BECKHOFF New Automation Technology
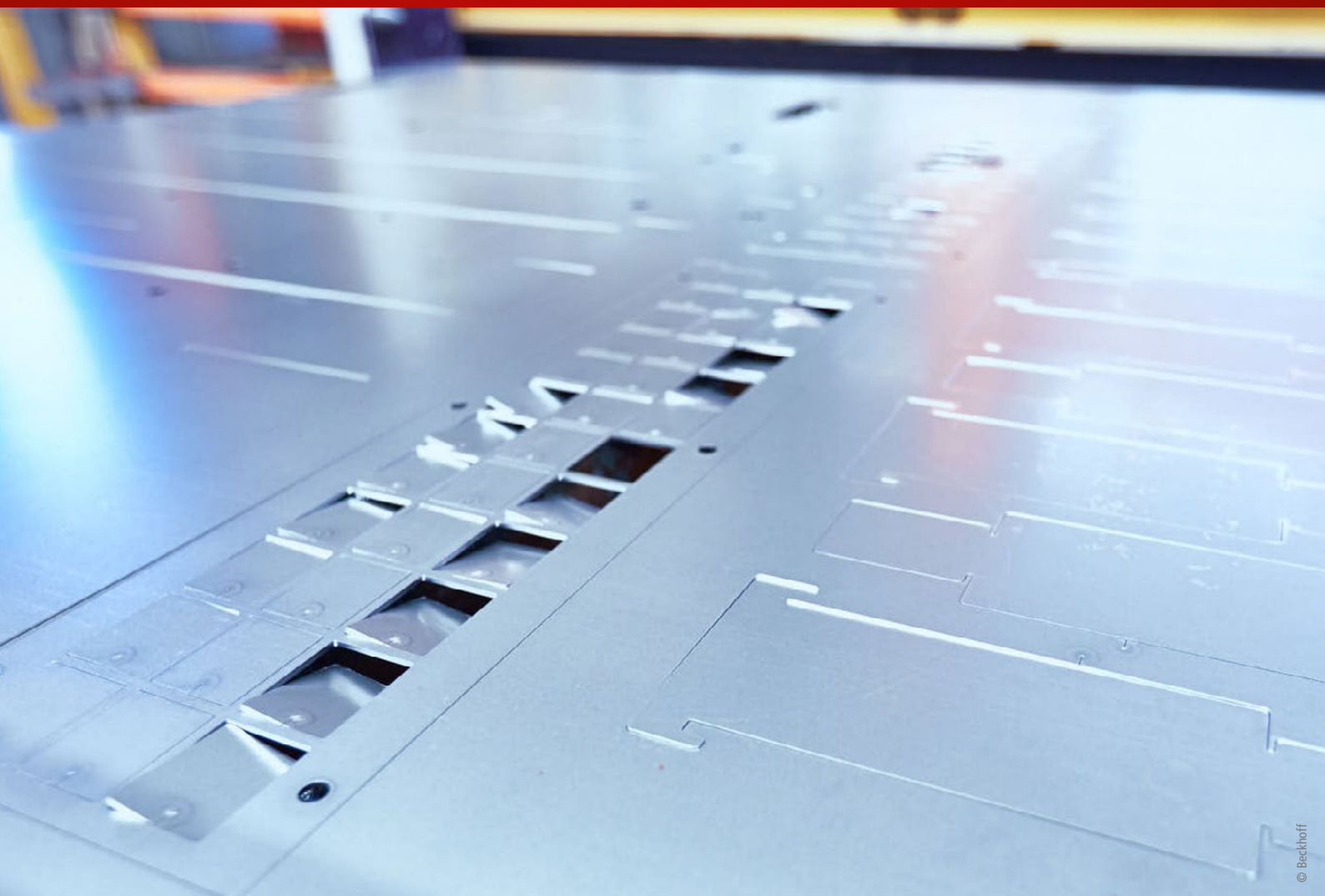
High performance built in:
PC-based control for sheet metal working

The Beckhoff solution for all control and drive tasks in sheet metal working

As a specialist in PC-based control technology, we can provide you with a universal control platform for all processes in sheet metal working. Our high-performance industrial PCs, a comprehensive I/O portfolio, the ultra-fast EtherCAT fieldbus, as well as dynamic servo drive technology and the TwinCAT automation software form an integrated automation platform for every task: from presses to cutting and welding, punching and nibbling through to bending. Modular in structure and precisely scalable to meet the performance requirements of specific applications, PC-based control is suitable for the entire range of requirements –

from a single machine to interconnected machine lines. Since all functions are consistently consolidated into software that runs on the industrial PC, only one CPU is required for PLC, visualization, motion control, robotics, machine safety, measurement technology and condition monitoring.

The high degree of integration and speed of our control solution consistently lead to process optimization and cost benefits. The reduced control complexity associated with a reduction in the number of components ensures greater reliability and simplified maintenance of machines and plants. Specific benefits are also offered for

the different areas of sheet metal working, with EtherCAT and EtherCAT P, in particular, ensuring your competitive edge in press lines. We offer a wide range of CNC functions for cutting and welding machines. Special applications for punching and nibbling are supported by fast signal processing based on EtherCAT, while ready-made function blocks are available to you with the TwinCAT Hydraulic Positioning software library.

▶ **www.beckhoff.com/sheetmetalworking**

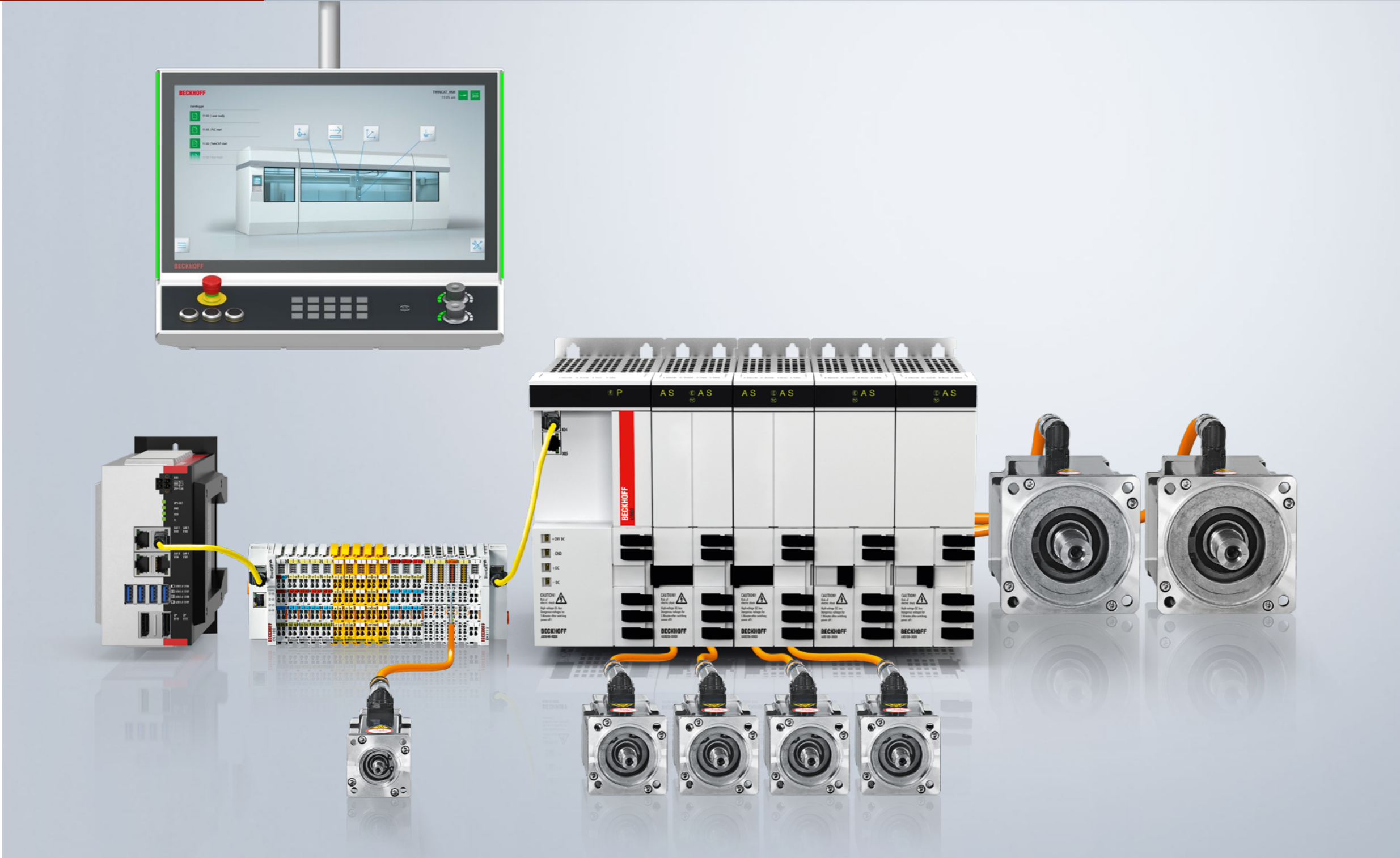Pressing, pages 4 to 5 and 22

Cutting and welding, page 23

Punching and nibbling, page 24

Bending, page 25

PC-based control offers integrated process optimization and cost savings

PC-based control allows central control of all processes along the entire press line. Industrial PCs with the latest generation of high-performance processors, TwinCAT, the software for engineering and real-time control, and EtherCAT, the high-speed fieldbus, together provide the foundation for our high-performance control solution. This solution allows you to increase the control accuracy, speed and precision of your press plant significantly.

