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PC control

The New Automation Technology Magazine

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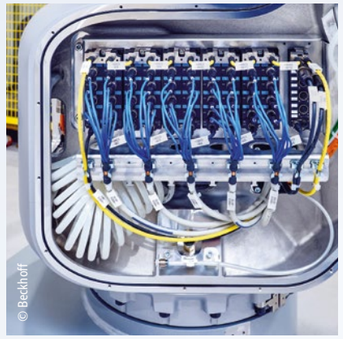

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The New Automation Technology Magazine

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Award for pioneering entrepreneurial achievement in automation and control technology

Hans Beckhoff receives the 2025 German Mechanical Engineering Award

On September 16, Hans Beckhoff received the 2025 German Mechanical Engineering Award (Preis Deutscher Maschinenbau) at the 15th German Mechanical Engineering Summit (Deutscher Maschinenbau-Gipfel), held in Berlin. This prestigious award has been presented by the Produktion trade journal since 2006 and honors entrepreneurs who have set standards in machine and system engineering, driven innovation, and taken on social responsibility. Hans Beckhoff, founder and Managing Director of Beckhoff Automation GmbH & Co. KG, won this award in recognition of his pioneering entrepreneurial achievements and numerous inventions.

The 15th German Mechanical Engineering Summit was held by the VDMA (Association of German Mechanical and Plant Engineering) and Produktion, a mi connect trade journal, on 16 and 17 September, 2025. “Manufacturing the future” was the event's motto. Top representatives from industry, research, and politics came together to discuss industrial policy, the role of Europe, Germany as a business location, and the future of production. The German Mechanical Engineering Award ceremony, which honors entrepreneurs for their life’s work, was the highlight of the first evening.

PC-based control lays the foundations for corporate success

Hans Beckhoff's visionary work was held up as a concrete example that demonstrates how technological progress can be achieved responsibly. He was one of the first to use standard PCs to control machinery and systems in order to replace proprietary approaches with open, flexible IT-based solutions. Beckhoff launched the first PC-based controller on the market in 1986. Since then, the company has regularly set new technological milestones, including the Lightbus, the first optical industrial fieldbus, in 1989, and modular bus terminals six years later that remain the industry standard today. In 2003, Beckhoff created EtherCAT, real-time Ethernet that also became established as a global standard. In 2011, Beckhoff presented the XTS, a multi-mover linear drive system, with the XPlanar planar motor system for intelligent product transport following in 2018. The MX-System is one of the company's latest technological innovations. It enables control cabinet-free automation of machinery and systems. TwinCAT control and engineering software is the heart of Beckhoff automation. This standard automation platform provides all the functions of a machine – from sequence and motion control to integrated measurement and analysis, along with motion control for machinery and robots, through to image processing and artificial intelligence.

Playing an important role in the advancement of mechanical engineering

This combination of hardware and software allows mechanical engineers to build highly optimized production systems, which thus conserve resources. Beckhoff technologies provide the IT world with open interfaces, real-time communication, and integrate edge and cloud services. The Beckhoff approach couples IT and automation, which helps to boost sustainability and efficiency in industrial processes. “Hans Beckhoff didn’t just deliver a technical innovation with the PC-based control technology concept; he made a critical contribution that paved the way into the digital age for mechanical engineering. Most importantly, his contribution was practical, rather than purely theoretical. His concept is as follows: standard hardware, open interfaces, maximum flexibility. This was completely liberating for many mechanical engineers, particularly in the SME sector,” stated Claus Wilk, Editor-in-Chief of Produktion and laudator.

Technology and humanity

The jury was constituted of specialist representatives from science and publishing, namely Professor Günther Schuh (Managing Director of the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University), Thomas Bauernhansl (Executive Director of Fraunhofer IPA) and publishing representatives including Stefan Waldeisen, COO, and Stefan Weinzierl and Claus Wilk, Editors-in-Chief. They were impressed by Beckhoff’s outstanding entrepreneurial achievements and also praised his commitment to improving society and his philosophy that technology and humanity are not mutually exclusive. Claus Wilk described the company as follows: “Beckhoff is a concept that unites people: with technology, with values, and with its ethos”. To this day, Hans Beckhoff’s main priority when managing his company is trust. This has resulted in a culture in which people treat each other as equals: “You haven't just built a company. You've created a space where thinking is encouraged, where ideas are allowed to grow, and where people count,” stated Claus Wilk.

More information:
www.beckhoff.com/technological-milestones

Claus Wilk,
Editor-in-Chief of Produktion and laudator

“His concept is as follows: standard hardware, open interfaces, maximum flexibility. This was completely liberating for many mechanical engineers.”

Hans Beckhoff (right) with Claus Wilk (center), laudator, and Ursula Heller, presenter, at the ceremony for the 2025 German Mechanical Engineering Award. The entrepreneur was honored for his outstanding inventions in automation and control technology. The award ceremony was held during the 15th German Mechanical Engineering Summit at Vienna House Andel’s Berlin.

© Anna McMaster

Beckhoff at SPS 2025

From November 25 to 27, 2025, Nuremberg's SPS (smart production solutions) exhibition will be opening its doors once again. With its New Automation Technology, Beckhoff will have an exhibition area of around 1,800 m² to demonstrate how smart automation solutions and digitalized machine and plant processes can be implemented efficiently and flexibly with PC and EtherCAT-based control technology. The focus will be on the next rollout stages of innovations relating to the TwinCAT PLC++ engineering and runtime platform, industrial and easy-to-use AI with TwinCAT CoAgent and Machine Learning Creator, as well as IPC technology, drive technology, I/Os, image processing, and control cabinet-free automation with MX-System – all of which can be seen at Booth 406 in Hall 7, including as part of "Beckhoff in a nutshell" highlight tours that can be booked without advance registration. The event will also be covered by the popular Beckhoff Live + Interactive livestream, which will be broadcast in English language daily from 10:00 a.m. right from our booth.

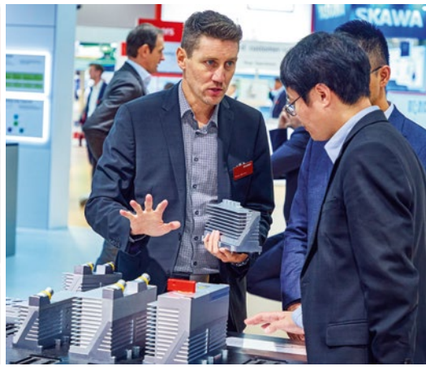
For more information, tickets, and live TV, visit:
www.beckhoff.com/sps

In addition to increasing performance, TwinCAT PLC++ focuses on DevOps principles and in this way consistently implements the Beckhoff philosophy of convergence of automation and IT.

TwinCAT CoAgent and TwinCAT Machine Learning Creator allow process and automation experts to use AI technologies directly and without specialized AI knowledge for their applications.

The Next multi-touch panel generation offers the consistently high quality of Beckhoff Control Panels and Panel PCs with an optimized price/performance ratio.

Despite being an economical device, the AX1000 servo drive still meets the highest technological standards and is fully integrated into the TwinCAT system, as is the new AF1000 variable frequency drive.



The decentralized, pluggable MX-System provides totally control cabinet-free automation of machines and systems, minimizing development time and machine footprint.

Future-proof automation solutions for semiconductor manufacturing

Precision and process diversity under control

In no other industry are the processes as complex as in semiconductor manufacturing. But how does this industry manage to meet increasing demands with innovative solutions? With its automation portfolio, Beckhoff demonstrates that advanced control concepts, flexible communication standards, and precisely coordinated systems not only make semiconductor production more efficient, but also ensure it is fit for the future.

Automation plays a key role in meeting the extraordinary requirements and high cost pressure in the semiconductor industry.

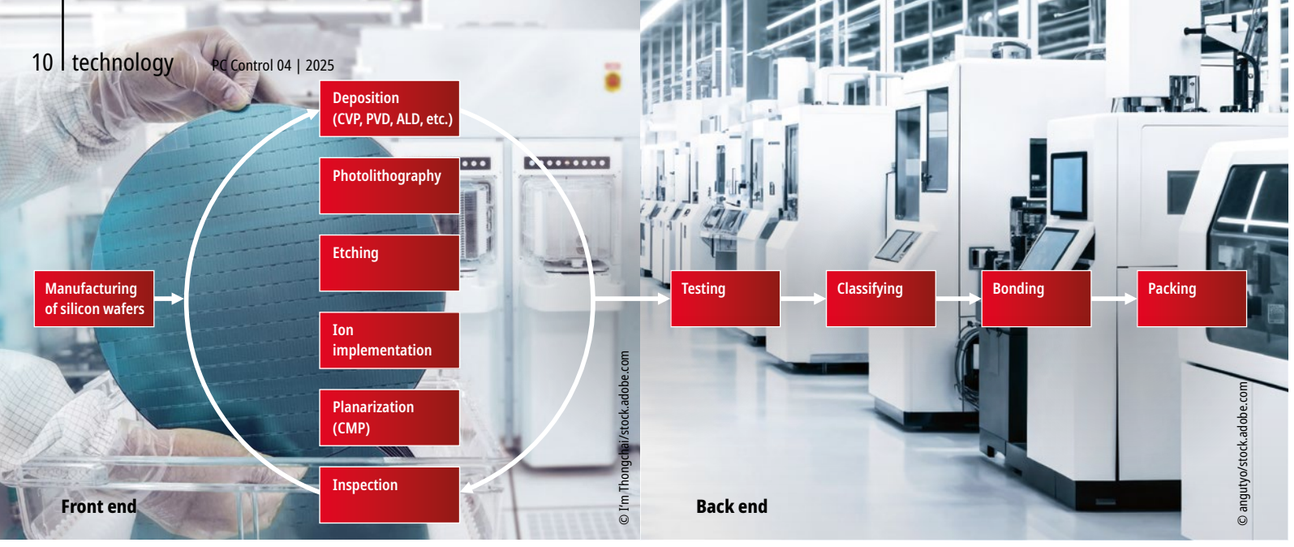
Around 3,000 to 8,000 semiconductor components are installed in today's electric cars for motor control, battery management, and assistance systems – and this figure is set to rise significantly. But whether in the fields of mobility, communication, health, safety, entertainment, energy supply, or environmental protection – semiconductors form the basis for innovation and progress in almost all areas of life. As a result, the semiconductor industry plays a prominent role in our society. However, the industry is facing the same challenges as other sectors: increasing requirements with respect to quality, efficiency, and productivity combined with rising cost pressure. To counter this, automation plays a key role in semiconductor manufacturing – just as it does in other areas.

However, manufacturing in this sector is very different from other industries in two respects: The first is the precision required in production. State-of-the-art processors often contain several billion transistors. To achieve this, structures with distances in the single-digit nanometer range have to be applied to the wafers. And this leads directly to the second point: An unprecedented number of different production steps are required for such precision work. Dozens of processes have to work together seamlessly, many of them in cleanroom environments. "As different as the steps are – from wafer production and lithography to testing and packaging – they all require precise control and seamless monitoring," says Marcel Ellwart, who works in semiconductor industry management at Beckhoff. "In addition, the production systems must be able to respond flexibly to changing product variants and ensure high throughput rates with maximum quality. This makes the use of advanced automation technology indispensable."

EtherCAT – the standard for the semiconductor industry

With its broad and versatile portfolio, automation specialist Beckhoff is able to cover the multifaceted processes and applications in the semiconductor industry perfectly. Communication plays a special role here: "With EtherCAT, Beckhoff has developed a fieldbus standard that has long been established as the leading communication protocol in semiconductor manufacturing," emphasizes Marcel Ellwart. The majority of major equipment manufacturers today rely on EtherCAT. Consistent real-time capability as well as a high level of flexibility and scalability were decisive in its success. "With its open architecture and broad acceptance by manufacturers, EtherCAT enables components and systems – from sensors and actuators to sophisticated control systems – to be integrated with ease," the industry manager says.

With PC-based control, Beckhoff provides the semiconductor industry with a customized control concept. It covers all automation tasks – from wafer



In the production of state-of-the-art semiconductor elements, many different processes have to work together seamlessly, many of them in cleanroom environments.

production to processing and chip packaging. The Beckhoff approach includes not only the PLC, but also HMI integration, motion control, measurement technology, and vision. The TwinCAT 3 software platform transforms the industrial PCs into efficient real-time control systems for all engineering and runtime processes. To meet the many different needs of the semiconductor industry, the automation software is modular by design and can be expanded with numerous functions.

Special added value for a special industry

With its portfolio, Beckhoff offers the semiconductor industry a powerful answer to the challenges mentioned above. These include a number of innovations from the Verl-based company that are particularly beneficial to the industry:

– The compact EtherCAT plug-in modules from the EJ series replace elaborately developed I/O boards in systems for series production. They are plugged directly onto a signal distribution board and distribute signals and/or voltage to application-specific connectors. This saves time, costs, and space. The risk of incorrect wiring is also eliminated. Like classic EtherCAT Terminals, the EJ modules offer a wide range of signals as well as fully integrated safety and motion.

The majority of major equipment manufacturers in the semiconductor industry today rely on EtherCAT – a development from Beckhoff.

– To reduce system complexity, Beckhoff integrates the drive control of servo and stepper motors directly into the I/Os. In the 48 V DC segment, EtherCAT plug-in modules, servomotor terminals, or box modules in combination with the AM8100 motor series facilitate extremely compact servo axes with high dynamics and precision. I/O-integrated control can also be implemented to operate adjustment axes or for drives with servo drives directly on the machine.
– The Beckhoff range meets the needs of the semiconductor industry when it comes to measurement technology too: from a one-second cycle to the kHz range, from measurement of voltage and current to vibrations and the measurement of forces. The high-end measurement modules from the ELM series are integrated seamlessly into the EtherCAT I/O system and are also reliable when it comes to recording process-critical measurement channels. TwinCAT provides powerful features for evaluating the generated data.
– Beckhoff Vision integrates real-time image processing for wafer production into both new and existing control environments. There is no need for a division between vision and automation technology. At the same time, the vision components offer a robust design as well as high scalability and long-term availability – from the cameras, optics, and illumination to the TwinCAT Vision software.
– XPlanar is revolutionizing handling processes in the semiconductor industry. This is because the planar motor system transports workpieces dynamically, with maximum accuracy and high freedom of movement – both within a system and from machine to machine. The movers float in a non-contact way and independently of each other along individual predefined routes. Products may overtake each other and be discharged or buffered without affecting the production flow.
– Modern AI solutions offer enormous potential for semiconductor manufacturing. Beckhoff has integrated machine learning capabilities into the TwinCAT 3 control software, providing a modular system of hardware and software to integrate AI models directly into the PLC. From data collection and model training to the execution of learned models, users receive an open system workflow without a lock-in effect. Applications for which Beckhoff already offers AI include anomaly detection for predictive maintenance, image classification in quality assurance, and time series analysis to improve production processes.

Driverless transport systems, for example, are increasingly being used due to the fact that autonomy is also playing an ever greater role in semiconductor manufacturing.

Semiconductor success stories from Beckhoff

With its extensive portfolio and in-depth industry expertise, Beckhoff has automated an impressive number of applications across the entire value chain in semiconductor production in recent years. The following examples, which have already been reported on in detail in the Beckhoff PC Control customer magazine, illustrate just how versatile the solutions are.

Crystal growth: Jingsheng Mechanical & Electrical (JSG) relies on a Beckhoff solution consisting of embedded PCs, TwinCAT 3, and EtherCAT I/O Terminals for the automation of its single-crystal furnaces. It replaces previous PLC and temperature control systems and offers much greater flexibility, scalability, and integration options. At the heart of process control is precise temperature control, which is essential for single-crystal growth, as it ensures its quality through uniform temperature control over long periods of time.

Marcel Ellwart, Semiconductor Industry Management at Beckhoff Automation

High-purity gases: Applied Energy Systems (AES) has developed a new controller for the supply of ultra-high purity gases to meet Industry 4.0 requirements in semiconductor manufacturing. In addition to a compact CP6606 Panel PC from Beckhoff, the company relies on the modular plug-in I/O modules from the EJ series. The ultra-compact system retains the previous housing size, but offers extended functions, OPC UA and cloud interfaces, flexible customization options, and a 50% reduction in installation time.

Chip handling: Mühlbauer also relies on EJ plug-in modules in its highly precise die sorting machines for the final semiconductor manufacturing stage. This makes it possible to process 30,000 microchips per hour with improved wafer handling and reduced wiring work. Four specially developed signal distribution boards with a total of 26 EtherCAT plug-in modules integrate digital and analog I/Os, incremental encoders, and stepper motor modules, as well as supply logic and servo drives for ceramic and piezo motors.

New materials: Gallium oxide offers great potential for the production of new semiconductor materials. However, development on the previous systems was restricted by limited flexibility, reliability, and high costs. Agnitron has created a flexible multi-purpose solution founded on PC-based control that can be converted within a few days. EtherCAT ensures compact, space-saving networking of the numerous thermocouples and I/Os with simple integration of existing field devices.

Advanced packaging: As miniaturization is increasingly pushing conventional lithography-based processes to their limits, start-up Fonontech is taking a new approach. Impulse Printing™ technology uses silicon printing plates with etched micrometer structures and integrated heating structures. The aim is to achieve a resolution of 5 µm with minimal overlay error. The controller used enables real-time synchronization and positioning via PC-based control, EtherCAT, and XFC technology (eXtreme Fast Control).

AI and edge: The beginning of a new era

These application examples underline not least that semiconductor manufacturing is at the beginning of a new era. "Automation solutions from Beckhoff offer the ideal foundations for meeting the new challenges and implementing intelligent manufacturing processes," summarizes Marcel Ellwart. The combination of PC-based control, powerful data processing, and real time EtherCAT communication allows the integration of AI algorithms for process optimization. Edge solutions facilitate decentralized data analysis directly at the machine, shortening response times and increasing system availability. Such approaches pave the way for even more efficient, flexible, and sustainable semiconductor production in the future.

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

On course for the future with AI-powered automation

Despite the economic turbulence the world is experiencing, Beckhoff Automation is heading into the future with a clear innovation agenda, new investments, and stable pricing. At the SPS exhibition, the focus will be on topics such as TwinCAT PLC++, a new multi-touch panel series, industrial PCs with new processors, new EtherCAT Terminals and ASICs, and – most importantly of all – AI integration. Ronald Heinze, editor-in-chief of Open Automation, caught up with Managing Director and owner Hans Beckhoff, along with Frederike Beckhoff (Corporate Development) and Johannes Beckhoff (Product Management), about the latest developments in economic efficiency and technical innovations.

Hans Beckhoff (right) and his children Frederike (center) and Johannes Beckhoff (left) can look forward to Beckhoff Automation continuing to operate successfully as a family-run company.

The economy in 2025 has been a rollercoaster for many companies – but for Beckhoff Automation, it has been more up than down and the company is reporting positive figures. “Our sales are up on the previous year, which was a very weak period,” says a delighted Frederike Beckhoff. “We are anticipating growth of between 7% and 10% at the end of the year.” She continues: “The inventory issue has largely been resolved, but we are still in the middle of an economic crisis.”

To cast our minds back, 2023 was a year like no other, with trends driven by one-off effects such as massive build-ups in inventory levels throughout the industry. “That didn’t reflect the real market capacity,” states Frederike Beckhoff. “Customers were hoarding parts because they were in short supply. As a result, in 2024 we had to report a -33% decline compared to 2023. Things aren’t completely a bed of roses now, but 2025 is proving to be healthier,” adds Hans Beckhoff. He points out that 2025 has also been a volatile year to date, with an acceptable start that was followed by a good second quarter and a less-than-favorable third quarter. It is difficult to forecast how 2026 will look, but Hans Beckhoff is optimistic and hopes to see the same kind of development as this year has shown.

Price stability as a principle

In a time when reports on inflation figures are making headlines, Hans Beckhoff’s attitude seems almost defiant. “Since the company was founded, we have only increased prices a few times,” he states. “We are committed to price stability. Our principle is that we grow through productivity and economies of scale – not through price.” This has continued to be the case in 2025, with no price increases for the company’s customers in its core European markets. Tariff-based surcharges have only come into play in a few export markets, such as the USA.

