BECKHOFF New Automation Technology

Scalable and powerful: The open CNC solution for machine tools



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PC-based control integrates all CNC functions on a single platform

The productivity and efficiency of machine tools can be significantly increased using powerful PC-based control solutions from Beckhoff. Based on standard components, the hardware and software platform integrates all automation and CNC functionalities in one system. The platform is scalable for all performance classes and is universally suited to all types of machines. Since every function is mapped in software, new machine features can be easily retrofitted, and functions for intelligent production approaches are relatively simple to integrate. Open interfaces permit simple integration with existing systems and fieldbuses as well as flexible exchange of hardware components. At the same time, machine tool manufacturers benefit from a maximum degree of freedom in machine design. With long-standing and comprehensive expertise in machine tool technology, we can guarantee performance-matched, industry-specific control solutions.

We understand that flexible processing, high speed, highest surface quality, energy efficiency and condition monitoring are among the most important engineering requirements in modern machine tool manufacturing. Regardless of whether the machine is designed for metal cutting, highly automated sheet metal working, the manufacture of high-precision surfaces in medical technology or next-generation additive manufacturing, the PC-based control solution from Beckhoff is universally applicable and harnesses the full potential of machine performance. As a scalable, powerful and open PC Control platform it also offers maximum flexibility to realize customer-specific solutions and specialized machines: Customers get tailor-made controllers for their machine tools that are actually cost-effective.

