BECKHOFF New Automation Technology

The control system
for process automation:
PC-based control

The integrated control system for all markets of the process industry

Chemical and petrochemical industry

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H_2

Hydrogen H_2

zero emission

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The control system for process automation

Beckhoff calls on a comprehensive range of modular components and deep-rooted, cross-sector expertise to create open automation systems using PC-based control technology. By consistently bundling control intelligence in the software and using established standard technologies from the IT and automation world, PC-based control combines a full range of functions in a single system, including PLC, visualization, cloud connection, and safety and measurement technology. For those working in the process industry, Beckhoff offers a comprehensive range of products to support the implementation of comprehensive solutions for unimpeded communication from zone 0 to the cloud. These include scalable industrial PCs and control panels, I/O modules with intrinsically safe interfaces, TwinCAT automation software featuring specific process technology interfaces along with the relevant hardware and software modules for simple IoT communication, the use of cloud-based services, plant networking, and much more besides. What's more, current industry standards are covered by embedding process technology-specific interfaces such as NAMUR, HART, and FDT/DTM. The comprehensive integration of these into TwinCAT also makes for straightforward navigation – even for users who have previously worked in other software environments. System-integrated controller and cable redundancy ensures reliable operation without downtime to increase plant availability. The open and flexible control system from Beckhoff offers an efficient alternative to traditional suppliers and is suitable for use in all process industry markets.

▶ www.beckhoff.com/process

PC-based control for the process industry:

- universal hardware and software platform for the automation of all process technology applications
- extensive portfolio of components for explosion protection
- high level of interoperability for investment protection and maximum flexibility
- controller and cable redundancy for increased plant availability
- established worldwide across all industries

Maximized availability

Controller and cable redundancy ensure reliable plant operation.

Cloud communication

Open communication standards enable the simple, system-integrated connection of private or public cloud solutions.

Simplified data analysis

TwinCAT Analytics supports data analysis and predictive maintenance concepts.

Integrated explosion protection

Intrinsically safe I/O modules facilitate communication from zone 0 to the cloud.

High-end measurement technology

Quick and accurate acquisition of measured values enables in-depth process analysis.

PC-based control: All control tasks on a single platform

The system-integrated automation solution from Beckhoff maps all components required for process control in hardware and software. Other functions, such as condition monitoring, can also be integrated directly into the control system and executed in real time. From data acquisition at decentralized measuring points to sophisticated control loops, PC-based control technology offers the necessary scalability and flexibility and is therefore ideal for the full automation of all process technology applications.

At the heart of the Beckhoff control is a powerful industrial PC. Our scalable industrial PC portfolio offers hardware solutions with performance levels and designs that can be perfectly tailored to any application. These industrial PCs are suitable for a wide range of applications: as a central or decentralized element of plant automation, as an HMI in the field, or as an edge device for IoT scenarios. Panels and panel PCs facilitate visualization and operation directly at the plant. Embedded PCs or fieldbus couplers with the modular I/O level allow terminals from our Beckhoff I/O range to be

directly connected, in turn enabling sensors and actuators to be linked to the control system with ease. The diversity of digital and analog signals in the extensive I/O portfolio also simplifies the cost-effective system integration of all functions. The TwinCAT automation software forms the central engineering and control environment. In addition to performing traditional PLC processes, TwinCAT can be expanded to include numerous functions, such as plant visualization, secure cloud connection via TwinCAT IoT, and the use of analysis functions via TwinCAT Analytics.

Condition monitoring

Pressure measurement

IoT

Flow control

TwinCAT 3 automation software

Control panel

Embedded PC with EtherCAT Terminals

© Beckhoff

Ideal for the process industry: The open EtherCAT fieldbus

Our very own EtherCAT fieldbus system has been in use worldwide since 2003 and is now widely considered to be the communication standard in a whole host of industries. As a universal and open high-speed fieldbus, EtherCAT is suitable for all areas of application, from PLC and drive technology to sensors, measurement and safety technology, and explosion protection. This means users only need a single communication technology for their entire plant. They can also rely on our in-depth expertise and benefit from the safety and optimal performance of the comprehensive EtherCAT architecture.

The EtherCAT-based control is open with regard to integrating third-party EtherCAT devices and other fieldbus systems. Not only does this simplify retrofits of existing plants, but it also increases investment protection – as does the fact that EtherCAT is only available in one version. This means that any new developments based on EtherCAT are always compatible with older device generations. The flexibility of EtherCAT also offers maximum freedom when it comes to setting up the network architecture, with all topology options supported. With its extended distance technology, EtherCAT also simplifies data acquisition across

expansive areas by allowing communication over distances of up to 300 m. For greater distances, fiber-optic solutions with a transmission length of up to 100 km are available. EtherCAT cable redundancy is used to set up a fault-tolerant ring topology to ensure that the network or network segments of a plant are always accessible. Moreover, the EtherCAT diagnostic concept enables comprehensive, complete, and fast error identification. This minimizes downtime, reduces maintenance requirements, and increases the availability of the plant.

EtherCAT optimizes the control architecture in the process industry:

- globally established high-speed fieldbus
- a single communication technology for the entire plant
- flexible topologies
- seamless diagnostics
- integrated cable redundancy

EtherCAT – the global communication standard: The EtherCAT Technology Group brings together over 7,600 manufacturers and users worldwide.
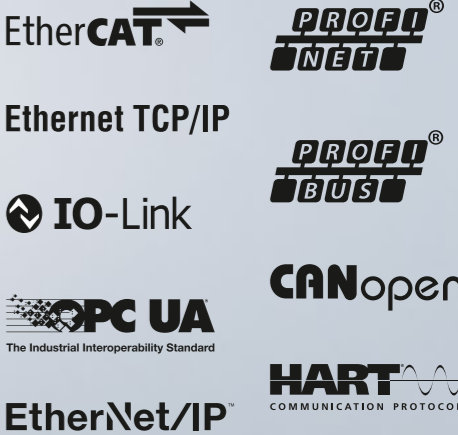
Safety, explosion protection, measurement technology: All functions integrated

Beckhoff uses the principle of PC-based control technology to combine a wide range of I/O components in a single system. For example, EtherCAT Terminals used for integrating functional safety can be freely combined with EtherCAT measurement terminals for precision and high-speed measuring, as well as with I/O modules featuring an integrated safety barrier for connecting intrinsically safe field devices from the hazardous area. These elements can then be integrated into a comprehensive control system, offering plant operators an efficient complete solution for all application-related requirements.