But where will the next growth spurt come from? “Throughout the world, developments in economic efficiency have been astonishingly even,” reports Frederike Beckhoff. “There is no booming region or countries that have experienced a particular boost.” Smaller countries are an exception to this, however – and, as Hans Beckhoff adds, “Italy has shown very healthy development. Italian machine building has been a remarkably strong industry in 2025, something that has come as a pleasant surprise to us.”

However, the Beckhoff model for success continues to be the breadth of scale on which it operates: “We are winning new customers with exciting projects,” says Frederike Beckhoff. “What’s more, our regular customers have started ordering again after reconciling their stock levels.” As Hans Beckhoff puts it: “It’s better to have a solid foundation in many markets than be dependent on just one.”

The company’s sales trend is also evenly distributed across the product portfolio. “This is due to the fact that around 70% of our customers rely on complete systems from us,” says Hans Beckhoff. According to the Managing Director, industry solutions are a vital part of the business alongside its focus on products, and both areas are being systematically expanded. He highlights the automotive industry when discussing this point. “Both areas open up promising ways of supporting customers.”

Hans Beckhoff,
founder and Managing Director

> “We have grown by around 40% since 2020. That’s a figure we’re very happy with.”

Investments: No end in sight

The Verl team simply doesn’t entertain the thought of stopping investments. As Hans Beckhoff puts it: “We are continuing to invest in the same way as always – it’s a part of our DNA.” The company has continued its expansion projects over the course of 2025. Frederike Beckhoff explains what this means right now: “The new building for the Austria branch will be completed, and the team there will move into it, in the first half of 2026. The building complex at the Rheda site in Germany’s East Westphalia region, which has 67,000 m² of space, will be completed at the end of 2025 and will then be kitted out with interior fittings – providing a basis for even more expansion.” Work will begin next year on the 20,000 m² production and office building for the Schirmer Maschinen subsidiary in Verl. Furthermore, production of the ATRO robots and the MX-System will be ramped up at the beginning of next year.

The sales department is continuing to expand at the same time – as Frederike Beckhoff explains: “Around 2,000 of our 5,300 employees worldwide work in

sales or in sales-related roles. Personal contact with the customer remains key. “That’s why we continue to build on our sales activities every year – which means geographical, product, and industry sales teams.”

Software: Speed matters – and TwinCAT PLC++ is a game changer
Beckhoff wouldn’t be Beckhoff if it didn’t keep pushing the rate at which things happen. “Speed matters – and that’s always been our motto,” says Johannes Beckhoff. “TwinCAT PLC++ has become a concrete example of faster speeds, and the increase in efficiency that we predicted has materialized. We are becoming 1.5 times faster in many projects – and the execution time is as much as 2.5 times faster in projects with a high degree of optimization.”

Faster control systems also increase the output of machines. Hans Beckhoff explains how this works: “Any time the control cycle time is reduced, the machine has less time to wait before the controller responds. Fractions of a second become percentage points in the efficiency of the machine. And that adds up. Even a 2% gain in speed can have a big impact both economically and environmentally.” Johannes Beckhoff adds: “Completely new machine concepts are also conceivable.”

TwinCAT PLC++ also offers advantages in engineering: faster compile times, shorter online changes, and reduced downtimes. “Efficiency means not only faster production, but also faster commissioning,” states Johannes Beckhoff. Diagnostics are improving too – something that has a big impact on the machinery’s Overall Equipment Effectiveness (OEE).

Another important consideration is that TwinCAT PLC++ was developed in very close harmony with the IEC 61131-3 standard. The excellent compatibility it achieves in this area and the use of high-level languages such as C++ make it possible to establish close links with a wide community of programmers and users.

AI for everyone: Machine Learning Creator
Many businesses keep AI locked in an ivory tower – but Beckhoff wants to bring it into the machine room. TwinCAT Machine Learning Creator provides a tool for exactly this purpose. “It allows the PLC programmer to train a neural network even if they aren’t an AI specialist,” says Johannes Beckhoff. “All they have to do is load a recorded and classified data set into our TwinCAT Machine Learning Creator software, then the training starts automatically – and the neural network is ready to go.”

The implementation started with image analysis. At the SPS, we also show analysis of signals and time series, from vibrations on a milling spindle or pressure curves to process signals. Johannes Beckhoff adds: “This makes it possible to conduct pass/fail assessments of processes and predictive maintenance.”

AI agents make engineering easier
TwinCAT CoAgent provides various agents that use what is known as the Model Context Protocol (MCP). MCP was created specifically for large language models (LLMs) and gives them access to external tools and data sources, making them more effective. According to Johannes Beckhoff, “This protocol appears fairly often in the standard world of large language models – that is, the world of ChatGPT. It’s a kind of standardized interface that describes how a large language model can deterministically access functions of an agent.” MCP was implemented in TwinCAT CoAgent.

“Everything that we intend to develop in TwinCAT, whether that means HMIs, PLCs, analytics, measurement technology functions, or even XPlanar, XTS, or motion control, will be provided with an MCP interface for connectivity with LLMs.” The user can then interact, asking questions such as “Can you create a specific code for me?” and “Can you set an alarm for me?” Johannes Beckhoff adds: “Using the MCP interface, the large language models can access exactly the right function of the automation module in question.” Hans Beckhoff paints a picture in his usual vivid way: “In the past, a person sat in front of the machine and pulled levers. In the future, there will be something like a little person inside the machine – an LLM – who listens, understands, and takes action.”

This has already been partially demonstrated at the K trade show, where a plastic blow-molding machine featuring the C6043 Industrial PC with NVIDIA® GPU was showcased. The industrial PC not only controls the machine, but also chats and uses artificial intelligence. “We integrate agent-based knowledge everywhere in our TwinCAT tool,” says Johannes Beckhoff, summing things up. In the future, it will be possible to direct even complex queries to a machine using voice input. This will allow the machine to be monitored reliably and enable fault diagnostics.

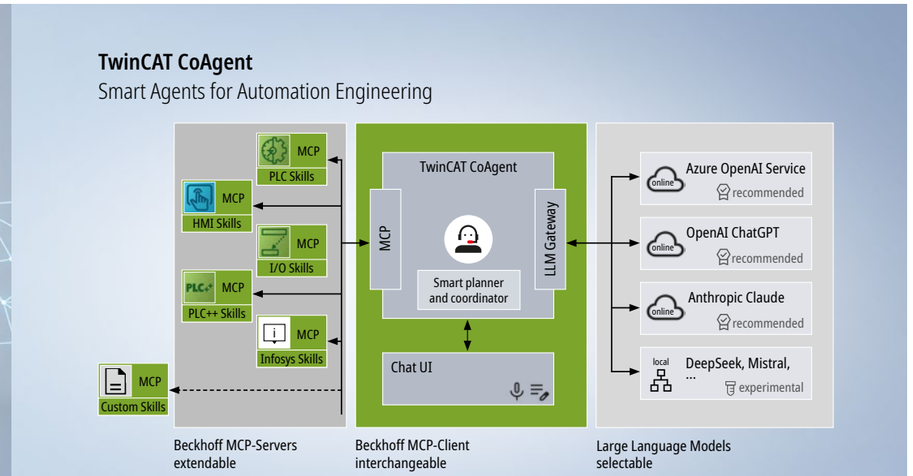
Frederike Beckhoff,
Corporate Development

“Our incoming orders are clearly up on the previous year and our sales have also increased by seven to ten percent.”

At the SPS trade show, the focus will be on many other software-themed aspects, such as container-based or virtual control systems and improved motion and vision algorithms.

Hardware offensive: New panels, new processors
“At the SPS, we will be showcasing the CP4xxx and CP5xxx Panel PC series in the Next multi-touch panel generation – the third generation of equipment designs since 1998,” reveals Johannes Beckhoff. The focus will be on cost-optimized solutions, appealing design, and a wide range of formats. Key features of the panel PCs include EtherCAT-based real-time communication, full integration into TwinCAT, high-quality displays with multi-finger touch function, reduced power consumption (especially with the Arm® processors that the PCs include), and industrial components with long-term availability. “The display is the face of the machine – and combines both elegance and machine compatibility,” says Hans Beckhoff.

To ensure the Next multi-touch panel PCs are fit for the future, the electronics concept has been revised and the mechanical and electronic interfaces have been standardized. These robust pieces of equipment, manufactured entirely in-house in Germany, are available as IP20 built-in variants and as IP65 variants for mounting arm installation. A new Arm® multi-core CPU is being offered for the first time – an especially appealing option for price-sensitive visualization tasks. If the panel PCs are also equipped with TwinCAT automation software, the display and control functions can run on the same device. According to Hans Beckhoff, this provides “an excellent, highly cost-effective introduction to Beckhoff control technology.” The panel PCs don’t just offer classic advantages such as reduced space requirements or less wiring and maintenance work,



Left: As the new generation of PLC technology, TwinCAT PLC++ marks a huge leap for engineering and runtime performance.

Middle: With TwinCAT CoAgent and TwinCAT Machine Learning Creator, process and automation experts can use AI technologies directly for their applications.

Right: The open architecture of TwinCAT CoAgent implemented via the Model Context Protocol (MCP) enables the use of different language models and flexible combination with customer-specific extensions.

however. As smart gateways, they are also designed to record and pre-process machine data, then pass it on to higher-level systems.

What's new in the world of processors? "At Beckhoff, we always have three to four processor classes that we use in our devices. These start with Arm® processors for our small controllers. Then there are the embedded PCs in the CX82xx and CX92xx series, for example, which use more powerful Arm® Cortex® CPUs," explains Hans Beckhoff. These can also be used for smaller motion control applications.

Next up is the x86 CPU family for more powerful industrial PCs. Beckhoff is introducing new processor lines in this case: "We will be using Intel® Amston Lake with up to eight cores for the compact controllers and Intel® Bartlett Lake for the high-performance systems. That covers an enormous bandwidth," says Johannes Beckhoff. The new processors will be designed this year and in 2026. "Our controls are available with Windows and Linux® operating systems as standard," adds Johannes Beckhoff. "Many customers look for this. Linux® is a widely accepted system," confirms Hans Beckhoff.

I/O and EtherCAT: Standard – but upgraded

EtherCAT has been part of the Beckhoff success story since 2003 and has become the global standard for industrial communication. "We will be releasing the ET1150, a new ASIC with more memory and improved performance, at the end of the year," says Johannes Beckhoff. It boasts energy consumption that is as much as four times lower than the ET1100. The new chip is pin-compatible with its predecessor, which will remain available. "It's great news for device manufacturers, as they can expect a significant boost in performance," states Hans Beckhoff.

The next highlight concerns the VHDL-based EtherCAT IP core. In this case too, Beckhoff is now offering a new, powerful version that makes it possible to implement EtherCAT functionality in various FPGAs and integrate EtherCAT into specific semiconductor chips. "It offers the same kind of benefits as the new ASIC," adds Hans Beckhoff.

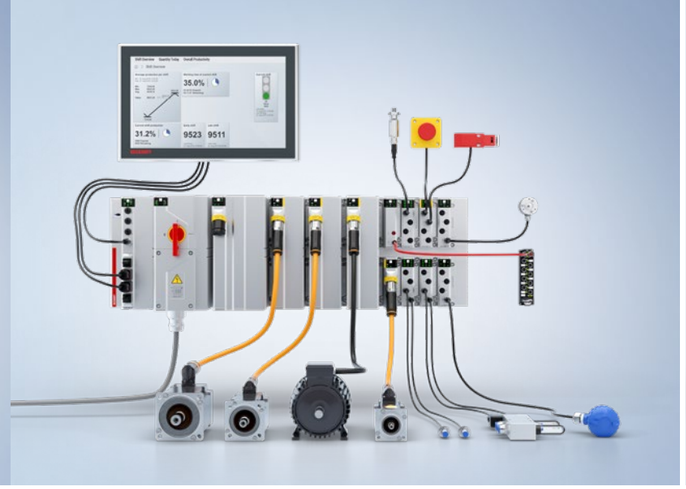
There are also innovations in EtherCAT Terminals: "We are presenting the ED series of EtherCAT Terminals in a new housing," says the Managing Director. This equipment features push-in connection technology for simpler wiring, improved thermal properties, and new electronics. "And, of course, the new series is compatible with previous EL terminals."

Hans Beckhoff assures: "We still supply our very first terminals from 2003 – when EtherCAT was launched on the market – as standard terminals. Even our K-bus terminals from 1995 are still available. Our new ED terminal blocks complement our existing portfolio. We rely on successful continuity."

Motion: Economy and intelligent handling

The area of motion applications showed intense activity in 2024, and that continues to be the case in 2025. The economy drives for cost-sensitive applications, the third basic drive series in the 300 V and 600 V range, were introduced during the past year. The AX1000 servo drives and AF1000 variable frequency drives have the same form factor. According to Hans Beckhoff, both drive types are "being greeted very enthusiastically by customers thanks to their excellent performance and attractive price." He summarizes: "Perfect is the enemy of good. Even if it means cannibalizing our own products, we will keep developing."

New panel PC series are expanding the range of the Next multi-touch panel generation.



The MX-System has arrived in regular delivery, marking the start of a new generation of automation – without traditional control cabinets, but with maximum efficiency, flexibility, and future-proofing.

The AX1000 economy servo drives and AF1000 economy variable frequency drives address cost-sensitive applications and reduce the complexity of the overall system.

Johannes Beckhoff,
Product Management

> "The hype around AI is justified. LLMs will profoundly change the engineering, commissioning, and operation of machines."

In the XTS product transport system, the EcoLine motor module – which creates 45% cost savings per meter – is particularly worth highlighting, as are the stainless-steel variants for hygienic applications. Curved modules for larger radii with 22.5° are available for XTS Hygienic, while larger tiles can be obtained for the XPlanar planar motor system. "With the new software update, the movers can also rotate 360° – anywhere on the surface, even during transport movements," says Johannes Beckhoff. "It's kind of like watching a fairground ride," he laughs.

The long-term tests for the ATRO modular industrial robot construction kit are now coming to an end. According to Hans Beckhoff, the design has been slightly adapted again and the system is now almost ready for series production. Pre-series are expected in the second quarter of next year and series production will start at the end of 2026.

MX-System: Control cabinet-free automation with regular delivery

Beckhoff has started regular delivery of the MX-System. The first machines to be fully equipped with this modular solution are already being used successfully. This marks the start of a new generation of automation systems – without traditional control cabinets, but with maximum efficiency, flexibility, and future-safety. To achieve this, the MX-System combines all automation functions in a pluggable, robust system design and offers machine builders and end users comprehensive benefits over the entire life cycle of the machine. The MX-System represents a paradigm shift in automation technology. It not only replaces the control cabinet, it redefines it. The combination of modular hardware, standardized interfaces, and integrated intelligence creates the basis for future-proof, flexible machine concepts. The technology is suitable for a wide range of uses, from packaging technology and building construction to the food and automotive industries. Beckhoff provides its customers with comprehensive support ranging from project planning and training to series integration. If desired, the Beckhoff specialists will even demonstrate how the MX-System can become the optimum solution for an automation task in individual customer applications.

Moving into the future with momentum

For many companies, the EU Machinery Regulation, Cyber Resilience Act, and NIS2 Directive are the stuff of nightmares. Hans Beckhoff remains pragmatic, however: "These are binding regulations and they do have elements that make sense. We are working on the necessary certifications staying in close communication with our customers. It is important that Europe is strengthened by these regulations, not weakened." Of course, he adds, it goes without saying that Beckhoff Automation will continue to deliver on time: "Our customers need to be able to rely on us."

Last but by no means least, the question of which adaptation is bringing customers the most benefit comes up. Hans Beckhoff chooses the MX-System: "It affects everyone who builds and uses control cabinets. It marks a radical change in automation best practices – and it's happening here and now."

Johannes Beckhoff, on the other hand, is banking on AI: "The hype is justified. LLMs will profoundly change the engineering, commissioning, and operation of machines. We have to be at the forefront of this movement." This is what will propel software into the future, he believes.

What do the Beckhoffs expect from the SPS 2025 show? Hans Beckhoff replies with a smile: "Great business opportunities, great conversations – and, most importantly, a great party." The Verl team is staying true to themselves, with a culture that is down-to-earth, innovative, and charming. A family business that is rethinking the future of automation between their MX-System and AI. Hans, Frederike, and Johannes Beckhoff are keeping the family business on course together with the input of around 5,300 employees worldwide. Between stable prices, bold investments, and visionary technologies, the family-owned company is continuing to benefit from a tailwind that will help them sail into 2026 and beyond.

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More information:
www.beckhoff.com/sps

With TwinCAT CoAgent and TwinCAT Machine Learning Creator, process and automation experts can use AI technologies directly for their applications.

TwinCAT CoAgent and TwinCAT Machine Learning Creator for AI-assisted automation

Unlock optimization potential even more easily with advanced AI functions

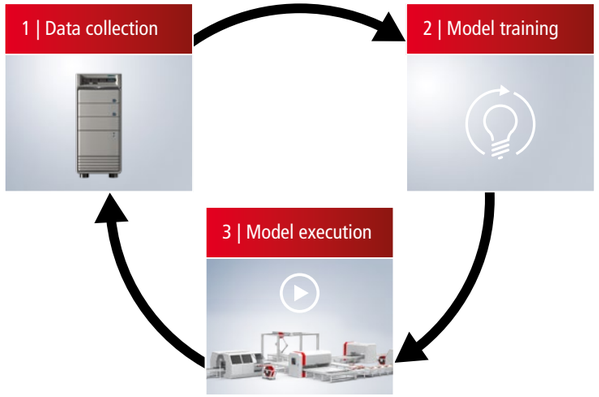
Artificial intelligence has long since found its way out of laboratories and research facilities and into everyday life – and is also proving to be a key driver of innovation in industrial automation. Beckhoff recognized this trend early on and integrated AI directly into the control environment. With TwinCAT Machine Learning, AI models can be executed in real time directly on the machine controller and are literally woven into the PLC code. Furthermore, TwinCAT CoAgent and TwinCAT Machine Learning Creator allow process and automation experts to use AI technologies directly for their applications. Recent functional enhancements to these products show how consistently Beckhoff is driving forward the democratization of AI in automation.

Two approaches to the use of artificial intelligence have emerged in industrial practice: task-specific AI and agentic AI. Task-specific AI handles clearly defined tasks such as visual quality control, predicting machine failures, or locating objects. It is based on domain-specific data and is closely integrated into the control environment – for example with TwinCAT Machine Learning Creator and TwinCAT Machine Learning. On the other hand, there is agentic AI, i.e., AI-based assistance systems built on generative models. These systems support engineers and machine operators through dialog-based interaction, automated code generation, or error analysis during operation – implemented with TwinCAT CoAgent. Both approaches complement each other by addressing different levels: task-specific AI increases efficiency and quality directly in the machine process, whereas agentic AI makes everyday engineering and servicing easier – from development to commissioning and ongoing optimization.

More efficiency in development, service, and machine operation

TwinCAT CoAgent for Engineering supports control programmers in a variety of tasks – from precise code suggestions and smart optimizations through to automatic documentation. Through integration into existing projects, verified content can be adopted directly. In addition, the CoAgent enables quick access to the Beckhoff documentation system, the development of user-friendly HMI controls, and the simple configuration of complete I/O topologies via chat or natural language. For developers, this means less time spent on routine work and search tasks, a significant acceleration in day-to-day project work, and more freedom to focus on demanding automation tasks. Thus, TwinCAT CoAgent is establishing itself as a personal assistant that makes the entire engineering workflow more efficient in the long term.

With PC-based control from Beckhoff, the entire workflow of AI-assisted automation can be seamlessly implemented in the TwinCAT control environment.



