**BECKHOFF** New Automation Technology

## PC-based Control for Plastic Machines





# Open and integrated automation solutions from Beckhoff ...

PC-based Control technology from Beckhoff has been successfully proven in a wide range of industries and applications for over 30 years. The company, with headquarters and production facilities in Verl, Germany, was founded in 1980 and currently employs over 2,200 people worldwide\*. 30 subsidiaries\* and distributors ensure a global presence in more than 60 countries. The continuing success of Beckhoff is based on the consistent development of innovative New Automation Technology products and solutions. Many of today's automation technology standards, such as PC-based machine control, Bus Terminals and EtherCAT, were introduced by Beckhoff as innovative breakthroughs. Continuous economic growth, large production capacities and high-performance IT and PC standards ensure Beckhoff technology is a future-proof and sustainable investment for users. Robust, industry-proven components and an expert team for applications support in the plastics industry make Beckhoff a reliable partner with a high level of technical competence along with worldwide customer service and support.

\* as of 04/2013



... your technological and competitive advantage in plastic machine design.

The plastics industry is regarded as a dynamic growth market worldwide, but one that is under increasing cost pressures. The demands for plastic machines in terms of productivity, product quality and energy efficiency are correspondingly high. The ultra-fast, high-precision, open and customisable Beckhoff control platform covers all qualifications for meeting these demands: it consists of a high-performance Industrial PCs, EtherCAT – the real-time Ethernet fieldbus system – modular Bus Terminal I/O and TwinCAT automation software. Universal PC-based control can be applied for use with all processes in the plastics industry, including injection molding, blow molding and extrusion. Special hardware for controlling all manufacturing processes is replaced with software that runs on a centralised PC. In addition to process control and visualisation, the high-performance PC platform also supports Motion Control, robotics, safety and measurement technology. This enables the optimisation of processes and the reduction of hardware costs and engineering efforts. In addition, open hardware and software interfaces offer machine manufacturers a high degree of freedom in machine concept and design.

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We reserve the right to make technical changes.

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# Modular and scalable control solutions from Beckhoff ...

The Beckhoff portfolio of control solutions is modular and covers all performance classes. The extensive range of Industrial PCs, offering a wide variety of housing options and features, includes embedded devices with integrated I/O interfaces, compact Panel PCs and Industrial PCs with powerful multi-core processor technology. A wide range of Control Panel versions in diverse formats, equipped with cutting-edge multi-touch technology, form the foundation for advanced operator interfaces. Beckhoff I/O systems with more than 400 signal types cover all common sensors and actuators. Integrated TwinSAFE technology is available for safe operation of machines and systems. For multi-axis Motion Control, Beckhoff offers high-performance servo motors and drives in different performance classes and voltage ranges that ensure efficient application worldwide. Technology software modules for typical plastics applications and Motion Control solutions for different handling systems complement the TwinCAT automation software.



# ... for all machine types and production methods in the plastics industry.

The modular line up of Beckhoff components enables machine manufacturers to configure control systems that are tailored to their individual applications, and into which they can integrate their own industry expertise. Interfaces for simulation programs facilitate virtual machine design. As an advanced workbench, TwinCAT facilitates teamwork across engineering departments and offers effective options for the protection and growth of intellectual property. Integrated solutions from Beckhoff for injection molding and blow molding applications offer control options that are scalable in terms of pricing and performance: The industry-specific software modules include proven algorithms for key manufacturing processes, reducing development time and costs for machine manufacturers. Industry-specific requirements, such as temperature and energy measurement or the connection of path sensors, can be easily implemented via standard I/O terminals. Compact IP 67 Fieldbus Box modules are machine-mountable and simplify modular machine design while saving space in control cabinets.

# EtherCAT, the global standard for injection molding machines ...

EtherCAT, the high-speed-communication system and servo-electric drive technology provide the basis for mastering demanding injection molding machine concepts. Leveraging AX5000 Servo Drives and EtherCAT-based eXtreme Fast Control Technology (XFC), Beckhoff offers maximum precision and energy efficiency, particularly for servo-electric machines. The TwinCAT Injection Molding PLC Framework technology software is based on proven TwinCAT automation software and includes standard functionality needed for injection molding machines. This saves users development time, without limiting their own technological developments. XMold and eMold offer complete solutions for injection molding machines, which are suitable for automating complex systems for the production of high-tech products (XMold) and for simpler machines designed for mass production (eMold).





