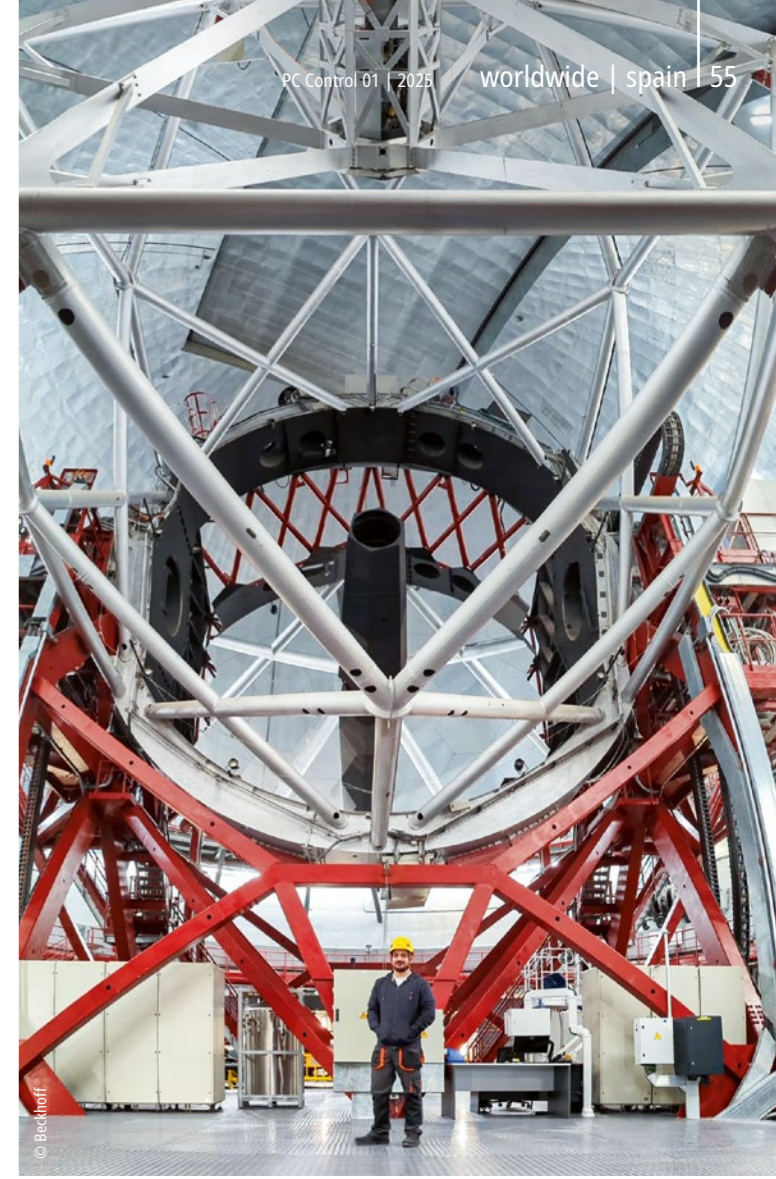
Top: The telescope's enormous dimensions are precisely aligned with stars and galaxies and tracked using TwinCAT 3, embedded PCs, and motion control from Beckhoff.

Bottom: CX2040 Embedded PC with EL6688 EtherCAT Terminal for synchronization via Precision Time Protocol IEEE1588.

higher speeds. The reason for this was the significant moment of inertia on the direct drive of the azimuth axis, which required extensive adjustments to the speed controller in the AX2000 servo drive used at the time, recalls Roberto Iraola, Sales Manager Beckhoff, who adds: "This was fundamental to the project's success."

This project was followed by the QUIJOTE II telescope for the TFGI (Thirty Forty GHz Instrument), which consists of a total of 30 receivers. AX5000 digital compact servo drives were already in use with this telescope. Beckhoff developed both telescopes in close cooperation with Spanish company IDOM, while IAC employees developed the control software. In 2022, both control systems were migrated to TwinCAT 3 and C5240 19-inch slide-in Industrial PCs. "We are currently working with Beckhoff on many projects such as 'Harmoni' for the Extremely Large Telescope (ELT), robotic telescopes, and various instruments mounted on these telescopes," says Jose Miguel Herreros.

Extensive modernization

The Carlos Sánchez (TCS) and IAC80 telescopes at the Teide Observatory on Tenerife are manually controlled by astronomers using computer applications that were developed back in the 1990s. In addition to motion control, these applications control subsystems such as the dome, windows, gates, and covers,

and monitor the weather station, alarms, and GPS signals. This control system initially consisted of a PC with plug-in cards for communication with the subsystems. It was operated using another PC, which communicated with the control computer via RS232. Although some modernization measures have been carried out, a large part of the control system is still based on components that are now completely outdated.