▶ www.beckhoff.com/machine-tools

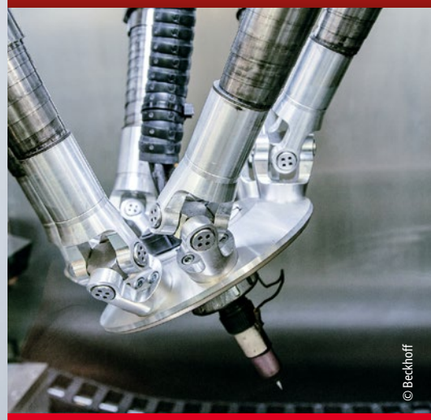




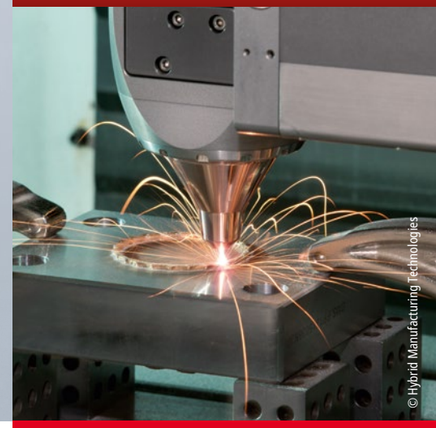
Milling, turning, grinding



Electric discharge machining



Forming, cutting, joining

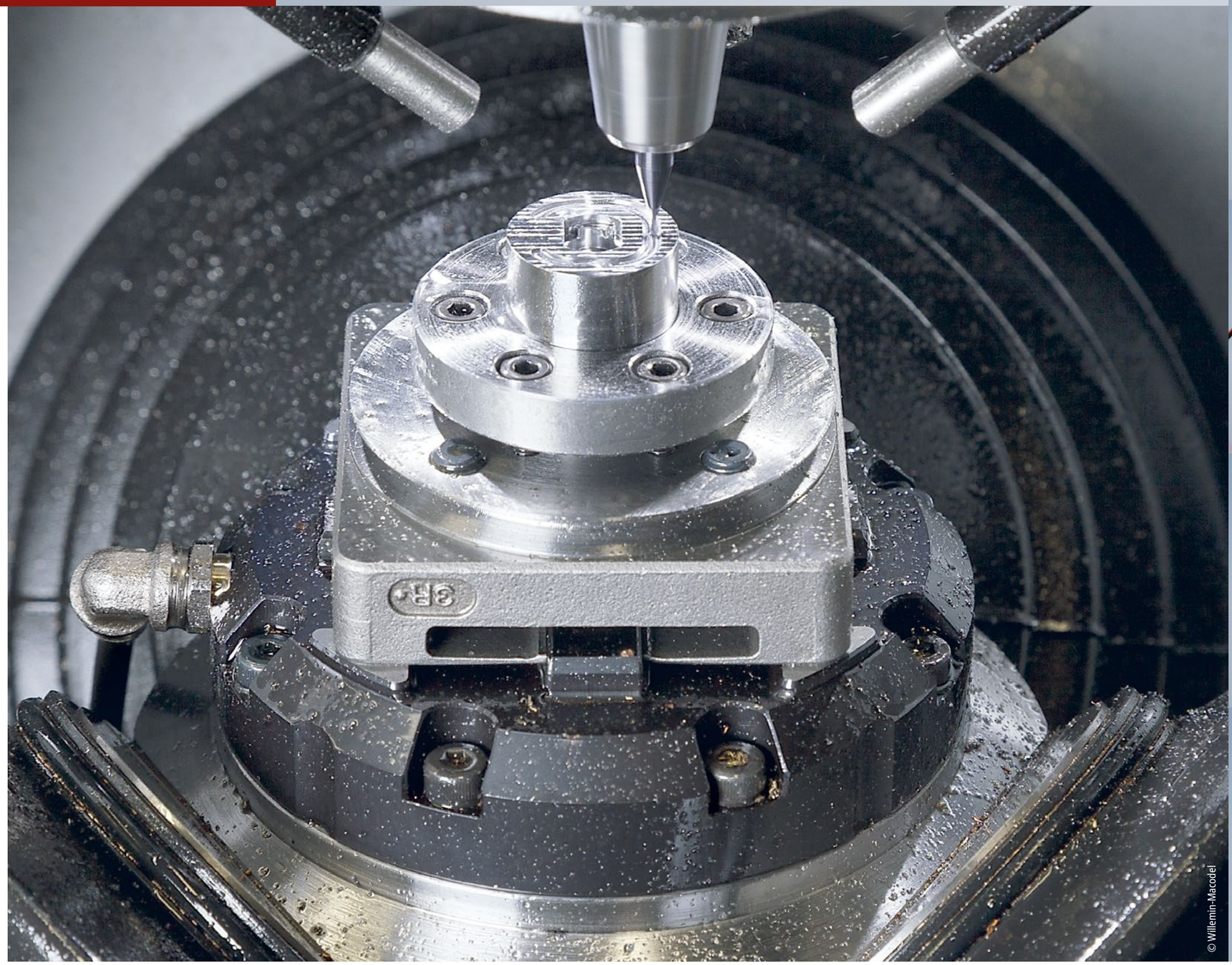


Additive manufacturing

Highly scalable: The control solution for all machines and applications

Beckhoff supplies open and scalable control solutions in all performance categories and formats for machine tools: from compact embedded PCs with direct I/O connection, up to high-end industrial PCs with multi-core processors. A large selection of multi-touch panels guarantees an industrialized version of the convenience found in consumer technology advances on the machine. Around 1000 I/Os for more than 100 signal types serve the entire range of sensors and actuators. A universal safety concept is available in TwinSAFE, which integrates safety functionalities into the standard control platform. The drive technology product portfolio extends from space-saving servo terminals to powerful EtherCAT Drives and highly dynamic servomotors with One Cable Technology. The core of the Beckhoff solution is TwinCAT software, the universal engineering and control platform.

We meet the challenging requirements for market-driven machine tool concepts with open, modular software and hardware control solutions, which are scalable in terms of computing power, complexity and costs. As if from a fully loaded toolbox, you can assemble a control solution that ideally suits the machine type and dimension it in accordance with specific performance requirements. If desired, services and applications can be outsourced to a private or public cloud. The modularity of the PC-based control system and its openness via a wide range of supported fieldbus systems and communication protocols also enables step-by-step system migration and the extension of existing machines and equipment.



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Control panels: Multi-touch displays and control panels



