CNC Technology

Perfection in Automation
www.br-automation.com

Computerized numerical control

For more than 40 years, the term CNC has been synonymous with high-precision machine tools used in the manufacturing and processing of many different kinds of workpieces. The primary objective of CNC machine tools is to ensure the precision of the programmed path. In addition, handling technology-specific process functions and signals at the fastest response speeds possible is a must.

CNC as a component of automation
With the expansion of automation technology throughout all industrial sectors and processing and handling demands for individual machine lines becoming increasingly more complex, the once clear-cut line between PLC and CNC functions is becoming more and more blurred. Machine manufacturers do not simply want a controller to automate machines; they want a complete platform. This platform would consist of drives, movement and path control systems, visualization devices and the networking necessary to connect them all together. CNC thus becomes an indispensable component in any automation system.

With our „Generic Motion Control" approach, B&R is able to combine all components into a single system. CNC, along with its extensive selection of interfaces, is embedded into the PLC's real-time operating system. This makes it possible to handle even the most complex of tasks.

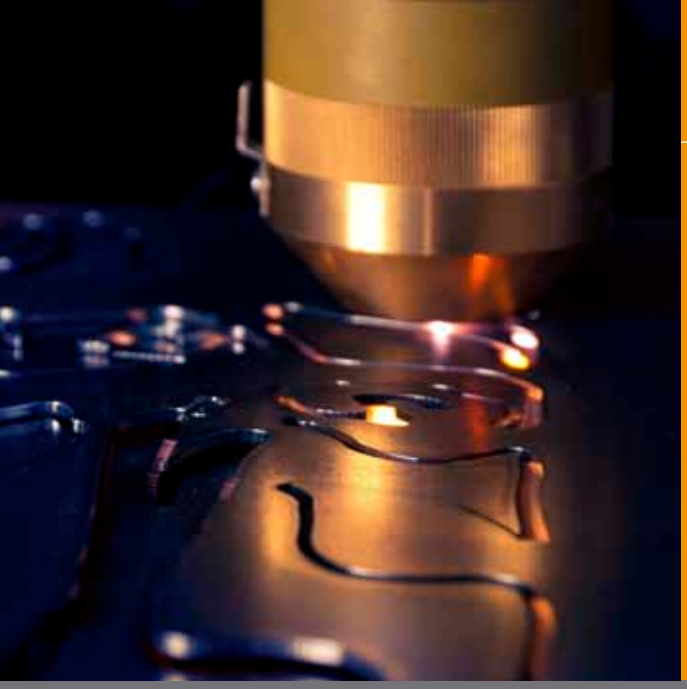
Diverse applications
B&R has been involved in a wide variety of industries since the company's founding. Our customers in all fields continue to profit from the seamless integration of controller, visualization and drive technology. This makes it possible for us to handle a broad array of different types of applications. With CNC, these applications range from wood, laser or glass processing and wire-cut EDM and grinding tasks all the way up to complex milling cells with integrated handling technology.

One of the most fundamental reasons to rely on Generic Motion Control has to do with the forthrightness of B&R's CNC solutions – customers are able to very easily and indepen-

dently implement machine processes on the controller. This reduces development times while providing a way to protect proprietary knowledge, which in turn makes it possible for manufacturers to take advantage of unique selling points for their products.

In addition, B&R's total solution combines excellent dynamics at the highest levels of precision for process movements and ensures the increased machine throughput that results. This is achieved by completing integrating CNC, the PLC and motion control on a single centralized control computer. Interpolation times in the microsecond range with absolute synchronization between the individual control programs form the perfect basis for providing customers with high-performance solutions.

All of these are compelling reasons for every machine manufacturer to choose B&R. All you have to do is ask! We will be glad to assist you with all aspects of your machine and cell solution, including design and implementation.



Generic Motion Control - The vision

Isn't it the wish of every machine or system designer to procure a complete platform to automate control tasks?

This is because the requirements and demands that need to be met when developing new machine concepts go far beyond simply lining up a sequence of individual processes.