A project that started in mid-2019 and has not yet been completed aims to migrate the control systems of these telescopes to state-of-the-art, robust software and hardware, and to implement advanced remote control in the process. This future high-level control software will be based on the ROS (Robot Operating System) open-source operating system, while the underlying control architecture will be based on EtherCAT and TwinCAT 3 from Beckhoff. To reduce the possibility of technical risks affecting the project, the team developed a telescope simulator to represent the telescopes' drive system and data network, and provide a virtual test bed for developing and testing the new system – which will not be implemented at telescope level until extensive testing has been performed. Additionally, an ongoing investigation is assessing the suitability of TwinCAT Vision for automatic star tracking by telescope. An autoguiding system has been selected for testing and can also be used for other telescope tracking systems.

More information:
www.iac.es
www.beckhoff.com/science

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The lighting scenarios and motion sequences created using 3D DMX software are converted into precise, synchronized control signals for the nozzles, pumps, and LED lights, working on the basis of a PC.

Control cabinet with the CP2216 multi-touch built-in Panel PC and TwinCAT 3 HMI for on-site operation and status queries.

© Fluidra

site, DMX control channels required for this purpose were created for each device in TwinCAT 3 HMI. Operators can also access the system remotely and, for example, respond quickly to an alarm message by email.
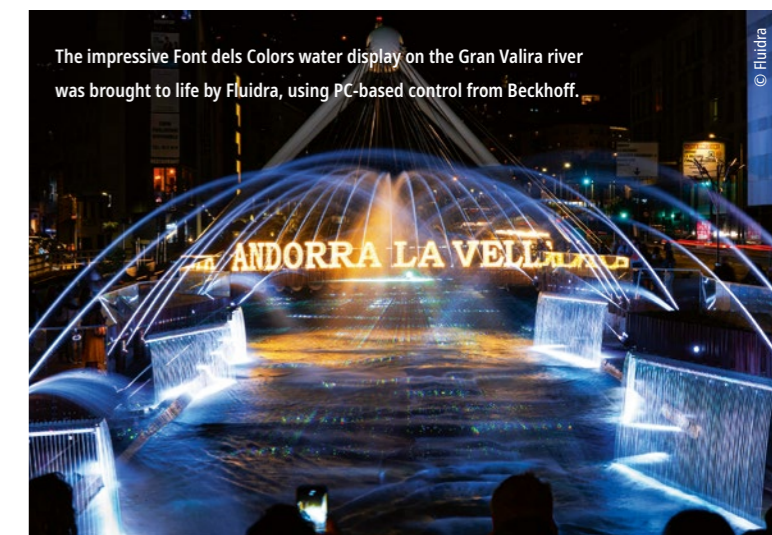
Conserving water resources

The solutions from Fluidra and Beckhoff don't stop at aesthetics and technology, however – both companies are also committed to using ecological resources sustainably. For this reason, Font dels Colors has implemented a water cycle that significantly reduces consumption and ensures efficient use of the valuable resource of water. In addition, UV filters and disinfection systems have been installed to maintain high levels of water quality without the use of harmful chemicals.

According to the experts at Fluidra, this integrated approach involving technological and ecological innovations is setting new standards for planning and constructing water systems. Combining aesthetically appealing water displays with ecological responsibility points the way toward a more sustainable and exciting future for urban spaces.

PC-based controlled water installations

Water, light, and audio coordinated with outstanding precision

Fluidra S.A. creates impressive installations involving water, light, and music – one example being the Font dels Colors fountain in Andorra's capital city. To automate and synchronize the technical systems, the company relies on PC-based control from Beckhoff, whose openness and flexible approach to creativity open up a whole host of possibilities for designers.

More information:
www.fluidra.com
www.beckhoff.com/entertainment-industry

The impressive Font dels Colors water display on the Gran Valira river was brought to life by Fluidra, using PC-based control from Beckhoff.

© Fluidra

Fluidra's technical skills and Beckhoff's expertise in automation technology are at the heart of spectacular water displays such as the Font dels Colors in Andorra, the twin fountains in Plaça de Catalunya (Barcelona), the fountains in La Pedrera Park (Argentina), and the Vadistambul shopping center fountain (Türkiye). These projects contain PC-based control technology from Beckhoff, including TwinCAT 3 PLC/NC PTP and TwinCAT 3 HMI Server as software, plus EtherCAT Terminals and EtherCAT Box modules – which can be installed in a decentralized configuration – acting as the I/O level. The lighting technology is integrated using technology including EL6851 EtherCAT Terminals (DMX master). A CP2216 multi-touch built-in Panel PC allows technicians to control the system as required, call up status messages, and respond to alarms.

