BECKHOFF New Automation Technology

EtherCAT – ultra-fast communication standard

EtherCAT: global standard for real-time Ethernet from the field to the I/Os

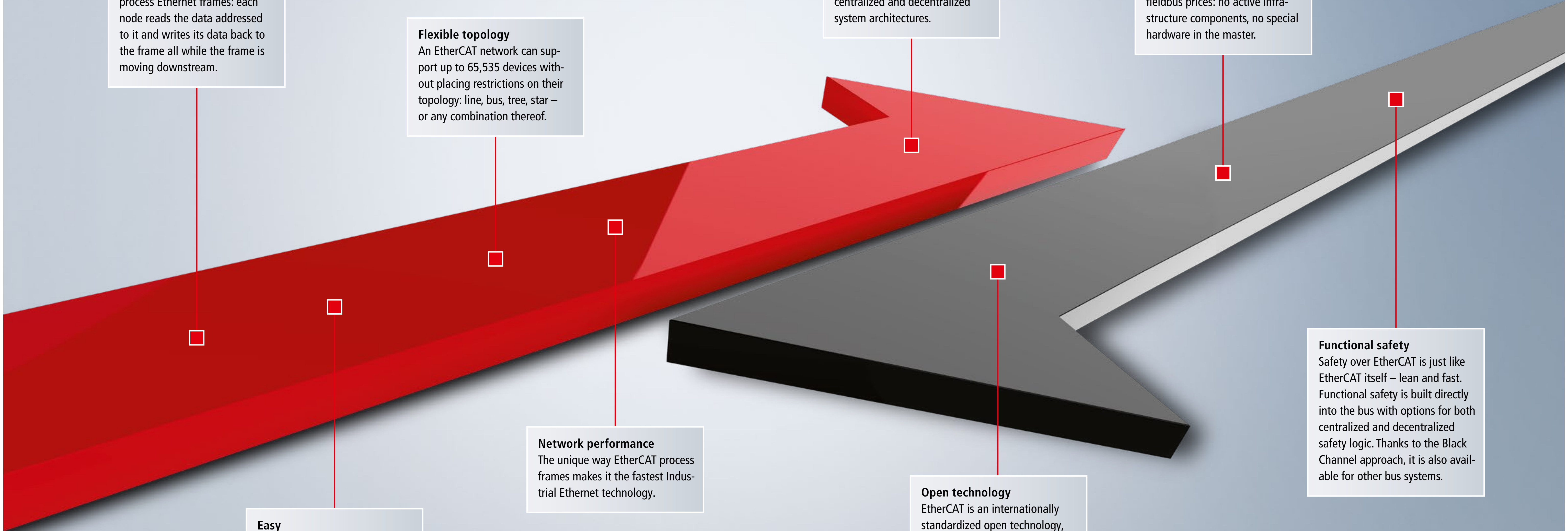
In 2003, Beckhoff introduces its EtherCAT technology into the market. The EtherCAT Technology Group (ETG) is formed, supported initially by 33 founder members. The ETG goes on to standardize and maintain the technology. The group is the largest fieldbus user organization in the world, with more than 5000 members (as of 2019) currently. In 2005, the Safety over EtherCAT protocol is rolled out, expanding the EtherCAT specification to enable safe transmission of safety-relevant control data. The low-footprint protocol uses a so-called Black Channel, making it completely independent of the communication system used.

In 2007, EtherCAT is adopted as an IEC standard, underscoring how open the system is. To this day, the specification remains unchanged; it has only been extended and compatibility has been retained. As a result, devices from the early years, even from as far back as 2003, are still interoperable with today's devices in the same networks.

Another milestone is achieved in 2016 with EtherCAT P, which introduces the ability to carry power (2 x 24 V) on a standard Cat.5 cable alongside EtherCAT data. This paves the way for machines without control cabinets.

The launch of EtherCAT G/G10 in 2018 introduces higher data transmission rates. Interoperability with the existing EtherCAT equipment base is a core requirement, so steps are taken to enable integration, including introduction of the so-called branch model.

EtherCAT Technology Group



How it works
The key functional principle of EtherCAT lies in how its nodes process Ethernet frames: each node reads the data addressed to it and writes its data back to the frame all while the frame is moving downstream.

Flexible topology
An EtherCAT network can support up to 65,535 devices without placing restrictions on their topology: line, bus, tree, star – or any combination thereof.

Versatile
Factory-wide communication: EtherCAT is suitable for both centralized and decentralized system architectures.

Low-cost
EtherCAT delivers all of the advantages of Industrial Ethernet at fieldbus prices: no active infrastructure components, no special hardware in the master.

Easy
Easier than classic fieldbus systems: onboard diagnostics with fault localization, node addresses can be set automatically, there is no need for network tuning.

Network performance
The unique way EtherCAT process frames makes it the fastest Industrial Ethernet technology.

Open technology
EtherCAT is an internationally standardized open technology, meaning anyone is free to use the technology in a compatible form. Today, the EtherCAT Technology Group is the world's largest fieldbus organization.

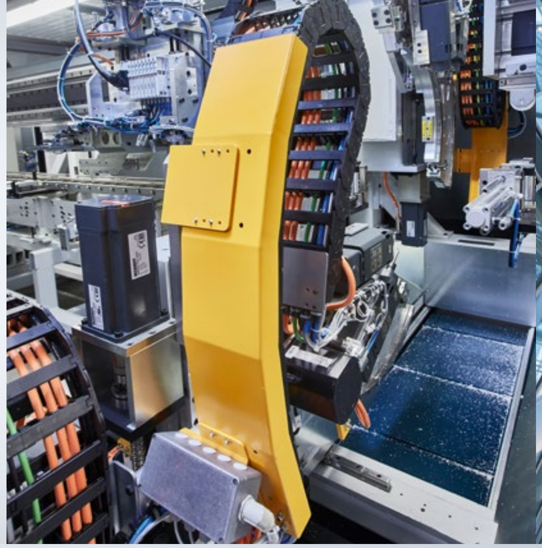
Functional safety
Safety over EtherCAT is just like EtherCAT itself – lean and fast. Functional safety is built directly into the bus with options for both centralized and decentralized safety logic. Thanks to the Black Channel approach, it is also available for other bus systems.

