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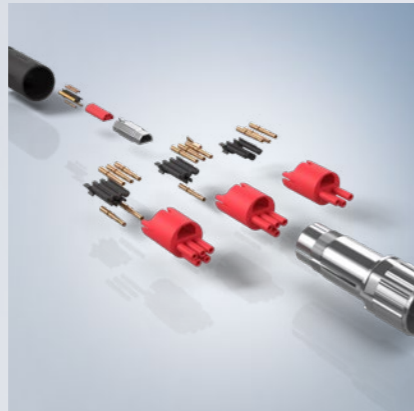
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Award winner Andreas Thome (center), Senior Product Manager PC Control at Beckhoff, between Intel representatives Torsten Kahrmann (left) and Hannes Schwaderer (right)



Intel honors Andreas Thome with the System Builder Award

Andreas Thome, Senior Product Manager PC Control at Beckhoff

“I am delighted that Beckhoff has received the Intel System Builder Award, as it reflects over 35 years of successful cooperation with Intel.”

At the Intel Germany System Builder Summit, which took place in Berlin at the end of 2022, Andreas Thome, Senior Product Manager PC Control at Beckhoff, received the System Builder Award for 35 years of Innovation with Intel. In the award speech, Beckhoff was recognized as a pioneer of PC-based automation that has been using Intel technology to control and develop innovative products for 35 years. The following were named as significant milestones in recent decades: real-time control with a Windows PC (TwinCAT, 1996), real-time Ethernet communication (EtherCAT, 2003), many-core IPCs (including C6670, 2014) and an AI-based contactless transport system (XPlanar, 2018).

Andreas Thome stated on the award, “I am delighted that Beckhoff has received the Intel System Builder Award, as it reflects over 35 years of successful cooperation with Intel. The foundations for this were laid in the mid-1980s, when Beckhoff recognized the advantages of PC-based control technology early on and consistently set its course in that direction. It quickly became

clear that the real-time-critical application field for industrial control technology could also benefit from the flexibility and increasingly powerful PC architecture as well as the well-developed software ecosystem consisting of the operating system and tools. Initially, Beckhoff’s objective was to incorporate the rapidly developing x86 architecture into its own innovations with the help of Intel and adapt it to meet industrial requirements. While this is still the case today, an important aspect has been added over time: bidirectional exchange. Intel actively researches the requirements and characteristics for the industrial environment and takes these into account in CPU product development wherever possible. Examples include real-time optimization in the architecture, TSN support, functional safety, and commercial aspects such as long-term availability of a large number of Intel products and integration of the FPGA category into the company. Intel has played a key role in our joint success as a reliable supplier and partner, and I am optimistic about our continued collaboration.”

More information:

- www.intel.com
- www.beckhoff.com/ipc



Kevin Barker, president of Beckhoff USA

“I look forward to driving strategy and policy at A3 as we work together to accomplish our mission to change the world for the better.”

Kevin Barker joins A3 Technology Strategy Board on Motion Control

Beckhoff USA President Kevin Barker was elected as the newest member of the Motion Control & Motors Technology Strategy Board of the US-American Association for Advancing Automation (A3). In this role he will drive the motion control and automation priorities of A3’s activities during the 2023/2024 term. “It is a great honor to be elected to the Motion Control & Motors Technology Strategy Board at A3,” Kevin Barker said. “I look forward to driving strategy and policy at A3 as we work together to accomplish our mission to change the world for the better.”

The Motion Control & Motors Technology Strategy Board is one of A3’s four Technology Strategy Boards (in addition to Robotics, Vision & Imaging and Artificial Intelligence). Along with the A3 Board of

Directors, these groups provide direction to ensure the organization remains a leader in the most important industry trends and requirements. According to Jeff Burnstein, president of A3, these boards and the dedicated members who steer them are key to the success of the industry association.

“Kevin Barker is an ideal candidate for our A3 Technology Strategy Board, and we could not be happier to have him join the team,” Jeff Burnstein said. “He is well known throughout the industrial automation community not just for his leadership at Beckhoff, but also for his expertise in motion control as well as his business savvy when it comes to identifying and taking action on industry trends as they emerge. We look forward to the new insights he will bring during his term with A3.”

More information:

- www.automate.org
- www.beckhoff.com



Beckhoff at Hannover Messe 2023

From April 17 to 21, 2023, Hannover Messe will open its doors with all its international charisma. As a technology leader and PC-based control pioneer, Beckhoff will again be present this year with numerous new products and innovations with which the digital transformation of production processes can be optimally advanced. Examples – to see in Hall 9, Booth F06 – include XPlanar planar motor system's floating movers, the ATRO (Automation Technology for Robotics) modular industrial robot system, the MX-System for control cabinet-free automation, and Vision as a system-integrated image processing system. The event will also be covered by the popular Beckhoff Live + Interactive livestream, which will be broadcast daily from 10:00 a.m. right from our booth.

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



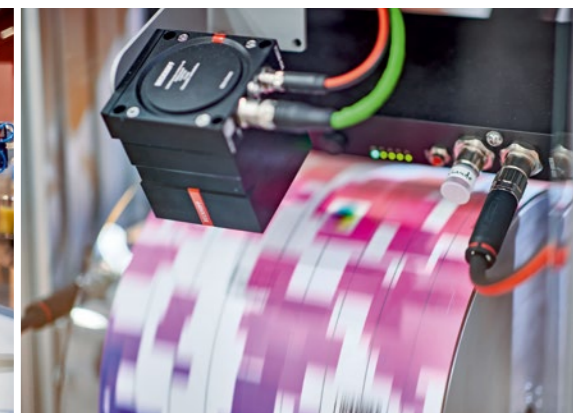
The MX-System makes it possible to achieve totally control cabinet-free automation of machines and systems for the first time ever – with a modular system that performs all of the tasks and exhibits the features of a classic control cabinet.



The XPlanar planar motor system enables completely new possibilities for handling products – both within the machine and between several machines – due to the floating 2D product transport.



The ATRO modular robotics system enables with its direct integration into the Beckhoff system solution allows machine builders to offer fit-for-production machines complete with fully integrated robotics and their own kinematics.



The machine vision product spectrum is now complete thanks to the vision hardware that covers all the components from software to illumination which, integrated into the system, provides users with significant competitive advantages.



Years of EtherCAT®

The ultra-fast EtherCAT developed by Beckhoff has already been used successfully for 20 years and has long since established itself as an open, global standard for real-time Ethernet communication.

Hans Beckhoff (center) and Martin Rostan (left) review the past 20 successful EtherCAT years and share their many years of experience with the next generation represented by Johannes Beckhoff (right).



Interview with Hans Beckhoff, Johannes Beckhoff and Martin Rostan on 20 years of EtherCAT

Compatible and open EtherCAT communication proven in practice for two decades

It has now been over 20 years since the EtherCAT story first began, and it is still just as successful as ever. Indeed, the communication system developed by Beckhoff and presented for the first time at Hannover Messe 2003 has certainly been established as a high-performance real-time Ethernet solution in a wide range of applications, firmly establishing its place on the market through continuity and technical development, and even becoming an open IEC standard. Here, Hans Beckhoff and Martin Rostan describe the stand-out aspects of this exciting period in the company's history, while Johannes Beckhoff represents the next generation of management by focusing on requirements for the future.

It was back in 1989 that Beckhoff first introduced its high-performance bus system known as Lightbus. What were the reasons for developing a new communication system with EtherCAT?

Hans: Beckhoff has always been renowned for high-performance control and the way we continually push performance limits in the world of automation. This is all based on the principle of PC-based control technology, which allows us to exploit all the advantages of a PC – most notably including the high computing power – directly on the machine. In terms of data communication, we came up with an excellent solution in 1989 in the form of the Lightbus. By the early 2000s, PCs had Ethernet interfaces as standard, and the first processors with integrated Ethernet interfaces were hitting the market. EtherCAT was developed so we would be able to use this new information technology medium on the machine, in line with our philosophy of connecting the IT world with automation. Our extensive experience with not just the Lightbus, but also all other fieldbuses such as CANopen and PROFIBUS, has been incorporated into the concept. This has certainly contributed to the overwhelming success of EtherCAT.

Martin: Our starting point was the fact that Lightbus – and indeed the other fieldbuses and first Industrial Ethernet technologies – could no longer keep up with the performance increase of the PCs. At the time, this resulted in highly complicated control architectures, as they were all decentralized. PC-based control, on the other hand, relies primarily on a centralized control approach and requires a correspondingly high-performance communication technology. EtherCAT bridged this gap and, in doing so, eliminated the former bottleneck in data communication – something it continues to do today some 20 years later.

Hans: That's right – with Ethernet and the 100 Mbit/s data rate that comes with it, control technology could benefit from a tenfold increase in transmission speed. The RS485 and CAN-based networks of the time worked well, but they were limited in terms of bandwidth and performance.

The experts



Hans Beckhoff is a physics graduate and the Managing Director and owner of Beckhoff Automation. He founded the company in Verl, East Westphalia, back in 1980, and developed a philosophy of PC-based control technology that has laid the foundations for the economic and technological success that has been achieved ever since.



Johannes Beckhoff is Hans' son and joined Beckhoff Automation in 2019. The graduate physicist (MSc) works in basic research and development processes and is already helping to shape the technological future of PC-based control.



Martin Rostan is a graduate engineer and Senior VP of Technology Marketing at Beckhoff, as well as Executive Director of EtherCAT Technology Group (ETG) in Nuremberg. He has been with Beckhoff Automation for 25 years, starting in 1998 as the company's first product manager for fieldbus products.

Which Ethernet aspects were particularly important when it came to implementing this technology on an industrial scale?

Hans: The Ethernet protocol is designed for the transmission of large amounts of data and long data telegrams, not for the small units of information common in the machine environment, such as a 1-bit limit switch value or a 16-bit analog value. With that in mind, the task was to find a synthesis between the 100 Mbit/s data rate and the fine 1 to 16 bit range found in the automation environment – and that is precisely the ideal solution we were able to achieve with EtherCAT. Not only did we completely reinvent the technical principles necessary for this, but we also integrated them into both the EtherCAT protocol and the EtherCAT hardware.

Martin: We took the basic principle of telegram processing on the fly from the Lightbus and elevated data communication to a whole new level. We also made constructive use of the new Ethernet technology, which had since arrived in the domain of automation technology, to elegantly circumvent the major bottleneck with Ethernet for real-time communication. A major contributing factor here was the high level of protocol efficiency – i.e., utilizing more than 90% of the available bandwidth. It was also significant that the complexity of the protocol was completely mapped in the hardware, as this simplified the entire EtherCAT implementation process considerably for the device manufacturers.

How would you summarize the fundamental advantages of EtherCAT?

Hans: First of all, the traditional RS485 and CAN-based fieldbuses are what are known as party-line buses, which feature multiple devices on a single connection. Network diagnostics and troubleshooting are significantly more complicated as a result. This is why EtherCAT has adopted the point-to-point connection of Ethernet so that each transmission path can be properly diagnosed, which is an essential feature. We also decided quite early on that we could manage with a standard Ethernet telegram and so do without a special communication card in the master, which is still a major advantage of EtherCAT. The key advantage, though, is the protocol efficiency that we have already discussed – i.e., the fact that data can be taken from or added to the 64- to 1,500-byte Ethernet telegram on the fly. This is the only way to ensure that the high bandwidth can be used consistently and for the many small information units of the numerous automation devices, with over 65,000 of these possible in the same network, in a single telegram.

Martin: This principle results in yet another advantage, in that the controller can already compile the process image perfectly in the data telegram, since the network nodes can insert or remove their data at any point. This eliminates the need for the bit operations required in other systems, which are complex to implement via an interface card. The EtherCAT master, on the other hand, does not impact the controller in any way, as a completely pre-sorted process image is available that can be processed directly. EtherCAT is therefore not only very fast in terms of actual communication with very short cycle times, but also in all upstream and downstream process steps.



Martin Rostan, Executive Director of ETG and Senior VP of Technology Marketing at Beckhoff:

“The basic protocol of EtherCAT has always remained the same and has only ever been extended in a 100% backward compatible way.”

Hans Beckhoff, Managing Director and owner of Beckhoff:

“The Fieldbus Memory Management Unit is one of the essential features of EtherCAT and enables data to be taken from a decentralized memory and written back again on the fly.”

Hans: That's right. And this principle is based on the IT function of the Memory Management Unit, which we have further developed into the Fieldbus Memory Management Unit (FMMU) for this purpose. The FMMU is one of the essential features of EtherCAT and allows data to be taken from and written back to a decentralized memory on the fly, so that any kind of mapping can take place between the data in the physical device and the data in the active telegram.



What's more, individual tasks and processor cores can also be mapped very well via the FMMU and defined with corresponding time levels, which ideally corresponds to modern and task-based control technology. Another central feature of EtherCAT can be found in the distributed clocks, which introduced a defined and automatically synchronized system time for the communication system. This is crucial since advanced control concepts are almost always time-slice based and require synchronized sampling points for data and signals. This entire concept of distributed clocks simply did not exist in previous fieldbuses.

Are these fundamental EtherCAT advantages also perceived in this way on the market?

Hans: Absolutely. All of these advantages add up to a technology that is inherently logical and quickly understood and loved by engineers worldwide. This rather emotional aspect is certainly also one of the reasons why EtherCAT has become so firmly established worldwide.

Johannes: I can only agree with that, despite not having been involved in this early development myself. By its very nature, EtherCAT is a high-performance and at the same time simple and logical protocol. Without even looking at the other systems, I asked myself right from the outset: What else would we use for Industrial Ethernet when EtherCAT is clearly the optimal solution?

Martin: Yes, back then, we even coined the phrase “EtherCAT is the engineer's choice”! And that sums it up well: EtherCAT was – and still is – the more convincing technology in comparison and so it is easy to justify its use in technological terms.



Global success for EtherCAT

EtherCAT owes its worldwide success as an Industrial Ethernet system to two key factors: its first-rate, outstanding technology, and its disclosure within the framework of EtherCAT Technology Group. With regard to the high acceptance of EtherCAT among chip suppliers, device manufacturers, and users alike, the following ETG figures speak for themselves:

- more than 7,000 ETG members from 72 countries and still well over 400 new members coming on board each year
- approx. 3,500 registered EtherCAT device manufacturers
- 12 EtherCAT chip suppliers with a total of over 40 different chips
- over 230 control system suppliers with EtherCAT as system bus
- over 200 motion control suppliers with more than 1,000 drive products

How important was the EtherCAT presentation at Hannover Messe 2003 for Beckhoff and how did the market react?

Hans: This was definitely a special event for the development team, with a core group of six experts, and everyone was proud of it. We had a huge presentation wall spanning 4 meters across at the event to really showcase the principle to maximum effect, and we even used oscilloscopes to demonstrate the real-time capability. Everything was incredibly well presented from start to finish, and customers were as enthusiastic as we had hoped. Even the representatives of the other fieldbus organizations and control suppliers were obviously impressed – at least that’s what I gathered from the stunned silence and a few pale faces at the time!

Martin: That’s right, I can still remember a competitor leaving our booth without even saying hello, with his mouth open and all the colour drained from his face. That was all the confirmation we needed. Everyone who understood how it all worked was immediately enthusiastic about it and confirmed that EtherCAT is the best way to use Industrial Ethernet.

A major contributing factor to the success of EtherCAT was the disclosure of the protocol and the associated foundation of EtherCAT Technology Group (ETG) at the SPS 2003 exhibition. What prompted Beckhoff to choose this moment to open up to the market?

Hans: Without a doubt, the founding of ETG has contributed just as much to our success as the sophisticated technology. ETG was built up by Martin and is now an independent organization that has put EtherCAT technology on the map worldwide. Without ETG, EtherCAT would probably have remained an exciting technology with a few followers, but would never have achieved its current widespread acclaim as a globally accepted standard.

Martin: Beckhoff has always stood for openness and supported all relevant open fieldbus technologies. At that time, there were around 20 different communication systems and industry-specific variants for which Beckhoff had all the relevant experts. This experience has been channeled into ETG not only technologically, but also in terms of the advantages and disadvantages of the respective user organizations. Once again, this includes the aspect of openness, in that ETG members very much appreciate how the development of EtherCAT technology is managed: Beckhoff is the technology driver, but the requirements of all partners are consistently taken into account. The principle of open fieldbus organization has clearly proven itself here. It is not without reason that ETG has now become by far the largest fieldbus organization, with more than 7,000 members from 72 countries, worldwide distribution, and Asian members accounting for over 40%. We have grown to the point that the “mere 14%” of our membership from the Americas makes us the largest American fieldbus association. It is also important in terms of the usability of EtherCAT that both device manufacturers and end users were involved from the beginning.

Johannes Beckhoff, R&D department at Beckhoff:

“EtherCAT gives us the possibility to centrally manage and program the intelligent transport systems XTS and XPlanar, which makes for a much easier and more convenient user experience.”



EtherCAT is now celebrating its 20th anniversary, but it is by no means a thing of the past. Why is it still the number-one industrial communication system even today?

Hans: Over the last 20 years, the technology has proven to be so well conceived that we have not had to make any changes to the basic protocol. This is a fundamental aspect of our success. What’s more, we have applied the EtherCAT principles to other application levels, such as the EtherCAT Automation Protocol (EAP) for control-to-control communication. We have even introduced the EtherCAT G extension as both a 1 Gbit/s and 10 Gbit/s variant, meaning the EtherCAT protocol also works at these rapidly increasing speeds.

Martin: It is actually one of the unique selling points of EtherCAT that the technology itself has never had to be changed. The basic protocol contained in the chip has always remained the same and has only ever been extended in a fully backward compatible way. The same applies to Safety over EtherCAT, where backward compatibility is also ensured throughout. Even 100 Mbit/s devices can still be integrated and operated in EtherCAT G networks. What this all means is that a current EtherCAT device will still work in a 20-year-old plant, which in itself is reason enough for many users to choose this fieldbus option, and means our technology will not create a bottleneck in the control architecture in the future. For most applications, this will continue to be the case with 100 Mbit/s; however, EtherCAT G offers sufficient potential to meet all the high-end requirements of the next 20 years without any problems and without a break in technology.

Johannes: I have to agree with Martin here: 100 Mbit/s is sufficient to handle most machine requirements – even for cycle times smaller than 1 ms. EtherCAT G can then be used to implement extremely data-intensive applications, such as XPlanar or Vision applications, with several kbytes of data in a sub-ms cycle. Without EtherCAT G, we would be limited to a maximum of maybe 20 tiles, so we wouldn’t be able to develop a really large XPlanar system. A Gbit/s data rate already enables over 100 tiles. This generally also applies to the XTS linear transport system, which works excellently with a transfer rate of 100 Mbit/s,

but would not be possible at all without the efficient EtherCAT protocol. This is because here, too, several kbytes of data have to be transferred with very short cycle times of 250 µs. Other communication systems cannot do this and require an elaborate decentralized control architecture for comparable systems.

Hans: And it is precisely our central control philosophy that makes it possible to calculate a mathematical-physical model of the entire process on one CPU. It essentially works in the same way as humans, whose central brain receives all data from the body via the central nervous system. The brain is modularly structured in terms of its subroutines, and effectively works out the desired movements or whatever action is required. Our automation technology is based on the same principle, and so EtherCAT corresponds to the central nervous system of a machine that allows as much peripheral data as possible to flow quickly into the central control model. The success of Beckhoff as an automation provider is largely due to the fact that we pursue precisely this approach – the “technological trifecta” of PC technology, EtherCAT, and central control philosophy.

Which topics are the focus of EtherCAT developments – both now and in the medium term?

Hans: As an Ethernet-based system, EtherCAT and the EtherCAT products will continue to follow the hardware layers available in the market. Even today, a wide range of Beckhoff-specific coupler designs is already available for RJ45, M8, and plastic- and fiber-optic cables, which will be expanded in the future to include other physical transmission types relevant to the market. Another major development step is the introduction of our hybrid technology for the one-cable solution. This is what prompted us to develop EtherCAT P, which integrates data and power into a 4-core standard Ethernet cable. Another particularly exciting development in this context is our series of EtherCAT P hybrid connectors in sizes B12, B17, B23, and B40, which will be included in an IEC standard as standard circular connectors for decentralized automation in future. We initially started EtherCAT as a communication protocol and use the complete hardware physics afforded by Ethernet. We also developed the electromechanical additions necessary for automation to make the system as practical as possible. In this context, EtherCAT P represents a huge step, as does the EtherCAT P connector series.

Martin: Another aspect that is becoming increasingly important in automation is the topic of cyber security. EtherCAT offers a number of advantages here, since its architecture and specific properties already provide everything inherently in the system to meet these challenges. Better still, EtherCAT can handle all of this without the need for a new protocol version, hardware changes, or special measures.

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

More information:

www.beckhoff.com/ethercat

www.ethercat.org



Florian Vogel,
Product Management I/O,
Beckhoff Automation

Interview with Florian Vogel on the hybrid connector portfolio and IEC standardization

Standardization promotes user safety and opens up new markets

The Beckhoff portfolio of hybrid connectors, and thus One Cable Automation (OCA), has already been proven in thousands of field installations. In this interview, Florian Vogel from I/O Product Management discusses the technical advantages associated with these connectors and the significance of their definition within an IEC standard for decentralized automation.

