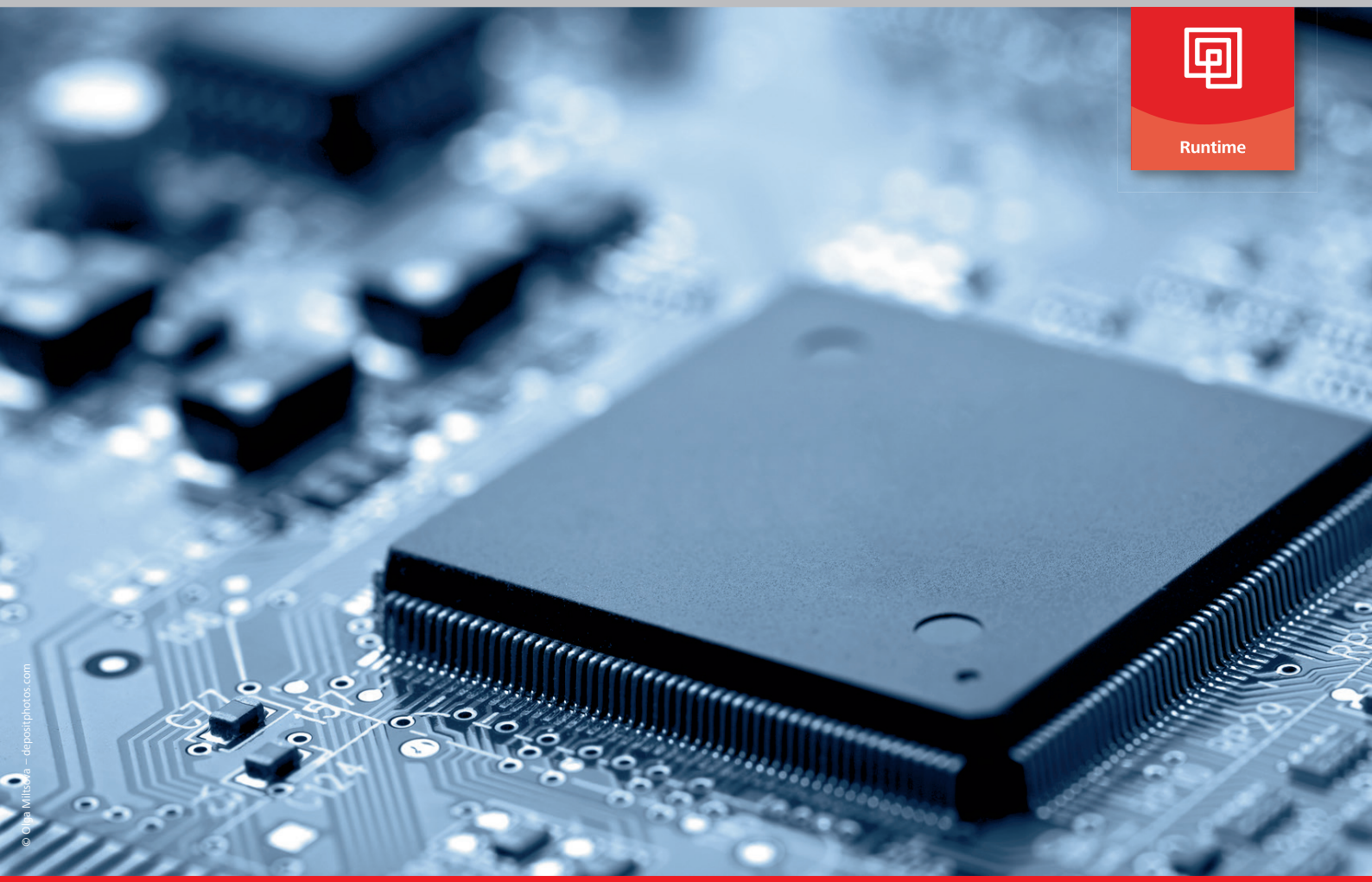
English

CODESYS

CODESYS® Runtime



Converting any intelligent device into an IEC 61131-3 controller using the CODESYS Control Runtime System

CODESYS Runtime

CODESYS Control – the Controller runtime system

CODESYS is the leading manufacturer-independent IEC 61131-3 development system. Programmable Logic Controllers (PLCs), ECUs/mobile controllers, visualization devices, motion controllers and additional automation devices in various industries are programmed with this automation software.

This requires the right software on the device:
the PLC Runtime System CODESYS Control. It turns intelligent industrial devices of very different designs into controllers programmable according to the IEC 61131-3 standard. CODESYS Control is a software product for device manufacturers that can be adapted to the specific properties of the device with the help of a runtime toolkit (Software Development Kit).

CODESYS users

Full attention can be devoted to the creation of applications as CODESYS Control is implemented on all available CODESYS controllers (in the CODESYS Device Directory under codesys.net). Furthermore ready-to-use SoftPLC systems for different standard platforms are available in the CODESYS Store. The systems for standard Linux devices won the Automation Award in 2017.

Device manufacturers

The CODESYS Control Runtime System can be adapted to almost any platform and requirement. The modular structure and scalability open up a wide range of options for adaptation onto the individual system structures.
This brochure covers the essential information device manufacturer need for an optimal implementation.

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Your trusted product and partner for creating successful controllers

CODESYS Control is the base software in many industrial control devices:

- Compact small controllers for mobile machines such as industrial compressors or road finishing machines
- Standard PLC systems for production machines, e.g. for wood processing or manufacturing engineering
- Process control systems for energy and process engineering, e.g. for controlling solar power plants or painting lines
- High performance motion controllers for PC-based manufacturing engineering, e.g. for the production of consumer goods with CNC machines
- Panel controllers for building automation, e.g. for the optimization of operating comfort and energy efficiency

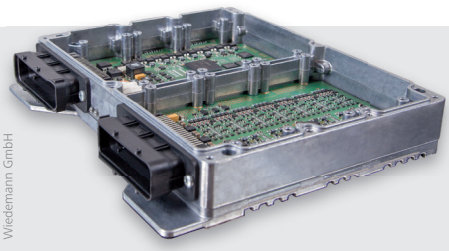
These devices differ quite considerably in design, CPU or operating system platform, I/O or fieldbus system, connectivity to cloud or other control systems, as well as in other system properties. One significant characteristic of CODESYS Control is the flexible adaptation option for varying requirements.