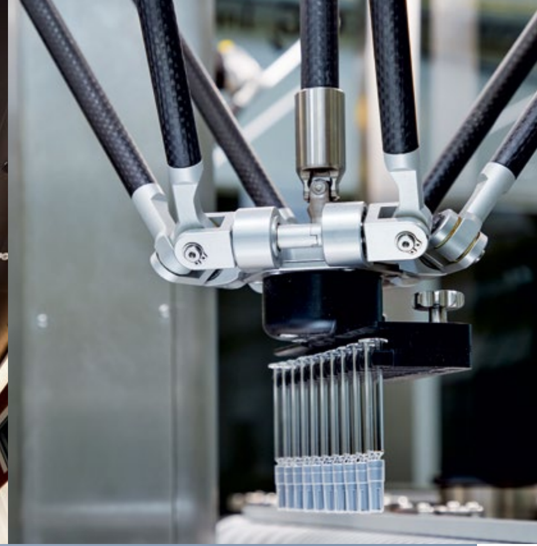
Engineer's choice: the 5 key benefits of EtherCAT

The unique way that EtherCAT works makes it the clear "engineer's choice" e.g. in:

- robotics
- machine tools
- packaging machines
- printing presses
- plastic manufacturing equipment
- presses
- test benches
- pick-and-place machines
- measurement systems
- power plants
- substations
- material handling applications
- baggage handling systems
- stage control systems
- tunnel control systems
- offshore applications
- building automation systems
- wind turbines
- automated guided vehicles
- medical devices
- woodworking machines
- etc.

▶ www.beckhoff.com/ethercat





Exceptional performance

1

EtherCAT is by and large the fastest Industrial Ethernet technology, but it also synchronizes with nanosecond accuracy.

This is a huge benefit for all applications in which the target system is controlled or measured via the bus system. The rapid reaction times work to reduce the wait times during the transitions between process steps, which significantly improves application efficiency. Lastly, the EtherCAT system architecture typically reduces the load on the CPU by 25 – 30 % in comparison to other bus systems (given the same cycle time). When optimally applied, the performance of EtherCAT leads to improved accuracy, greater throughput, and lowered costs.

Flexible topology

2

In EtherCAT applications, the machine structure determines the network topology, not the other way around. In conventional Industrial Ethernet systems, there are limitations on how many switches and hubs can be cascaded, which thus limits the overall network topology. Since EtherCAT does not need hubs or switches, there are no such limitations. In short, EtherCAT is virtually limitless when it comes to network topology. Line, tree, star topologies and any combinations thereof are possible with a nearly unlimited number of nodes. Thanks to automatic link detection, nodes and network segments can be disconnected during operation and then reconnected – even somewhere else. Line topology is extended to a ring topology for the sake of cable redundancy. All the master device needs for this redundancy is a second Ethernet port, and the slave devices already support the cable redundancy. This makes switching out devices during machine operation possible.

It is simple and robust

3

Configuration, diagnostics, and maintenance are all factors that contribute to system costs. The Ethernet fieldbus makes all of these tasks significantly easier: EtherCAT can be set to automatically assign addresses, which eliminates the need for manual configuration. A low bus load and peer-to-peer physics improve electromagnetic noise immunity. The network reliably detects potential disturbances down to their exact location, which drastically reduces the time needed for troubleshooting. During startup, the network compares the planned and actual layouts to detect any discrepancies. EtherCAT performance also helps during system configuration by eliminating the need for network tuning. Thanks to the large bandwidth, there is capacity to transmit additional TCP/IP together with the control data. However, since EtherCAT itself is not based on TCP/IP, there is no need to administer MAC addresses or IP addresses or to have IT experts configure switches and routers.

Integrated safety

4

Functional safety as an integrated part of the network architecture? Not a problem with FailSafe over EtherCAT (FSoE). FSoE is proven in use through TÜV-certified devices that have been on the market since 2005. The protocol fulfills the requirements for SIL3 systems and is suitable for both centralized and decentralized control systems. Thanks to the Black Channel approach and the particularly lean safety container, FSoE can be used in other bus systems. This integrated approach and the lean protocol help keep system costs down. Additionally, a non-safety critical controller can also receive and process safety data.

Affordability

5

EtherCAT delivers the features of Industrial Ethernet at a price similar or even below that of a classic fieldbus system. The only hardware required by the master device is an Ethernet port – no expensive interface cards or co-processors are necessary. EtherCAT Slave Controllers are available from various manufacturers in different formats: as an ASIC, based on FPGA, or as an option for standard microprocessor series. Since these inexpensive controllers shoulder all the time-critical tasks, EtherCAT itself does not place any performance requirements on the CPU of slave devices, which keeps device costs down. Since EtherCAT does not require switches or other active infrastructure components, the costs for these components and their installation, configuration, and maintenance are also eliminated.

EtherCAT Technology Group: international standardization and global activities

The EtherCAT Technology Group (ETG) keeps EtherCAT technology open for all potential users. It brings EtherCAT device manufacturers, technology providers, and users together to further the technology. They are focused on one common goal: keeping EtherCAT stable and interoperable. The ETG holds multiple Plug Fests in Europe, Asia, and America each year. The Plug Fests bring EtherCAT device developers together to test and ensure device interoperability. Using the official EtherCAT Conformance Test Tool, each manufacturer conformance tests its EtherCAT devices prior to their release. The ETG awards the manufacturer a Conformance Certificate following a successful test in an accredited test lab.

The ETG has the largest number of members out of any fieldbus organization in the world. The list of members can be found on its homepage. However, the decisive factor is not how many members there are, but how active the members are in the ETG. Both the number and variety of EtherCAT devices is unparalleled, and the adoption rate of EtherCAT across Europe, Asia, and America is outstanding.

Milestones

2003	Introduction of EtherCAT technology at Hannover Messe
2003	EtherCAT Technology Group founded at SPS IPC Drives
2005	Safety over EtherCAT
2007	EtherCAT is IEC standard.
2016	EtherCAT P: ultra-fast communication and power via one cable
2018	EtherCAT G: the next performance level with 1 Gbit/s

▶ www.ethercat.org

Communication standards for industrial automation

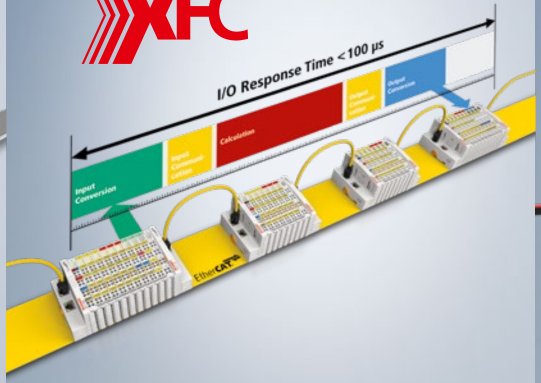
Common features of all EtherCAT technologies

- real-time Ethernet down to the I/O level
- flexible topology
- outstanding diagnostics
- synchronization accuracy better than 100 ns
- exceptionally simple configuration
- low system costs
- maximum performance
- ability to integrate functional safety
- IEEE-802.3-compliant