What sets the hybrid connectors from Beckhoff apart?

Florian Vogel: Hybrid connectors are essentially used to transmit power and data via a single line to save on cables and connectors. But the solution developed by Beckhoff together with a partner offers the additional advantage of a high degree of modularity, which allows a wide range of variants for a host of different applications, while also providing mechanical coding and connection security. It also features a uniform data core in all four connector sizes – B12, B17, B23, and B40. These are all fundamentals to successfully establishing itself as the ideal connector for decentralized automation – also known as One Cable Automation. There's also the fact that some 95,000 connectors have already proven themselves in the field, so this is by no means a completely new product that has yet to demonstrate its worth. In fact, our development has benefited from the fact that Beckhoff has always maintained close contact with its end

customers and has therefore been able to implement their requirements more consistently than a straightforward connector manufacturer.

How does the modular design impact the fabrication or installation effort?

Florian Vogel: The modularity of this design actually represents a considerable simplification rather than additional work. As the individual parts can only be assembled in one direction, the whole process is essentially intuitive and prevents any possibility of incorrect assembly from the outset. What's more, there are clear colored markings on the contact carrier that correspond to the wire color of the cable, which does away with the need for a complex assignment plan detailing each individual pin assignment. Our hybrid connectors also comprise just ten individual components – significantly fewer than comparable

third-party products. In combination with the additional data module, this usually results in a reduction of the assembly time by two thirds.

The hybrid connectors from Beckhoff will form part of an IEC standard in the future. What exactly does this mean?

Florian Vogel: Beckhoff hybrid connectors are among the first products to comply with the upcoming IEC 61076-2-118 standard, which is expected to be published at the end of 2024. The aim of establishing a global standard like this, first and foremost, is to ensure security for the customer or user; not only with regard to supply chains and second-source strategies, but also in terms of the level of product reliability defined by established and widely adopted standards. Key focal points here are always technology and being fit for the future, and our hybrid connectors already tick these boxes with their modularity, uniform data core, and optimal design for OCA. All things considered, standardization within the framework of an IEC standard is certain to also lead to an expansion of the market for a circular connector like this. Initial estimates see an immense market potential of 800 million to 1 billion euros. In addition to the advantages of standardization already discussed, connector manufacturers have also recognized that the market addressed by these highly functional and universally applicable hybrid connectors has largely not yet been tapped, and can be reached much more easily through IEC standardization.

Who will find this standardization particularly important?

Florian Vogel: In our experience, all users see a clear need for this development, from machine builders and end users across a range of sectors, including automotive, through to device manufacturers. After all, compliance with an IEC standard does not mean that development will come to a standstill for the next few years or decades. On the contrary, our modular hybrid connectors are the ideal solution not only for retrofitting current systems, but also for use in conjunction with EtherCAT G/G10 to facilitate system developments over the next ten or 20 years. Being fit for the future to this extent is generally quite unusual for a normed standard, but in this case it is a given.

To what extent do device manufacturers and technology user groups such as the EtherCAT Technology Group (ETG) benefit in particular?

Florian Vogel: Device manufacturers have a keen interest in an IEC standard because it promotes and ensures worldwide availability of the components.



The modular design of the hybrid connector simplifies installation and cable preparation considerably.

Furthermore, the openness of standardization and a corresponding variety of suppliers usually lead to a much lower procurement price. For technology groups such as the ETG, there is another fundamental aspect in that these organizations want to concentrate as fully as possible on the development of their technology and not deal with all of the peripheral considerations. As for connector manufacturers, they also have a vested interest in following standards, since it is not common to find a complete portfolio of circular connectors, and standardization can facilitate rapid market entry here.

With One Cable Automation, Beckhoff is one of the pioneers in the field of decentralized automation. To what extent will hybrid connectors further advance the concept of decentralization?

Florian Vogel: With CP-Link, OCT, and later EtherCAT P, Beckhoff advanced and implemented the concept of the one-cable solution very early in the game. So across our entire portfolio, from IPC, Motion, and I/O through to the new MX-System and Vision product categories, there are already opportunities for decentralized automation with PC-based control from Beckhoff. With the modular hybrid connectors, it will be possible to implement this One Cable Automation even more consistently and universally going forward.

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

More information:

www.beckhoff.com/hybrid-connectors



Dr. Guido Beckmann,
Senior Product Manager ATRO,
Beckhoff Automation

Interview with Dr. Guido Beckmann on the advantages of the ATRO modular industrial robot system

Modularity for maximum flexible robotics

The new ATRO (automation technology for robotics) system from Beckhoff is a modular industrial robot system that can be used to custom-build the ideal robot structure for any application, thus offering great flexibility. Dr. Guido Beckmann, Senior Product Manager for ATRO, explains how this was achieved and the user benefits that it provides in this interview.



With ATRO, a robot solution can be precisely adapted to the task at hand with any number of axes, and will be freely scalable, modifiable, and expandable.

ATRO

As active drive elements, the motor modules form the core of the ATRO system. Can you explain what sets them apart in detail?

Dr. Guido Beckmann: That's right, the standardized motor modules have integrated drive functionality and so are ultimately responsible for the kinematics. Different designs are available as either straight I-shaped modules or angled L-shape modules, and these both come in five power classes. Each power class, in turn, can be configured with different transmission ratios. These decentralized EtherCAT drive modules each constitute a highly dynamic servo drive for each individual axis of the robot – i.e., all the electronics for controlling the axes are built into the modules in the form of an EtherCAT-based 48 V servo drive, the motor with dual encoder and brake, and a highly compact gear unit. This saves space in the control cabinet.

What do the passive link modules do?

Dr. Guido Beckmann: It is only when combined with the link modules in different designs and lengths that the motor modules enable the user to create a custom robot configuration with a multitude of options for the mechanical design. The shape and length of the link modules are variable, so the reach of a robot configuration can be adapted, or multi-arm kinematics can be created using T or X modules. The modules are also used for mechanical adaptation of the different motor module sizes, which generally become smaller from the main axes to the wrist axes. Electrically, the link modules also represent EtherCAT devices that can be recognized and read by the controller, allowing the entire robot structure to be scanned automatically.

Doesn't this modularity also make assembly trickier and require more effort?

Dr. Guido Beckmann: No, because all modules can be linked to each other easily via the ATRO interface, which guarantees a fixed, screw-type connection. The modules can be screwed together by the user in just a few minutes to form the mechanical structure of the desired robot kinematics. In this way, even large robots can be built by a single person, piece by piece, with only a single tool needed for assembly.

The field of robotics involves the transportation of various media. How is this achieved with ATRO?

Dr. Guido Beckmann: Various types of media are fed through all ATRO modules internally, including EtherCAT, a Gigabit Ethernet interface, power (230/480 V AC or 600 V DC), and fluids (compressed air, vacuum, and water). These media are fed into the base module before being passed through the ATRO kinematics and can be decoupled and reused at the ATRO interfaces. This means that any robotic tool can be integrated at the end effector, including electric, pneumatic, and vacuum grippers, or else a camera can be connected via the Gigabit Ethernet interface, which is used for process monitoring or object detection. Conventional robotic solutions will route these media externally and are therefore limited in terms of rotation and use of the workspace. This limitation is completely eliminated with the Beckhoff solution, since all axes are designed to rotate endlessly, which allows for a much better Cartesian reach as well as for short positioning paths. Furthermore, interfering contours (due to externally located cables, for example) and interfering torques, particularly for cobot applications, are prevented by eliminating external media feeds.

What are the advantages of adaptable robotics in terms of sustainability?

Dr. Guido Beckmann: The most sustainable aspect of this new system is that only the axes that are really needed for the application are installed. Because, ultimately, not every application requires a 6-axis serial jointed-arm robot. Palletizing tasks can be resolved with five degrees of freedom, and pick-and-place tasks can often be executed with four degrees of freedom or with the help of 3-axis delta kinematics. In 2022, approximately 200,000 6-axis robots were installed worldwide. We assume that around 40% could have performed just as well with a 5-axis system. For a straightforward pick-and-place application, this would suffice; in fact, even fewer axes are required in some cases. This would have saved the users around 100,000 axes, which equates to 20,000 5-axis robots.

How can ATRO increase efficiency in terms of control technology?

Dr. Guido Beckmann: To date, one of the main tasks in robot integration has been mastering the interfaces between the control systems. This usually requires a lot of effort (up to 80% of the programming work) that does not add value. In the ATRO system, a PC-based control platform with the TwinCAT automation suite performs all these tasks while helping to ensure that all processes work in sync with each other and that data is available to all processes simultaneously. This also makes sophisticated applications possible, as the combination of line control, vision, and robot control, for instance, can be used to separate products using sorting processes (bin picking). Machine learning functionalities in the controller can aid movement optimization and path planning. Since all axes of the ATRO system can rotate endlessly, this unique feature provides the perfect

foundation for optimization, as it eliminates any restrictions in motion. Finally, there is no external robot controller needed, which significantly reduces the space required in the control cabinet.

Are there other advantages for robotics users from an economic point of view?

Dr. Guido Beckmann: The main economic advantage for the user is that, for the first time, the robot has been created using the application as the starting point rather than the other way around, as was previously the case. The customer only needs to buy what they need, and doesn't have to simply buy what is available on the market. With our system, we can guarantee that the customer can always put together the most efficient solution for their application. Using the same motor and link modules in different combinations also reduces variance in inventory management, thereby reducing costs and increasing flexibility at the same time. In the event of a malfunction, individual modules can be replaced quickly instead of having to have the entire robot serviced by an external specialist, as was previously the case. This reduces MTTR (mean time to repair) times, which equates to an increased machine availability in the application.

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

More information:

www.beckhoff.com/atro



Since the XTS elements with NCT are fully compatible with the standard system, they can be easily integrated into existing plants.



The end effector on the XTS mover with NCT aligns the product to facilitate barcode scanning or quality inspections.



Equipped with a vacuum pump, the XTS mover with NCT plays an active role in the production process.

XTS with NCT: Linear transport system as a highly flexible multi-robot system

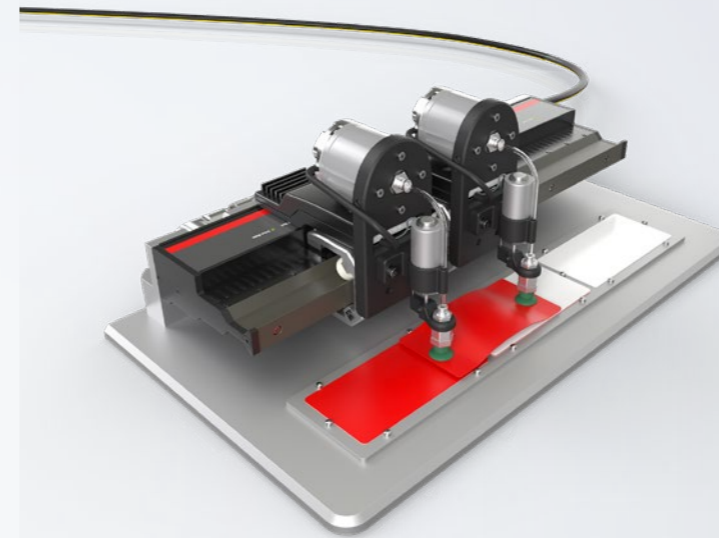
How XTS movers can replace robots

The XTS linear transport system from Beckhoff has already proven to be an innovation factor in thousands of machines, and the ongoing expansion of its range of functions offers plenty of market potential for the future. A prime example here is No Cable Technology (NCT), which provides contactless energy transfer and synchronous real-time data communication directly on the XTS movers. This allows the movers to perform a variety of different robot functions via end effectors. Furthermore, the ability to have a large number of movers on an XTS enables a flexible multi-robot system that increases area productivity many times over by executing process steps in parallel.

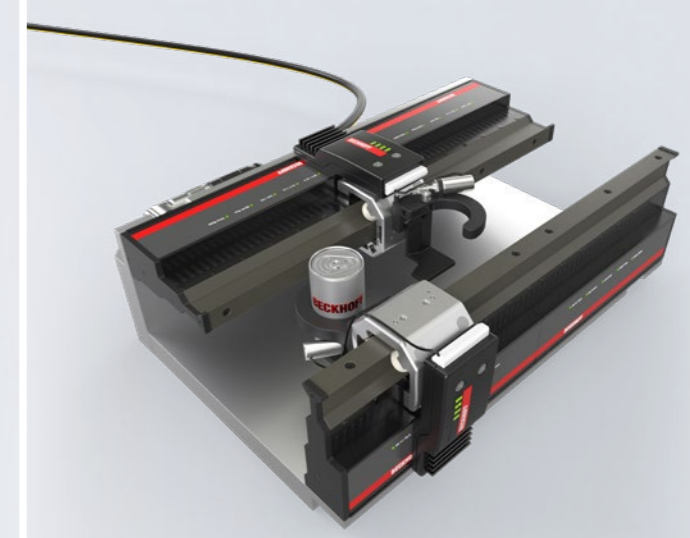
systems for the infeed or manufacturing process can benefit from this technology. This allows new breakthrough solutions to be created that enable sophisticated product and material handling in highly automated systems. In addition, the XTS and NCT reduce the required installation space many times over compared to conventional robotic systems, allowing significantly more functionality to be accommodated in less space.

Virtually unlimited application possibilities

As one of many examples, motion sequences can be implemented directly on the mover for performing tasks such as rotating and aligning a product for scanning a barcode or running quality checks. Electromotive grippers, magnetic grippers, or vacuum cups on the movers can pick up, transfer, and deposit products on the fly, making the movers mobile material flow systems.



New possibilities through XTS with NCT: Coupled movers can work together to move even bulky products.



The transfer of a product from one production system to another is also possible with NCT – for example, for the optional integration of additional workstations or manual workstations.

XTS is a linear transport system in which a large number of movers move independently of each other along a track. The movers offer a host of functionalities, including forming groups and synchronizing to other process sequences. The track is made up of motor modules based on a modular principle, and can be open or closed to facilitate the implementation of application-specific system layouts. A closed travel path enables an increase in productivity, as the movers do not have to return to the starting point on the production line empty.

No Cable Technology as an extension supports the use of a wide variety of end effectors without reducing the high dynamics and flexibility of the XTS solution. End effectors mounted on the mover, such as standard actuators or sensors, are used to perform various process steps during linear travel. In the packaging sector, for example, almost all conveyor, sorting, robotic, or material handling

Countless applications stand to benefit from the use of a multi-gripper system such as this. In a meal kit filling application, for example, various electro-mechanical or vacuum grippers would collect the necessary ingredients to assemble a complete menu. The movers would pick up the ingredients from predefined stations and place them at individual product locations, facilitating an exclusively software-based format changeover up to production with a lot size of one. Thanks to the traceability of the XTS, every ingredient could be tracked seamlessly from picking to order labeling and supplier pickup. Pharmaceuticals are another similarly obvious use case. Here, the appropriate end effector could rotate a container so that it can be sealed or validated.

Fully compatible function extension

Since the XTS elements with NCT are fully compatible with the standard system, NCT can be integrated into existing XTS applications. The continued

use of existing system components not only cuts down on implementation time, but also saves resources. Furthermore, the complete integration into the XTS modular system offers the advantage that no additional components are required apart from the end effectors used. The end effectors on the movers are also controlled via the central TwinCAT automation software, allowing all processes in TwinCAT to be coordinated with microsecond precision, and the engineering effort to be reduced to a minimum.

More information:

www.beckhoff.com/xts

www.beckhoff.com/nct

Thomas Beckhoff, Product Manager XTS,
Beckhoff Automation



TwinCAT Controller Redundancy: Software-based solution protects uptime through redundant control



TwinCAT Controller Redundancy protects plant uptime through redundant control operation using standard components.

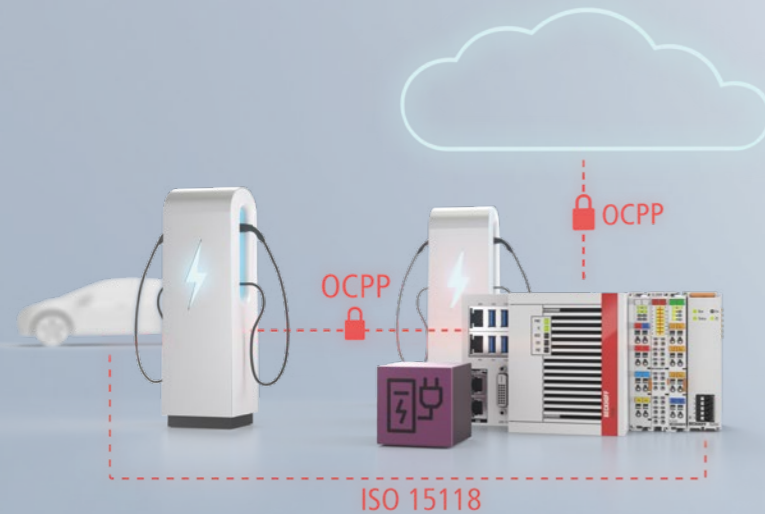
While the robust design of the company's Industrial PCs alone already ensures a high level of availability, Beckhoff is now expanding its product portfolio to check yet another box with TwinCAT Controller Redundancy (TF1100). This entirely software-based solution allows two standard industrial PCs that both run the same PLC program to operate as redundant controllers in just a few easy steps.

An additional, high-performance network connection between the two controllers provides the necessary synchronization. Standard Ethernet is used here, so no dedicated hardware components are required. With minimal effort, this ensures that only one of the two industrial PCs addresses the fieldbus components at any given time, and that the control programs are executed simultaneously on both computers. This synchronicity is the basic prerequisite for changing the primary industrial PC in the event of a fault without losing any information.

In addition to controller redundancy, the well-established EtherCAT Redundancy (TF6220) software protects against failures caused by faulty cable connections. The I/O modules are connected by two separate cables, which should ideally be laid in different locations. While EtherCAT Redundancy addresses communication from the controller to the fieldbus, the TwinCAT Parallel Redundancy Protocol (PRP, TF6230) now also provides cable redundancy for Ethernet communication according to IEC 62439-3 to higher-level systems such as MES or decoupled HMI systems. The protocol defines a redundant and transparent network connection, which can be monitored and diagnosed in TwinCAT.

More information:
www.beckhoff.com/redundancy

TwinCAT 3 IoT OCPP and EL6761: A complete solution for communication with the charging infrastructure and electric vehicles



Beckhoff has added the Open Charge Point Protocol (OCPP) to the TwinCAT IoT product portfolio based on the WebSocket protocol which has recently been introduced for the IoT driver. OCPP standardizes the communication between charging stations for electric vehicles and the associated central management systems. This is combined with the new EL6761 EtherCAT Terminal, which serves as a communication interface in accordance with IEC 61851 and ISO 15118, to create a universal solution for charging infrastructure communication. With the new function TwinCAT 3 IoT OCPP (TF6771), OCPP was implemented as a C++ driver with the associated PLC library as a wrapper. Due to their high market relevance, OCPP versions 1.6 and 2.0.1 are being implemented first. The focus is on the following two use cases:

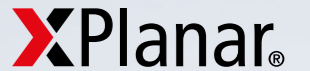
- TwinCAT is used as a controller for a charging station together with the new EL6761 EtherCAT Terminal, and is then connected to the central management system as an OCPP client.
- When connecting other charging stations via the OCPP protocol, TwinCAT represents part of the central management system, e.g., to enable local load management of a charging station network. In parallel, TwinCAT can be connected to another management system, e.g., to implement authentication or billing mechanisms. ▶

Combining the EL6761 EtherCAT Terminal with TwinCAT 3 IoT OCPP results in a complete communication system for charging infrastructure applications.

The EL6761 1-channel communication interface also offers two options: the EtherCAT Terminal can be used to enable communication for the charging infrastructure, directly to the electric vehicle and from it to the higher-level charging management system. Two independent communication standards are supported – PWM communication according to IEC 61851 and powerline

communication according to ISO 15118. The latter provides a flexible communication channel to transmit all necessary data between the vehicle and the charging station.

More information:
www.beckhoff.com/el6761
www.beckhoff.com/tf6771



One of the latest XPlanar functional enhancements, the ID bumpers, which can be easily mounted on the mover, enable unique mover identification even after a power supply failure and eliminate the need for homing during system startup.

XPlanar with mover identification and new mover variants

The XPlanar bumpers with ID function enable unique identification of the XPlanar movers by reading out the individual serial number of the mover. The ID bumper is easy to mount or retrofit to the mover and requires no additional hardware. This makes it possible to seamlessly track movers and products – even after a power supply failure. In addition, there is no need for homing at system startup if the application has been programmed appropriately.