With TwinCAT CoAgent for Operations, Beckhoff brings agentic technology directly into machine operation. The CoAgent continuously monitors process values, log files, and KPIs, detects deviations, and initiates a structured problem-solving process together with service personnel:

1. Form a hypothesis.
2. Perform evidence-based diagnosis.
3. Provide concrete suggestions for action, including step-by-step instructions.

Agent-supported error diagnostics make it possible to evaluate alarm messages in context – e.g., by correlating increased power consumption, falling throughput, and log warnings. This allows false alarms to be reduced and critical faults to be prioritized. Typical potential benefits include a significantly shorter time to resolution (TTR), a higher first-fix rate for the most common error patterns, and a noticeable workload reduction for service personnel. Another advantage lies in the documentation: TwinCAT CoAgent creates detailed, target group-oriented service reports for any period of time as desired. These reports include root cause analyses, impact, duration, recommended corrective actions, and follow-up of outstanding issues. Shift reports can also be generated automatically – including KPIs, trend charts, and unresolved maintenance tasks scheduled for the next shift. Thus, TwinCAT CoAgent for Operations is being established as an interactive service agent that makes ongoing operations more intelligent, from faster troubleshooting and improved transparency to a consistently higher quality standard in reporting.

In summary, Beckhoff TwinCAT CoAgent proves to be a powerful AI assistant over the entire automation lifecycle – from code generation in engineering to error diagnostics during operation. The open architecture of TwinCAT CoAgent enables the integration of different language models and flexible combination with customer-specific extensions – supported by interface standards such as the Model Context Protocol (MCP). For example, a company can provide its own knowledge database as an MCP server and integrate it seamlessly with the CoAgent. By extending the product to cover the entire lifecycle, all development and service processes can be accelerated, complexities reduced, and downtimes significantly shortened. Developers benefit from more efficiency and freedom in their day-to-day project work, while service teams can respond more quickly and receive targeted support. The increased flexibility and openness of the system also ensures investment security and future viability.

Automatic AI model creation for signal and time series analyses

The TwinCAT Machine Learning Creator (MLC) from Beckhoff is aimed at automation and process experts and adds automated AI model creation to the TwinCAT 3 workflow. This opens up the potential of artificial intelligence for smaller companies too – with benefits in terms of competitiveness and in dealing with the increasing shortage of skilled workers. At the same time, the tool also makes work easier for AI developers: as a "version zero generator", it automatically creates initial model variants, reduces sources of error, and accelerates the development process. In addition, extensive methods are available to represent the behavior of the models transparently, compare variants, and support auditing processes through automated report generation. With the provision of the right tools, those directly affected – the automation engineers – can solve their challenges themselves. This way, the expertise becomes more deeply embedded in the company and is built up over the long term.

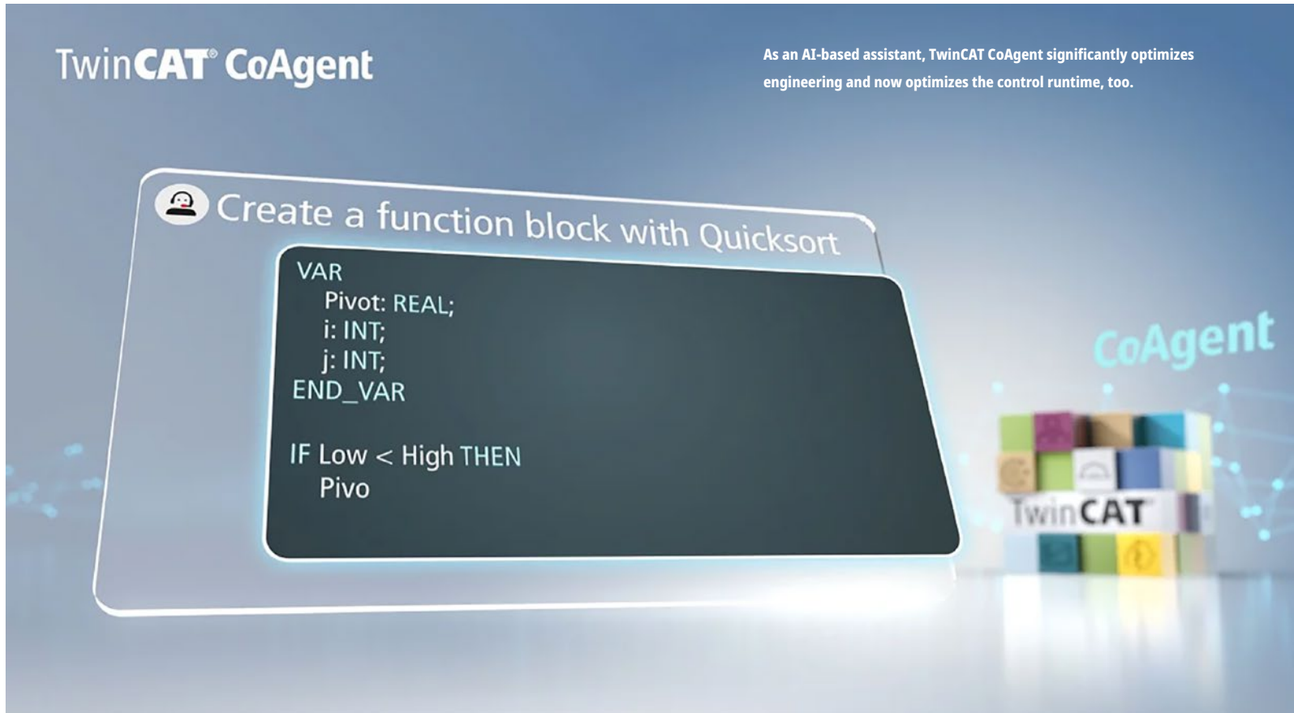
The model that has been automatically trained with TwinCAT MLC can be exported in the ONNX open standard format and is optimally adapted to the real-time requirements in the control environment in terms of latency and accuracy. The focus to date has been on AI-supported image processing. With TwinCAT MLC Signals and Time Series, Beckhoff is expanding the functional scope of the Machine Learning Creator: In addition to image processing (TwinCAT MLC Computer Vision), signals and time series can now also be analyzed efficiently. Typical applications include:

- classification (e.g., for quality inspection)
- forecasting (e.g., to predict energy consumption or wind speed)
- anomaly detection (e.g., in condition monitoring)

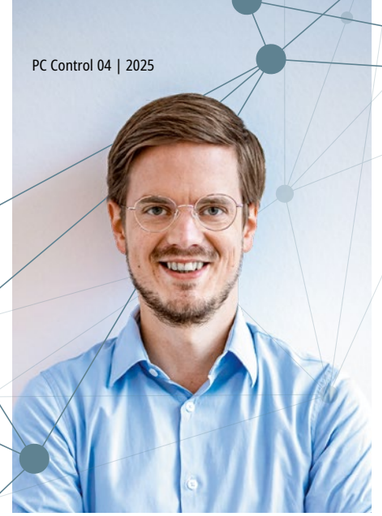
Signals and time series include both the progression of a single signal over time or over other variables (such as frequency, wavelength, distance, or angle) as well as the development of several signals in parallel over different dimensions, e.g., the progression of pressure, temperature, and electrical power over time.

Dr. Fabian Bause
Product Manager TwinCAT, Beckhoff Automation

"With TwinCAT MLC Signals and Time Series, historical, time-ordered data can be analyzed to detect patterns and trends as well as to predict future values or identify anomalies."



As an AI-based assistant, TwinCAT CoAgent significantly optimizes engineering and now optimizes the control runtime, too.



Jannis Doppmeier
Product Manager TwinCAT, Beckhoff Automation

> “TwinCAT CoAgent optimizes both engineering and runtime applications and serves as a team member that helps with diagnostics, interactively guides service personnel through checklists, and is actively involved in problem solving.”

Signal and time series analysis opens up a wide range of possibilities in industrial applications, especially as comprehensive machine data is already available with PC-based control from Beckhoff. Numerous TwinCAT tools can be used for convenient data collection directly from the control process, such as TwinCAT Scope View, Analytics Logger, Database Server, or Data Agent.

Anomaly detection and condition monitoring

A central area of application for signal and time series analysis is anomaly detection: the temporal correlation of disruptive events – such as faulty signal transmissions, power supply fluctuations, operating errors, or environmental conditions – allows causes to be reliably identified. Typical applications include:

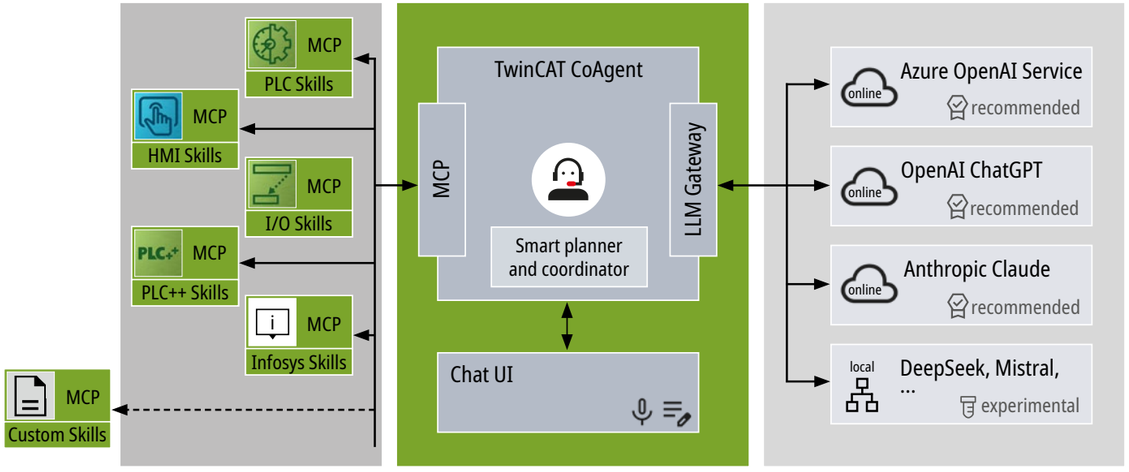
- detection of motor malfunctions (bearing damage, imbalance, mechanical problems) based on current, vibration, or acoustic signals
- diagnosis of pump and compressor faults via current and temperature data
- detection of leaks in hydraulic or pneumatic systems via pressure monitoring
- wear detection on milling and drilling tools based on spindle currents

Quality assurance and process monitoring

There is also new potential in the field of quality assurance. Sensor-based, non-optical end-of-line tests can evaluate electrical properties (e.g., impedance curves) or geometric variables. Inline analyses enable process-integrated quality monitoring for applications such as:

- welding processes via current and voltage curves
- cutting and packaging processes based on servo motor currents
- sealing, grinding, or forming processes based on motor currents

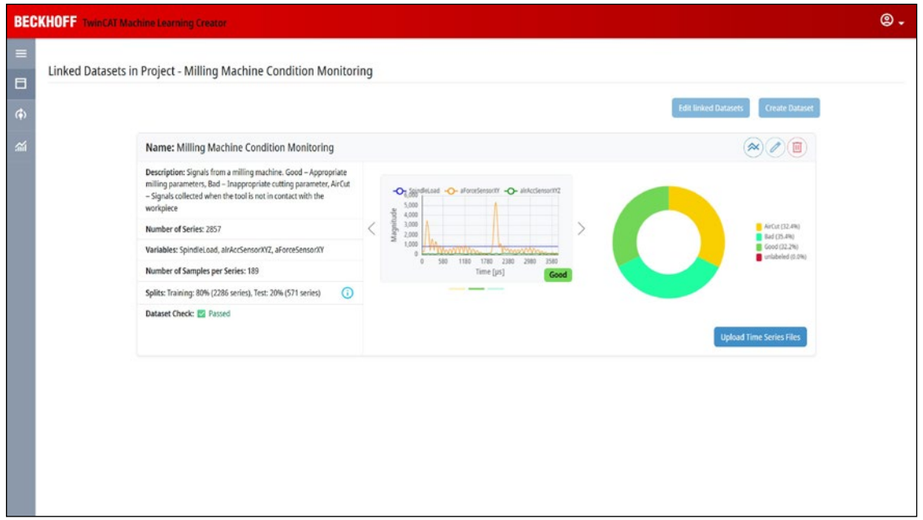
The open architecture of TwinCAT CoAgent implemented via the Model Context Protocol (MCP) enables the use of different language models and flexible combination with customer-specific extensions.



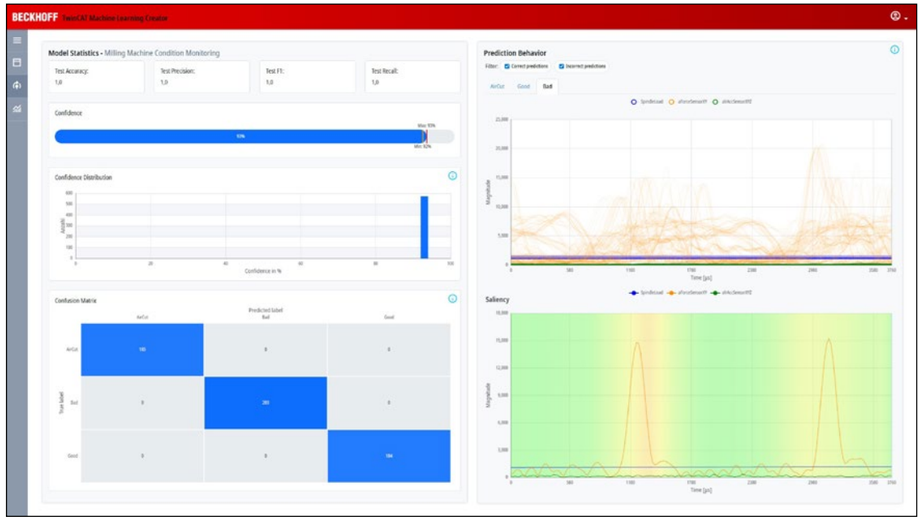
Beckhoff MCP-Servers extendable

Beckhoff MCP-Client interchangeable

Large Language Models selectable



Example of a time series analysis with TwinCAT Machine Learning Creator



Verifying the quality of an AI model with TwinCAT Machine Learning Creator

- kneading and fermentation processes in food production using temperature-time profiles
- complex processes such as crystal growth in semiconductor production

Process optimization and energy efficiency

In addition, time series analysis contributes to process optimization and energy efficiency. Examples include the dynamic adjustment of adaptive process parameters (e.g., feed rate, pressing force), the optimization of energy consumption based on load profiles and forecasts, or the predictive control of complex systems. In the context of wind power, for example, the nacelle and rotor blades can be optimally aligned based on the predicted wind direction and speed.

More information:
www.beckhoff.com/twincat-coagent
www.beckhoff.com/te3850

The control panels and panel PCs in the new Next multi-touch panel generation from Beckhoff offer a modern, attractive design for cost-optimized HMI solutions.

Next multi-touch panel PCs as a smart HMI solution for the connected industry

Future-proof control and visualization

The human-machine interface (HMI) has long since evolved from a simple operating panel into an intelligent hub for data acquisition, local processing, secure communication, and user-centric interaction, making it a key component in digitalized, networked production environments. This is precisely where Beckhoff brings its new next-generation multi-touch panel PCs into play, combining advanced control and visualization features in a single device. Equipped with the latest CPU generations, these industrial PCs are designed for future-proof performance and long-term availability.

In terms of processors, the latest industrial CPU generations are integrated on both the x86 and Arm® platforms.

The CP56xx and CP57xx Panel PCs are designed for mounting arm installation, while the CP46xx and CP47xx series are available as built-in variants.

Beckhoff first showcased the versatile control panels in the Next multi-touch panel generation at Hannover Messe 2025.

Driven by digitalization, modern industrial plants are increasingly evolving into intelligent, connected systems – designed not only for performance and efficiency, but also for high flexibility and transparency. This shift further increases the importance of panel PCs. Where machine control and HMI were once implemented separately, devices that now combine both offer clear advantages – from a smaller control cabinet footprint and reduced cabling to lower maintenance requirements. For this reason alone, the integration of both functions has become the standard in many applications.

Users also benefit from enhanced performance and reliability. When control and visualization tasks run on the same hardware without additional interfaces, latency times decrease and system responsiveness increases. This real-time aspect is particularly relevant, since HMIs are no longer just displays, but smart gateways that capture, preprocess and forward machine data to higher-level systems such as MES or cloud platforms. These properties form the foundation for predictive maintenance, big data analytics, and digital twin applications.

Next-generation HMIs

Beckhoff has consistently aligned its portfolio with these requirements and offers a wide range of advanced panel PCs for the manufacturing industry. The new Next multi-touch panel generation, comprising both control panels and panel PCs, significantly expands this range. The focus is on cost-optimized solutions, a modern and appealing design, and an extensive variety of formats and functions. At Hannover Messe 2025, Beckhoff introduced the two Control Panel series CP49xx (built-in version) and CP59xx (mounting arm version), combining renowned Beckhoff quality with an excellent price–performance ratio.

Beckhoff is taking the next step at SPS 2025, bridging the gap between stand-alone visualization solutions and fully integrated high-end industrial PCs. The new next-generation multi-touch panel PCs, which will make their debut at the exhibition in Nuremberg, expand the product line to include HMI solutions that can handle not only visualization, but also control tasks for the respective machine or system as a full-fledged industrial PC. The new Panel PC series are available as built-in variants CP46xx and CP47xx with an IP20 protection rating, as well as the IP65-rated CP56xx and CP57xx models for mounting arm installation. The robust HMI devices are made of die-cast aluminum. They are available as built-in versions with display sizes from 7 to 23.8 inches, while the mounting arm versions range from 15.6 to 23.8 inches. As with the entire Next multi-touch panel generation, Beckhoff achieves high cost efficiency through state-of-the-art production methods and comprehensive cost management – all without compromising on product quality or functionality.

Leveraging 25 years of HMI production

Drawing on more than 25 years of in-house panel production experience, the devices in the Next multi-touch panel generation incorporate all the latest features and technologies to meet current and future user requirements. What remains unchanged are the ergonomic operating concept and the high quality standards Beckhoff customers have come to expect. The new panel PCs feature a sleek electronics and device design, EtherCAT-based real-time communication, full integration into TwinCAT, and premium displays with multi-finger touch functionality, anti-glare and anti-ghosting effects. Additional highlights include continuous EtherCAT communication (FSoE) for push-button extensions and, for the mounting arm versions, direct customer installation on a 100×100 VESA mounting adaptor or optionally on a 48 mm round tube.

To ensure that the Next multi-touch panel PCs – just like the entire new family – remain future-proof, the electronics design has been revised and the mechanical and electronic interfaces standardized. The elegant devices are manufactured entirely in-house in Germany, offering durability, long-term availability, and worldwide service support.

State-of-the-art CPUs for automation

Alongside all relevant advanced interface standards, the latest industrial CPU generations have been integrated on both the x86 and Arm® platforms. The CP47xx and CP57xx Panel PC series are equipped with CPUs from the new Intel Atom® x7 processor family. They are specially designed for industrial systems such as robotics, automation, and IIoT, combining performance, energy efficiency, and high reliability in harsh environments. Variants with up to four cores are available, with base clock rates ranging from 1 to around 2 GHz. The multi-core architecture enables virtualization and parallel execution of various edge applications, including HMI and AI inference. The chips offer a balanced ratio of power consumption to performance and can be scaled across different performance classes to meet diverse industrial requirements.

With new Arm® CPUs, Beckhoff is paving the way for modern Linux®-based HMI and edge solutions. Installed in the CP46xx and CP56xx Panel PC models, these processors are also designed to meet the specific requirements of automation. The high-performance Arm® processors have six cores, consisting of two Arm® Cortex®-A78, 2.0 GHz and four Arm® Cortex®-A55, 2.0 GHz cores, thus striking an excellent balance between performance and efficiency. Ethernet and other interfaces are integrated for use in networked industrial applications. Overall, these processors are ideally suited for the next generation of smart, connected industrial devices, Linux®-based applications, and more.