EtherCAT

EtherCAT: ultra-fast communication standard

XFC



EtherCAT: even faster with XFC

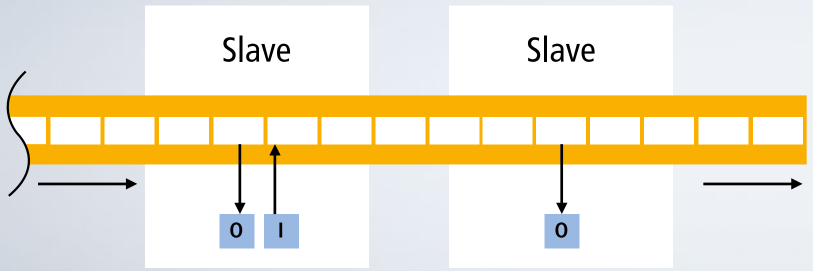
EtherCAT P

EtherCAT P: ultra-fast communication and power in one cable

EtherCAT G

EtherCAT G: scalable I/O performance from 100 to 10,000 Mbit/s

EtherCAT: the technology in detail



Processing on-the-fly

Ethernet header			ECAT	EtherCAT telegram				Ethernet	
DA	SA	Type	Frame HDR	Datagram 1	Datagram 2	...	Datagram n	Pad.	FCS
(6)	(6)	(2/4)	(2)	(10+n+2)	(10+m+2)		(10+k+2)	(0…32)	(4)
	Ethertype 0x88A4								

EtherCAT: standard Ethernet frame according to IEEE 802.3

Based on Ethernet

EtherCAT is Industrial Ethernet and utilizes standard frames and the physical layer as defined in the Ethernet standard IEEE 802.3. However, it also addresses the specific demands faced in the automation industry, where:

- There are hard real-time requirements with deterministic response times.
- The system is usually made up of many nodes, each only having a small amount of cyclic process data.
- Hardware costs are even more important than in IT and office applications.

The above requirements make using a standard Ethernet network at the field level practically impossible. If an individual Ethernet telegram is used for each node, the effective data rate sinks significantly for just a few bytes of cyclic process data: the shortest Ethernet telegram is 84 bytes long (including the Inter Frame Gap), of which 46 bytes can be used for process data.

For example, if a drive sends 4 bytes of process data for the actual position and status information and receives 4 bytes of data for the target position and control information, the effective data rate for both telegrams sinks to 4/84 = 4.8 %. Additionally, the drive usually has a reaction time that triggers the transmission of the actual values after receiving the target values. At the end, not much of the 100 Mbit/s transfer rate remains.

Protocol stacks, such as those used in the IT world for routing (IP) and connection (TCP), require additional overhead for each node and create further delays through the stack runtimes.

How does EtherCAT work?

EtherCAT overcomes the difficulties described in the previous section with its high-performing mode of operation, in which a single frame is usually sufficient to send and receive control data to and from all nodes.

The EtherCAT master sends a telegram that passes through each node. Each EtherCAT slave device reads the data addressed to it "on the fly," and inserts its data in the frame as the frame is moving downstream. The frame is delayed only by hardware propagation delay times. The last node in a segment or branch detects an open port and sends the message back to the master using the full duplex feature.

The telegram's maximum effective data rate increases to over 90 %, and due to the utilization of the full duplex feature, the theoretical effective data rate is even greater than 100 Mbits/s.

The EtherCAT master is the only node within a segment allowed to actively send an EtherCAT frame; all other nodes merely forward frames downstream. This concept prevents unpredictable delays and guarantees real-time capabilities.

The master uses a standard Ethernet Media Access Controller (MAC) without an additional communication processor. This allows a master to be implemented on any hardware platform with an available Ethernet port, regardless of which real-time operating system or application software is used.

EtherCAT slave devices use a so-called EtherCAT Slave Controller (ESC) to process frames on the fly and entirely in hardware, making network performance predictable and independent of the individual slave device implementation.

The EtherCAT protocol

EtherCAT embeds its payload in a standard Ethernet frame. Since the EtherCAT protocol is optimized for short cyclic process data, the use of bulky protocol stacks, such as TCP/IP or UDP/IP, can be eliminated.

The EtherCAT frame contains the frame header and one or more datagrams. The datagram header indicates what type of access the master device would like to execute:

- read, write, or read-write
- access to a specific slave device through direct addressing, or access to multiple slave devices through implicit addressing

Implicit addressing is used for the cyclical exchange of process data. Each datagram addresses a specific part of the process image in the EtherCAT segment, for which 4 Gbytes of address space is available. During network startup, each slave device is assigned one or more addresses in this global address space. If multiple slave devices are assigned addresses in the same area, they can all be addressed with a single datagram.

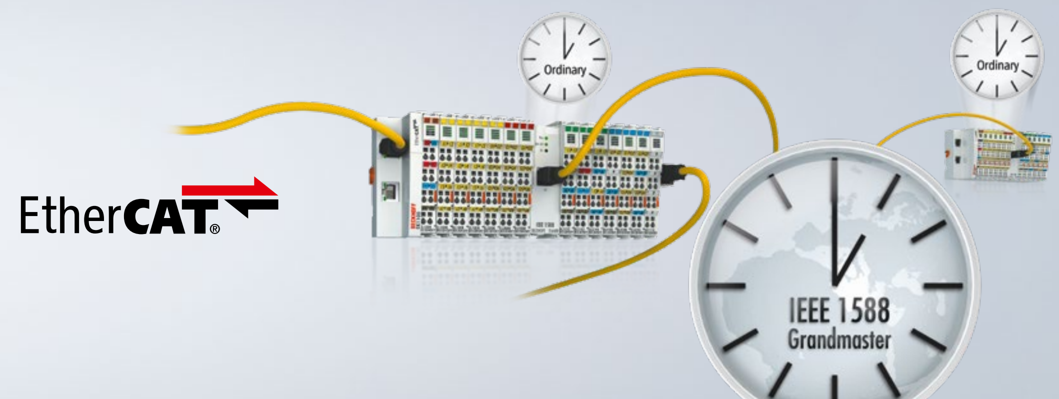
Since the datagrams completely contain all the data access related information, the master device can decide when and which data to access. For example, the master device can use short cycle times to refresh data on the drives, while using a longer cycle time to sample the I/O; a fixed process data structure is not necessary. This relieves the master device in comparison to conventional fieldbus systems, in which the data from each node had to be read individually, sorted with the help of the process controller, and copied into memory. With EtherCAT, the master device only needs to fill a single EtherCAT frame with new output data, and send the frame via automatic Direct Memory Access (DMA) to the MAC controller.

In addition to logical addressing, the master device can also address a slave device via its position in the network. This method is used during network boot up to determine the network topology and compare it to the planned topology. After checking the network configuration, the master device can assign each node a configured node address and communicate with the node via this fixed address. This enables targeted access to devices, even when the network topology is changed during operation, for example with Hot Connect Groups.