The new APM4221 XPlanar mover, the second largest model in the APM4xxx family, is designed for a payload of up to 1 kg and is ideal for handling small products with high packing density. With dimensions of 127 x 127 mm, it can even be used in bidirectional operation on appropriately sized tiles, so that a complete production cycle, including recirculation, can be performed on the width of just one tile with minimal footprint. The same applies to the APM4230 rectangular mover, which is also new and measures 115 x 155 mm, for payloads of up to 0.8 kg. If a second track is added to the tile surface area, the APM4350

rectangular mover (155 x 235 mm), which is new as well, enables tridirectional transport of longer products weighing up to 3.0 kg.

The APM4550 XPlanar mover is the largest version (235 x 235 mm) and can transport a payload of up to 4.2 kg, making it the perfect device for handling larger, heavier products. More elaborate workpiece carriers and attached parts can also be used to meet individual requirements. Even payloads weighing far more than 4.2 kg can be transported and positioned with XPlanar: using an adapter, several movers can be fixed together mechanically; the payload increases linearly. If, for example, four of these movers are coupled, this results in a maximum payload of 14.8 kg when the adapter weight is deducted.

More information:
www.beckhoff.com/xplanar

The new Vision hardware components from Beckhoff impress with a robust, attractive design as well as high scalability and long-term availability.

Beckhoff Vision: Camera, lens and illumination hardware complement TwinCAT Vision

Beckhoff Vision offers machine builders and end users a complete image processing system that covers all the necessary components from software to illumination. Seamlessly integrated into EtherCAT-based control technology, it opens up significant competitive advantages for users, including highly accurate synchronization with all machine processes, reduced engineering and hardware costs, and simplified commissioning and support.

In addition to the TwinCAT Vision software, the Vision portfolio also includes:

- Cameras: The area-scan cameras generate high-quality image data using color and monochrome CMOS sensors with up to 24-megapixel resolution and 3.45 µm and 2.74 µm pixel pitch, in addition to offering transfer rates of 2.5 Gbit/s.



- Lenses: The robust, industrial C-mount lenses ensure easy handling and high availability while also offering a VIS and NIR AR coating, up to 2 µm resolution, and image circles of 11 mm (2/3") and 19.3 mm (1.2") respectively.
- Illumination: The multicolor LED illumination in three designs – area, ring, and bar illumination – produces constant illumination conditions for consistently high-quality images. It also creates the best possible contrast between the inspection feature and its surroundings – even in spectrally adjustable pulse mode.
- Complete units consisting of camera, illumination devices, and focusable lenses are also available.

More information:

www.beckhoff.com/vision

EL8601-8411: The compact multi-I/O interface for up to twelve signal interfaces and nine signal types



With a width of just 12 mm and a combination of up to twelve signal interfaces, the EL8601-8411 EtherCAT Terminal can be used in a highly flexible manner.

Beckhoff's new EL8601-8411 EtherCAT Terminal offers maximum flexibility in a compact design as a 12-channel multi-interface which is only 12 mm wide. It is therefore particularly suitable for applications where only a few complex signals are required as well as in special-purpose machine building, where its highly flexible signal configuration enables minimized storage.

The EL8601-8411 EtherCAT Terminal offers a combination of up to 12 signal interfaces (8 x DI, 2 x DO, 1 x AI, 1 x AO) and up to nine different signal types. Thanks to the large number of configurable combinations, it offers a compact solution for applications where only a few complex signals are required – for example, as an ideal complement to the CX7000 Embedded PC.

In addition to the digital inputs and outputs, one analog input and one analog output can be configured as a current or voltage signal. The digital inputs with configurable filter times can also be used for 24 V HTL encoders with A/B track incl. latch and gate function or as an up/down counter with a counting frequency of up to 100 kHz. Two of the digital outputs can be used as a PWM signal that can be modulated in both pulse width and frequency in a range of 20 Hz to 25 kHz. This allows the EL8601-8411 to be used in an extremely flexible manner, e.g., in digital/analog, counter/PWM/analog, or encoder/PWM/analog configuration.

More information:

www.beckhoff.com/el8601-8411

C6040: Ultra-compact Industrial PC sets a new benchmark for power density

The addition of the C6040, which brings even more power to the table, as the latest member of the ultra-compact C60xx Industrial PC series from Beckhoff is opening up a whole new world of application possibilities for users. One of the many ways it achieves its unprecedented power density is by implementing the 12th generation Intel® Core™ processors featuring up to 16 cores.

Depending on the processor type, the 12th generation distinguishes between classic performance cores and efficiency cores. As with previous processor generations, the 12th generation of Intel® Celeron®, Pentium®, and Core™ i3 and i5 are equipped exclusively with classic performance cores. However, the special feature of the Intel® Core™ i7 and i9 processors used in the C6040 is that they are the first to be built in a hybrid architecture. This means that four additional efficiency cores are added to the Core™ i7 and eight to the Core™ i9 processors. This combination of performance and efficiency cores allows applications to be implemented on a total of 12 or 16 processor cores.

While performance cores are primarily suitable for high-performance, single-thread applications, many additional threads can be executed in real time or in user mode on the additional efficiency cores. What's more, each individual core



Measuring just 132 x 202 x 76 mm, the C6040 offers enormous power density for applications including extensive axis control or vision.

can be configured individually via the clock frequency. The additional power supply integrated on the motherboard, which was developed and produced in-house in Verl, offers sufficient power reserves to fully utilize the available computing power of the processors. In terms of its size, the C6040 measures just 132 x 202 x 76 mm. The versatile new industrial PC is particularly suited to sophisticated axis controls, complex HMI applications, and applications with extremely short cycle times, as well as machine learning and machine vision applications.

More information:

www.beckhoff.com/c6040

CX82xx and CX9240: Modern multi-core CPU, double main memory, and fast 1 Gbit interface

The CX82xx Embedded PC series is a further development of the CX81xx series and unites higher computing power with a compact format for a wide range of automation tasks. Equipped with a fast ARM Cortex™ A53 processor with 64 bit architecture, a higher clock frequency of 1.2 GHz and two CPU cores are available for compact controls. This advanced CPU with the same low power consumption expand application options. In addition, the series features the faster 1 Gbit Ethernet interface and the double 1 GB LPDDR4 RAM main memory. Currently, the Embedded PC series includes the following devices:

- CX8200 with Gbit interface
- CX8210 with Gbit and EtherCAT slave interface
- CX8280 with Gbit and RS232/RS485 interface
- CX8290 with Gbit interface and second, switched Ethernet port for various Ethernet protocols

The CX9240 Embedded PC (L) and the CX82xx series (here CX8200) open up whole new areas of application and options with the modern ARM Cortex™ A53 CPU and low power consumption.



The new CX9240 Embedded PC is a compact, DIN rail-mountable Ethernet control system which also has a 1.2 GHz ARM Cortex™ A53 CPU and represents a further development of the CX9020. The more powerful processor with four cores is used here. The CX9240 features two independent 1 Gbit Ethernet interfaces, which enable significantly higher transfer rates. With 2 GB LPDDR4 RAM, the main memory has also been doubled compared to the predecessor device.

More information:

www.beckhoff.com/cx82xx

www.beckhoff.com/cx9240



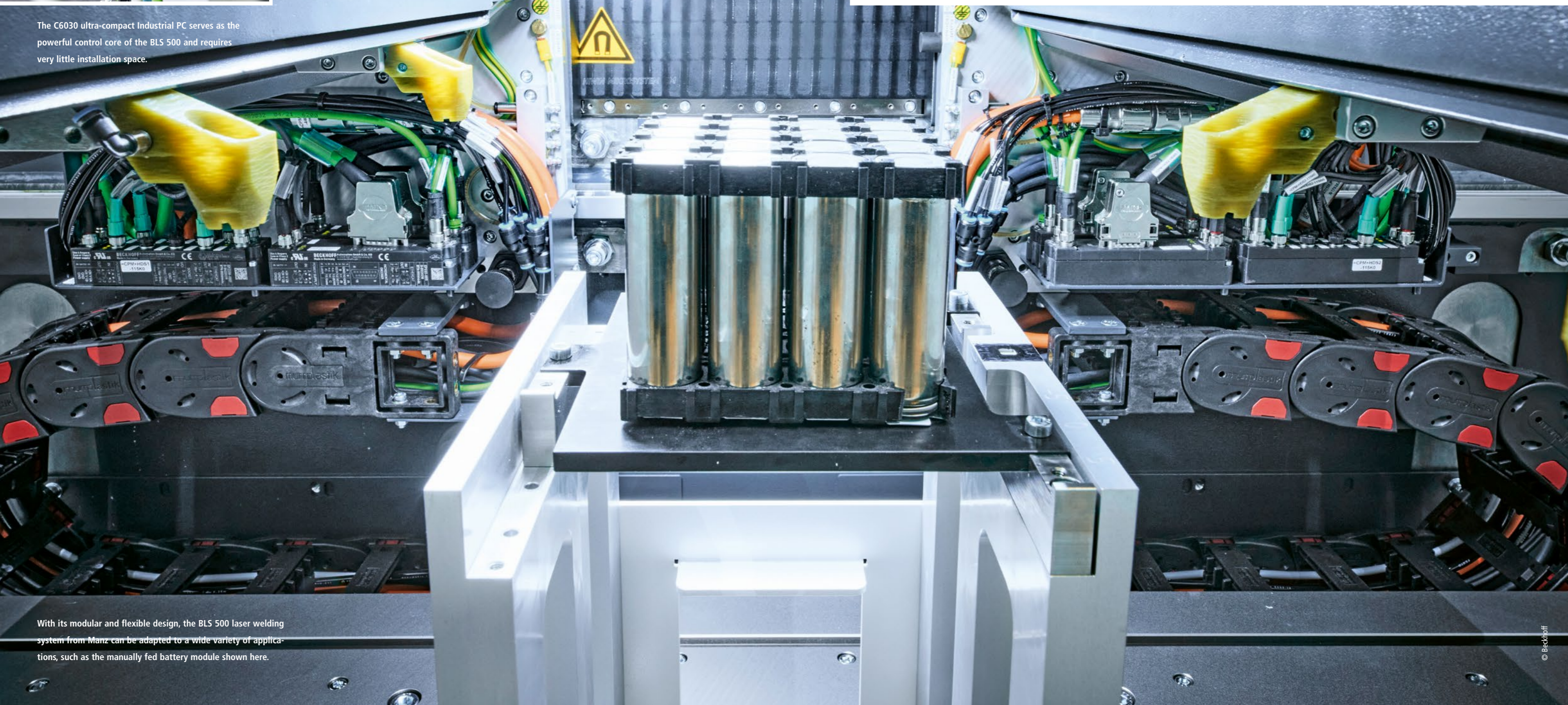
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The C6030 ultra-compact Industrial PC serves as the powerful control core of the BLS 500 and requires very little installation space.

PC-based control and OPC UA communication in a laser welding system for the electromobility sector

Automation for highly precise and efficient production of lithium-ion battery modules

In order to serve the rapidly growing electromobility market, particularly efficient manufacturing processes are required when it comes to the production of lithium-ion battery systems. This is made possible by Manz's BLS 500 laser welding system, which allows individual battery cells to be contacted highly precisely and thus connected to form battery modules. High efficiency is ensured by a graphical programming tool and a virtual commissioning tool from Manz, as well as through fast PC-based control technology from Beckhoff and the continuous OPC UA communication that can be achieved using it.



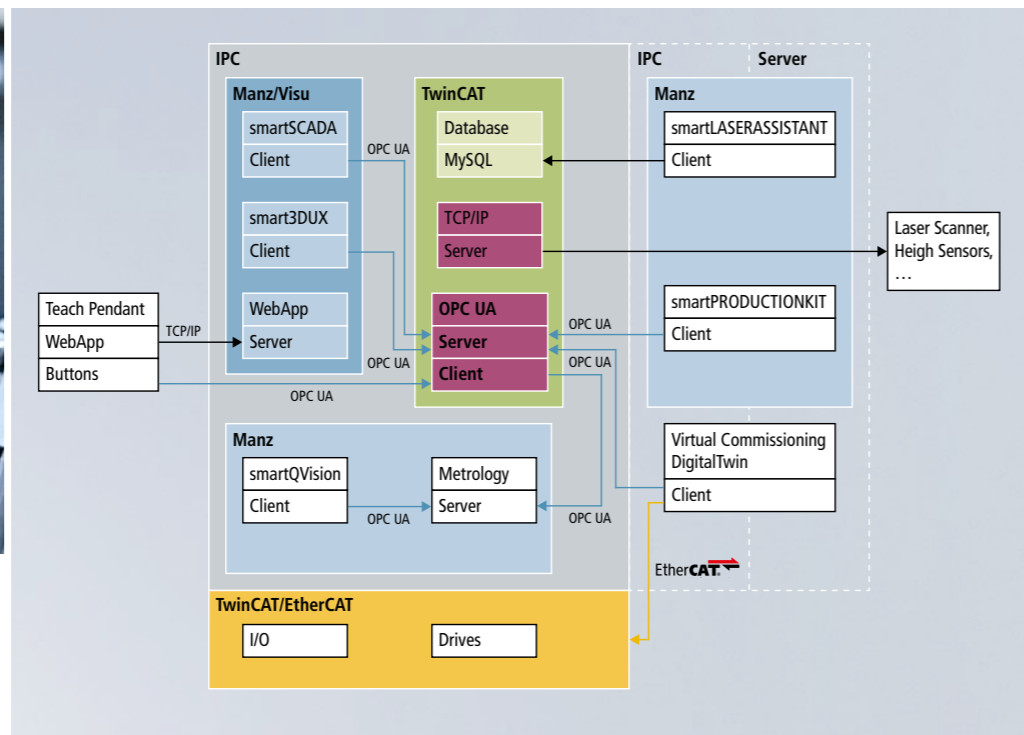
With its modular and flexible design, the BLS 500 laser welding system from Manz can be adapted to a wide variety of applications, such as the manually fed battery module shown here.

© Beckhoff



Example of a lithium-ion battery module constructed from round battery cells

Right: Communication topology with EtherCAT and OPC UA for the BLS 500 laser welding system



The wide I/O spectrum of IP20 EtherCAT Terminals and IP67 EtherCAT Box modules (here: EP2338 and EP5101 in the BLS 500) facilitates the modularization of Manz systems.



The project participants in front of the BLS 500 (from left to right): Oliver Heilig, sales and system consulting at Beckhoff, Axel Bartmann, Director Marketing and Corporate Communications at Manz, Stephan Lausterer, Head of Software Core Design and Product Development at Manz, Jörg Rottkord and Tilman Plaß, both automotive industry managers at Beckhoff, and Felix Röckel, process developer at Manz

Manz AG, based in the German city of Reutlingen, is a globally operating high-tech engineering company that focuses on production solutions for electromobility, battery production, electronics, energy, and medical technology. Its portfolio ranges from customized single machines for laboratory production or pilot and small series production to standardized modules and systems or turnkey lines for mass production. Consequently, the company has particularly high requirements regarding the flexibility and performance of the automation technology used, as can be seen in the production equipment for lithium-ion battery cells and battery systems as well as capacitors, to name but a few examples.

Application-specific customizable laser platform

A prime example is the new Battery Laser System (BLS) 500, which is designed as a flexible platform for the various laser processes used in the manufacture of lithium-ion batteries. Starting from a standardized machine base, it can operate individually as a single system where the workpiece is loaded manually or as part of an integrated production line to achieve high-precision laser welding, as well as laser cutting and drilling, or partial material removal.

In the BLS 500 application described here, a battery module consisting of round battery cells is inserted into the machine manually in a laboratory scenario, but otherwise this is an automated process. The individual cells are then welded to the contacting elements by laser. As a graphical programming tool, the Smart Laser Assistant uses the CAD data of the underlying battery module to create the associated recipe, i.e., the optimum path calculation for all welding points as well as the appropriate laser power in each case. Stephan Lausterer, Head of Software Core Design and Product Development at Manz, describes the clear application advantage as follows: "Our programming tool makes it much easier to adapt the BLS 500 to diverse applications, i.e., to different cell types and module formats." He adds that the result can then be conveniently examined in Manz's virtual commissioning tool, and not only that: "Commissioning is accelerated and simplified by the fact that using the model the control program can be tested in detail and realistically in advance, i.e., before the machine has

actually been mechanically assembled. In addition, high precision is achieved by using image processing to compare the CAD data of the battery pack with real-life data and to take any offset values into account during the welding process. In all these aspects, we benefit from the TwinCAT control software with its convenient and powerful OPC UA integration."

System advantages of PC-based control

The importance of high-performance and, above all, flexible control technology has also increased significantly at Manz in recent years, and it was this that ultimately led to the partnership with Beckhoff which has been sustained for over ten years now. Stephan Lausterer explains this in more detail: "Originally, Manz developed its own control technology; however, this became increasingly difficult due to the growing relevance of electronics in mechanical engineering and the exceptionally fast innovation cycles in this field. We therefore went in search of a suitable specialist as a new control supplier. In a corresponding benchmark, PC-based control proved to be the optimal solution, in particular due to the PC-based concept and the flexible, open, and finely scalable system architecture. In addition, there was the innovative strength of Beckhoff – a factor that we regarded highly even back then."

Tilman Plaß, automotive industry manager at Beckhoff, adds the following from an automation perspective: "The high requirements of the Manz systems can be met very well with PC-based control. These requirements include the short cycle times that can be achieved with our control technology as well as a logic that covers all processes throughout the application, an aspect which promotes speed during format changeovers in particular. The comprehensive functionality of TwinCAT up to OPC UA communication results in further advantages – and on both sides. For example, as a very early user of TwinCAT 3, Manz was able to provide us with important user feedback as part of our partnership."

The hardware core of the BLS 500 controller is formed by a C6030 ultra-compact Industrial PC, whose main advantages Stephan Lausterer describes: "The

C6030 is ideally suited to applications like this with limited installation space. In addition, the computer equipped with an Intel® Core™ i7 CPU provides sufficient computing power for both machine control and visualization. This also holds true for future requirements, especially since Beckhoff is gradually integrating suitable new processor generations and – with the C6032 – also has a compact device variant with more interfaces in its portfolio." Such a versatile industrial PC also makes sense for Stephan Lausterer from another perspective: "Purchasing and warehousing are significantly simplified as a result. The same applies to the entire test tool chain for hardware and software, something which is hugely important to us at Manz. Accordingly, all the software is tested on virtual machines as well as on the real hardware."

All in all, the TwinCAT automation software meets Manz's requirements very well, as Stephan Lausterer confirms: "Among other things, we benefit from the integration of TwinCAT in Visual Studio, as our software team also includes high-level language programmers. Added to this is the overall high level of flexibility, for example with the editors for the respective programming languages and through the variety of functions up to Safety Editor, TwinCAT Scope, and TwinCAT HMI. In our view, this level of integration is a unique selling point of TwinCAT." He also adds that motion control can be programmed and simulated very conveniently in C++ and with the TwinCAT 3 NC PTP, NC I, and Kinematic Transformation blocks, and then run as a TcCOM module in the real-time context. In addition, the TcCOM concept makes it easier to reuse program code and provide suitable protection of intellectual property.

Higher-level communication via OPC UA

In addition to fast EtherCAT communication for the machine processes themselves, i.e., between the industrial PC and the EtherCAT terminals or drives, Manz relies on data exchange via OPC UA throughout the BLS 500. This is realized via the TwinCAT 3 function OPC UA (TF6100) for aspects including the transmission of camera images to the HMI, integration into higher-level systems, and cross-control communication. The virtual commissioning tool also exchanges

data with the TwinCAT controller via OPC UA. Tilman Plaß notes the following in this regard: "The scope of OPC UA communication is very impressive. Manz recognized the advantages of standardized, secure, and vendor-independent communication early on and uses the TwinCAT OPC UA server and client at a considerable scale and with high performance." Stephan Lausterer confirms this: "Almost all external communication runs via OPC UA, both for our Industrie 4.0 products and for customer applications. For non-OPC-UA-capable third-party components, the TwinCAT 3 function TCP/IP (TF6310) or XML Server (TF6421) is used – options which demonstrate the high level of system openness offered by PC-based control."