Our control technology is flexible and open with regard to integrating third-party controllers and other higher-level control systems. By supporting a variety of common, industry-specific communication protocols, such as EtherCAT, PROFINET, PROFIBUS, Modbus, and EtherNet/IP, PC-based control also offers users a whole host of advantages when renewing or expanding existing systems. The connection can be established using appropriate fieldbus couplers and embedded PCs depending on the application and control topology. In this way, plants are easy to upgrade or optimize, and the system openness protects operators' investments with a view to future expansions. Faced with ever

more stringent requirements in terms of functional safety, we ensure our automation systems come complete with fully integrated safety technology. Thanks to its compact form and modular structure, TwinSAFE fits seamlessly into the control platform. And when it comes to demanding measurement applications, we also offer a range of I/O components for high-precision, fast, and synchronous data acquisition. The measured values are processed by means of extensive analysis functions directly in the real-time program. This allows condition monitoring applications to be combined with process control in a single system, to name just one of many potential uses.

Flexible plant design with PC-based control:
- integration of all I/O components into a single system
- combination of safety, measurement technology, and explosion protection
- openness towards third-party systems
- high interoperability to simplify retrofits
- system openness for investment protection

EtherCAT

Ethernet TCP/IP

IO-Link

OPC UA
The Industrial Interoperability Standard

EtherNet/IP

PROFINET

PROFIBUS

CANopen

HART
COMMUNICATION PROTOCOL

Fieldbus couplers

Use of controllers or fieldbus couplers enables connection to various communication protocols

Safety

Integration of functional safety into the control system with modular TwinSAFE components

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

I/O modules for direct connection of field devices from zone 0/20

The ELX series: Highly compact EtherCAT Terminals featuring intrinsically safe interfaces

The Beckhoff ELX terminals combine highly compact remote I/O modules with safety barriers for the direct connection of intrinsically safe field devices from zone 0/20 and 1/21. This results in extremely narrow EtherCAT Terminals for the direct connection of intrinsically safe sensors and actuators. With their high resolution and accuracy, ELX terminals guarantee the standard of measurement quality that customers have come to expect from Beckhoff over the years. Another advantage stems from the compact design of the terminals, with up to eight intrinsically safe inputs available in the 12 mm housing. The absence of intermediate external barriers not only makes for a significant reduction in the space needed in the control cabinet, but also offers real cost advantages. With certification according to ATEX, IECEx, and NEC/CEC, as well as other country-specific standards and directives, ELX terminals can be used in virtually all markets worldwide.

The EPX series: Decentralized acquisition of intrinsically safe signals

The EtherCAT Box modules in the EPX series combine intrinsic safety with an IP67 protection rating and are suitable for the implementation of modular and control cabinet-free system concepts in hazardous areas. The robust EPX modules can be mounted directly on the machine or plant and enable the acquisition of intrinsically safe signals up to zone 0/20. In this way, they offer reliable data acquisition in hazardous areas where control cabinets cannot – and should not – be installed. What's more, their extremely compact modular design offers significant space savings, which in turn serves to cut down on costs. Additional advantages include simple commissioning, the avoidance of installation errors due to incorrect contact assignments, and the reduced cable lengths facilitated by on-site signal acquisition.

Hardware and software for maximum ease of use

Control panels and panel PCs combine elegant design and industrial compatibility
With a comprehensive range of high-quality control panels and scalable panel PCs, we offer state-of-the-art ease of use for a wide variety of application scenarios in the process industry, meaning optimized functionality and an elegant design are guaranteed. The housings for our control panels and panel PCs are made from solid aluminum and comply with protection rating IP65, while the meticulous development and integration of electronic parts, displays, touch screens, and front laminates ensures high levels of availability

and reliability in operation. Advanced multi-touch technology meets tried-and-tested housing technology and perfectly tuned PC hardware, and a selection of connections and cable technologies are available to link control panels and industrial PCs. The control panels and panel PCs in the CPX series also enable the devices to be used in zone 2/22 hazardous areas. At the same time, the appearance of the panels remains unchanged in terms of their look and feel, making them a visual highlight in explosion-proof environments.

TwinCAT HMI: Advanced, platform-independent, and efficient
The TwinCAT HMI visualization solution enables the convenient development and maintenance of visualization objects and user interfaces. TwinCAT HMI consistently relies on widely used IT standards such as HTML5, JavaScript, and CSS. The integration of a graphic editor with an extensive toolbox into the familiar TwinCAT Engineering environment makes it possible to create individually designed visualization pages with little effort. Customer-specific objects and functions can be created directly in the engineering tool or

programmed in high-level languages and imported via extensions. The user interface can be launched in any HTML5-capable browser, irrespective of the operating system, resolution, or display. In this way, TwinCAT HMI provides a future-proof, open, and high-performance visualization solution.

Panel

Robust and elegant
Combination of appealing design and industrial usability

Intuitive
Operation via state-of-the-art multi-touch technology and optional push button extension

Flexible
Numerous form factors, display sizes and mounting concepts

HMI

Configuration rather than programming
Easy configuration of the HMI via graphical editor

HTML5 design
Modern and ergonomic user interface based on HTML5

Live View
Display of the HMI with live data from the real-time system during engineering

Controls for the process industry
The Beckhoff Process Library offers a broad selection of controls for the process and other industries.

Wide range of TwinCAT functions for every application

Our TwinCAT automation software offers a central platform for controlling process machines and systems. In addition to classic process control in the PLC program, algorithms written in C++ or MATLAB®/Simulink® can also be executed in real time. Further TwinCAT features include the HMI, a secure cloud connection via TwinCAT IoT, and the use of analysis functions via TwinCAT Analytics. The Beckhoff OPC UA server and client offer global distribution of process data along with location-independent plant monitoring and remote maintenance. The full integration of the HART functionality into both the remote I/O system and TwinCAT

Engineering ensures simple project planning and commissioning. Field device DTMs can be integrated via the TwinCAT FDT container to allow a convenient device configuration to be achieved directly in the development environment.

