

**BECKHOFF** New Automation Technology

PC-based Control for the Tire and Rubber Industry



# Beckhoff | Open automation solutions for the rubber and tire industry

Rubber and tire production is based on a very complex process that requires control and coordination of different production stages. Compliance with top-quality standards is just one of many entrepreneurial challenges the sector has to face. As suppliers to the automotive industry, rubber and tire producers are subjected to strong economic cycles and therefore fluctuating demand. Other factors include enormous competitive and price pressures. What the sector needs in view of these underlying conditions are intelligent and cost-effective automation solutions. This is exactly what Beckhoff offers with its PC-based control, both for new systems and existing systems, in which the machines are often in good condition mechanically while the control and drive section is no longer state-of-the-art. In such cases, a retrofit can achieve the required adaptation to market requirements and increase the productivity and reliability of the machines many times over. Many companies are not fully automated and operate in a very labour- and cost-intensive manner. However, in the long-term, the product quality expected by end users can only be combined with cost-effectiveness and profitability of the production facilities through the application of cutting-edge production equipment.

In the tire industry the requirements for control technology are clearly defined: fast cycle times, precise positioning, flexible programming and parameterisation, adequate memory for large process images, central control for sequential and positioning control, user-friendly user interfaces, integration in shop floor networks, open interfaces – and all that at low costs. In addition, the control components must also be able to withstand the extreme industrial conditions with high contamination and high temperatures encountered in vulcanisation, for example.

## Cost-effective solutions for high performance

With its extensive range of robust, high-performance Industrial PCs in compact design, without fans or rotating mass storage, industrial Control Panels, a wide range of I/O components, the high-speed EtherCAT fieldbus and cutting-edge Servo Drive Technology, Beckhoff offers an integrated, coordinated, scalable control system for the rubber and tire industry.

Through the application of top-quality industrial components Beckhoff Industrial PCs guarantee absolute reliability for 24-hour operation. Advanced processors provide ample computing power for sequential control, control and Motion Control on a single platform. The tire sector also benefits from the long-standing experience that Beckhoff has with embedded systems in the form of an extensive range of Embedded PCs in different performance classes. For each control task a tailor-made solution with regard to computing power, complexity and costs can be found based on standard components.

An industrial display unit (protection class IP 67) complements the Industrial PC. The Beckhoff Control Panels are the visually appealing front end of a tire production machine. Customers are offered an optimum control unit that is individually tailored to the requirements of the respective application. Distances of up to 100 m between the display/control unit and the control computer enable maximum flexibility.

## Continuity and openness

All processes including control, regulation of pressure and temperature, Motion Control and HMI, run on a central CPU, resulting in optimum



transparency and flexibility for the user. The high processor power offered by PC technology enables integration of all functions and replaces complex and expensive special hardware. The central control system, with local I/O level, also reduces the cabling effort and downtimes. Additional factors are cost and system benefits, for example due to the visualisation running on the same IPC that also deals with the machine control.

## High performance thanks to EtherCAT

EtherCAT, the fast real-time Ethernet technology for industrial automation, improves the update and reaction times by at least a factor of 10 compared with conventional fieldbus technology. Apart from the standard Ethernet port, the PC controller requires no special plug-in cards. Conventional fieldbus systems such as PROFIBUS or CANopen can easily be integrated into the EtherCAT I/O system via gateways. Simple and reliable connection technology reduces the cabling effort and therefore the costs.

XFC (eXtreme Fast Control), the EtherCAT-based control technology from Beckhoff, can also be used to optimise other areas of application in the tire industry, including high-precision acquisition of measuring probe events with time stamps, high-precision synchronisation of coupled servo axes, acquisition of measured values for quality assurance purposes with the aid of oversampling terminals, fast control of process pressures through fast analog terminals and TwinCAT controller structures, and high-precision and fast temperature measurement through temperature input terminals based on 4-wire technology.

It is conceivable that special hardware in measuring and testing machines will be entirely replaced by EtherCAT I/Os in the future.



### TwinCAT – one software for all functions

TwinCAT, the automation software from Beckhoff, is a pure software PLC and Motion Control solution for PCs. PLC programming is based on the international IEC 61131-3 standard. Open communication interfaces support integration into existing visualisation, control and database systems. Process tracking or remote maintenance are therefore easy to realise. Comprehensive TwinCAT libraries with different control algorithms, cam and hydraulic controls, flying saw and cam plates simplify programming. Master and slave axes can be linked in almost any configuration, and the high-performance and versatile motion functions cover all requirements of the tire industry: linear master/slave couplings with variable coupling factors can be used for angularly aligned application of carcass and belt layers onto the winding drum. The cam plate functionality enables angle-dependent wrapping of bandages onto the winding drum. The measuring probe function integrated in TwinCAT enables logging of actual positions "on the fly" for determining the position and length of fabric and belt layers on supply and splice belts.

### Integrated safety

In recent years, operational and work safety have played an ever larger part in machine construction. In TwinSAFE, Beckhoff offers a uniform system solution for optimum synergy between automation and safety technology. The safety solution integrated in the fieldbus also reduces the space requirement in the control cabinet and the wiring effort.

[www.beckhoff.com/rubber](http://www.beckhoff.com/rubber)

### Beckhoff | New Automation Technology

Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

### Innovative products and a full range of services

Since the foundation of the company in 1980, continuous development of innovative products and solutions using PC-based control technology has been the basis for the continued success of Beckhoff. Many automation technology standards that are taken for granted today were conceptualised by Beckhoff at an early stage and successfully introduced to the market.

