CODESYS® Motion + CNC

Motion + CNC

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Logic control and motion integrated in one single IEC 61131-3 system: Development kit for everything from basic motion applications to advanced CNC controllers

CODESYS Motion + CNC

CODESYS from 3S-Smart Software Solutions is the established market standard for programming industrial controllers according to IEC 61131-3. Hundreds of different machine types, both standard and special-purpose, which are used in manufacturing engineering, are automated by CODESYS, as well as other industrially controlled applications in diverse industries.
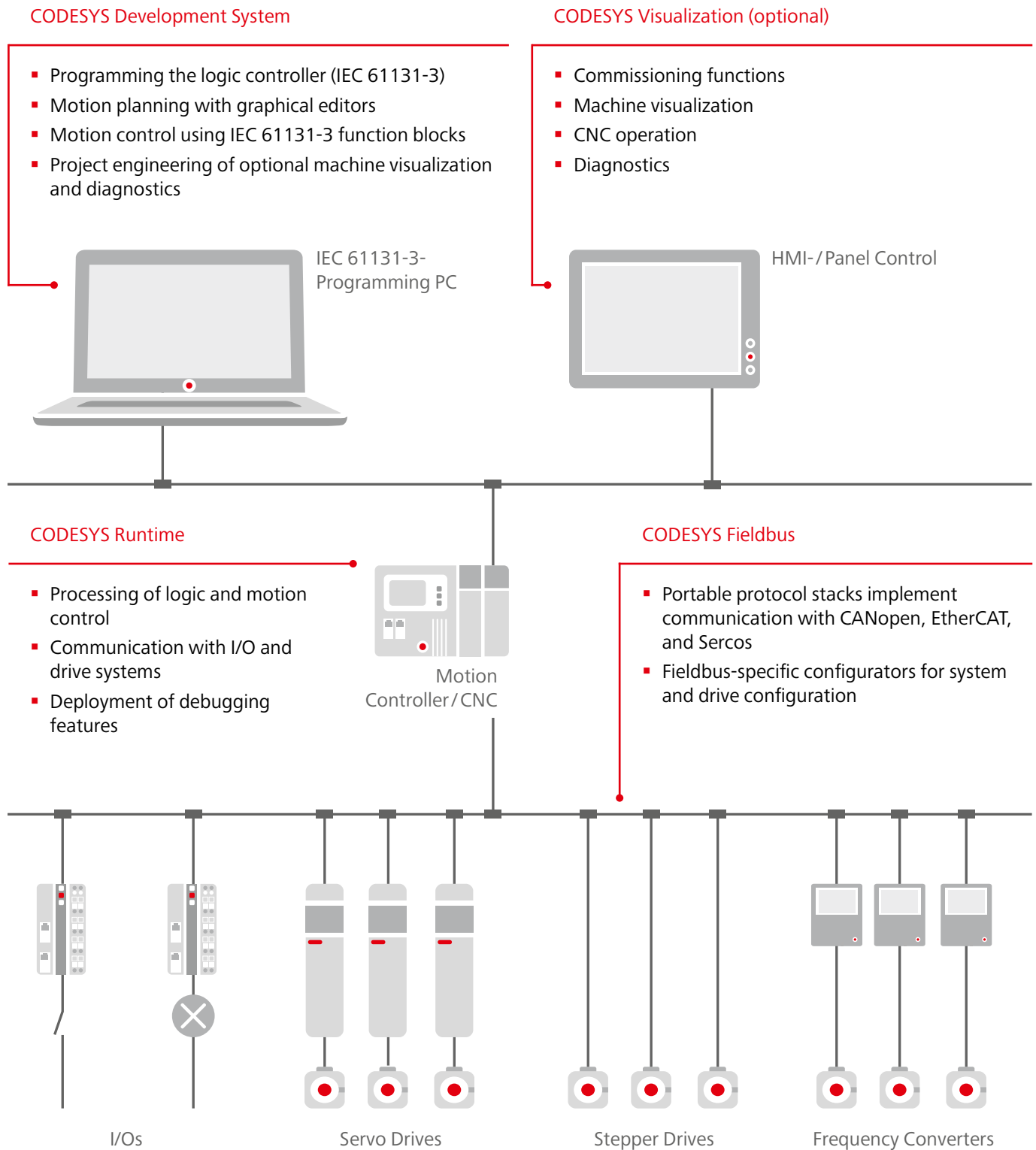
A large number of these machines and plants require a versatile controller for motion sequences in addition to the logic program. Thanks to the high performance of modern processor platforms, these kinds of tasks for motion control and CNC can be processed on the same devices as the logic controller. With the open architecture of CODESYS, it is indeed possible to link or even integrate external engineering tools for motion planning and control. It is easier with CODESYS Motion + CNC: Manufacturers of automation devices can integrate the CODESYS SoftMotion and CODESYS SoftMotion CNC products into the CODESYS platform. In this way, the logic controller assumes the role of an integrated motion controller with all of the required components, such as motion editors, kinematic transformations, and CNC kernel.