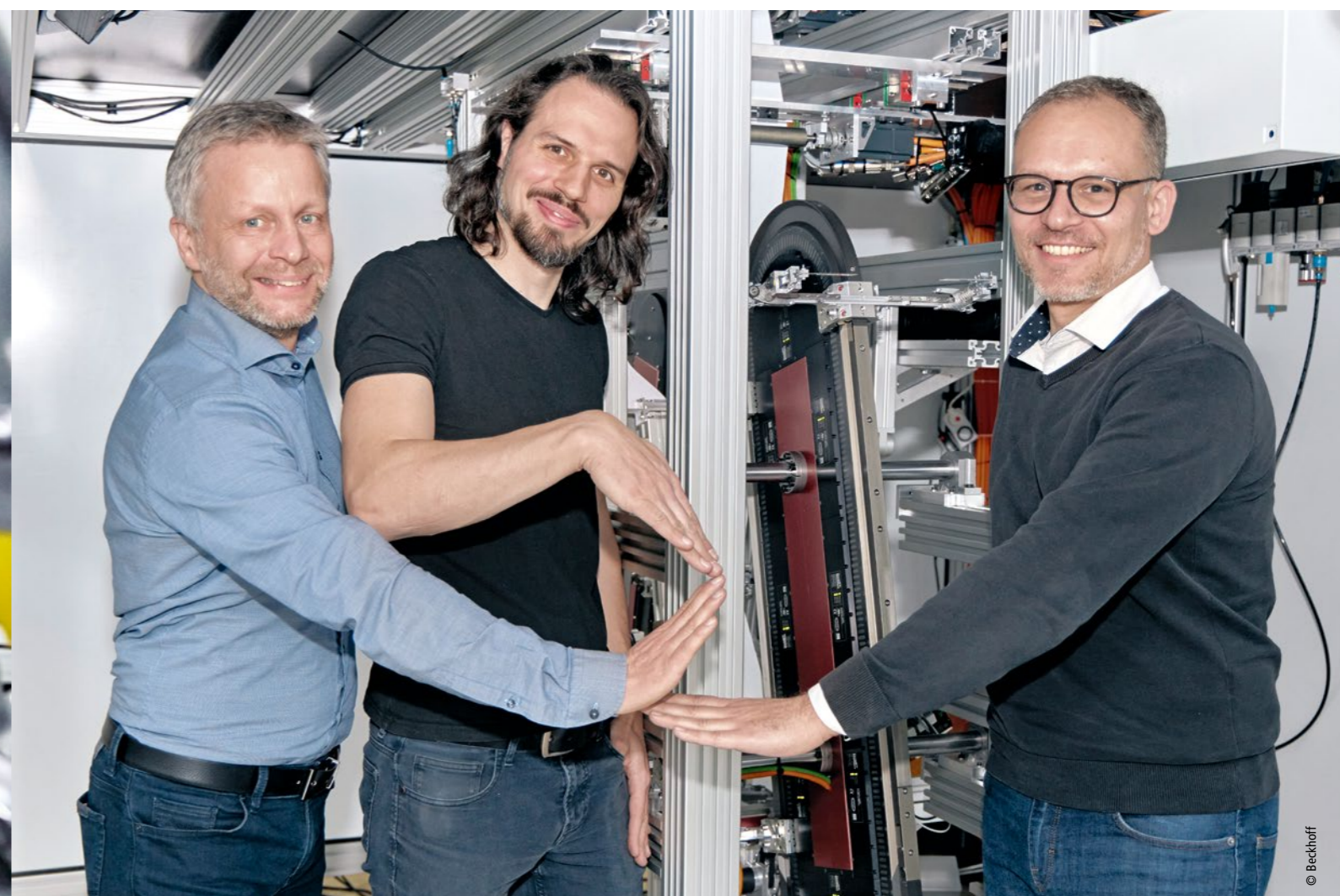
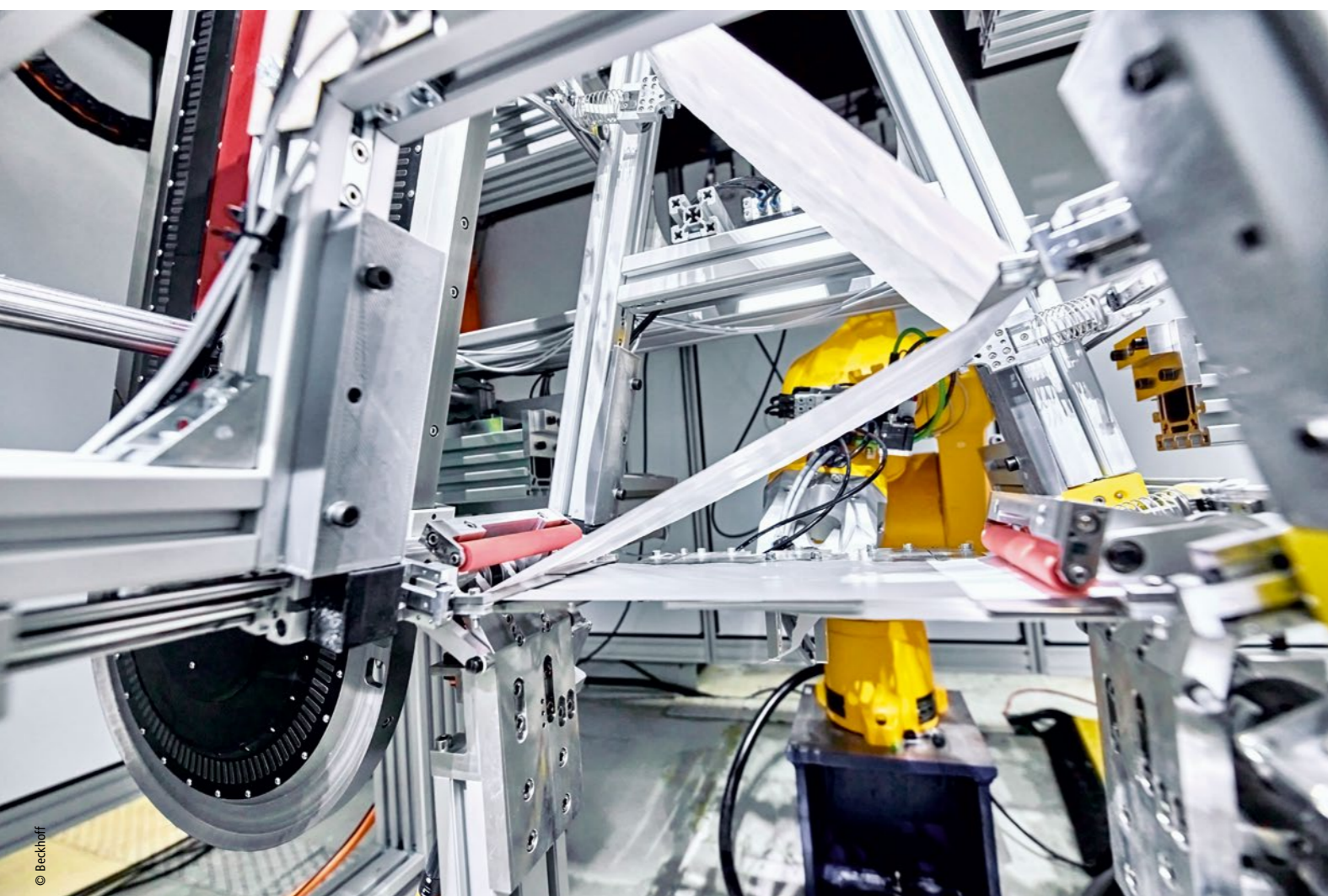
In addition to manufacturer independence, IT security is an important aspect for Manz. Here, OPC UA offers the clear advantage that the corresponding security mechanisms are already integrated into the communication stacks, meaning that the necessary security capabilities are already provided from the outset. According to Stephan Lausterer, this is a topic that will become increasingly important in the future. Another benefit is that Beckhoff as an early adopter has already implemented an OPC UA client on the control side at a very early stage. Tilman Plaß also confirms this: "Beckhoff had already presented an application scenario of TwinCAT 3 in 2014 with the SOA PLC (SOA = service-oriented architecture), which combines logic functions and OPC UA services for data-consistent, secure, and standardized communication."

More information:

www.manz.com

www.beckhoff.com/automotive

www.beckhoff.com/opc



Battery cell production with XTS and PC-based control

Linear transport system eliminates slow pick-and-place process

Low-cost lithium-ion battery cells (LIB) are the key to mass electromobility, although the manufacturing process has always been a cost driver – until now. Researchers at TU Berlin are using continuous Z-folding to replace the traditional pick-and-place movements that have been used so far, thus accelerating battery cell production. The XTS linear transport system from Beckhoff has played a crucial role here.

The biggest challenge in the production of lithium-ion battery (LIB) cells is that the assembly of the electrode-separator composite, which consists of many layers, is very slow. Many pick-and-place operations performed by robots or special kinematics are required here for the Z-folded structures destined for electric vehicles. This process is time-consuming, as each electrode requires a pick-and-place operation and a single 50 Ah LIB has up to 53 individual electrodes in 300 x 125 mm format.

“The problem and the productivity bottleneck are evidently caused by these many pick-and-place movements,” explains Dr.-Ing. Arne Glodde, senior researcher at the Institute of Machine Tools and Factory Management (IWF), Department of Handling and Assembly Technology at the Technische Universität Berlin. He says that handling and joining times cannot simply be reduced by faster braking and acceleration in the industrial robots. “That would impair positioning accuracy when placing the electrodes,” states Dr. Arne Glodde.

Left: Continuous Z-folding with XTS and PC-based control significantly reduces production times of lithium-ion battery cells for electric vehicles, thus cutting manufacturing costs.

This would result in a lower degree of coverage in the cell array, at the expense of cell capacity, service life, and even short circuits. “The previous process flow has reached its productivity limit in practical terms,” points out Dr. Arne Glodde, in reference to what was ultimately the impulse that led to the development of the new LIB production process.

Battery stacking accelerated by 150%

The researchers at TU Berlin have replaced the pick-and-place process with continuous material transport of the electrodes and separator. “This has enabled us to increase production by more than 150% compared to the current state-of-the-art process,” says Dr. Arne Glodde, outlining the most significant improvement. This increase in throughput means that, in the future, 250 cells will be able to be produced in the time that it currently takes to produce 100. The key innovation in this process is the patented Z-folding technique based

Demonstrating Z-folding (from left to right): Guido Sieder, sales engineer, Beckhoff Berlin branch; Dr.-Ing. Arne Glodde, senior researcher at the Institute of Machine Tools and Factory Management (IWF), Department of Handling and Assembly Technology at the Technische Universität Berlin; and Mathias Arndt, Beckhoff application engineer.

on the XTS linear transport system and its rotating grippers. Two of these systems with a total of ten movers ensure continuous folding with precise positioning of the electrodes in the stack.

The electrodes are available as stacks of individual sheets, and the separator is available as belt material. Using a vacuum-based process, the flexible electrodes are each picked up by an individual roller and accelerated to the speed of the separator belt. During transportation, positions are detected and the electrode sheets are precisely aligned with the separator. The electrodes are then fixed alternately on the separator material as it is continuously conveyed.

This is followed by Z-folding, whereby the separator belt with the electrodes fixed to it is fed into the folding process from above via two guide rollers. Two commuter rollers deflect the belt material for this purpose and to facilitate



For continuous Z-folding, the cut electrodes must be fixed on the separator film. With two XTS and their rotating grippers, the cells can then be folded quickly and precisely.

- Mover in relation to the position of the other movers precisely and in real time.
- Accurately synchronizing the rollers over the shortest distance requires high dynamics.
- The number of actively intervening movers must be able to be adjusted dynamically during the process.
- To ensure that the positions along the separator belt are approached at the right time, a high degree of repeatability is needed.
- Load fluctuations require high-quality control.

alternating gripping from the rear with special grippers. These are mounted on the movers of the two interlocked XTS systems, and guide the folds until the belt material is deposited on the folding table, where a hold-down system secures the folds. The XTS systems are mounted in a vibration-free structure that can be integrated into the individual sequence of any battery production system.

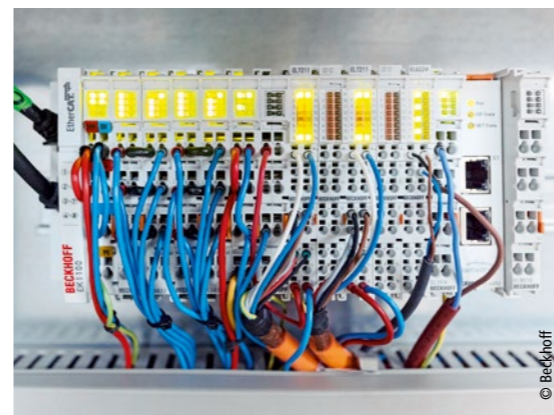
XTS opens up potential for innovation

“Without the linear transport system from Beckhoff, we would not have been able to implement continuous Z-folding with this process control properly and achieve these significantly shorter processing times,” enthuses Dr. Arne Glodde. The processing time has been cut from over one second per fold to 0.7 s for large-format z-folded electrode-separator composites, and the process is still far from reaching the limits of its potential. In the future, times of around 0.35 s per fold could be achieved.

To create a fold in 0.7 s, the movers travel at a speed of about 600 mm/s. For the targeted 0.35 s per fold, this speed would be around 1,000 mm/s. “Our XTS is designed to travel at up to 4 m/s as standard, so it has enough capacity to accelerate the process further,” states Guido Sieder, sales engineer at Beckhoff’s Berlin branch. “The mechanical properties of the separator material and the moments of inertia will probably always be the limiting factors in the long run,” confirms Dr. Arne Glodde.

The special features of XTS and PC-based control are responsible for the current leap in performance. Dr. Arne Glodde comments: “With its freely controllable movers, XTS brings our demanding motion sequence to life.” The grippers have to be moved in relation to each other in order to fold the material with adequate belt tension while coping with the stresses. While this may sound simple, it actually requires high-performance yet flexible automation technology:

- TwinCAT has to calculate the position of a mover in relation to the position of the other movers precisely and in real time.
- Accurately synchronizing the rollers over the shortest distance requires high dynamics.
- The number of actively intervening movers must be able to be adjusted dynamically during the process.
- To ensure that the positions along the separator belt are approached at the right time, a high degree of repeatability is needed.
- Load fluctuations require high-quality control.



To calculate the exact positions in real time, the researchers rely on XFC’s timestamp technology and the relevant EtherCAT Terminals.

A total of 15 servo drives (AX8206, AX5125 and AX5206) and additional EL7211 servomotor terminals control the positions of the AM8000 servomotors, which complement the two XTS systems, in the various feed units. The researchers at TU Berlin also rely on a Beckhoff panel for operation.

“To calculate and control all of the kinematics in real time, we had to ensure that the XTS servo axes can seamlessly switch from NC (point-to-point) operation to interpolation,” explains Mathias Arndt, application engineer at the Beckhoff branch office in Berlin. Dr. Arne Glodde, who is responsible for the project, says that the module-specific programming and synchronization of the controllers, thanks to TwinCAT’s multitasking capabilities, was also very helpful during implementation.

Path planning for all axes is performed directly in the controller based on the kinematic calculation that has been performed. The sequences in the other modules are coupled via virtual axes and corrected via superpositioning movements in relation to the other elements in the process. Another plus point for Dr. Arne Glodde is the simple integration and synchronization of the six-axis robot kinematics that eject the folded electrode packages.

Position detection of objects that is as fast and accurate as possible is crucial for precision and repeatability. The Berlin researchers relied on XFC technology to provide this. “We use eXtreme Fast Control Technology’s timestamping feature for calculating the positions,” specifies Dr. Arne Glodde, “and signal acquisition thus becomes independent of the PLC cycle.” The advantage is that control technology is no longer the limiting factor in position detection; instead, the current sensor technology with sampling rates of 62.5 kHz constitutes the limit here.



Further acceleration through actively controlled grippers

It goes without saying that Dr. Arne Glodde and his team are working on pushing the boundaries of Z-folding further still. “We do actually see lower accuracy at higher speeds due to vibration and inertial forces. This could be counteracted with even stiffer guide rails or active grippers.” Beckhoff has solutions for both: the XTS linear transport system with its V-shaped guide system and No Cable Technology (NCT) for wireless transmission of communication and power to the movers broadens the scope for further optimization, making the folding processes faster and more flexible.

“More specifically, we are working on the further development of our grippers and want to use NCT to replace the mechanical positive guidance with active control of the grippers,” says Dr. Arne Glodde. This increases the flexibility of the system with regard to electrode formats and enables errors in the feed to be compensated dynamically. “Furthermore, we also want to integrate a vision system into the system for quality assurance,” states Dr. Arne Glodde, outlining the upcoming expansion plans.

More information:

www.tu.berlin/iwv

www.beckhoff.com/automotive

www.beckhoff.com/xts

Precision measurement terminals in the final inspection of steering systems

PC-based control makes quality audible

Nobody wants to hear cracking, scratching, knocking, or whirring while driving. But how can subjective noise perception be quantified and measured objectively? thyssenkrupp Presta tests this by measuring structure-borne noise during end-of-line testing. Joachim Sutterlüty, Karsten Mauersberger, Michael Sauerwein, and Julius Ellmann have replaced the previous external electronics with high-end ELM measurement terminals in conjunction with TwinCAT Scope. This saves a lot of engineering work and time, in addition to a great deal of space and money.

Just a few moments are crucial in the life of a steering system – when thyssenkrupp Presta puts it through its paces in an end-of-line test rig, as it does with every steering system. In addition to various functional tests, the noise generated plays an essential role. “Acoustic testing is about ensuring that drivers do not perceive any annoying noises while driving,” explains Joachim Sutterlüty, head of automation at thyssenkrupp Presta. Translating these noise perceptions into measurable values is the job of the experts at the thyssenkrupp Presta acoustic center of excellence. Together with customers, they analyze and define noise behavior right from the development stage on prototypes and pilot series, and measure subjective acoustic properties in objective terms. This noise profile and its permissible limits later form the basis for measuring structure-borne noise in production.

If the noise spectrum of a steering system lies outside this profile, it is returned from the test rig to a rework station, where the measured structure-borne sound spectrum is used to decide whether to rework or disassemble the component. As Joachim Sutterlüty says: “With our sensors, together with the measurement terminals and PC-based control from Beckhoff, we can evaluate the noise so precisely that the worker can narrow down the cause of the noise accurately based on the displayed spectrum.”

Structure-borne sound – a complex matter

A large number of tests on prototypes are needed before a noise profile of this type can be developed. Accordingly, thyssenkrupp Presta has a large number of test rigs in operation in the prototype shop, where the acoustics of a steering system are designed. These must then be adhered to in the fully automated assembly plant. “As development is incredibly dynamic with frequently changing variants, we need a very high level of flexibility,” says Joachim Sutterlüty. That’s why Presta designs and automates all test rigs completely in-house, purchasing only the mechanical setup and electrical components.

For the latter, the automotive supplier has relied on Beckhoff components for more than 20 years. It now also uses the high-end measurement technology ELM3604 EtherCAT Terminals and the TwinCAT Scope for measurement data acquisition.

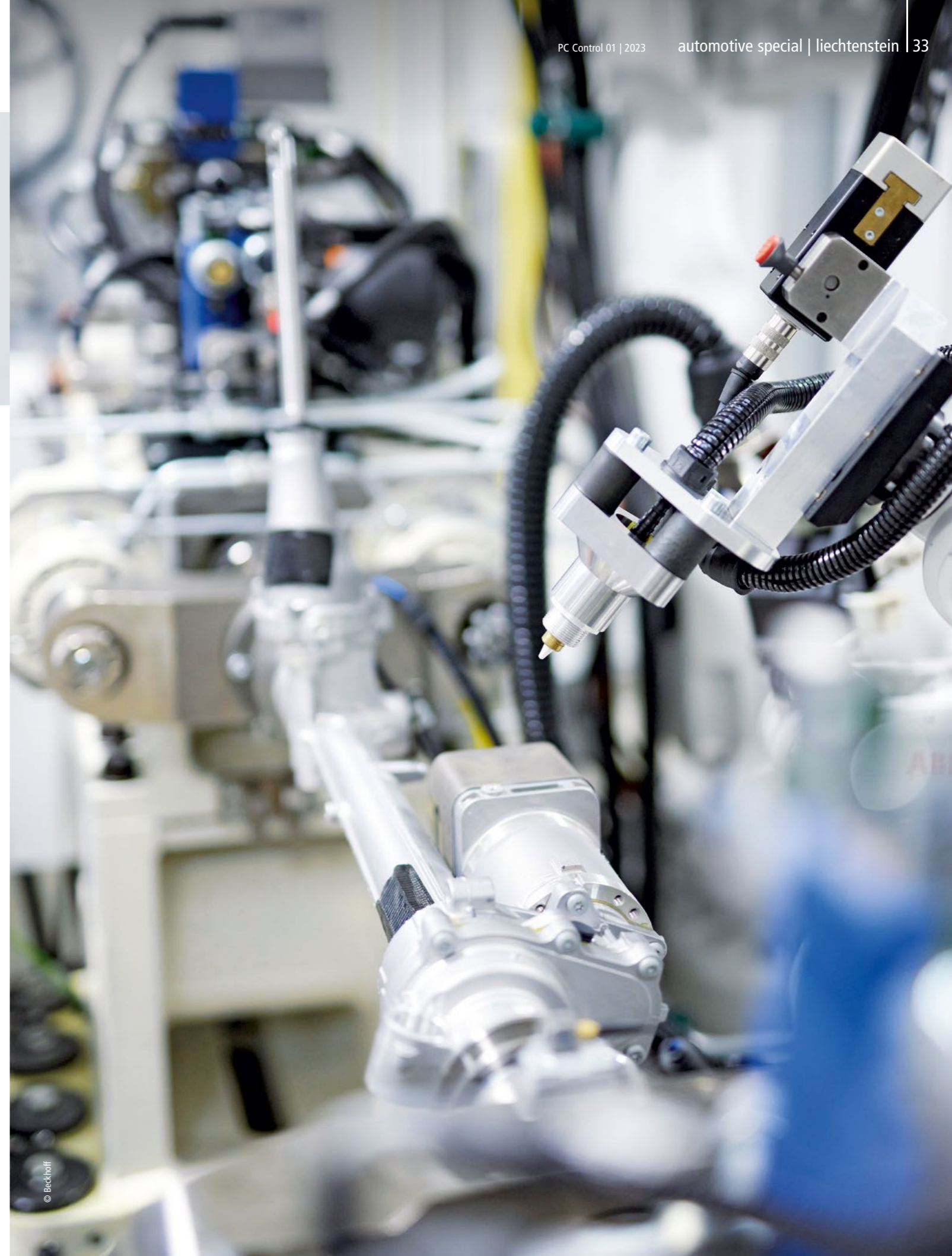
High-end measurement terminals replace stand-alone system

The previous concept was based on an external system for acoustic testing, which necessitated complex interfaces and signal splitters for the actual test rig control system. As electrical engineer Michael Sauerwein says: “This equipment alone required a separate control cabinet and repeatedly caused problems during commissioning, from complex EMC shielding to double calibration and wiring errors.” Additional considerations were the project planning, configuration, and programming of the separate system. With PC-based control, EtherCAT, and the high-end measurement terminals, he was able to completely eliminate these interfaces, gaining significant flexibility and time with a massive reduction in complexity and costs. “Roughly speaking, we save about 5 percent of the investment costs per test module,” says Joachim Sutterlüty.