Paving the way to the smart factory

The use of these processors at Beckhoff is not limited to the Next multi-touch panel PCs. The latest CPU series are also intended for use in the ultra-compact Industrial PCs of the C601x family. For the first time, the C602x series of ultra-compact Industrial PCs will also be available with Intel Atom® CPUs. A further expansion of the processor and device range is also planned for the new panel PCs. The computing power of the panel PCs will be significantly expanded in the foreseeable future through the use of Intel® Core™ processors.

All in all, the Next multi-touch panel generation meets all the requirements placed on HMIs in their crucial role driving Industrie 4.0 and the smart factory. For users aiming to make their production processes future-proof, efficient, and digital, it offers cost-effective solutions without compromising Beckhoff's hallmark quality and functionality.

Roland van Mark, Senior Product Manager, Beckhoff Automation

More information:
www.beckhoff.com/next-panel-generation

PC-based control in vehicle development

Reproducible test results with EtherCAT-based remote vehicle control

© Beckhoff

Left: On a commercial vehicle manufacturer's R2R test bench, battery electric, fuel cell, and conventional diesel-powered trucks are tested fully automatically under real-world conditions.

The fully automated test sequences are started and monitored via the control station; a camera installed in the driver's cab serves as a visual control point.


© Beckhoff

One of the largest commercial vehicle manufacturers is testing different powertrain configurations – diesel engines, fuel cells, and battery electric drives – on a roller test bench. Reproducible results are ensured by a vehicle remote control system designed by Softing Engineering & Solutions GmbH, which uses EtherCAT and an embedded PC from Beckhoff to access the trucks' CAN bus systems directly and control functions such as gear changes.

The commercial vehicle manufacturer tests all model series sold worldwide under various brands on the Road-to-Rig (R2R) test bench in Wörth. This provides an initial indication of the conditions and dynamic driving situations that are simulated on the R2R test bench. A powerful fan and huge cooling units generate a wide variety of climatic conditions and air currents of around 100 km/h. "The commercial vehicle manufacturer uses its test bench to test how the various powertrain configurations interact with the other vehicle functions, superstructures, and driver cabs under realistic conditions," says Jörg Rottkord, automotive industry manager at Beckhoff. Typical tests include range studies of various battery types and hydrogen-powered fuel cells, as well as consumption and exhaust gas measurements for trucks with diesel engines.

Since the vehicles are already equipped with measuring technology when they arrive at the test bench, all the test bench personnel have to do is set up the trucks – which means securing them with chains and preparing them for the various tests. This work also includes installing the remote control and connecting it to the on-board electronics.

Test bench electronics control gear changes and accelerator pedal position

The remote control allows important vehicle functions such as the driving mode, gear selection, cruise control, retarder, and accelerator pedal position to be remotely controlled from the control station via the test bench automation system. "This enables commercial vehicle manufacturers to carry out many complex measurements – of the kind that were previously only possible on the road – under realistic driving conditions and with a high degree of repeatability on the test bench," says Dr. Tobias Kolb, highlighting the advantage of remote control.

The system consists of a compact control box in the vehicle, which is connected to the vehicle electronics via a vehicle-specific adapter cable set, plus another box in the control station and an embedded PC from Beckhoff as an interface with the test bench automation. The remote control box converts the setpoints of the test bench automation into corresponding messages for the vehicle's CAN bus and feeds them into the on-board electronics. "To do this, we disconnect the CAN bus in the vehicle at a suitable point," says Dr. Tobias Kolb, who works in automotive test bench development at Softing Engineering & Solutions GmbH.

Jörg Rottkord,
automotive industry manager, Beckhoff

> "There is huge added value in the automated processes and the reproducible results."

Access to vehicle electronics with PC-based control

Simple though it may sound, the process actually requires a great deal of specific expertise. Data from the vehicle's common power train controller is needed to control the test sequence. In addition, certain CAN messages – used for gear changes, for example – must be filtered, manipulated, and fed back into the telegram stream with the appropriate checksum. "To do this, Softing uses our CX20x0 Embedded PCs and several CAN interfaces – the EL6751 EtherCAT Terminals," says Jörg Rottkord, automotive industry manager at Beckhoff.

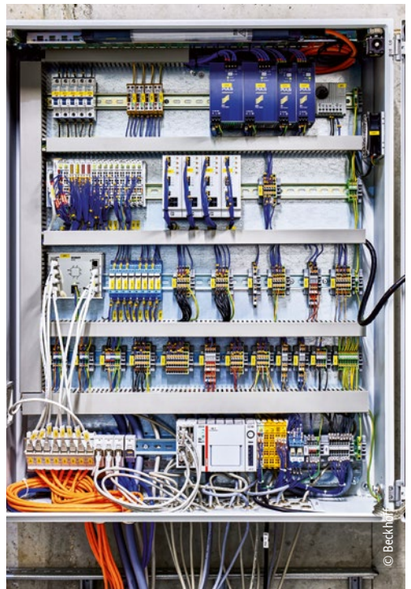
"However, you have to take a smart approach to filtering the CAN messages from the entire vehicle," says David Welsch, who is responsible for

The project participants (from left to right): Franek Dodek (sales, Beckhoff branch in Balingen), David Welsch (software development), Carsten Hafner, (senior test bench engineer, Daimler Truck AG), Dr. Tobias Kolb (automotive test bench development, Softing Engineering & Solutions GmbH), Max Brunner (sales, Beckhoff branch in Munich), and Jörg Rottkord (automotive industry manager, Beckhoff)

programming the remote control. For example, only the messages to be manipulated are extracted, modified, and fed back into the vehicle. The setpoints for a gear change, for instance, then come from the test bench automation. The Beckhoff TwinCAT software calculates the necessary data and copies it into the relevant CAN frames. "This frame is then sent back to the vehicle in real time with the correct CAN message number and checksum," explains Dr. Tobias Kolb. The two main tasks of the remote control are to emulate the switching commands and the accelerator pedal sensor via two opposing PWM tracks generated by a 2-channel EL2502 EtherCAT Terminal.

PC-based control for reproducible test sequences

While drivers previously carried out test procedures manually in sometimes extreme temperatures, the commercial vehicle manufacturer can now use remote control to execute a wide range of scenarios with high precision and repeatability, either fully automatically according to the specified sequence or, if necessary, manually from the control station. "There is huge added value in the automated processes and the reproducible results," emphasizes Jörg Rottkord.



The control cabinet with the CX20x2 Embedded PC (below) for remote vehicle control and the interface with the building automation system is located in the basement of the test bench.

Dr. Tobias Kolb, who developed the remote control, cites two reasons for choosing PC-based control: the modular and compact design of the embedded PCs and EtherCAT Terminals, and the low cost of hardware and software compared to typical rapid prototyping systems. "Since TwinCAT is available free of charge as a development environment, practically the only costs incurred are those for the runtime licenses," Dr. Tobias Kolb continues. "We can also run the development system directly on the CX20x0 Embedded PC, which we operate with Windows," adds David Welsch. Its performance is more than adequate for the cycle time of 1 ms and offers sufficient reserves in case further CAN messages need to be calculated in the future. "A major advantage of PC-based control is that the computing power can be easily adjusted as needed using an embedded PC with a different CPU – in the same form factor," adds Jörg Rottkord.

The flexibility and openness of PC-based control helped Dr. Tobias Kolb solve a configuration problem: "Some vehicles operated at a transfer rate of 500 kbit, others at 667 kbit. Therefore, the CAN interfaces had to be able to switch between the two bit rates during runtimes when vehicles were changed. "Beckhoff's support was very helpful in implementing this function with sample programs," says David Welsch.

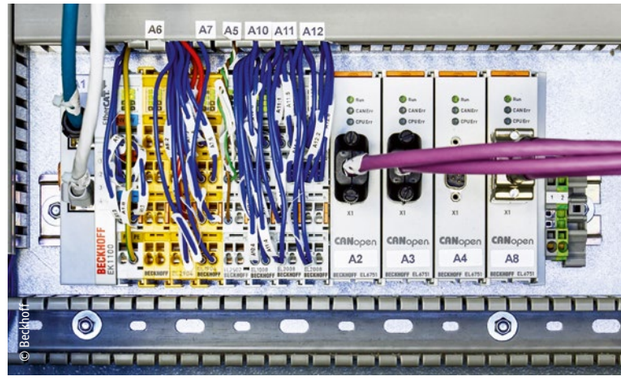
A total of four CAN interfaces are used for remote control: two for sending and receiving messages to and from the truck, and two for integrating a legacy system and configuring other CAN devices in asynchronous mode. "This is where the modularity and easy expandability of PC-based control technology proves to be a real advantage, especially thinking ahead to future vehicle generations that will use CAN FD as their communication system," emphasizes Jörg Rottkord. Beckhoff supports CAN FD physics with the EL6753 EtherCAT Terminal, which can handle flexible data rates (FD) as well as extended data fields with up to 64 bytes. A powerful CANopen protocol implementation makes it possible to integrate any CANopen devices into the EtherCAT Terminal network.

Safe operation with TwinSAFE

Safety plays a major role in test bench technology and, in the case of the test bench remote control, takes the form of Safety over EtherCAT (FSoE) and TwinSAFE Terminals. The remote control is integrated into the emergency stop chain of the building automation system via contacts. Emergency stops are also installed in the vehicle and control station, and disconnect communication with the vehicle when activated. When this happens, the truck also enters emergency mode and the test bench goes into a safe state. In addition, communication is continuously monitored via a live cycle bit exchanged between the test bench and remote control via EtherCAT.

"We see the remote control as a blueprint for many other automotive projects," says Dr. Tobias Kolb, highlighting the potential of the solution. With Beckhoff's open and modular control technology in conjunction with EtherCAT, it is possible to implement cost-effective and powerful gateways between test benches and vehicles with a wide variety of peripherals.

A compact control box is connected to the vehicle electronics via a vehicle-specific adapter cable set. The control box receives CAN messages modified with TwinCAT and feeds them into the vehicle communication system.

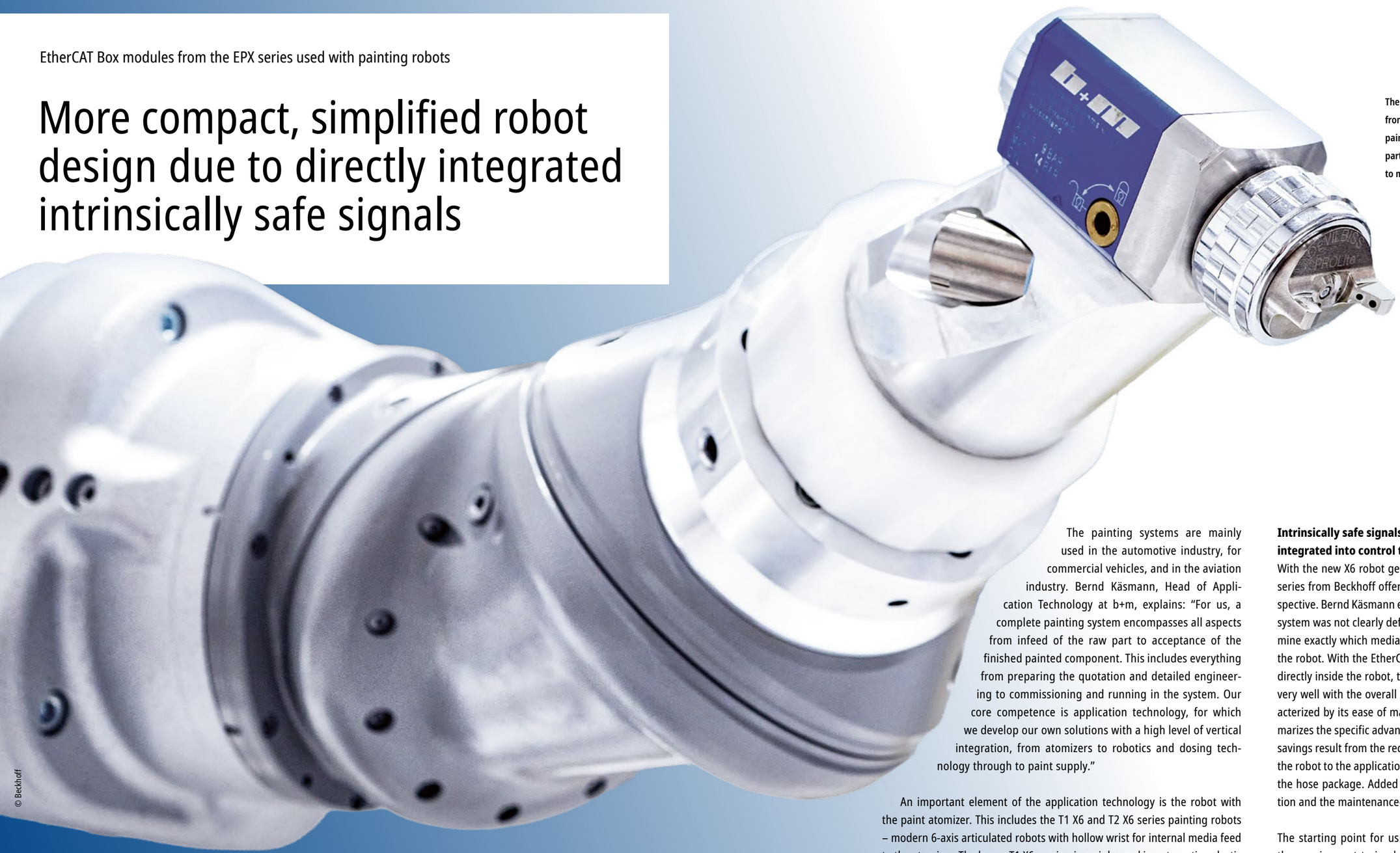


The CAN messages recorded by the remote control box using EL6751 EtherCAT Terminals are modified by a CX20x0 Embedded PC according to the test sequence and sent back to the truck's control units.

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

EtherCAT Box modules from the EPX series used with painting robots

More compact, simplified robot design due to directly integrated intrinsically safe signals



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The robots of the X6 generation from b+m enable very high painting quality and are also particularly compact and easy to maintain.

b+m surface systems GmbH, based in Eiterfeld in Germany, plans and builds complete painting systems – encompassing the process, conveyor, and application technology. The company's extensive expertise results in particularly application-oriented solutions. This is exemplified by the 6-axis articulated robots from the T1 X6 and T2 X6 series, which have been specially optimized for paint application and are particularly easy to maintain due to the use of EtherCAT Box modules from the Beckhoff EPX series, among other things.

The painting systems are mainly used in the automotive industry, for commercial vehicles, and in the aviation industry. Bernd Käsmann, Head of Application Technology at b+m, explains: "For us, a complete painting system encompasses all aspects from infeed of the raw part to acceptance of the finished painted component. This includes everything from preparing the quotation and detailed engineering to commissioning and running in the system. Our core competence is application technology, for which we develop our own solutions with a high level of vertical integration, from atomizers to robotics and dosing technology through to paint supply."

An important element of the application technology is the robot with the paint atomizer. This includes the T1 X6 and T2 X6 series painting robots – modern 6-axis articulated robots with hollow wrist for internal media feed to the atomizer. The larger T1 X6 version is mainly used in automotive plastic painting systems, while the smaller T2 X6 is particularly suitable for limited painting areas or installation positions dictated by the process. According to Bernd Käsmann, the entire robot concept is tailored to the requirements of the painting sector. Various directives, e.g., ATEX, must be complied with for use in hazardous areas. To fulfill these requirements, pressurized enclosures (Ex p) are used.

Intrinsically safe signals seamlessly integrated into control technology

With the new X6 robot generation, the IP67 I/O modules of the EP and EPX series from Beckhoff offer advantages from both a developer and user perspective. Bernd Käsmann explains: "In the previous models, the cable routing system was not clearly defined, so from the very beginning we had to determine exactly which media, hoses, or cables needed to be routed away from the robot. With the EtherCAT Box modules of the EPX and EP series installed directly inside the robot, this work was reduced significantly. And this fits in very well with the overall concept, as the X6 generation is particularly characterized by its ease of maintenance and high system availability." He summarizes the specific advantages of the EPX modules as follows: "The greatest savings result from the reduced number of lines that need to be routed from the robot to the application cabinets. This means significant space savings in the hose package. Added to this are the simplified and centralized installation and the maintenance-friendly overall design."

The starting point for using the EPX modules in the painting robots was the requirement to implement an IP67 I/O level with integrated intrinsic safety in a small installation space – achieved in the T2 X6 painting robot, for example, with four EPX1058 EtherCAT Box modules (8-channel digital input) and, depending on the configuration, one or more EPX3158 EtherCAT Box modules (8-channel analog input). Both I/O Box modules allow intrinsically safe field devices from hazardous areas of zones 0/20 and 1/21 to be directly connected.

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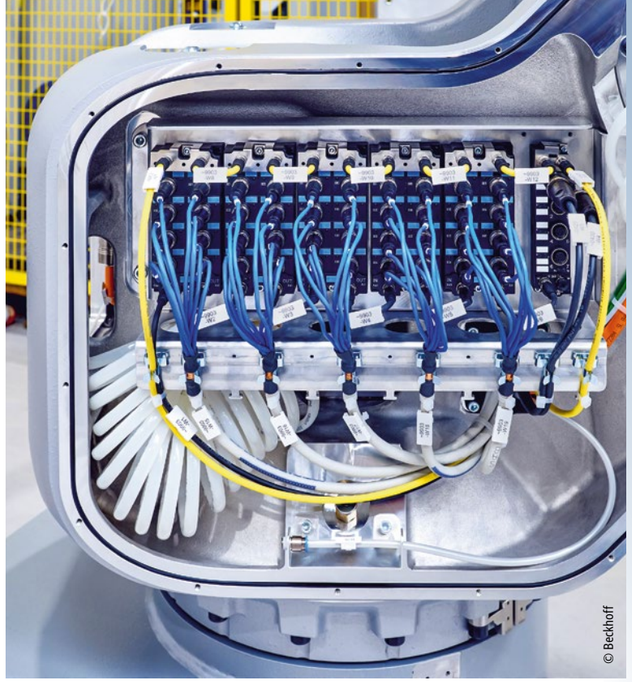
The robot experts from b+m who work with Bernd Käsmann (second from right) next to the T2 X6 painting robot and between Andres Oetken (left), Beckhoff process industry management, and Michael Heumüller (right), Beckhoff sales office in Fulda

Andres Oetken, who works in process industry management at Beckhoff, explains the development of the EPX modules: "The idea of using IP67 I/O modules to integrate intrinsically safe signals had been around at Beckhoff for some time. The first implementation was then realized in connection with the b+m robot project." According to Bernd Käsmann, the starting point was the optimization of the X6 robot generation's internal components, which resulted from customer feedback on the previous generation. In addition, the digital and analog signals that had previously been captured through individual wiring were to be fully integrated via EtherCAT, since this allowed significant savings in material and space: "Among other things, all valves in the robot were converted to EtherCAT-based control, as were the up to 40 process technology sensors in the robot's process arm. These are primarily digital sensors such as position encoders and rotary encoders as well as pressure sensors upstream and downstream of the paint pump. Previously, all these sensors were connected via individual cables that ran along the outside of the robot and out of the hazardous area into the application cabinets. As a result, the hose packages could reach very large diameters. With the desired cross-section, two hose packages would have been required for all lines as well as the medium- and air-carrying hoses. And this could be avoided due to the EtherCAT-capable sensors, which required significantly less wiring work."

Special requirements for I/Os and connection technology

As the robots are approved for Ex zone 1 and are therefore intrinsically safe to operate, a solution suitable for such applications was required as an EtherCAT-capable I/O level. An additional IP54 housing would have been required inside the robot for implementation with the IP20 EtherCAT Terminals from the ELX series. Bernd Käsmann explains: "The robot's requirements as a pressurized enclosure system would have made active air purging of the I/O housing necessary. This is difficult to reconcile with the IP54 protection rating. With the EtherCAT Box modules from the EPX series, however, we were able to avoid this conflict."