Application developers benefit twice as much: just one single hardware device is required for logic and motion control, and both application components can be engineered with one and the same development system. The consistent operating structure makes the engineering of motion tasks considerably easier and more flexible as compared to conventional systems.

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Image: © RainerPlendl – depositphotos.com
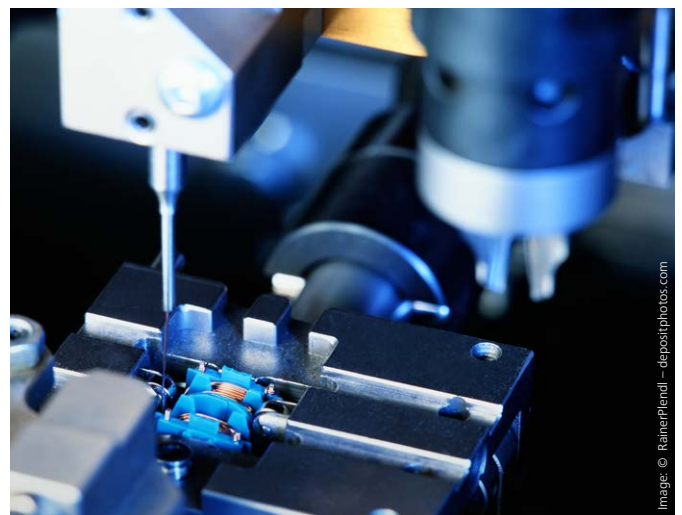
The Ideal Platform for Motion Control – From an Experienced Partner

- CODESYS provides all core requirements for Motion + CNC:
  - Integrated library design ⇨ easy integration of motion functions depending on the application
  - Integrated compilers for the most varied processor platforms ⇨ cross-system deployment of products without any need for customization
  - Integrated fieldbus support ⇨ configuration of the employed drives and I/O components
  - Motion engineering abstracted from drive and bus systems and based on the IEC 61131-3 data structure ⇨ ideal for simulation, testing, commissioning, and machine refitting
  - Simple description of drives via DeviceDescription in XML format ⇨ uniform definition and configuration independent of device type and manufacturer

  - Easy integration of additional configuration and planning tools by the device manufacturer thanks to plug-ins, e. g. for motion editors or specific drives ⇨ full integration of all engineering components
  - Integrated visualization facilitates simulation, testing, and commissioning ⇨ no additional components required

- 3S-Smart Software Solutions is an experienced motion partner:
  - Over 10 years of product experience in software development for coordinated motion control
  - Motion specialists for product management, development, testing, support, and training

CODESYS Development System

- Programming the logic controller (IEC 61131-3)
- Motion planning with graphical editors
- Motion control using IEC 61131-3 function blocks
- Project engineering of optional machine visualization and diagnostics

IEC 61131-3-
Programming PC

CODESYS Visualization (optional)

- Commissioning functions
- Machine visualization
- CNC operation
- Diagnostics

HMI-/Panel Control

CODESYS Runtime

- Processing of logic and motion control
- Communication with I/O and drive systems
- Deployment of debugging features

Motion
Controller / CNC

CODESYS Fieldbus

- Portable protocol stacks implement communication with CANopen, EtherCAT, and Sercos
- Fieldbus-specific configurators for system and drive configuration

I/Os

Servo Drives

Stepper Drives

Frequency Converters

Available control methods

For servo drives

- Motion controller delivers trajectory bases to servo drive in cycles
- Drive control by servo drive

