BECKHOFF New Automation Technology

TwinCAT 3: the flexible software solution for PC-based control

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Beckhoff developed the first PC-based machine controller back in 1986. Ten years later, TwinCAT followed as the first version of a control software that combined all automation functions on a central platform. This laid the foundation for the success story of PC-based control technology, which customers in mechanical engineering and other industries worldwide rely on to ensure their competitive edge and future sustainability. After more than 40 years of practical application and continuous further development, Beckhoff continues to be the technology leader when it comes to PC-based control technology, and TwinCAT is still the established, modular software platform used to implement powerful and highly flexible automation solutions in more than 30 industries and in over 75 countries worldwide. By incorporating control intelligence into software, it can be flexibly executed on PC hardware in a wide range of performance classes. TwinCAT 3 integrates all essential automation tasks in a single solution, from classic sequential control (PLC, C++, or MATLAB®/Simulink®) to motion control, robotics, vision, IoT, analytics, HMI, and safety.

Automotive industry

Window production machines

Plastics machines

Metal forming

Building automation

Warehouse and distribution logistics

Stage and show technology

Semiconductor manufacturing

Printing machines

Woodworking machines

TwinCAT: the established software platform

25 years
30 industries
40 years PC-based control
75 countries
20,000 customers
2,000,000 controllers

The advantages of PC-based control:

- integration of control intelligence into software
- full usability of the PC performance enhancements for the control technology
- availability of familiar PC interfaces: Ethernet, USB, DisplayPort, etc.
- integration of all essential control functions into a single platform
- simplified IoT communication for cloud connectivity
- consistent, optimized runtime across different CPU architectures and operating systems

Food industry

Photovoltaic/solar industry

Shipbuilding industry

Special-purpose machine engineering

Processing industry

Packaging machines

Medical technology

Test systems

Machine tools

Assembly/handling technology

Tire and rubber industry

Wind turbines

The world of TwinCAT 3: open, scalable, and a safe investment

As a specialist in PC-based control, Beckhoff is renowned for its integrated automation solutions. It offers a comprehensive range of components, which includes the areas of IPC, I/O, and drive technology in addition to the TwinCAT 3 software platform. Quite simply, Beckhoff has demonstrable experience in all areas. As a pioneer of PC-based control, Beckhoff has achieved numerous impressive feats, including setting world standards with the development of the Bus Terminal principle and the high-performance EtherCAT fieldbus technology, which are now firmly established as the basis of automation technology. In combination with TwinCAT, the Beckhoff portfolio results in optimally coordinated automation concepts that fulfill the basic principles of an open and highly scalable control solution. The Beckhoff modular automation components ensure both flexibility and investment security: The modularly expandable hardware and software components facilitate function changes and additions at any time and, if required, the openness of the control solution allows not only the integration of third-party components, but also customized retrofit solutions for existing machines and systems.

TwinCAT: the third generation

TwinCAT has been shaping the world of automation since 1996, with TwinCAT 3 already in its third generation.

Open and platform-independent

Free choice of CPU, long-term support of several relevant operating systems, open interfaces – including to third-party tools – and support of all common fieldbus systems.

Integrated IPC diagnostics

Comprehensive diagnostics on factors including temperature and hard disk condition at any time.

Comprehensive control concepts with TwinCAT:

- comprehensive Beckhoff expertise in the areas of IPC, I/O, motion
- high-performance control solutions through optimal interaction of all components
- open control architecture
- individual, highly scalable control solutions
- simple function extensions through modular software
- complete automation portfolio from a single source

EtherCAT-based technology

TwinCAT – the control software that optimally corresponds to the high-performance EtherCAT fieldbus developed by Beckhoff.

In-house BIOS and motherboard development

As a specialist in PC-based control, Beckhoff keeps its development expertise within the company itself.

The basic principle of TwinCAT: simplification

One software tool for all functions
The basic principle of simplification applies to all aspects of TwinCAT 3 – from the engineering process and runtime to transparent cost representation. Engineering complexities are significantly reduced with TwinCAT 3 by:

- full integration with Microsoft Visual Studio®
- flexible choice of programming languages including C++ and MATLAB®/Simulink®
- efficient, team-based software development via the integrated source code control connection

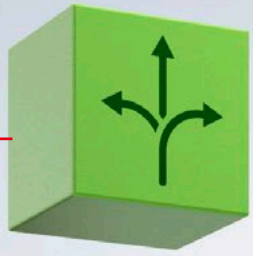
Diverse interfaces facilitate straightforward connection to all common fieldbus systems, databases, OPC UA, and the cloud, and users can benefit from a central execution environment for all systems in the runtime. Also, long-term availability, backward compatibility, and maximum cost transparency – including free evaluation and support – all serve to increase the level of investment security. In terms of extensions to the machines and system functions, these can be implemented simply by integrating corresponding TwinCAT modules.