In 2020, the new concept was intensively tested and examined in an initial testing plant in Eschen. The Beckhoff technology was then integrated into the test field and the sensor signals were tapped in parallel with a previous system to verify the results. Would the high-end measurement technology from Beckhoff come close to the external system?

Acoustics expert Julius Ellmann comments: “We wanted to see if we could replace the old system with something that would live up to the same measurement quality.” After all, some sensor signals have to be recorded synchronously at a high resolution with 24 bits and up to 20 ksamples/s. All of the requirements for metrological complexity were met, and at much better value for money. This is because the ELM360x EtherCAT measurement terminals are directly integrated

With EtherCAT measurement terminals and PC-based control, the high-frequency signals of the IEPE transducers are acquired and recorded via PC-based control synchronously with the test sequences.





Joachim Sutterlüty (right), head of automation technology at thyssenkrupp Presta, with his team, which designs and automates the test rigs for global steering gear production: acoustics expert Julius Ellmann, electrical engineer Michael Sauerwein, and software expert Karsten Mauersberger. In between (second from left): Maurus Kaelin, sales engineer at Beckhoff Switzerland.

into EtherCAT. They are also very flexible in terms of the number of channels and – with TwinCAT Scope – are very quickly configured for data collection. “As part of the changeover to ELM measurement technology, we were able to increase the number of measurement channels due to the advantageous price. Together with optimized measurement sensor technology, we were also able to enhance the measurement quality,” explains Julius Ellmann.

Resolving the software interface bottleneck

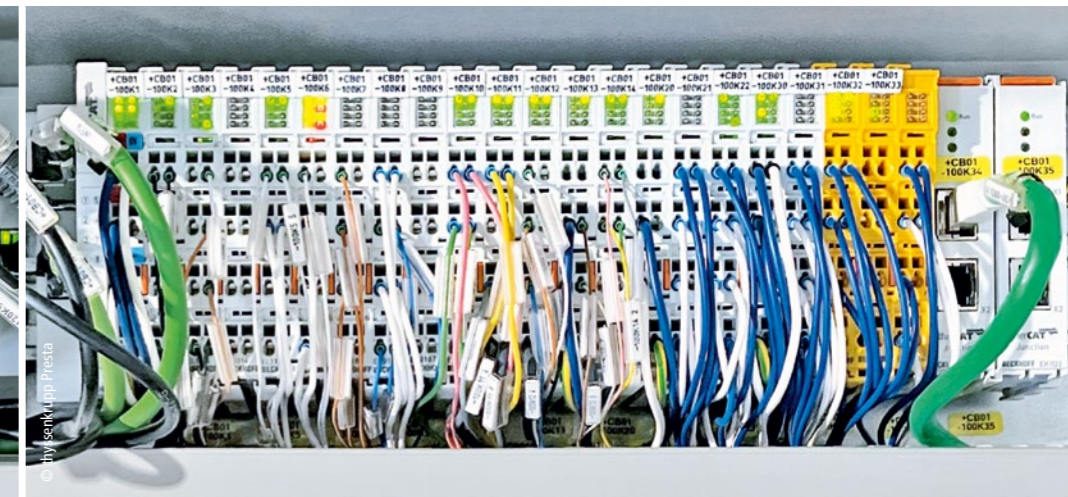
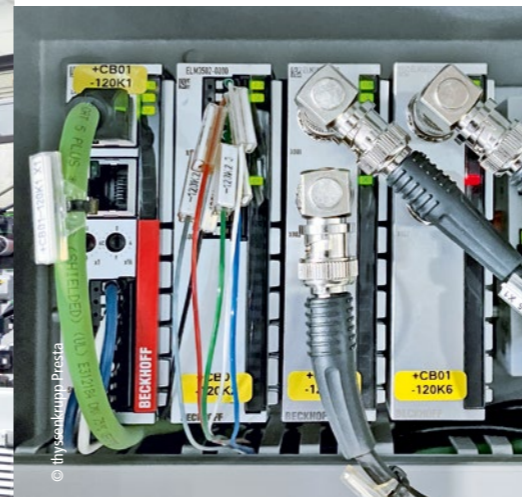
The success of the changeover was due in no small part to the flexibility and openness of PC-based control. This was confirmed when TwinCAT was integrated into the external evaluation software – something that was required because Joachim Sutterlüty was not willing or able to dispense with the existing evaluation software from the previous manufacturer, as various departments use functions of the software. “But the TwinCAT Scope API from Beckhoff is a powerful interface for reading out the data,” says Maurus Kaelin from Sales at Beckhoff Switzerland. However, the interface of the evaluation software turned out to be a bottleneck. “We had to optimize the software interface so that the data packets could be received and analyzed quickly enough,” recalls Karsten Mauersberger, who develops the software for the test rigs.

Pascal Dresselhaus, Product Manager TwinCAT, was on hand with his Scope development team to work with thyssenkrupp Presta and the evaluation software provider and achieve the best possible performance for the application. “Joachim

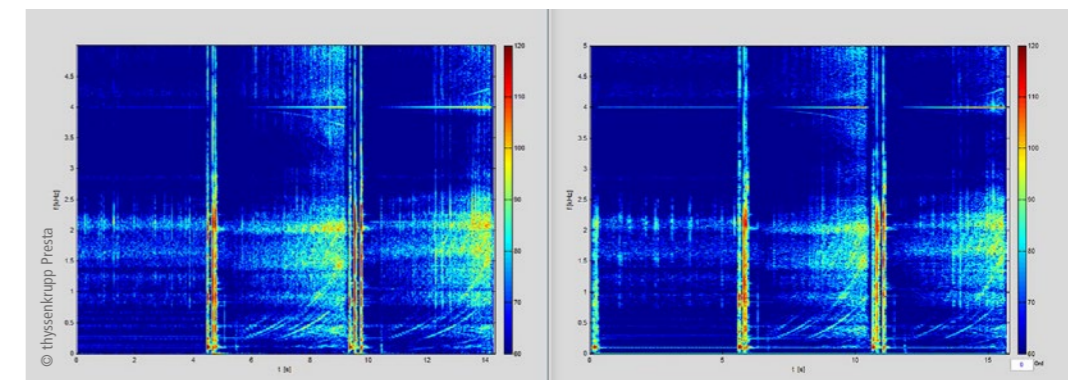
Sutterlüty and his team set out their requirement for a powerful, state-of-the-art interface for data acquisition,” recalls Pascal Dresselhaus. Many TwinCAT users are familiar with TwinCAT Scope only from its integration in Microsoft Visual Studio for measurement data analysis and machine commissioning. However, in addition to the front end in the TwinCAT engineering environment, there is also an extensive programming interface (API) for the TwinCAT Scope (TE1300). Especially in the .NET environment, this can be used to integrate the charts of a Scope View as a Control in your own visualization, for example. This finalizes all of the charting, including the backend with the Scope Server. Many Scope properties can be used on a highly customizable basis, so in some cases it may not even be possible to spot a TwinCAT Scope from Beckhoff performing its role.

In this specific case, however, the API was not used in the conventional manner for the visual display, but instead for relaying the recorded measurement data from the ELM3604 terminals. Using sample code with sophisticated data buffers, smooth integration with the third-party software could be ensured. “In terms of functionality, it was possible to implement the application directly based on the current state of the Scope API. Our support essentially consisted of writing a kind of best practice for using high-resolution data,” says the TwinCAT Scope and Analytics product manager.

The openness of the software solution was an important criterion for thyssenkrupp Presta. This was highly advantageous when it came to integrating the



The high-frequency signal acquisition of the IEPE sensors is performed via two- or four-channel ELM terminals (ELM360x) with a galvanically isolated EtherCAT Coupler (EKM1101) and TwinCAT 3 on a CP6930-1090-0060 Industrial PC in the central control cabinet.



The comparison of the expensive external measuring system (right) with the integrated solution based on the precision measuring technology EtherCAT Terminals, TwinCAT, and PC-based control shows practically no difference in accuracy, but a huge difference in terms of space requirements, project planning work, and costs.

evaluation software and the many export formats. At the same time, thyssenkrupp Presta also retains the ability to use the analysis options available in TwinCAT. “All options are available, particularly those involving TwinCAT Analytics,” emphasizes Pascal Dresselhaus: “We have great engineering products for data analysis with over 100 algorithms. From the cycle times of the test rigs to frequency analyses of noise development, as soon as the data is available in the Scope format svdx, TwinCAT Analytics can be used to find many needles in the data haystack,” says the product manager, highlighting the additional possibilities for thyssenkrupp.

Global roll-out under way

What began around two years ago with an initial concept is now proving itself in practice: in addition to the test rig at the company headquarters in Eschen, the first systems are already in regular operation at the production plant in Hungary. “Further systems are currently on their way to China and Mexico or are already being set up there,” says the automation expert. Due to the results in the areas

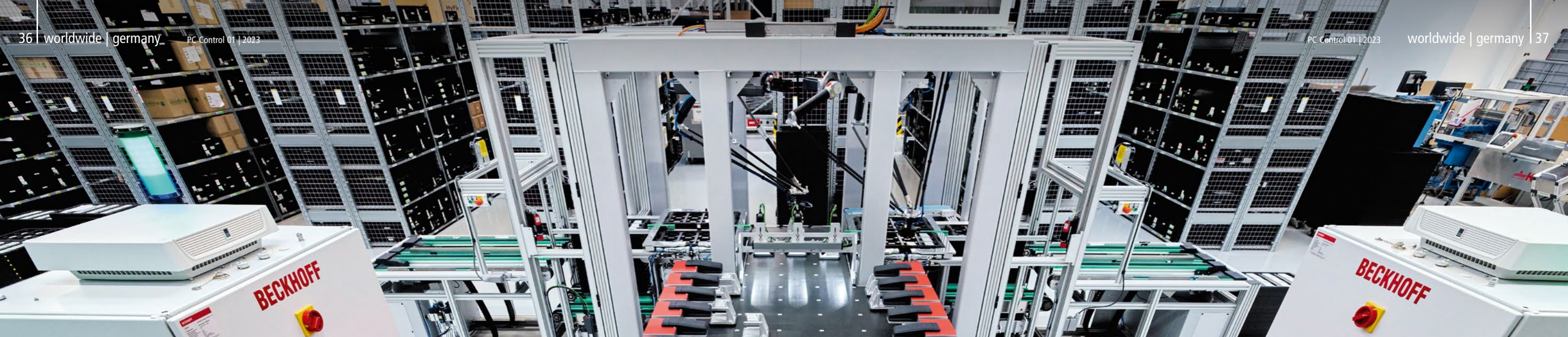
of both measurement accuracy and test speed, as well as the much simpler implementation and commissioning processes, the concept based on the high-end measurement technology EtherCAT Terminals will form the basis for all further acoustic measurement modules. In the future, all new acoustic test systems in the production area will be equipped with it. That is because the advantages of PC-based control are compelling, as Joachim Sutterlüty explains: “We can completely replace external measurement technology hardware.”

More information:

www.thyssenkrupp-presta.com

www.beckhoff.com/measurement

www.beckhoff.com/analytics



Flexible final inspection for I/O terminal production from Beckhoff

The XPlanar greatly increases testing capacity and throughput

In the fall of 2021, Beckhoff began to completely rethink the way it carried out final inspections of I/O components. Its aim was to significantly increase testing capacity and throughput, even though many different types of terminals are produced. The system, which was created entirely by the company's own equipment manufacturing department, can program, adjust, and test around 10,000 terminals per shift fully automatically. The high speed and flexibility are the result of not only the sophisticated system concept, but also the intelligent XPlanar transport system, PC-based control, and the wide range of EtherCAT Terminals.

"Keeping pace with the growth that Beckhoff achieves year after year." This was and remains a challenge for Michael Golz, head of the demo systems department, and his approximately 40 employees, who are responsible for building the operating equipment, among other things. They have taken a completely new approach to the system for final inspection of I/O terminals – with the XPlanar as a transport system, specially developed firmware programmers, and test stations with universal test cabinets. "On average, a fully tested I/O terminal that is programmed with the appropriate firmware leaves the system every 3 s," stresses Michael Golz, "regardless of the type of terminal and the order in which they are delivered." Currently, over 200 different types of terminal can be programmed and tested on the system. The number of different types present in the system also has no impact on the output rate of 10,000 terminals per shift.

It seems like Beckhoff is trying to square the circle, particularly as, depending on the type of terminal – with/without FPGA, a controller, or with analog channels – programming and the subsequent function test take different amounts of time. "It can take up to 30 s for the firmware to be installed and all analog channels to be adjusted," explains Stefan Engelke, who developed and programmed the test cabinets together with his team.

The solution to this time issue lies in the parallelization and separation of the firmware installation on the one hand and the function tests on the other. This is not a groundbreaking idea in itself; the pioneering



The programming and test times for an I/O terminal have not changed, but the throughput has, significantly: approximately every 3 s, a programmed and extensively tested terminal leaves the system.

element is the systematic use of the XPlanar's degrees of freedom for the entire internal logistics and infeed of the terminals to the workstations. Due to the free 2D movement of the products, it is irrelevant whether a single bus terminal needs to spend 10 s or 1 min in a tester. The remaining movers simply go past the occupied stations to the next free station. The overall output of the system is therefore unaffected by individual delays.

Easy, flexible, and transparent handling

"The process is nevertheless very simple," says Michael Golz. "The operator doesn't have to set up anything; all they have to do is place a stack of trays with terminals at the infeed station and press a button." The stack then enters the picking station, where a delta robot picks up the modules from the trays and places them individually on the waiting XPlanar movers. The system has two main paths, almost like high-ways, leading left and right to the programming and testing stations. The stations are located at exits or parking bays on the side of both lanes. Between the lanes, there is a third path where all movers return to the picker. This symmetrical set-up has the advantage that even if an entire half of the system fails, the other side can continue to operate.

The movers pass the terminals under a reading station through to the lateral programming stations. The reading station captures the individual Beckhoff Identification Code (BIC) of each terminal by means of multiple cameras and Beckhoff Vision. "After that, the system knows the terminal type and does everything completely autonomously – programming, adjusting the analog channels if necessary, and function testing," adds Ulrich Brockhaus, who is responsible for system programming. At the same time, the BIC is "married" to the mover via its ID. This means that the mover ID can be used to track the location of each individual mover or terminal, even after a power failure.

When the mover has reached a free programming station, it positions the terminal precisely under its contact pins. Then, depending on the BIC, the corresponding firmware is loaded onto the terminal.

It then moves on to one of the universal testing stations, which in turn calls up the device-specific test sequence based on the BIC. If the software has been

loaded correctly and the function test reports no issues, the mover transports the terminal to the picking station's second delta robot, which places the terminal on another tray, via the middle track. The mover passes through the reading station a second time, only this time in the opposite direction. "The terminal is booked out via the renewed capture of the BIC on the return track, and the installation of the firmware and the function test of each individual terminal are documented in the central database, including all adjustment values in the case of analog terminals," Stefan Engelke states.

All XPlanar degrees of freedom used

The basis for this flexible yet fast process is an XPlanar system consisting of 100 tiles. "We built the two main paths with two outbound lanes and the return track in the middle from six XPlanar base sets, each containing 3 x 4 tiles," says Michael Golz. For the add-ons (programmer and tester), the remaining 28 tiles are screwed onto the side of the basic system. Each mounting position has a standardized interface with power supply (400 V AC), safety, Ethernet (LAN), as well as EtherCAT. "The interface and the system layout enable future expansions without major conversion work," emphasizes Daniel Golz, who is responsible for the mechanical design of the system and the specific details for terminal contacting.

XPlanar makes machinery modular while also simplifying mechanics in many sectors. For example, the programming stations use XPlanar's XY precision positioning. Therefore, immediately after reaching the exact position, programmers can lower their pins onto the terminal contacts and start loading the firmware.

At the test stations, another XPlanar feature reduces the design work: the variable flight height. When it arrives at the test station, the mover lifts first so that the slide-in unit of the test station can move under the terminal. Then the mover lowers its hovering level again, and the terminal then rests on the slide-in unit and is drawn into the tester. The benefit of this is that all contacts are freely accessible and can be contacted. After the test, the terminal is then placed back on the mover in reverse order.

The option to rotate the movers comes into play again during insertion and removal. It is used to rotate the movers by 180°, depending on the side of the

system used. "This feature has also significantly reduced the mechanical complexity and has made space-saving configuration of the tester and programmer on both sides possible in the first place," points out Daniel Golz.

Overall, the system layout benefits from four XPlanar properties:

- The 2D product movements individualize transport of the terminals and facilitate parallel processing in the programming and testing stations.
- XY precision positioning means there is no need for a handling system at the programming stations.
- The transfer of the bus terminal with the aid of the Z movement (lifting/lowering) replaces complex mechanics in the test stations.
- 360° rotation enables the mirror-symmetrical set-up of the system.

Taking a closer look at the electrical and optical functions

The testing stations don't just check the electrical properties and functions of a terminal. "For terminals with analog signals, the corresponding test sequences and calibrations are included too," says Stefan Engelke. An integrated vision system also checks that the prism is present and in the correct position and measures the colors and intensity of the LED.

A very wide range of EtherCAT Terminals, with their diverse functions and measuring ranges, can be tested fully automatically on the system, and this is all thanks to the universal test cabinet. Its complete measurement and testing technology is based on Beckhoff technology, with a focus on the precise measurement terminals from the ELM series. Mounted in mobile cabinets and coupled to the system by means of a plug connector, the test cabinets can be replaced quickly, without shutting down the entire system. This needs to be performed regularly, since the ELM terminals are measurement devices which must be re-calibrated and certified in specific cycles.

The strengths of PC-based control are also evident in the overall coordination and evaluation. If a tester detects a discrepancy on a terminal, this is registered via the BIC while the tester sends the terminal back to the programming stations for reconfiguration. However, if error messages accumulate on a programmer or tester, this indicates a malfunction. "In this case, the tester is reported to the sys-

tem as unavailable and this position is no longer approached by the movers until the tester has been examined and, if necessary, replaced," says Ulrich Brockhaus. Although the system will then run with one station less for a short time, it is still up and running and not significantly slower. "An I/O terminal that could cause any problems for a customer would not leave our system," adds Michael Golz.

The system is a prime example of how PC-based control can be used to perform a wide variety of tasks and functions. In addition to a C6670 control cabinet industrial server, which coordinates the 33 movers on the 100 tiles, a total of ten C6032 ultra-compact Industrial PCs control the other system components. The delta robots are automated with the AX8000 multi-axis servo system and AM8000 servomotors. "We use the AMI8100 integrated servo drives to infeed and eject the trays because they are extremely compact and only require EtherCAT and 48 V voltage to operate," says Ulrich Brockhaus. AA1000 linear actuators are used by the programmers to contact the terminals; AA3000 electric cylinders are also used by the testers to feed in the terminal carriers. The entire safety technology is implemented with TwinSAFE. TwinCAT Vision captures the DataMatrix codes. Around 40 EtherCAT measurement terminals from the ELM series are installed in each of the four test cabinets. In addition, a wide range of EtherCAT Terminals from the EL series are also used. Michael Golz says, "PC-based control has made a lot of things easier for us in this project and leaves us the option for further expansions."

Michael Klasmeier, head of I/O production at Beckhoff, adds, "Our I/O terminal portfolio comprises a wealth of products, from 2-channel digital input terminals to compact drive technology, with differing levels of complexity, which are produced in annual quantities ranging from a few thousand to hundreds of thousands of units. All of our products are produced locally in Verl, East Westphalia. Our objective is increase production output with our current employee numbers and in the space available, which is impossible without automated testing."

More information:

www.beckhoff.com/xplanar



The bridge with the vision systems which is positioned over the three lanes captures the DataMatrix code of each terminal as it passes through, which is then "married" to the ID of the XPlanar mover.