Machines often have to be able to handle direct connections between path control systems and I/O as well as intervening actions in drive functions that derive from the process itself. Auxiliary axes need to be coupled to path axes, and it must be possible to visualize all sequences in real time. Networking machines so that it is possible to intervene and perform diagnostics remotely also goes without saying.

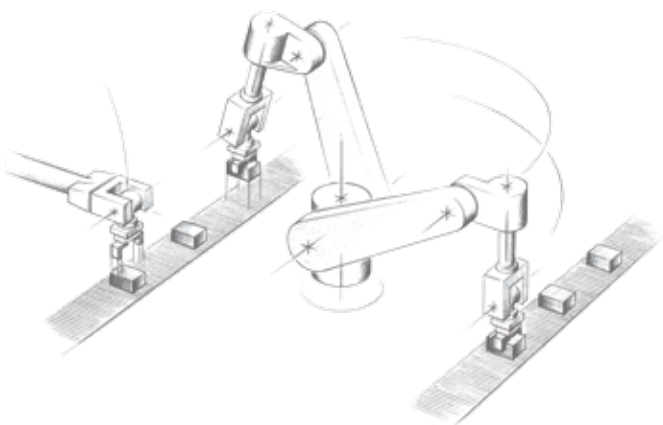
At B&R, our controller architecture takes these customer demands extremely seriously. Controller programs, I/O processing, visualization and GMC run synchronously on a deterministic real-time system.

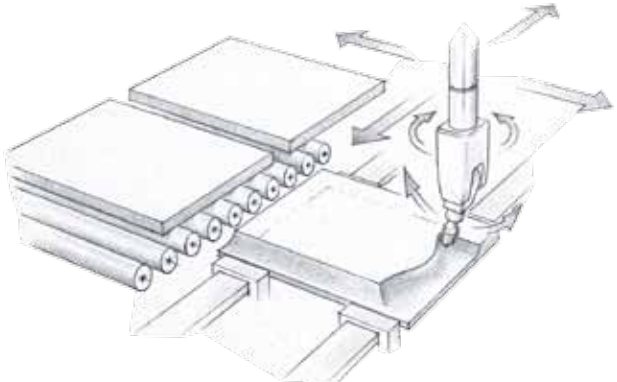
With Generic Motion Control, we combine the worlds of robotics, CNC, linked axis movements and single axis positioning into a single homogeneous system. This allows complex path information for robots to also be applied to machine tools and production machines. Controlling articulated arm robots is also possible, as is intricate CNC processing in 3D.