TwinCAT: The control platform for the process industry

- a single tool for engineering and runtime
- control-integrated Industrie 4.0 and IoT applications
- comprehensive data evaluation with analytics functions
- standardized communication via OPC UA
- simplified field device configuration via FDT/DTM
- execution of MATLAB®/Simulink® models

OPC UA

Based on OPC UA (OPC Unified Architecture according to IEC 62541), secure, reliable and vendor-independent communication for transporting process data to the control system is very easy to implement. The use of Beckhoff OPC UA servers and OPC UA clients enables the exchange of data in a secure and reliable way. Data access is controlled via a user management interface in such a way that only authorized users can communicate permissible data.
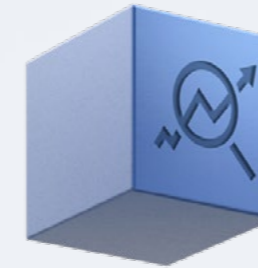
Analytics

TwinCAT Analytics enables complete and cycle-synchronous acquisition of all machine and process data. They serve as the basis for extensive analyses, which can be used to realize predictive maintenance to reduce machine downtimes. Moreover, cloud-supported big data evaluation concepts can be created in combination with TwinCAT IoT to ensure sustainable process quality control.

IoT

Beckhoff has developed the TwinCAT IoT software library for the communication between the machine controller 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 private cloud systems in the company's own network.
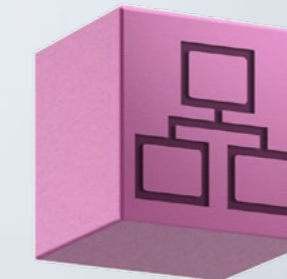
HART and FDT

Thanks to the comprehensive integration of the HART protocol in TwinCAT, the functions from the Engineering interface can be used. The integration of the FDT container enables opening of the field device DTMs within TwinCAT, so that all configuration options are available in one software.

MATLAB®/Simulink®

Thanks to the connection from TwinCAT to MATLAB® and Simulink®, it is possible to integrate models and simulations developed in these languages directly into the controller. Programming that has previously been validated and transferred to the connected TwinCAT system landscape can directly assume the control and monitoring tasks as a productive code.

Modular automation with TwinCAT MTP

The modularity of process systems is standardized by the Module Type Package concept (MTP). MTP describes individual modules based on various aspects, including their functionalities in the form of executable services and the modular structure. The information about the module is stored in an MTP file, which is imported into the control level. The MTP contains all the information and standardized interfaces required to easily integrate individual process modules into the process orchestration layer (POL). Once modules have been developed, they can be easily reused in other plants, regardless of the controller vendor.

This increases flexibility, minimizes engineering effort, and shortens the time-to-market in the process.

With TwinCAT MTP, Beckhoff integrates the Module Type Package into the familiar TwinCAT Engineering environment. With automatically generated PLC templates and visualization, TwinCAT MTP simplifies guideline-compliant automation of plant modules. A prefabricated project structure is provided, in which the user can simply program the process-specific functions of the services. An MTP file can then be exported directly from the project.

The advantages of the MTP concept shine brightest in greenfield settings, involving a completely modular plant consisting of individual process equipment assemblies (known as PEAs or modules). The PEAs can be controlled and freely combined via a local visualization or the POL. The MTP concept can also open up new potential in brownfield environments. A software update can provide existing plants with the ability to integrate MTP modules, allowing them to be expanded on a modular basis. The resulting hybrid architecture combines the best of both worlds and can be expanded on an incremental basis

as required. Modules can be integrated independently of the control system and replaced quickly if necessary to minimize downtime.