The expert engineers of the CODESYS Group support the device manufacturers in selecting the necessary product components of the runtime system as well as in the adaptation of specific components to the respective target device. Project experience with about two dozen operating systems as well as with all the important CPU platforms for industrial applications guarantees a successful runtime system implementation in all phases. For the development of customized add-on components, the CODESYS Group offers support upon request.

The product components themselves are developed by a specialized team of product developers from the CODESYS Group. Prior to each release the runtime system is automatically tested on different reference systems in hundreds of steps. These tests guarantee the product quality of the system.

The objective: Achieve rapid market maturity for the new controller while retaining high product quality.

Evidence from many millions of individual devices and approximately 1000 different device types from over 400 manufacturers worldwide has proven it: **The objective is achieved with CODESYS Control!**



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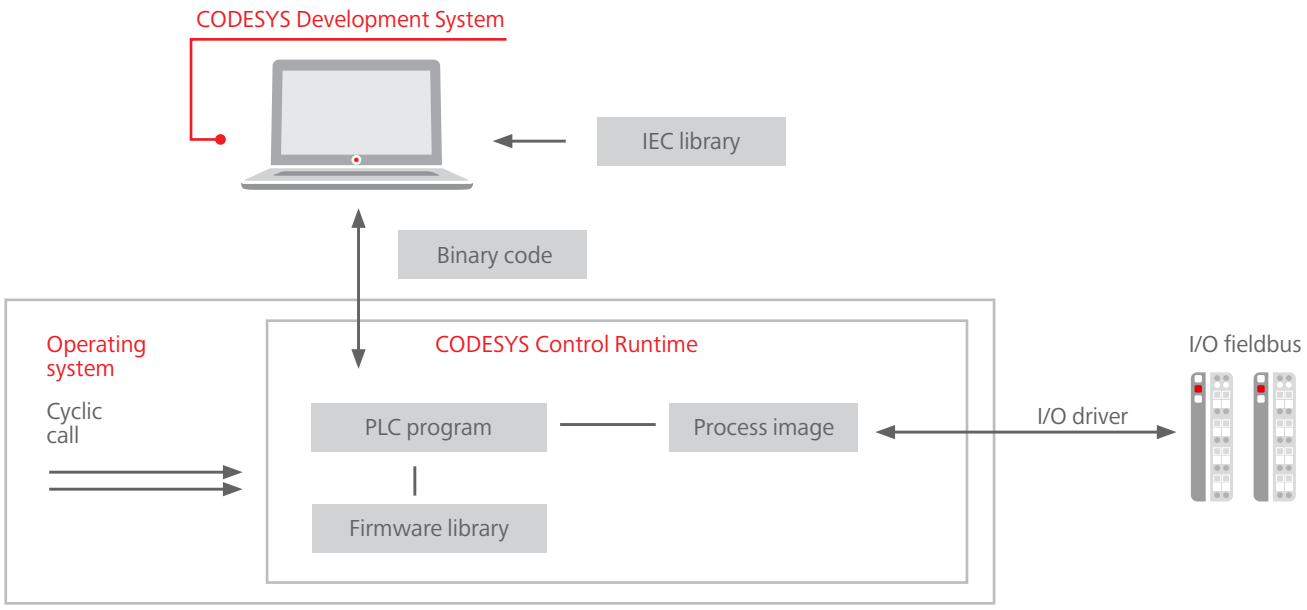
Detailed information on CODESYS Control

Tasks and functions

- Communication with the CODESYS Development System
- Loading, management and execution of the application code compiled by CODESYS in binary format
- Debugging of the application within CODESYS
- Handling of the I/O systems and fieldbuses
- Provision of Security functions for data and know-how protection
- Execution of optional components (see page 10)



CODESYS Control is the "brains" for the processing of control tasks.

The right runtime system for each device

Each industrial device has its specific properties. Through its modular structure CODESYS Control shows these properties to their best advantage and makes project engineering possible with the CODESYS Development System. To this end the runtime system comes supplied pre-configured in different variants as CODESYS Runtime Toolkit (SDK).

The CODESYS Runtime Toolkit includes the following:

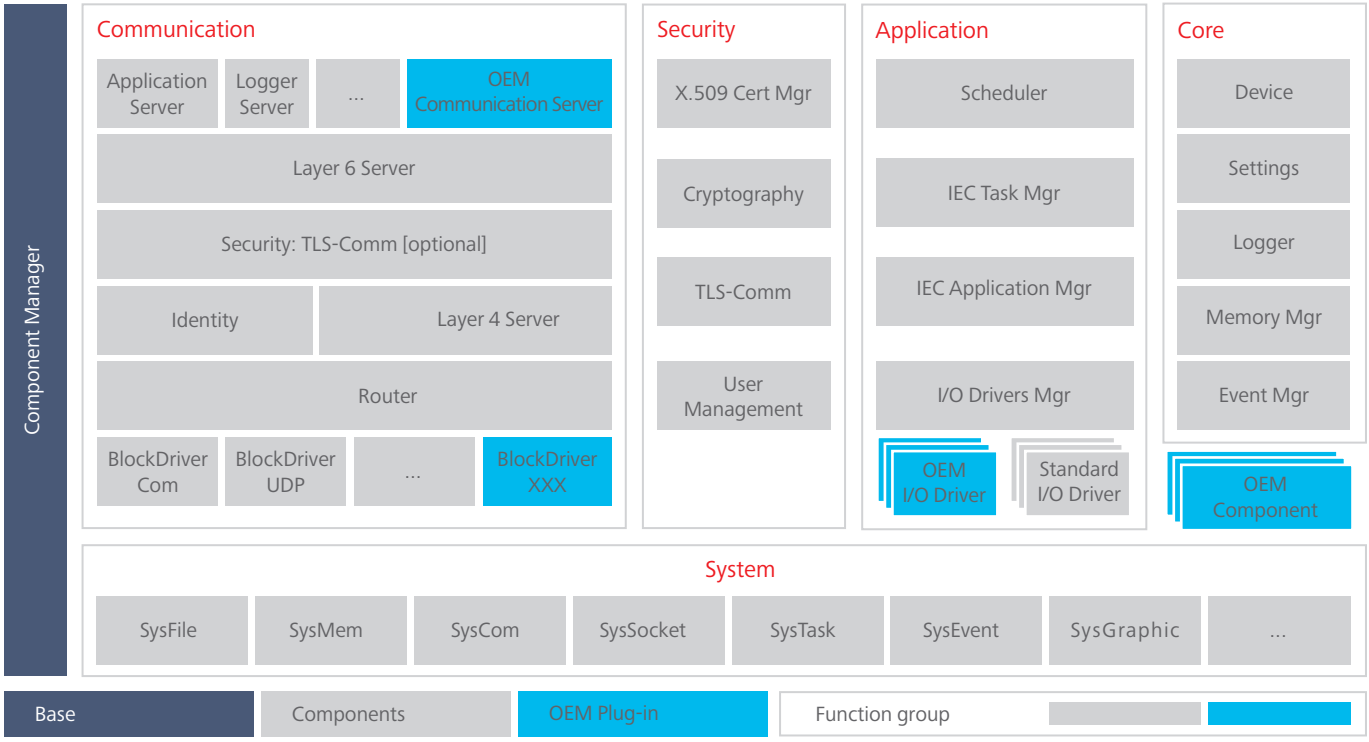
- Runtime system components in the form of object or source code each depending on the system environment,
- System configurator for tool guided component selection / configuration,
- Documented adaptive interfaces for separate components or extensions,
- Comprehensive integration manual for the implementation of the runtime system,
- Workshop for developers who are responsible for the porting and extension of the runtime system.

This allows device manufacturers to perform a structured adaptation of the software to their products (see page 7).

Specific properties

Simple adaptation to different operating systems and development environments (toolchains), as well as to performance and memory layout of the target device to different 32- and 64-bit CPU platforms (CISC/RISC) with single and multicore architectures.

- Functionality scalable on the basis of available product components for different tasks: within the scope of the implementation components can be added, omitted, replaced or supplemented by additional separate components.
- Security components included in the delivery scope of the toolkit protect the device against unauthorized operation or piracy of the application code
- The components of the runtime system have been developed as products and as such are subject to continuous quality assurance measures.



The components of CODESYS Control allow for size and functionality of the system to be scaled.

Business model

- Distribution as a toolkit (SDK) for the respective device platform as well as device licensing ("Runtime Royalties"). Software license protection is realized per controller platform.
- Licensing of add-on products or optional components (from page 10) as buyout per platform, as a surcharge to the device license or in a service package.
- Alternative: Licensing per industrial controller for pre-adapted platforms (e.g. Windows/Linux based devices) as Single License (suffix "SL"). License protection is realized via software or CODESYS Runtime Key (USB/Flash card dongle). Add-on products or optional components of the runtime system are partly included (e.g. fieldbus support, OPC UA server).

Delivery variants

- **CODESYS Control:** Full extension including all scalable components for control platforms with a pre-emptive multitasking operating system and corresponding performance data. Customization to specific operating system versions may be required as a service that is subject to fees.
- **CODESYS Control – embedded configuration:** Pre-configured runtime system for control platforms based on embedded devices with or without a proprietary operating system (single or multitasking). Ready to run immediately on regularly tested reference platforms with reference implementations. Upscaling possible with all available product components of CODESYS Control.
- **CODESYS Control – pre-configured SoftPLC for standard device platforms:** Ready to use SoftPLC Runtime Systems convert any industrial device into a high-performance PLC – scalable at the customer's discretion via CPU performance.

Supported standard platforms

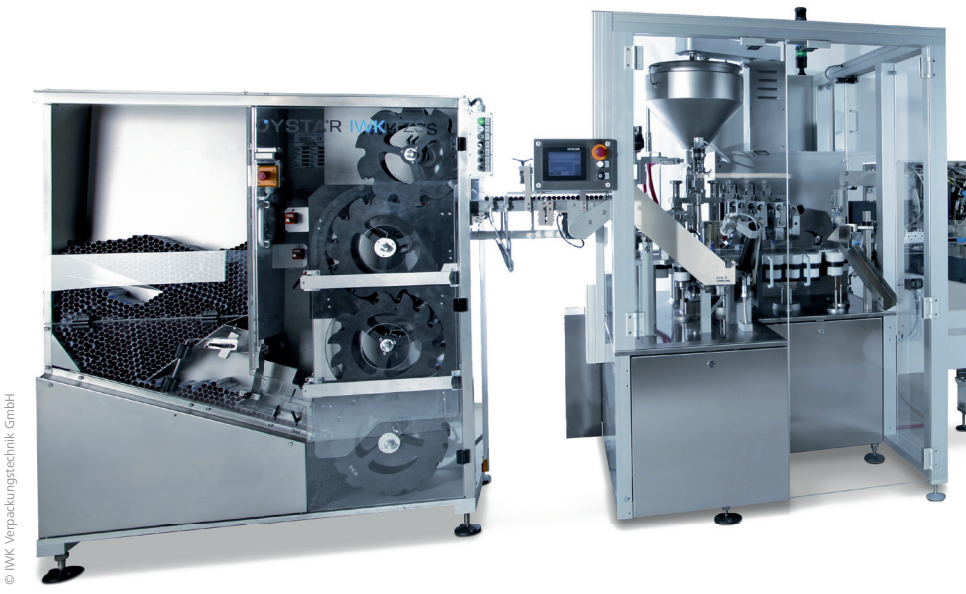
CPU series	with operating system
Intel 80x86 80186, Pentium, Atom (full 32-bit and 64-bit support)	Windows, Windows CE, Linux (OSADL real-time expansion), VxWorks, QNX
ARM based CPUs (ARM7, ARM9, ARM11) ARM Cortex CPUs (Thumb2 Instruction Set: Mx, Ax)	Windows CE, Linux (OSADL real-time expansion), VxWorks
Power architecture PowerPC and distributions, VLE support	Linux (OSADL real-time expansion), VxWorks

Other target device platforms

In the CODESYS Development System, integrated compilers are available for the following CPU platforms:

- Infineon TriCore
- Renesas RZ/N1, RX
- Analog Devices Blackfin
- NXP (Freescale) ColdFire
- Texas Instruments DSP C2xxx/28x

The CODESYS Development System generates native machine code for all cited CPU platforms.
As a result, the CODESYS Control runtime system can process the generated application code without an external compiler for optimum performance.
Intelligent devices based on these and other CPU platforms can be equipped with CODESYS Control on request. Reference implementations are available for more frequently used combinations of CPU and operating system. With customization support and services, implementing CODESYS Control is possible on almost any operating system platform.