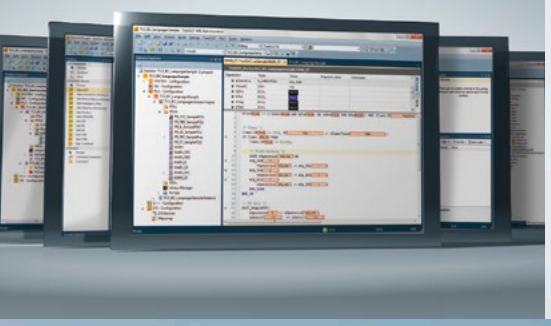
Reduced engineering effort

TwinCAT integrates all engineering components in Microsoft Visual Studio®. From PLC programming to visualization and data analysis, everything takes place in an integrated environment. This helps to keep training and familiarization costs low, offering further benefits to users. The connection to source code management systems such as Git allows people to work on TwinCAT projects in a team, which makes it easy to manage anything from individual changes through to entire versions. What's more, modern agile development approaches can be implemented thanks to the ability to incorporate continuous integration and continuous delivery into the engineering workflow.

Maximum flexibility

TwinCAT enables hardware-independent development of the application: from small, ARM-based controllers to many-core CPUs. When it comes to programming the real-time control software, a flexible choice can be made between the IEC 61131-3 programming languages, C++, and MATLAB®/Simulink®.





TwinCAT benefits at a glance:

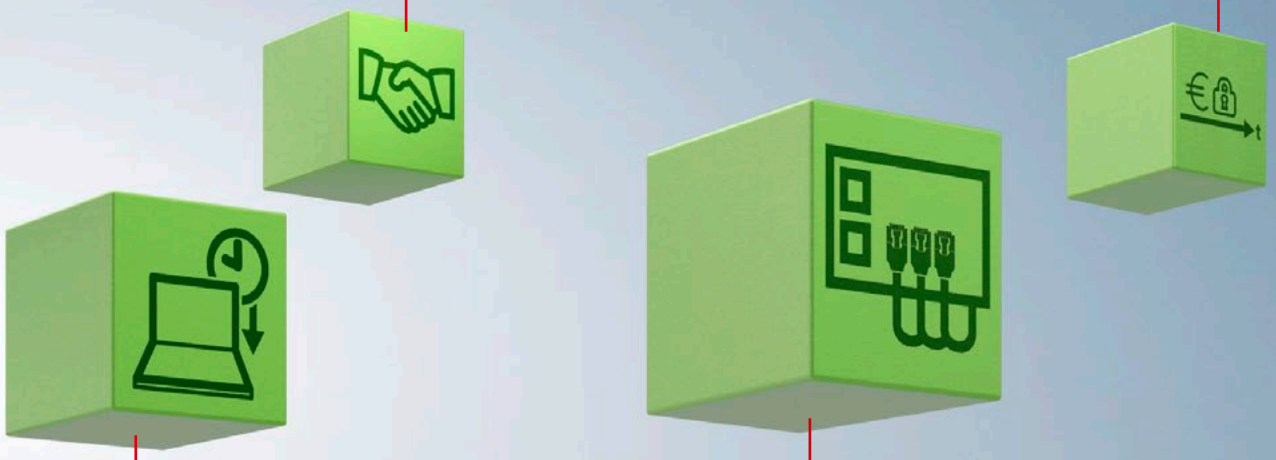
- integration of all engineering tools in one environment – Microsoft Visual Studio®
- free choice of programming language: IEC 61131-3, C/C++, MATLAB®/Simulink®
- support with the object-oriented extension of IEC 61131-3
- easy teamwork with the help of the source code control connection
- multi-user functionality for efficient programming
- integrated engineering tool for all platforms
- integrated motion control solution
- integrated safety solution
- complete mapping of machine functionality in the software
- TwinCAT modular system consisting of basic components and extension functions
- deterministic real time for different CPUs and operating systems
- active support of multi-core CPUs
- support for 32-bit and 64-bit operating systems (Windows, TwinCAT/BSD)
- long-term availability and backward compatibility
- open interfaces for extensibility
- connection to all common fieldbuses

Fair pricing

TwinCAT Engineering is available free of charge with basic functionality. The TwinCAT Runtime environment used to execute the control code can also be trialled on a renewable 7-day license. For permanent operation, a license model applies depending on the performance of the hardware used. In terms of support, this is available free of charge to all customers worldwide.