▶ www.beckhoff.com/mtp

Process orchestration layer
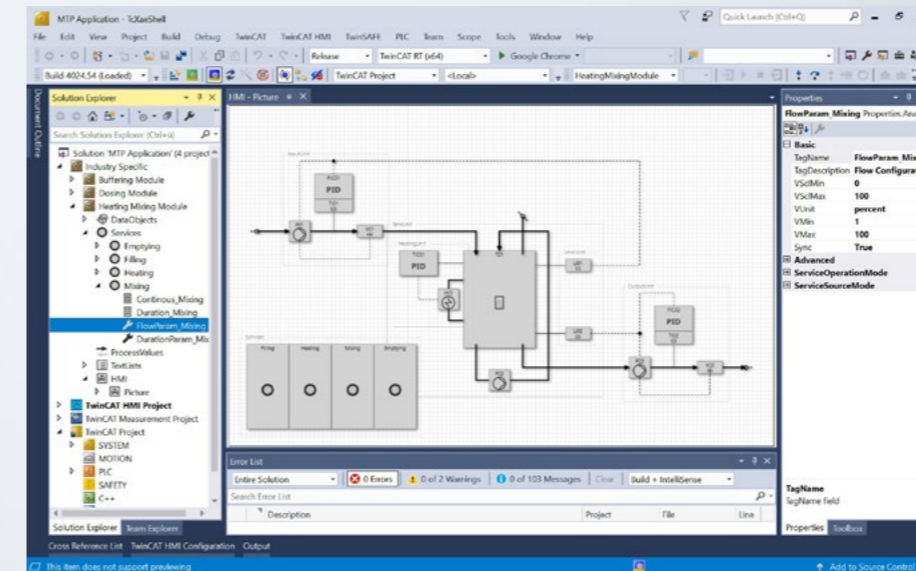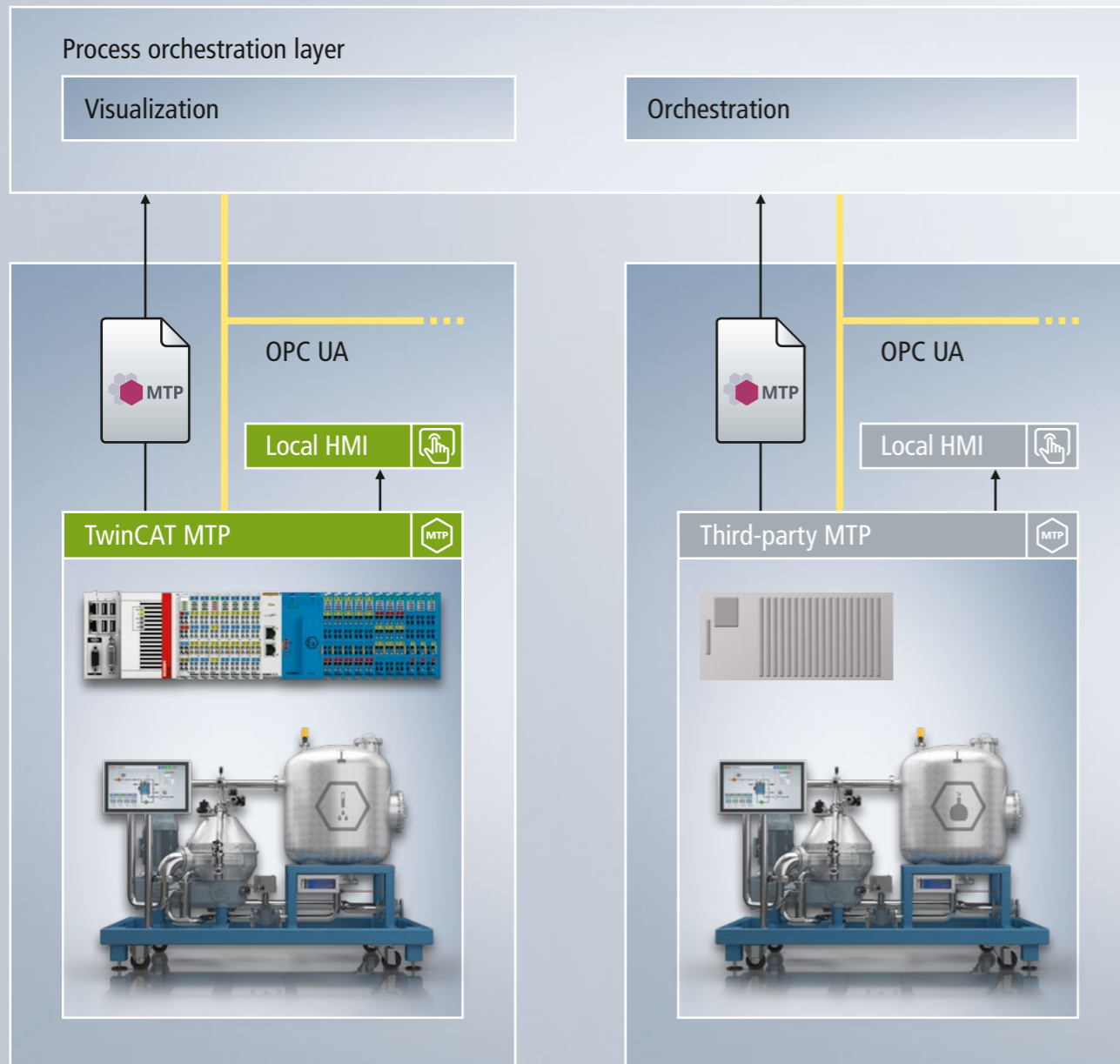
TwinCAT Engineering environment with integrated MTP project management
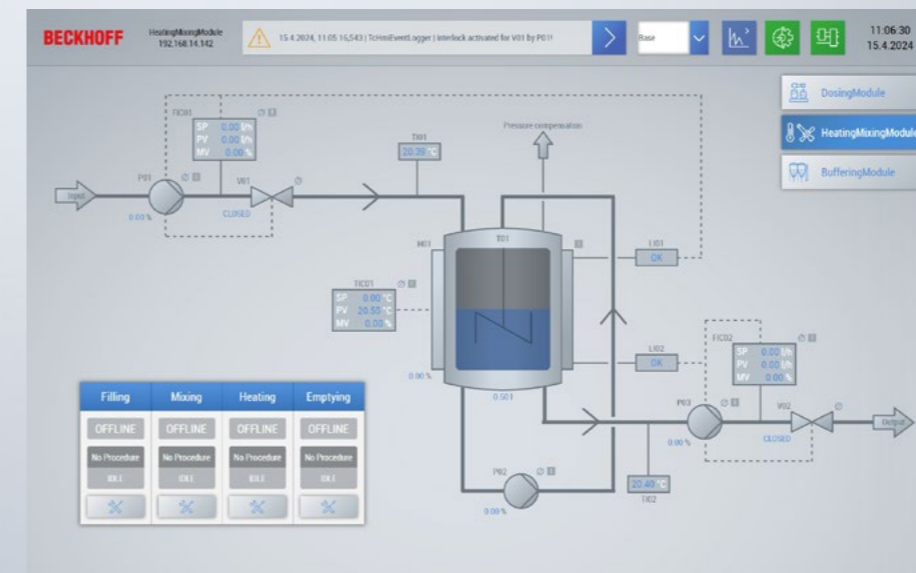
Automatically generated HMI in live view

- Seamless integration into TwinCAT Engineering
- Interface-driven MTP engineering
- Option to import and export MTP files before programming
- Integrated engineering achieved by importing P&ID information
- Automatic PLC code generation based on the module definition
- Automatic generation of the local HMI

Implementation of the NAMUR Open Architecture (NOA)