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Implementation / adaptation of the CODESYS Control Runtime System onto individual devices

- Selection of CPU and operating system
- Installation of the CODESYS Control Runtime Toolkit on the individual PC workstation
- Tool guided selection and configuration of the components for the desired functionality of CODESYS Control
- Adaptation of the specific components to operating system interfaces, if applicable
- Configuration / adaptation of the communication drivers to the CODESYS Development System
- Implementation of available / individual fieldbus drivers for support of the fieldbus configuration via the CODESYS Development System
- Implementation of individual drivers or integrated add-on functions ("external libraries")
- Optional: Integration of runtime system extensions for additional CODESYS functions (e.g. fieldbus support, visualization, motion control or redundancy)
- Optional: connection to external systems based on available interfaces
- Compiling / linking of all components to the executable runtime system if applicable, downloading onto the target device
- Provision of the device driver (device description) for using the device in the CODESYS Development System
- Validation and testing of the system, optional with CODESYS Test Manager

CODESYS Control developers workshop

The CODESYS Runtime Toolkit includes a multi-day developers workshop for engineers who are responsible for the implementation of the CODESYS Control Runtime System.

Range of services

- Extensive training on the concept, architecture and implementation of the runtime system
- **For CODESYS Control**
  Installation of the runtime system on the target platform such as Linux or Windows CE
- **For CODESYS Control Embedded configuration**
  Customization and compilation of the runtime system for the target platform
- Basic function tests
- Training on the generation of customer-specific components as an extension of the runtime system, for example for calling external functions, for developing specific I/O drivers
- Additional e-mail support in limited scope beyond the workshop

Extensive support starting from the implementation all the way to a complete customization can be provided upon request.

CODESYS in tube fillers:
The CODESYS Control Runtime System executes the user programmed control application.

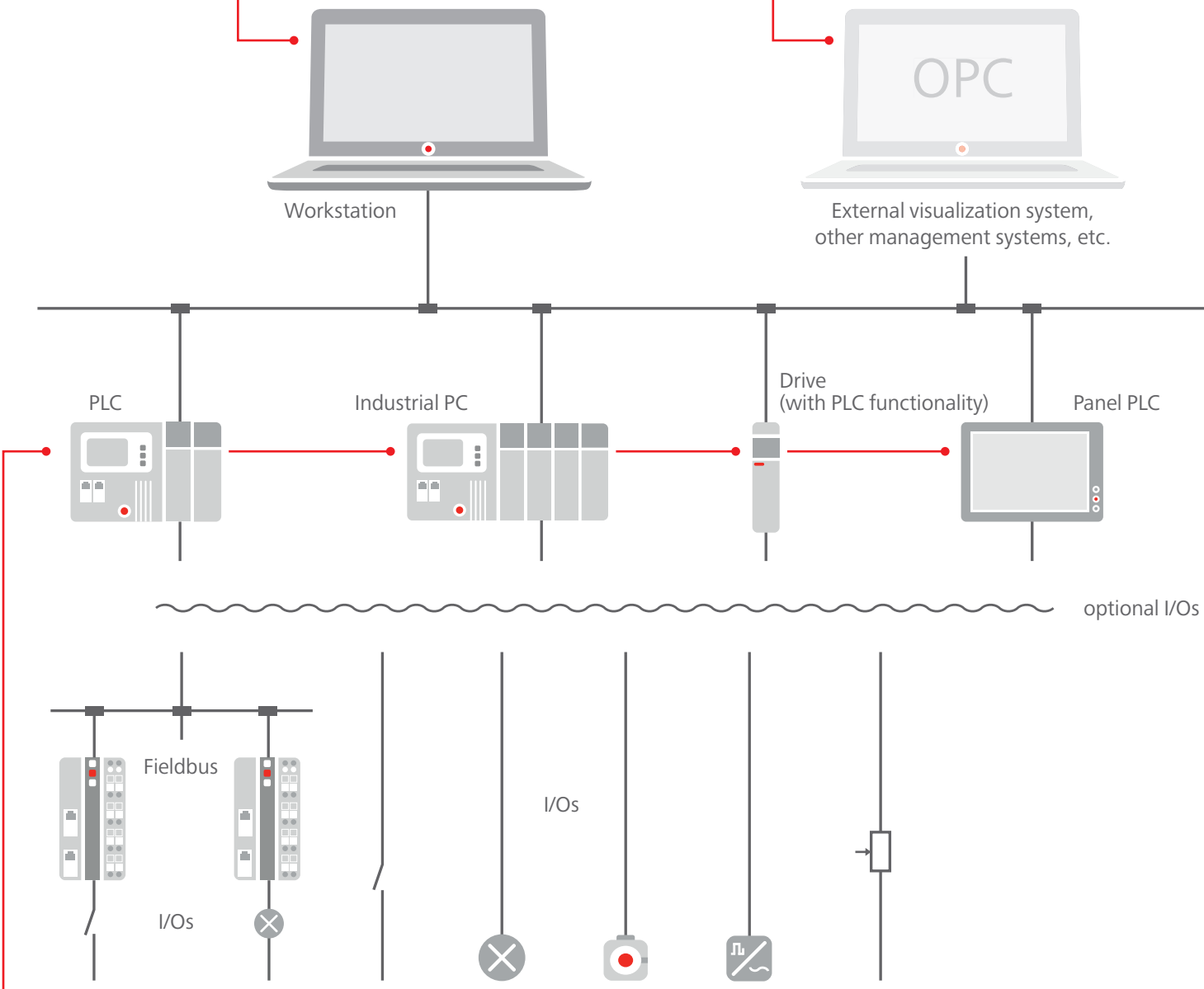
CODESYS Development System

- Application programming
- Call of device-specific system libraries
- Compilers for different CPU families
- Loading of application code as binary code to the selected target system
- Communication of debugger with CODESYS Control