- 1982: P1000 – single-board motion controller
- 1986: PC Control – first PC-based machine controller
- 1988: S1000 – software PLC/NC on PC (DOS)
- 1989: Lightbus – high-speed fieldbus utilising optical fibre
- 1990: All-in-one PC motherboard
- 1995: Bus Terminal – fieldbus technology in terminal block format
- 1996: TwinCAT – real-time software package under Windows with PLC and Motion Control functions
- 1998: Control Panel – remote IPC Control Panels
- 1999: Fieldbus Box – the I/O system in IP 67
- 2002: CX1000 – modular Embedded PCs for DIN rail mounting
- 2003: EtherCAT – real-time Ethernet fieldbus system
- 2005: TwinSAFE – safety solution for the Bus Terminal system
- 2005: AX5000 – EtherCAT Servo Drive
- 2007: Industrial Motherboards – Made in Germany
- 2008: XFC – eXtreme Fast Control Technology
- 2009: HD Bus Terminals – 16-channel terminals in 12 mm

The Beckhoff PC Control philosophy and the invention of the Lightbus system, the Bus Terminals and TwinCAT automation software represent milestones in automation technology and have become accepted as high-performance alternatives to traditional control technology. EtherCAT, the real-time Ethernet solution, makes forward-looking, high-performance technology available for a new generation of leading edge control concepts.

### Worldwide presence on all continents

The central divisions of Beckhoff, such as development, production, administration, distribution, marketing, support and service are located at the Beckhoff Automation GmbH headquarters in Verl, Germany. Rapidly growing presence in the international market is taking place through 28 subsidiaries. Through worldwide cooperation with partners, Beckhoff is represented in more than 70 countries.

# Beckhoff | PC-based control for tire production

## Mixing

TwinCAT enables integration of different fieldbus systems for variable-speed drives. High-performance Industrial PCs enable large process images and multi-tasking for process control, weighing, metering, controlling and palletising on a single platform.

## Preparation

The use of EtherCAT and XFC enables fast and precise extruder control. EtherCAT guarantees short cycle times and increases the output of cutting systems through shorter cutting cycles.

## Tire building

This is where angularly aligned, linear gear coupling for layer feeding to the winding drum, cam plates for bandage winding and fast sequential control is used. PC Control combines user interface, sequential control and Motion Control on a single platform.



## Curing

Beckhoff Control Panels in curing design with PLC function keys on the side enable convenient and fast operation of the curing press. Thanks to PC technology, the complete heating process can be documented and transferred to higher-level systems in the network for archiving.

## Material handling

Beckhoff fieldbus technology is ideal for extensive material handling systems. Thanks to the open architecture, local drive systems, bar code scanners and RFID systems can be integrated into the fieldbus.

## Testing machines

TwinCAT for controlling the machine processes and the Motion Control solution, TwinSAFE for machine safety and EtherCAT as a fast communication system provide an ideal basis for testing machines.



### TwinCAT

Automation software for PLC and Motion Control with a uniform engineering tool for different processor platforms

# Beckhoff | Universal system solutions for the tire and rubber indu

Ethernet

Control Panel

DVI/USB



### Industrial PC

With the Industrial PCs and Panel PCs Beckhoff offers PC technology with top performance. The IPC is complemented by an industrial display unit. The Beckhoff Control Panels are the visual front end for machines or plants. Spatial separation of display/control unit and control computer offers maximum flexibility.

### EtherCAT drives

The AX5000 Servo Drive series is available in single- or multi-channel form and is optimised in terms of function and cost-effectiveness. Integrated control technology supports fast and highly dynamic positioning tasks. EtherCAT as a high-performance communication system enables ideal interfacing with PC-based control technology.

**EtherCAT** 



### EtherCAT

EtherCAT is the real-time Ethernet fieldbus for industrial automation, offering flexible topology and simple handling, among other benefits. With its high communication speed and high user data rates, EtherCAT features the basic qualification for fast control technology.



**Software PLC and Motion Control**

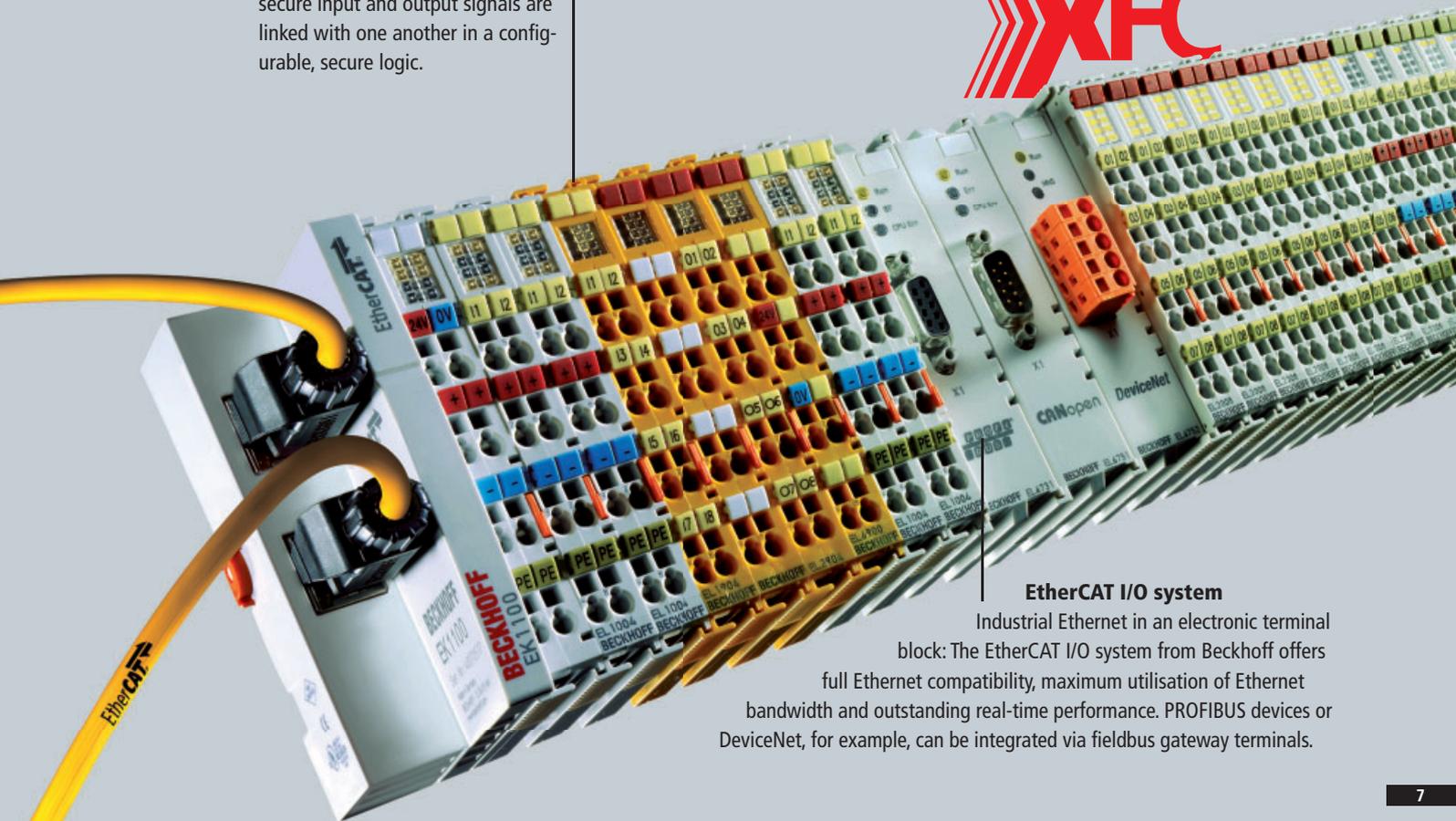
TwinCAT integrates real-time control with PLC system, Motion Control and programming environment in a single package. Programming is executed in accordance with the IEC 61131-3 standard.