The NAMUR Open Architecture (NOA) is intended to make previously unused data from the field level available for higher-level plant monitoring and optimization without affecting the existing automation structure. Beckhoff has developed a NOA Edge Device specifically for this NOA scenario. The edge device, which consists of a compact embedded PC, EtherCAT Terminals, and the relevant TwinCAT project, can be placed directly in the plant.
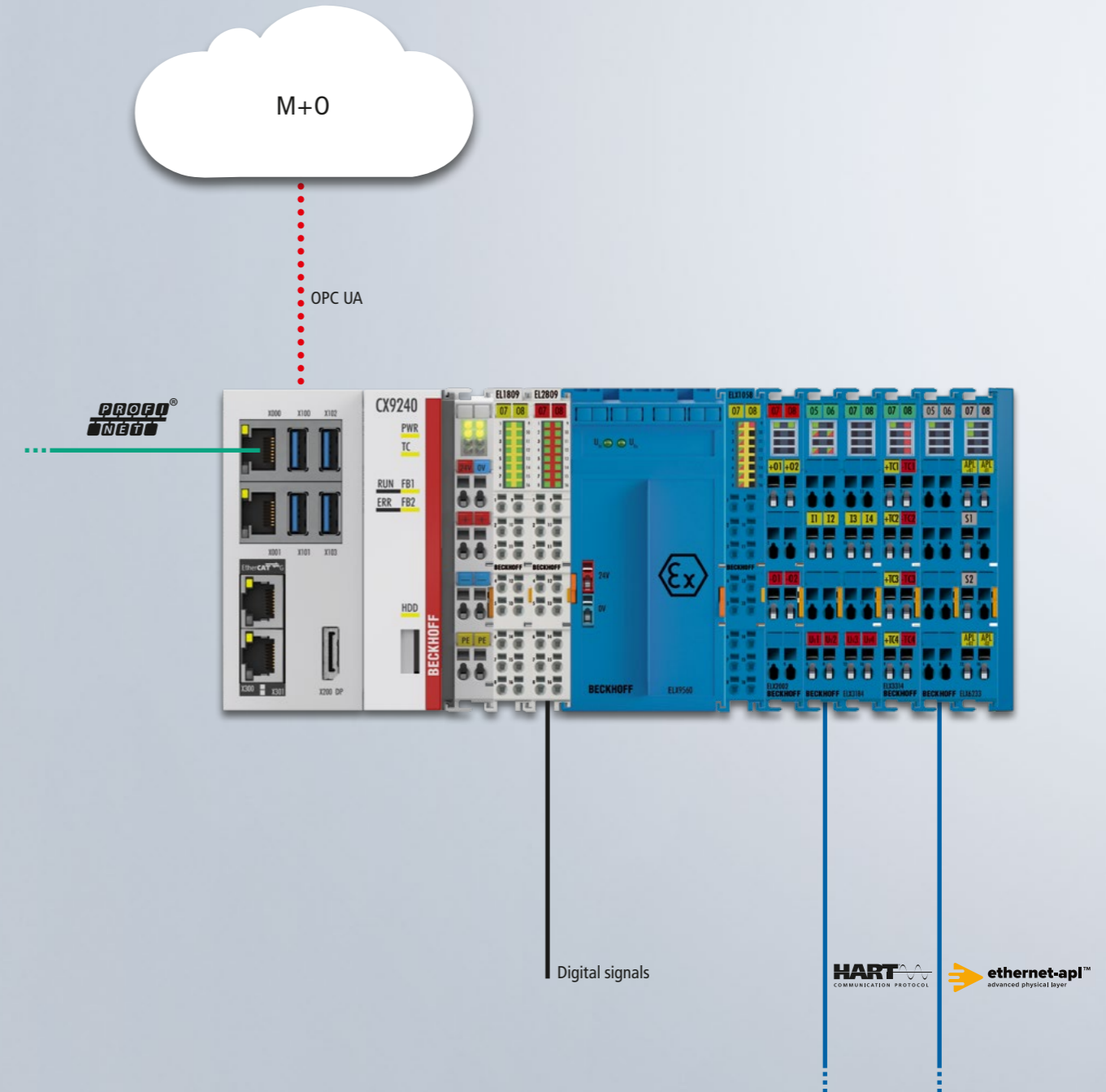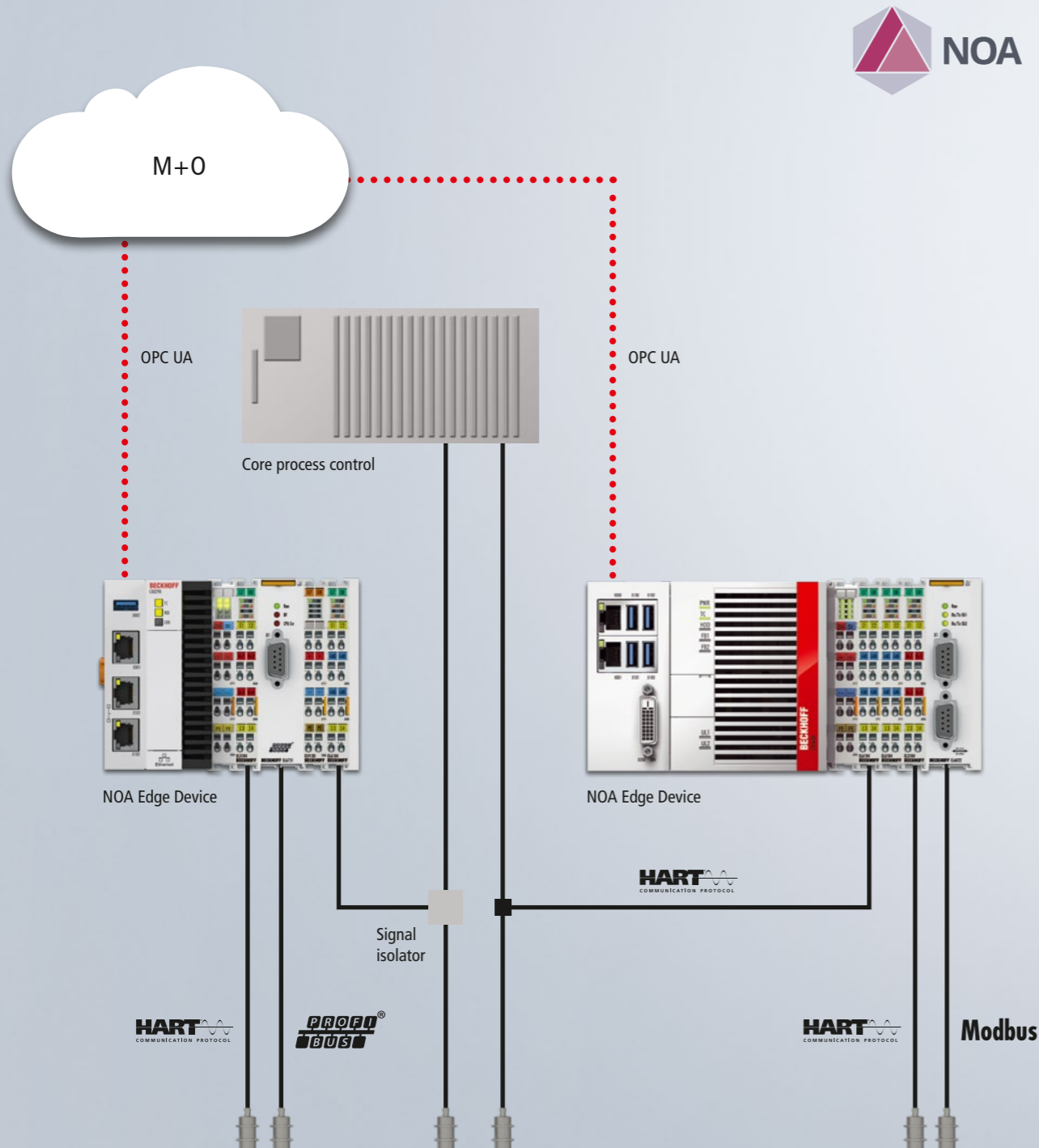
▶ www.beckhoff.com/noa