With numerous hardware and software interfaces, our open, standards-based control architecture offers you a high degree of flexibility. This means that you can integrate a variety of different devices – even from third-party vendors – and implement your customers' needs flexibly and cost-efficiently. In addition, support for all common fieldbus systems and software protocols guarantees end-to-end horizontal and vertical communication: starting with connectivity between individual machines through to the IT level and the cloud.

In addition, you can increase the productivity of your plant using the TwinCAT Analytics data analysis software tool: Comprehensive condition monitoring enables predictive maintenance and reduces downtime. In combination with direct cloud connectivity, it is possible not only to realize Industrie 4.0 solutions, but also to optimize all process steps right through to product handling. Improved deep drawing with minimized tolerances, increased workpiece quality, reduced reject rates, maximum synchronization precision and increased output all ensure clear competitive advantages. The consistency of the PC-based control solution guarantees efficient interaction between all components and ensures maximum transparency. This helps to avoid data incompatibility and latencies, such as those that occur in communication between different systems. As a user, you benefit not only from synchronization and optimization of the individual processes, but also from cost advantages gained by reduced hardware and engineering requirements.

TwinCAT Vision: position detection of components in real time for optimized feed-in

TwinCAT Motion Control: highly dynamic regulation of servo drive technology

TwinCAT IoT: exchange of data between machines with low overhead

IPC: high-performance industrial PCs for controlling plant sections with minimum cycle times

TwinCAT Condition Monitoring: monitoring of process data and predictive maintenance

TwinCAT Analytics: recording and analysis of all relevant machine data

Scalable and modular: The Beckhoff hardware and software platform

With our open, precisely scalable and modular control technology, we meet the requirements of the sheet metal working industry for needs-based and cost-efficient solutions. You can assemble the ideal control solution in a modular way to suit your machine or plant type according to performance, price and design. A wide-ranging portfolio of industrial PCs as well as control panels and displays in all performance categories and form factors are available. EtherCAT, the global standard for real-time communication, offers maximum performance for all devices, including those from third-party providers. The comprehensive Beckhoff I/O system in IP20 and IP67 covers a broad range of sensors and actuators with more than 100 signal types and supports interfaces to different fieldbus systems. TwinSAFE provides an integrated safety solution for I/O and motion control applications. Our portfolio of drive technology products ranges from compact servo terminals and distributed servo drive systems with integrated servo amplifiers to high-performance EtherCAT drives and servomotors with One Cable Technology (OCT). The drive technology portfolio is rounded off by the intelligent XTS and XPlanar transport solutions that empower you to realize novel and space-saving machine concepts. TwinCAT automation software from Beckhoff integrates the engineering environment and the machine controller into a universal software platform.

Our modular automation concept is backed by comprehensive industry know-how and specific process expertise in all areas of sheet metal working, which has been developed over decades of collaboration with customers. Together with our innovative product developments, they form the basis for control solutions that offer investment security well into the future.
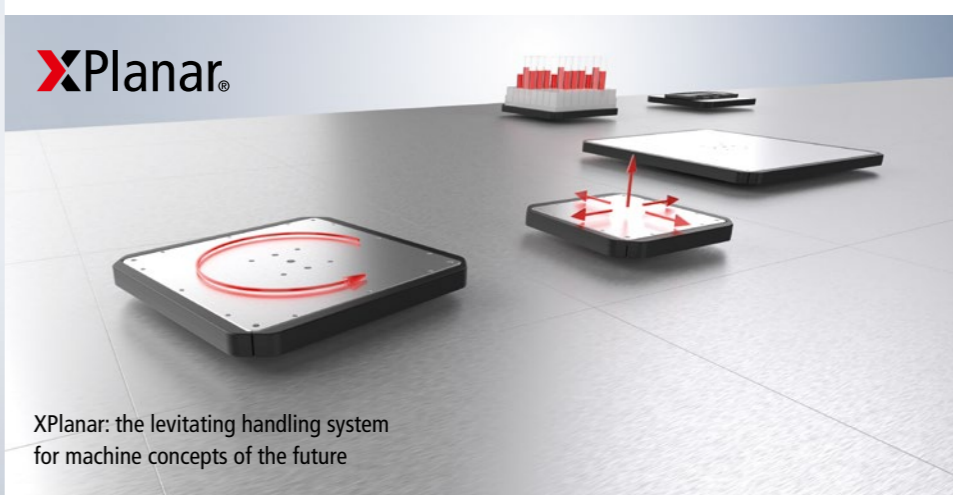
XPlanar: the levitating handling system for machine concepts of the future

TwinCAT: the universal software for engineering and runtime

C60xx ultra-compact Industrial PCs: maximum computing power in the smallest possible footprint

Control panels: operating units for integration in control cabinets or mounting-arm installation

XTS: the intelligent product transport system for innovative machine concepts

Pluggable system solution for control cabinet-free automation: MX-System

TwinSAFE: the integrated safety system from I/Os through to drives

EtherCAT I/Os: the complete I/O portfolio in IP20 and IP67

Drive systems for highly dynamic positioning tasks

Distributed servo drive systems for implementing machine concepts without control cabinets

Compact drive technology: ideal for direct motor connection in the I/O system

C7015 ultra-compact Industrial PC with connection for EtherCAT P Box modules in IP67

EtherCAT, the high-speed fieldbus: Global standard for sheet metal working

As the inventor of EtherCAT, Beckhoff introduced this breakthrough technology onto the market in 2003 and made it available as an open standard for automation technology. With its outstanding performance, flexible topologies, extensive diagnostics and easy configuration, EtherCAT is ideal for use in sheet metal working machines and is one of the most commonly used standards in the industry. We deliver the largest number of EtherCAT-compatible automation products both for I/O and drive technology. A large variety of third-party EtherCAT-compatible sensors and actuators are also available on the market, ensuring a high level of investment protection. Future TSN implementations will be realized based on the EtherCAT Automation Protocol.

Our fast and highly precise control solution eXtreme Fast Control (XFC) is based on the EtherCAT communication protocol and special I/O modules that are optimized for XFC, which record signals and trigger actions with the highest accuracy. With I/O response times of less than 100 µs, the system scans the status of the sheet metal processing machine up to 10,000 times per second to achieve exceptional control precision and repeatability even in the most dynamic processes. This improves the productivity of your machine and reduces waste and resource consumption.

More recently, we developed EtherCAT G for use in high-performance machines and highly complex applications. As a continuation of the successful EtherCAT technology, it offers speeds ranging from 1 Gbit/s to 10 Gbit/s, allowing the current EtherCAT transmission rate of 100 Mbit/s to be increased by a factor of 10 or 100. Both performance levels represent system-compliant enhancements of EtherCAT technology from Beckhoff – the well-known function principle of on-the-fly processing remains unchanged. And with the branch concept in EtherCAT G, 100 Mbit/s EtherCAT segments can be integrated into the network to reduce hardware propagation times in large networks by processing segments in parallel.