Industrial PCs: Control cabinet and panel PCs



Embedded PCs: IPCs with integrated I/O level



EtherCAT I/Os: Broad I/O spectrum in IP20 and IP67



Distributed servo drives



Servo terminals: Compact drive technology



Compact servo drives



TwinCAT: Software for engineering and runtime



TwinSAFE: Integrated safety solution



EtherCAT P: One Cable Automation for the field level

TwinCAT: The integrated engineering and control platform

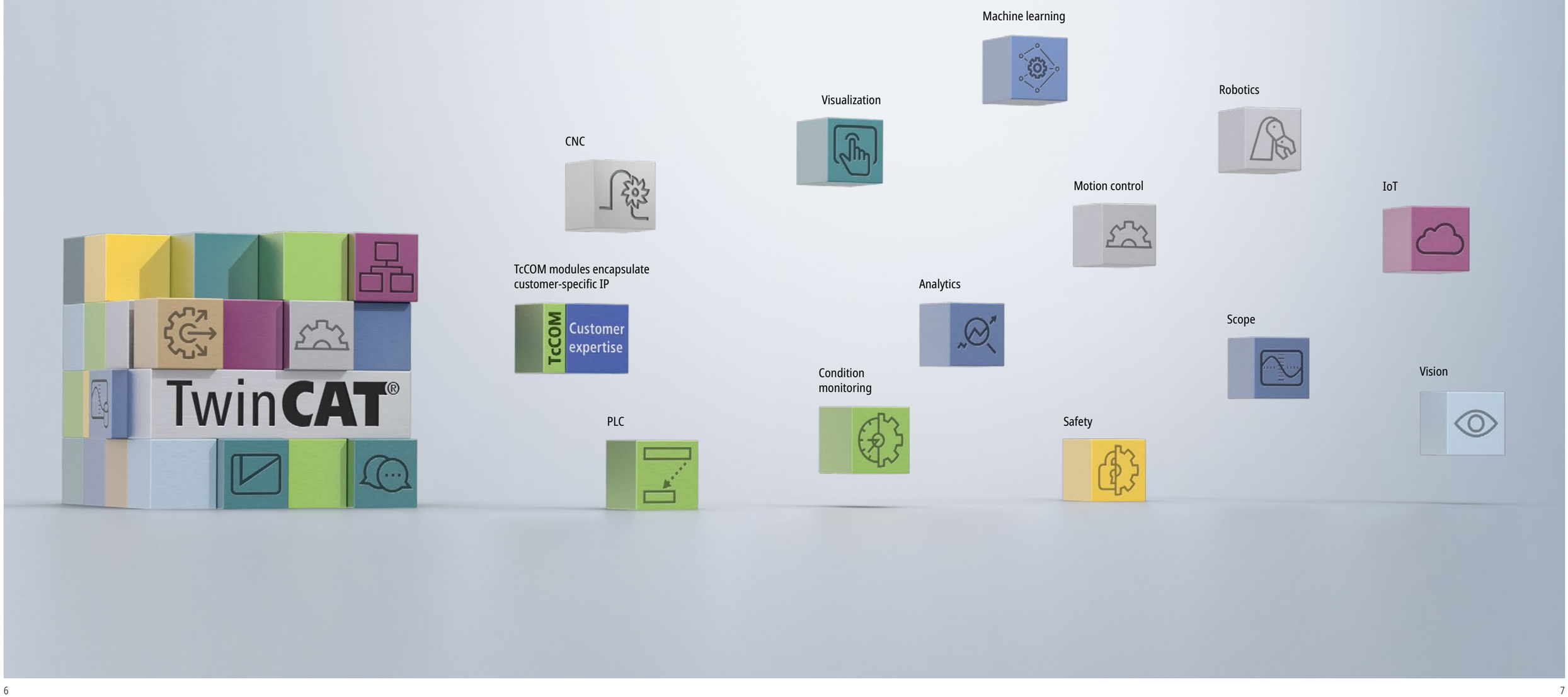
TwinCAT automation software consists of a runtime system for the real-time execution of PLC, HMI, NC, CNC and robotic applications and is at the same time the development environment for programming, diagnostics and configuration. All main IEC 61131-3 programming languages are available for real-time applications. C/C++, MATLAB® and Simulink® modules can be integrated into the IEC context via existing interfaces or operated independently in the TwinCAT 3 real-time environment. Moreover, open interfaces and support of the latest technological standards through current Windows operating systems open up a wide range of options, such as integration with existing visualization, control and database systems.

The engineering suite in TwinCAT offers a tool chain that is optimized for machine design in which all control applications, including HMI, IoT communication and analytics, can be implemented. Multi-core and many-core control technologies are fully supported by TwinCAT so that the above functions can be implemented alongside all other machine control elements. The object-oriented extensions of the IEC 61131-3 standard enable modular programming of code, the encapsulation of machine functions in software and, in conjunction, improved code structuring, simpler maintenance, reusability and expandability of the software. Extensive software function blocks and libraries for industry-specific applications facilitate efficient engineering and implementation of machine functions. The TwinCAT Automation Interface supports you in the automatic generation of advanced machine configurations.

▶ **www.beckhoff.com/twincat**



TwinCAT CoAgent now opens up a new world of potential for the automation environment with AI.



Technological highlights for optimized machine tools

With PC-based control we offer a modular automation toolkit full of components that are precisely scalable in terms of performance: TwinCAT, the all-in-one CNC solution, maps all CNC functions in a single software platform. Applications such as predictive maintenance can be implemented through the integration of advanced measurement technology and cloud services into the control system/platform. TwinCAT TcCOM provides effective IP protection. Our highly scalable drive technology portfolio permits the implementation of cost-effective, performance-matched motion control solutions. The complete Beckhoff I/O toolkit not only supports all common fieldbuses and signals, it also offers a particularly efficient wiring solution for large-scale series production with the EJ plug-in I/O modules. Control panels with specific operating elements for machine tool applications guarantee solutions that meet individual requirements. Machine manufacturers and users can consistently strengthen their competitive advantage by leveraging each of these technological highlights.

On the basis of the scalable and open PC Control platform from Beckhoff, machine manufacturers can develop attractively priced control solutions, because only the performance required for the application in question needs to be purchased. At the same time, the PC- and EtherCAT-based control system optimizes all crucial production parameters: Short cycle times enable ultra-fast processing as well as quick tool and workpiece changes, increasing machine productivity and throughput. State-of-the-art control algorithms significantly improve the precision of workpiece machining while increasing process quality. The simple and secure integration of customer-developed functions via TcCOM modules allows you to securely integrate core expertise into the open controller. Standard programming tools are used for this, enabling a fast learning curve and development process. Enhanced availability and investment protection are other benefits which immediately increase the competitiveness of both machine builders and end users.