For stepper drives

- Motion controller controls stepper drives via pulse / direction interface
- Pulse counter reports the position to motion controller
- Position control in the motion controller

For frequency converters

- Motion controller specifies the expected rotational speed of the frequency converter
- Sensors, such as rotary encoders, report the position
- Position control in the motion controller

The Structure of CODESYS Motion + CNC

CODESYS Motion + CNC is seamlessly integrated into the CODESYS Development System as a tool box and thus benefits from the available functions of the platform. Motion is processed in the controller within the context of CODESYS Control (IEC 61131-3 runtime system).
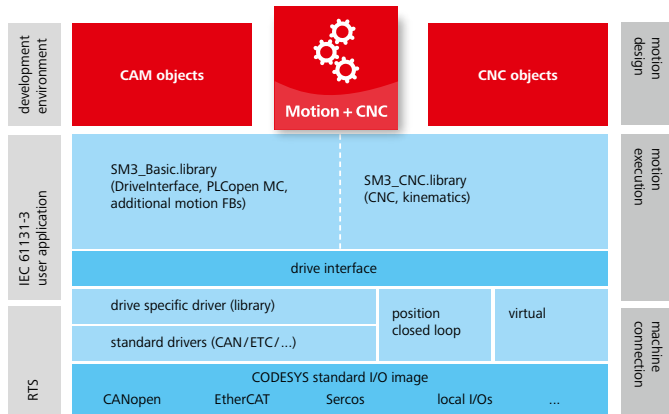

The tool box contains numerous components:

- Editors for motion planning (cams, CNC)
- Extensive library with IEC 61131-3 program blocks for implementing motion and for help functions
- Accompanying visualization templates for simplified engineering and commissioning
- Support for the most widely used fieldbus systems
- Generic and specific drivers for the most popular servo drives, e. g. from Schneider Electric, KEB, Bosch Rexroth, Control Techniques, Festo or Stöber (more details under www.codesys.com)
- Samples and documentation for creating motion applications

Principal Application

- Configuration and commissioning of drives:
  - Adding the necessary bus system to the CODESYS project. Support for CANopen, EtherCAT, and Sercos, as well as standard systems, such as stepper drives and drives with an analog controller. More upon request.
  - Adding the required drives
  - The device name represents implicitly provided IEC data structure with abstracted data for each drive, allowing smooth exchange of drives and drive buses
  - Configuration of the drive / bus-specific parameters, such as baud rate, emergency, and sync
  - Drive commissioning with integrated „Online Config Mode"
- Motion planning and processing:
  - Calling of POUs for PLCopen MotionControl in the CODESYS project (e. g. MC_POWER, MC_MoveAbsolute, MC_MoveVelocity)
  - POU parameters are IEC 61131-3 variables that can be changed when the application is in runtime mode, e. g. by the logic application, sensor values, or user input in the visualization.
  - Optional call from included additional block, e. g. for diagnostics or error handling
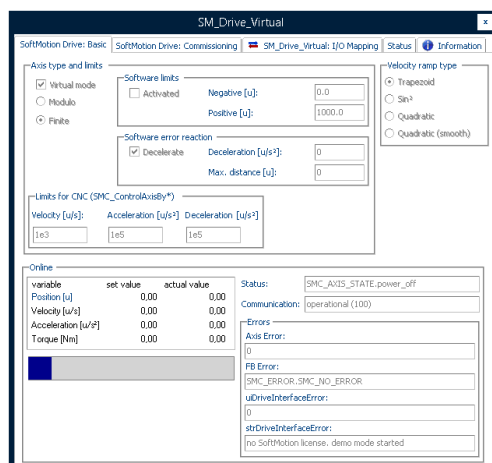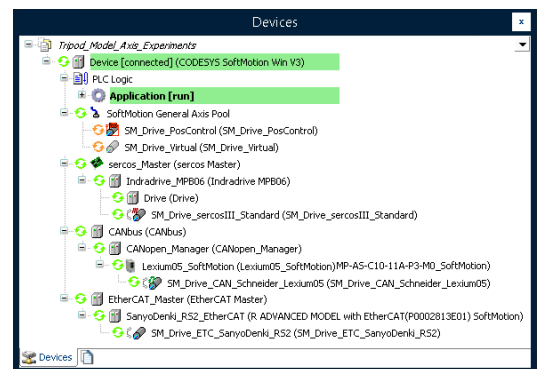