Safe investment

TwinCAT 3 has been available on the market for ten years, and the software is constantly being further developed with innovative technologies such as image processing and machine learning. Projects created in the previous version can still be migrated today using a converter. This ensures that the expertise from older projects can continue to be exploited in new versions and expanded with the latest functionalities.



Efficient project planning

The modular architecture of TwinCAT facilitates the reuse and maintenance of software components. Reusable structured program code can be generated on the basis of object-oriented programming. Communication between modules is also easy to implement via standardized data exchange, so that the modules can be flexibly combined with each other in the IEC 61131-3 programming languages, C++, or MATLAB®/ Simulink®.

Free choice of interfaces

TwinCAT provides a wide range of interfaces, which facilitates a connection to the IT world from databases to cloud systems via OPC UA and other protocols. The existing protocols can be extended with customerspecific adaptations. Beckhoff also supports all common fieldbus systems, which allows it to react flexibly to requirements in the fieldbus area.

A single platform for engineering and runtime: TwinCAT

The TwinCAT 3 automation software consists of an engineering and a runtime component.

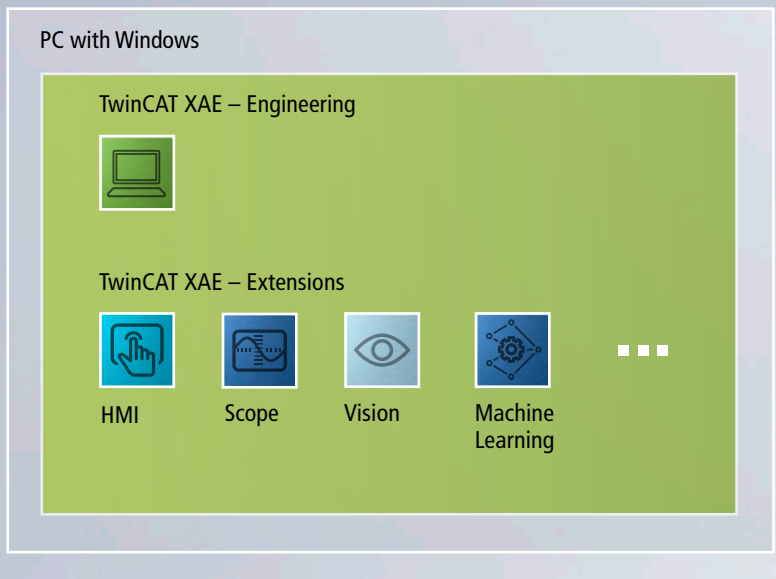
The TwinCAT XAE (eXtended Automation Engineering) engineering component is integrated in Microsoft Visual Studio®, whereby either the TcXAE shell based on the Visual Studio Shell (supplied free of charge) or existing Visual Studio versions can be used.

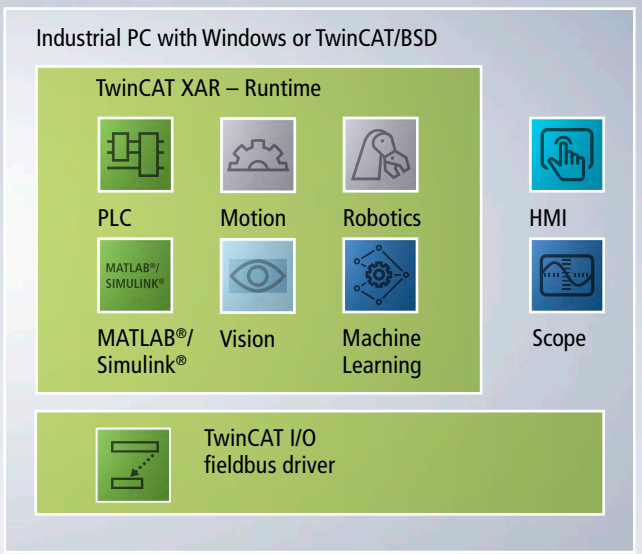
The TwinCAT XAR (eXtended Automation Runtime) runtime component is the real-time-capable runtime component in which the control software can be executed in both Windows and TwinCAT/BSD. This makes it available for anything from the smallest controllers through to powerful many-core systems, and the same control code can be flexibly executed on the hardware at the necessary performance level.

A runtime component is always installed together with the engineering component so that the execution of the program code can be tested locally using the 7-day test licenses. What's more, both the engineering and the runtime can be flexibly extended by functions, so that the TwinCAT system can be perfectly adapted to suit specific requirements.