Developed by Fluidra in collaboration with architects Pere Cervós of Pere Cervós Arquitectura and Ricard de Deus of Causa Estudi Arquitectura, along-

side the construction company Locub S.A., the Font dels Colors water display combines an impressive installation with light and music located next to the Gran Valira river and the Puente de París bridge in the heart of Andorra's old town. This attraction transforms the city promenade into a living work of art that captivates tourists. Another special feature of the project is its innovative, sustainable approach in which the water for the cascades is taken from the river and then reused.

Precise synchronization a must

PC-based control allows all the components of the Font dels Colors and other projects to work in perfect synchronicity – from the lighting effects and background music to the dynamic choreography of the water jets and pumps. Fluidra makes full use of Beckhoff's extensive modular I/O portfolio, which covers everything from simple digital inputs and outputs to motion control and

AM8000 servomotors. The communication options with DMX management systems are a key advantage; Fluidra uses these for programming and operating the water installations, for example.

Fluidra uses its 3D software to create the sequences for its water displays, from the jets and illumination features to the sound system. The control data for the light and water jets is then output via what are known as DMX control universes. These sequence programs are installed on a separate DMX player, which is included in every system. The sequences are transferred to the CP2216 Panel PC via an EL6851-0010 EtherCAT Terminal (DMX slave) and EtherCAT, and are executed in TwinCAT 3 PLC/NC PTP – in other words, converted into control signals for the various components, including the servomotors. Any components with a DMX connection can be integrated directly via additional EL6851 EtherCAT Terminals (DMX master). To allow intervention in the sequences on

PC-based control for a food capsule and pod packaging machine

The sky is the limit for performance and innovative capacity

AX5000 servo drives precisely control the AM8000 servomotors.

For TME, a machine builder specializing in the packaging of powdered foods, Beckhoff was the obvious choice of system supplier: Beckhoff PC-based control technology offers unlimited opportunities when it comes to the performance and innovative capacity – in terms of flexibility, scalability, and openness – of its packaging machines. This is particularly evident in the latest Cialdy Evo machine series.

PC-based control enabled TME to increase the output of the Cialdy EVO packaging machine to 200 individual pods per minute.

© TME

Founded in Fidenza, Italy, in 1982, TME Packaging Solutions is known around the world for its packaging solutions, particularly for powdered food such as coffee in capsules and pods. "TME was one of the first companies to produce packaging lines for single-dose products and is currently focusing on technologies for sustainable packaging," emphasizes Alice Magnani, head of HR and marketing, and member of the founding family's second generation. TME's export share of over 80% reflects not only the company's standing on an international scale, but also its reliability and ability to innovate, which is necessary in the face of tough international competition.
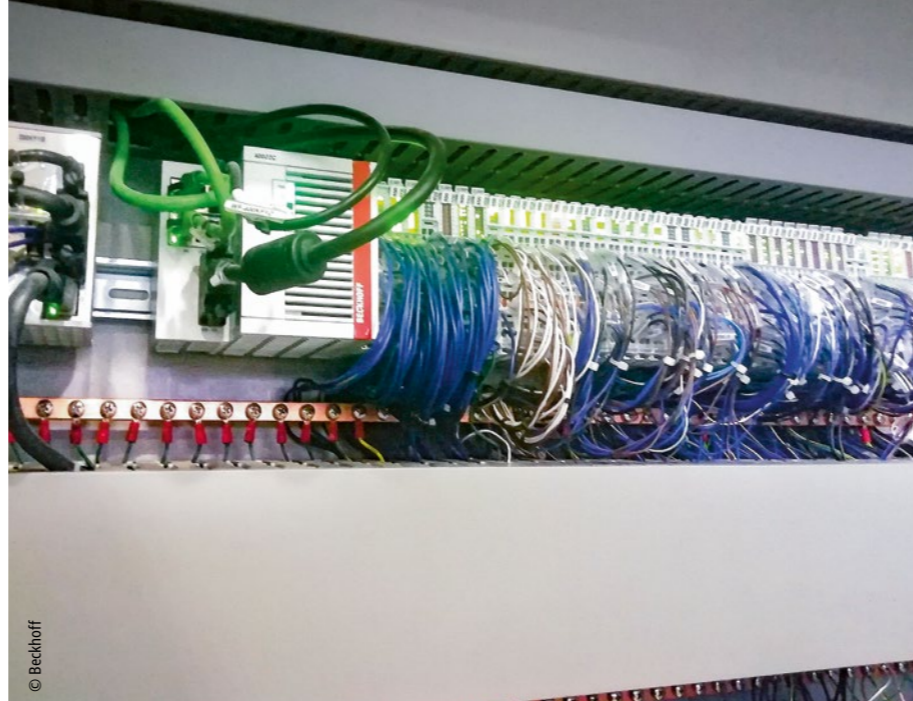
With the Cialdy Evo, TME has developed a compact packaging machine for coffee, barley, tea, and herbal teas in sealed paper filter pods in single-portion bags. The machine precisely dispenses and fills up to 200 pods per minute which are then sealed with the integrated sealing unit. "The special thing about this packaging machine is that the packaging process takes place around the pod that has just been formed," explains Andrea Zuccheri, who is responsible for software engineering and automation at TME. In addition to higher productivity, the integration of the packaging and sealing process offers further advantages such as a smaller footprint of just 10 m². The compact automation components from Beckhoff also play a part.