There are two approaches for slave-to-slave communication. A slave device can send data directly to another slave device that is connected further downstream in the network. Since EtherCAT frames can only be processed going forward, this type of direct communication depends on the network's topology, and is particularly suitable for slave-to-slave communication in a constant machine design (e.g. in printing or packaging machines). In contrast, freely configurable slave-to-slave communication runs through the master device, and requires two bus cycles (not necessarily two control cycles). Thanks to the excellent performance of EtherCAT, this type of slave-to-slave communication is still faster than with other communication technologies.

EtherCAT: the technology in detail

Simple integration of other bus systems via EtherCAT gateways as underlying system



The EtherCAT distributed clocks are a basic XFC technology and a general component of EtherCAT communication.

Flexible topology

Line, tree, star, or daisy-chain: EtherCAT supports almost all topologies. Pure bus or line topologies with many nodes are possible without limitations. When wiring the system, the combination of lines with branches or drop lines is particularly beneficial: the ports necessary to create branches are directly integrated in many I/O modules, so no additional switches or active infrastructure components are required. Naturally, the star topology, the Ethernet classic, can also be utilized.

Modular, complex machines switch network segments or individual nodes during operation (Hot Connect). EtherCAT slave controllers already include the basis for this feature. If a neighboring station is removed, the port is automatically closed so the rest of the network continues to operate without interference. Very short detection times < 15 µs guarantee a smooth changeover.

A lot of flexibility thanks to cable variance: Inexpensive Industrial Ethernet cables can be used between two nodes up to 100 m apart in 100BASE-TX mode. Fiber optics (such as 100BASE-FX) can be used for distances greater than 100 m. The complete range of Ethernet wiring is also available for EtherCAT.

The ample bandwidth of EtherCAT makes it possible to embed conventional fieldbus networks as an underlying system via an EtherCAT gateway, which is particularly helpful when migrating from a conventional fieldbus to EtherCAT. The changeover to EtherCAT is gradual, making it possible to continue using automation components that do not yet support an EtherCAT interface.

EtherCAT supports up to 65,535 devices per segment, so network expansion is virtually unlimited. Because of the practically unlimited number of nodes, modular devices such as "sliced" I/O stations are designed in such a way that each module is an EtherCAT node of its own. Hence, the local extension bus is eliminated; the high performance of EtherCAT reaches each module directly and without any delays, since there is no gateway in the bus coupler or head station any more.

Diagnostics and error localization

Experience with conventional fieldbus systems has shown that diagnostic characteristics play a major role in determining a machine's availability and commissioning time. In addition to error detection, error localization is important during troubleshooting. EtherCAT features the possibility to scan and compare the actual network topology with the planned topology during boot up. EtherCAT also has many additional diagnostic capabilities inherent to its system.

The EtherCAT Slave Controller in each node checks the moving frame for errors with a checksum. Information is provided to the slave application only if the frame has been received correctly. If there is a bit error, the error counter is incremented and the subsequent nodes are informed that the frame contains an error. The master device detects that the frame is faulty and discards its information. The master device is able to detect where the fault originally occurred in the system by analyzing the nodes' error counters. This is an enormous advantage in comparison to conventional fieldbus systems, in which an error is propagated along the entire party line, making it impossible to localize the source of the error. EtherCAT can detect and localize occasional disturbances before the issue impacts the machine's operation.

Thanks to the unique principle of bandwidth utilization of EtherCAT, which is orders of magnitude better than industrial Ethernet technologies that use single frames, the likelihood of disturbances induced by bit errors within an EtherCAT frame is substantially lower – if the same cycle time is used. And, if in typical EtherCAT fashion much shorter cycle times are used, the time required for error recovery is significantly reduced. Thus, it is much simpler to master such issues within the application.

Distributed clocks for high-precision synchronization

In applications with spatially distributed processes requiring simultaneous actions, exact synchronization is particularly important. For example, this is the case for applications in which multiple servo axes execute coordinated movements.

In contrast to completely synchronous communication, whose quality suffers immediately from communication errors, distributed synchronized clocks have a high degree of tolerance for jitter in the communication system. Therefore, the EtherCAT solution for synchronizing nodes is based on such distributed clocks (DC).

The calibration of the clocks in the nodes is completely hardware-based. The time from the first DC slave device is cyclically distributed to all other devices in the system. With this mechanism, the slave device clocks can be precisely adjusted to this reference clock. The resulting jitter in the system is significantly less than 1 µs.

Since the time sent from the reference clock arrives at the slave devices slightly delayed, this propagation delay must be measured and compensated for each slave device in order to ensure synchronicity and simultaneousness. This delay is measured during network startup or, if desired, even continuously during operation, ensuring that the clocks are simultaneous to within much less than 1 µs of each other.

If all nodes have the same time information, they can set their output signals simultaneously and affix their input signals with a highly precise timestamp. In motion control applications, cycle accuracy is also important in addition to synchronicity and simultaneousness. In such applications, velocity is typically derived from the measured position, so it is critical that the position measurements are taken precisely equidistantly (i.e. in exact cycles).

High availability requirements

For machines or equipment with very high availability requirements, a cable break or a node malfunction should not mean that a network segment is no longer accessible, or that the entire network fails. EtherCAT enables cable redundancy with simple measures. By connecting a cable from the last node to an additional Ethernet port in the master device, a line topology is extended into a ring topology. A redundancy case, such as a cable break or a node malfunction, is detected by a software add-on in the master stack. That is all there is to it. The nodes themselves do not need to be modified, and do not even "know" that they are being operated in a redundant network.

Link detection in the slave devices automatically detect and resolve redundancy cases with a recovery time less than 15 µs, so at maximum, a single communication cycle is disrupted. This means that even motion applications with very short cycle times can continue working smoothly when a cable breaks.

With EtherCAT, it is also possible to realize master device redundancy with Hot Standby. Vulnerable network components, such as those connected with a drag chain, can be wired with a drop line, so that even when a cable breaks, the rest of the machine keeps running.

EtherCAT: even faster with XFC

XFC (eXtreme Fast Control) represents a control technology that enables very fast and highly deterministic responses. It includes all hardware and software components involved in control applications: optimized input and output components that can detect signals with high accuracy or initiate tasks; a very fast communication network, advanced Industrial PCs, and automation software that links all system components. This technology opens up new process optimization opportunities for the user that were not possible in the past due to technical limitations. With XFC it is possible to achieve I/O response times < 100 µs.

XFC is based on optimized control and communication architectures comprising a high-performance Industrial PC, ultra-fast I/O terminals with extended real-time characteristics, the EtherCAT high-speed Ethernet system, and TwinCAT automation software.