**XFC – eXtreme Fast Control Technology**

XFC is based on an optimised control and communication architecture comprising an advanced Industrial PC, ultra-fast I/O terminals with extended real-time characteristics, the EtherCAT high-speed Ethernet fieldbus, and the TwinCAT automation software.

**TwinSAFE**

With the TwinSAFE I/O terminals, secure input and output signals are linked with one another in a configurable, secure logic.

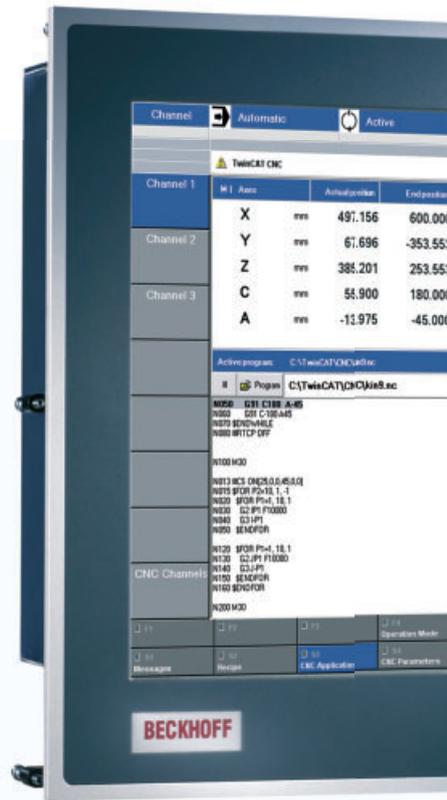


**EtherCAT I/O system**

Industrial Ethernet in an electronic terminal block: The EtherCAT I/O system from Beckhoff offers full Ethernet compatibility, maximum utilisation of Ethernet bandwidth and outstanding real-time performance. PROFIBUS devices or DeviceNet, for example, can be integrated via fieldbus gateway terminals.

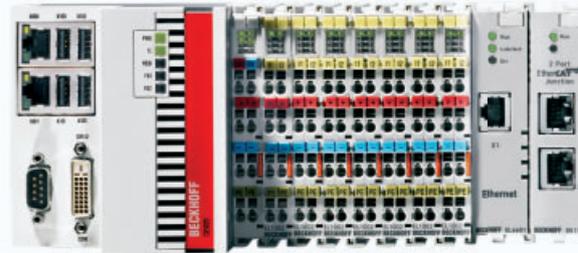
# Beckhoff | Customised automation

Beckhoff offers a scalable, modular control system that provides suitable solutions for any task in terms of computing capacity, complexity and costs. All Beckhoff controllers, irrespective of their performance class, are programmed in IEC 61131-3 via the TwinCAT automation software.

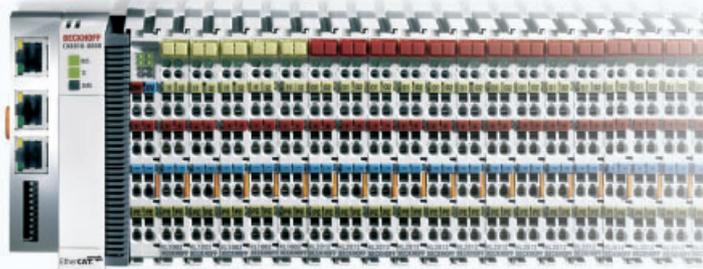


→ IPC

→ CX

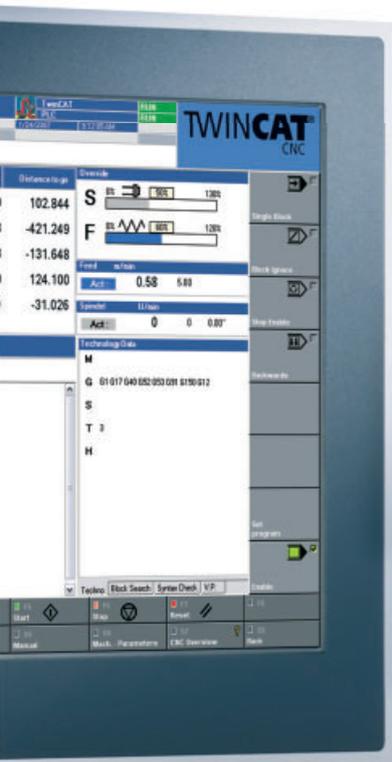


→ CX



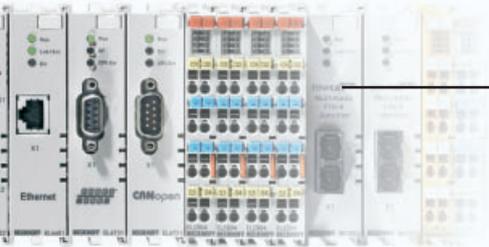
→ BC





### PC Control

- the most powerful hardware platform equipped with top-performance components
- based on open IT and automation standards
- Individual housing constructions ensure optimised adaptation to the control requirements.