# ... ensures optimum product quality, reproducibility and energy efficiency.

XFC technology can be used in conjunction with fast servo drive technology in order to reduce non-productive time during mold opening, for example. Based on very fast algorithms, XFC enables precise switching from the speed-controlled injection phase to the pressure-controlled holding pressure phase while maintaining exact control of pressure profiles, for example. This ensures that stringent quality requirements for the end product are met and that energy efficiency and raw material usage during plastics production are optimised. In addition to speed, another important factor in the injection molding process is precise reproducibility of the process steps at exactly definable points in time. This can be achieved using the time stamp functionality provided by XFC. Manufacturers of plastic machines also benefit from the openness of EtherCAT and the fact that it is so widely used. In other words, manufacturers not only have the extensive Beckhoff portfolio at their disposal, but also a virtually unlimited choice of components from third-party suppliers, which can be easily integrated into any EtherCAT-enabled control architecture.

### Complete solutions for injection molding machines | XMold and eMold



## XMold: the system solution for complex applications

The XMold solution is suitable for complex applications involving hydraulic, servo-electric or hybrid injection molding machines. It includes a CP6216-1004 Panel PC with a 2<sup>nd</sup> generation Intel<sup>®</sup> Celeron<sup>®</sup> processor, a 15.6" widescreen display in portrait format, Beckhoff I/Os, industry-specific software and drive components. The XMold Panel features a key arrangement that is optimised for injection molding processes and is designed to suit most applications. The technology software includes standard functions, such as the switch-over to holding pressure, which reduces engineering complexity for users. With the Icon Editor Beckhoff has created a simple graphic programming interface that requires no special programming knowledge and therefore minimises the effort for adapting certain machine sequences. In conjunction with XFC technology, XMold offers ultra-fast system responses and is ideally suited for precision manufacturing.

- 9" TFT display
- LED backlight

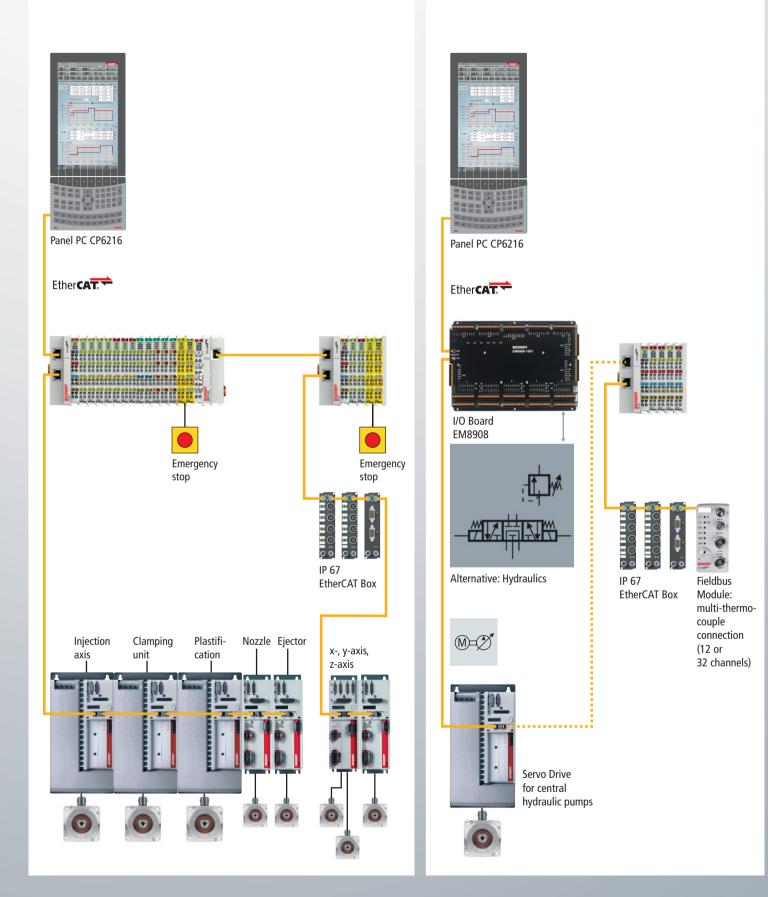
via Internet

- keypad for injection molding applications, 72 membrane keys
  - Ethernet interface for remote service host computer connection USB interface for recipe storage language selection different user levels permanent display of important process data storage of guality data eight hot runners (optional)
- suitable for all hydraulic injection molding machines
- supports injection control via the central pump or servo-valves
- supports toggle levers and linear injection units
- suitable for servo pumps
- four core pullers included as standard
- linearisation of pumps and valves
- eMold: the compact solution for cost-sensitive applications

eMold is an integrated solution for cost-sensitive injection molding applications. A 9-inch CP6616-1004 Panel PC with Intel® Atom™ processor is used as an integrated control and operating solution. It features a special I/O board for injection molding machines that is linked via EtherCAT and corresponding technology software. The key arrangement of the eMold Panel is optimised for injection molding processes and is designed to suit most applications. Clearly, an important factor for the acceptance of a machine by operators is ergonomic, intuitive operation. The dynamic user interfaces of the XMold and eMold solutions are based on Microsoft Silverlight Embedded. Thanks to the distinction between the attractive, ergonomic design and programming of the actual operating logic, machine manufacturers are able to customise their user interfaces very quickly and flexibly.