To ensure reliable signal acquisition, the challenge was to find a torsion-resistant, shielded, and slim cable suitable for installation inside the robot. Furthermore, the eight M12 connectors that are required had to be connected to the cable in a watertight manner. Beckhoff developed a solution for this where pairs of wires were individually molded onto M12 connectors.



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Four EPX1058-0022 EtherCAT Box modules and one EPX3158-0022 EtherCAT Box are used in the T2 X6 painting robot to integrate the intrinsically safe signals.

With this individual wire overmolding, a particularly space-saving, IP65/IP67-protected sensor cable was provided, which fits perfectly with the compact footprint of the system – as Bernd Käsmann confirms: "The solution developed together with Beckhoff was intended to combine eight channels in one cable in order to save installation space. Other important aspects for us were EMC shielding, twisted pair design, the smallest possible diameter, overmolded connectors to ensure IP protection, a terminal strip for initiators, and double-sided assembly for time-saving wiring." Easy accessibility, without having to open the entire robot, and the availability of cables in all required configurations and lengths were also crucial. And no other provider has been able to implement all of this.

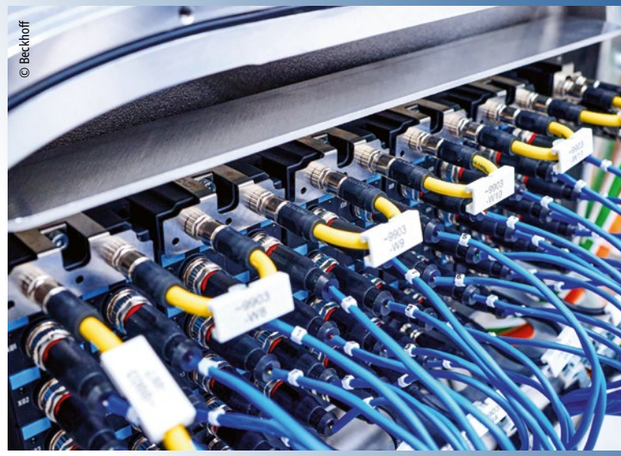
Flexibility through diversity with PC-based control

Openness, scalability, and component diversity are key features of PC- and EtherCAT-based control technology from Beckhoff. In addition to the EPX modules, EtherCAT Box modules from the EP series are also used in the robot, e.g., the 8-channel EP2338-1002 for recording digital signals and the 1-channel EP5151-1002 encoder interface for controlling the gun valves and for speed evaluation in the high-rotation atomizers. Bernd Käsmann also confirms the advantages of the wide I/O spectrum, including EtherCAT and TwinSAFE Terminals from the EL series in the application cabinets: "b+m benefits from the wide variety of I/Os and communication advantages in all areas of application, whether due to the simple integration of third-party components or with the components for the direct integration of intrinsically safe signals, without having to use separate, costly, and installation-intensive safety barriers as with conventional solutions.

These are good reasons which explain why b+m has been using PC-based control from Beckhoff since 1996. According to Bernd Käsmann, the decisive factor at the time was being able to use TwinCAT software as a very powerful and flexible control technology: "Our company is extremely flexible – we develop customized painting systems and the Beckhoff product portfolio offers us precisely this flexibility. EtherCAT is also an important factor due to its high market penetration, high performance, and openness to other fieldbus systems. Overall, performance limits for automation are no longer an issue in our applications with the Beckhoff system."

Bernd Käsmann,
Head of Application Technology,
b+m surface systems GmbH

> "The solution developed together with Beckhoff was intended to combine eight channels in one cable in order to save installation space."



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The connection technology of the EPX modules meets the specific requirements of robots approved for hazardous areas.

More information:
www.bm-systems.com
www.beckhoff.com/epx
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XTS in an assembly line for vehicle battery cells

Five intelligent transport systems optimize space requirements and productivity

IMA EV-Tech, a business unit of IMA Automation, has developed a new battery cell assembly line based on integrated Beckhoff technologies. The key element here is the XTS linear transport system, which features a high level of software functionality and a significantly more compact layout compared to conventional solutions. This results in an assembly line with high productivity and quality in operation combined with a minimized system footprint.

With more than 60 years of experience, over 7,400 employees, more than 3,500 registered patents, and an international network of factories and subsidiaries, IMA S.p.A. is a world leader in automated machines for the processing and packaging of pharmaceuticals, cosmetics, food, tea, and coffee. IMA EV-TECH was founded to strengthen its presence in the electric vehicle sector. This business unit of the IMA Automation division specializes in the development of technologies and complete assembly lines for electric vehicle solutions such as battery cells, hydrogen cells, electric traction motors, motor stators, and motor rotors. Fabio Tozzi, Sales Manager at IMA EV-Tech, comments: "The latest result is a high-performance system for assembling battery cells, which owes its development in part to the innovative contribution of Beckhoff automation solutions."

The individual battery cells look similar to small cylindrical cans. Although they are conceptually simple, producing them on a large scale is a rather complex process. The anode and cathode are separated by a polymer material and rolled together to form what is known as a jelly roll. The cell as a whole consists of this jelly roll and other elements in a cylindrical metal container that is hermetically sealed and filled with an electrolyte solution.

High performance and low space requirements with XTS

"The market is currently dominated by Asian manufacturers, especially from China and Korea," explains Fabio Tozzi. "The lack of real competition at an international level has so far resulted in little technological development of the available solutions. In this environment, our as-

View of two of the five XTS systems in IMA EV-Tech's complex battery cell assembly line

sembly line stands out due to its high productivity and assembly quality, its small footprint and, above all, its very competitive total cost of ownership." The XTS product transport system with its individual control of all movers plays a key role in this innovative solution. It enabled the individual phases of the assembly process to be decoupled and made it possible to overcome the limits previously imposed by a strictly sequentially controlled production process. In this way, it was possible to increase the speed and precision while reducing the working space.

XTS and PC-based control are nothing new for IMA, as the company has been working with Beckhoff for many years and uses products including embedded PCs, panel PCs, TwinCAT software, EtherCAT, and the corresponding I/O components as well as drive technology. In addition to these basic components of the Beckhoff automation architecture, IMA has already used XTS successfully in some of its recently developed solutions for the pharmaceutical sector and food and beverage industry, among others. "XTS is a system that offers very interesting application possibilities for our goals," says Fabio Tozzi. "With the flexibility of PC-based control and the TwinCAT automation software in particular, XTS offers us a major advantage – namely the ability to manage the individual movers with special motion profiles. This has proven to be ideal for the specific characteristics of this application."

Assembly line comprising five modules

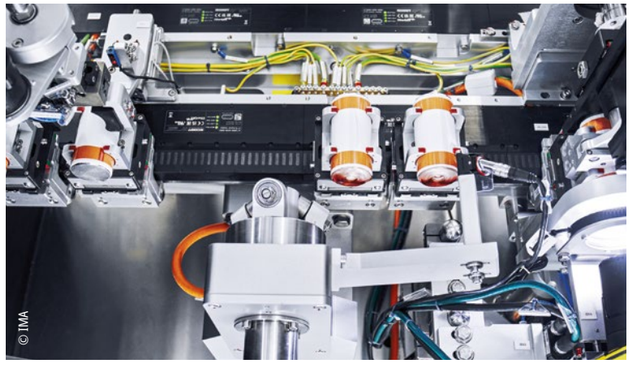
Each system section is equipped with a C6030 Industrial PC and a CP3916 multi-touch Control Panel, with an additional CP3918 Control Panel integrated in three sections. The entire control system is equipped with advanced servo drive technology for high performance and reliability, including the AX8000 multi-axis servo system, the AM8000 servomotors, and the AMP8000 distributed servo drive system. To make the process even more efficient, five enclosed XTS systems with a total length of approx. 43.5 m are provided for linear product transport within the system.

According to IMA EV-Tech, the application is characterized by a modular and efficient structure that enables orderly and easily scalable management of the production process. The division of the assembly line into functional sections corresponds to a clear operating logic, while the integration of industrial PCs and modern control panels ensures reliability and easy monitoring. The use of XTS also enables an approach that is geared toward maximum flexibility and precision in parts handling and complies with the latest standards of industrial automation.

Sophisticated cell assembly

Assembling battery cells involves a number of challenges, as handling, manipulation, and inspection must be managed with very high throughput and high demands on the quality of the end product. The system must therefore not only be fast, but also guarantee very high precision, which the XTS movers ensure with a positioning accuracy of ±0.25 mm.

The assembled battery cells entering a test station



Transporting the battery cells attached to the XTS movers from one assembly station to the next

The assembly phases are combined with functional and visual inspection processes, which are carried out using elements such as image processing systems and X-ray detectors. If these processes were carried out completely sequentially, some process steps – such as the aforementioned checks – could develop into potential bottlenecks due to the longer throughput times. This is where the flexibility of XTS comes into play, especially with the ability to place multiple cells simultaneously on multiple instances of slower workstations. According to IMA EV-Tech, this enables a significant increase in system throughput.

Another factor to consider is that production lines often have to operate in clean and dry rooms in order to prevent contamination from a wide range of sources and thus ensure the quality and durability of the battery cells. These are classified environments in which critical environmental parameters such as temperature and humidity – to prevent oxidation or corrosion – as well as particle concentration are strictly controlled. In this context, using machines that not only increase productivity but also require less space is a great advantage. For IMA EV-Tech, this is the only way to make optimum use of the available space and ultimately increase the profit margin.

For the new assembly line, IMA EV-Tech relies almost entirely on the Beckhoff ecosystem: CPUs, panel PCs, communication modules, I/Os, AX8000 servo drives, AM8000 servomotors and the AMP8000 distributed servo drive system, EtherCAT (with Safety over EtherCAT, FSoE), TwinCAT and, of course, XTS as the heart of the overall system. It was an obvious choice for Fabio Tozzi, especially as the openness of PC-based control did not rule out the possibility of integrating third-party devices, e.g., electrical inspection systems, specific controllers, or ad hoc handling systems. He adds: "The support offered by Beckhoff proved to be crucial. The direct contact with the Italian subsidiary and, if necessary, with the head office in Germany proved to be a key factor that led us to a genuine technological partnership. We also took part in training that enabled us to get to know the XTS system thoroughly and thus utilize its full potential."

Particularly high system flexibility

Although the shape and size of the battery cells are defined as standard, the assembly line must also be able to process certain product variants. This requires additional steps, such as the incorporation of plastic elements. A system of this kind, to be able to adapt quickly to different production requirements, must work very efficiently. According to Fabio Tozzi, the XTS system and TwinCAT were the key elements in ensuring the success of the project in this context.

With the assembly line developed by IMA EV-Tech, new stations and devices can also be integrated if required. This increases system flexibility – so that, for example, new work processes can be added in the future or, alternatively, certain process steps can be selectively excluded. All of this makes it easier to manage product variants without compromising the overall performance of the line. "In parallel to the assembly line for cylindrical battery cells, we have developed assembly solutions for prismatic cells," adds Fabio Tozzi. "Their shape and composition, which varies greatly in terms of size, process sequence, and components to be assembled, requires an additional degree of flexibility. Our aim is to provide the market with modular solutions that can be adapted to the needs of each individual customer and integrate all the necessary processes. At the same time, we want to further increase the performance of the systems and reduce the number of operators required to operate them. This is a factor that is particularly important with regard to relocating production activities from Asia to Europe or the United States."

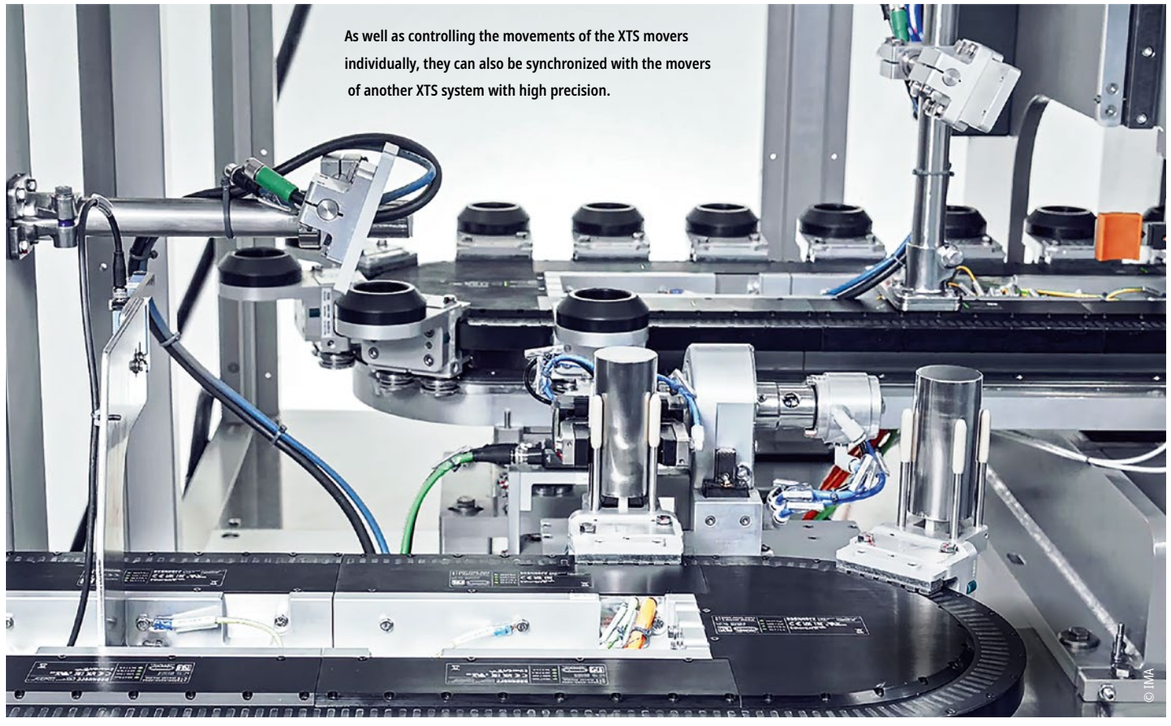
Fabio Tozzi, Sales Director Battery Division at IMA EV-Tech: "With the flexibility of PC-based control and the TwinCAT automation software in particular, XTS offers us a major advantage – namely the ability to manage the individual movers with special motion profiles."

More information:

www.imautomation.com/ev-tech

www.beckhoff.com/automotive

www.beckhoff.com/xts



The IRPD experts (2nd to 4th from left) Stefan Lang, CEO, Dr. Kai Gutknecht, Head of Process and Software Development, and Dominik Lenherr, Software Engineer Automation, in front of the IMPACT 4530 machine tool and between René Zuberbühler (left), Managing Director of Beckhoff Switzerland, and Christoph Nessler (right), Head of the Beckhoff sales office in Arbon

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PC-based control for additive machine tools

Industrial additive manufacturing of metal parts under controlled process conditions

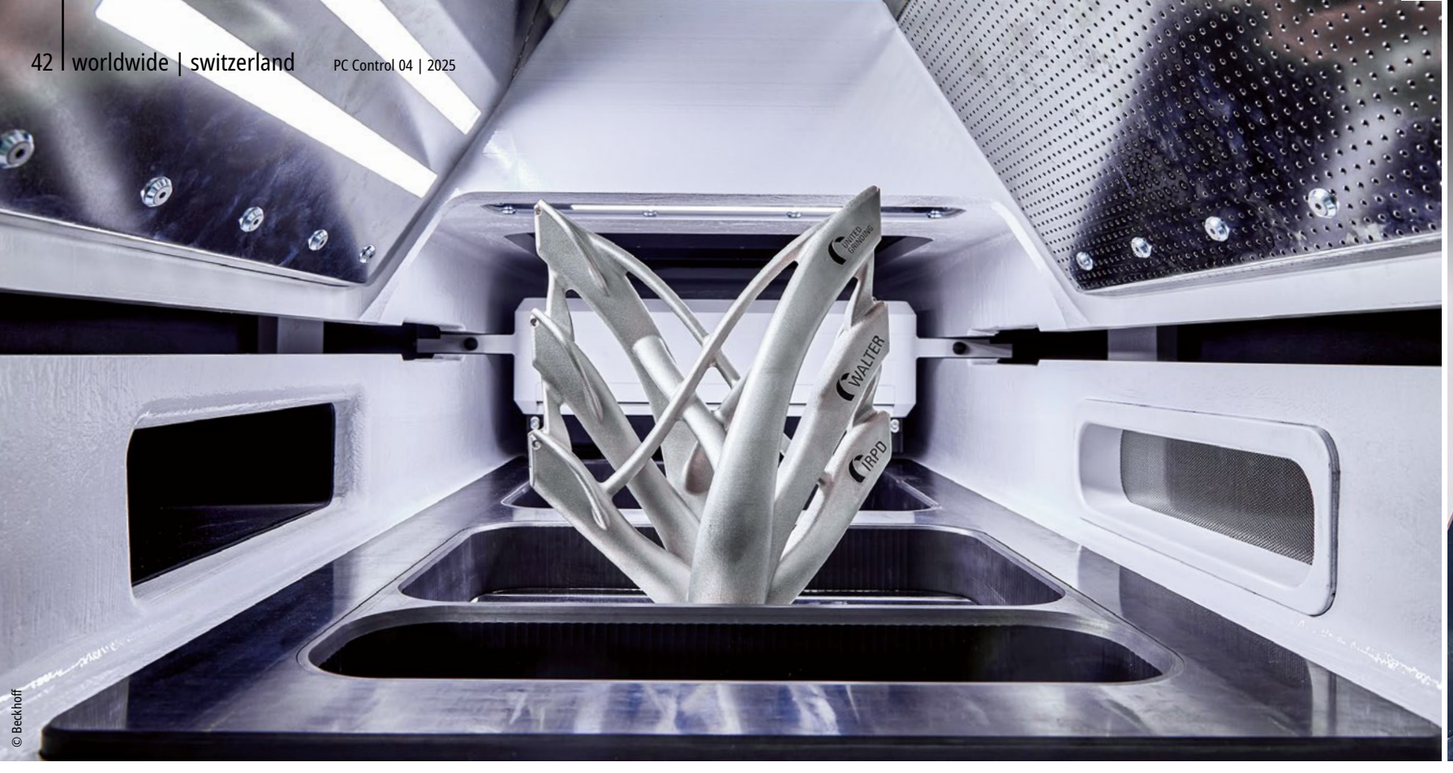
IRPD, based in St. Gallen, is a specialist in additive machine tools with over 25 years of experience in this field. Development is heavily focused on high system throughput and consistently high process quality. This goal was achieved with the help of PC- and EtherCAT-based control and drive technology from Beckhoff, among other things.

The main customer segments of the parent company UNITED MACHINING SOLUTIONS Group – and thus also the areas of application for the additive machine tools – are automotive manufacturers and suppliers as well as the aviation industry and cutting tool manufacturers. Stefan Lang, CEO of IRPD, explains: “In additive manufacturing, parts often have to be reworked at connection surfaces. Our parent company supplies the appropriate systems for this, which facilitates the vertical integration of the production process and offers the customer an end-to-end solution.” Dr. Kai Gutknecht, Head of Process and Software Development at IRPD, adds: “In our target markets, the main priority is ensuring an efficient process from beginning to end. Accordingly, machine development specifically focused on achieving a high number of produced parts and ensuring consistently high quality. This starts with the large build area, the four 1,000 W fiber lasers, and the container concept designed for fast job and material changes – and extends to the thermally and mechanically stable production environment, preparation for automation, and complete monitoring of the production process.”

LPBF system with machine tool standard

At the heart of the IMPACT Fab complete system is the IMPACT 4530 machine tool for the additive manufacturing of metal parts. Laser powder bed fusion (LPBF) enables the flexible production of high-quality parts from a wide variety of metals. In addition, there is the PM1 depowdering and recycling system, which removes the remaining metal powder from the build container, sieves it under inert conditions, and transports it to the powder container for future tasks. Other system components include the LS1 loading station, which is used to lift the build plates out of the container, and the HM1 handling module, which moves the containers between the individual production stations.