### Embedded PC Control

- for control tasks in the medium performance range
- DIN rail mountable, modular and can be configured according to the task in hand
- CX controllers combine PLC, Motion Control and direct I/O interface
- fanless CPU modules with different processors without rotating storage media
- expandable PC and fieldbus interfaces



### Embedded Control

- small controllers with integrated interface for the Beckhoff Bus Terminal system
- interfaces for all common fieldbus and Ethernet systems

### TwinCAT

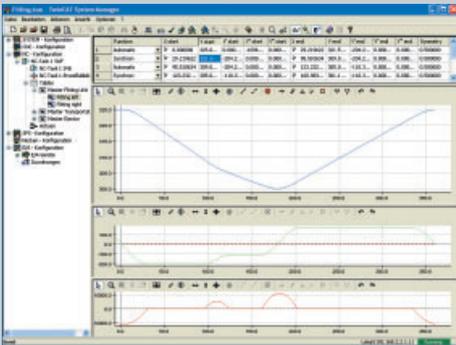
- software-based real-time controller with multiple PLCs, Motion Control, robotics and programming environment
- runs under Windows NT/2000/XP/Vista, Windows 7, NT Embedded, Embedded Standard and Windows CE
- connection to all common fieldbuses and PC interfaces
- data interfacing via open standards such as OPC
- TwinCAT PLC is an IEC 61131-3 PLC with up to four run-time systems for each PC.
- highly deterministic real-time

# Beckhoff | TwinCAT – The universal solution for PLC and Motion



## High-end PLC

- international IEC 61131-3 programming standard
- reusable software modules
- almost unlimited memory
- no restrictions in terms of number of blocks and variables
- minimum PLC cycle times through native code generation
- 1,000 instructions in < 1  $\mu$ s (Intel® Core™2 Duo)
- high-speed software solutions for camming, controllers, etc.
- up to four run-time systems per PC, up to four tasks per run-time system



## TwinCAT NC

- PC-based Motion Control for up to 255 axes
- support for a wide range of axis types:
  - electrical servo axes
  - stepper axes
  - DC motors
  - hydraulic axes
- support for a wide range of drive interfaces:
  - EtherCAT and Lightbus
  - SERCOS
  - ProfiDrive
  - CANopen
  - SSI
  - analog interfaces
- convenient commissioning and maintenance



## Highly deterministic real-time capability

- pure software solution, developed by Beckhoff
- highly deterministic
- pre-emptive multi-tasking from 50  $\mu$ s
- low jitter (< 2  $\mu$ s with Intel® Core™2 Duo)
- open fieldbus interface

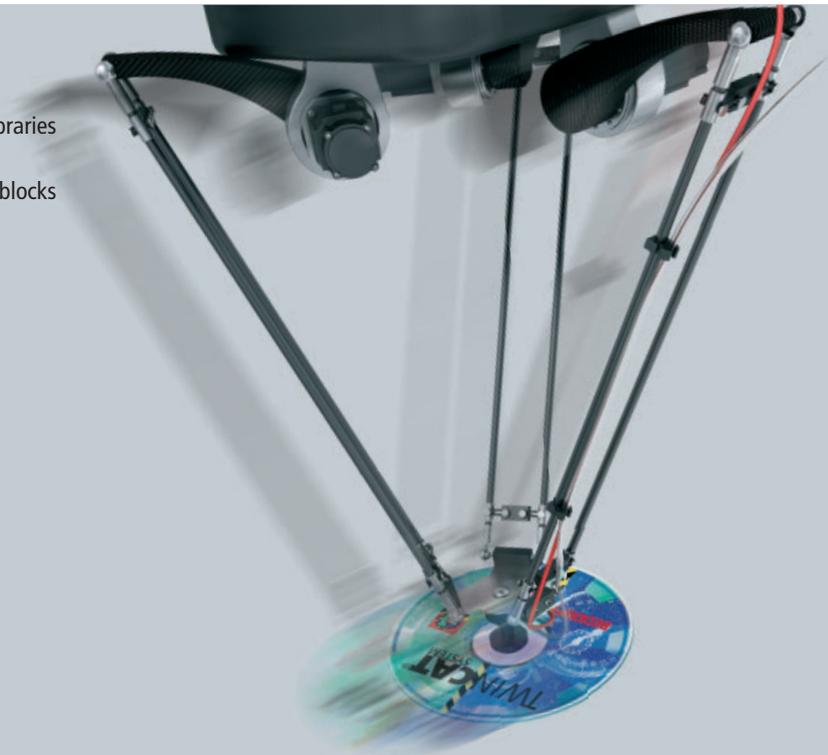


# Control



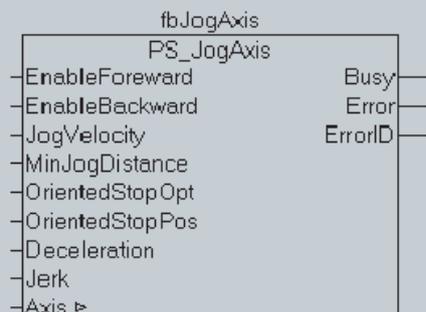
## Software libraries

- wide range of TwinCAT libraries available
- PLCopen Motion Control blocks
- serial coupling
- control technology



## Motion Control functionality

- point-to-point motion
- gear coupling
- master/slave coupling
  - cam plates
  - Cam Design Tool
  - Motion laws can be modified from within the PLC.
- position-synchronous coupling (flying saw, flying shear)
  - synchronisation from any dynamic phase
- superposition
- axis interpolation in 3 dimensions
- programming according to DIN 66025
- PLC library for NC interpolation