With EtherCAT P, we offer a superior one cable solution for the field level for linear systems and modular machine concepts, which handles the EtherCAT communication as well as the power supply for the system and peripherals. In addition, EtherCAT P enables power to be forwarded directly via the subscribers. One Cable Automation (OCA) simplifies system wiring in the machine design since the components, terminal box and machine modules only need to be connected using a single cable. With the EtherCAT P standard, for example, the AMP8000 distributed servo drive system is supplied with power and data over a single cable to save space in the control cabinet.

▶ www.beckhoff.com/ethercat

TwinCAT: The integrated engineering and runtime platform

TwinCAT 3 automation software consists of runtime systems for real-time execution of PLC, HMI, NC, CNC and robotics applications. At the same time, it also serves as the development environment for programming, diagnostics and configuration. TwinCAT 3 features all IEC 61131-3-compliant programming languages for real-time applications. The object-oriented enhancements from IEC 61131-3 enable modularization of the programming code, encapsulation of machine functions as software modules and – alongside this – better structuring, simple maintenance, as well as reuse and enhancement of software applications. C/C++ and MATLAB®/Simulink®

modules can be integrated into the IEC context via existing interfaces or operated autonomously in the TwinCAT real-time environment.

Furthermore, open interfaces as well as the use of the latest technological standards based on Windows operating systems provide you with a wide range of options such as integration into existing visualization, control and database systems. Multi-core and many-core technologies are fully supported by TwinCAT 3. Extensive software function modules and libraries for an industry's typical requirements simplify the engineering and implementation of machine functions. The TwinCAT Automation Interface supports you in

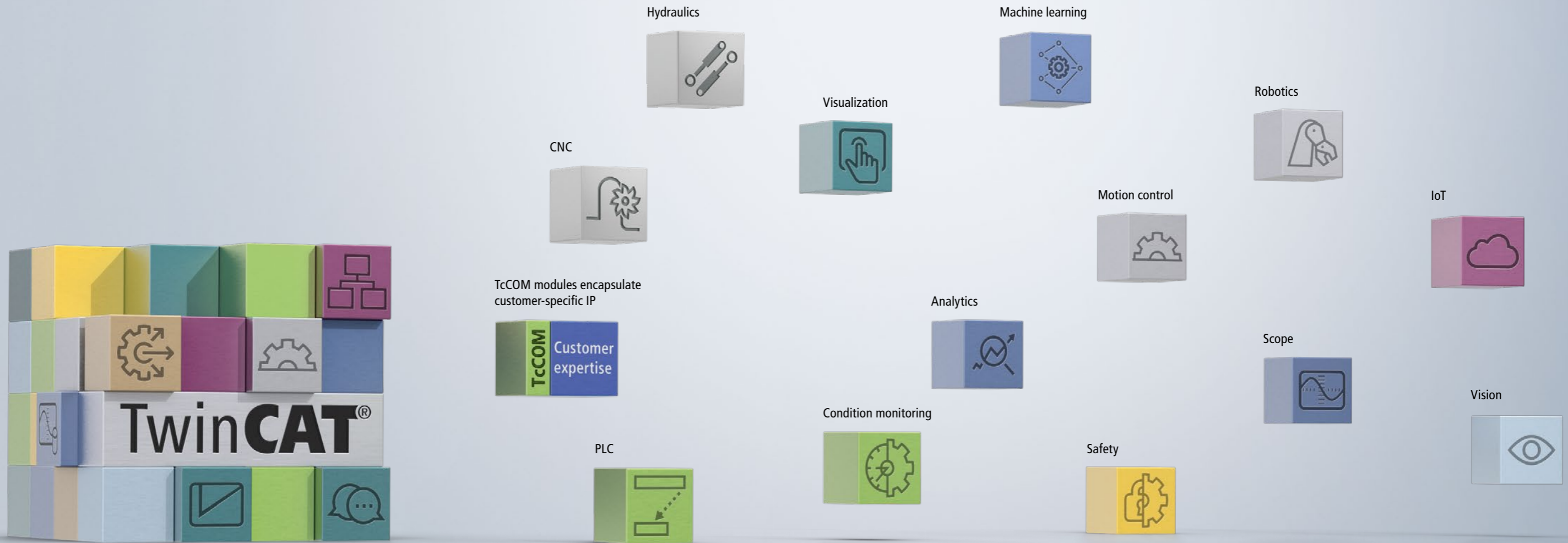automatically creating machine programs and configurations.

Comprehensive TwinCAT libraries for motion control as well as various robot kinematics reduce your development time through verified and optimized algorithms. TwinCAT Hydraulic Positioning provides you with all the software functions required for valve or pump-controlled axes or servo pumps. Standardized PLCopen interfaces reduce your engineering effort. TwinCAT Scope is a software oscilloscope that is integrated fully into the TwinCAT system architecture. It accelerates commissioning and service processes – and increases your machine quality as a result.

TwinCAT Vision integrates image processing into the control platform; configuration and programming can be therefore carried out in the familiar environment, simplifying engineering. TwinSAFE can serve as a software-based safety solution, which simplifies the wiring of complex systems; variants can be replicated in the software.

TwinCAT HMI is an integrated, browser-based visualization solution that enables convenient development and maintenance of visualization objects and user interfaces. The information is presented either on the machine or in a web browser over the Internet.

TwinCAT interfaces to machine learning algorithms allow use of AI methods in the traditional control environment and support product and process optimization.

▶ www.beckhoff.com/TwinCAT

Hydraulics

Machine learning

Visualization

Robotics

CNC

Motion control

IoT

TcCOM modules encapsulate customer-specific IP

TcCOM Customer expertise

Analytics

Scope

Condition monitoring

Vision

PLC

Safety

TwinCAT®

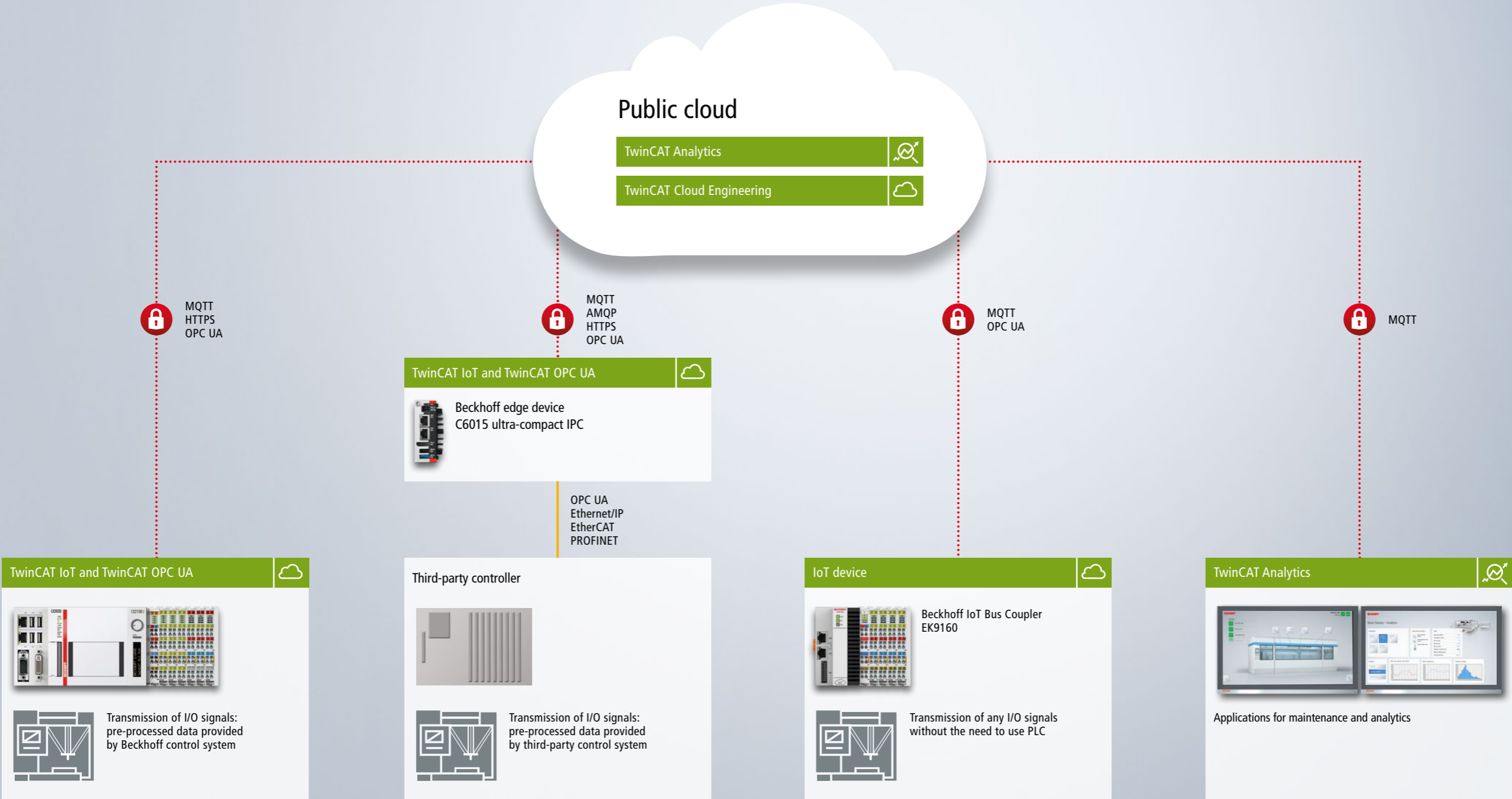# System-integrated cloud connectivity and data analysis