  - Convenient motion planning of cams and CNC motion with special editors (Detailed information about the CODESYS SoftMotion and CODESYS SoftMotion CNC products are found on page 5.)
- Commissioning of the motion application on the motion controller
  - Compiling, downloading, and running the application
  - Additional tools: Visualization templates for program blocks enable easy online operation and parameterization of the blocks.
  - Commissioning of the motion application using the CODESYS Development Systems – motion program runs on the controller as a subtask

CODESYS Motion + CNC – Available Products

CODESYS SoftMotion

For single-axis and coordinated multiple-axis movements, such as master / slave functions and cams:

- Use of available library POUs and programming of the motion function based on the IEC data structure
- Any interconnection of the function is possible within the logic application
- Graphical planning of cam functions with the help of an integrated cam editor (CAM)
- Numerous POU-specific visualization templates for easy commissioning with the CODESYS Development System
- Additional visualization templates for online editing of cams in runtime mode with optional products: CODESYS HMI, CODESYS TargetVisu, or CODESYS WebVisu
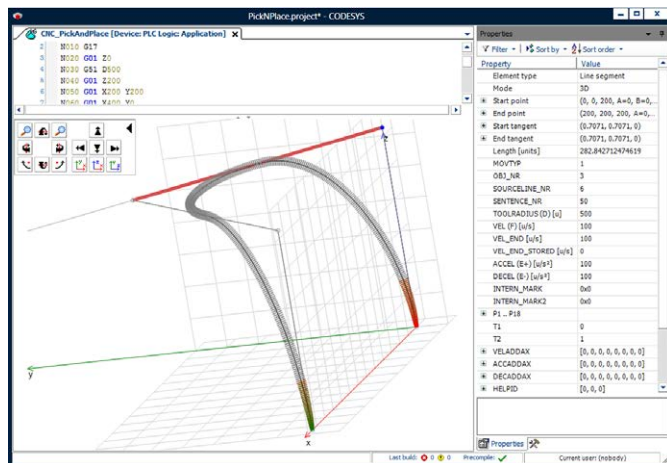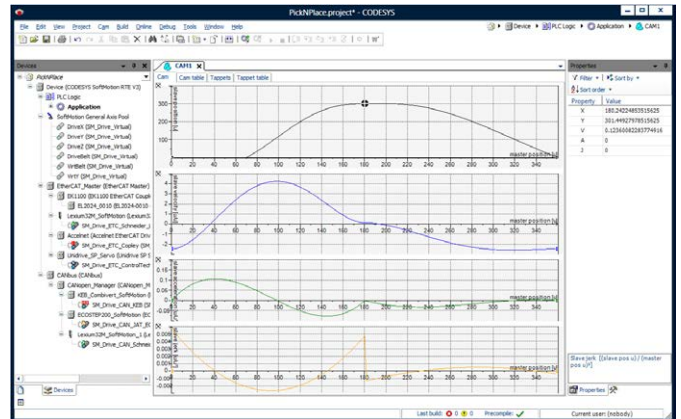
CODESYS SoftMotion CNC

For CNC movements with multiple coordinated axes and precisely defined motion path

- With complete functionality of CODESYS SoftMotion
- Motion planning in the integrated DIN 66025 editor with graphical 3D display
  - Step-by-step using an extensive set of G-code movement commands, e. g. linear, circular, spline
  - Graphical in the 3D display and follow-up editing of the G-code
  - By data input in a tabular editor
  - By reading existing G-code files in ASCII format
  - Import of DXF files for automated creation of matching G-code

- Support for different speed profiles: trapezoidal, sigmoidal, quadratic (jerk-limited, S-profile)
- Definition of the necessary path speed (feed) and limits for acceleration, deceleration, and reverse
- POUs for restricting the dynamics of spatial and additional axes
- Processing of CNC motion by POUs based on the IEC data structure
- Numerous additional functions, such as tool-radius correction, edge smoothing, and limited curve speed
- Creation of customized POUs using IEC 61131-3 means for personalized functions, e. g. application-specific angle smoothing for laser cutting
- Decoder and interpolator as portable IEC 61131-3 library POUs
- Numerous kinematic transformations for different task ranges, e. g. gantry systems and robots
- Visualization templates for online editing of CNC projects in runtime mode, as well as for diagnostics and testing kinematics with optional products: CODESYS HMI, CODESYS TargetVisu, or CODESYS WebVisu