### Servo-electric machine with integrated handling

### Hydraulic machines with options



### XMold user interface for injection molding machines

The XMold user interface can be used for controlling standard applications as well as complex processes. The XMold control system is ideally suited to large machines, multi-component machines and high-speed applications. Complex tools with comprehensive core pulling functions or servo-driven turning tools are supported. The large screen area with touch function enables clear visualisation of the process. Permanent status displays and active operating screens provide a quick overview. Graphic profile input with a variable number of support points and clear display of core pulling movements facilitate mold validation. Process analysis tools include the quality table and clear cycle display. Standard functions include user administration, input log, language and unit switching. An icon editor enables fast and convenient programming of complex process steps.

Operator Mold 1234   • • • • • • • • • • • • • • • • • • •	5 <b></b> 50.0		
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	n 1 RPM P	arts 1200	ф ч <sub>%</sub>
13.3 mm 12.1		p 10.0 p bar	p 10.0 bar
320.3 mm	12.0 mm	-	45.0 mm
		<u>un</u>	
	240   235   220   21	5   210   205   20	0   190   °C
Pressure [%] Turnrate [RPM]	90   90   90   90	0   90   90   90	≥ <u>≥</u> 0   90   %
Actual Parts 16630	Oil Temperature 35	°C Melt Temp	erature 210 °C
Good Parts 14514 Rejected Parts 25	Cooling Ring 40	°C Melt Press	aure 1600 bar
Remaining Parts 2116	to be all a stress		
	Injection Time		2.9 s 2.7 s
	Metering Time		
			6.9 s 7.5 s
	Cooling Time		
+ ]· + (0000			10.2 s 10.0 s
	Cycle Time		
*			21.0 s 20.0 s
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#### **Overview screen**

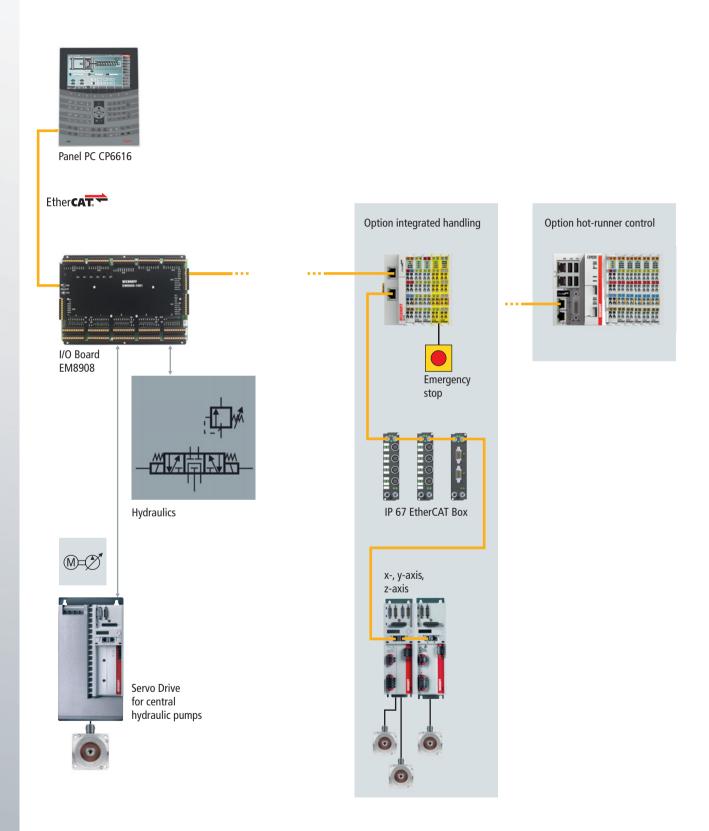
- permanent display of the main process data in the header
- optional display of cycle monitor and time diagram or quality table
- display of production data
- cycle time monitor with sequence display



#### Clamping unit

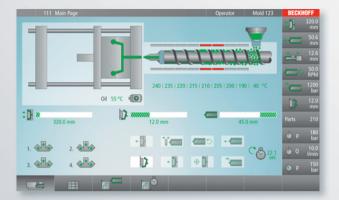
- flexible number of support points, depending on the complexity of the process
- path input for tool protection and locking
- input of clamping force monitoring
- display of actual values in the graphic

### Hydraulic machine with options



### eMold user interface for injection molding machines

The user interface of the eMold control system is clearly arranged and easy to manage. Important process parameters are permanently



- All key process values are shown on the right in the status field.
- Axis movements are shown in the bar chart display.