We developed the TwinCAT IoT software library for communication between machine controllers and cloud-based services. It supports the standardized OPC UA, AMQP and MQTT protocols for communication with common cloud systems such as Microsoft Azure™ and Amazon Web Services, as well as private cloud systems on your corporate network. Integrated security mechanisms prevent misuse of data as a result of unauthorized access and protect your company's intellectual property.

Via TwinCAT Analytics, process data is logged and analyzed synchronously with each machine cycle. Using appropriate analysis tools, all necessary information can be derived from the stored data in order to optimize your 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 the reliability and availability of your machines and plant. However, the data analysis also provides you with extensive information about the operational performance of your machines, which you can use in future design and manufacturing processes in order 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.

Public cloud

TwinCAT Analytics

TwinCAT Cloud Engineering

MQTT
HTTPS
OPC UA

MQTT
AMQP
HTTPS
OPC UA

MQTT
OPC UA

MQTT

TwinCAT IoT and TwinCAT OPC UA

Beckhoff edge device
C6015 ultra-compact IPC

OPC UA
Ethernet/IP
EtherCAT
PROFINET

TwinCAT IoT and TwinCAT OPC UA

Transmission of I/O signals:
pre-processed data provided
by Beckhoff control system

Third-party controller

Transmission of I/O signals:
pre-processed data provided
by third-party control system

IoT device

Beckhoff IoT Bus Coupler
EK9160

Transmission of any I/O signals
without the need to use PLC

TwinCAT Analytics

Applications for maintenance and analytics

Pluggable system solution for control cabinet-free automation

For the first time, the MX-System enables completely control cabinet-free automation solutions in machine and system engineering through a comprehensive, modular, and pluggable IP67 system. The composite of baseplate and function modules resulting from the modular system combines all tasks and features of a control cabinet from the power supply to the connection level for the field devices. The full system integration of all machine functionalities is achieved via freely selectable IPC, coupler, I/O, motion, relay, and system modules, which can be configured and combined according to the specific application.

The consistently systemic approach of comprehensively coordinated assemblies enormously reduces the effort required for planning, assembly, machine installation, and maintenance. Since considerably fewer components are required than in traditional control cabinet design to implement the same requirements, the entire MX-System is significantly more compact than previous solutions. The system footprint is reduced, and system availability and flexibility are also increased. In each life cycle phase of a control system, the MX-System offers significant advantages over the classic control cabinet.

The possible uses of the MX-System are highly flexible and can be precisely adapted to suit the requirements of any application. On the one hand, the MX-System can be used as a stand-alone solution for complete plant automation. With the help of the corresponding system modules, cascaded system structures in different topologies can easily be created. This also makes it possible to implement decentralized automation solutions that are specially adapted to suit each application. On the other hand, the MX-System can be connected to conventional automation components via industry-typical communication interfaces so that the aforementioned advantages also come into play in existing plants.

MX-System

OPC UA

EtherCAT

+ 24 V DC, 48 V DC

EtherCAT

+ 24 V DC, 48 V DC
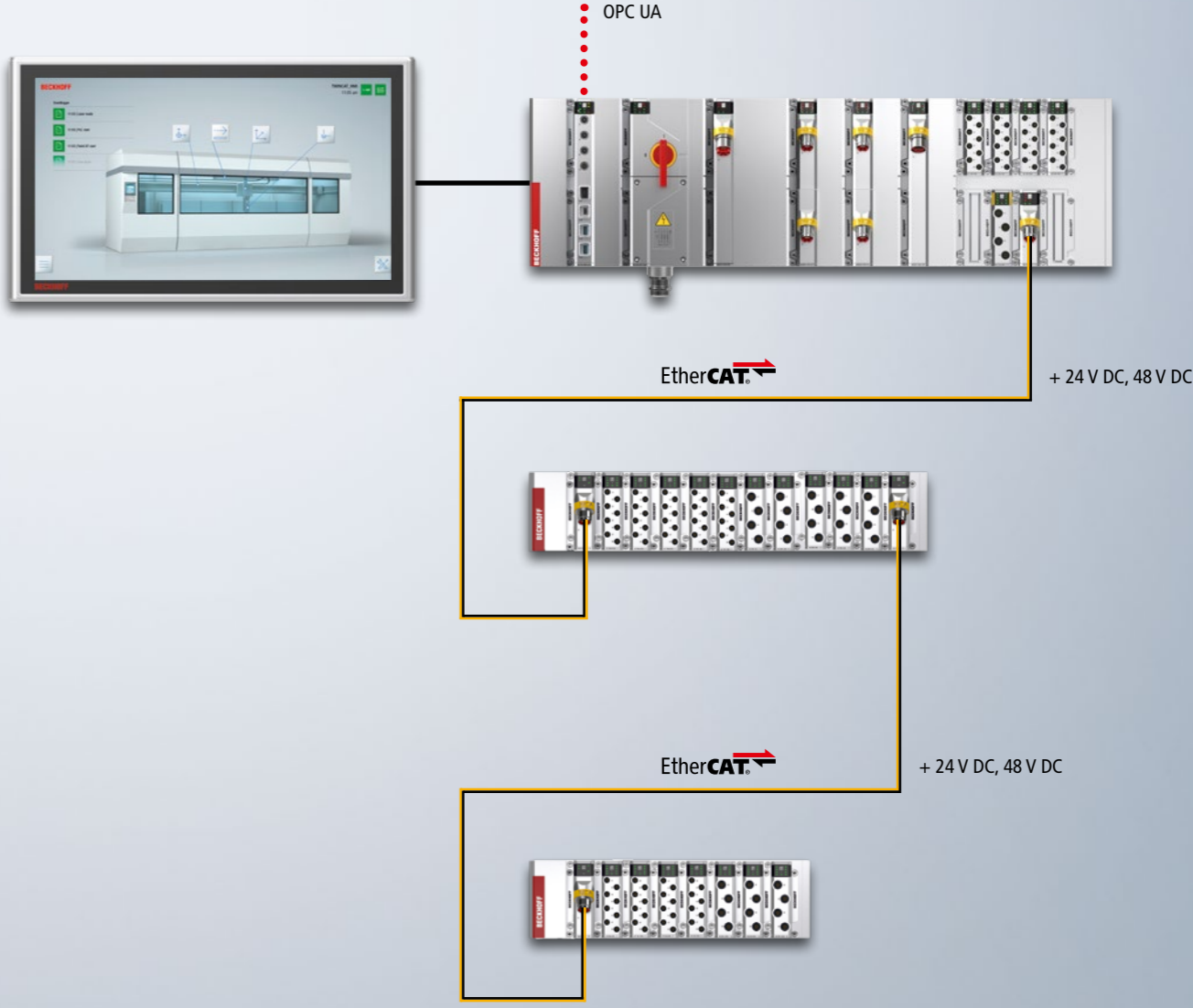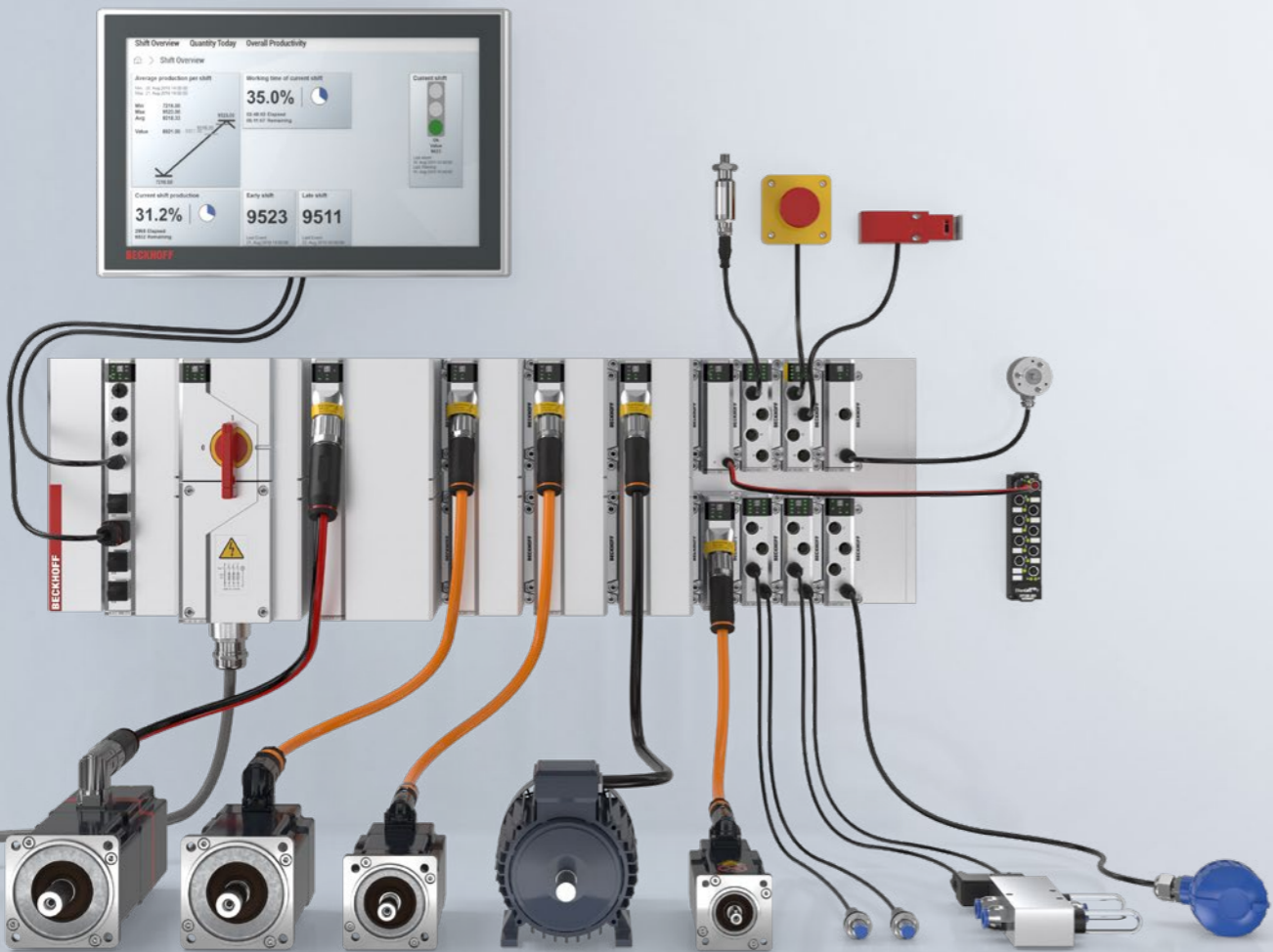
The all-in-one CNC: From entry-level to high-performance solutions