▶ www.beckhoff.com/machine-tools

TwinCAT:
The all-in-one CNC



Integrated IP protection through TwinCAT TcCOM



Integrated cloud connection and IoT functions



Highly scalable and powerful industrial PCs





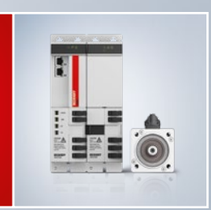
Customer- and industry-specific control panels



Comprehensive and modular I/O portfolio



Highly scalable drive technology



Control cabinet-free automation with the MX-System



The all-in-one CNC: From basic to high performance

TwinCAT NC Interpolation (NC I) is the CNC system for interpolated path movements and robotics that replaces conventional axis modules. CNC applications can be implemented for the most diverse processing machines through direct integration of the TwinCAT PLC and TwinCAT motion control functions. Powerful software libraries for various robot kinematics supplement TwinCAT NC I for various assembly and manipulation functions. All well-known fieldbus systems and programming standards in the CNC world, such as DIN 66025, are supported. TwinCAT NC I uses the processing power of current PC technologies to enable high-performance axis control under Windows.

TwinCAT CNC provides extensive CNC functionality as a pure software solution running on standard PC hardware. TwinCAT CNC covers the complete range of classic CNC path control, including high-end systems for complex motion and kinematics requirements. Up to 128 interpolated axes with up to 32 channels as well as a wide range of coordinate and kinematic transformations can be controlled. The necessary axis and spindle functions, interpolation and feeding functions, tool and help functions as well as cycle programming with specific extensions are available for all kinds of machining technologies (milling, turning, grinding, electric discharge machining, forming, cutting, additive manufacturing and specialized machines).

▶ **www.beckhoff.com/cnc**

Attractively priced entry-level software solution: TwinCAT NC I

For complex machines: powerful, scalable TwinCAT CNC software

Up to 32 channels

Control up to 128 axes with multi-core support (of which 32 axes can be interpolated simultaneously)



Picometre interpolation (control resolution of 10 pm)

CNC features:

- fast cycle times
- high-speed cutting
- Kinematic Transformation
- technology packages
- 3/5-axis machining with TCP
- volumetric compensation
- cycle programming
- calibration and measurement functions
- spline functionality

Integration of customer-specific process expertise into the CNC software in hard real-time through TcCOM

TwinCAT TcCom: Integrate your existing process knowledge with ease

TwinCAT 3 provides a modular automation toolbox that is simple and cost-effective to extend. The TcCOM concept is a "Component Object Model" similar to the well-known Microsoft COM technology, but is adapted for use in a real-time context. Custom technology building blocks can be securely and flexibly supplemented and coupled directly to the Beckhoff components via TcCOM. This offers the option to choose the programming language best suited for the task at hand. The modules can offer and use proprietary methods, defined in interfaces. Therefore a method in a module that was implemented, for example, in C++, MATLAB® or Simulink®, can be called up directly from another module, such as a PLC.

TcCOM offers an open interface with which you can integrate your own proprietary process knowledge and special self-developed functionalities into a standard control platform. The great advantage of this is that the core competences remain entirely in your hands and are protected against third parties. Modifications and adaptations can be carried out quickly and conveniently. The software written in-house can be licensed securely for the machine with industrially compatible hardware dongles. The configuration takes place in TwinCAT Engineering, while the TwinCAT Runtime validates licences in real-time. This enables effective and reliable protection of the software and the customer's IP respectively.

▶ www.beckhoff.com/twincat3



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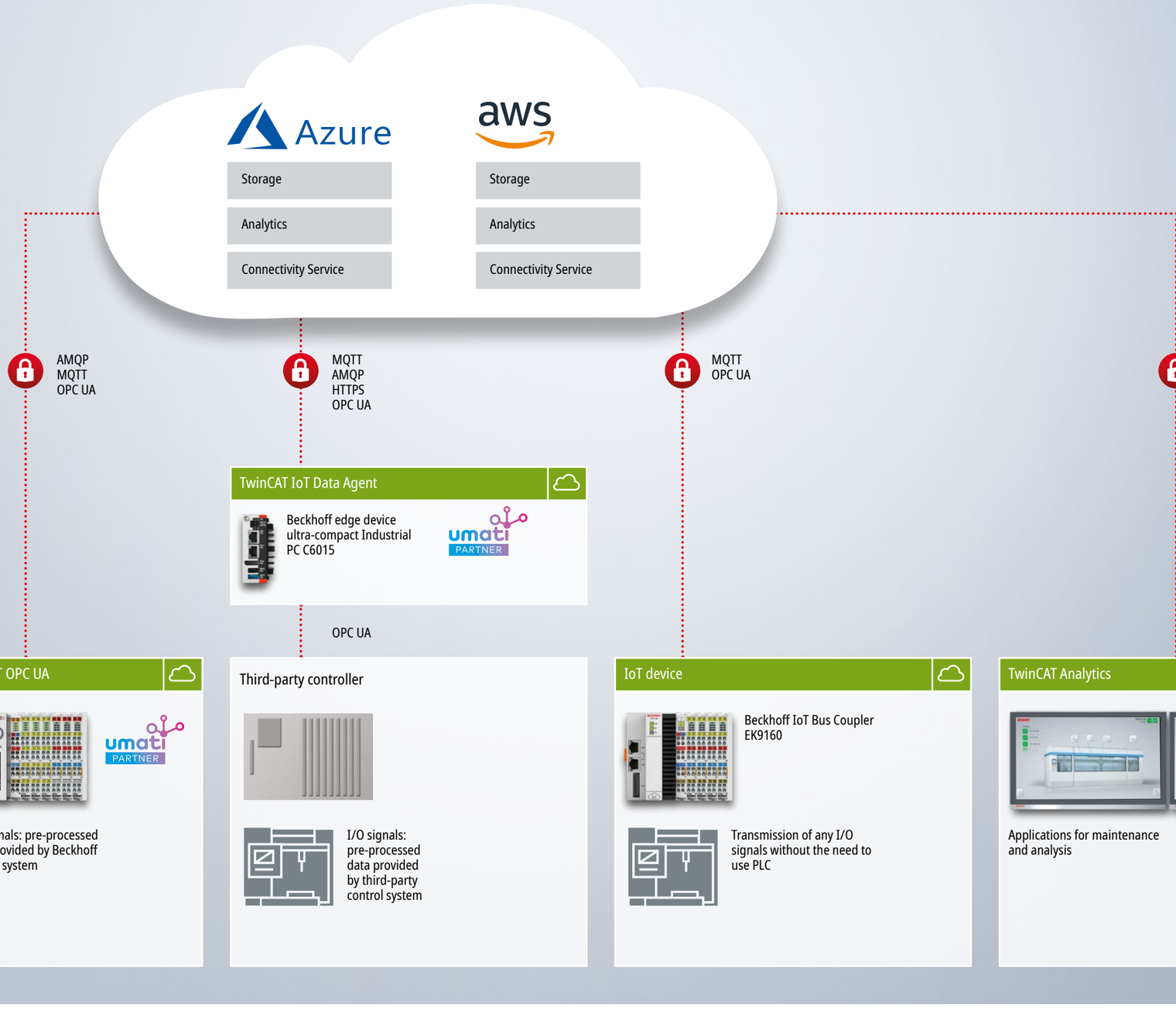
Industrie 4.0 for machine tools