Engineering

TwinCAT XAE (eXtended Automation Engineering) allows hardware to be programmed and configured in a single engineering tool. In addition to the IEC-61131-3 programming languages, C/C++ and MATLAB®/Simulink® are also available for programming. The tool also offers integrated debugging options for the program code and diagnostic functionalities for the control hardware. Functions are available to flexibly extend the basic engineering to include additional functionalities such as a software oscilloscope.





Runtime

TwinCAT XAR (eXtended Automation Runtime) is a real-time-capable runtime in which the program code can be executed to control the field level of the machine. The modular architecture makes it possible to install and load extensions on an application-specific basis in the form of functions. In addition to the actual real time, which is executed independently of the operating system, an operating system always runs on the PC-based controllers, which also enables other programs to be executed. This means the control platform can also be used for tasks such as visualizing or executing customer-specific software.

TwinCAT 3 bundles all control tasks: from motion control to safety

TwinCAT is a modular system that can be assembled individually for projects according to requirements. In addition to the actual engineering and control system, this modularity is mapped via 100 so-called Functions, which are assigned to different subject areas.

Engineering itself, for example, provides modules for analyzing real-time behaviour or for connecting other engineering tools. The TwinCAT execution environment for PLC, C++, or MATLAB®/Simulink® must be considered separately from this.

The TwinCAT functions extend the basic system in areas such as motion and safety individually depending on the application. Measurement or, for example, a TwinCAT HMI-based user interface are also modules that interact seamlessly with the actual machine controller via a uniform interface.

To support additional communication protocols such as OPC UA, only a subsequent installation of the corresponding module is required. Even the latest Functions, such as those from the fields of machine learning or vision, can be retrofitted to existing systems in the same way.

This modular concept of TwinCAT 3 is the key to a modern, flexible, and stable platform with long-term availability, based on which machine series can be continuously developed over many generations with minimum migration effort.

TwinCAT System
One of the great advantages of TwinCAT 3 is the wide range of extension options with TC3 Functions. The Functions from the "System" area extend the basic components with important properties.

TwinCAT HMI
TwinCAT 3 HMI enables the development of platform-independent user interfaces based on current web technologies (HTML5, JavaScript/TypeScript). These act "responsively" and automatically adapt to the resolution, size and orientation. The engineering of the TwinCAT HMI integrates into the familiar TwinCAT development environment and offers a graphical What-You-See-Is-What-You-Get (WYSIWYG) editor.

TwinCAT Measurement
TwinCAT is more than just an automation software, it's also a measurement software. TwinCAT Measurement functions extend TwinCAT with additional measurement technology functions, providing support for machine commissioning, machine monitoring, documentation of processes, and the presentation of both measurement and analysis results.

Additionally, the current version – currently TwinCAT 3.1 in Build 4024 – is continuously being further developed and expanded with new features, most recently including TwinCAT Vision, TwinCAT Machine Learning, and support for TwinCAT/BSD. Users also stand to benefit twice thanks to backward compatibility with previous versions, as they can protect their investments and adapt their applications to current and future market requirements.

TwinCAT Control
Control technology tasks can also be handled with ease using products in the TwinCAT 3 modular system. In addition, a product for voice input and output is also available in the form of the TF4500.

TwinCAT Motion
TwinCAT Motion includes scalable software packages for motion control. It includes modules ranging from a simple PTP (point-to-point) application to robotics and complex CNC applications. An abstraction layer to the hardware enables a very flexible control of a wide range of drive devices.

TwinCAT Connectivity
One of the great advantages of TwinCAT 3 is the wide range of options for interaction and communication with other systems. Numerous functions are available for addressing different communication scenarios and implementing protocol functions.

TwinCAT Vision
TwinCAT 3 Vision offers an open and scalable image processing solution that is fully integrated into the universal TwinCAT automation platform. As the configuration of the cameras and the programming of the image analysis take place in the familiar TwinCAT environment, the engineering is simplified.

Industry-specific
TwinCAT is a universally applicable control technology for a correspondingly wide range of applications. However, specific requirements that are indispensable for specific industries are also covered, e.g. through precisely tailored extensions, the TwinCAT Functions for industry-specific tasks.

TwinSAFE
The integrated TwinSAFE safety solution is the logical continuation of the open, PC-based Beckhoff control philosophy. Due to their modularity and versatility, the TwinSAFE components fit seamlessly into the Beckhoff control system.

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How can TwinCAT 3
optimize your automation solution?
Get in touch to find out more.

▶ **www.beckhoff.com/twincat3**

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