TwinCAT NC Interpolation (NC I) is the software for interpolated path movements and robotics that replaces conventional axis modules. NC 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 to support various motion tasks.

TwinCAT CNC provides you with extensive CNC functionalities as a pure software solution running on the PC. It covers the complete range of traditional 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. With support for multi-core and 64-bit operating systems, TwinCAT 3 opens up hardware performance reserves that can be utilized for highly precise control of high-speed laser cutting machines, for example.

Our wide range of multi-touch panels with varied display sizes and formats meets all HMI requirements. The standard .NET-based CNC user interface covers all required functions, such as online language changeover, setup functions, global message system and user management.

Application-specific parameter adaptation and expansion options enable the flexible and fast implementation of your individual requirements. Our scalable CNC solution is available in all performance classes: from compact embedded PCs with integrated I/O interface to industrial PCs with multi-core processors. You can choose between optional functions and scalable hardware platforms to configure a performance-based, efficient and cost-effective CNC control system.

All controllers are universally configured and programmed using TwinCAT automation software. Through cyclic data transfer of control and status information, the embedding of NC or CNC func-

tions into the overall system ensures extremely fast communication and high efficiency.

▶ **www.beckhoff.com/cnc**

Attractively priced entry-level software solutions: TwinCAT NC I

For complex machines: powerful, scalable TwinCAT CNC software

Up to 32 channels

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

Picometer interpolation (control resolution of 10 pm)

CNC features
- fast cycle times
- high-speed cutting
- kinematic transformation
- 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