CODESYS Motion + CNC – From Intelligent Device to Motion Controller

Image: © STÖBER ANTRIEBSTECHNIK GmbH & Co. KG

Image: © Schneider Electric Automation GmbH

Image: © Parker Hannifin Manufacturing Germany GmbH & Co. KG

PC-based motion controller with industrial PC

- Real-time capable SoftPLC with motion control
  - Download and installation of CODESYS Control SoftMotion RTE SL for IPCs for Microsoft Windows (available in the CODESYS Store at store.codesys.com)
  - License purchases and single licensing via sofware/USB security key per PC-based motion controller
- Options: Additional licenses for
  - CODESYS SoftMotion CNC
  - CODESYS TargetVisu: Visualization on the motion controller
  - CODESYS WebVisu: Monitoring and diagnostics in HTML5 web browser

Motion controllers – also integrated in mechatronic controllers or intelligent drives

- Requirements:
  - Real-time capable system
  - Hardware with appropriate performance resources according to the intended use
  - FPU recommended
  - Compatible communication links to drives and standard fieldbuses (CANopen, EtherCAT, Sercos)
- Business model
  - Purchase of the CODESYS Control Runtime Toolkit
  - Implementation of the SoftPLC for CODESYS SoftMotion or CODESYS SoftMotion CNC with a complete motion kit for distribution of the motion controller to the end user
  - Purchase of the necessary fieldbus support as an additional option
  - Purchase of runtime licenses for CODESYS SoftMotion or CODESYS SoftMotion CNC per delivered motion controller, price depending on quantity and device platform
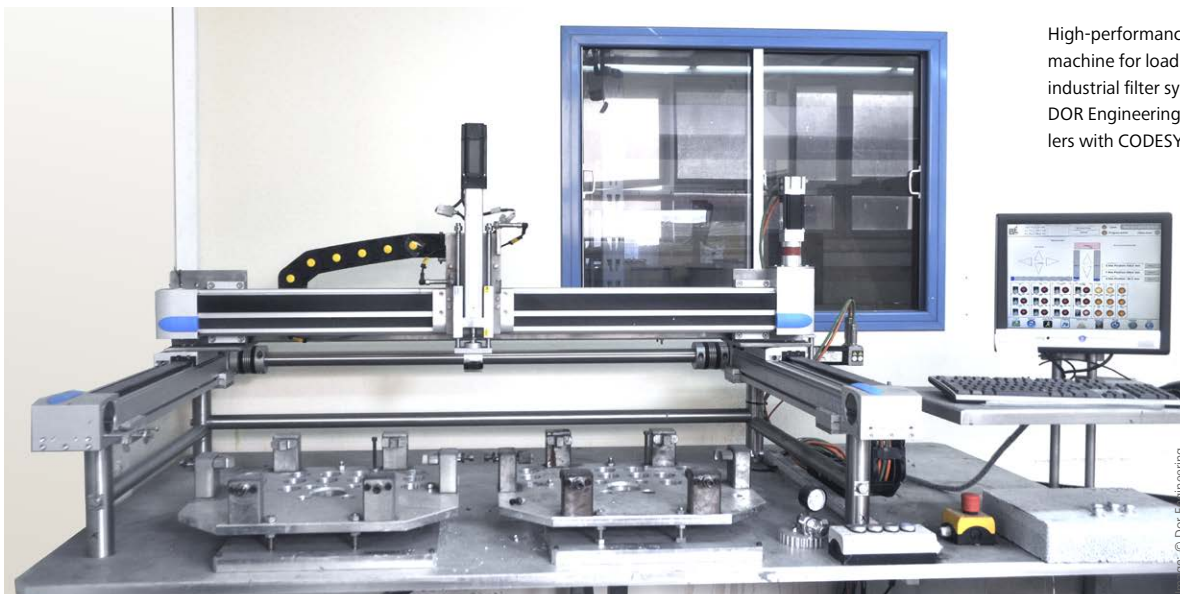
High-performance manufacturing machine for loading and completion of industrial filter systems – automated by DOR Engineering on PC-based controllers with CODESYS Motion + CNC