NAMUR Open Architecture

ERP
MES
HMI
PLC
Field level
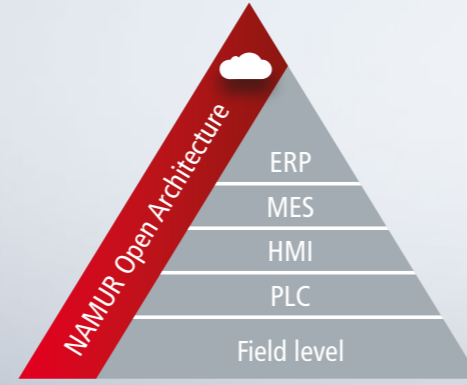
Modular integration of Ethernet-APL

The Ethernet-APL concept aims to implement the entire communication in process technology plants – from field level to higher-level control systems – on an Ethernet foundation. Beckhoff integrates the Ethernet-APL technology into its modular terminal portfolio. The compact ELX6233 can be mounted in the control cabinet in combination with other EtherCAT Terminals so that Ethernet-APL field devices can be read in together with other digital and analog signals in the same I/O terminal segment.

▶ www.beckhoff.com/ethernet-apl

ethernet-apl™

NOA

M+O

OPC UA

Core process control

OPC UA

NOA Edge Device

NOA Edge Device

HART
COMMUNICATION PROTOCOL

Signal isolator

HART
COMMUNICATION PROTOCOL

PROFI BUS®

HART
COMMUNICATION PROTOCOL

Modbus

M+O

OPC UA

PROFI NET®

CX9240

Digital signals

HART
COMMUNICATION PROTOCOL

ethernet-apl™
advanced physical layer

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, drive, 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.
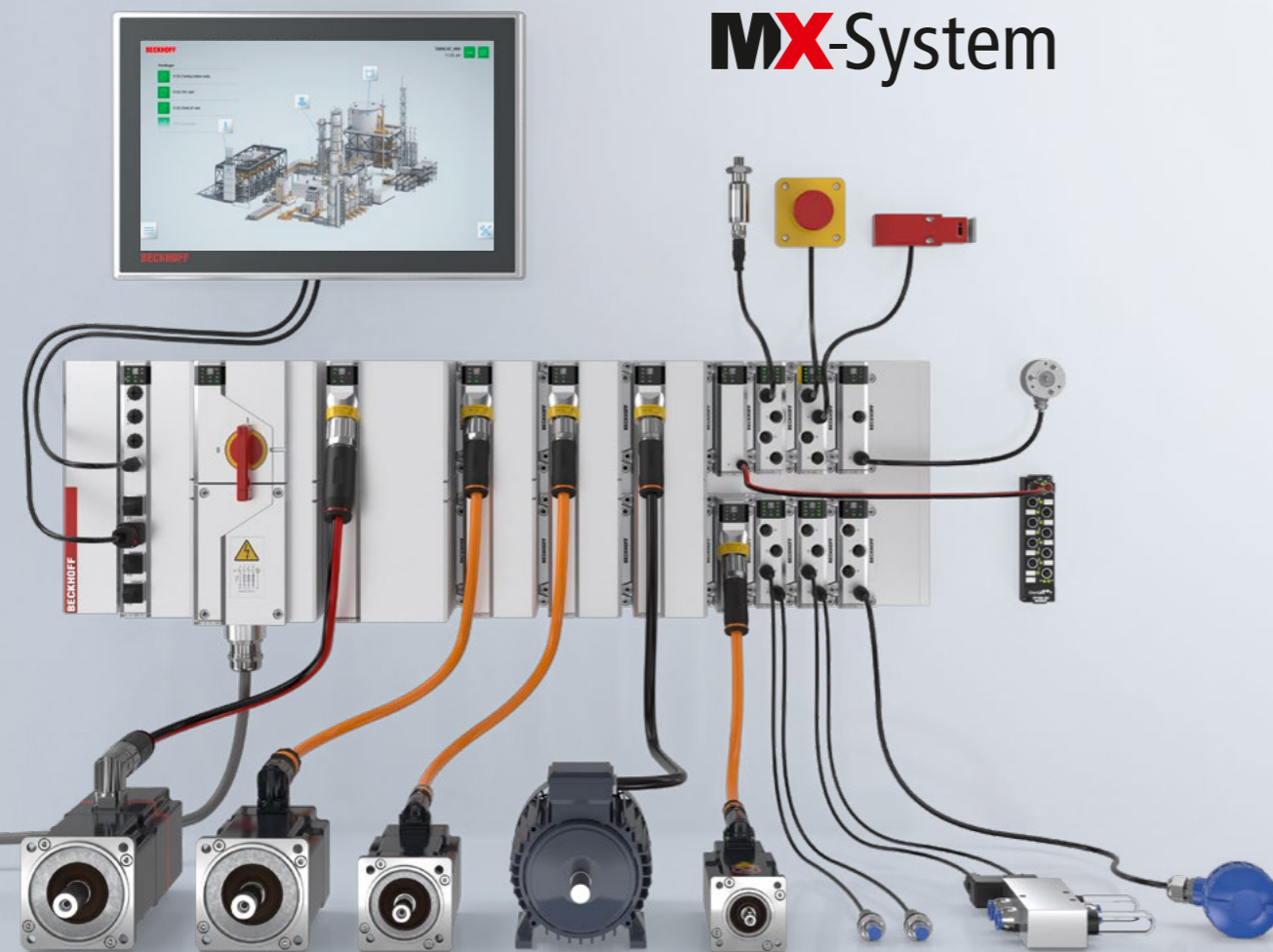

MX-System

Controller redundancy increases availability

With plant availability playing such a crucial role in the process industry, measures to increase this include using redundant architectures to safeguard against failures of individual control components. Beckhoff offers a wide range of solutions in this regard, including EtherCAT cable redundancy for avoiding failures due to faulty cable connections.