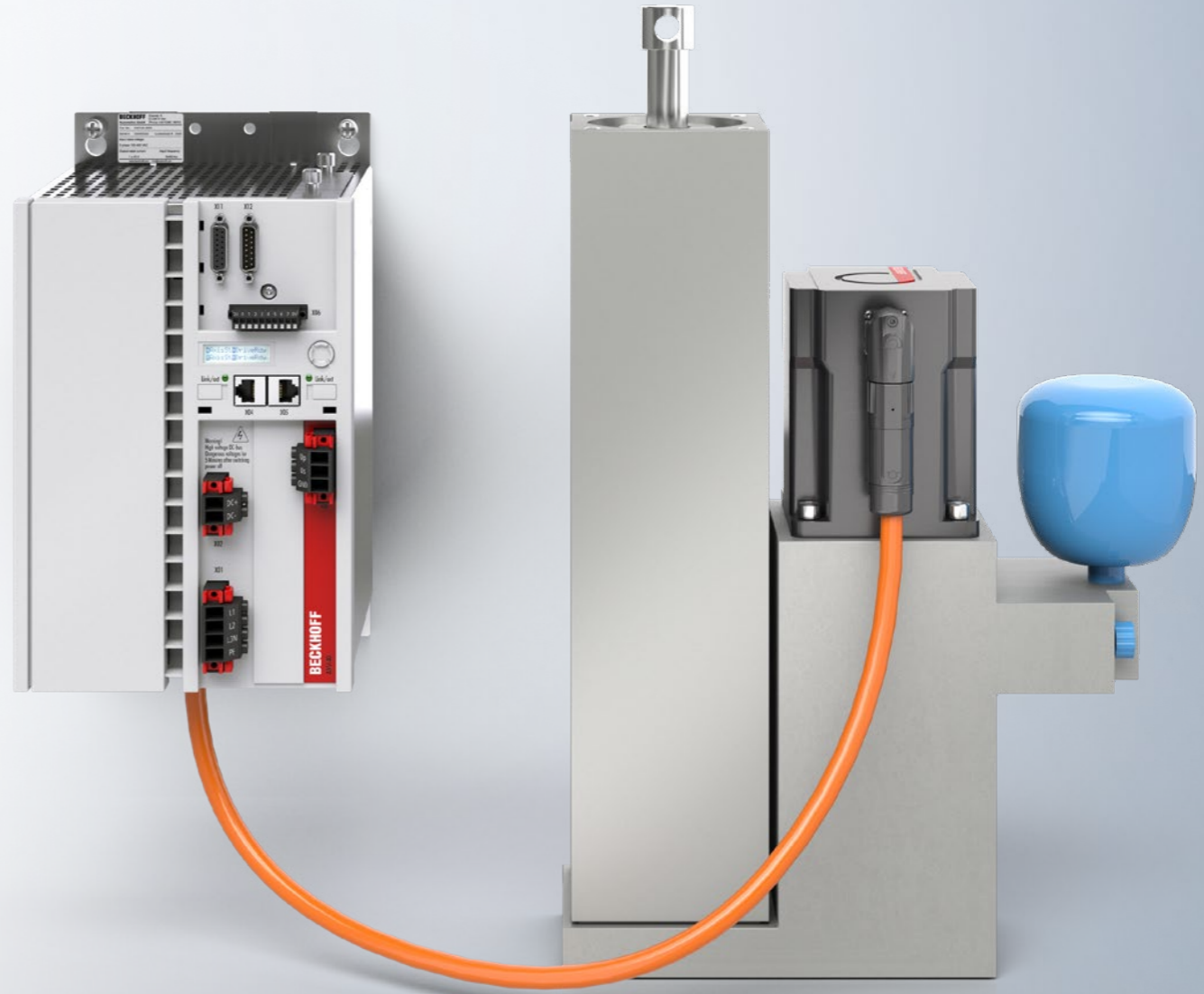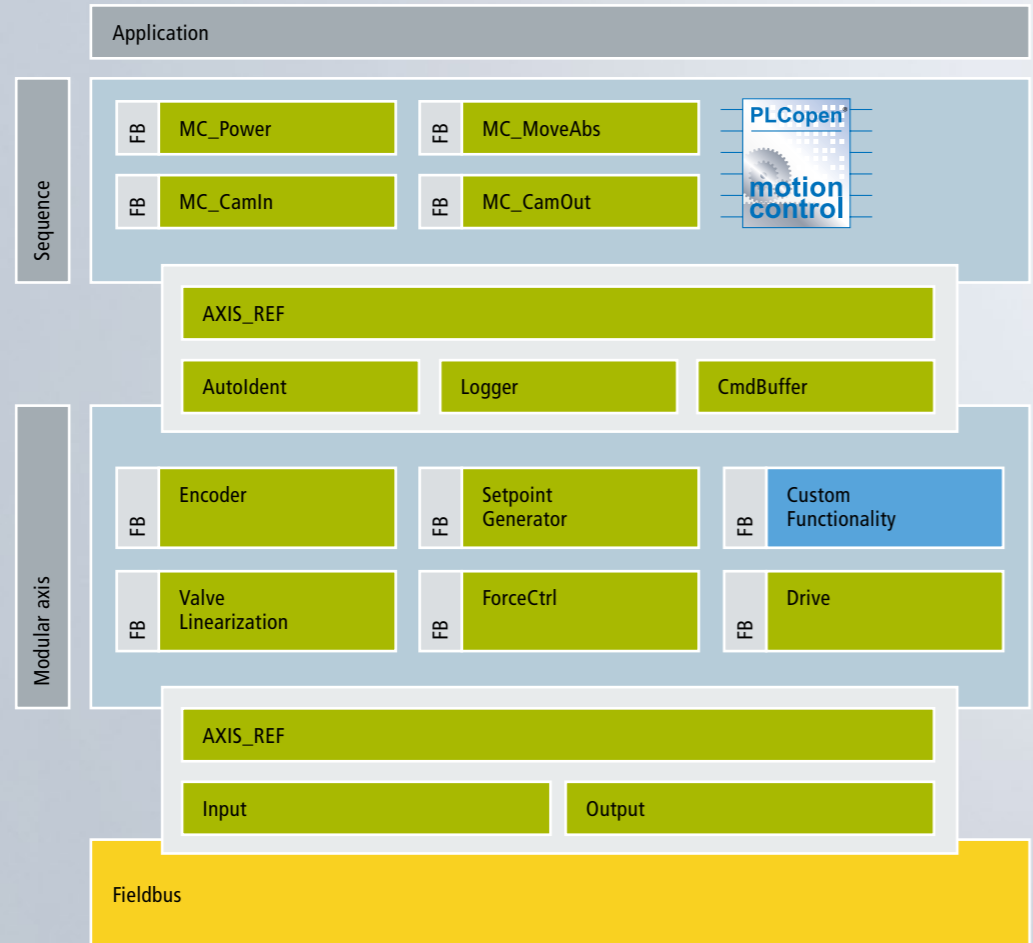# Beckhoff hydraulics expertise optimizes forming processes

The TwinCAT Hydraulic Positioning software library (TF5810) provides all the software functions required for valve- and pump-controlled axes and servo pumps. As a rule, the solution is vendor-independent, which means that as a user you are free to choose your preferred hydraulics equipment supplier. The integration of motion control technology into the PLC makes separate hardware controllers unnecessary and eliminates additional communication effort. At the same time, the software-based architecture offers maximum flexibility for optimal motion control performance. The Hydraulic Positioning library uses standardized PLCopen interfaces, reducing engineering effort.

Any hydraulic axes can be optimally operated through adapted setpoint generators, automatic characteristic curve identification, segmented movements and freely programmable switching between force, pressure and position control. The Hydraulic Positioning library concept enables motion control for any number of axes with matching CPU performance. Hydraulic axes can be operated in interpolating mode when TwinCAT NC I or TwinCAT CNC is used.

Highly dynamic servo drives for hybrid axes

The strengths of hydraulic drive technology, such as fast motion cycles and low mounting space requirements, are offset by higher maintenance costs and lower efficiency. However, servo-hydraulic axes offer an interesting alternative since they are both low maintenance and energy efficient. Our highly dynamic servo drive technology with a current controller cycle time of 16 µs ideally complements these innovative concepts. Use of our One Cable Technology makes encoder cables unnecessary, reducing cabling effort and space requirements.

Adaptive parameter switching during motion enables smooth switchover between different feed constants with optimally adapted control parameters. Using the TwinCAT Hydraulic Positioning library, you therefore achieve short machine cycle times with minimum deviations from the setpoint. All commonplace servo-hydraulic axis concepts can be easily configured, reducing your programming effort to a minimum. Condition monitoring for pump wear and energy consumption is also available as an option.

Application

Sequence

| FB MC_Power | FB MC_MoveAbs |
| FB MC_CamIn | FB MC_CamOut |

PLCopen
motion
control

AXIS_REF

| AutoIdent | Logger | CmdBuffer |

Modular axis

| FB Encoder | FB Setpoint Generator | FB Custom Functionality |
| FB Valve Linearization | FB ForceCtrl | FB Drive |

AXIS_REF

| Input | Output |

Fieldbus

■ Software module from the TwinCAT Hydraulics library

■ Customer-specific software module

□ Application code

Scalable drive technology in a compact design

As a provider of scalable drive technology, we offer a comprehensive hardware and software portfolio for all drive concepts, price points and application areas: The motion control solutions in TwinCAT automation software are supplemented by a broad range of servomotors and drive controllers, ranging from the compact servo drive in terminal format through to the AX5000 Servo Drive for highly dynamic positioning tasks.

With the AMP8000 distributed servo drive system, a host of new opportunities are offered for modular machine concepts. It integrates the servo drive directly into the servomotor, resulting in a highly compact form factor. By relocating the power electronics to the machine, the control cabinet needs to house only a single coupling module that supplies multiple servo drives over a single cable via a distribution module. The result: significant savings in terms of materials, cost, footprint and installation effort.

The AMP8600 supply module featuring a high protection rating can even shift the entire drive system directly on the machine. The configuration is extremely easy: Only a single cable type is required to connect the supply and distribution modules and drives together. No additional components such as motor chokes, circuit breakers or filters are needed. All connections and supply modules additionally have an EtherCAT P connector for the Beckhoff I/O portfolio, which simplifies connection to additional inputs, encoders or latch units significantly.

The AMI812x servo drive combines servomotor, output stage and fieldbus connection in a compact design and facilitates machine design without control cabinets. The bundling of all individual components results in a connector level with all interfaces located directly at the servo drive, eliminating the need for an upstream I/O level.