- 4 core pullers included as standard
- 12 standard core pulling sequences with priority control

Number	Jality Table	Switch over	Injection	Metering	Operator	Mold 123	BECKHO
	position [mm]	pressure [bar]	time [s]	end position [mm]	position [mm]	speed [mm/s]	
6570	9.0	99.1	6.0	105.6	7.3	119.7	-
6569	9.0	99.3	6.0	105.6	7.4	119.8	
6568	9.0	99.3	6.0	105.4	7.5	119.9	- C
6567	9.0	99.4	6.0	105.8	7.5	120.0	20000
6566	9.0	99.4	6.0	105.7	7.6	120.1	1.0
6565	9.0	98.9	6.0	105.6	7.7	119.9	12
6564	9.0	99.4	6.0	105.5	7.6	119.8	Parts
6563	9.1	99.3	6.0	105.5	7.5	119.7	
6562	9.1	99.4	6.0	105.6	7.4	120.0	🌻 P
6561	9.1	99.4	6.0	105.7	7.3	119.9	🖕 Q
Page	1 2 3			Columns	1-6		• P
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- display of quality data for the last eight parts on one page
- configurable buffer capacity
- choice of 12 process parameters

displayed in a status bar. Units and language switching as well as quality documentation are included as standard.



- customisable number of interpolation points
- display of switching criterion



- customisable number of interpolation points
- graphic profile input
- mold safety stroke input



- user management
- units and language switching



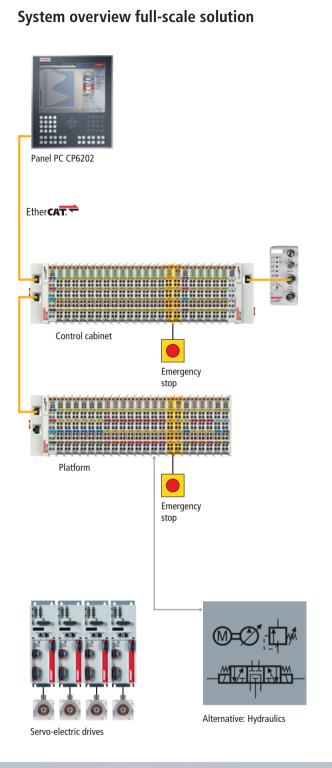
### Complete solutions for blow molding applications ...

Beckhoff offers turnkey system solutions for the blow molding industry that integrate industry expertise acquired over many years. The full-scale platform is suitable for simple to complex applications. The compact solution also represents a cost-optimised alternative for controlling blow molding processes with reduced functionality. Fast and precise wall thickness control and fast control of the transport movement and clamping units are key factors for ensuring product quality in the blow molding process. EtherCAT, high-performance Industrial PCs and industry-specific Beckhoff software for blow molding applications strike the optimum balance between fast motion and exact positioning. Blow molding machines benefit particularly from the decentralised distribution of I/Os, which enable different machine components such as extruders, clamping units and blow heads to be equipped with individual I/O stations for communication via EtherCAT.

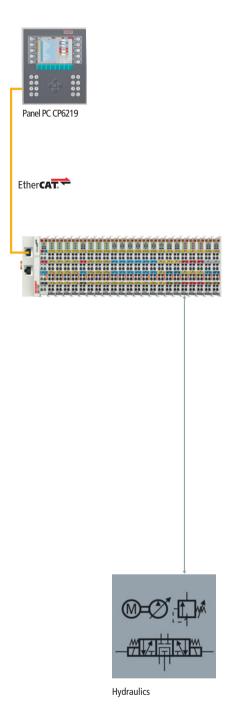


## ... simplify operation and optimise the production process.

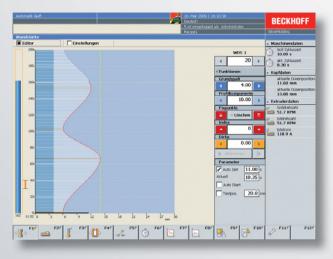
The blow molding controller, designed by Beckhoff specifically for blow molding machines, has 40 manual keys. In addition, it features functions such as user administration with different access rights and language selection. With the user-friendly feature "undo" memory, the operator can easily cancel the last changes he/she made. The user interface was designed with particular emphasis on a clearly structured design, to ensure that the machine operator has a good overview of all key data and is able to quickly intervene in the running process, if necessary. Softkey functions support intuitive operation. The main operating screen of the blow molding controller is the wall thickness editor. Colour grading makes interpolation points and curved segments of the wall thickness curve easily identifiable.