The positions of the 33 movers hovering over a total of 100 XPlanar tiles are displayed in real time in the visualization created with TwinCAT HMI.



AA3000 electric cylinders are used to insert the terminal carrier; AA1000 linear actuators are used to lower the contact pins.



Such a sophisticated system could only be designed and implemented by a full team (Beckhoff experts from left): Daniel Golz (Mechanical Design), Mathis Blattner (Test Cabinet Software Development), Ulrich Brockhaus (System Programming), Stefan Engelke (Testing Equipment Development), and Michael Golz (head of the Demo Systems department).



Similarly to the entire systems engineering, the mobile test cabinets are also built solely with components from the Beckhoff portfolio.



Automation of a 10 MVA test rig for wind turbines

Precisely controlled stress tests increase availability

Major points of interest to the German energy industry right now include the service life of power electronics in wind turbines along with determining the environmental and load conditions that play a role in this regard. Keen to find answers, scientists at the Institute for Electrical Drives, Power Electronics, and Devices (IALB) at the University of Bremen are working closely with the Fraunhofer Institute for Wind Energy Systems (IWES) to learn more. The data set for this project is determined on an enormous test rig, automated with PC-based control from Beckhoff.

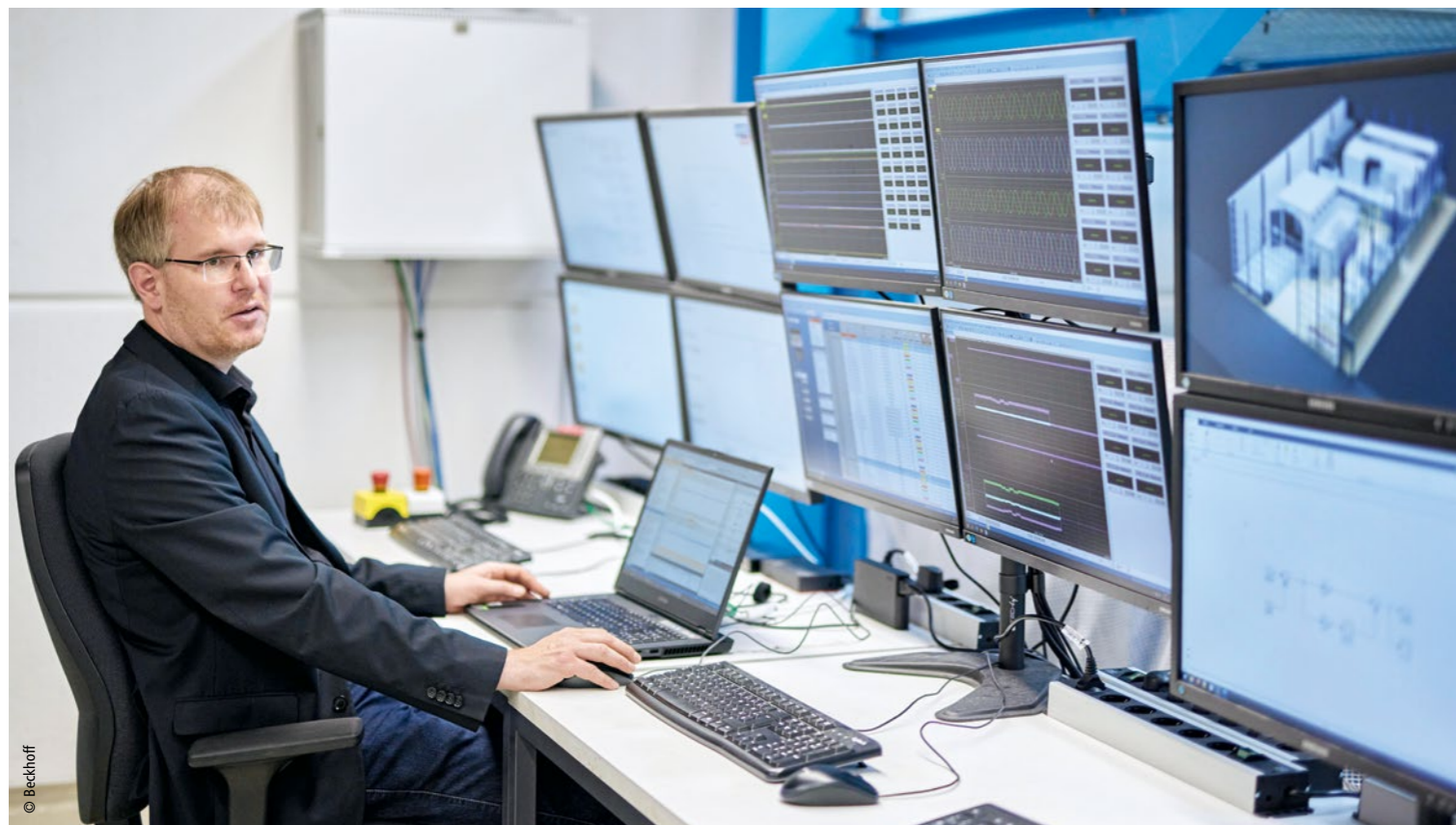


The IALB's HiPE-LAB for high-performance electronics at the University of Bremen offers a unique opportunity to subject complete frequency converters with power ratings of up to 10 MVA to comprehensive climatic and electrical stress tests.

Right: All measured values converge in the main controller, one of the three C5102 19-inch rack-mount IPCs.

Faults in the power electronics are one of the main causes of wind turbine failures. The combination of environmental stresses and electrical operating loads have a significant impact on the service life of the power electronics – and consequently on the wind turbine as a whole. Predicting the effect of these multi-modal loads is therefore hugely important when it comes to avoiding field failures and ensuring long-term product success.

In a bid to determine the causes of the faults, a full-scale test rig with a maximum power of 10.8 MVA generated by four 2.7 MV frequency converters was set up at the University of Bremen. This was within the remit of the "Multidimensional loading of high-performance electronics in wind turbines (HiPE-Wind)" joint project funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK). The project allows complete wind



Dr.-Ing. Wilfried Holzke, scientific director of the IALB at the University of Bremen explains, "In order for us to make reliable statements on service life, it is important that all measured and setpoint values – from the test specimen, climatic chamber, and load converters – are recorded synchronously and with high precision."

turbine power control cabinets to be tested under realistic climatic conditions (onshore and offshore) and under different electrical loads to find answers to the following important questions:

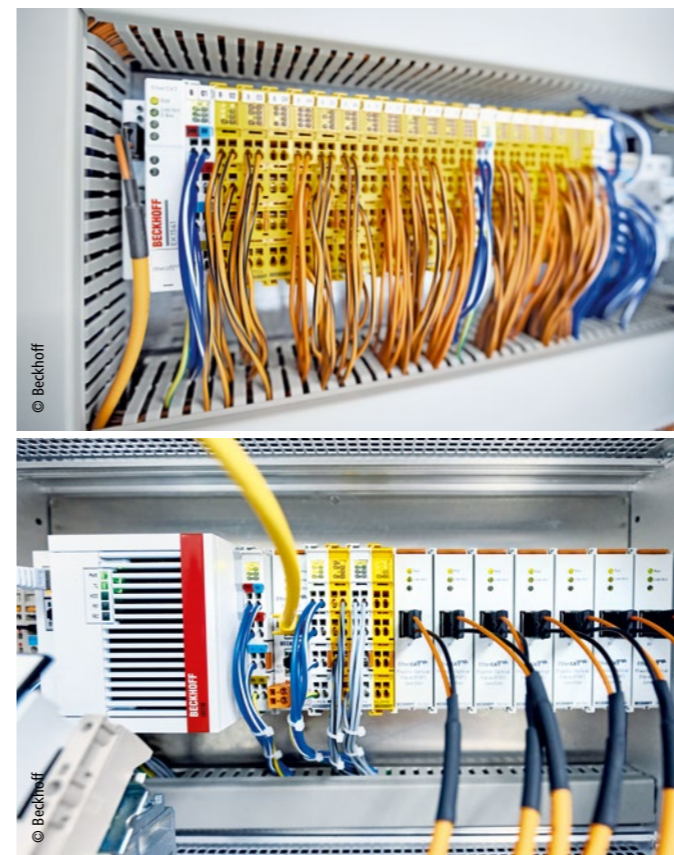
- How does the converter system behave when starting up after it has been idle for a long time and has accumulated moisture in the process?
- Does condensation occur?
- How quickly can a turbine be dried out by heating from its own losses?
- Which components or areas in the converter control cabinet are particularly critical?

"We wanted to get a better understanding of the factors that influence the service life of power electronics," explains Professor Bernd Orlik from the IALB at the University of Bremen. The aim was – and is – to develop concepts for optimizing the robustness of power electronics, especially for offshore turbines, and then to test these concepts experimentally. "So far, however, very little is known about how the specific environmental conditions and operating situations that the power electronics are exposed to affect their service life." Professor Nando Kaminski (also of IALB) adds: "Our preliminary findings show that moisture is particularly critical for power semiconductor components. Electrochemical processes such as corrosion can quickly lead to component failure."

"As the central wind turbine component, the power electronics control the electrical energy flow of the turbine and are subject to a great deal of stress – for example, from the constantly changing wind conditions and the loads from the grid," explains Professor Jan Wenske from Fraunhofer IWES. A wide variety of environmental influences are added to this. Ultimately, the decisive factor for the reliability and service life of power electronics is always the combination of loads in the respective system. "Sometimes we make the converters work in very cold conditions, other times in warm environments with high levels of humidity," says Bernd Orlik. Simultaneously, "normal" electrical loads along with malfunctions and system interactions are simulated as often as required. Similarly, scientists can replicate real environmental conditions from the field in the climate chamber and specifically study the behavior of components under these circumstances. This makes it possible to test the effect of changes in the structure and configuration of a converter in advance, with the advantage being that weaknesses and potential problems can be identified and eliminated as early as the development phase.

Offshore conditions reproduced with climatic cabinet

Anyone who has ever stood in front of a 10 MW wind turbine will have a clear idea of the dimensions of the electronics used. The climate chamber is also large, with a volume of over 170 m³ – or 7.5 x 5.3 x 4.3 m to be precise. This is where the scientists install the control cabinets with the power electronics and connect them to the load converters and the external control unit with PC-based control. Only then do the actual tests begin in all known and conceivable climatic zones. Dry temperatures from –40 to +120°C are just as possible as wet and cold or tropical conditions with a relative humidity of between 10 and 95% in a temperature range from +10 to +95°C. Dynamic, reproducible electrical load profiles enable accelerated aging of the power electronics under the corresponding climatic conditions.



Above: When working with such high voltages and currents, safety is paramount: the system is monitored via TwinSAFE Terminals for over 620 safety-relevant channels.

Below: The communication interfaces have to be easy to adapt on account of the constantly changing test specimens. According to the IALB, EtherCAT Hot Connect and the EK1561 EtherCAT POF junctions offer an elegant solution in this regard.

A considerable amount of work goes into making all of this possible in the first place: The test rig consists of the load system with the four frequency converters, a climate room for the test specimen with the corresponding refrigeration/air conditioning and safety technology, and an electrical distribution system which is appropriate for the power. Finally, the researchers run dynamic load simulations with up to 9,000 A (4 x 2,250 A) and voltages between 0 and 1,000 V. "All components have to be controlled simultaneously to achieve reproducible results," explains Dr.-Ing. Wilfried Holzke, scientific director of the HIPE-LAB at the University of Bremen, pointing out an initial automation challenge. This is because the various components have to be controlled via different bus systems (Ethernet, PROFINET, Modbus RTU, Modbus TCP, and CANopen) and different protocols. In terms of the safety system, this also has to be easy to integrate into the overall system. All this requires a flexible and powerful automation system. "PC-based control from Beckhoff offers a number of advantages for this," notes Dr. Wilfried Holzke, "starting with support for a wide range of bus systems and protocols and extending to the integration of HMI and databases. This makes it possible to select the previously created sequences for electrical and climatic loading with ease and transfer them via the PLC to the loading equipment, the climatic room, and the test specimen.

More than 72 voltage and current channels are acquired at up to 2 MS/s via external measurement technology. Temperature, humidity, and air flow in the climatic chamber – totaling a further 64 channels – are integrated at up to 20 kS/s. To this end, EtherCAT offers an option to acquire all channels via the distributed clocks function with a high degree of accuracy and synchronicity. The EL6688 EtherCAT Terminal (IEEE 1588/PTP synchronization) extends this functionality further to all measurement technology systems located on the test rig and creates a uniform temporal foundation across all applications.

Climatic chamber, test specimen, and load converter – all centrally controlled

The sequences are programmed in TwinCAT 3. The test specimens are connected via a separate controller (CX5130 Embedded PC) and controlled via an EL669x EtherCAT bridge terminal. According to Dr. Wilfried Holzke, "This provides an advantage: the program can be individually adapted to the test specimen without having to modify the main controller (C5102 19-inch rack-mount IPC). As the test specimens are changing constantly, the communication terminals also have to change continuously," he adds, pointing out another advantage of EtherCAT and PC-based control. The wide-ranging portfolio of EtherCAT components meant it made sense to implement a large part of the cabling in POV/fiber optic multi-mode. Ultimately, fiber optic cables are resistant to the electromagnetic interference that is inevitable at high currents and frequencies.

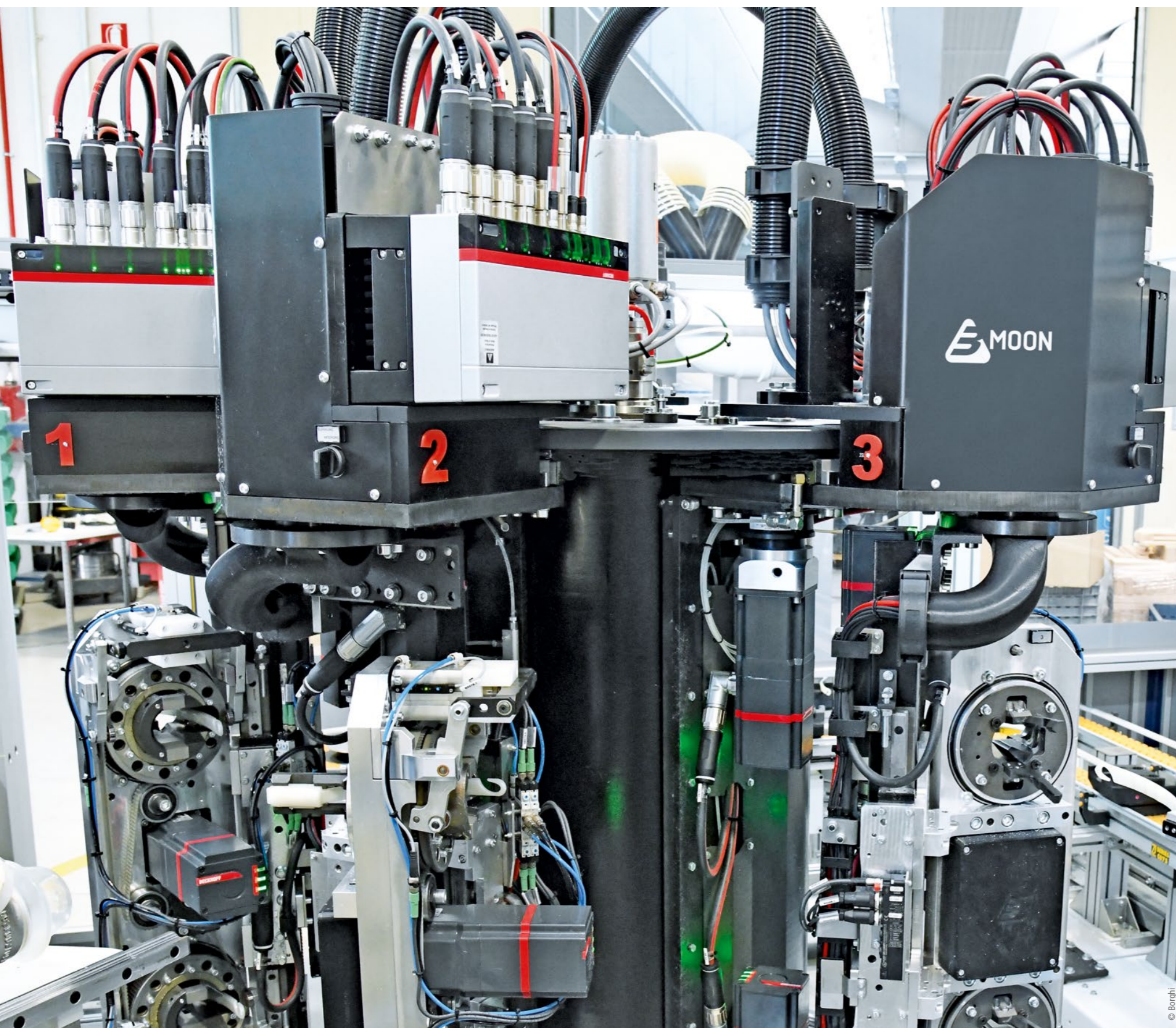
As many as ten controllers are used in the complete test facility, including the pre-test platform and test station. In addition to three C5102 19-inch rack-mount IPCs (main control system, pre-test platform, and test station), six CX5130 Embedded PCs are used for the test specimens, along with one CX7080 Embedded PC. A CP2916 multi-touch built-in Control Panel is integrated into a generic demonstrator for controlling the frequency converters. Almost the entire spectrum of EtherCAT Terminals is installed, starting with digital I/Os, A/D and D/A converters, and encoder I/Os. Safe operation of the facility is monitored by TwinSAFE Terminals, such as EL1904 and EL2904, with a total of over 620 safety channels. The TwinSAFE project is controlled system-wide via ten EL6910 TwinSAFE Logic Terminals.

EtherCAT Hot Connect allows preconfigured sections to be removed from or added to the data traffic before system startup or during operation. This results in further advantages for partial shutdowns in hazardous situations in the vicinity of the test specimen or for modifications. The EtherCAT distributed clock function also offers interesting potential for development here. "This would allow complete and continuous synchronization from the main control to pulse pattern generation," Dr. Wilfried Holzke reveals, outlining how the project is set to develop.

More information:

www.hipe-lab.de

www.beckhoff.com/wind



The new machine concept from Borghi based on flexible machining turrets and the AMP8000 distributed servo drive system with AMP8620 supply modules enables continuous production of brooms and brushes.

New machine concept for the industrial production of brooms and brushes

Distributed servo drive technology and EtherCAT P facilitate production process overhaul

Industrial production of brooms and brushes is not much different from the classic manual approach: the machines just work faster – but still not fast enough for Italian machine builder Borghi S.p.A. This is where the Moon project came in, allowing the company to make a significant leap in terms of productivity. The project saw the development and implementation of a completely new production sequence using PC-based control and the AMP8000 distributed servo drive system based on EtherCAT P.



The distributed connection concept based on EtherCAT P and the compact AMP8000 servo drives save valuable space in the machine.

At first glance, they are just everyday objects – brooms and brushes in a wide variety of shapes, materials, and colors for both domestic and industrial use. The range of materials and dimensions is just as broad, spanning from small brushes made of steel, polypropylene, horsehair, or Tampico fiber through to large rollers for street cleaning vehicles. Therefore, state-of-the-art production technology is required to manufacture brooms, brushes, and mops the way Borghi does: economically, in high volumes, and with precision and quality.

Based in the Italian town of Castelfranco Emilia, Modena, Borghi's roots date back to 1948, giving the company close to 75 years of expertise in this specific segment. Today, Borghi produces in several subsidiaries, including those in Brazil, China, India, Poland, and Spain. It also has sales offices in a number of strategically important regions, such as Asia, Europe, and the USA. "Borghi is now an international group," explains Chairman Paolo Roversi, "where more than 250 employees are involved not only in the production of machines, but also in the assembly of control cabinets, mold making, and much more besides. You will often find the work of one of our machines behind the products marketed by a host of major brush and broom brands," he goes on to point out.

Broom production with stringent requirements

When it comes to manufacturing a broom, the brush is the most important element. Brushes consist of several rows of fibers that are threaded into what is known as a 'lath'. Not only can these have completely different geometries, but they can also be made of different materials. "For example, the ability to process synthetic, natural, and metallic fibers all in a single plant calls for extremely high flexibility," notes Paolo Roversi.

The classic cycle of brush production starts with feeding in the base plates, which are sent to the drilling station once inserted. In the next phase, the tufts are inserted into the drilled plates before being cut to size. The final step is for the finished product to be set aside. This last machining step almost always coincides with the insertion of the next base plate ready for a new cycle to begin. "During the transition between the various processing steps, the motion axes of the work stations constantly have to stop briefly and allow the semi-finished product to pass to the next station," explains Paolo Roversi, pointing out a major productivity bottleneck. This brief stop typically lasts for 2 to 3 seconds, which might not sound like much, but still represents a productivity loss of around 20 percent for a complete cycle of about

15 seconds. At the same time, these forced breaks hold enormous potential for productivity gains.