All disciplines combined in one system

"We're thrilled about PC-based control as an automation solution, which is why we have fully automated our machines with Beckhoff technology," explains Andrea Zuccheri. TME has implemented the entire range of Beckhoff components, from CX series Embedded PCs and CP-Link 4 remote control panels to numerous EtherCAT Terminals, AX5000 servo drives, and AM8000 servomotors with One Cable Technology (OCT). As Andrea Zuccheri goes on to explain: "PC-based control ensures a clear control architecture, saves space in the machine, and also reduces installation, wiring, and maintenance work." What's more, EtherCAT ensures fast and synchronous communication with all components.

Moreover, several applications can be integrated into a single control system, including PLC and motion control, visualization and vision, as well as external applications such as the management of additional devices. For example, users can access the labeler integrated via EtherCAT in the control panel using a browser to set the parameters for labeling.

Innovation without limits

The decision in favor of PC-based control was also made due to the continuous innovations and the resulting development potential that Beckhoff offers machine builders like TME. "PC-based control offers endless possibilities in the design phase. If we have an idea, we're certain that we'll be able to implement it," says Andrea Zuccheri. The system-integrated approach also makes it possible to divide scarce personnel resources between the various machine series. This has enabled TME to reduce the overall design, development, and testing times for its machines.

"You can't build flexible and truly open machines today without using a PC-based architecture," states Andrea Zuccheri, describing the paradigms of Industry 4.0. With PC-based control, it is possible to connect the machine to the Internet, communicate with other machines or devices on a production line and, if required, also manage devices and systems from other manufacturers. All this with a standardized, scalable solution that can be upgraded to the latest available PC technology or a more powerful CPU at any time – without having to adapt the application. This is a great advantage in the design phase, during commissioning, or when servicing.