▶ **www.beckhoff.com/motion**

AMP8805-1000-0000

- distribution module with 5 outputs
- simple topology
- installation directly on the machine

AMP8805-1000-0000 + AMP8000

- distributed servo drive system
- compact design
- installation directly on the machine
- saves material, space and cost

AMI8121x

- servo drive with integrated output stage
- compact design
- installation directly on the machine
- for motion requirements of up to 400 watts
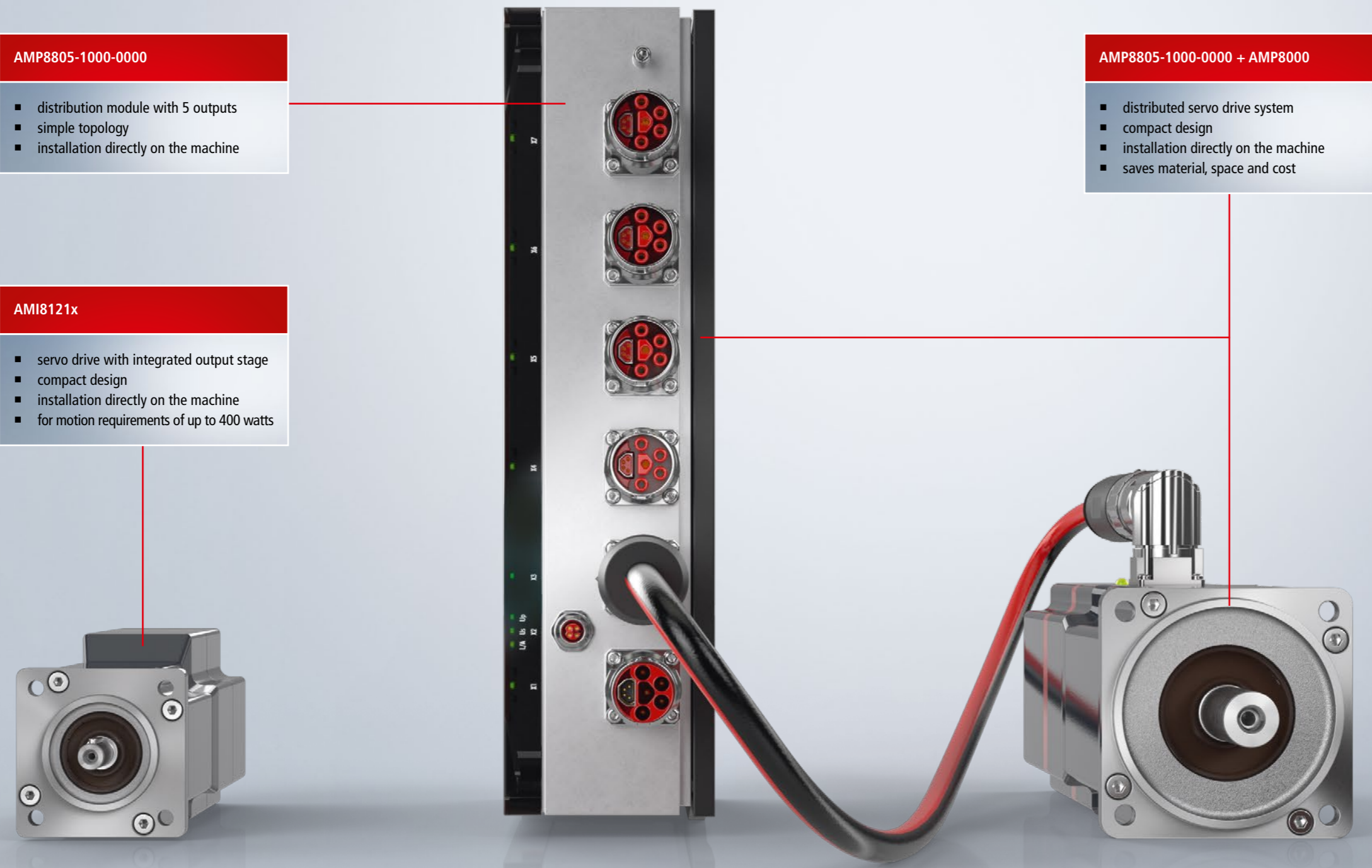
PC-based automation of presses ensures process optimization

Our modular and scalable control technology is suitable for automating all types of presses, such as hydraulic deep drawing presses or servo-electric transfer presses. With their high performance, our industrial PCs stand out in this respect, in particular when it comes to controlling dynamic processes. Together with the fast EtherCAT communication system, signals can be recorded in the shortest possible time and commands can be forwarded to the different actuators. Especially in the area of fully automatic transfer presses or complete press lines, this allows intervention times – for example of the feeders between the different

press stations – to be minimized so that the number of strokes per minute increases.

The entire range of control requirements can be covered with I/O systems for all common fieldbuses, the TwinCAT automation software for PLC and motion control, a comprehensive portfolio of drive technology components, as well as TwinSAFE, the integrated safety solution. Special, optimized gear couplings and pressure controllers with feed forward are available for deep drawing processes.

Ultra-precise control of high-speed laser welding and cutting machines

Our CNC controllers are used globally in autogenous, plasma, laser and water jet machining for cutting and welding sheet metal. Two key parameters play a critical role in competitiveness: control speed and the scope of CNC functions. Our solution is superior in both aspects. First, it offers high-performance control via EtherCAT that enables cycle times of less than one millisecond, supporting especially fast cutting and welding applications. Second, the TwinCAT NC I/CNC automation software offers special software modules, which seamlessly cover all specific CNC requirements and integrate them into the control platform.

Our entire product portfolio focuses on space-saving, compact form factors and helps you realize a streamlined machine design. This starts with the ultra-compact Industrial PCs in the C60xx series to the I/O peripheral components in IP67 with EtherCAT P through to the AMP8000 modules and the matching servomotors with integrated power output stage. All in all, this significantly reduces space requirements in the control cabinet and in some cases fully eliminates them.

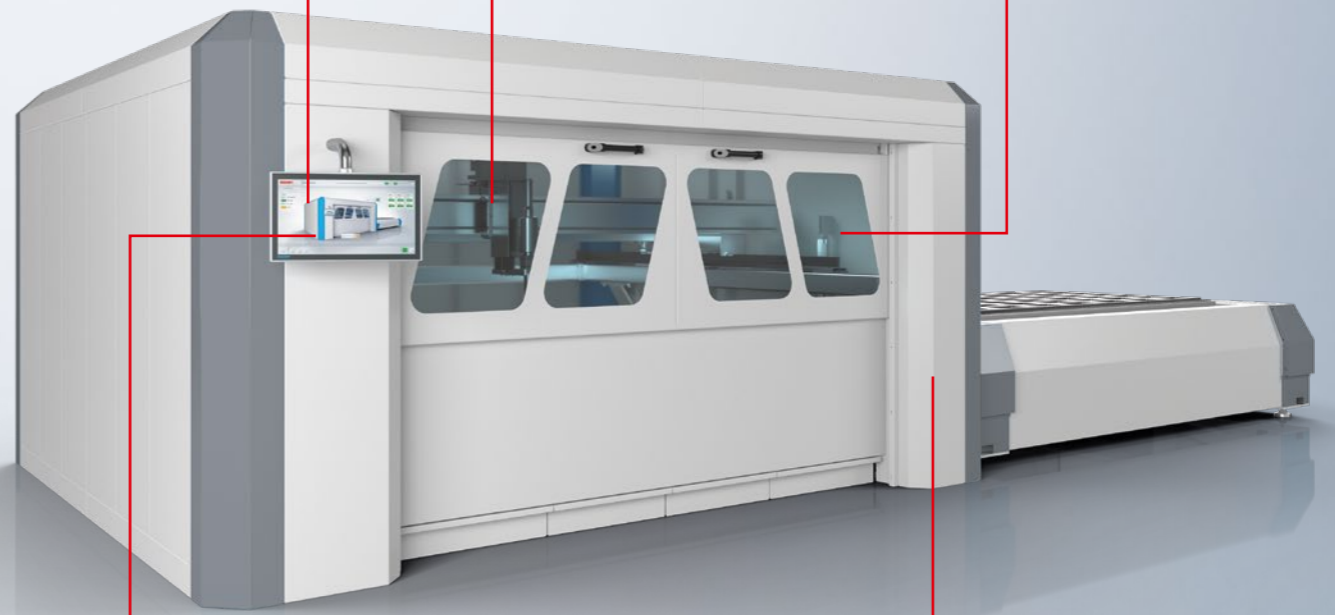**TwinCAT Motion Control:** highly dynamic regulation of servo drive technology
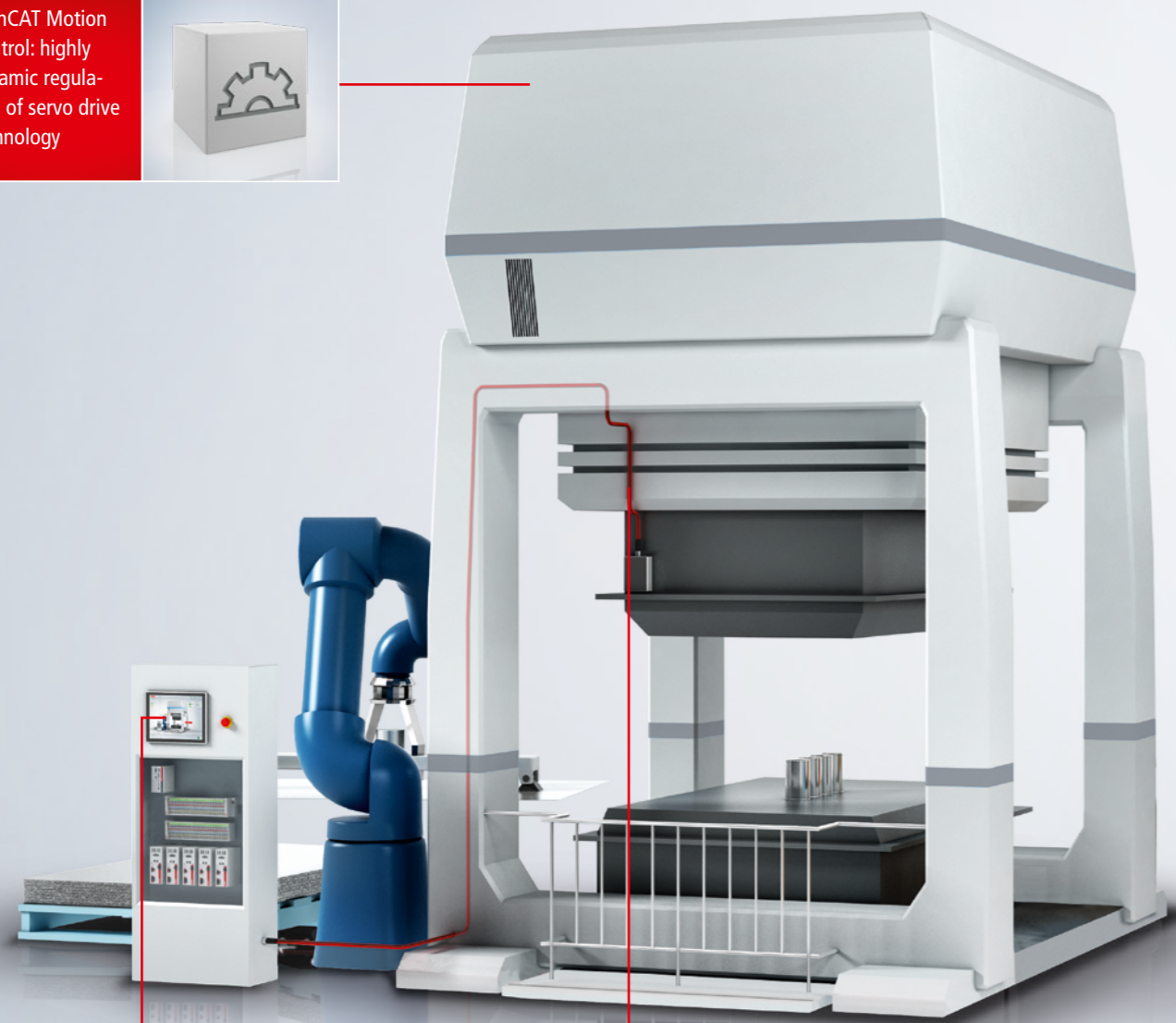
IPC: high-performance industrial PCs for controlling presses with minimum cycle times