Pause times eliminated via motion control

This is exactly where Borghi's Moon project came into play to optimize the performance and efficiency of the machines. "With our new generation of machines, we wanted to break with the classic pattern of phase change cycles and develop a machine concept that can operate continuously," Paolo Roversi notes, pointing out the optimized approach to brush production. This requires a completely different machine design and an automation supplier who can handle this high level of complexity with a safe, reliable, and deterministic approach. After evaluating various automation concepts, the decision was made in favor of Beckhoff, whose automation solutions, which include the AMP8000 distributed servo drive system and EtherCAT P, made implementation of the concept possible in the first place, recalls Paolo Roversi.

Around half of the servo drives are still controlled via the AX8000 multi-axis servo system.

The mechanics had to be extensively redeveloped to enable continuous operation of the machine, with the core element comprising four small, independent machining turrets that transfer the plates seamlessly from one machining phase to the next. Each machining turret can be flexibly positioned via five servo drives to suit the formats of the plates being processed. This concept requires compact and powerful drive technology in the form of AMP8000 distributed servo drives with integrated power electronics. A single EtherCAT P line is used to connect power and communication, including safety, which not only saves space on the turrets, but also cuts down weight.

Optimized space requirements in the machine and control cabinet

The AMP8600 supply module plays a key role in the distributed power supply: one IP65-protected power supply per turret is sufficient to supply its five drives with power and communication via EtherCAT P. The small footprint of the AMP8000 servo drives, the small size and flexibility of the distributed supply module, and the minimal wiring work required for EtherCAT P were essential for meeting the requirements in terms of machine compactness, performance, and reliability.

"We were never on our own when it came to implementing this innovative automation concept," recalls Paolo Roversi, "The on-site support from the Beckhoff experts made everything easier. What's more, the fact that we were working with a single project partner to handle all the automation elements from the control panel to the drive meant the compatibility issues that used to occur with multiple suppliers were no longer a problem."

The consistently distributed approach, with around 50% of the power electronics located directly on the machine, also has a positive effect on the footprint: despite having a total of 45 axes, the machine control cabinet is highly compact and offers sufficient space for the CX2040, the EtherCAT Terminals, and additional servo drives from the AX8000 series. Paolo Roversi enthuses, "This concept has resulted in significant savings in terms of cost, materials, space, and installation effort."

Ready for Industrie 4.0 and the future

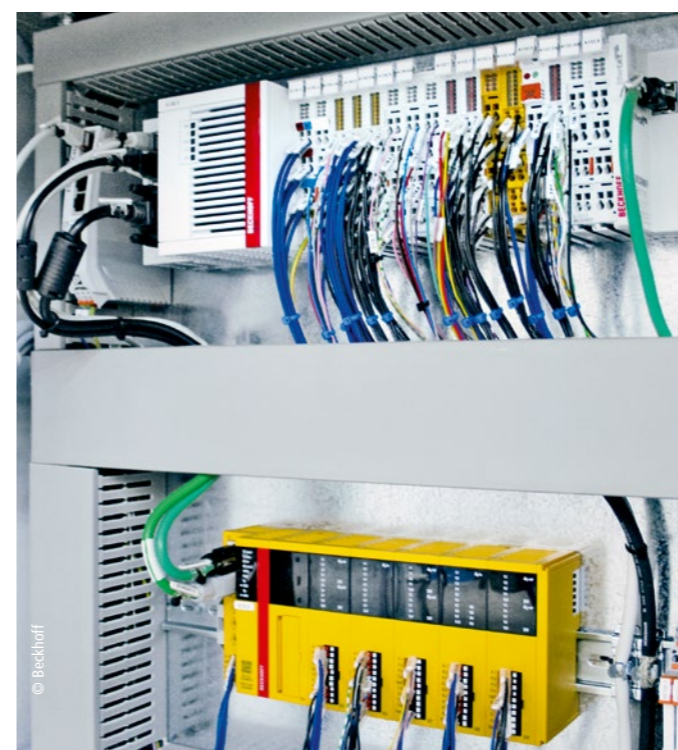
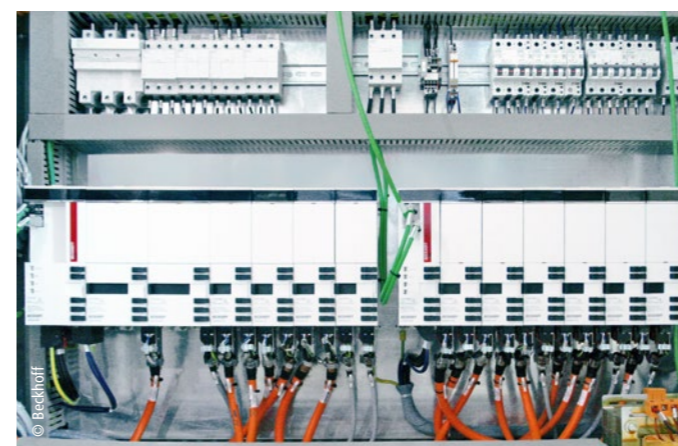
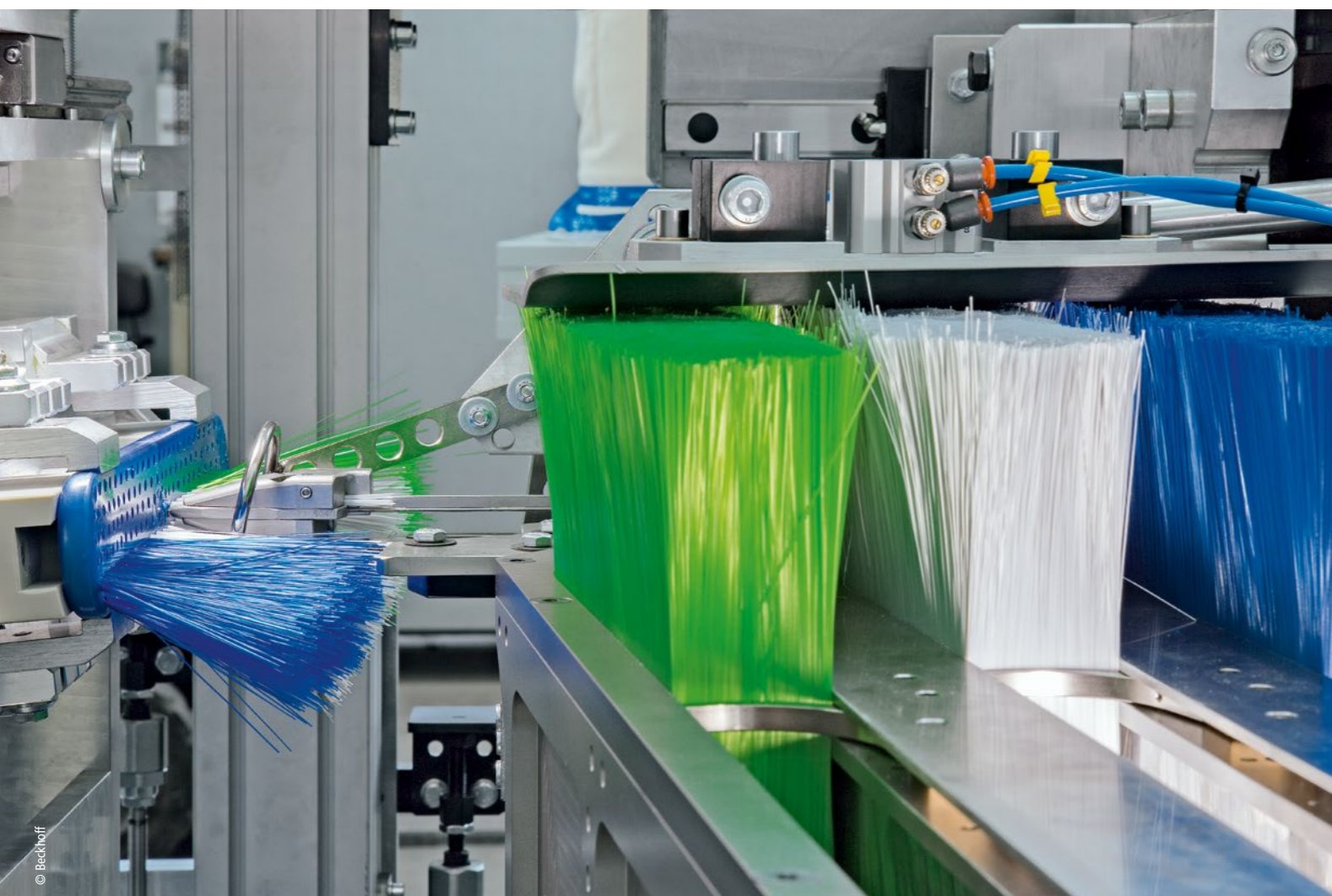
Today's machines are now all developed with Industrie 4.0 in mind as standard, complete with the corresponding connectivity and sensor technology. According to Paolo Roversi, Beckhoff has also simplified programming in this respect, with TwinCAT 3 using the standardized architecture that is new to Borghi throughout: "At the same time, there is also plenty of space left for future expansions, for developing new models, and for OT/IT integration. PC-based control from Beckhoff offers maximum scalability for this and enables simple integration of multiple controllers and the HMI in a single standard hardware."

More information:

www.borghi.com

www.beckhoff.com/amp8000

Borghi implements the safety functions with the EK1960 TwinSAFE Compact Controller (below) and additional TwinSAFE terminals, which are integrated into the upper EtherCAT Terminal segment and directly connected to the CX2040 Embedded PC.



Household items such as brooms are mass-produced goods and therefore often have to adapt to trends – for example, in terms of bristle color.



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Flexible PC-based control for additive manufacturing with solid-state metals

Simplified engineering and futureproof development in melt-free metal 3D printing

Another advantage of the MELD process: the printed metal remains stronger than parts made through melt-based metal 3D printing.



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A B8 machine from MELD prepped and ready to print

Meld Manufacturing has pioneered a solid-state metal additive process that is based on applying friction and force. The advantages compared to melt-based processes include very large-format 3D printers and higher part strength. For optimal control of its systems, the company relies on flexible EtherCAT and PC-based control technology from Beckhoff.

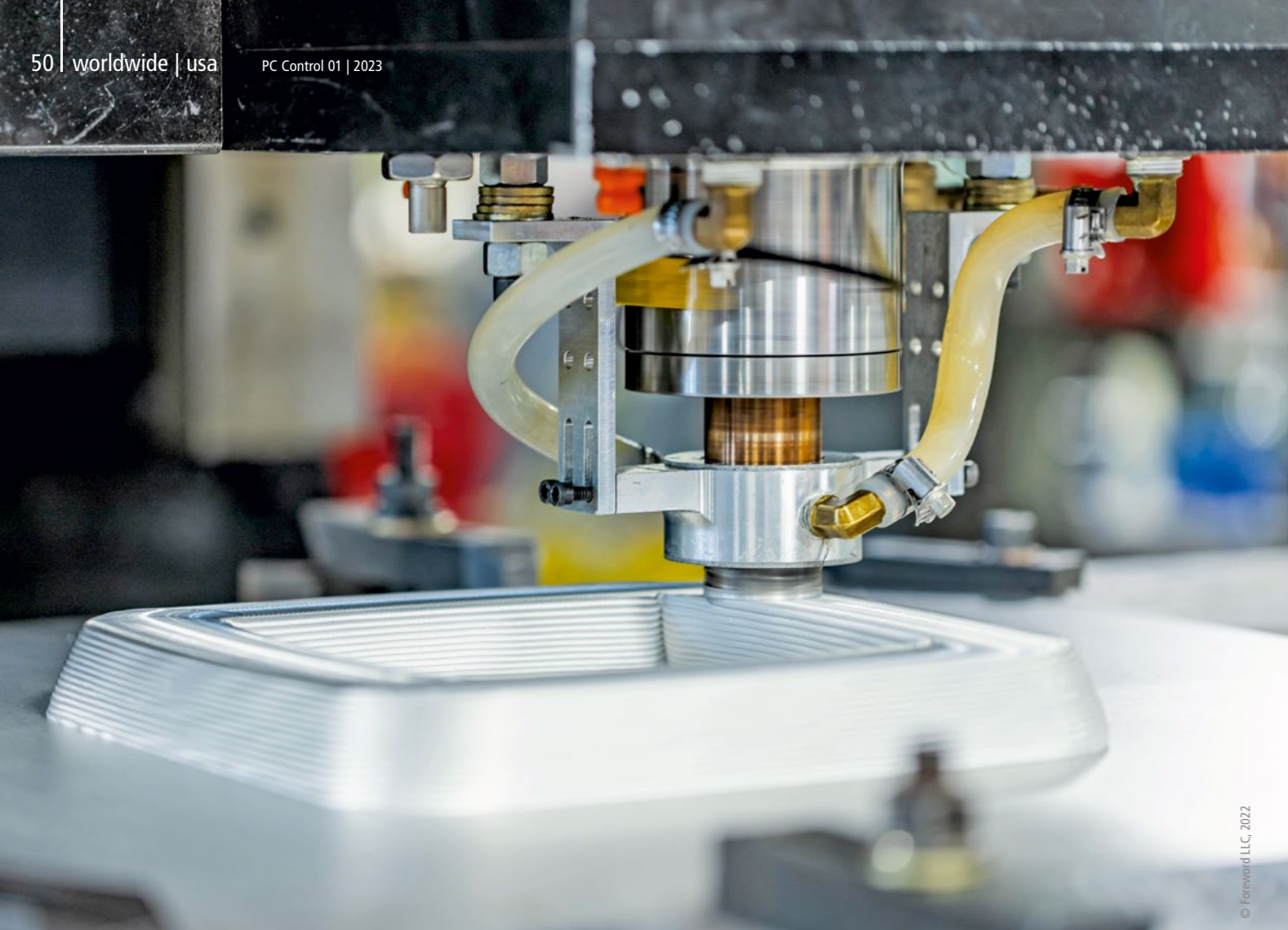
The Christiansburg, Virginia-based company led by CEO Nanci Hardwick offers its capabilities to a wide range of customers in defense, research and manufacturing. MELD spun off from its parent company, Aeroprobe, in 2018 to apply the principle of friction stir welding to additive manufacturing technologies, according to Dr. Chase Cox, Director of Technology at MELD. Friction stir welding is a method for welding metals without melting them.

From this, MELD developed an additive process to enable deposition of multiple layers for 3D printing applications. The patented process entails rotating a bar of solid metal while applying a specified force at the point of deposition. Friction causes the metal to plastically deform and be deposited in a layer. Through adiabatic heating, i.e. without exchanging heat with the environment, the metal feedstock will continue to flow if spun continuously at the correct speed.

The innovative process allows equipment end users to print parts using any metal, including aluminum alloys and others that have typically posed problems for other additive manufacturing systems. As it doesn't require melting like most other established 3D printing methods, the process also doesn't affect the metals' properties. As a result, the product remains stronger and is less susceptible to porosity, hot-cracking or other typical issues of melt-based additive processes. The solid-state process is also at least 10 times faster and requires less energy.

Continued development needs flexible automation

MELD currently offers several standard machines – L3, K2, and 3PO – for various part sizes ranging from around 3 feet (90 cm) long and 1 foot (30 cm) tall to roughly 13 feet (4 m) long and 3.5 feet (1 m) tall. It also offers the CD-14 package consisting of a spindle with rotating deposition tool, electrical enclosure,



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The additive manufacturing process developed by MELD can print with any metal.

sure and HMI, which machine builders can implement in large, custom systems. Open, scalable control technologies have proven critical to enabling continued development.

After the company launched in 2018, its original controls platform could not keep pace. First, Fred Lalande, Sr. Automation Engineer at MELD, had to write a G-code interpreter for that vendor's platform. Also, a separate PC using a separate software package was necessary to run the HMI and communicate performance data. Finally, the platform had difficulty connecting field devices. As Fred Lalande worked to make the platform communicate to a Beckhoff stepper motor terminal from the EL70xx series, he got in touch with members of the local Beckhoff team, Regional Sales Engineer Chuck Padvorac and Application Engineer Jack Plyler. As he learned about fully integrated PC-based control from Beckhoff, Lalande believed he had found the ideal platform for MELD.

What pushed Fred Lalande toward Beckhoff was TwinCAT 3 automation software. Lalande had programmed the first machine's code in structured text using Codesys, but within the TwinCAT engineering platform, he found it relatively

easy to convert the code in a short timeframe. In that period, he not only implemented a program that can execute G-code files within the PLC using the TwinCAT NCI package, but he also designed a new HTML5-based operator interface in TwinCAT HMI. "Previously, I had to use two or three different software packages. That was a pain," he says. "With TwinCAT, I open one program and everything I need is there."

As the solutions have developed, the code has grown more sophisticated over time. The portability of code in TwinCAT made it easy to adapt one machine's program when designing the next. In addition, IP protection is critical in additive manufacturing and especially so with this unique patented process. TwinCAT provided advantages in this area, as Chuck Padvorac from Beckhoff points out: "The Beckhoff software platform gave MELD the ability, using our OEM Certificate feature, to lock down its valuable code. Everything is password protected and encrypted, so no one can copy MELD's developments."

In this 3D process, the spindle speed must be modulated for each specific material to maintain the desired temperature for continuous printing, Chase Cox

explains. To accomplish this, the PID controller in the TwinCAT Controller Toolbox provides dual-loop closure on the axis, ensuring successful implementation of MELD's unrivaled technology.

For each machine, TwinCAT runs on a single Beckhoff C6920 control cabinet Industrial PC. A CP2924 multi-touch Control Panel from Beckhoff provides the operator interface with custom push-button extensions and further options.

Motion control and functional safety

The L3, K2 and 3PO machines rely on Beckhoff servo solutions for motion control. A variety of AX5000 servo drives and AM8000 servomotors with appropriate gearboxes handle movement in X, Y and Z coordinates. EL72xx servomotor terminals power a continuous feeding system, Fred Lalande explains: "The feeding system allows operators to load eight hours' worth of material at once. The material automatically moves to the turret as needed using Beckhoff compact motion solutions." The drive components also offer One Cable Technology (OCT), which combines power and feedback in one cable to simplify commissioning.

A VFD and spindle motor from a third party spin each machine's rotating deposition tool, and since the VFD is EtherCAT-based, Lalande found integration to be simple. EtherCAT provided the ease of plug-and-play operation, according to Lalande, when using devices from Beckhoff as well as from third parties.

MELD also leverages TwinSAFE, the integrated functional safety solution from Beckhoff. This allows Fred Lalande to implement E-stops, safety doors and TwinSAFE motion functions for the drives with programming in the same TwinCAT engineering environment. "TwinSAFE is straightforward to use," Lalande says. "By implementing this solution, we elevated the level of safety that our machines provide to PLe, the highest level."

3D printing grows with futureproof technologies

As MELD continues to make advances in additive manufacturing, PC-based control provides a solid foundation to build upon. EtherCAT and OCT shorten commissioning times, while TwinCAT consolidates HMI, motion control, PLC and other machine control functions. The automation platform also simplifies the use of OPC UA, LabVIEW™, MATLAB®/Simulink® or other applications.

To keep pace with the company's innovations, TwinCAT provides development tools that help maintain a uniform code base across the machines. Seamless integration of source code control tools, such as Git, into TwinCAT engineering and the TwinCAT Project Compare Tool are just two advantages. "Managing our beta testing is made easier with these tools," Fred Lalande says.



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The CP2924 multi-touch Control Panel – here in portrait orientation – and TwinCAT HMI allow for a comfortable and intuitive operator interface with web-based programming.



From left: Jack Plyler and Chuck Padvorac of Beckhoff with Chase Cox and Fred Lalande of MELD

More information:

www.meldmanufacturing.com

www.beckhoff.com/print



The Deepsight inspection machine operates either stand-alone with manual product feed or in 2- to 4- machine pods with robot-assisted feeding.

EtherCAT-based servo technology in inspection machine for smart display devices

Fast and precise surface inspection of smart devices

The grading of cell phones and tablets according to cosmetic defects determines the necessary measures for refurbishment. In its inspection machine – for both new and used smart devices –, AI expert Griffyn Robotech uses PC-based control from Beckhoff for precise motion control in product handling. This enables the detection of micron-level surface defects in split seconds.

Griffyn Robotech, headquartered in Pune, India, specializes in visual inspection, robotics, and AI-based automation. With its solutions for industrial manufacturing and quality control, Griffyn caters to the automotive, telecom, pharmaceutical, FMCG, and machine tool industries.

Due to easy upgrade options, warranty and insurance cases, the reverse supply chain of smart display devices such as smartphones, tablet PCs, and wearable electronics is increasing day by day. Cosmetic inspection and grading is one of the crucial steps in processing returned devices because the detected optical flaws decide on the further disposition. Up to now, this has mostly been done by manual visual inspection. Although nothing beats the human eye for versatility, its repetitive accuracy and productivity are limited. In addition, millions of de-

vices need to be inspected and graded before recirculating them in the forward supply chain every year.