CODESYS OPC Server

Page 12

- Setup included with delivery, licensing required
- Operating system: Microsoft Windows
- Data exchange with OPC clients
- Certified by OPC Foundation



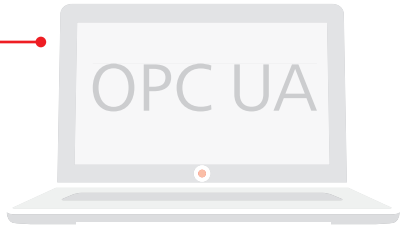
CODESYS Control

Page 4

- Runtime toolkit required
- Any operating system: with or without preemptive multitasking
- Individual I/O driver
- Optional: fieldbus support, CODESYS TargetVisu, CODESYS WebVisu, CODESYS SoftMotion, CODESYS Redundancy, CODESYS OPC UA Server, CODESYS C-Integration

CODESYS OPC UA Server Page 13

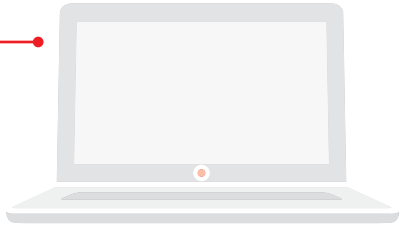
- Any operating system
- Data exchange with OPC UA clients
- Certified by OPC Foundation



External OPC UA client

CODESYS PLCHandler Page 14

- For manufacturers of third-party systems / device manufacturers
- Lean interface for a user-friendly exchange of data with the controller
- Any operating system
- Toolkit required

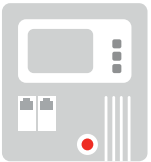


PC or hardware with external systems

Configuration variants of CODESYS Control

SoftPLC Page 6

- CODESYS Control RTE (SL), CODESYS Control Win (SL) etc.
- Preconfigured for common hardware platforms (e.g. Industrial PCs, partly with individual real time support)
- Operating systems: Windows / Linux / VxWorks / QNX
- Licensing: per platform / as single license (SL)



CODESYS Control – embedded configuration Page 6

- Preconfigured for selected embedded devices
- Small footprint for compact PLCs
- Unlimited upward scalability

Options for the CODESYS Runtime Toolkit

Fieldbus support

The CODESYS Development System supports a wide range of I/O and fieldbus systems (e.g. PROFIBUS/PROFINET, CANopen, EtherCAT, etc.) with communication libraries, configurators as well as portable protocol stacks.
In order for a device to profit from this, the implementation of a base driver along with a corresponding fieldbus component is necessary in the CODESYS Control Runtime System. In the process, there are base drivers available for the most important systems. Individual I/O systems can be easily connected.

CODESYS SoftMotion/SoftMotion+CNC

CODESYS SoftMotion Runtime System extensions designed to process complex movements, CNC programs or robotics tasks on the target device convert intelligent devices into motion controllers: Single- or multi-axis movements created in the CODESYS Development System, CNC programs or robotics tasks are processed with the control application.

CODESYS TargetVisu/CODESYS WebVisu

Runtime system extensions are necessary for a device to display the user interfaces created in the CODESYS Development System: On a built-in display (CODESYS TargetVisu) or in any web browser based on HTML5 (CODESYS WebVisu).

These extensions are integrated as additional product components in the implementation of the runtime system.

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CODESYS Runtime Test Package

After implementation or update of the CODESYS Control Runtime System it makes sense to perform release tests. Device manufacturers can carry out these tests as unit, regression or system tests either manually or by means of individual test systems.

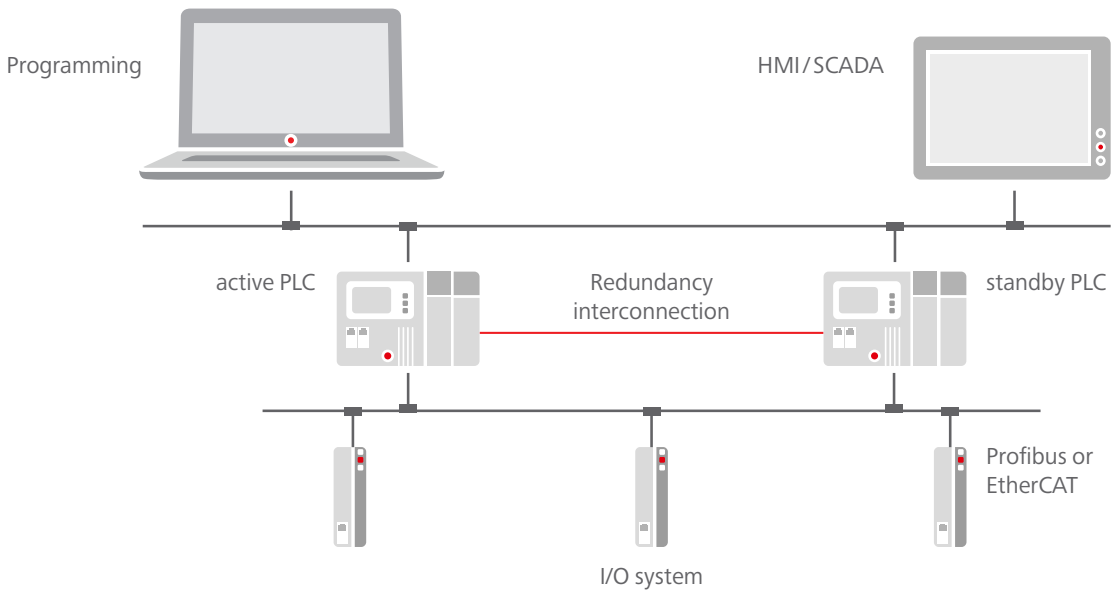
The CODESYS Test Manager is an extension integrated in the CODESYS Development System which allows for automated testing on application level.
By using this functionality, the CODESYS Runtime Test Package provides pre-defined test scripts for the most relevant test cases. Thus, device manufacturers can automate quality assurance of their runtime system implementation.