When it comes to redundant controller operation, TwinCAT Controller Redundancy with its system-integrated software solution allows two standard industrial PCs to be operated as redundant controllers that both run the same PLC program in just a few steps.

Redundant controller operation with TwinCAT Controller Redundancy:
- redundant design of the control prevents downtime and data loss
- standard hardware components
- based on Ethernet and EtherCAT
- simple project planning and transparent addressing of the redundant system
- support for PLC features such as online change

Components for plant automation
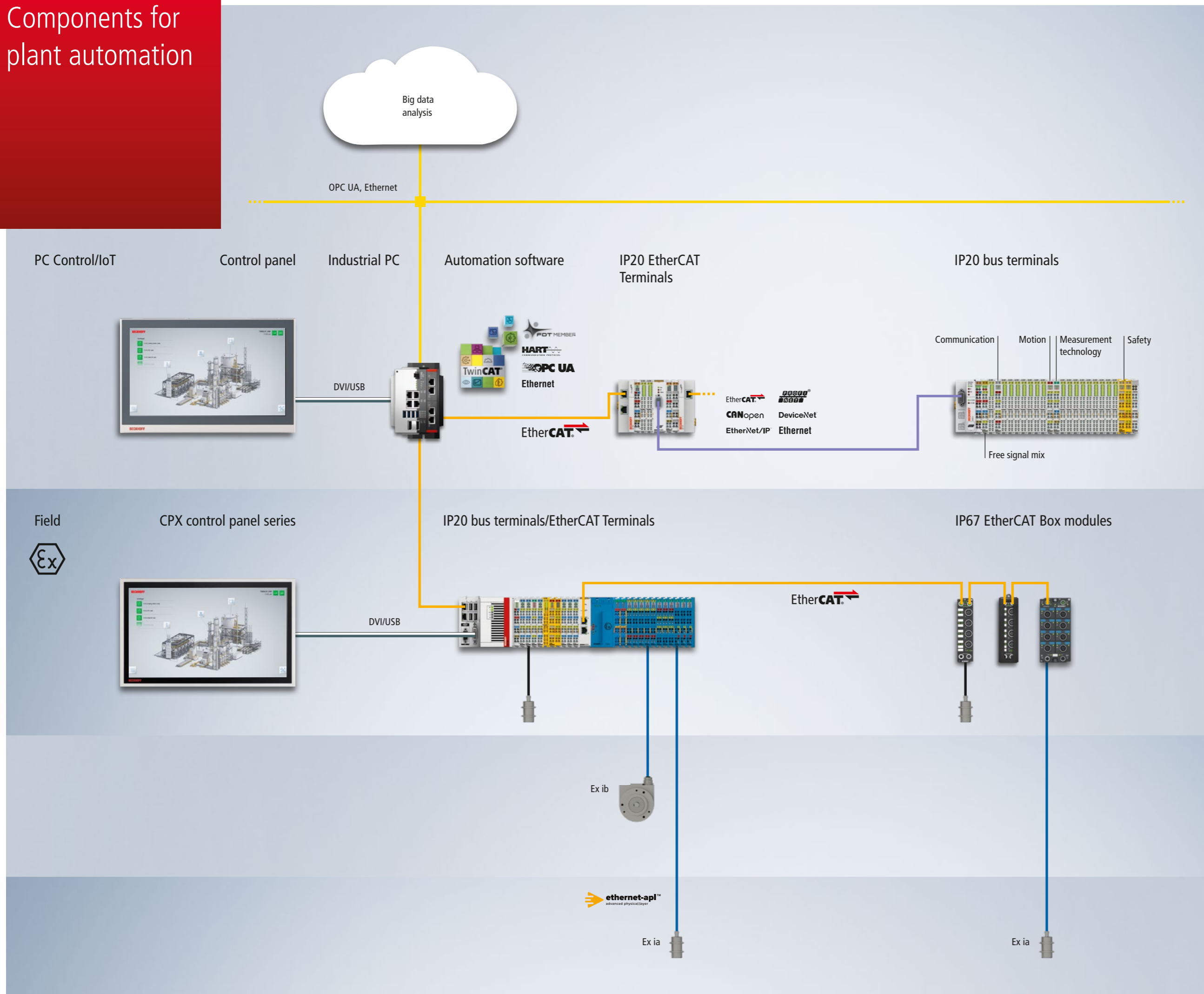
The Beckhoff product range includes all the components required for process automation: from PC-based control and the remote I/O level for all common signal types and bus systems to high-quality IP65 control panels.

Big data analysis

OPC UA, Ethernet

| PC Control/IoT | Control panel | Industrial PC | Automation software | IP20 EtherCAT Terminals | | IP20 bus terminals |

DVI/USB

TwinCAT

FDT MEMBER

HART

OPC UA

Ethernet

EtherCAT.

EtherCAT.

PROFINET

CANopen   DeviceNet

EtherNet/IP   Ethernet

Communication | Motion | Measurement technology | Safety

Free signal mix

| Field | CPX control panel series | IP20 bus terminals/EtherCAT Terminals | IP67 EtherCAT Box modules |

⟨Ex⟩

DVI/USB

EtherCAT.