## EtherCAT

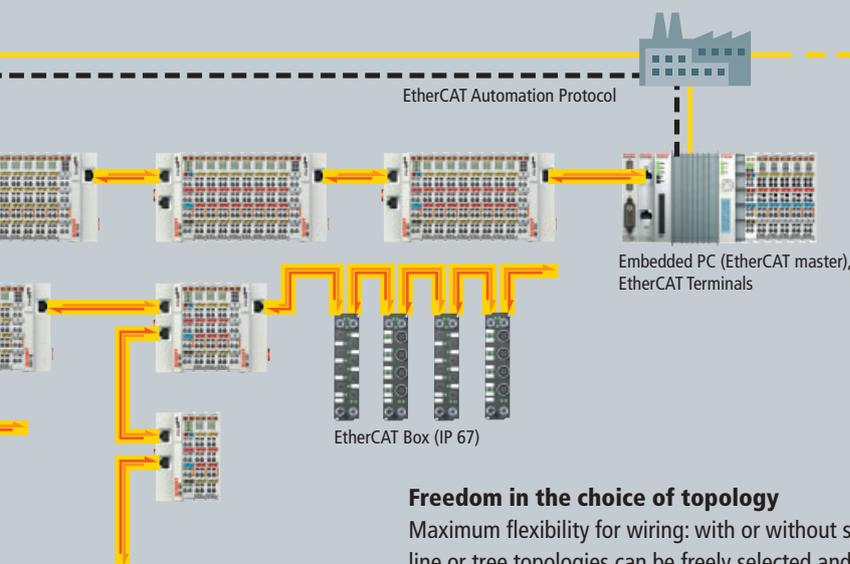
- real-time Ethernet for automation
- flexible topology
- maximum performance
- easy configuration
- fully Ethernet-compatible



## EtherCAT Box

- EtherCAT I/O system in IP 67
- high performance for harsh environments
- compact and robust
- fitted directly to machines without control cabinets and terminal boxes

[www.beckhoff.com/EtherCAT-Box](http://www.beckhoff.com/EtherCAT-Box)



## Freedom in the choice of topology

Maximum flexibility for wiring: with or without switch, line or tree topologies can be freely selected and combined. Address assignment is automatic; no IP address setting is required.

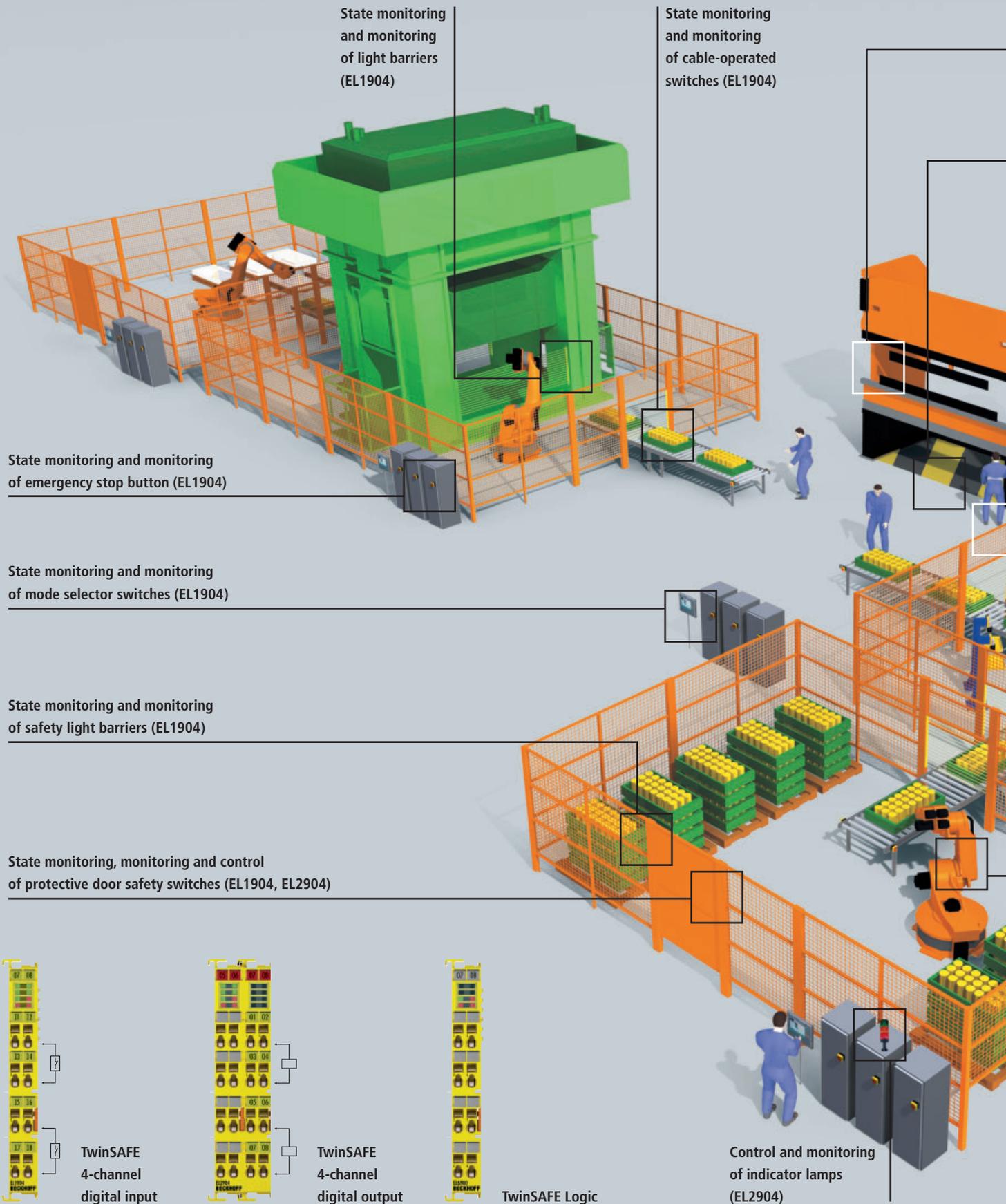
## EtherCAT Technology Group

The EtherCAT Technology Group (ETG) is an association of automation users and manufacturers aiming to support the development of the EtherCAT technology. The consortium represents a wide range of sectors and application areas. This ensures that the EtherCAT technology functions and interfaces are ideally prepared for a wide range of applications. The organisation ensures that EtherCAT can easily and cost-effectively be integrated in a wide range of automation devices, and it also ensures interoperability of the implementations. The EtherCAT Technology Group is the official IEC partner organisation for fieldbus standardisation. Membership is open to all companies.