Additional products for the CODESYS Control Runtime System

CODESYS Redundancy Toolkit

As an extension to the CODESYS Runtime Toolkit, the CODESYS Redundancy Toolkit allows for redundant control systems.

Two independent industrial controllers execute one and the same IEC 61131-3 application and monitor or synchronize one another. In the case of an error, the passive controller becomes active without interruption. Only the currently active controller operates the I/O system. The redundancy function is projected in the CODESYS Development System.



Range of services

- Additional component for CODESYS Control
- Supported I/O systems:
  - EtherCAT (with integrated CODESYS EtherCAT solution)
  - Proprietary I/O systems via an interface for proprietary I/O drivers
- Library functions and extensive OEM documentation for the CODESYS Development System to configure the redundancy function
- Development support for the implementation of CODESYS Redundancy

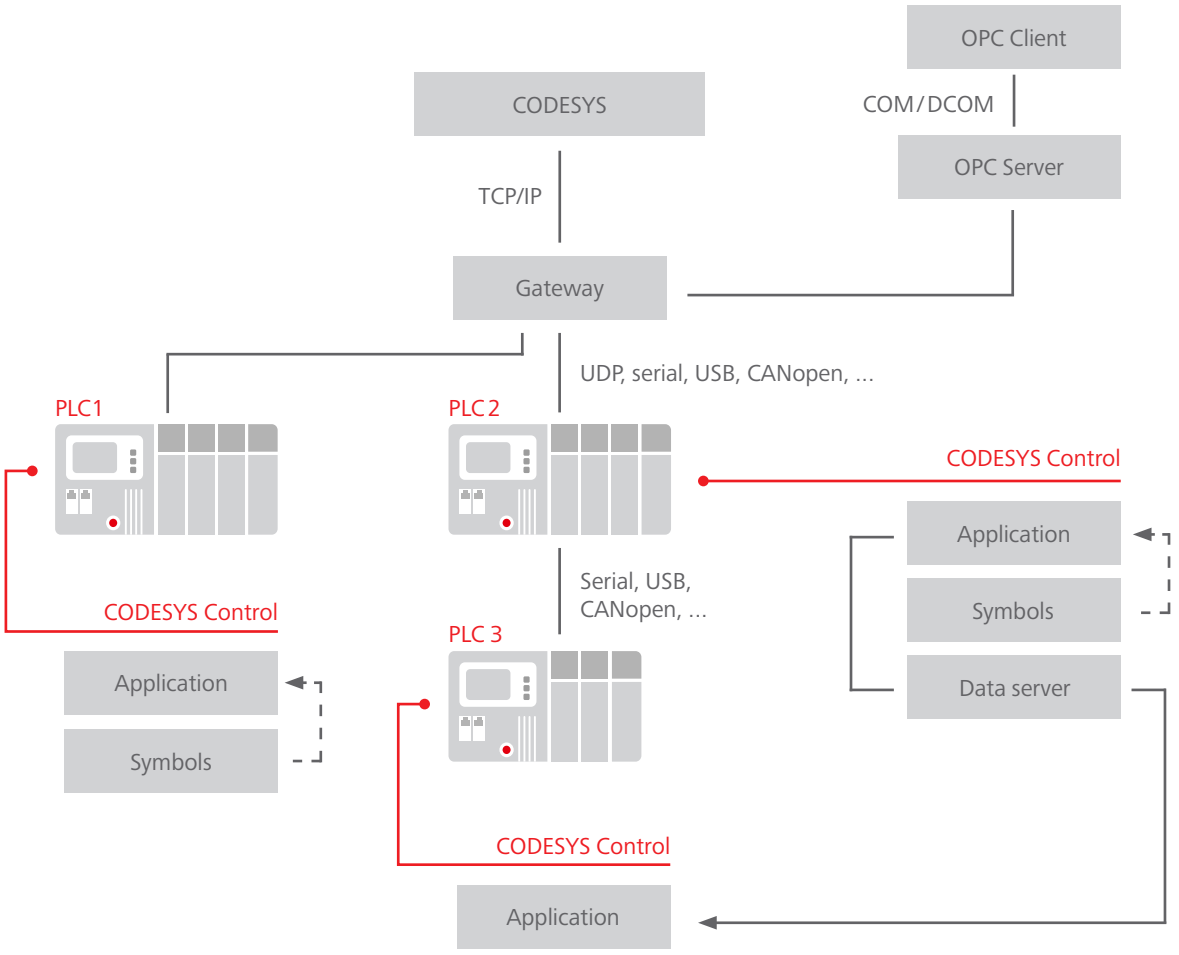
CODESYS OPC Server

With the CODESYS OPC Server, data from visualizations or programs for production data acquisition are exchanged with the controller (CODESYS V3 or V2.3). It is included in CODESYS as an additional Windows program and consists of the server, a server configurator, as well as an event logger.

The CODESYS OPC Server is certified by the OPC Foundation among others in accordance with the Data Access specifications.