### System overview compact solution

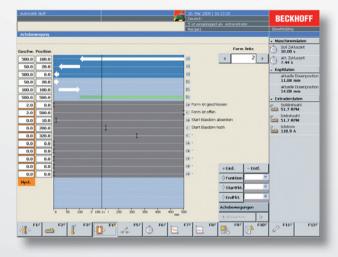


### User interface of the full-scale solution for blow molding machines



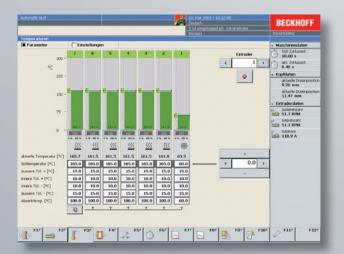
#### Wall thickness control

- wall thickness curve with up to 400 interpolation points
- display of the accumulator level
- display of the current parison length
- display of the current curve (in red)
- undo memory for up to 10 curves and up to 5 wall thickness markers



#### Clamping unit

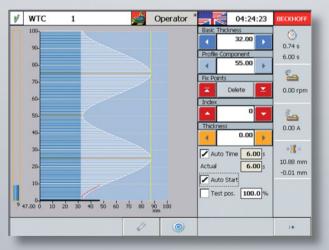
- up to 25 motion channels for clamping unit, carriage, blow pin, etc.
- up to 5 motion segments for each direction
- up to 10 switching cams with hysteresis and direction of movement for the control of auxiliary functions
- Specific start/stop functions can be called up at the start or end of the movement, axis labelling for motion and cams via XML file.



#### **Temperature controller**

- bar chart display of set value/actual value and tolerances
- colour change
- display of heating/cooling
- two tolerance bands
- input of all set values with one button
- switching functions

## User interface of the compact solution for blow molding machines



#### Wall thickness control

- maximum 200 interpolation points
- continuous or discontinuous machines
- multiple heads are supported
- real-time display of the wall thickness curve

#### PC-based Control for extrusion machines



## Multi-touch display concepts ...

Just like for other applications, the trend for extrusion lines and extrusion blow molding equipment is moving towards large displays with multi-touch functionality. Beckhoff offers a wide range of built-in Control Panels and Panel PCs with display sizes from 9" to 24" and optional multi-touch functionality. Multi-touch enables implementation of innovative and ergonomic operating concepts for any industry. In large systems this enables operators to zoom into the details of individual machines for production data, equipment conditions, etc.

The TwinCAT PLC Plastic Processing Framework provides special temperature controller software components for extrusion processes and functions for drive synchronisation, which the machine manufacturer can integrate into their application. The tried and tested algorithms of the temperature controller library are suitable for extrusion cylinders with high heat capacity. The optimised PID structure shows a dynamic step response with low overshoot. The zoning feature can be used to control the power output such that short-term current peaks are avoided, which significantly improves energy efficiency and sustainability.

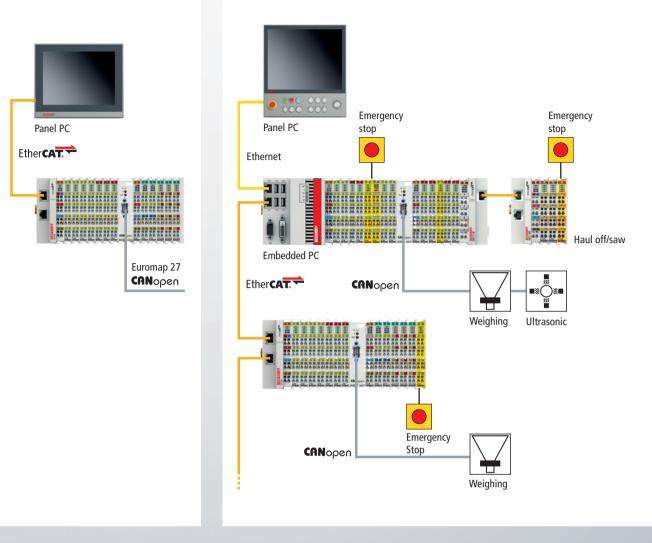
### ... for controlling single units or line extrusion systems.

Exact temperature control of inert loops is crucial for the safe operation of extrusion systems and the production of high-quality plastic components. The software-based temperature controller offers a number of benefits for commissioning and diagnostics. For example, it enables control parameters to be stored and used for other machines, which is a great time-saver in parameterisation. In addition, the software controller offers a high degree of flexibility for meeting customer requirements: additional heating zones can be implemented easily, since the software is prepared for a maximum number of zones and only additional I/O terminals need to be installed. Measuring systems or weighing units can be integrated in the control system via standard EtherCAT Terminals and special data sampling algorithms. Downstream equipment such as saws or take-offs can be integrated via Euromap 27 or TwinCAT Motion Control functions such as "flying saw" or synchronous operation.