Zone 2/22

In addition to the IP20 bus terminals/EtherCAT Terminals for control cabinet mounting, Beckhoff also supplies IP67 modules (for direct mounting in the process environment) for use in zone 2/22. Products with an increased temperature range and optional coating are available for use under harsh environmental conditions. All components for zone 2/22 are tested by external certifying bodies.
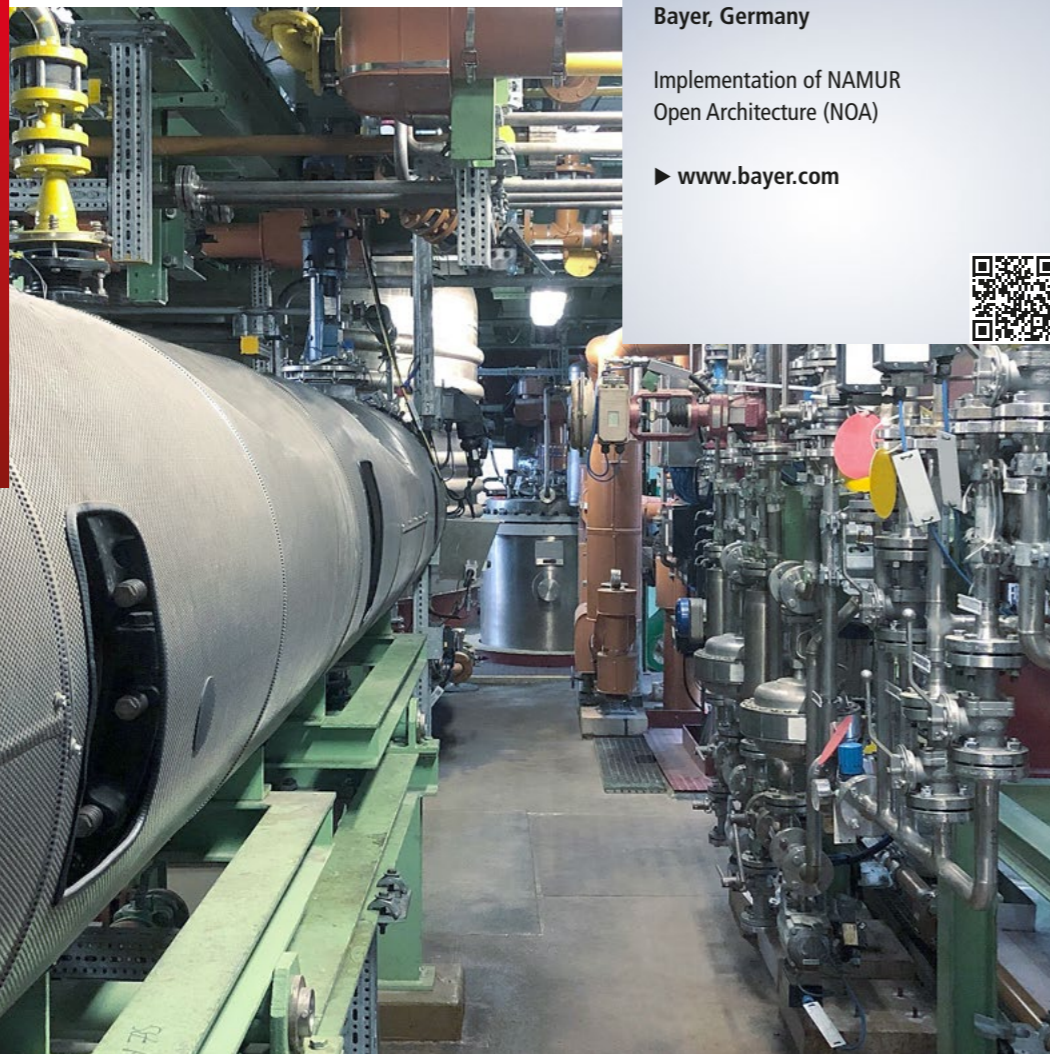
Ex ib

Zone 1/21

Intrinsically safe field devices from zone 1/21 are connected directly to I/O modules with intrinsically safe interfaces.

ethernet-apl™
advanced physical layer

Ex ia

Ex ia

Zone 0/20

Intrinsically safe field devices from zone 0/20 are connected directly to I/O modules with intrinsically safe interfaces.

Our references

Bayer, Germany

Implementation of NAMUR
Open Architecture (NOA)

▶ www.bayer.com

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FourPhase, Norway

PC-based control optimizes oil
and gas production
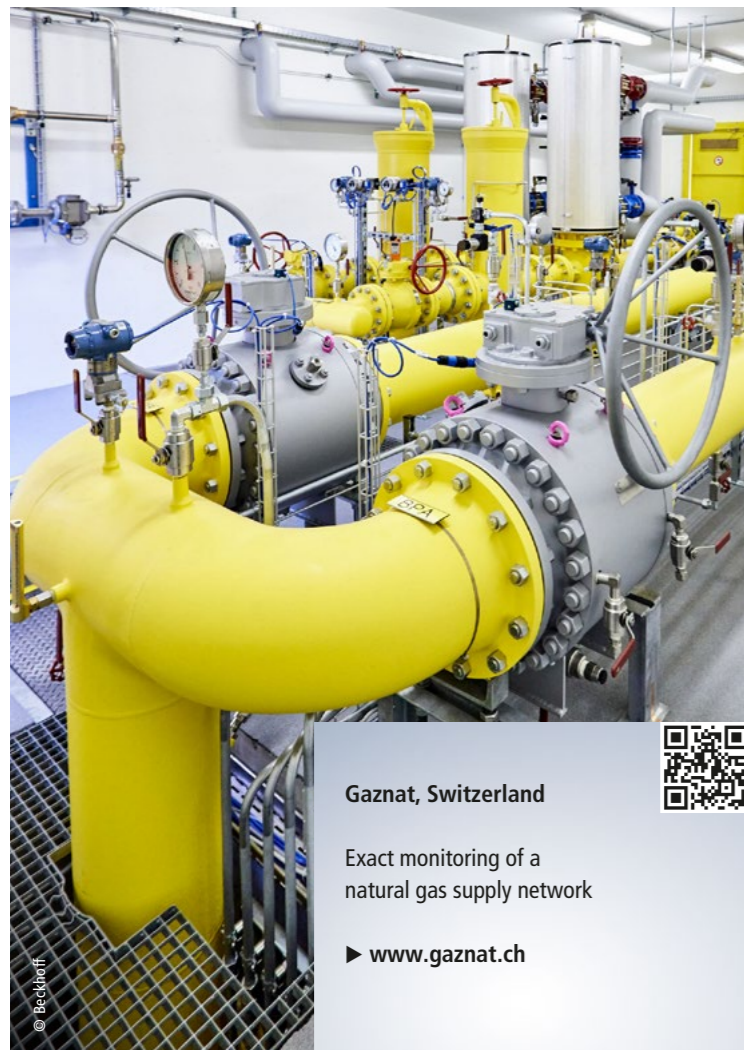
▶ www.fourphase.com

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Denmark**

Real-time control of hydrogen
filling stations

▶ www.nelhydrogen.com

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Exact monitoring of a
natural gas supply network

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