The IMPACT 4530 itself consists of two main components: the machine core for the actual additive manufacturing process and the supply unit for preparing various media. Dominik Lenherr, Software Engineer Automation at IRPD, explains the process flow: “The machine core is largely designed as a cast construction to ensure a stable and reproducible process both thermally and mechanically. The machine is set up using two cube-shaped containers, one for the build process and the other for storing the metal powder as the starting material. The automated insertion and docking of the containers speeds up and standardizes the set-up process, resulting in minimal downtimes and allowing the start of a build job to be reproduced.” Once the containers are hermetically docked in the machine, a high-quality process atmosphere is created in a time-efficient manner. A horizontal axis then applies metal powder layers to a build plate. These layers are then melted by several lasers and welded to the desired component cross-section. After lowering the build plate by a layer thickness of typically a few hundredths of a millimeter, new powder is applied and the process is repeated. According



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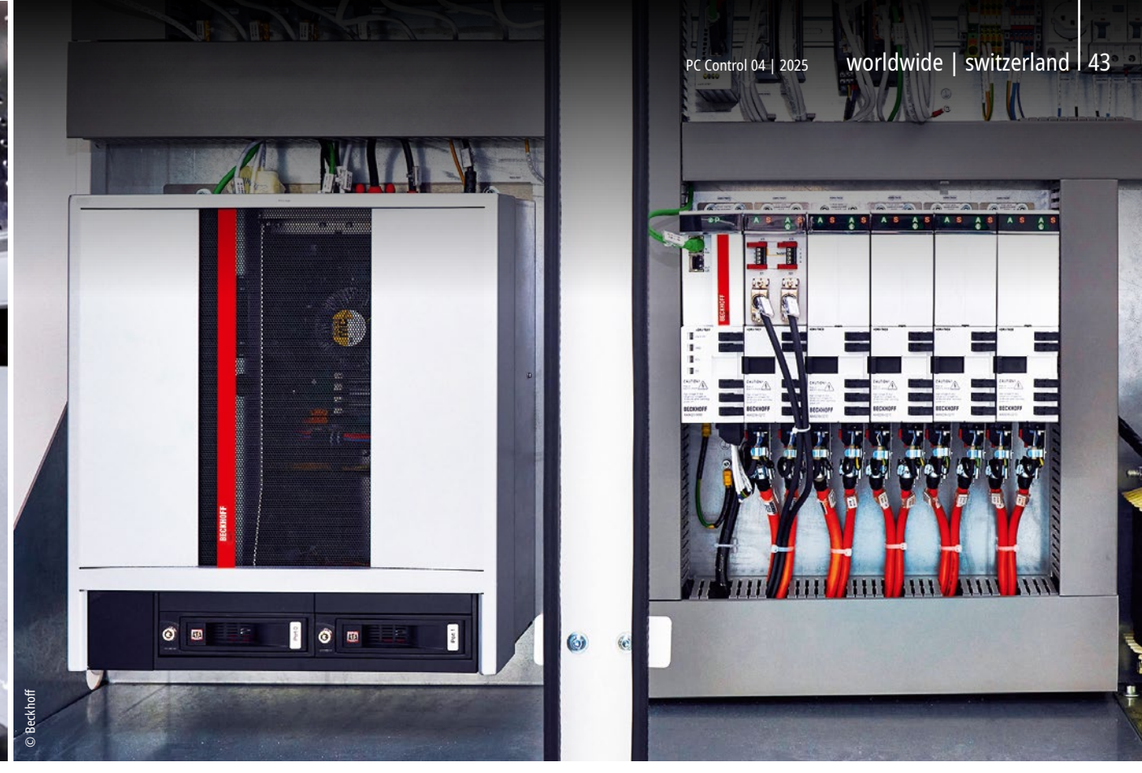
Build space of the additive machine tool with a complex metal component



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The C6675 control cabinet Industrial PC (left) offers sufficient computing power – both for machine control and motion control implemented via the AX8000 multi-axis servo system (right) as well as for future functional expansions, e.g., with TwinCAT Machine Learning.

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Left: The One Cable Technology of the Beckhoff AM8000 servomotors significantly reduces cabling work and the risk of wiring errors.

Right: In addition to the EtherCAT and TwinSAFE Terminals from the EL series, the I/O level also includes the compact EtherCAT and TwinSAFE Box modules from the EP series, which are suitable for decentralized installation.

to Dr. Kai Gutknecht, the key components here are the lasers and the galvanometer scanners, which can be used to move the laser beam quickly and with micrometer precision. The system is rounded off by various monitoring solutions and the intuitive C.O.R.E. (Customer Oriented Revolution) operating software used on all UNITED MACHINING SOLUTIONS Group machines, which communicates with the Beckhoff TwinCAT control system via a simple, high-performance ADS interface.

Requirements for automation

As Stefan Lang explains, the starting point for the project was ideal when it came to choosing suitable automation technology: “As the IMPACT project opened up a completely new technology sector for IRPD, the control platform could be selected to meet the specific requirements of additive manufacturing. The system openness, the advanced development environment, and the innovative products from Beckhoff were all arguments in favor of PC-based control with TwinCAT. Added to this was the PC-based control approach itself, which opens up interesting possibilities with regard to a lean, easily expandable overall system architecture.”

PC-based control from Beckhoff controls all hardware-related machine functions in the IMPACT 4530 except for the movement of the laser over the powder bed. These functions include mechanical axes, pneumatics, machine safety, inert gas circulation, and cooling. The hardware core of the control system is the C6675 control cabinet Industrial PC. Dr. Kai Gutknecht explains: “One of our goals was to create a system architecture with low-threshold interfaces, and as few of them as possible. The basis for this is a powerful central system that maps the control and high-level language software on one piece of hardware – the C6675. We are not yet making full use of its high computing power, although the PLC, the vision application, and the resource-intensive C.O.R.E. application are already running on it alongside Windows. Further applications such as process monitoring via cameras, big data and machine learning applications as well as additional process controls will be added in the course of further development.”

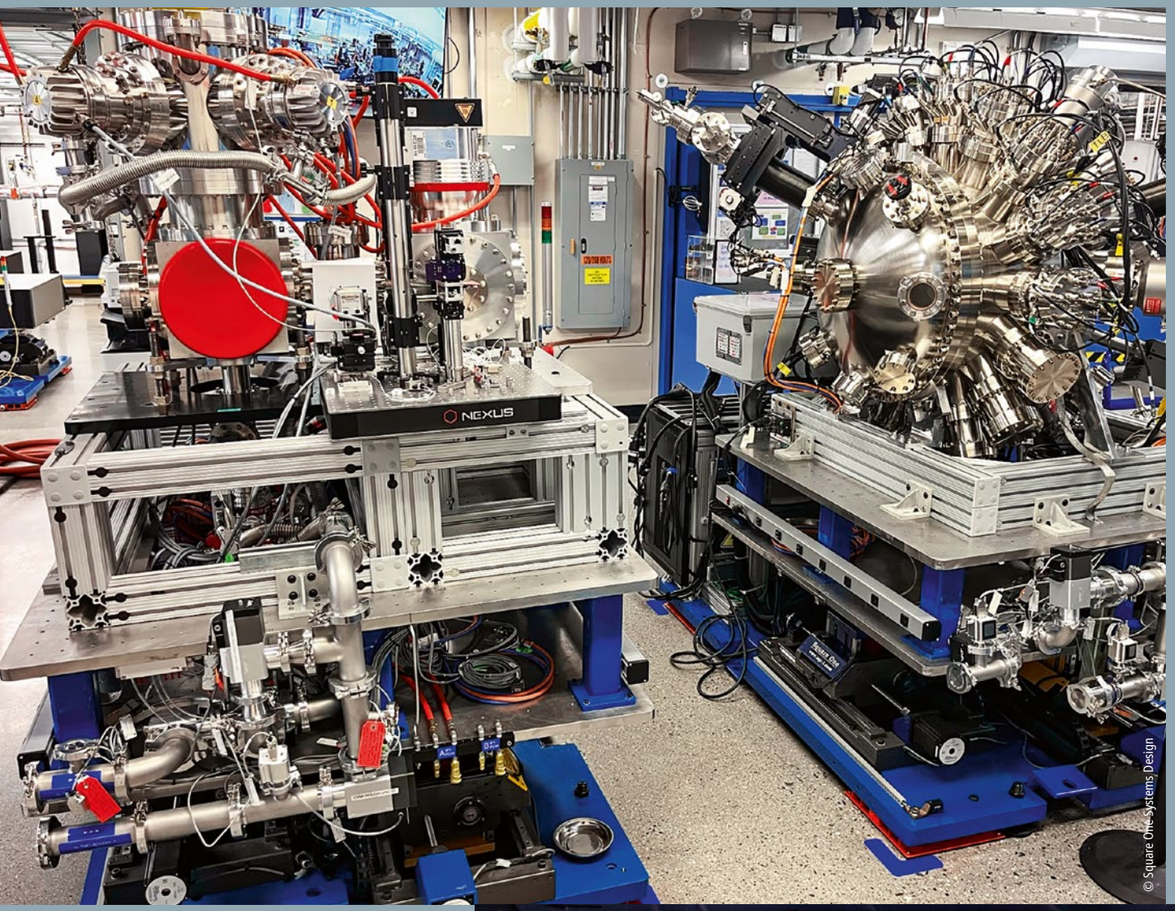
From IRPD’s point of view, the application-oriented approach to solving automation tasks was also very well supported by the modular TwinCAT software. TwinCAT Vision was used to quickly and easily integrate a camera for process monitoring into the control system. In addition, according to Dominik Lenherr, executing the image processing algorithms directly within the control environment makes it possible to capture image data with precise timing and in sync with the machine sequences, without having to set up and maintain complex interfaces. He adds: “The TwinCAT libraries – such as TwinCAT HMI, Motion, and even Vision – provide comprehensive support with their ready-made function blocks for programming, commissioning, and diagnostics of the various software components. I see integrated troubleshooting and analysis in particular as one of the biggest advantages of TwinCAT Engineering. With TwinSAFE, machine safety is also seamlessly integrated, so we don’t have to work with different tools and only have to maintain one piece of software.”

Efficiency in motion control and EtherCAT communication

According to Dr. Kai Gutknecht, IRPD also benefits from the TwinCAT function blocks when it comes to motion control: “We use the standard functions MC_MoveAbsolute, MC_Jog, and MC_Reset, among others, which significantly reduces the programming effort for us. The associated servo axes are implemented with the very compact AX8000 multi-axis servo system and AM8000 servomotors. The One Cable Technology (OCT) offers us particular advantages, as it simplifies the system cabling considerably and reduces the risk of errors during installation. In addition, our system is easy to take apart for transport, with the minimized cabling saving a lot of time when separating the parts.”

The high-performance EtherCAT communication also contributes to system efficiency, especially during commissioning. Dominik Lenherr explains: “A good example of this is EtherCAT’s hot connect functionality, which we use for a coater, for example. The coater is available in a version with and without a drive controller and can be replaced quickly and easily via hot connect if required, without having to shut down the entire system or interrupt any necessary diagnostics.” Together with automatic device addressing, this also comes into play with regard to the modularity of PC-based control. For example, if requirements change, a higher-level controller can simply be added via the EP series EtherCAT Box modules with an IP67 protection rating, without the need for complex addressing. With regard to the Beckhoff I/O portfolio, he concludes: “A clear advantage of the EtherCAT I/Os from Beckhoff is their compact design, which saves a lot of space in the system. Added to this is the extremely wide range of components, which we could not find anywhere else on the market. Good examples include the multifunction EtherCAT Box modules with their combined analog and digital inputs and outputs plus the TwinSAFE Box modules for the direct connection of field sensors for safety functions.”

More information:
www.irpd.ch/en
www.beckhoff.com/machine-tools



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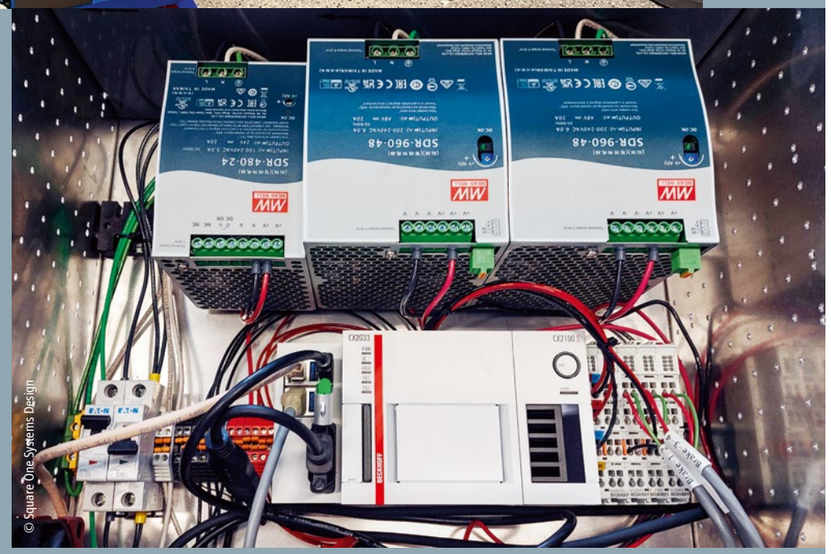
Square One's patented Tri-Sphere Robotic Positioning System is a state-of-the-art parallel robot that accelerates experiments in high-energy physics.



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Tri-Sphere relies on Beckhoff CX2033 Embedded PCs, real-time EtherCAT communication, and TwinCAT NC PTP software for motion control.

Square One Systems Design leverages PC-based control and EtherCAT in robots that support X-ray laser experiments at SLAC National Accelerator Laboratory

Robotic positioning system reduces changeover times from two days to 12 hours

At the SLAC National Accelerator Laboratory in Menlo Park, California, an advanced robotic system by Square One Systems Design and Beckhoff speeds up high-energy physics experiments. Streamlining operations, the Tri-Sphere Robotic Positioning System increases the utilization of "beam time." This helps with maximizing access for researchers and improving research outcomes.

Square One's patented Tri-Sphere robot is a state-of-the-art parallel robot whose design was tailored to meet the rigorous demands of high-energy physics research. Like revolute jointed industrial robots, the Tri-Sphere offers six degrees of freedom in movement. However, unlike traditional robots, the Tri-Sphere robot delivers huge payload capacity, ultra-high precision, and a compact design that fits seamlessly into tight spaces. The Tri-Sphere also conforms to the EPICS standard (Experimental Physics Integrated Control System) which is widely adopted in the physics community. EPICS provides researchers and technicians with a standardized control system architecture and software toolkit to interface with and control high-end equipment. This improves process tracking performance and optimizes analysis of the metadata gathered during experiments.

SLAC's deployment of Tri-Sphere robots is part of larger upgrades to their Linac Coherent Light Source (LCLS), the world's most powerful X-ray free-electron laser (XFEL). A recent upgrade (LCLS-II) increased the capabilities of the original system from 120 pulses per second to 1 million pulses per second, and a future upgrade (LCLS-II-HE) will increase the X-ray energy. In simple terms, this opens up an entirely new realm for advanced research projects that were previously considered impossible by scientists, including a new generation of solar energy technologies, superconductors, advanced drug discovery, etc.

Breaking through the limits of physics research

The unique design of the robot offers several advantages to accommodate the rapid succession (removal and replacement) of complex research setups and operate in the demanding environment typical of facilities like LCLS. The robot's compact geometry means it can fit into the tight confines of a mainstay in research facilities, the hutch, or the equipment used in research facilities where X-ray beams pass through test samples. The robot's high-precision positioning system ensures that it can precisely move research equipment into beams as narrow as 100 nanometers.

Tri-Sphere is not only accurate, it's also very strong – supporting rapid movement and repositioning of heavy objects with the accuracy required to perform cutting-edge experiments. "The robot is designed with heavy payloads in mind and has the ability to handle up to 12,000 pounds equaling 5,440 kg – which is essential when positioning heavy objects in national labs like SLAC," explains Bob Viola, Director of Engineering at Square One Systems Design. "This performance far exceeds that of conventional robots that may be more suited to industrial use."

Maximizing beam time is essential to accommodate as many experiments as possible. "National labs like SLAC are literally priceless national resources, and every second of beam time counts," Bob Viola emphasizes. "The ability to

perform quick changeovers without compromising precision or reliability is a game-changer."

Jace Walsh, Chief Controls Engineer at Square One, explains further, "The Tri-Sphere's asymmetric work envelope and software-tunable rotation point provide unmatched versatility and precision, allowing it to adapt to a wide range of experiments. This flexibility is crucial for experiments, where the ability to quickly and accurately reposition experimental setups can significantly impact research outcomes."

The Tri-Sphere upgrade integrates automation and control technology from Beckhoff across multiple experimental hutches, allowing SLAC to conduct high-precision experiments with minimal downtime. The staff can set up a new center for the beam in the Tri-Sphere's user-friendly front-end software, dial in new configuration settings, and enter new height parameters and rotation settings.

Mathew Garcia,
Business Development Leader,
Beckhoff USA

> "It's exciting to see how our technology is helping improve research outcomes and efficiencies at SLAC and other facilities."

The SLAC robotic systems are mounted on air casters. This enables the robots to be quickly moved in and out of different hutches. The Tri-Sphere can handle delicate samples with precision, another key advantage. "The robot features a vacuum transfer system to ensure that the system can handle a wide variety of container types without damage, including delicate products with soft-touch finishes," says Bob Viola. "This is crucial for experiments using highly sensitive sample materials."

Automating what's next in research and discovery

Instrumental to the success of the Tri-Sphere Robotic Positioning System has been the integration of PC- and EtherCAT-based control technology from Beckhoff. The Tri-Sphere currently relies on Beckhoff CX2033 Embedded PCs as the primary controller, leveraging real-time EtherCAT communication and high processing speeds to seamlessly handle all automation and control tasks. The CX2033 runs TwinCAT NC PTP software for motion control.

EtherCAT's automatic addressing of the highly modular devices, numerous wiring topology options, and high device count – up to 65,535 devices in one network – ensure a robust and scalable network infrastructure. In addition, the compact size of the EtherCAT Terminals easily fit in compact enclosures distributed throughout the Tri-Sphere robot. Not just relegated only to data acquisition, EtherCAT Terminals can also incorporate compact drive technology from Beckhoff with the EL7041 and EL7047 stepper motor terminals and the EL5042 dual channel interface terminals for the connection of absolute encoders with BiSS® C or SSI interface.

Beckhoff TwinSAFE I/O terminals and Safety over EtherCAT (FSoE) technology provide robust machine safety functionality that integrates seamlessly with SLAC's personnel and equipment protection system for monitoring the safety status whenever personnel are in a hutch and initiating e-stops if they're ever needed. "TwinSAFE supports these unique safety requirements, ensuring safe access to the hutches at all times and reliable control of these powerful positioners," emphasizes Bob Viola.

The Tri-Sphere system is also compatible with the seismic anchoring requirements typical of installations in California. This ensures that the systems can withstand seismic activity and maintain their precise positioning.

A promising future for leading research projects

"When SLAC can prepare an experimental work setup on a Tri-Sphere outside of the working hutch without shutting down the beamline, it speeds things up," Bob Viola says. "The system reduced the time required for SLAC experiment changeovers from two days to just 12 hours."

Mathew Garcia, Business Development Leader at Beckhoff USA, echoes this sentiment. "The Tri-Sphere project is a testament to the collaborative efforts of Square One and Beckhoff. It's exciting to see how our technology is helping improve research outcomes and efficiencies at SLAC and other facilities." The Tri-Sphere, as demonstrated by its successful deployment at SLAC, is helping overcome key challenges in many areas of scientific research. With proven flexibility and performance to adapt to a wide range of difficult testing spaces, the system has since been deployed at other world-renowned laboratories to help reach the next big discovery.

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The Tri-Sphere robot's high-precision positioning system ensures that it can precisely move research equipment into beams as narrow as 100 nanometers.