### Single extruder

Line extruder



### **User interface**

The user interface is based on the still widely used individual temperature controllers. The main parameters for the temperature zones are displayed in a familiar block format. Important parameters of the extrusion process are shown in a status field. This means that

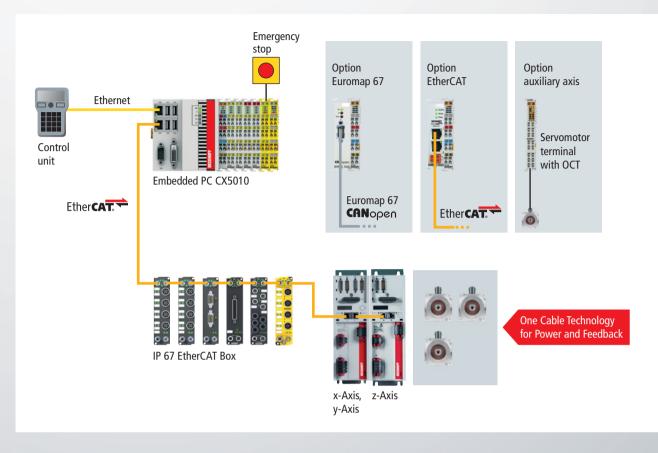


additional indicating instruments are no longer required. An extensive alarm system, the trend graphs, and loading and storage of production data increase process safety and product quality.





### PC Control for handling and Motion Control



# PC Control integrates handling systems in the centralised control system ...

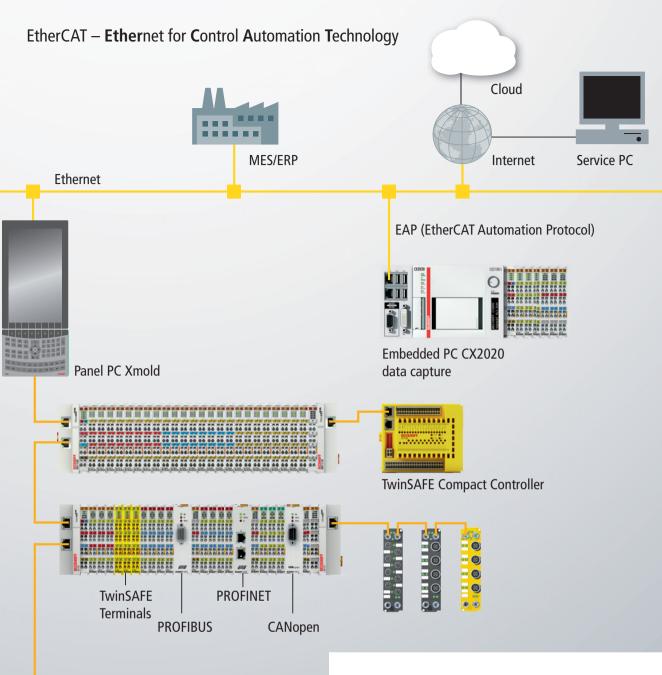
High-performance Industrial PCs, the EtherCAT communication system, I/O components, Servo Drives and Servomotors, plus the TwinCAT supplement for robot applications provide an ideal platform for implementing a wide range of robotic solutions: the software can run a variety of applications ranging from simple, small Cartesian robots to complex kinematic systems for SCARA or articulated robots. Beckhoff offers a wide selection of drive components, from compact servo amplifier terminals right up to highperformance EtherCAT Servo Drive amplifiers, which meet all requirements for handling systems used with plastic machines around the world. The AM8000 Servomotor series with One Cable Technology (OCT) reduces costs in applications with motion axes. A further advantage of the Beckhoff Drive Technology solution is optional integrated TwinSAFE safety technology directly in the drive.

# ... and ensures perfect synchronisation of robotics and machines.

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Integrated handling systems are becoming increasingly important for plastic machines. Highly dynamic Beckhoff drive components, together with the TwinCAT Motion Control software, play an important role in removal handling. With EtherCAT as the communication platform, robot movements can be coordinated with the machine processes such that delays are virtually eliminated. This is crucial, for example, for in-mold labelling applications with short cycle times and high positioning accuracy. Special IP 67 I/O modules with integrated force and acceleration measurement log acceleration forces in three axes in order to optimise the motion behaviour. Pneumatic sensors in IP 67 design are ideally suited for monitoring gripper functions. This integrated solution also provides cost benefits, since a special robotic control system is no longer necessary.