For further information see  
[www.ethercat.org](http://www.ethercat.org)

**EtherCAT**<sup>®</sup>  
Technology Group

# Beckhoff | TwinSAFE – Safety and I/O technology in one system



State monitoring and monitoring  
of two-hand switches (EL1904)

State monitoring and monitoring  
of surface scanners (EL1904)

State monitoring and monitoring  
of safety foot switch (EL1904)

State monitoring and monitoring  
of safety confirmation switch (EL1904)

State monitoring,  
monitoring and control  
of power contactors,  
stop category 0 and 1  
(EL1904, EL2904)

State monitoring  
and monitoring of  
safety position  
switches (EL1904)

### The I/O construction kit is extended "safely"

With the TwinSAFE Bus Terminals, Beckhoff offers the option of simply expanding the proven Bus Terminal system and to transfer the complete cabling for the safety circuit into the already existing EtherCAT cable. Safe signals can be mixed with standard signals without restriction. This saves design effort, installation and material. Maintenance is simplified significantly through faster diagnosis and simple replacement of only a few components.

The new ELx9xx series Bus Terminals only include three basic functionalities: digital inputs EL1904, digital outputs EL2904 and a link unit EL6900. The TwinSAFE I/O terminals enable the connection of all common safety sensors and actuators. The TwinSAFE Logic Bus Terminal is the link unit between the TwinSAFE input and output terminals. It enables the configuration of a simple, flexible and cost-effective decentralised safety control system. Therefore, there are no safety requirements for the higher-level control. The typical safety functions required for the automation of machines, such as emergency stop, safety door monitoring, two-hand control, etc., are already permanently programmed in the EL6900. The user configures the EL6900 terminal according to the safety requirements of his application. The EL6900 is suitable for applications up to SIL 3 according to IEC 61508 and performance level e (PL e) as specified in DIN EN ISO 13849-1:2008.

### Open communication with Safety over EtherCAT

In the interest of realising safe data communication for EtherCAT, the Safety over EtherCAT protocol has been disclosed. The protocol meets the requirements of IEC 61508 up to Safety Integrity Level (SIL) 3 and of IEC 61784-3, as approved by the TÜV. Any transmission link can be used, including fieldbus systems, Ethernet or similar transfer routes, optical fibres, copper cables or radio links.

Safety over  
**EtherCAT**<sup>®</sup>

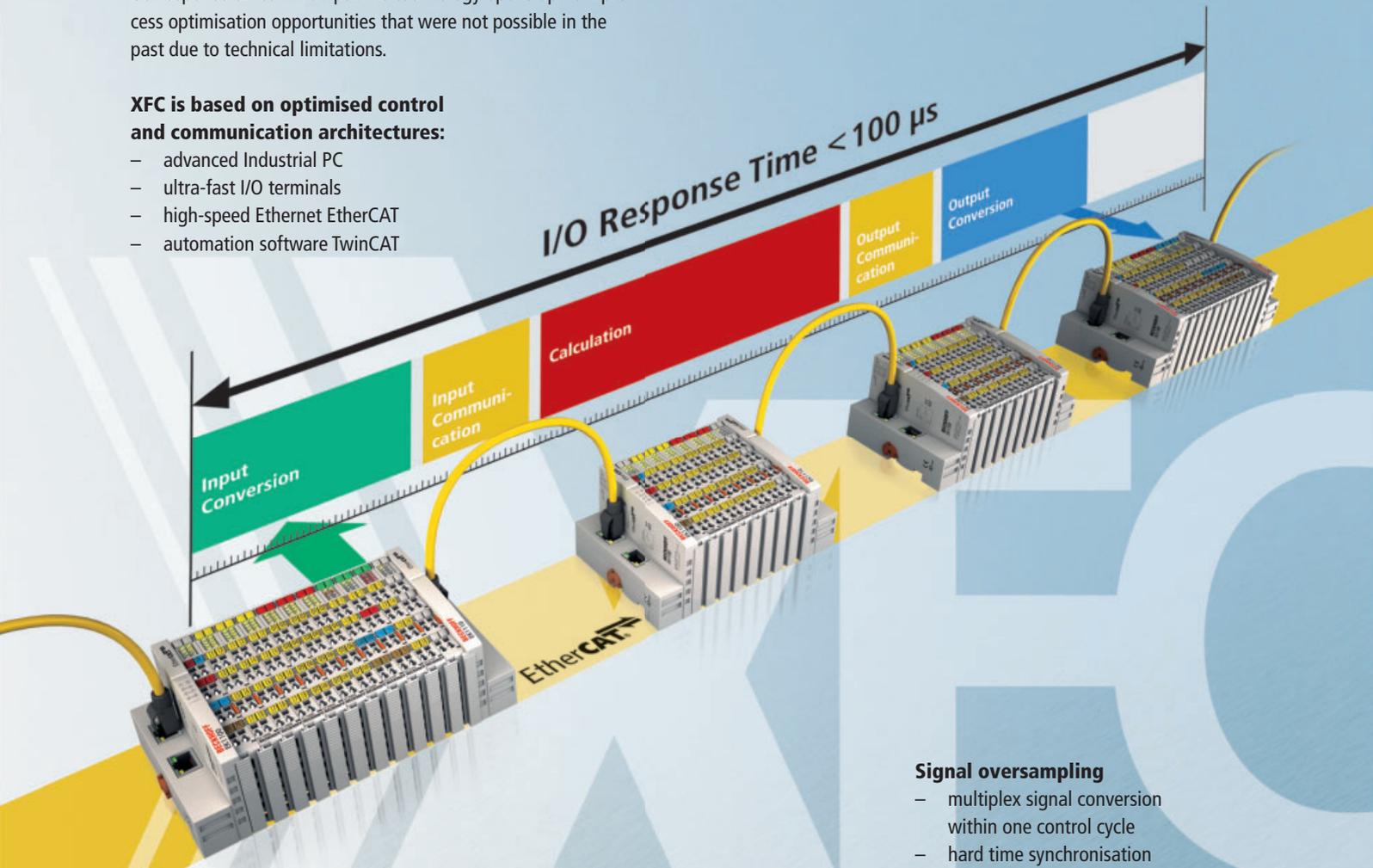
[www.beckhoff.com/TwinSAFE](http://www.beckhoff.com/TwinSAFE)