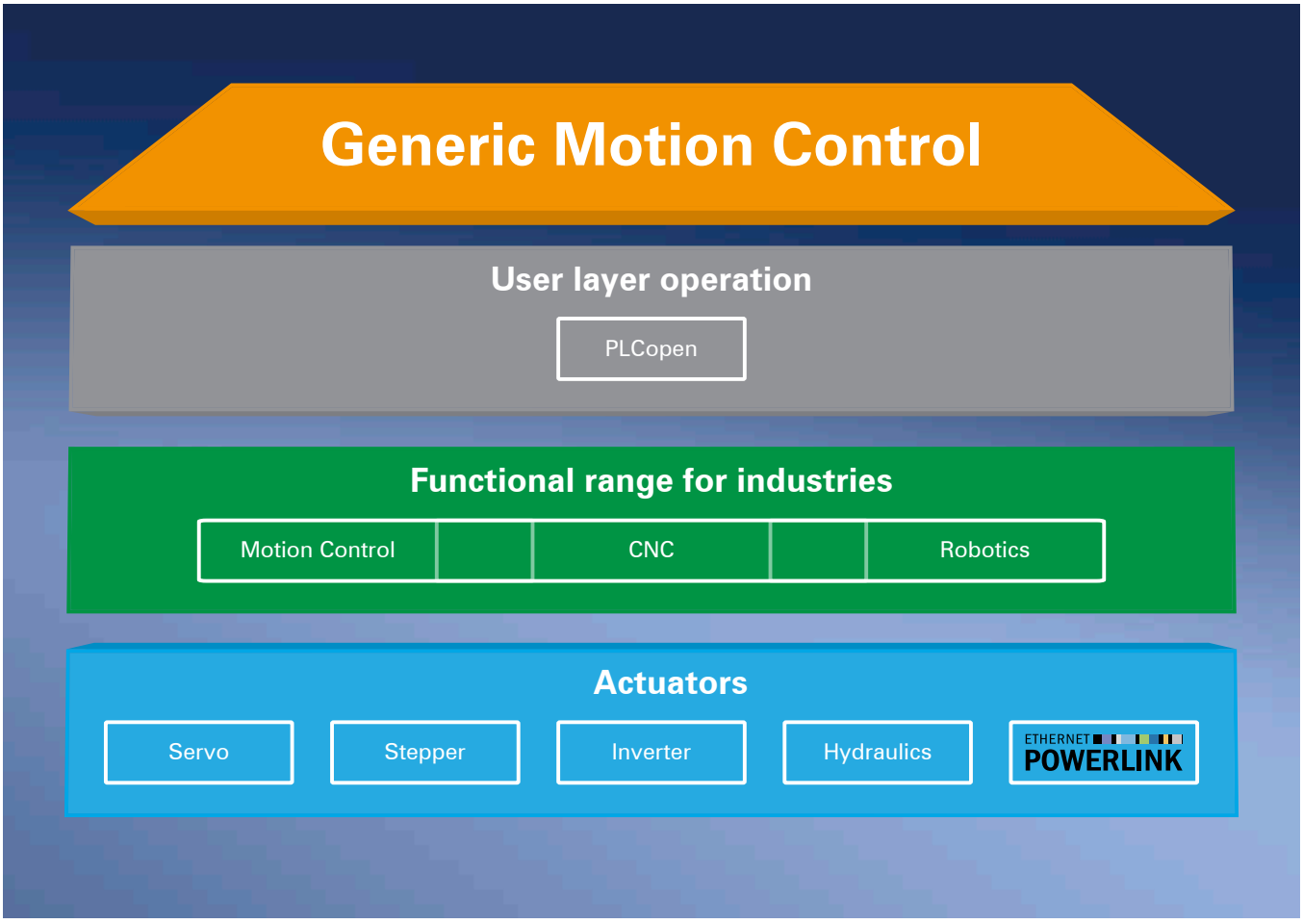
In each case, actuators are integrated consistently throughout the system. This makes it possible to configure a servo motor, a stepper motor or a hydraulic axis; it all depends on the demands being placed on the machine.

The seamless integration of GMC components into the real-time operating system, offering integrated I/O nodes and direct links to PLC functions, provides additional advantages so that automation processes can be implemented as easily as possible.

This allows us to offer our customers the perfect platform for designing innovative solutions.







Generic Motion Control combines all important functions into a single homogeneous system.

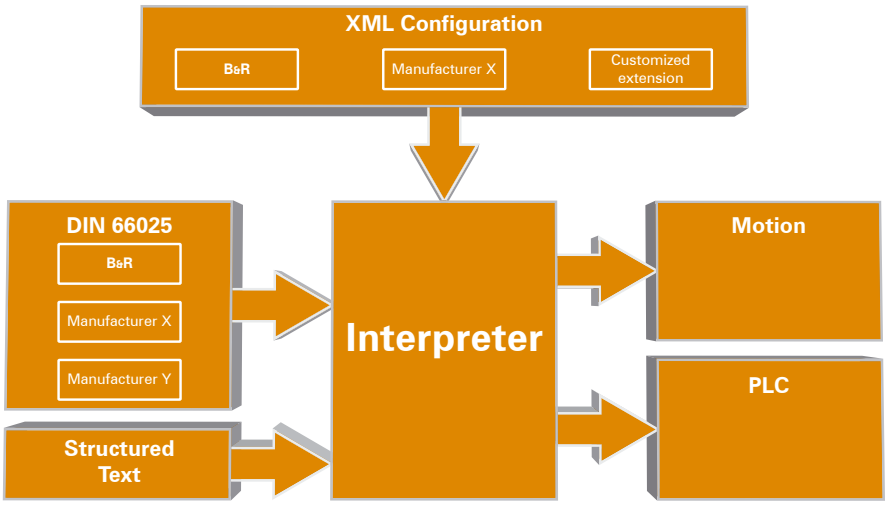
Range of CNC functions

Room for interpretation
The GMC interpreter acts as the interface to the user. Text-based CNC programs and movement sequences for robots are translated by the interpreter, evaluated in the subsequent function modules and then converted into movements.