EtherCAT drives AX5000 (optionally with TwinSAFE function)

# EtherCAT, the integrated communication system ...

EtherCAT was developed by Beckhoff and launched in 2003. Ten years later, the EtherCAT Technology Group (ETG) brings together 2500 manufacturers worldwide\* who develop devices based on EtherCAT. Thanks to its high-speed communication and high usable data rate, this ultra-fast fieldbus can deal with all process communication and acts as the I/O, safety and drive bus system all in one. Beckhoff offers an integrated product range for EtherCAT, including controllers, fieldbus components in IP 20 and IP 67 design and safe Servo Drives. In addition, the real-time bus system is characterised by a flexible topology, virtually unlimited network size and interfaces to other fieldbus systems, including PROFIBUS and CANopen. EtherCAT provides a perfect gateway between the process I/Os and the standard Ethernet world and can therefore be used for teleservices and cloud applications.

\*as of: 09/2013



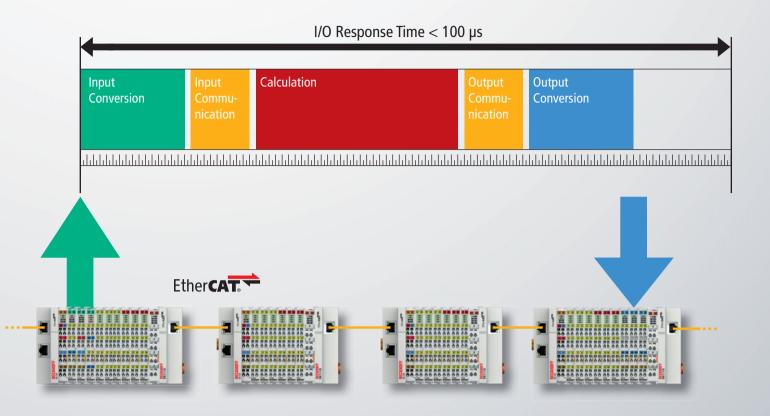
# ... enables perfect integration of plastic machines in the production environment.

Due to its excellent real-time characteristics and high bandwidth, EtherCAT is ideally suited for controlling the complex processes encountered in plastic machines and serves as a backbone for linking production equipment. The openness of EtherCAT in terms of connecting to other fieldbus interfaces facilitates integration of peripheral systems such as cooling devices, hot runner controllers or handling systems. The CANopen-based Euromap standard, which is used in the plastics industry worldwide, can be implemented simply via gateways. In this way EtherCAT enables exceptional integration of plastic machines into the production environment – be it towards the master computer or towards the peripheral equipment. Because EtherCAT is a worldwide standard today, machine manufacturers can choose from a wide range of drive solutions available on the market and are able to integrate components into their control architecture that are best suited for their respective applications. Compatibility with other EtherCAT-based devices is guaranteed.

## Safety integrated

Occupational health and safety plays an increasingly important role in machine design. With TwinSAFE, Beckhoff offers an advanced safety solution that is integrated into the primary control system. It is based on safety Bus Terminals and the TwinCAT Safety Editor and enables safe operation of axes and integration of machine safety devices without the need for additional wiring. In extrusion systems, for example, downstream equipment such as take-offs and saws can be connected with an EtherCAT fieldbus cable without separate emergency-stop cabling. Due to the modularity of the Beckhoff safety solution, system retrofits are guite straightforward, and subsequent modifications or extensions can be implemented with ease through software adaptations.





## Very precise and fast: eXtreme Fast Control ...

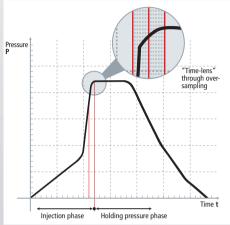
eXtreme Fast Control (XFC), the fast, high-precision control solution is based on: high-performance Industrial PCs; EtherCAT, the high-speed communication network; optimised I/O components (which can sample signals and trigger actions with high precision); and TwinCAT, the integrated software platform. This unified system enables I/O response times of less than 100 µs, so that very fast and highly deterministic responses become possible. Accordingly, XFC opens up new opportunities for process optimisations. Oversampling technology enables exact determination of the signal characteristics. In combination with the time stamp function of EtherCAT, which links each event with a precise point in time, the reproducibility of procedures is significantly increased compared with conventional solutions. Drives can be perfectly synchronised based on the distributed clocks function of EtherCAT.



# ... reduces raw material consumption and increases parts quality.

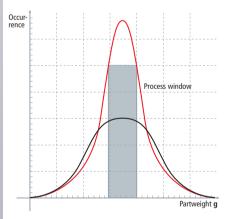
Logging of highly variable input signals with high temporal resolution enables precise control of the injection molding process. Fast algorithms enable the magnitude and trend of the control value to be precisely calculated as a function of the switching event time. The working window becomes narrower, while part weight fluctuations and raw material consumption are reduced. High-precision servo drive technology, in conjunction with XFC, increases the reproducibility of the injection molding process even further. XFC also enables the integration of measurement technology into the machine control system, eliminating the need for special hardware. In this way it is possible to implement a cost-effective solution for Condition Monitoring, for example, which can extend the service life of machines and minimise downtime through preventive maintenance.