# Beckhoff | eXtreme Fast Control Technology (XFC)

With XFC technology (eXtreme Fast Control) Beckhoff presents an ultra fast control solution: With XFC it is possible to achieve I/O response times  $< 100 \mu\text{s}$ . This technology opens up new process optimisation opportunities that were not possible in the past due to technical limitations.

## XFC is based on optimised control and communication architectures:

- advanced Industrial PC
- ultra-fast I/O terminals
- high-speed Ethernet EtherCAT
- automation software TwinCAT



## Cost benefits from using XFC

- increased machine and system throughput due to significantly reduced signal delays
- achieves faster sequences of motions
- condition monitoring with standard control system
- standard I/O instead of expensive special local controllers
- standard I/O instead of expensive instrumentation interfaces
- measurement technology in integrated control system, no separate system required

## Very short controller cycle time

- new performance class for PLC applications: from  $50 \mu\text{s}$

## Very fast I/O response time

- from  $85 \mu\text{s}$
- Deterministically synchronised conversion of the input and output signal leads to reduced process timing jitter, independent of the communication and CPU jitter.

## Distributed clocks

- local absolute system synchronisation for CPU, I/O and drive units
- resolution:  $10 \text{ ns}$ , accuracy  $< 100 \text{ ns}$

## Signal oversampling

- multiplex signal conversion within one control cycle
- hard time synchronisation through distributed clocks
- for digital/analog input/output signals
- sampling rates up to  $100 \text{ kHz}$  (analog) and  $500 \text{ kHz}$  (digital)
- application
  - fast signal monitoring, fast signal generator output
  - signal sampling independent of cycle time
  - fast controllers

## Signal time stamp (resolution $10 \text{ ns}$ )

- exact edge time measurement for local digital inputs
- exact timing of local output signals, independent of the control cycle

# Beckhoff | Scientific Automation

## Scientific Automation: From the black box into the PC

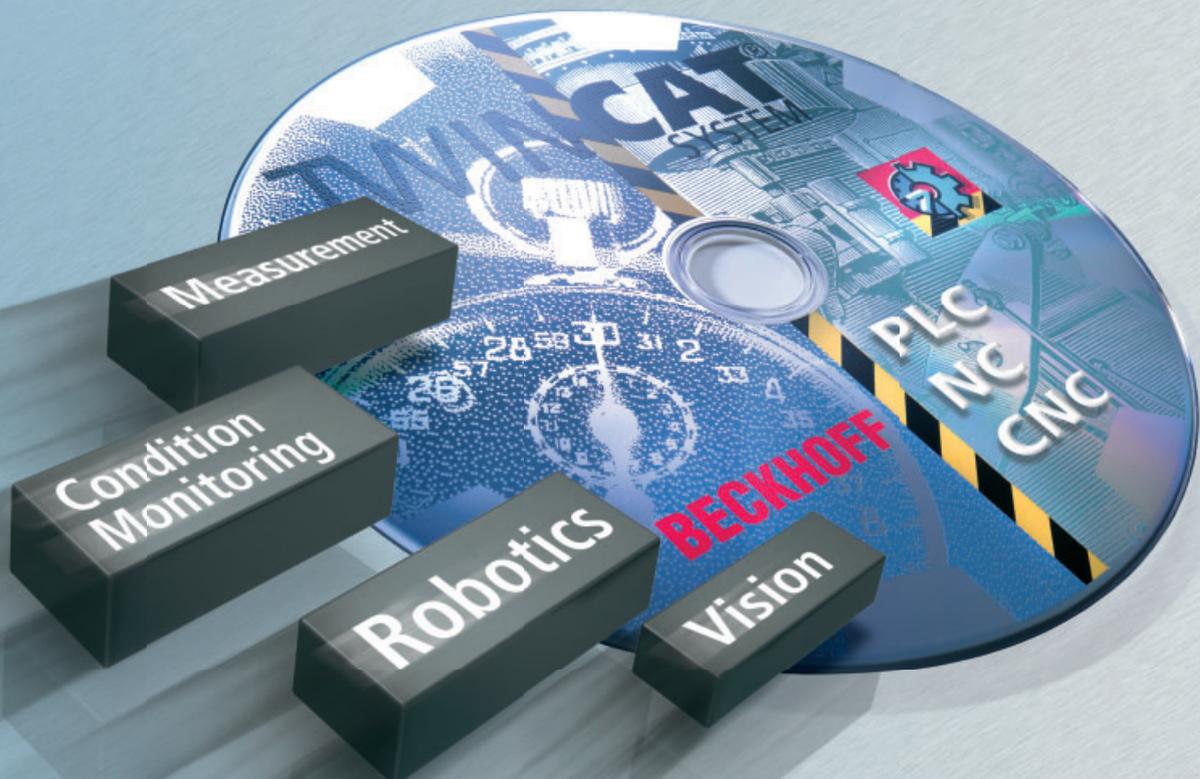
Scientific Automation is the integration of automation software with findings from engineering science which go beyond the limits of conventional control.