Beckhoff has developed the TwinCAT IoT software library for system-integrated communication between machine controllers and cloud-based services. It supports the standardized protocols OPC UA, AMQP and MQTT for communication with common cloud systems, such as Microsoft Azure, Amazon Web Services and as well as for private cloud systems in a company's own network. Built-in security mechanisms prevent the misuse of data through unauthorized access, further protecting your company's intellectual property.

Via TwinCAT Analytics process data are seamlessly logged and analyzed synchronously with the machine cycle to be used for applications such as predictive maintenance and machine optimization, among other enhancements. Using appropriate analysis tools, all necessary information can be derived from the stored data in order to optimize the machine in terms of energy efficiency or the process workflow. Post-mortem analyses, the diagnosis of sporadic errors, early detection of quality losses and recognition of production bottlenecks help increase plant reliability and availability. The data analysis also provides extensive information about the operational performance of your machines, which can be used in future designs and manufacturing processes to reduce costs and achieve ideal machine layouts.

TwinCAT Cloud Engineering enables the instantiation and use of existing TwinCAT engineering and runtime products directly in the cloud. Easy access is provided via the Beckhoff website: As a registered user, you also have the option here to create TwinCAT Cloud Engineering instances. The physical control hardware is linked to the TwinCAT Cloud Engineering instance via a secure transport channel. This gives you access to all benefits of the TwinCAT architecture directly in the cloud, making it much easier for multiple developers to work together, to name just one of the advantages.

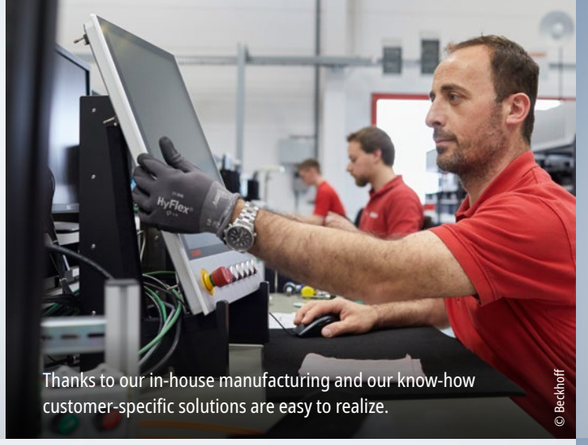
▶ **www.beckhoff.com/twincat-industrie40**



Robust panels and panel PCs with customer-specific designs

In addition to an extensive range of standard panels, we also offer control panels and panel PCs in customized designs. Customer-specific adaptations conforming to machine tool and CNC standards, such as key extensions and specific operating elements, enable ergonomic designs that are tailored precisely to the specific application, promoting optimized and intuitive machine operation. Customized control panels give the machine an easily recognizable visual appearance through an individualized housing design. This can include a company logo, a customer-specific membrane keyboard, and on up to customized housing construction and colour schemes according to your branding standards. Moreover, different interfaces from the control panel to the IPC enable a free choice in terms of connectivity, further increasing flexibility in production as a result.

▶ **www.beckhoff.com/customer-specific-ipcs**



Thanks to our in-house manufacturing and our know-how customer-specific solutions are easy to realize.