EtherCAT P: One Cable Automation minimizes cabling and installation costs

EtherCAT P

TwinCAT: the scalable all-in-one CNC controller

Motion: scalable drive technology in a compact design

TwinCAT IoT: cloud-based data analysis for predictive maintenance

Control panel: industry- and customer-specific control panels

TwinCAT TcCOM: integrated intellectual property protection for customers

Fast and highly precise: Punching and nibbling with PC-based control

With PC-based control technology, you can realize the highly dynamic axis movements and fast control functionalities required for punching and nibbling machines used in sheet metal processing. Precisely programmable strokes, automatic tool changes and the option to modify program code and machine settings during operation all lead to significant increases in productivity. More than 2,000 strokes per minute can be realized with high-performance industrial PCs and the EtherCAT communication system.

In addition, our eXtreme Fast Control Technology (XFC) enables ultra-fast data transmission. This means, for example, that the data from press force monitoring or tool backup can be recorded with cycle times of less than 100 µs. This can only be achieved because all sensors transmit their data to the high-performance, central controller practically simultaneously. Another advantage of a centralized control architecture is that it is much easier to integrate complex functions such as envelope curve monitoring or other functions, such as image processing or machine learning.

PC-based control optimizes bending processes

In die bending, an upper die pushes the metal sheet into a V-shaped lower die. Particularly with free bending, very precise position guidance is essential for a perfect bending result. The TwinCAT Hydraulic Positioning software library allows for optimal compensation of non-linearities and pressure drops on the valve. With the aid of compact drive technology from Beckhoff, the back gages can be addressed directly in the terminal network. This enables significant savings in terms of space requirements and wiring effort.

Our extensive range of panel PCs with scalable processing power combined with variable screen sizes offers you maximum freedom when it comes to choosing a controller tailored to your application. The EtherCAT I/O modules allow you to draw on the entire Beckhoff I/O portfolio if you want to connect additional functions such as safety technology, energy monitoring and condition monitoring, as well as optional peripherals.
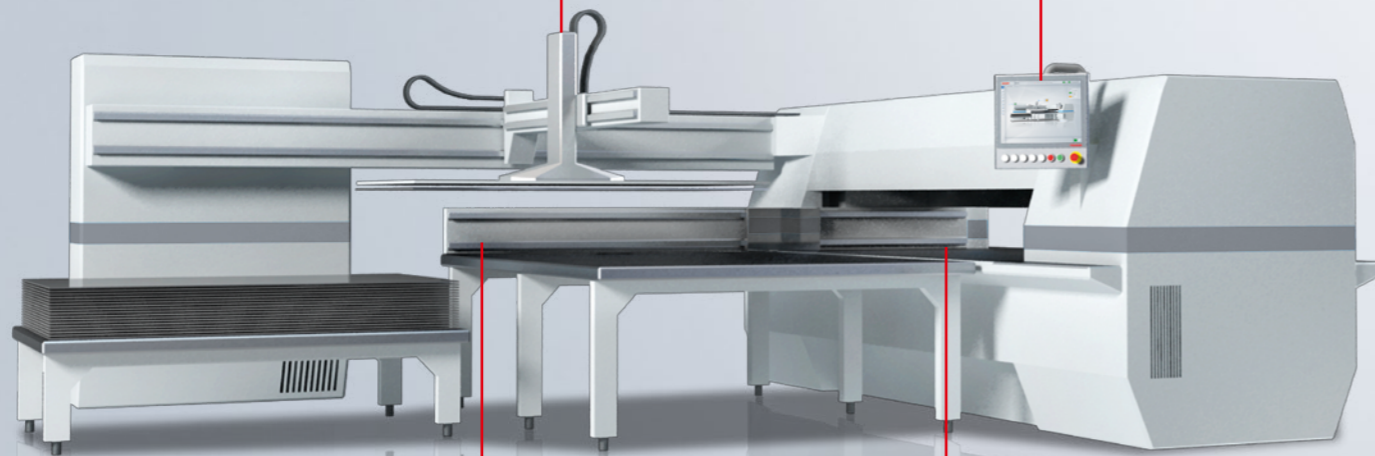
AMP8000: distributed servo drive system reduces space requirements

Panel PC: industry- and customer-specific control panel with integrated CPU

Panel PC: industry- and customer-specific control panel with integrated CPU

EtherCAT: fast communication with cycle times of 50 µs

TwinCAT Vision: position detection of components in real time optimizes infeed

TwinSAFE: integrated safety solution simplifies system communication

AMP8000: distributed servo drive system reduces space requirements

Our references

Bruderer AG, Switzerland

Stamping presses with optimal availability and precision

▶ **www.bruderer.com**

Penta-Tec CNC-Automation GmbH, Austria

Production of high-quality sheet metal parts for the Airbus A320

▶ **www.penta-tec.com**

Jinan Aotto Automation Co., Ltd., China

Multi-station press line for the automotive industry

▶ **www.aotto.cn/en**

Schuler Group, Germany

Fully automatic press lines

▶ **www.schulergroup.com**

Power-Tech, Eagle Group, Poland

High-tech laser cutting system with high-performance PC platform and EtherCAT

▶ **www.eagle-group.eu**

Aida Engineering Ltd., Japan

PC-based control and EtherCAT for optimized forming technology in the automotive industry

▶ **www.aida.co.jp/en**

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Which sheet metal application would you like to optimize
with PC-based control? Get in touch with us at
▶ **www.beckhoff.com/sheetmetalworking**

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