Higher production efficiency with extremely fast control technology

XFC also includes technologies that not only improve cycle times but also temporal accuracy and resolution:

- distributed clocks
- timestamp/multi-timestamp
- oversampling
- fast I/Os

Users benefit from options for enhancing the quality of their machines and reducing response times. Measuring tasks such as preventive maintenance measures, monitoring of idle times or documentation of parts quality can simply be integrated in the machine control without additional, costly special devices. In a practical automation solution, not everything has to be extremely fast and accurate – many tasks can still be handled with "normal" solutions. XFC technology is therefore fully compatible with existing solutions and can be used simultaneously with the same hardware and software.

▶ www.beckhoff.com/xfc

Industrial PC – The extremely fast control CPU

- Industrial PC based on high-performance real-time motherboards
- compact form factors optimized for control applications

EtherCAT Terminals – The extremely fast I/O technology

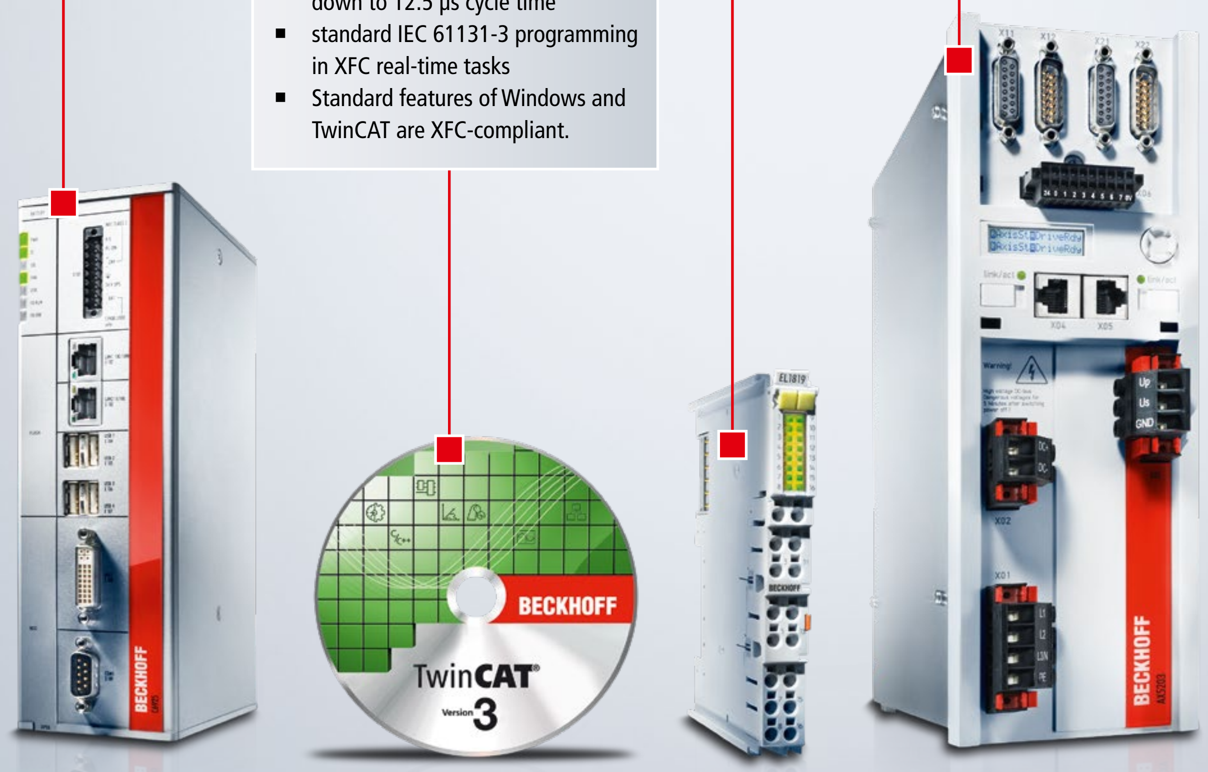
- full range I/O line for all signal types
- high-speed digital and analog I/Os
- Timestamping and oversampling features allow extremely high timing resolution (down to 10 ns).

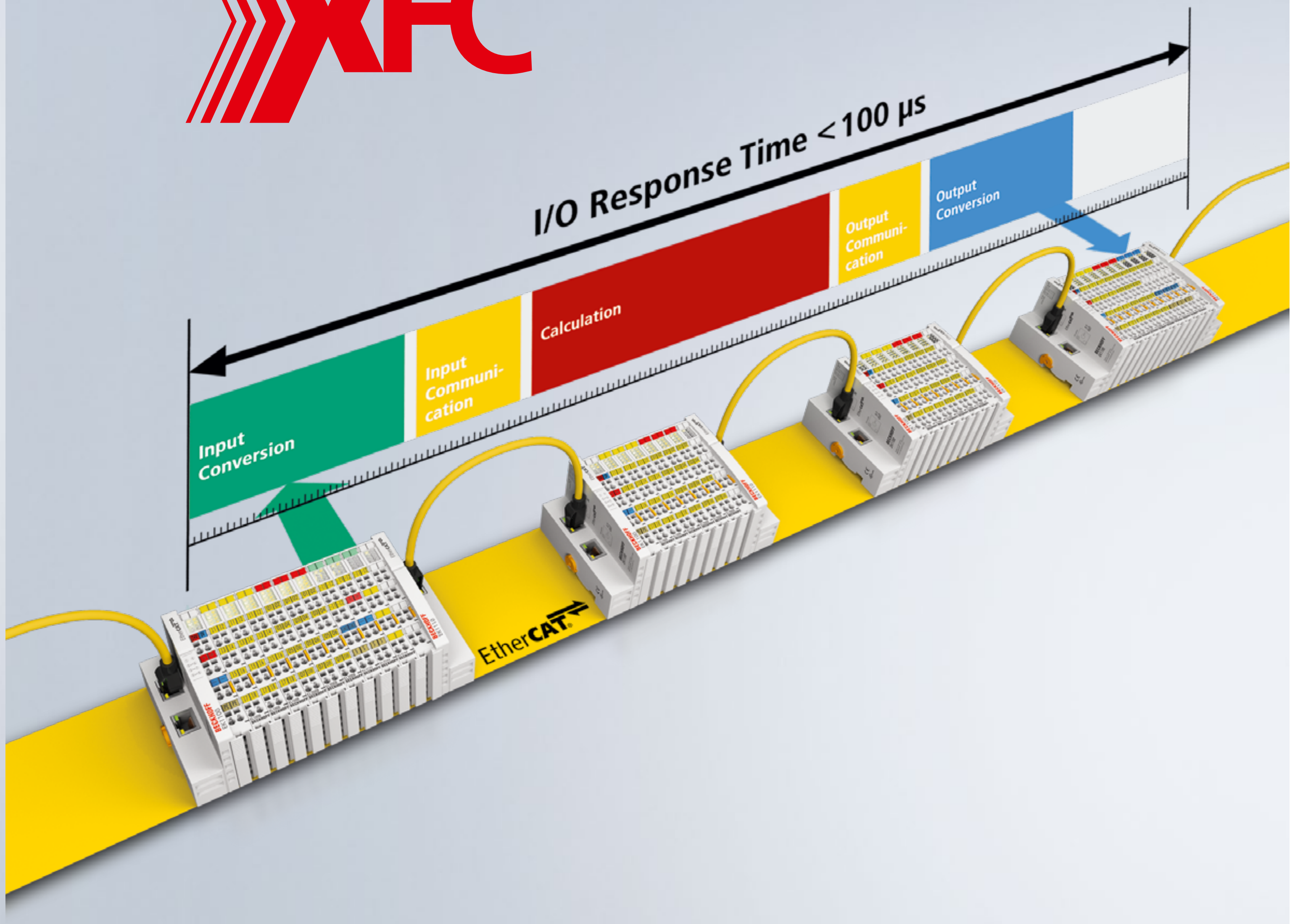
EtherCAT – The extremely fast control communication technology