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Your label



Your configuration



Your features



Your corporate design



Safety, explosion protection, measurement technology: Integrated with EtherCAT

With around 1000 I/Os for more than 100 signal types, Beckhoff offers an extensive modular automation toolkit with fieldbus components for all common I/Os and bus systems. You can flexibly assemble the ideal components for your control architecture – of course, with the option for future functional expansions. An extensive range of I/O housing formats, a variety of channel densities and flexible interfaces ensure that the ideal product is available for every application scenario.

In addition to standard functionalities, our I/O portfolio includes products for specialized applications, such as safety technology, explosion protection, measurement technology and the control of small motors via drive technology. Communication and power measurement terminals for charging infrastructure are also available. By combining a wide variety of I/O components, all control tasks can be centrally integrated on one platform. This significantly reduces the complexity of your control system – and what's more, a complete solution can deliver considerable advantages in terms of efficiency when compared to stand-alone solutions.

The I/Os are connected as standard via the high-speed EtherCAT fieldbus developed by Beckhoff. With outstanding performance, flexible topology selection, comprehensive diagnostics and simple configuration, EtherCAT is the fastest bus system on the market and ideally suited for use in automotive production facilities. With EtherCAT, telegrams are transmitted without prioritization; no switch technology is required. The one cable solution EtherCAT P, which combines communication and power supply in one cable, reduces the cabling effort and enables control cabinet-free machine concepts. For machine mountable installation, EtherCAT Box modules are available in an IP67 design – including in highly robust stainless steel or zinc die-cast housings for welding applications.

A large number of EtherCAT-compatible sensors and actuators are available due to EtherCAT's high level of acceptance on the market. However, our control technology is also open with regard to the integration of other fieldbus systems. Support for common communication protocols, such as CANopen, IO-Link, PROFINET or Modbus, gives you maximum freedom in control design, even when it comes to retrofits or conversions of existing systems.



Fieldbus couplers

Connection of sensors and actuators – via EtherCAT or any other common communication protocols

Safety

Integration of functional safety into the control system with TwinSAFE

Measurement technology

ELM modules in metal housings for precision and high-speed measurement technology

Explosion protection

Highly compact I/O modules with integrated safety barriers for the direct connection of intrinsically safe field devices

Highly scalable drive technology for all motion-related tasks

Our wide range of scalable drive technology components enables perfectly tailored solutions for drive concepts in all price and performance classes. The motion control solutions in TwinCAT automation software are complemented by an extensive range of servomotors and drive controllers, ranging from compact servo drives in I/O terminal format through to powerful servo drives for highly dynamic positioning tasks. For example, the integrated and high-performance control technology used in the AX8000 multi-axis servo system is ideally suited for robotic and material handling tasks to dynamically coordinate and position numerous axes. The servomotors are connected using space-saving One Cable Technology, which combines the motor power and feedback lines in a single cable. With the option of integrated safety technology, our drive portfolio meets strict machine safety requirements and therefore makes it easier to configure control systems.

Decentralized servo drive systems, such as the AMP8000 and AMI8100, in conjunction with the EtherCAT P one cable solution, are breaking new ground in modular, cabinetless machine concepts. The integration of the servo drive into the servomotor enables mounting directly on the machine. This reduces machine footprint and the complexity of your system, and leads to significant savings in materials, cost and control cabinet space requirements.

Our product range is complemented by intelligent and flexible transport systems. The XTS linear transport system and the XPlanar planar motor system replace rigidly timed product transport systems and pave the way for new agile machine concepts. Offering maximum speed and flexibility, they create a clear advantage in global competition. The space-saving design of these technologies reduces your machine footprint. What's more, there are no limits to the innovation you can bring to your machine and production designs.



TwinCAT 3 Autotuning
Autotuning represents the simple commissioning and optimization of servo axes in machines. At the push of a button, the servo drive determines all essential parameters of the application within seconds. TwinCAT 3 Autotuning simplifies the commissioning of servo axes through automated interpretation of stability criteria and characteristics, especially for phase and amplitude.

ATRO®

XTS®



Drive technology

Compact drive technology

Linear motor

XPlanar®

MX-System: For control cabinet-free automation

The MX-System opens up completely control cabinet-free automation solutions. Combining various baseplates and function modules (IPC, coupler, I/O, drive, relay, and system modules), the modular system encompasses all the functions and properties of a control cabinet: power supply, fuse protection and power distribution, generation and monitoring of auxiliary voltages, sequence control with inputs and outputs, control of motors and actuators, and the connection level for the field devices. The internationally certified assemblies reduce the work required for planning, assembly, machine installation, and maintenance.