CNC applications are programmed in accordance with the DIN 66025 standard, with corresponding expansion possibilities for special functions.

Language definition of the G-code is not inflexibly integrated in the interpreter as is usually the case; rather, users can create definitions themselves using XML configuration files. In addition to the B&R-specific G-code, the system can also work with dialects from other CNC controller manufacturers such as Siemens. It is also possible for the user to define any number of application-specific instructions.

On top of all this, the integrated system architecture enables the interpreter to access PLC variables and call system functions and function blocks.



Sequences being run in the classic PLC part are executed in real time parallel to path control.

The advanced range of functions that the GMC interpreter can handle underscores the many ways that B&R is able to implement functions for several different technologies.

Variables
Support is provided for simple variables, arrays and structures. When variables are used, they are checked accordingly for validity.

- Local variables
- Variables global to the interpreter
- Variables global to NC
- PLC variables

Depending on the needs of the application, variables can be synchronized either to the interpreter or to the path itself. It is also possible to directly access internal system variables for axes and CNC system values and states (e.g. positions, paths, speed, etc.).

Synchronous actions
Independent sequences can be started in parallel to the CNC program already being executed by the interpreter. These sequences are

Highlights:
- Ability to understand different NC dialects
- Complete processing sequences can be programmed in the NC code that affect the PC and NC simultaneously
- Simplified NC programming by encapsulating complex functions

processed cyclically until either an assigned termination condition is met or the end of the CNC program is reached.

Functions and function blocks
Functions and function blocks used in a CNC program may be grouped together into a B&R library. Both functions and function blocks are executed synchronously to the interpreter or to the path depending on the configuration.

Generic CNC functions
- Functions for all technologies: milling, grinding, cutting, welding, handling, packaging, etc.
- Eight independent CNC channels per system
- Up to 15 axes per CNC channel
- Unrestricted axis assignment to a CNC channel
- Axis replacement
- Dynamic „look ahead“ function over any number of path sections
- Optimized motion profiles
- Tool data correction
- Automatic tangential tool guidance
- Reverse movement along the contour
- Freely definably coordinate systems
- Kinematic transformations
- Rotary axis handling

Error compensation
The ability to compensate for errors from the controller is very important for many machines. With this in mind, the CNC system offers integrated compensation functions, such as unidirectional and bidirectional spindle slope error correction and reverse backlash compensation for individual axes.

It is even possible to correct axis skew with respect to an ideal Cartesian coordinate system.

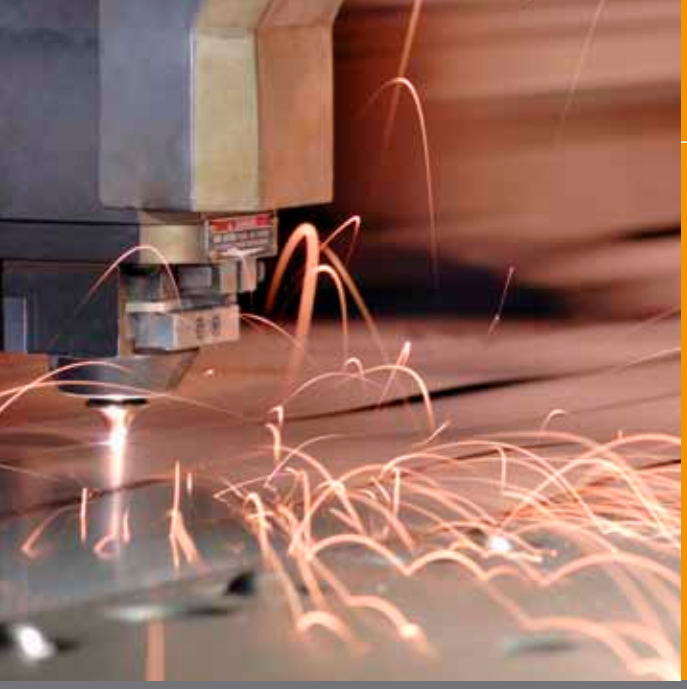
Diagnostics
Recording characteristics such as axis positions and axis speed is an essential part of configuring machines and localizing errors. To handle this, the Soft CNC is equipped with an integrated software oscilloscope (trace) that makes it possible to not only read out data online, but also to store it in a file for later analysis. A monitor data structure allows the user to display current values on a visualization device.