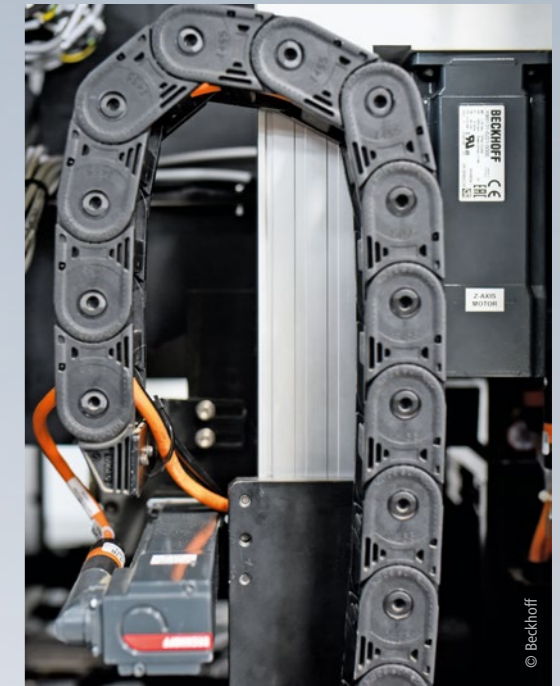
To meet the increasing demand in the reverse supply chain and eliminate the subjectivity of human grading, Griffyn Robotech launched the Deepsight Cosmetic Grading Machine (CGM). The patented vision system enables fast and accurate detection, measurement, and analysis of all surface defects with high repeatability. It intelligently identifies surface defects such as scratches while tolerating natural variations in complex patterns and surface textures, including glossy, shiny, or rough surfaces. It also takes into account significant differences in tolerances that apply to the make and model of the devices.

Efficient product handling reduces cycle times

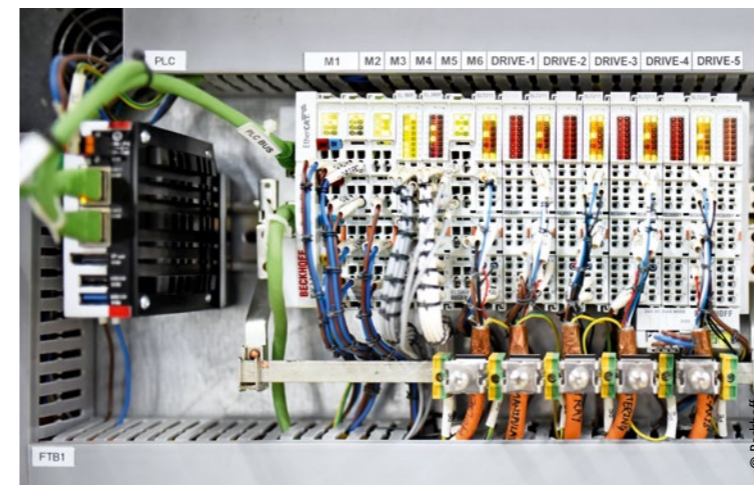
The machine uses a high-resolution camera sensor to determine any handheld device's "true" quality by capturing multiple images of all six sides of the device. However, the basis for accurate image capture is suitable product handling for flipping, turning and positioning the devices. For precise and fast motion control with accurate object orientation, Griffyn employs TwinCAT NC I motion control installed on the ultra-compact C6015 Industrial PC from Beckhoff. Combined with the AM81xx servomotors and EL7211 servomotor terminals, this enables complex multi-axis interpolated motion on a small footprint. Ultra-fast EtherCAT communication and sub-millisecond processing times reduce machine cycle times and boost throughput, according to Griffyn.

The captured images are put through Griffyn's proprietary deep learning algorithms to identify various surface defects such as scratches, cracks, dents, and discoloration. After analysis, the machine provides a detailed report that includes raw images and a processed image highlighting defects that may not be obvious to a human operator. While the human eye can detect visible scratches larger than 80 μm wide on the surface, the Deepsight machine identifies defects as small as 40 μm in width and 3 μm in depth. The report details the number of scratches on the device, the length of the most significant scratch, and the depth of the deepest scratch.

The machine provides out-of-the-box integration with supply chain management systems, where grading data drives downstream processes and the ulti-



The AM81xx servomotors drive the five servo axes for turning and positioning the smart devices, and simplify installation and commissioning with the One Cable Technology (OCT).



The ultra-compact C6015 Industrial PC and various EtherCAT Terminals including the EL7211 servomotor terminals enable an extremely compact control cabinet installation.

mate disposition of the device. Sub-standard smartphones with defects within acceptable ranges will be directed to a buff and polish process. For example, devices with scratches less than 15 μm deep can typically be buffed and polished, resulting in a flawless upgraded device. With its high-accuracy grading data, Deepsight is able to reliably determine whether devices are good candidates for simple refurbishment or need more intensive remanufacturing.

Compact machine design as a goal

As Griffyn wanted to build a sleek, aesthetic-looking machine, they were looking for components that were as compact as possible. According to Griffyn, the compact drive technology from Beckhoff controlling the five servo axes, various EtherCAT Terminals and the ultra-compact C6015 Industrial PC really fit the bill. In addition, the One Cable Technology (OCT) of the drive components provided easy routing and installation. The TwinCAT software with its rich programming library, convenient user interface, and easy engineering and debugging made the design process very user-friendly. Excellent customer support from the local Beckhoff subsidiary facilitated the implementation.

The Deepsight cosmetic grading machine is available as a stand-alone device fed by a human operator or as a "pod" of two to four machines with automatic product feed by a robotic arm. With an inspection cycle of less than a minute, the machine has an output of four inspected devices per minute in the 4-machine pod configuration. Precise motion control technology from Beckhoff helps ensure 95% uptime of the machine with a throughput in the range of 200 devices per hour.

"Team Beckhoff understood our requirements well and gave clear assessment and recommendations of the options available with them for manufacturing Deepsight. We were impressed by the integrity, service, quality, and global customer support," says Mr. Ameya Kandalkar, Director of Griffyn Robotech.

More information:

www.phoenix.tech/griffyn

www.beckhoff.com/measurement

www.beckhoff.com/compact-drives

Sophisticated, highly efficient production line through PC- and EtherCAT-based servo drive technology

Almost 70 servo axes synchronized with high precision in real time

Mitec Enginy, a young and dynamic automation integrator based in northern Spain, says it has developed a sophisticated and powerful production technology masterpiece. The core element is a revolutionary motion control system with a total of 67 servo axes synchronized by camming function. The result is a production line that feeds, cuts, and bends wire, produces springs, and mass-produces the final product – a rat trap – in just 1.5 s. In addition to the servo drive technology, Beckhoff also supplies the required control performance with the CX2062 Embedded PC and TwinCAT software.

© Mitec Enginy

Mitec Enginy has been developing and integrating application-specific automation systems for customers around the world since 2006. In its own words, the engineering company continuously focuses on innovation in the automation of industrial processes, the modernization of a wide variety of machines, and the implementation of comprehensive solutions. Managing Director Albert Gratacos confirms this: "We constantly strive to keep up with the latest technologies in order to offer our customers the most appropriate solutions for their automation problems, and our close cooperation with Beckhoff is one of the most fundamental elements in this regard."

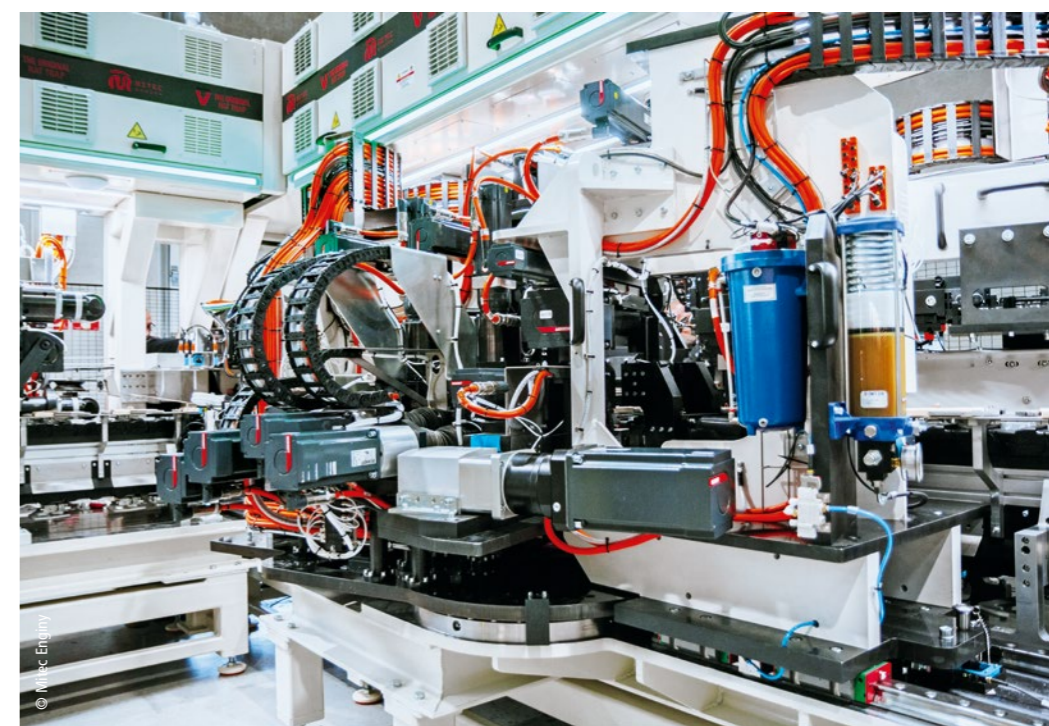
Servo drive technology replaces mechanics

"Looking back at the history of automation, it is essential to appreciate the foundations that are simply taken for granted today," notes Albert Gratacos. He continues, "Eighty years ago, mechanically driven machines were quite common, often powered by a motor and connected by gears, crankshafts, and cams. These inventions still drive our innovations today, yet these machines predate 3D CAD, CNC machining, and software. With today's technology, mechanical machine components are replaced by multi-axis servo movements and controlled more reliably and flexibly by software."

The latest project, the rat trap machine, reflects exactly this, as described by Albert Gratacos: "The customer needed to modernize their product manufacturing to remain competitive, so we devised an appropriate way to do that. At first, the idea of precisely synchronizing around 70 servo axes sounded almost crazy, but it ultimately proved to be the right solution for the complex process sequences, and we were able to implement it using PC-based control from Beckhoff."

A CX2062 Embedded PC serves as the central controller, along with 61 AX51xx and AX52xx servo drives, and 67 AM80xx servomotors. In terms of software, TwinCAT 3 with the camming function (TF5050 TwinCAT 3 NC Camming) ensures precisely synchronized motion sequences. In addition, all necessary safety functions (STO, SOS, SS1, and SS2) are implemented directly in the automation system with TwinSAFE and Safety over EtherCAT. Lluís Moreno, sales engineer at Beckhoff Spain, adds: "This is a very advanced machine featuring the latest automation technology. It is fully equipped with powerful servo drive technology networked via EtherCAT, and can be reliably coordinated with the CX2062 from just one computer."

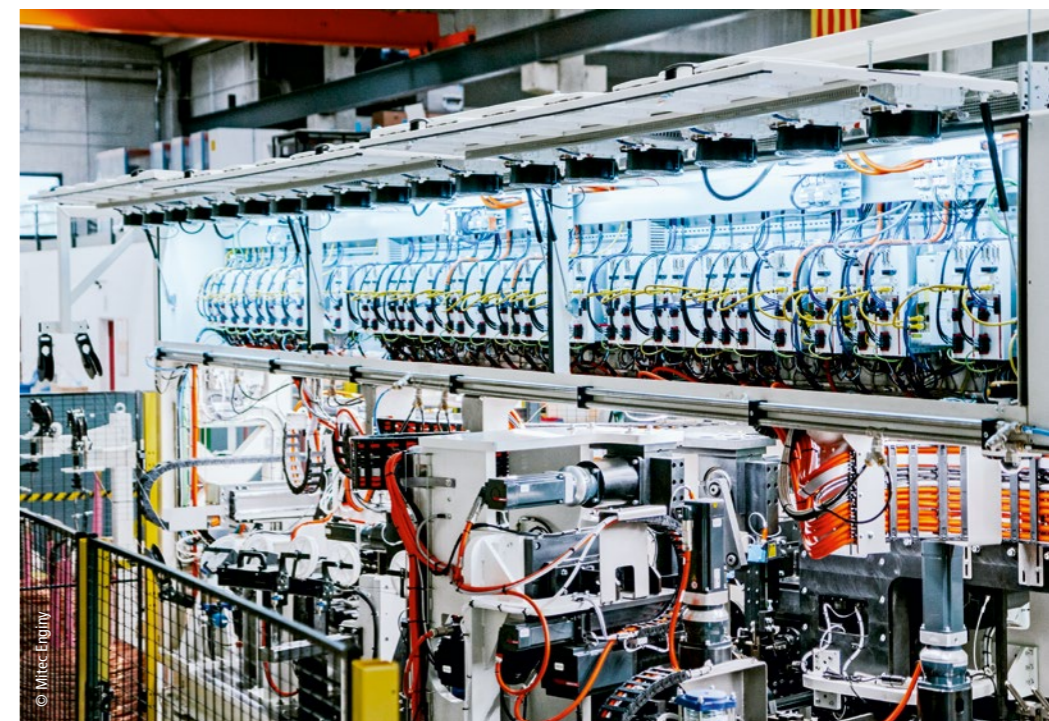
The many dynamic motion sequences are provided by 67 AM8000 series servomotors from Beckhoff.



© Mitec Enginy

A total of 61 Beckhoff AX5000 series servo drives are housed in the control cabinets placed at the head of the production line.

Left: Despite the rather small end product, the rat trap production line is quite impressive in size.



© Mitec Enginy

Complex solutions require a strong team

According to Albert Gratacos, Mitec Enginy's success can also be attributed to the team that has been created to develop complex automation solutions: "We handle all of the mechanical and electrical design, programming, and assembly of the automation in-house. At the same time, we recognize that no one person can be the expert for the entire automation system, which is why we have specialists in mechanics, electrics, and programming working closely together to develop innovative automation solutions. But the team at Mitec Enginy doesn't just stop with our employees; we also consider customers and suppliers like Beckhoff to be project partners and part of the Mitec team."

The importance of intensive and trusting collaboration is also confirmed by Lluís Moreno: "Mitec Enginy is a long-standing partner of Beckhoff Spain, with whom we have already implemented a number of very different and complex customer projects – often in a very special way. But I have to admit

that the current production line is the most efficient and 'beautiful' machine in terms of design so far. Each of the many movements is just so fast, precise, and smooth that no unnecessary stresses are transferred to the mechanics of the machine."

More information:

www.mitec.cat

www.beckhoff.com/motion



New ETG Board of Directors member Dr. Gerhard Grunwald

Newly elected Board of Directors at the EtherCAT Technology Group

6,819 days in office: Prof. Dr. Peter Heidrich was elected in the beginning of 2004 as a member of the Board of Directors at the first Membership Assembly of the EtherCAT Technology Group (ETG) after its foundation and has been confirmed in office eight times since then. After almost 19 years, Prof. Dr. Peter Heidrich did not stand for re-election at the Membership Assembly. The members and the board of the ETG thanked him for his many years of commitment and unanimously elected him an honorary member of the association. In 2004 he was still Director of the Drives Engineering Department at ETG founding member Baumüller, and since 2010 he has also represented the interests of the academic and scientific world on the board of the world's largest fieldbus organization as Professor of Control and Drive Engineering at Pforzheim University: of the nearly 7,000 members, more than 300 are universities and colleges, and many research institutes and large-scale research facilities are also active in the ETG.

The new board was also elected without dissenting votes: Dr. Gerhard Grunwald. However, the "new guy" is anything but new: In November 2003, he was the very first to sign the membership application for the newly founded ETG, thus making DLR member number 1! Dr. Gerhard Grunwald has been with the Institute of Robotics and Mechatronics of the German Aerospace Center (DLR) in Oberpfaffenhofen-Weßling since 1988 and has since coordinated many national and international research projects. From 2003 to 2005, he set out with his team and project partners to investigate performant communication systems for robot and space applications as part of the "PAPAS" project. The initial expectation was not to find anything suitable and to continue developing the appropriate system for each project: but EtherCAT exceeded expectations and has since proven to be the system of choice for virtually all subsequent projects. Dr. Gerhard Grunwald has been DLRs Responsible Coordinator Orbital Robotics since 2012 and actively contributes to the dissemination of EtherCAT in space projects as co-author of several ETG publications. As a representative of one of the largest research institutions in Germany, his involvement in the ETG board seamlessly follows that of Prof. Dr. Peter Heidrich.

The Membership Assembly also confirmed unanimously Dmitry Dzilno from ETG founding member Applied Materials in Santa Clara and Martin Rostan from Beckhoff Automation in office in the Board of Directors of the ETG.

Prof. Dr. Peter Heidrich (left) and Martin Rostan (right) at the ETG Membership Assembly 2022



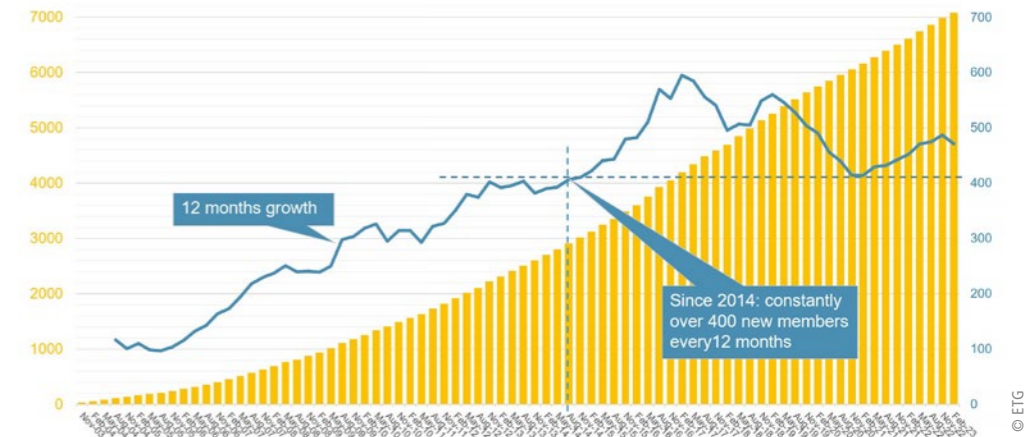
EtherCAT Technology Group now over 7,000 members

There could be no better way to celebrate the 20th anniversary of EtherCAT than with the continued membership growth of the EtherCAT Technology Group (ETG). Recently the organization exceeded the 7,000 mark for member companies. And with more than 400 new members every year since 2014, the ETG is not only by far the largest fieldbus organization, but also the fastest growing. About two-thirds of the member companies are manufacturers of EtherCAT devices, plus end users and universities: according to the statutes, individuals can only be accepted as honorary members. So far there are three honorary members: long-time board members Erich Hutflesz and Prof. Dr. Peter Heidrich, as well as Hans Beckhoff with membership number 4242. When looking at the worldwide distribution of ETG member companies, the high concentration in Asia

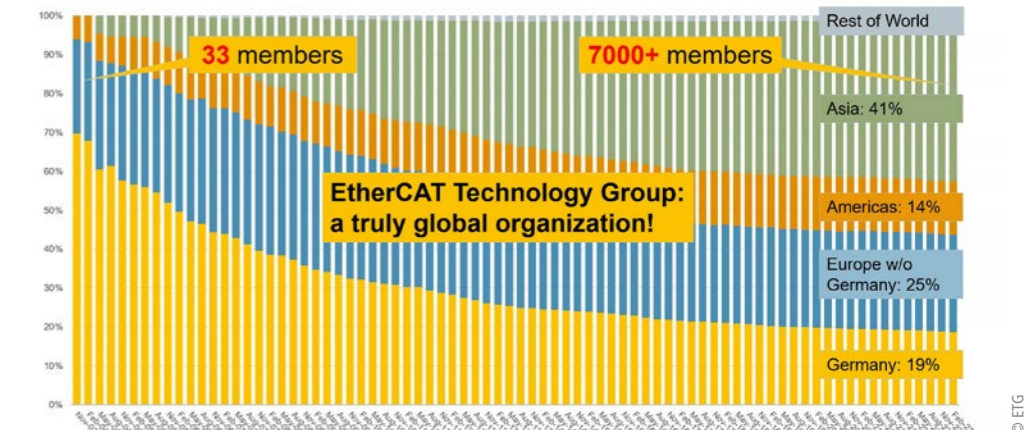
is particularly striking. More than 2,500 members are in China, Taiwan, Japan or Korea. In total, over 40% of members are from Asia. These figures show that the EtherCAT technology has fully arrived and also been broadly accepted on the Asian continent. The number of countries with ETG members also continues to increase: recently ETG welcomed companies from Cyprus, Saudi Arabia and Oman. Thus, ETG now has members from 72 countries. Another milestone in ETG's success story: last year, membership in Europe alone exceeded 3,000. This continued membership development reflects the spread and worldwide success of the EtherCAT technology. It is largely due to the quality of the EtherCAT technology itself, but also to the comprehensive support and information offered by the ETG, to which the members have unlimited access.



Development of ETG members



Worldwide distribution of ETG members



More information:
www.ethercat.org



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