Another argument put forward by Andrea Zuccheri is that, unlike other software platforms, the TwinCAT development environment is free of charge: "Our technicians are always able to access the complete development environment on their laptops – this means that they can carry out upgrades or software reconfigurations at our customers' premises at any time." In the event of acute faults, the end customer can install TwinCAT on a local computer and connect to the system within a few minutes. Using remote maintenance, the service technician can then search for and rectify the fault. "During the COVID-19 pandemic, our support team was able to carry out commissioning and maintenance tasks on systems that were thousands of kilometers away," adds Alice Magnani.
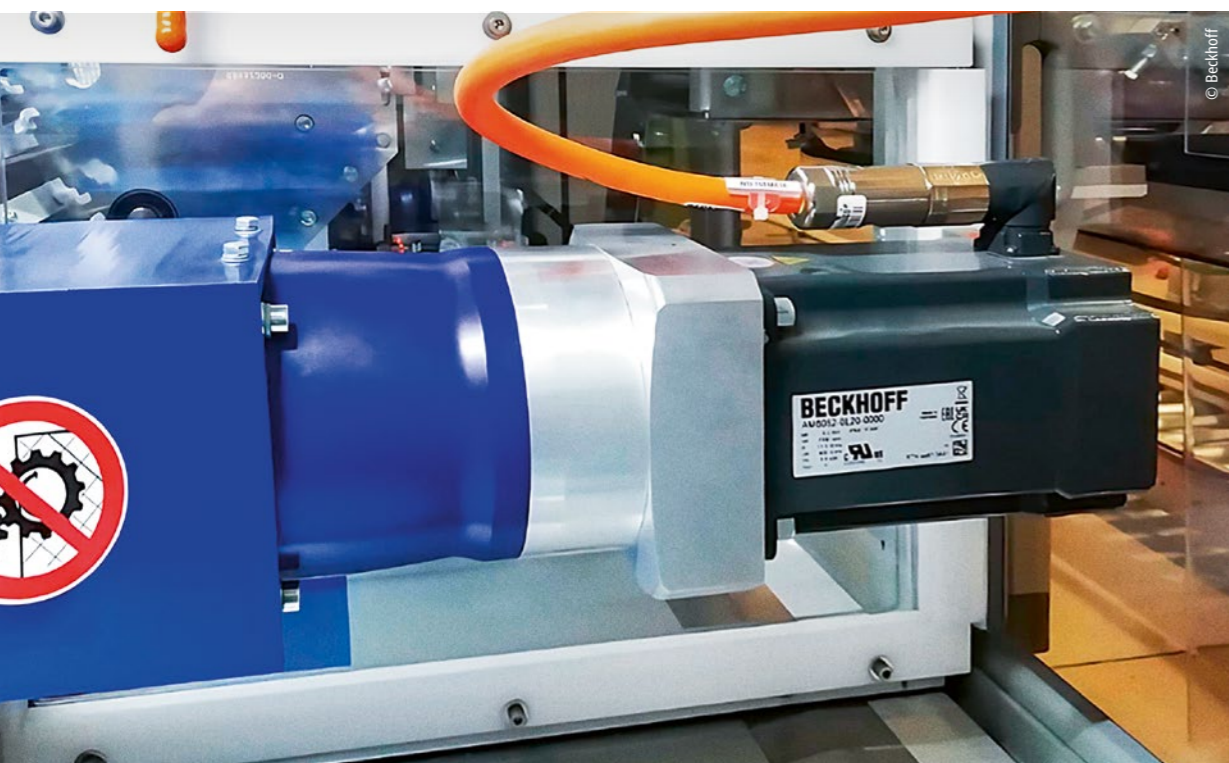
Investing in sustainability

According to the machine builder, system supplier Beckhoff optimizes purchasing management and accelerates the implementation of innovations with its product developments. TME is currently focusing on sustainability, both in terms of reducing energy consumption and processing environmentally friendly materials. "Our upcoming machine series will be even more modular and open for integration – and will come with an app for monitoring," concludes Andrea Zuccheri.

Left: For the Cialdy EVO packaging machine, TME uses a CX5130 Embedded PC with numerous EtherCAT Terminals (right) and the CU8802 CP-Link 4 transmitter box (left) for communication with the control panel.

Right: The openness of PC-based control and EtherCAT makes it possible to configure third-party devices such as a labeler via the CP3916 Control Panel.

© Beckhoff

The One Cable Technology connection technology for the AM8000 servomotors speeds up installation and saves valuable space.

© Beckhoff

© TME

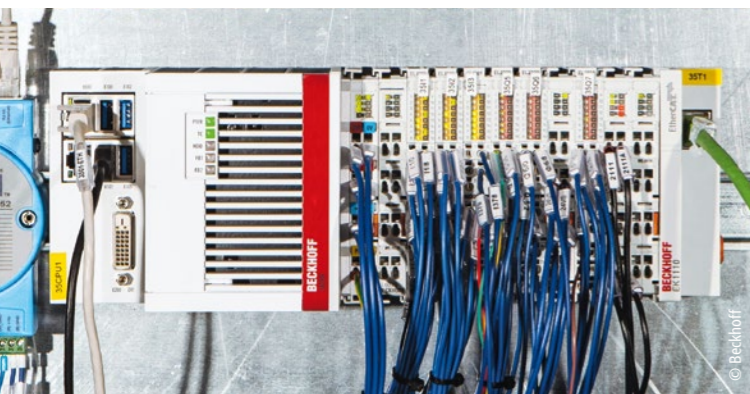Andrea Zuccheri, head of software engineering and automation at TME:

" With Beckhoff as our system partner and PC-based control, we are confident that we can implement our ideas."

More information:
www.tmeitaly.com
www.beckhoff.com/packaging

PC-based control and EtherCAT in a new generation of sorting machines

PC- and EtherCAT-controlled for parts sorting with 100% inspection

Dimac designs and develops innovative solutions for 100% inspection of fasteners and small metal parts. The company has identified EtherCAT and PC-based control from Beckhoff as the mainstays of the next generation of sorting machines, which will make the La Mille concept machine – the thousandth Dimac project – even faster, more powerful, and open to the integration of additional systems.