The advantages of the MX-System at a glance:

- more floor space in production due to the elimination of control cabinets
- IP67 housing to facilitate use in all areas
- increased efficiency in machine manufacturing due to reduced engineering, assembly, and testing work
- combinable with EtherCAT Box modules and an AMP8000 distributed servo drive system
- integrated safety functionalities for drives and I/Os via FSoE (FailSafe over EtherCAT)
- significantly less work and time for planning and assembly

MX-System®





PC-based control: The scalable, application-oriented CNC solution

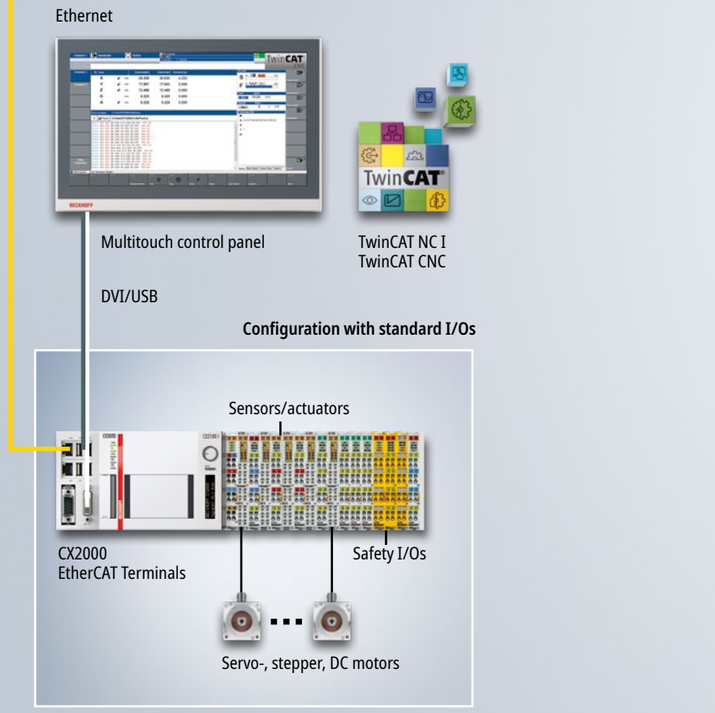
Example configuration for a compact metalworking machine

- DIN rail-mounted embedded PCs from the CX2000 and CX5100 series with integrated EtherCAT interface, plus optional communication and fieldbus interfaces
- control panel with DVI/USB interface for remote installation in up to 50 m, extensive range of products as well as industry and customer-specific solutions
- TwinCAT NC I/CNC software solutions with integrated TwinCAT PLC and IEC 61131-3 programming; TwinCAT NC PTP with extensive motion control functionality
- EtherCAT system with high performance, flexible topology and modular structure is suitable for all I/O and drive applications.
- eXtreme Fast Control (XFC) and condition monitoring functions can be integrated via EtherCAT Terminals.
- Drive technology up to 8 A directly in bus terminal format for stepper motors, DC motors and servomotors. The AX5000/8000 Servo Drive series is designed for higher power.
- As an integrated component of the modular I/O and TwinCAT systems, TwinSAFE makes safety technology universally available.

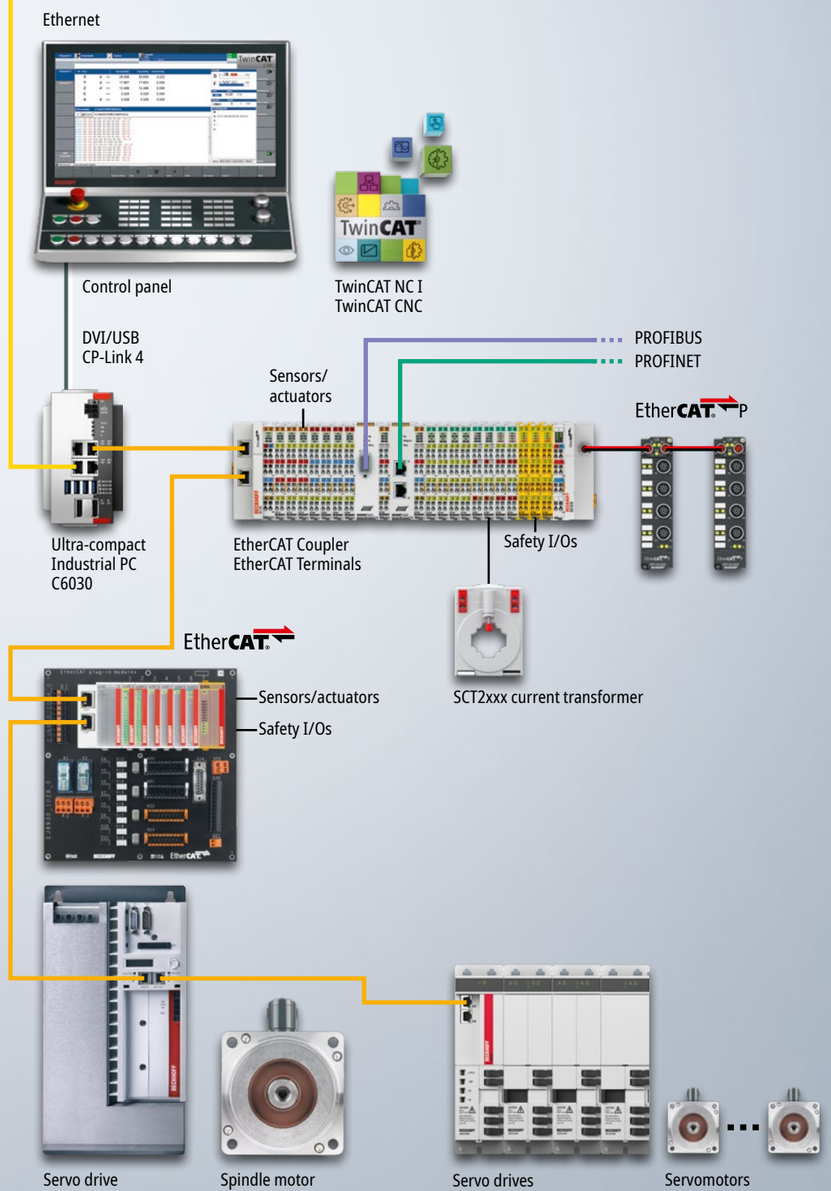
Example configuration for a complex metalworking machine