Properties and functions of the CODESYS OPC Server (excerpt):

- Automatic start on establishment of a client connection
- Automatic trigger on change of data value or status (OPC items)
- Management of the items in the data cache
- Possible with direct access to items in the controller (without cache)
- Organization of the items in groups
- Integrated event logger for diagnostic purposes is optionally selectable
- Multi-client and multi-PLC support

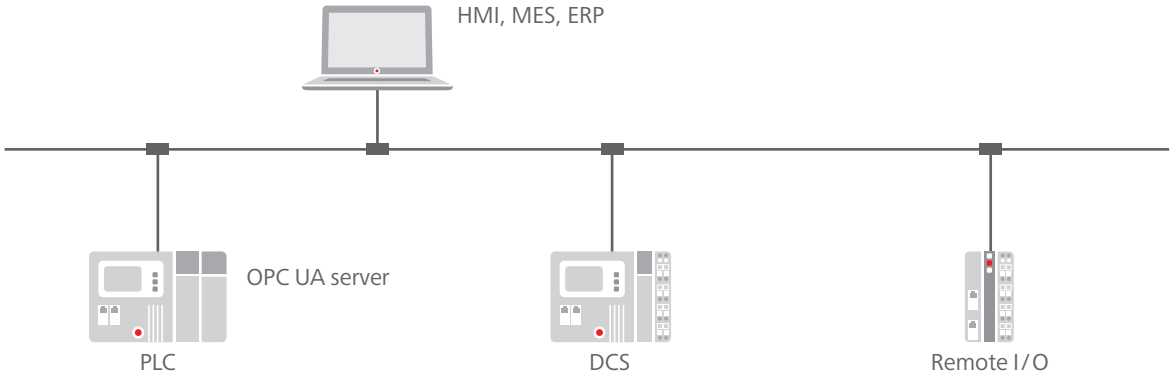


Example of a network with CODESYS controllers and communication clients

CODESYS OPC UA Server

- Additional CODESYS Control runtime system component for any controller with sufficient performance
- Provision of configured variables from the IEC application for OPC UA clients
- Integration of OEM specific objects via integrated provider interface possible
- Two ways to embed the component: binary and source delivery
- PLCopen Information Model
- OPC UA security (x.509 based authentication and encryption)
- Pending: OPC UA client, OPC UA PubSub

OPC Unified Architecture

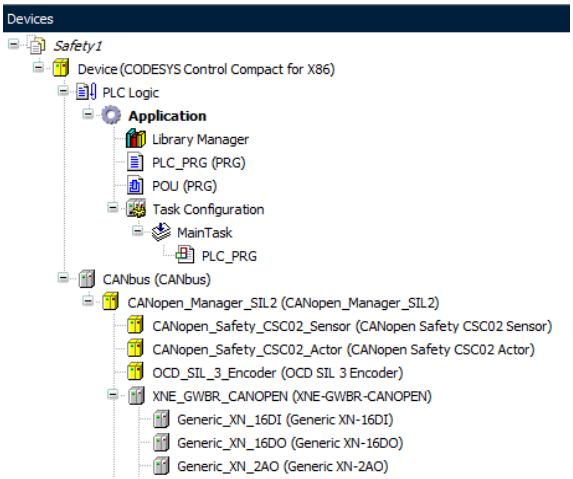


CODESYS Safety for IEC 61508 SIL2/SIL3 safety controllers

- Toolkits allowing for easier development and certification of safety controllers to be used in applications according to IEC 61508 SIL2 or SIL3
- Runtime system and integration manual pre-certified by TÜV, therefore reduced effort for integration and approval of safety controllers thanks to a certified test framework

CODESYS Safety SIL2

- For manufacturers of safety controllers for applications according to EN ISO 13849 to PL d, category 2 or 3/ IEC 61508 SIL2, for example for mobile machines
- Extension of the runtime system CODESYS Control and the CODESYS Development System.
- Development and debugging of software applications for safety controllers, validated for the editors Structured Text (ST), Function Block Diagram (FBD), Ladder Logic (LD), Continuous Function Chart (CFC) and UML (State Chart)
- Optional: completely adapted and approved platform adaptation for the RM48 MCU by Texas Instruments