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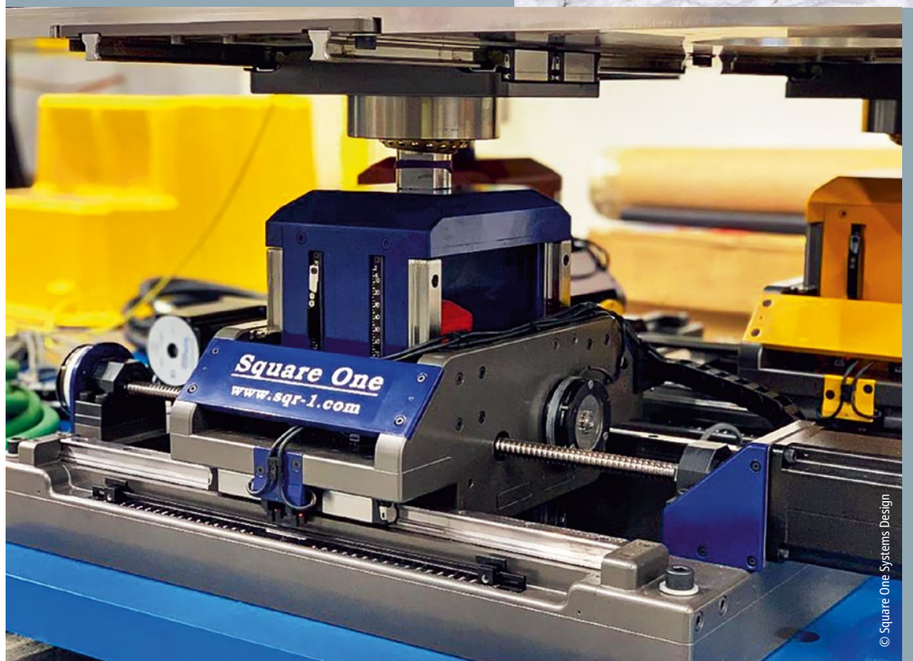
The Square One engineering team during their annual ski day in Wyoming in 2025. Left to Right: Sam Johnson (Mechanical Engineer), Wilton Springer (Mechanical Engineer), Connor McCullough (Electrical Engineer), Erik LaCourt (Controls Engineer) Bob Viola (Director of Engineering), Jace Walsh (Controls Engineering Manager), Ryan Freeman (Mechanical Engineer), Dena Horstkotte (Mechanical Engineer)



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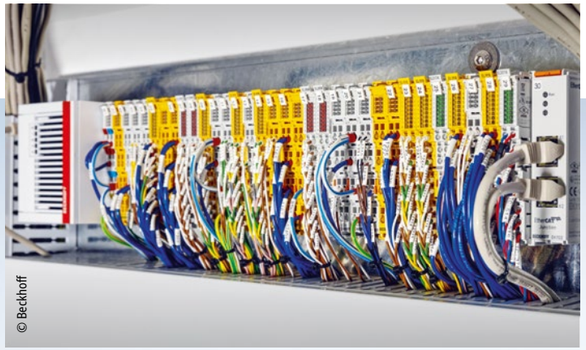
A detailed view of one of the three jack units that comprise a Tri-Sphere robot.

More information:
www.sqr-1.com
www.beckhoff.com/science

Modular control platform facilitates innovation in the hydrogen industry

Reliable and safe electrolysis testing



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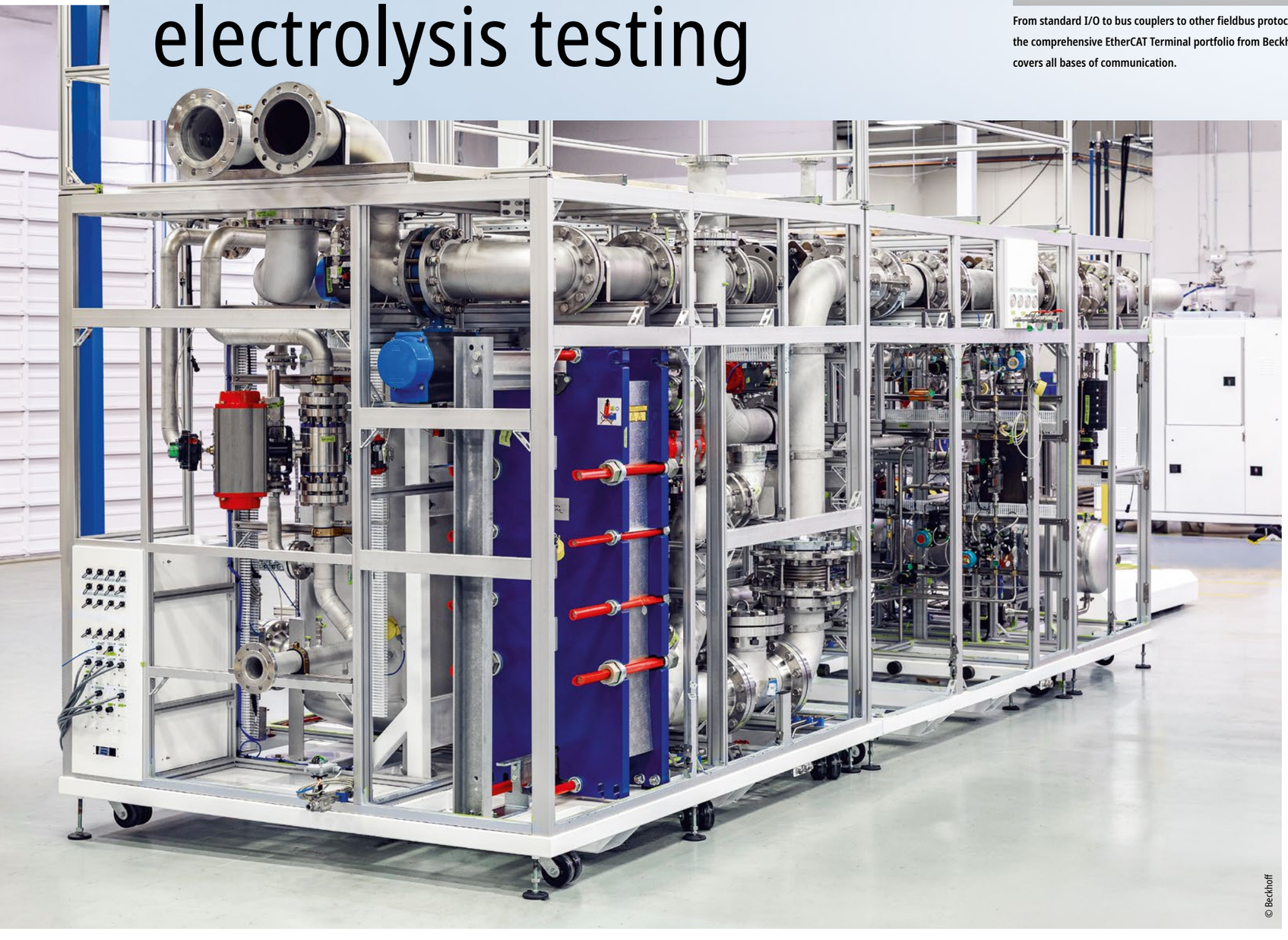
From standard I/O to bus couplers to other fieldbus protocols, the comprehensive EtherCAT Terminal portfolio from Beckhoff covers all bases of communication.

With a seamless modular control solution from Beckhoff featuring over 500 data points and numerous ELX series terminals with intrinsically safe interfaces, Greenlight Innovation is breaking new ground in hydrogen testing. This advanced setup allows for precise and safe monitoring and management of complex hydrogen processes, enhancing both reliability and efficiency in testing operations.



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Greenlight electrolysis test stations are critical for fuel cell development to validate and ensure safety under various loads.

As the world increasingly looks to hydrogen as a clean energy solution, the companies developing these technologies face a critical challenge: safely and accurately testing their innovations before they reach the market. Greenlight Innovation, headquartered in Burnaby, British Columbia, has emerged as a global leader meeting this need, as the company says.

In 1992, Greenlight was founded as a supplier to the fuel cell industry. “Since then, electrolysis has become a major focus,” says Greig Walsh, Chief Commercial Officer at Greenlight. “As the hydrogen industry evolved, we saw increased demand for equipment to test hydrogen production technologies.”

Reliable control platform for complex test processes

Among Greenlight’s product portfolio are test stations for industrial-scale electrolyzers – systems that split water into hydrogen and oxygen using electricity. Their largest systems, capable of testing 4 MW electrolyzer stacks, represent their most complex engineering challenge. “The equipment is very complicated and technologically demanding,” says Christian Bosio, Managing Director at Greenlight. “That machine has thousands of components that we’re putting together, and it has to work as one. Everything has to be top-notch, very high quality, and reliable.”

These test stations must control high-pressure gases up to 50 bar, regulate temperature across multiple zones, and manage potentially explosive hydrogen-oxygen mixtures – all while ensuring continuous operation with minimal operator intervention. Under these conditions, safety presented the most demanding challenges. “Electrolyzer test equipment operates at higher pressures, so the safety requirements are significant,” Christian Bosio says. “As we get into these megawatt-class systems, the safety requirements have been compounded, making safety a critical factor in all of our designs.”

Greenlight’s systems needed to support different safety protocols depending on deployment location while maintaining the same high performance standards as well as meeting customer-specific requirements.

The Greenlight team and Beckhoff at their Burnaby, British Columbia facility: (from left) Christian Bosio, Greig Walsh, Amir Kassaian (Beckhoff), Martin Greyling, Christian Bordin and Kriss Koutzarov

The Greenlight electrolyzer test station evaluates and validates performance, durability, and efficiency.

Beyond standard EtherCAT Terminals from Beckhoff, Greenlight also uses TwinSAFE terminals for integrated functional safety and ELX terminals for safe connection of field devices installed in hazardous areas.

Standardizing on flexible automation from Beckhoff

Before finding the right control platform, Greenlight overcame a number of specific challenges, including struggling with bulky I/O modules and communication reliability issues with their previous systems. “We were very conscious that this equipment needs sophisticated electronics and control systems, so we wanted to make an educated choice at the beginning,” explains Greig Walsh.

Kriss Koutzarov, Electrical Engineer at Greenlight, highlighted the technical advantages that drove their decision to select Beckhoff: “The modularity and flexibility were key factors. With Beckhoff, we had different options for I/O module channel density. Also, each module was very compact – they were just half an inch compared to five inches with other solutions. As a result, we managed to save a lot of space in the cabinet.”

To connect the hundreds of sensors, valves, and controls needed in their systems, Greenlight uses various EtherCAT input/output terminals throughout their machines. These terminals handle everything from basic valve control to sophisticated analog measurements, with systems often incorporating up to 500 data points. This modular approach allows Greenlight to easily add or modify capabilities as project requirements evolve.

Building on the safety challenges mentioned earlier, Greenlight implemented Beckhoff’s TwinSAFE terminals to create comprehensive safety systems. The TwinSAFE architecture integrates digital inputs through EL1904 and EL1918 terminals and digital outputs via EL2904 and EL2912 terminals, providing Safety Integrity Level (SIL) 3 protection. Moreover, the system utilizes TwinSAFE SC terminals to monitor analog parameters such as temperature, pressure, and other critical parameters to ensure safe operation under all conditions up to SIL 2 level.

For areas with potential hydrogen exposure, Greenlight uses the Beckhoff ELX terminals with intrinsically safe inputs and outputs. These specialized terminals integrate isolation barriers and remote I/O in a single compact housing, eliminating the need for external barriers while enabling direct connection to field devices in hazardous environments up to Zone 0/20. “Wherever there might be fuel and oxidant, we must eliminate the ignition source. The ELX terminals’ outputs don’t have the energy to cause a spark, even if you shorted them,” says Kriss Koutzarov.

The ELX terminals provide significant space and cost advantages. With up to eight intrinsically safe inputs available in a 12 mm housing, they eliminate the need for external barriers, reducing control cabinet space requirements. Certified for ATEX, IECEx, and NEC/CEC, these terminals meet all industry-specific guidelines for explosion protection and support Greenlight’s global deployments.

PC-based control simplifies system development

At the heart of their 4 MW electrolyzer test station is the CX5130 Embedded PC, which manages the entire testing process. With its dual-core processor and fanless design, the CX5130 provides the ideal balance of computing power and reliability for demanding industrial environments. This compact PC-based controller handles everything from data acquisition to complex control algorithms while offering the connectivity needed to integrate with their extensive I/O network. The ability to perform PLC and measurement tasks simultaneously makes the controller particularly well-suited for Greenlight’s sophisticated test sequences, where precise timing and coordination are essential.

Christian Bordin,
Automation and Controls Developer,
Greenlight Innovation

> “It’s just plug and play, which is amazing. There’s no need for writing complex drivers.”

The system architecture leverages TwinCAT automation software for process control and the EtherCAT industrial Ethernet system for seamless integration. “It’s just plug and play, which is amazing,” said Christian Bordin, Automation and Controls Developer at Greenlight, explaining the advantages of EtherCAT’s simplicity. “There’s no need for writing complex drivers. With the TwinCAT engineering environment, we can easily configure the system and communicate with all our components.”

Testing the future of hydrogen production

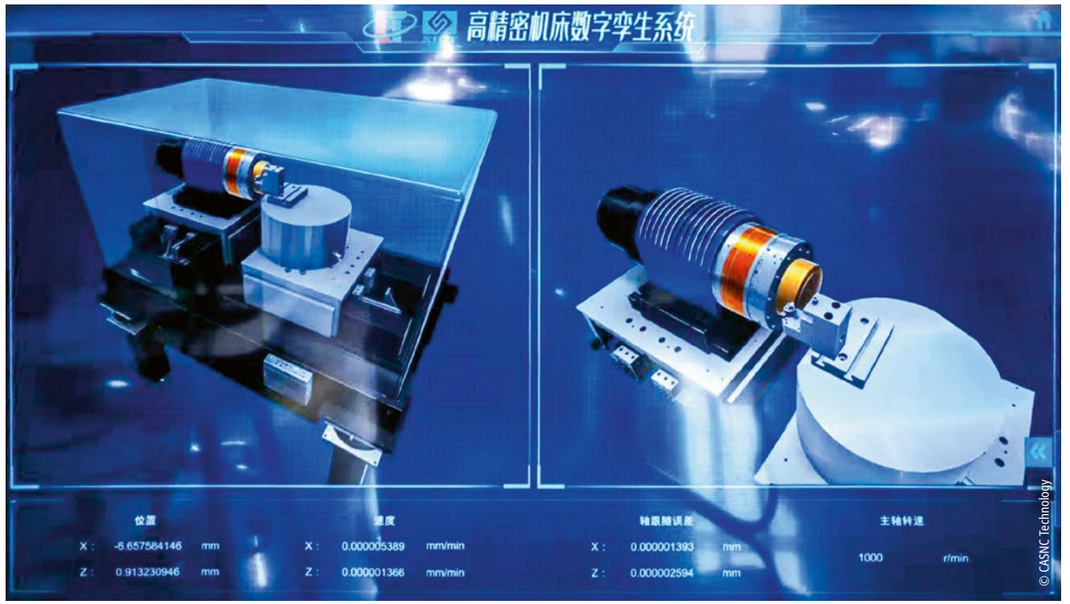
The impact of Greenlight’s standardized Beckhoff control platform has been significant for both the company and its customers. Their test stations now provide comprehensive data collection and analysis capabilities that enable manufacturers to validate and improve their system designs. One such customer, cellcentric, has found Greenlight’s test stations invaluable for their fuel cell development, allowing them to evaluate performance under varying gas flow rates, humidities, temperatures, pressures, and electrical loads. Using Greenlight’s Emerald software, they can develop and execute automated test scripts, view real-time data, and log precise instrumentation outputs – providing fast and reliable feedback to validate design changes and ensure product quality before shipment.

Looking ahead, Greenlight is focused on standardizing its electrolyzer test systems across a wider range of sizes. As Greenlight continues to scale, their approach remains consistent: deliver flexible, high-performance systems that let customers focus on their core technologies while Greenlight handles the complexity behind the scenes. “The key to our success has been adaptability, which allows us to meet the changing needs of this growing industry,” Christian Bosio concludes.

More information:
www.greenlightinnovation.com
www.beckhoff.com/elx
www.beckhoff.com/ethercat

PC-based control for digitalization in the machine tool sector

Integrated and open control platform maximizes project development efficiency



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CASNC Technology is driving forward the digitalization and virtualization of its machine tools, particularly with Beckhoff TwinCAT 3.

Shenyang CASNC Technology's CNC solutions rely on the integration of sensors, data acquisition systems, and network communication technologies to monitor and analyze machine tool operating statuses, process sequences, and machine conditions in real time. By seamlessly integrating advanced information technology, the company is driving digitalization in this area. TwinCAT 3 automation software from Beckhoff serves as the cornerstone for the successful implementation of digitalization and virtualization strategies.

Machine tools are central pieces of equipment in the manufacturing sector, with a wide range of applications, such as in aerospace and automotive manufacturing, as well as in the energy sector. From the perspective of Shenyang CASNC Technology Co., Ltd. (CASNC Technology), the performance of machine tools is directly related to a country's industrial competitiveness, which is why they are regarded as "pillars of the nation" in China.

The Chinese high-tech company specializes in the development and manufacture of CNC systems, servo drives, robot controllers, automation equipment, digitalized manufacturing as well as mechanical and electrical products. The results are advanced machine tools such as 5-axis machining centers.

Digitalization and virtualization in TwinCAT

The Beckhoff TwinCAT software is used as an important cornerstone. Firstly, it enables the use of standard programming languages in accordance with IEC 61131-3, which is consistent with customers' established debugging practices. What's more, TwinCAT 3 also benefits the digitalization and virtualization of systems. MATLAB® and MapleSim offer user-friendly graphic design environments with which even sophisticated systems can be modeled using simple and intuitive operations, making them a universal option in areas such as model simulation. For the current project, these simulations can be executed seamlessly within TwinCAT using TwinCAT 3 Target for FMI in the XAE development environment and on the corresponding XAR models exported from MapleSim. Position commands interpolated by TwinCAT 3 NC I are fed into the model, while the model outputs the collected voltage and current data. TwinCAT 3 ADS is used to dynamically display the actual position of the machine tool movement in the interface. This not only facilitates hardware-in-the-loop (HIL) simulation, but also enables digital twins to be generated without the need for physical objects. This allows aspects such as the rationality of path planning and the efficiency of milling machine processing to be evaluated at an early stage.

From CASNC Technology's perspective, the digitalization and virtualization of machine tools is primarily based on an open software platform. In this context, TwinCAT offers inherent advantages due to its integration in Visual Studio, the robust compilation environment, and its own real-time operating kernel. In the

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project development and design phase, the ECAD tools can be integrated via TwinCAT 3 XCAD Interface in order to import the data directly into the TwinCAT PLC with ease. This reduces errors between hardware and software and increases programming efficiency. TwinCAT 3 PLC Static Analysis can be used to analyze the source code to minimize ambiguities and optimize its usability. TwinCAT 3 PLC Profiler enables the runtime behavior of PLC projects to be analyzed in order to identify time-intensive calls and program segments for subsequent code optimizations. In addition, TwinCAT 3 Realtime Monitor ensures precise diagnostics and optimization of the temporal behavior of the controller. The tool analyzes the execution sequence and priority of the code during the operation of multi-core or multitasking programs. TwinCAT 3 Scope View can also be used to collect data with precise timestamps to form XY, YT, or even XYZ diagrams in TwinCAT 3 Vision, which, among other things, enriches debugging methods and enables event-driven recordings.

With TwinCAT 3 EtherCAT Simulation, virtual debugging is achieved without the need for real hardware. This not only supports basic PDOs, but also offers corresponding functions for CoE, SoE, AoE, and even distributed clocks. Errors can also be simulated in order to test the corresponding mechanisms and codes. TwinCAT 3 Interface for Inventor® provides an interactive connection between TwinCAT and 3D CAD systems for simple 3D simulation of models. TwinCAT 3 Target for Simulink®, for MATLAB®, for Embedded Coder®, and for MATLAB® and Simulink® enable model-in-the-loop (MIL), HIL, and software-in-the-loop (SIL) simulations.