- 1000 distributed digital I/Os in 30 µs
- EtherCAT down to the individual I/O terminals, no sub bus required
- optimized use of standard Ethernet Controllers, e.g. Intel® PC chipset architecture in the EtherCAT master
- advanced real-time feature based on distributed clocks
  - synchronization
  - timestamping
  - oversampling

TwinCAT – The extremely fast real-time control software

- real-time under Microsoft Windows down to 12.5 µs cycle time
- standard IEC 61131-3 programming in XFC real-time tasks
- Standard features of Windows and TwinCAT are XFC-compliant.





EtherCAT P: ultra-fast communication and power in one cable

EtherCAT P (P = power) is an addition to the EtherCAT protocol standard. It enables not only the transmission of communication data, but also the peripheral voltage via a single, standard four-wire Ethernet cable.

EtherCAT and EtherCAT P are identical in terms of the protocol technology, as the addition exclusively affects the physical layer. No new EtherCAT Slave Controllers are necessary when using EtherCAT P. EtherCAT P has the same communication advantages as EtherCAT, but also provides the power supply via the communication cable, offering attractive benefits and enhancements for numerous applications.

Two electrically isolated, individually switchable 24 V supplies power the EtherCAT P devices:

- U_S for system and sensor supply
- U_P for periphery and actuator supply

Both voltages are directly coupled into the 100 Mbit/s EtherCAT communication line, including the power transmission to cascade several EtherCAT P devices. The bundling of these features results in reduced cabling, more compact, cost-effective wiring, lower system costs and a smaller footprint for devices, equipment and machines.

Simplified system cabling

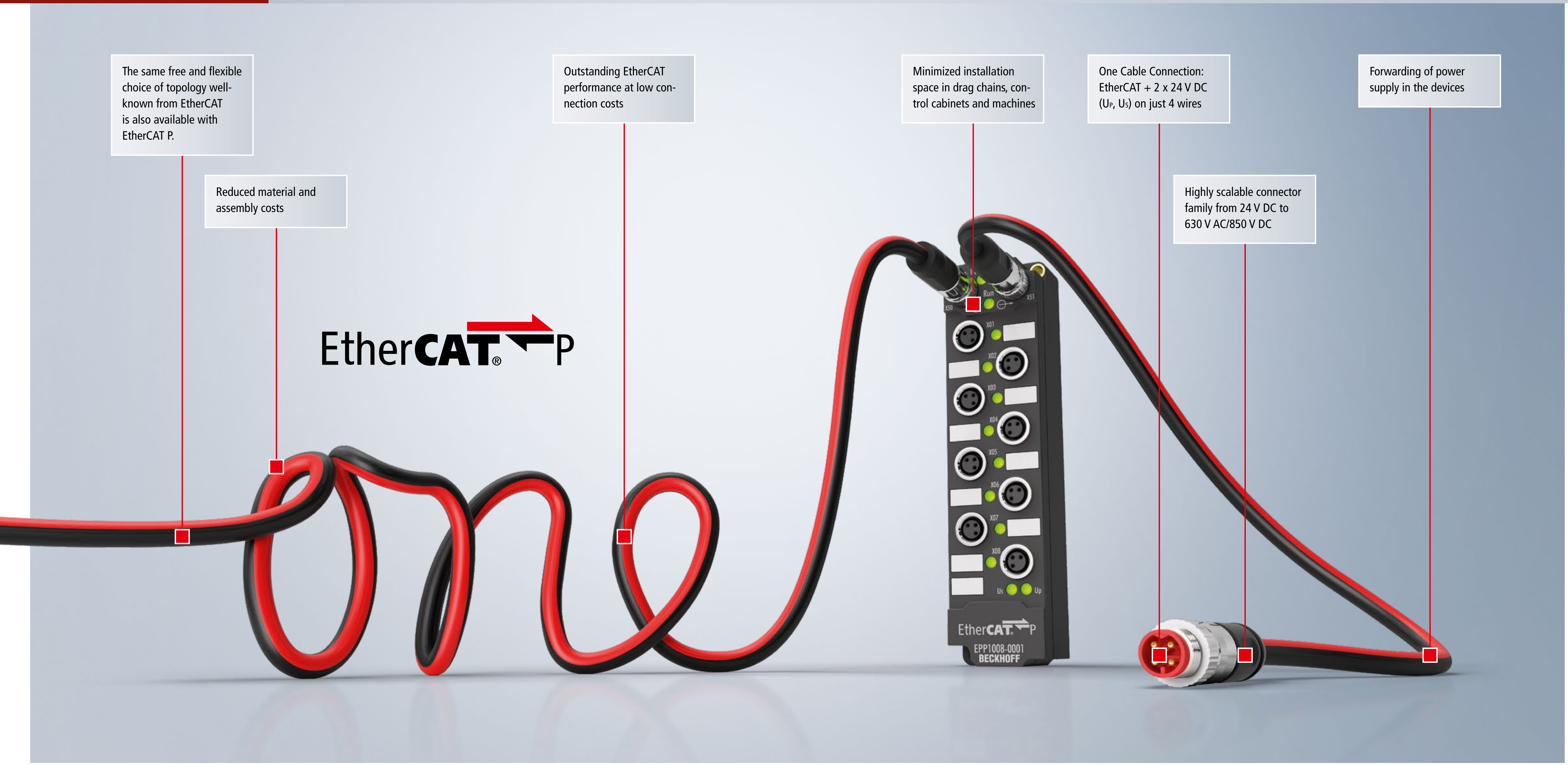
The fundamental idea of EtherCAT P is to simplify system wiring by reducing the number of connectors on automation components and devices. The single-cable solution, which is highly scalable according to individual power requirements, can be deployed on the entire field level: A conventional standard Ethernet cable is used for the 24 V range. For higher voltages and currents, EtherCAT P is integrated into the corresponding power cable.