Guido Noce (right), general manager, and Enrico Ottaviano (left), engineering and R&D manager, (both from Dimac) in front of the La Mille concept machine with image processing already integrated in TwinCAT HMI.

© Beckhoff

The CX5240 Embedded PC and the connected EtherCAT Terminals – incl. the EK1110 EtherCAT extension for setting up a line topology – provide the performance and flexibility for integrating additional function modules.

© Beckhoff

Dimac srl, based in Tortona, Italy, states that it is one of the few companies in the world to specialize in manufacturing high-speed machines for 100% sorting and quality control of small metal parts and fasteners. "Fast is up to 1,200 parts per minute," explains Guido Noce, general manager of Dimac. With an export share of over 70% and having installed more than 1,000 machines, the company supplies the most important American and European manufacturers of fasteners – with the automotive sector as one of its most important markets. In addition to screws, nuts, and washers, Dimac machines are used to inspect a wide range of components. These range from motors, airbags, and other electromechanical components to jeans buttons, the tiny screws used in glasses, and chain links.

High flexibility and speed

The variety of different parts and quantities requires a flexible and powerful automation solution for the sorting and inspection systems. This is because the control technology ultimately determines the speed and reliability of the machines. With its La Mille concept, Dimac initiated an ambitious project, with

the aim of completely redesigning the existing automation solution in order to further enhance the performance and reliability of the machines.

"The reliability of our machines is the result of a concept based on a single piece of software that has been constantly updated with variants and new functions," explains Guido Noce. Over the years, the many extensions to the previous solution had led to limitations in the operation and management of the software. After 25 years of overlapping software layers, it was time to make a new technological leap. "When we conducted a market analysis among automation providers, we found that PC-based control from Beckhoff and EtherCAT were the best for fulfilling our needs," emphasizes Enrico Ottaviano, engineering manager at Dimac. Guido Noce adds: "With La Mille, we want to comprehensively test the best that the market currently has to offer, in our view. The aim is to create an automation platform that will shape the next generations of Dimac machines."

Performance and openness were the deciding factors

"We chose PC-based control from Beckhoff and EtherCAT primarily because of their openness and performance," emphasizes Ottaviano. He was looking for a solution that did not prescribe a specific topology or tie the company to one supplier or a limited group of manufacturers. The open EtherCAT protocol and the many providers of corresponding masters, devices, actuators, and solutions fulfill this requirement. In addition, the cycle times and update intervals of the decentralized peripherals needed to be significantly shorter than before. With regard to future developments, the aim is to reduce cycle times from 10 ms to around 1 ms. Guido Noce comments: "Even during the first tests, we realized that we could achieve the required performance with the high-performance EtherCAT protocol."