Mit TwinCAT 3 Interface for Inventor® provides an interactive connection between TwinCAT and 3D CAD systems for simple 3D simulation of models.

In this cooperation project, CASNC Technology used TwinCAT 3 Target for FMI to export the machine tool axis models generated by the MapSim software to TwinCAT 3 for execution in real time. The models record the initial positions from the Beckhoff interpolation algorithm, which converts the position signals internally into current and voltage signals. By simulating the inertia and other factors of the actual hardware load, the algorithm recalculates the actual speed and position that the axis can achieve. This position is then sent to another host software for simulation and display of the actual motor position. Fast communication is facilitated by ADS and the correspondingly low latency in the millisecond range. According to CASNC Technology, this approach allows MIL and HIL simulations to be realized in an optimum manner and used as an implementation basis for digital twins via third-party tools. In addition, vibration sensors are included in new projects in order to carry out predictive maintenance and life cycle management using the sensor data and algorithms developed in-house.

Powerful and EtherCAT-based hardware

CASNC Technology not only relies on the integration and openness of PC-based control for the digitalization and virtualization of its machine tools: The powerful, flexible Beckhoff hardware, which benefits from the IT environment, is also used to implement new technologies and functions in machine tool applications. The diverse, sophisticated path planning in this area places high demands on the computing power of the controllers. In addition, further performance is required for digital simulation, virtual operations, and extensive data acquisition as a basis for data analysis, predictive maintenance, and life cycle tracking of machine tools.

For the control core, CASNC Technology has opted for the C6030 ultra-compact Industrial PC, which is equipped with an Intel® Core™ i5 processor. TwinCAT allows its high multi-core computing power to be fully utilized. Based on CASNC Technology's experience, this leads to faster processing times for the controller and shorter control cycles for the servo axes, which has further increased control accuracy. In combination with the EtherCAT XFC terminals from Beckhoff, precise control can be achieved through multi-time-stamps independent of the task cycle.

The EtherCAT master interface of the C6030 provides a simple connection to the dynamic and cost-effective EtherCAT servo drives. EtherCAT also offers topology freedom: Linear networks can be set up with EtherCAT Couplers such as EK1100 and EK1110 and star topologies using EtherCAT junctions such as EK1122. In connection with the EL3351 analog EtherCAT input terminal, a flexible static and dynamic weighing function and strain measurement can be implemented. With the EL3632 analog input terminal, IEPE vibration sensors can be connected directly, and a current source of 2 to 8 mA can be integrated without the need for an additional converter. The data obtained can be evaluated in TwinCAT 3 with the vibration analysis library for frequency range, time range, envelope diagrams, etc. or – owing to the system openness – also via customer-specific algorithms or standard analysis libraries from third-party providers. Analog temperature measurement terminals such as EL3204 and EL3314 can directly access information on resistance and thermoelectric voltages and convert this into precise temperature information using integrated characteristic curves, which also supports the predictive maintenance of machine tools, according to CASNC Technology.

Further advantages for CASNC Technology are the extensive range of EtherCAT hardware and the powerful, simple, and flexible EtherCAT fault diagnosis and localization. Added to this is the openness of the PC- and Windows-based Beckhoff control technology, which enables seamless interaction with higher-level planning systems. By using sockets, web servers, FTP, SMTP, etc. to integrate numerous IT concepts into the automation technology, the systems are also freely expandable and easy to develop further.

Dynamic and precise servo drive technology

Machine tools place high demands on the accuracy and speed of axis movements in particular. The position, speed, and current control loops of the AX5000 servo drive from Beckhoff can achieve a cycle time of 62.5 ms. According to CASNC Technology, this is sufficient to meet the requirements of the control algorithms. Regardless of whether it is a 1-channel or 2-channel version of the drive, each channel is equipped with up to two feedback signals. By selecting the AX5805 TwinSAFE drive option card, various safe stopping methods can be implemented, such as SLS, SSR, and STO. For application scenarios with higher synchronization requirements for stops, this can be implemented in connection with the gantry function of the AX5000.

Both internal and external brakes are supported for vertical axes; corresponding parameter settings for counterbalance systems are provided. A PID parameter autotuning function can also be used. TwinCAT 3 Bode Plot is suitable for analyzing the overall system and can be used to identify resonance points and apply suitable filters by means of slight, controllable oscillations. This approach enables the stability of the system to be improved, the rigidity to be increased, subsequent faults to be reduced, and the service life to be extended.

The AX8000 multi-axis servo system, which mainly consists of a power supply module and several axis modules – or alternatively a combined power supply and axis module – is also suitable for controlling the Beckhoff AM8000 servomotors. There is also a capacitor module to support the DC link and the AX8820 universal regenerative unit for feeding regenerative energy back into the supply grid. AX8000 not only makes it easier to save energy, but also increases the efficiency of servo axis movements, decreases overall power consumption, lowers the cost of braking resistors, reduces the temperature rise in the control cabinet, and minimizes its magnitude.

The trend toward control cabinet-free automation can also be implemented with PC-based control from Beckhoff: firstly, with the MX-System as a pluggable system solution to completely replace control cabinets and, secondly, with the AMP8000 distributed servo drive system consisting of distributed servo drives as well as supply, distribution, and coupling modules. The latter can replace the servo drive technology in the control cabinet, saving a significant amount of space.

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The C6030 ultra-compact Industrial PC forms the powerful control core of CASNC Technology's machine tools.


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Test setup for machine tool control

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More information:
http://casnc.com.cn
www.beckhoff.com/machine-tools

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David Dobón, Applications Engineering Manager; Agustin Cano, Team Leader Control Systems; and Hector Ortega, Team Leader Software (all Power Electronics) in front of a power block (from left to right)

Dynamic control of industrial solar plants and energy storage systems

Scalable energy supply without system limits

Spanish Group Power Electronics has demonstrated its comprehensive expertise in sustainable energy supply in over 3,000 solar and energy storage projects with a total installed capacity of 120 GW. To control its modular systems, the company relies on open, high-performance Beckhoff control technology: powerful embedded PCs combined with TwinCAT enable flexible scaling and dynamic load changes of 330 MW within 110 ms.

Based in Llíria near Valencia, Power Electronics specializes in inverters for utility and battery storage systems and is a leading manufacturer of solar inverters for photovoltaic systems around the world. Founded in 1987, the company is represented in 36 countries and has implemented more than 3,000 solar and energy storage projects with 120 GW of installed capacity (AC), preventing the release of almost 120 million tons of CO_2. In addition to the production of solar, battery, and hybrid inverters, Power Electronics also supplies its own control system for plants – with the battery controller interface (BCI) and power plant controller (PPC) as core elements.

A plant consists of many individual power blocks with solar and/or battery modules, each of which is monitored and controlled by a BCI that uses PC-based control. A power block contains an inverter for the solar modules and

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– if battery storage is also used – a DC/DC converter. The inverter converts the direct voltage of the solar modules into alternating voltage to supply either the grid or the batteries bidirectionally, depending on demand. The central PPC is responsible for the higher-level control and coordination of all power blocks in a plant according to the grid operator's requirements.

Higher economic efficiency through dynamic control

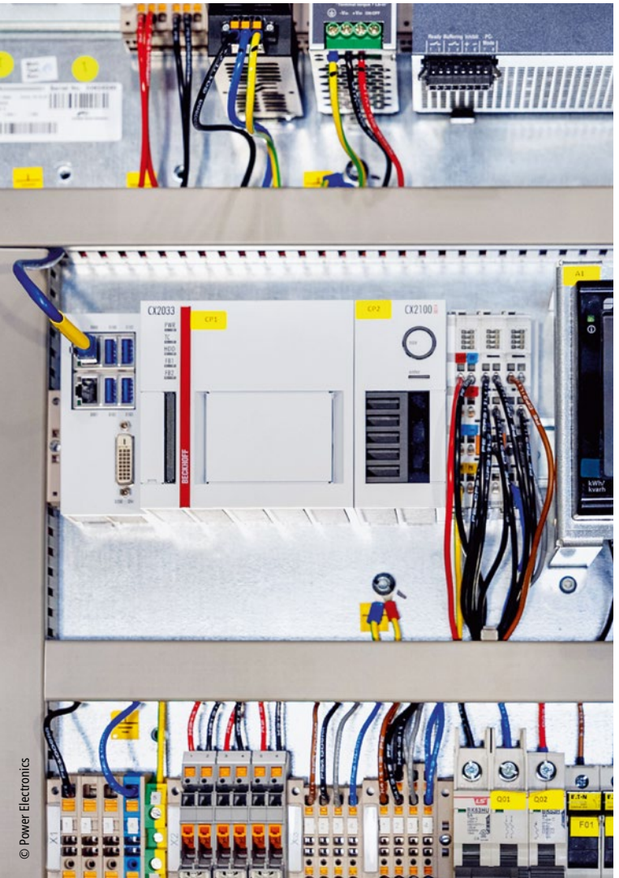
With its decades of expertise, the company complies with the demanding energy supplier regulations which vary across the globe and, among other things, define how plants need to behave in order to ensure the stability of energy grids during certain events. "If a plant also meets even stricter requirements in terms of response times, it can provide what are known as support services," says David Dobón, Applications Engineering Manager at Power Electronics, emphasizing the importance of high-performance control technology. The advantage for the operators is that they can sell the energy fed into the grid at a higher price point. "Initially, we were able to switch our systems from consuming 150 MW of power to delivering 180 MW in 130 ms, for example. Now we can do that in as little as 110 ms," adds Agustin Cano, Team Leader Control Systems at Power Electronics. Extremely short switching times like these require a fast and sophisticated automation system, which Power Electronics implements using hardware and software from Beckhoff. It can thus control all three power block variants: solar, battery, and hybrid.

The challenge of hybrid power blocks

"The most sophisticated scenario arises when the inverter of a BCI manages both solar modules and batteries at the same time," describes Hector Ortega, Team Leader Software at Power Electronics. These hybrid power blocks then function as small autonomous solar plants and must essentially manage themselves to maintain an energy balance.

Power Electronics uses Beckhoff CX series Embedded PCs with TwinCAT 3 PLC (TC1200) to control the various battery controller interfaces. "Depending on the configuration of a power block, a CX5120 or CX5240 Embedded PC with an Intel Atom® processor is used, for example," explains Javier Menchén, Technical Support at Beckhoff Spain. The BCIs communicate with the inverters, batteries, and other components via Modbus TCP and execute sophisticated control algorithms with very short cycle times.

CX2033 Embedded PCs with AMD Ryzen™ processors are used for the power plant controllers (PPC) and the individual power blocks are controlled via TwinCAT and ADS.



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Agustin Cano,
Team Leader Control Systems,
Power Electronics

> "The TwinCAT real-time task management is essential for ensuring the short response times of the solar plants and battery storage systems."

TwinCAT 3 PLC HMI Web (TF1810) is also installed as a visualization system on the embedded PCs of the controls. This enables service personnel to access the parameters of the connected devices directly on site or remotely via a web interface.

Future functional enhancements and software optimizations are expected to require additional computing power. In this case, performance can easily be adjusted by switching to an CX5330 Embedded PC with two CPU cores. Miquel Coca, sales at Beckhoff Spain, comments: "Beckhoff regularly expands its portfolio of industrial PCs and embedded PCs with more powerful variants, while at the same time ensuring the long-term availability and easy scalability of its control computers."

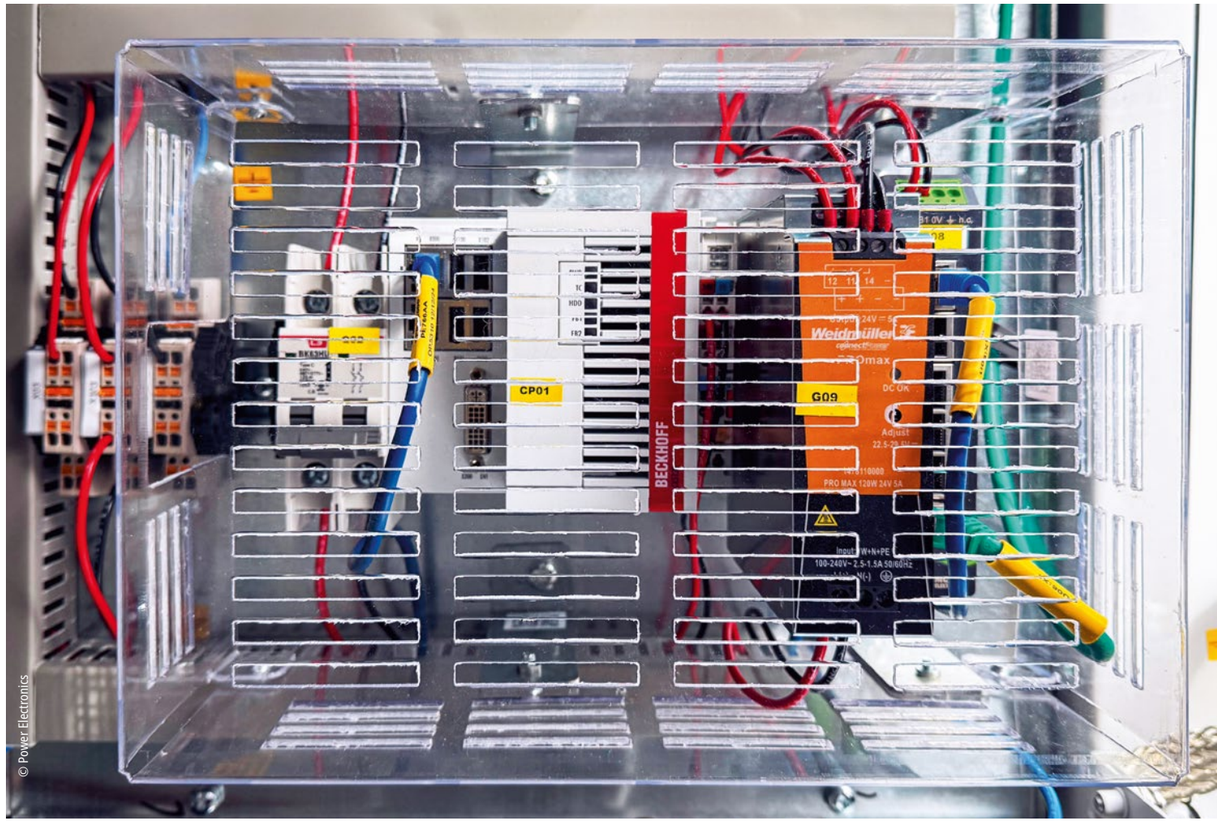
Battery storage as a dynamic control reserve

The PPC monitors and controls multiple BCIs and is responsible for coordinating all power blocks in a plant as a key element. Here, Power Electronics relies on a CX2033 Embedded PC with an AMD Ryzen™ processor. "In one project, we have already coordinated 160 BCIs with the embedded PC and have not yet come close to its power reserve," says David Dobón. The PPC records and processes the information from each BCI via the ADS communication protocol and provides them with the operating setpoints. "ADS is very fast, is flexible, and enables communication via the plant's Ethernet network," emphasizes Miquel Coca. Expansions are also planned for the PCC software, with a CX2043 Embedded PC featuring four CPU cores set to be used in future.

Openness facilitates system integration

"The use of a control PC with an open operating system enables the integration of .Net code, which is a major advantage for us," says Hector Ortega, highlighting an important feature of PC-based Control from Beckhoff. Power Electronics was thus able to implement the DNP3 telecontrol protocol used by many energy suppliers for communication between the higher-level SCADA system and the substations. In addition, .Net is used to manage the databases and develop the visualization.

"The TwinCAT real-time task management, together with the powerful embedded PCs, is essential for ensuring the short response times of the solar plants and battery storage systems," emphasizes Agustin Cano. What's more, the diagnostic tools provided by TwinCAT are extremely helpful for monitoring the execution time of each task across all cores and cycles. The compatibility of the hardware and software was another criterion for choosing Beckhoff as a supplier. Cooperation between the teams at Power Electronics and Beckhoff in clarifying technical issues was quick, smooth, and efficient to boot.



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In its solar and battery storage projects, Power Electronics benefits from the openness and broad scalability of Beckhoff's control hardware and software, and uses CX5120 Embedded PCs, for example, for the battery controller interfaces.

More information:
www.power-electronics.com
www.beckhoff.com/electrical-power-distribution
www.beckhoff.com/embedded-pc

Looking forward to the joint work on the interoperability of EtherCAT devices at EtherCAT Plug Fest

Successful EtherCAT Plug Fest at the Beckhoff Silicon Valley Technical Center

The EtherCAT Technology Group (ETG) has hosted another successful EtherCAT Plug Fest – this time at Beckhoff's Silicon Valley Technical Center in California. Numerous developers came together to test their devices in a practical environment and verify the interoperability of their EtherCAT products.

Focused work and extensive sharing of experience

A Plug Fest is a practice-oriented developer meeting at which manufacturers network their EtherCAT devices – both MainDevices (controllers) and SubDevices (e.g., I/O modules or drives) – and operate them in realistic test setups. The aim is to ensure smooth interaction between the different implementations. The Plug Fests therefore make a key contribution to interoperability within the EtherCAT ecosystem.

The event was accompanied and supported by EtherCAT experts from Beckhoff Germany and USA, who were on hand to provide advice and assistance to the participants. An important part of every Plug Fest is the testing of SubDevices with the official EtherCAT Conformance Test Tool (CTT) from the ETG. This ensures that all devices meet the high EtherCAT quality and compatibility requirements.

In addition to the technical tests, the participants particularly appreciate the opportunity to share experiences directly with each other and with the ETG experts. Many companies regularly take part in Plug Fests – not because their devices would not be compatible if they didn't, but because they always come across new devices and developers at the events. This allows potential interoperability problems to be identified and resolved in advance, before they occur in the field.

The atmosphere during the Plug Fest was relaxed but focused, as is usually the case at these events. The size of such meetings is usually only limited by the capacity of the event spaces. Particularly noteworthy at this Plug Fest was the unusually high number of controller manufacturers, i.e., MainDevice participants. This underlines both the openness of EtherCAT technology and its outstanding market position.

While EtherCAT was originally developed by Beckhoff, Beckhoff is still actively involved in the ETG and supports the global EtherCAT community and the open EtherCAT ecosystem. In doing so, the company promotes technology to ensure the best possible compatibility and innovative strength.

The EtherCAT Technology Group organizes four to five Plug Fests worldwide every year – usually two in Europe, one in America, and two in Asia. In addition, there is a specialized Plug Fest on Safety over EtherCAT, which deals exclusively with safety-related implementations.

Well-attended EtherCAT Technology Seminar in Beijing

Numerous trade visitors from the automation and electronics industry recently attended the EtherCAT Technology Seminar in Beijing, which was organized by the EtherCAT Technology Group in cooperation with Beckhoff. The all-day event offered a varied program covering the latest developments in EtherCAT technology and its successful application in various industries.

In several specialist presentations, participants gained a comprehensive overview of the technical features and market trends of EtherCAT, success stories from the semiconductor industry, and the possible applications of open PC-based control systems in high-tech industries. Beckhoff applications in the new energy industry were also showcased.

In the afternoon, the focus was on practice-oriented topics, including diagnostic functions, network planning, and system integration with EtherCAT, as well as the presentation of the wide range of I/O products and PC-based control architectures from Beckhoff. During the breaks, participants took the opportunity to attend demonstrations and technical discussions with the experts on site.

The huge interest in the event underlines the strong presence and growing importance of EtherCAT in China, especially in dynamic industries such as the semiconductor and new energy sectors. Beckhoff supports the local industry with its open, high-performance automation technology.

Above: A full house at the EtherCAT Technology Seminar in Beijing
Bottom: Huge interest, a close look, and in-depth technical discussions

More information:
www.ethercat.org

PCcontrol
The New Automation Technology Magazine

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