Eliminating the need for separate supply cables reduces material costs, installation effort and time, as well as the risks of installation errors. In addition, the installation space required in drag chains, control cabinets and in the machine itself is minimized. Moreover, cable routes become smaller and less cluttered, and the size of sensors and actuators can be reduced. Overall, this opens up significantly more freedom in system design, while minimizing material or system costs, which can be further reduced using specific tools for system planning.

Flexible topology

EtherCAT P topologies are just as freely selectable and customizable as with EtherCAT. The current carrying capacity of 3 A per EtherCAT P segment enables a wide range of sensors/actuators to be used. The IP 67 infrastructure components can be used for creating the required network structure directly in the field. EtherCAT P can be used in the same network together with standard EtherCAT technology. Appropriate rectifier units transform common EtherCAT physics to EtherCAT P by consistently maintaining the Ethernet data encoding. In the same way, a device itself can be supplied with EtherCAT P but, in turn, can also transmit the EtherCAT protocol.

▶ www.beckhoff.com/ethercatp



EtherCAT G: scalable I/O performance from 100 to 10,000 Mbit/s

EtherCAT G builds on the principles of the successful EtherCAT technology but moves the available data rates up to 1 Gbit/s and 10 Gbit/s. The EtherCAT protocol itself remains unchanged. All of the devices on a network receive the telegrams sent by the EtherCAT master. Each EtherCAT slave still reads the data addressed to it "on the fly" and inserts its own data into the frame as the frame moves downstream; now, though, it does this at 1 Gbit/s or 10 Gbit/s.

Hardware propagation times are the only factor delaying telegram processing. The last device in a segment or stub line identifies an open port and utilizes the full duplex feature of Ethernet network physics to send the telegram back to the master. EtherCAT G and EtherCAT G10 also retain all other capabilities of EtherCAT.

Devices with three or four ports (junctions) enable users to flexibly configure network topologies that suit the exact requirements of their machine architecture. Optional machine modules can still be plugged and unplugged via the Hot Connect feature. Network-wide diagnostics are available to help minimize machine downtime and increase availability. And the built-in system of distributed clocks still ensures devices are synchronized precisely in better than 100 ns.

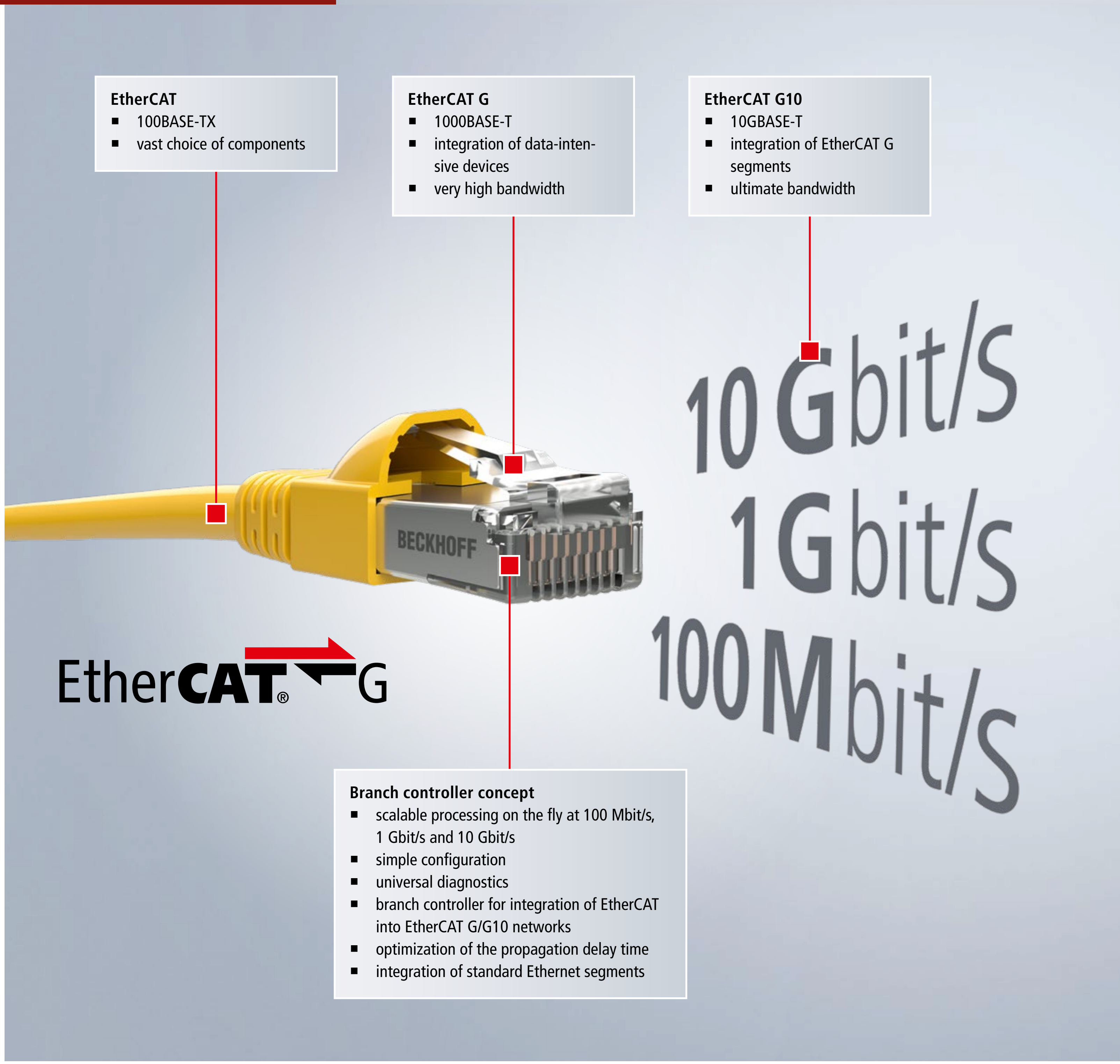
Technology expansion for data-intensive applications

Machine vision, condition monitoring and highly innovative transport systems like the eXtended Transport System (XTS) and XPlanar all rely on the ability to transmit several hundred bytes of process data per device and cycle. This, along with short cycle times of ≤ 1 ms, calls for high data bandwidths. With EtherCAT G, applications and systems like these can generally be supported with a single EtherCAT G master while at the same time incorporating other automation equipment or drives. The branch model for EtherCAT G was developed to address growing demand for ever shorter cycle times in increasingly extensive systems integrating large numbers of devices. On a branch controller, each branch represents its own EtherCAT segment. As usual with EtherCAT, the branch controllers can be configured via the EtherCAT master, without the need for additional configuration tools. The branch controller supports diagnostics and distributed clocks synchronization, forwarding both transparently to connected segments. Branch controllers with multiple branches offer users immense flexibility when creating network topologies.