- The power of the PC Control philosophy offers sufficient capacity to integrate numerous advanced functions beyond standard control.
- Scientific Automation complements the conventional areas of control technology such as PLC, Motion Control and control technology, for instance, with precise and fast measurement technology and the associated engineering algorithms.
- The Beckhoff PC-based control technology provides the necessary basic foundation with powerful CPUs, fast I/O, the fast EtherCAT bus system and TwinCAT software.

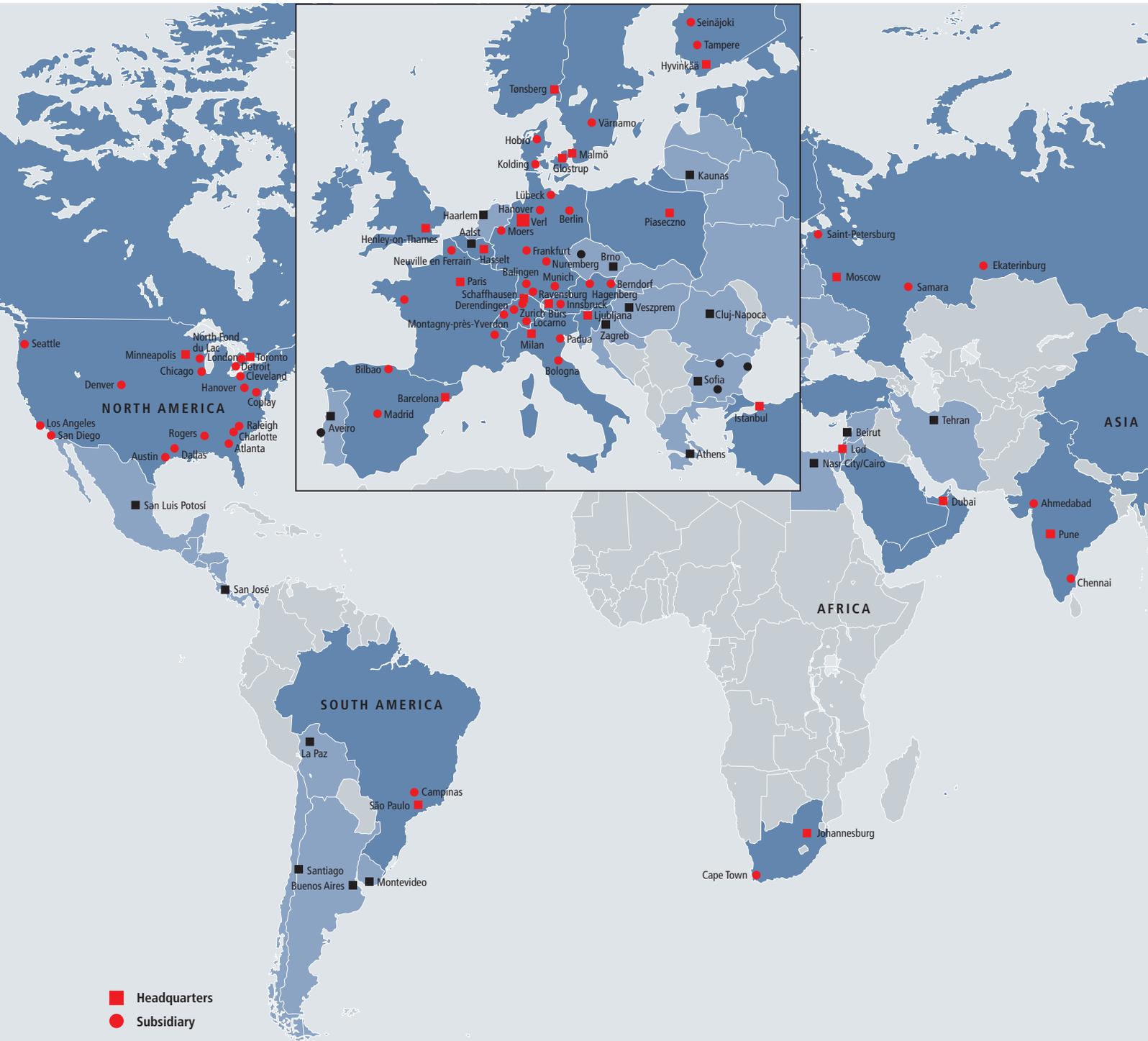
## Robotics, measurement technology and Condition Monitoring as an integral part of PC-based control

The concept of Scientific Automation serves as the prerequisite to enable functions such as Condition Monitoring or robotics for a wide range of PLC programmers in a familiar format.

- The aim is to integrate the functions from the traditional “black box” into a standard PC-based software environment. This results in seamless integration in the overall control system as well as dispensing with additional CPUs.
- The PC-based control system from Beckhoff combines PLC, Motion Control, measurement technology and Robotics on a single hardware and software platform.
- Further functions such as the integration of Vision System will follow.
- Scientific Automation from Beckhoff is available in products in real terms and offers enough further potential for future developments and visions.



# Beckhoff | Worldwide



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# Beckhoff | Information media



## Applications & Solutions online

The web page "PC-based Control for the Tire and Rubber Industry" offer further information, e.g. application reports or industry-specific solutions.

[www.beckhoff.com/rubber](http://www.beckhoff.com/rubber)



## Products online

At [www.beckhoff.com](http://www.beckhoff.com) you can get detailed information on the range of products from Beckhoff. Animations, videos and interactive online presentations supplement the large variety of information.

[www.beckhoff.com](http://www.beckhoff.com)

## Printmedia online

The Beckhoff catalogs and flyers are available for download on the Internet. Printed copies are available on request. Please use our online order form to specify your requirements.

[www.beckhoff.com/media](http://www.beckhoff.com/media)



Main catalog



Product overview



News catalog



PC Control magazine



Product DVD

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