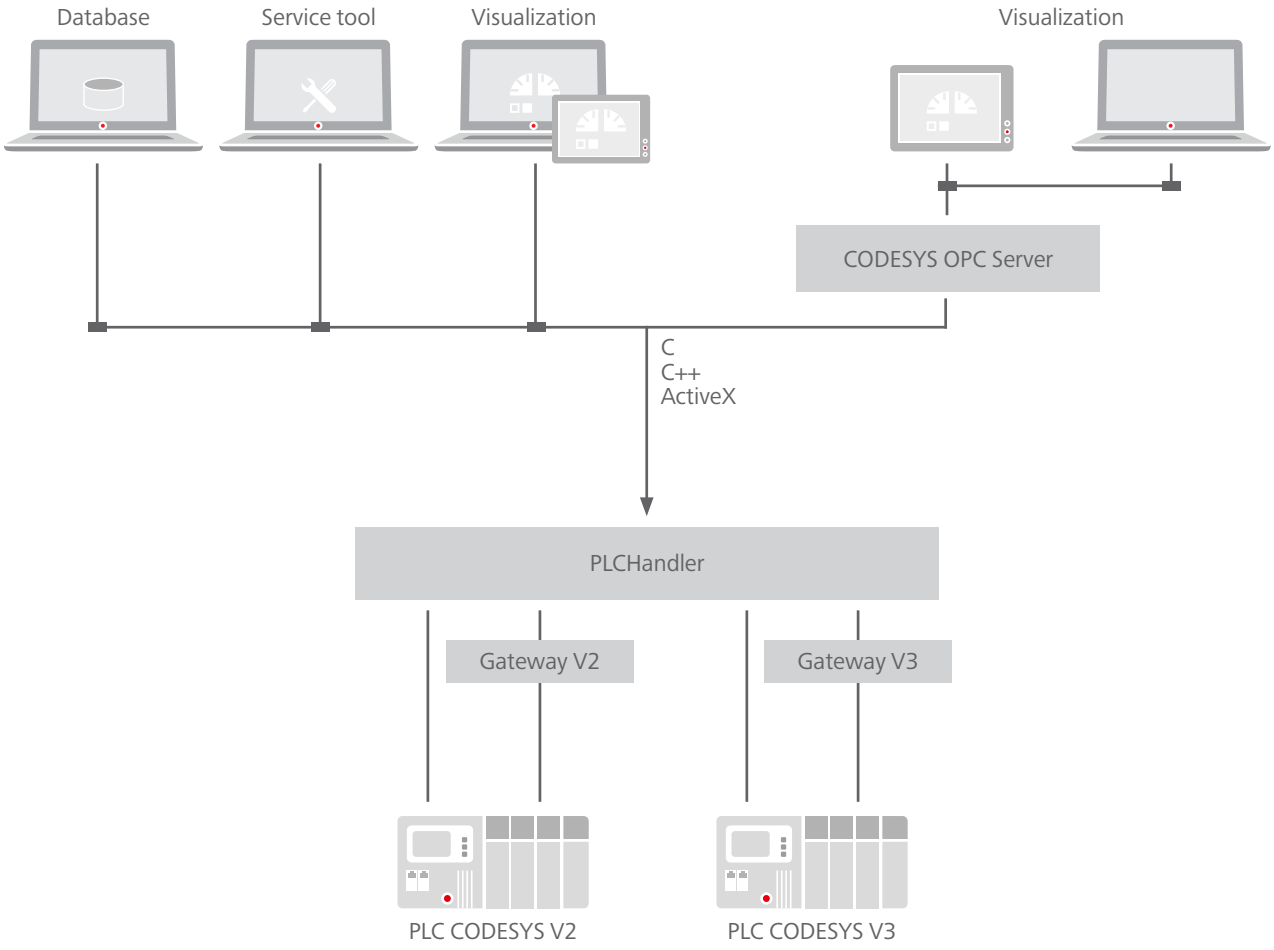


CODESYS Safety

- For manufacturers of safety controllers for applications according to IEC 61508 SIL3, e.g. in machine construction
- Independent runtime system and plug-in extensions for the integrated development of safety applications in the CODESYS Development System with a safe FBD editor and safe data exchange between safety controllers

CODESYS PLCHandler

Convenient software interface (API) for communication between a controller programmable with CODESYS and client systems, such as external visualizations, operational, service or diagnostic devices. The client can access IEC 61131-3 variables and online services of the controller. The CODESYS PLCHandler is implemented as C++ class and comes supplied in a software development kit (SDK). Along with an additional C interface the SDK comes with platform-specific files, e.g. for Windows, Windows CE, Linux or VxWorks, demo clients in the source code for different platforms as well as an ActiveX component for Windows.



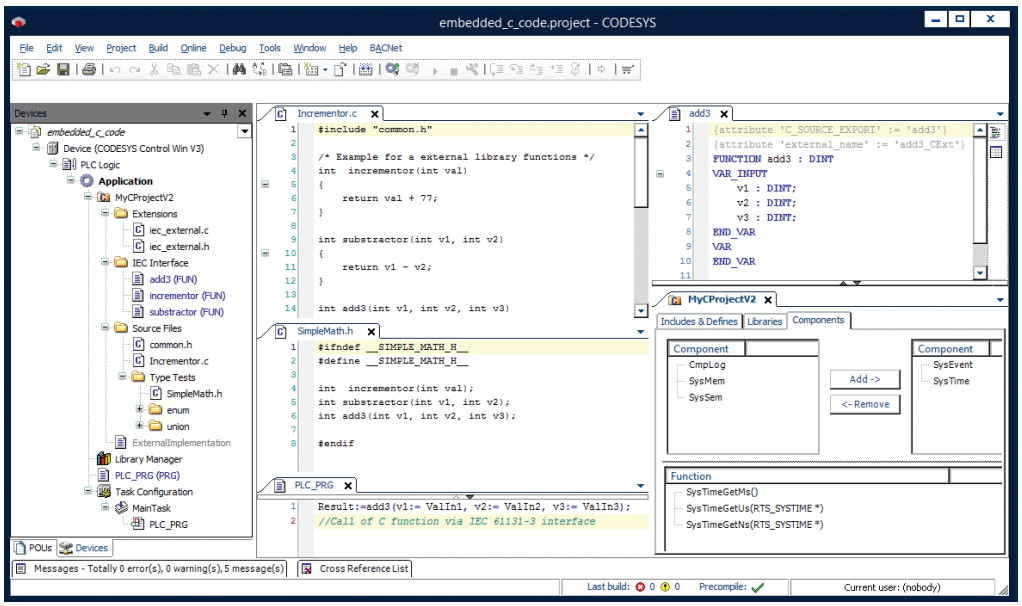
Range of functions of the CODESYS PLCHandler (excerpt):

- Connection to/disconnection from the controller; automatic re-establishment of connection after loss of connection
- Synchronous or cyclical exchange of variable values (read/write) with the controller
- Instantiation for simultaneous communication with several controllers
- Transfer of files to and from the controller

CODESYS C-Integration

Users can dynamically integrate existing or generated C code (for example from tools like Matlab/Simulink) in the application and call it from the IEC 61131-3 code. To this purpose, the C objects are integrated seamlessly into the CODESYS project tree. A text editor fully integrated in the CODESYS Development System allows for basic extensions and modifications of the C source code.

Integrated C objects are compiled via external toolchains and linked to the runtime system as one ore more dynamic components. Device manufacturers provide the toolchain in the form of a plug-in extension for their devices in the CODESYS Development System.



Existing C code is seamlessly integrated in an IEC 61131-3 project.

At a glance

- The runtime system CODESYS Control converts intelligent devices into CODESYS controllers.
- Device manufacturers implement the runtime system with the help of a runtime toolkit as well as qualified adaptation support from the CODESYS Group.
- Reference implementations and fully adapted SoftPLC systems available for PC-based control platforms as well as special embedded platforms
- Added functionality for CODESYS Control refine the automation device.

The benefit for device manufacturers

- Tested and proven runtime system in thousands of industrial applications
- Flexible scaling and adaptation of the runtime system to individual requirements
- Structured and foreseeable development effort for the implementation of a controller
- High market acceptance of the controller due to the wide distribution of CODESYS
- Optimum device performance based on CPU-specific binary code generation in CODESYS

Members of the CODESYS Group

3S-Smart Software Solutions GmbH
Memminger Str. 151
87439 Kempten, Germany

Tel.: +49-831-54031-0
info@codesys.com

codesys.com

CODESYS Italia Srl
Milan, Italy

CODESYS Corporation
Beverly, USA

CODESYS Software System (Beijing) Co., Ltd.
Beijing, P.R. China

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CODESYS – the manufacturer-independent IEC 61131-3 automation software.

CODESYS Product Families:

Note: Not all CODESYS features are available in all territories. For more information on geographic restrictions, please contact sales@codesys.com.

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