Image: © Dor Engineering

Typical Application Cases, Selected References, and Benefits at a Glance

- CNC applikation
  - Use of the CNC editor
  - Jogging the axes with PLCopen POUs
  - Portal kinematics with stepper drives
  - Teach feature
- Pick & Place applikation
  - Use of CNC and PLCopen POUs for positioning (gripping) and for placing an object onto a moving target (conveyor belt synchronization)
  - Depiction of the process via visualization templates

- Tripod robot
  - Use of the CNC editor
  - Parallel kinematics (transformation)
  - Visualization template for parallel kinematics
  - Configuration of EtherCAT drives
- Labeling and cam application
  - Use of the cam editor
  - PLCopen components and virtual axis as master shaft
  - Various visualization templates
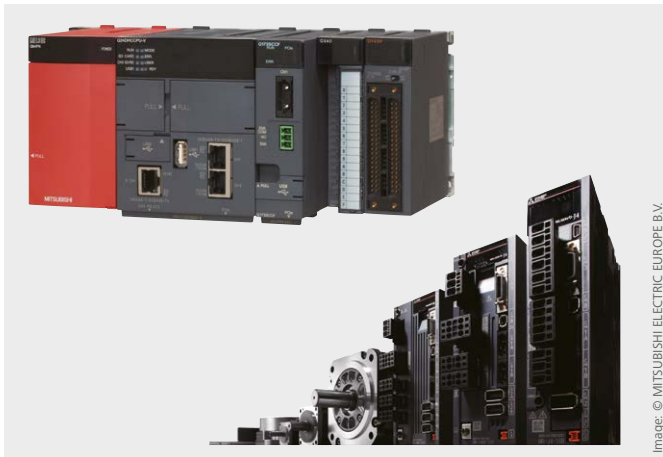 - CANopen servo drives
  - Use of the touch probe / latching feature

Image: © MITSUBISHI ELECTRIC EUROPE B.V.

Selected References for CODESYS Motion + CNC

- ASYS Automatisierungssysteme GmbH
- Bosch Packaging Technology B.V.
- Festo AG & Co. KG
- KEB Karl E. Brinkmann GmbH
- MITSUBISHI ELECTRIC EUROPE B.V.
- Parker Hannifin Manufacturing Germany GmbH & Co. KG
- Schneider Electric Automation GmbH
- STÖBER ANTRIEBSTECHNIK GmbH & Co. KG

CODESYS Motion + CNC – Benefits at a Glance

- Versatile motion planning:
  - Status of the logic application can control motion and vice-versa, e. g. simple scaling of trajectories
  - Control of trajectories and motion from the optional visualization
- CNC programming independent of kinematic design:
  - Change of kinematics via library POUs
- No absolute restrictions:
  - Number of axes and update rate limited only by the employed fieldbus and the available memory and processing power
- Motion programming independent of drive:
  - Drive change without changing the software
- Portable to different platforms:
  - Libraries and applications created in the IEC 61131-3 implementation languages
  - CODESYS compiles the motion program for the specific target system
- Integration into the CODESYS Development System:
  - One hardware device and one user interface for logic application, motion application, and visualization
  - Consistent engineering and cost-efficient implementation

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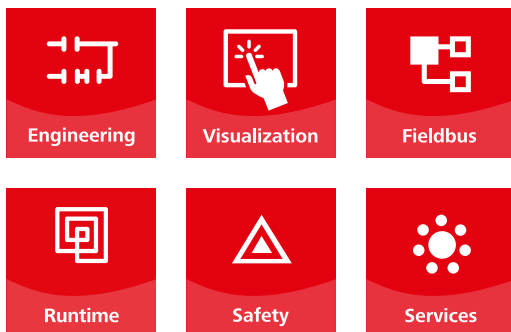Via Vittoria Colonna 50, 20149 Milan, Italy

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

CODESYS Product Families:

Engineering	Visualization	Fieldbus
Runtime	Safety	Services

Inspiring Automation Solutions