#### Oversampling



XFC enables high-resolution analysis of the corresponding pressure curve. Oversampling enables resolutions even below the minimum I/O response time. The distributed synchronised clocks, combined with the time stamp functionality of EtherCAT, facilitate sampling at precisely defined times.

#### **Reduction of material consumption**



Logging of highly variable input signals with high temporal resolution enables precise control of the injection molding process. As a result, the working window becomes narrower, and part weight fluctuations and material consumption are reduced.

### **Beckhoff Drive Technology**



# Electrical servo technology replaces hydraulic systems ...

The TwinCAT technology modules for plastic machines support hydraulic drive technology and servo-electric drives, therefore offering a wide selection of drive technology components. The integrated, fast control technology of the AX5000 EtherCAT Servo Drive series enables the realisation of fast and highly dynamic motion processes. The flexible drive design, with 1- and 2-channel units as well as the variable distribution of motor output allocation, allows cost-optimised solutions, in particular for handling systems. The comprehensive range of Beckhoff Servomotors is optimised for the AX5000 Servo Drives. One Cable Technology, which combines the power and feedback cables into one standard motor cable, reduces cable runs, mounting space and commissioning costs. Thanks to the integrated TwinSAFE technology the Servo Drives meet the stringent safety requirements for plastic machines and simplify the configuration of production cells.

# ... and increases the energy efficiency of plastic machines.

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PC-based control technology in combination with EtherCAT Servo Drives is ideally suited for replacing hydraulic axes with electrical drive solutions, which helps reduce the energy consumption of machines. When it comes to energy-efficient machines, a distinction is made between all-electric machines, where each axis is equipped with an electric motor and a spindle, and so-called servo hydraulics, where the hydraulic pump is operated with a servomotor. For both drive concepts solutions exist that include the AX5000 and TwinCAT technology software modules. In this way it is possible to effectively trigger crucial mold protection procedures that quickly stop the machine movement if a plastic part is detected in the mold. For the development of new machines Beckhoff can offer support for the configuration of motors and gear units.

## 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.

www.beckhoff.com

## Beckhoff at a glance

- Headquarters Verl, Germany
- Sales 2012: 408 Mio. €
- Staff worldwide: over 2.200
- Branch Offices Germany: 11
- Subsidiaries/Branch Offices worldwide: 30
- Distributors worldwide: in more than 60 countries (as of 04/2013)



# Worldwide presence on all continents

The central divisions of Beckhoff, such as development, production, administration, distribution, marketing, support and service, are located at Beckhoff Automation GmbH headquarters in Verl, Germany. Rapidly growing presence in the international market is ensured by 30 subsidiaries. Through worldwide co-operation with partners, Beckhoff is represented in more than 60 countries.

## Further information

The web pages "PC-based Control for Plastic Machines" offer further information, e. g. application reports or industry-specific solutions.

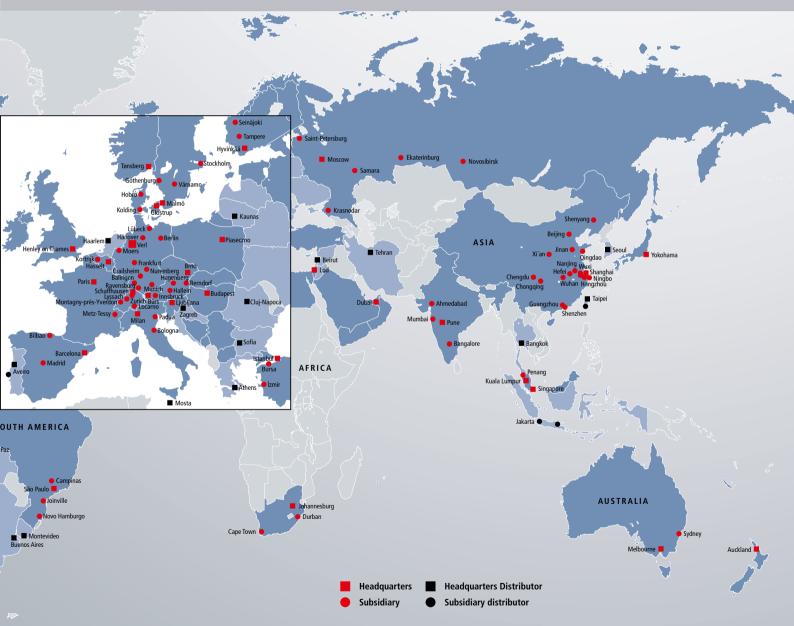
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The Beckhoff catalogs and flyers are available for download on the Internet.

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