- TwinCAT NC I/CNC solutions with integrated TwinCAT PLC and IEC 61131-3 programming; TwinCAT NC PTP with extensive motion control functionality.
- industrial PCs with multi-core processors, integrated EtherCAT interface, optional communication and fieldbus interfaces, and extensive option list
- control panel with DVI/USB interface for remote installation in up to 50 m or with CP-Link 4 for distances up to 100 m from the PC; extensive range of standard products as well as industry and customer-specific solutions
- EtherCAT system with high performance, flexible topology, modular structure and simple configuration, is suitable for all I/O and drive applications. Implementation of XFC and condition monitoring functions via standard EtherCAT terminals. Master/slave gateway terminals ensure openness to other fieldbus technologies.
- Highly dynamic, fast motion control system with servo drives for synchronous servo and linear motors up to 118 kW, with spindle functionality
- As an integrated component of the modular I/O and TwinCAT systems, TwinSAFE is universally available to all control systems.
- Drive-integrated TwinSAFE functions enable the implementation of numerous safety functions in a simple way.

Compact metalworking machine



Complex metalworking machine



Our references



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GROB-WERKE, Germany

Open PC-based control and drive technology for additive manufacturing

▶ **www.grobgroup.com**

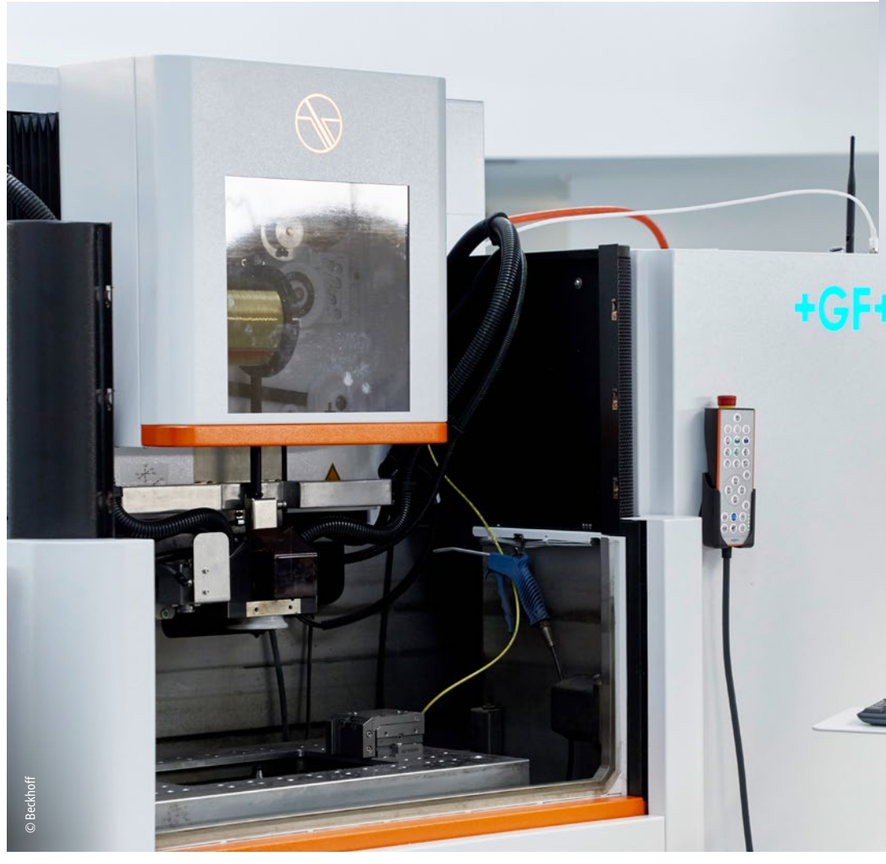


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Rampf and Feldmann, Germany

TwinCAT HMI enhances operator interface for dispensing systems and robots.

▶ **www.rampf-group.com**
▶ **www.feldmannmediagroup.com**



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GF Machining Solutions, Switzerland

TwinCAT as powerful CNC solution for wire EDM machines improves flexibility and integrates intellectual property protection.

▶ **www.gfms.com**



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Power-Tech, Eagle Group, Poland

High-tech laser cutters rely on a powerful IPC platform and EtherCAT for maximized precision and speed.

▶ **www.eagle-group.eu**

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