Another important aspect was the ability to use open, standardized software and development environments such as IEC 61131-3. "We chose the Beckhoff TwinCAT software system precisely because of these properties," adds Ottaviano. Dimac uses a CX5240 Embedded PC with an Intel Atom® processor with 1.6 GHz clock frequency (quad-core) as the controller; another industrial PC is
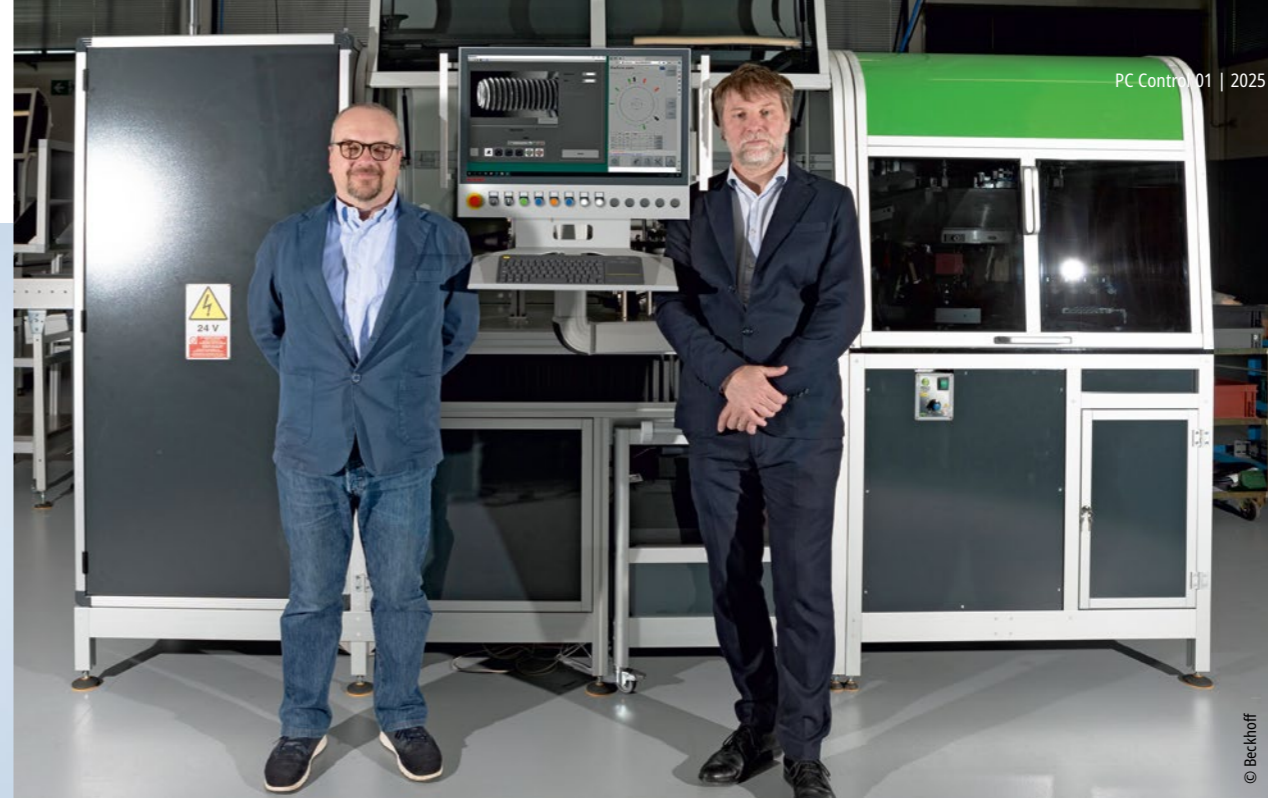
currently being used for the image processing application. In the first phase, the project team wanted to ensure that image processing was not subject to any external influences.
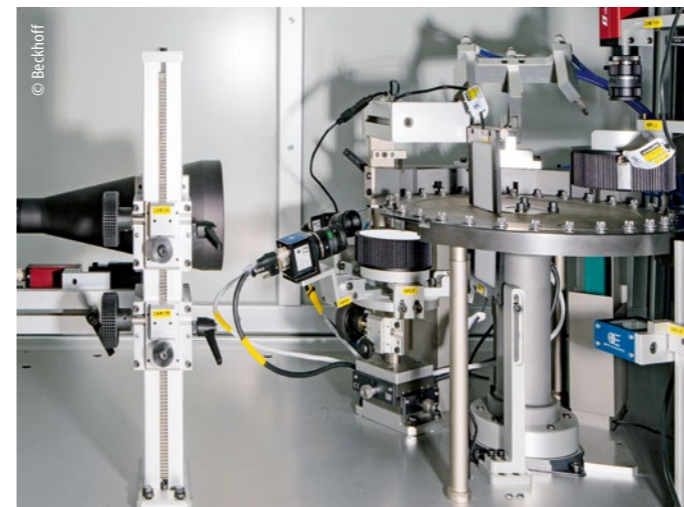
Added value for end users too

For the machine end user, the La Mille control concept means higher sorting system speeds plus additional inspection criteria. "Our solution increases productivity, the number of stations, and the number of inspections that our machine can perform in the future," says Noce. In addition, the openness of EtherCAT enables further components to be integrated. Users also benefit from the significantly improved user-friendliness based on TwinCAT HMI, e.g., for diagnostics and configuration. In addition, Dimac integrates the image processing software into the visualization and can therefore combine all machine functions on one Beckhoff Control Panel.

Inspections during production

The 100% inspection and sorting of parts normally only takes place after production. In the production process itself, the most important parameters of a component are still measured manually and spot-checked in the labora-

tory. However, there is growing interest among manufacturing companies in integrating the data from sorting machines into inspection processes during production and using the objective and reliable data for continuous quality improvement and predictive maintenance.