Rollout of EtherCAT G made easy

EtherCAT is the leading communication standard in industrial automation, and this means machine builders today can choose from a broad, unparalleled variety of thousands of compatible devices. This device compatibility is core for the technology expansion to EtherCAT G.

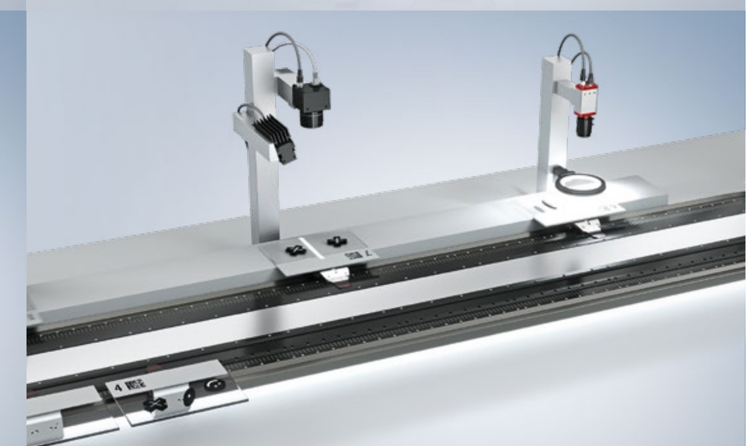
▶ www.beckhoff.com/ethercatg

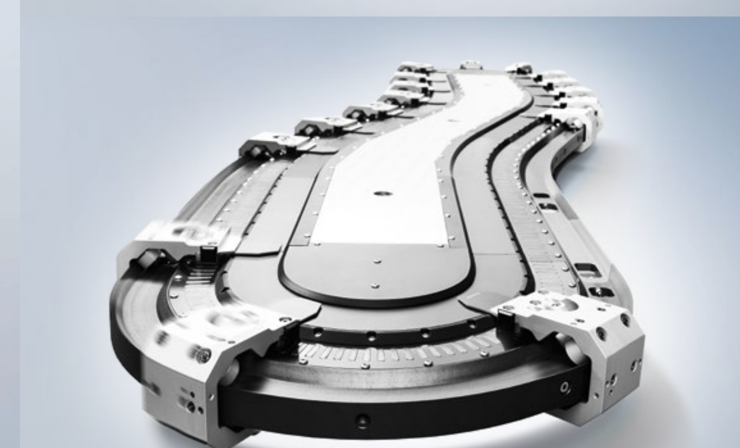



Measurement technology


Motion

XFC – eXtreme Fast Control


Vision


XTS


XPlanar

EtherCAT accessory milestones in the Beckhoff portfolio

With EtherCAT accessories from Beckhoff, future-oriented technologies can be easily integrated: EtherCAT G/G10 combines the advantages of EtherCAT with speeds of up to 10 Gbit/s in an 8-wire Cat.6 cable. EtherCAT P combines communication and power in the 4-wire standard Ethernet cable for automation without control cabinets. Hybrid cables as single-cable solutions for high currents and voltages enable potential savings with maximum flexibility in machine design.

▶ www.beckhoff.com/io-accessories

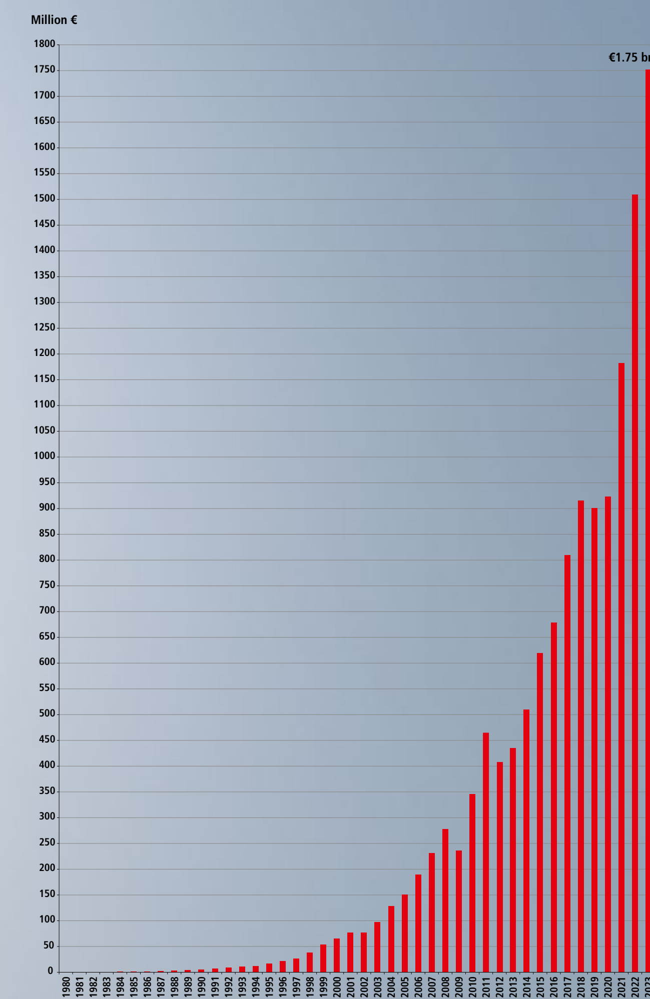
Beckhoff worldwide

New Automation Technology
Beckhoff implements open automation systems using PC-based control technology. The product portfolio comprises these main areas: Industrial PCs, I/O and fieldbus components, drive technology and automation software. Product lines are available for all areas and can be used as individual components or as a complete system. The New Automation Technology philosophy from Beckhoff represents innovative and open control and automation solutions that are used worldwide in a variety of applications ranging from CNC machine tools to intelligent building automation.

Worldwide presence on all continents
With local presence in 75 countries, Beckhoff ensures fast service worldwide and technical support in the local language for globally operating customers. In addition, Beckhoff sees close geographic proximity to customers as a prerequisite for a profound understanding of the technical challenges facing customers.

Beckhoff Automation at a glance
- 2023 global sales: €1.75 billion (+16 %)
- Headquarters: Verl, Germany
- Managing owner: Hans Beckhoff
- Employees worldwide: 5,500
- Engineers: 2,000
- Subsidiaries/representative offices worldwide: 40
- Sales offices in Germany: 23
- Representatives worldwide: > 75

▶ **www.beckhoff.com**



Sales from 1980 through 2023.
Status: March 2024

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