Dimac is already working on integrating cobots, linear axes, and transport systems into its machine concept in order to replace the classic inspections operators carry out using plug gauges and other types of gauge with automated spot checks. Guido Noce comments: "We see PC-based control and EtherCAT as key technologies for these applications, which, previously, we have often been unable to implement due to excessive development costs." PC-based control provides the necessary functions in an integrated system: control, image processing, motion, safety, human-machine interface, connectivity, and interoperability. Enrico Ottaviano and his team are assisted by the Beckhoff support team. "We are very satisfied with the technical support in terms of technical expertise and response times. Using EtherCAT and PC-based control as the automation architecture will take Dimac's new generation of machines to a new level in terms of performance, reliability, and data analysis capability," emphasizes Ottaviano.

Image processing is an important part of Dimac's sorting and inspection machines.

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www.dimacsrl.com
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Japanese EtherCAT Plug Fest offers a breath of fresh air

The participants of the 2024 Japanese EtherCAT Plug Fest in Yokohama

The ETG Board of Directors is traditionally elected every two years at the SPS trade fair in Nuremberg, Germany.

Members elected ETG Board of Directors at SPS 2024

At the end of October, the ETG held one of its EtherCAT Plug Fests in Yokohama, Japan. A total of 9 EtherCAT MainDevices and 10 EtherCAT SubDevices were tested for interoperability. The knowledge gained improved the compatibility of the products and prepared them optimally for use in the field.

Four companies attended the event for the first time and contributed significantly to the dynamic and diversity of the event. In addition to the interoperability tests, the meeting also focused on the personal exchange between the attendees and with the EtherCAT experts on site, which helped with identifying and solving technological challenges.

The employees of the Japanese ETG office, who organized and were on-site hosting the event, explain: "The increase in the number of participating companies made the 2024 Japanese EtherCAT Plug Fest a special event this year. While the events were already characterized by great success in the past, the atmosphere was further enlivened by the new faces and the great interest in the topics of EtherCAT interoperability." The EtherCAT Plug Fests take place at regular intervals in Europe, Japan, Korea and North America.

The ETG traditionally uses the first evening of the SPS trade fair in Nuremberg, Germany, as an opportunity to hold its Membership Assembly. Every two years, the board of the EtherCAT user organization is also re-elected as part of this event. In November 2024, all three board members were unanimously re-elected.

And so the ETG is pleased to announce the following board members for the next two years:
– Dmitry Dzilno from Applied Materials in Santa Clara, California, represents a major user of EtherCAT technology.

– Dr. Gerhard Grunwald from the Institute of Robotics and Mechatronics at the German Aerospace Center (DLR) in Oberpfaffenhofen-Weßling stands for the scientific users of EtherCAT.
– Martin Rostan from Nuremberg, who represents the inventor of the technology and the manufacturers of EtherCAT devices in the board with the company Beckhoff Automation.

The course of SPS – Smart Production Solutions 2024 itself also gave the EtherCAT Technology Group cause for celebration. Together with 51 co-exhibitors, the ETG presented over 500 EtherCAT products at its joint booth in hall 5 and was able to make more contacts with trade fair visitors than in the previous year despite the current tense economic situation.

ETG welcomes Norwalt Automation Group as member 8,000

Norwalt Automation Group is ETG member 8,000: Kyle Seitel, Technical Operations Manager & Marketing Coordinator, Keith Harman, Executive Director of Business Development, and Trevor Seitel, Digital Print Manager (from left).

At the end of 2024, the ETG reached another milestone in its membership development and now counts 8,000 members with the addition of U.S.-based Norwalt Automation Group.

Norwalt joins the ETG as another leading machine builder that wants to provide the numerous advantages of EtherCAT technology to its customers today and in the future. Just like the ETG itself, Kyle Seitel, Technical Operations Manager at Norwalt, is also pleased about joining: "Without EtherCAT, our new machine would not be nearly as successful: the performance and synchronization precision of EtherCAT enable the outstanding accuracy and high throughput of this system with its many axes. In this way, EtherCAT helps us meet the high expectations of our customers and continues to do so in the future."

The EtherCAT Technology Group continues to expand its position as the largest fieldbus user organization in the world. Hitting this 8,000-member milestone, in combination with the approximately 80 million EtherCAT nodes in the field, once again confirms the success and market penetration of the technology. The continuous membership growth of the EtherCAT Technology Group continues unabated more than 20 years after its foundation, with over 400 new members joining every year for the past 10 years. And although EtherCAT originated in Germany, the structure of the ETG is absolutely global: case in point, the number of Asian member companies has recently overtaken those from Europe. This means that 43% of members come from Asia, 42% from Europe, 14% from America and 1% from the rest of the world. According to the organization's guidelines, only legal entities such as companies or universities can become members of the ETG, not individuals.

More information:
www.ethercat.org

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