Restarting
CNC programs are sometimes aborted due to machine error or at the request of the user. The Soft CNC offers a range of options for restarting a program at the moment it was aborted, or at any other point on the programmed path. When restarted, the CNC program is automatically simulated internally up to the desired restarting point.

Program simulation
The CNC system's simulation function can be used during the production preparation phase to quickly predict the program's runtime. The program's runtime is calculated internally without having to calculate actual set positions for the axes.

In simulation mode, a data interface can be used to read out and display a graphic primitive (line or arc) to visualize the programmed path.

In addition, the GMC system can be operated completely in a virtual controller environment (AR000). In this case, all of the program logic for the application program as well as all of the core functions of the system are handled in a virtual controller environment in Windows. The user can scale this underlying „virtual real time“ as needed (time zoom).



From a single source

Open system architecture with fully scalable hardware

- Drive, controller or visualization-based CPU
- 100 MHz Pentium, Atom up to 2 GHz, Core2Duo
- 3.5“ up to 19“ displays
- All drive types

Highlights:

- Reduced hardware costs
- Reduced installation space
- Reduced personnel and wiring costs
- Accelerated commissioning (PVI Transfer, automatic module recognition, ServoScan, modular software)
- Easy maintenance (System Diagnostics Manager (SDM), remote diagnostics)

Real-time operating system

- High-speed interpolation cycles up to 400 µs
- Precise synchronization of CNC, PLC, I/O and drives down to the microsecond
- Integration, drive coordination and logic control on a single processor
- CNC and PLC run as synchronized tasks

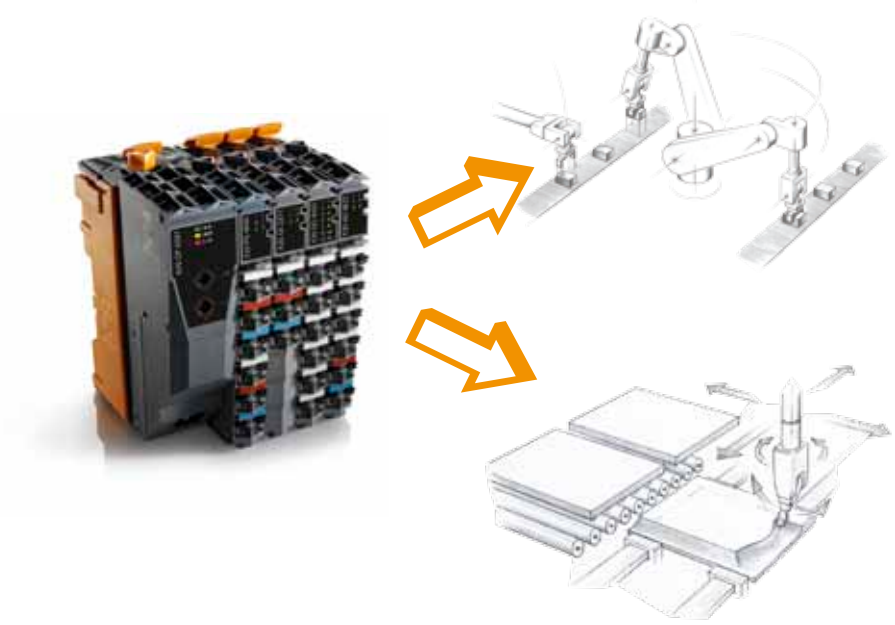
Highlights:

- High-precision processing results with transparent and flexible real-time interfaces between CNC and the PLC
- Simple programming of path and interpreter-synchronous processes such as laser output control, distance control and tool changes
- Know-how remains with the machine manufacturer since complex, position-dependent processes can be implemented on the PLC using logical code

From a single source

Inclusive cell control

- All sequences within a cell, e.g. interpolation of NC axes, control of peripheral axes, logic processing, robot control, visualization, etc. controlled by a single CPU
- Open kinematic interface
- Identical database for robots and CNC



Highlights:

- Hardware costs reduced due to use of a single CPU
- Very simple maintenance of the entire cell made possible by transparent data structure

Customized visualization

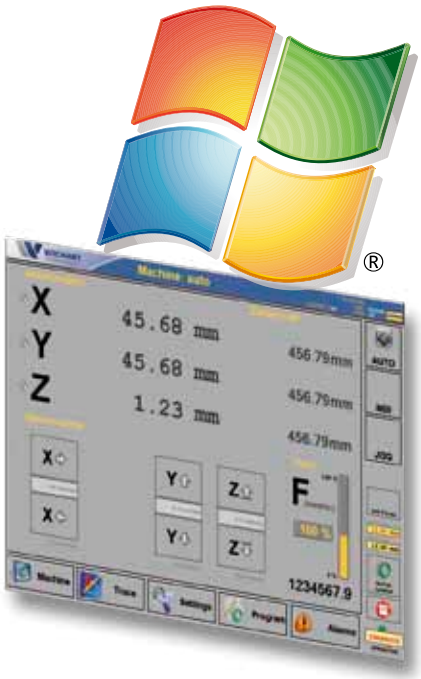
- Visual Components as an embedded solution with an editor integrated directly into the Automation Studio configuration tool

Highlights:

- Cost efficiency through sleek hardware
- Complete freedom of design when creating the visualization
- No additional licensing costs

Customized visualization

- Windows connected to the real-time operating system via PVI or TCP/IP socket communication



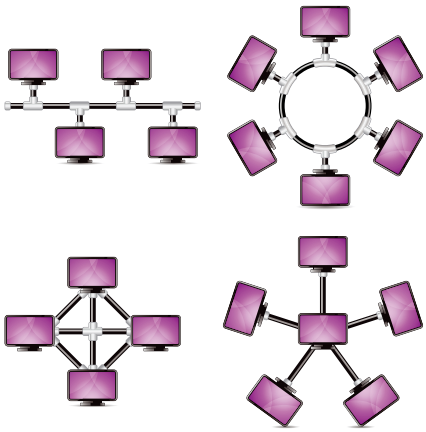
Highlights:

- Reusability of Windows visualizations
- Shorter development times
- Continuous machine operation

POWERLINK: Communication in deterministic real time

- One network for all tasks
- Topologies: Line, star, tree or ring
- Remote peer-to-peer communication
- Safety certified

ETHERNET **POWERLINK**



Highlights:

- Cost savings on wiring
- Decentralization while retaining synchronization
- Short response times
- High data throughput

The perfect foundation…

Generic Motion Control components form the heart of applications in a wide range of fields. Especially in the area of CNC machine tools, however, there is a series of standard functions that can be found on practically every machine.

It is this area where B&R is now going a step further toward standardized system modules. In particular, the development of a standard CNC package will significantly reduce commissioning times for customized machine tool solutions.

The standard CNC package includes both the hardware components as well as the software functions needed to operate a typical CNC machine.

The hardware is comprised of a 15" CNC panel with integrated keys for machine operation, a keyboard and a handheld operating device with handwheel.

The software contains all of the most important basic functions for operating, configuring and diagnosing the entire system, in particular all axes and CNC channels.

…for your machine

The graphical display is based on Visual Components, B&R's integrated real-time visualization system. Through the visualization, the user can access the system functions of the software, and the interface is designed so that the visualization itself can be complemented with or even totally replaced by customer-specific functions.

The preprogrammed visualization components include both "classic" components, e.g. for setting parameters and operating motion programs, as well as tools for simulating, tracing and diagnosing processes.

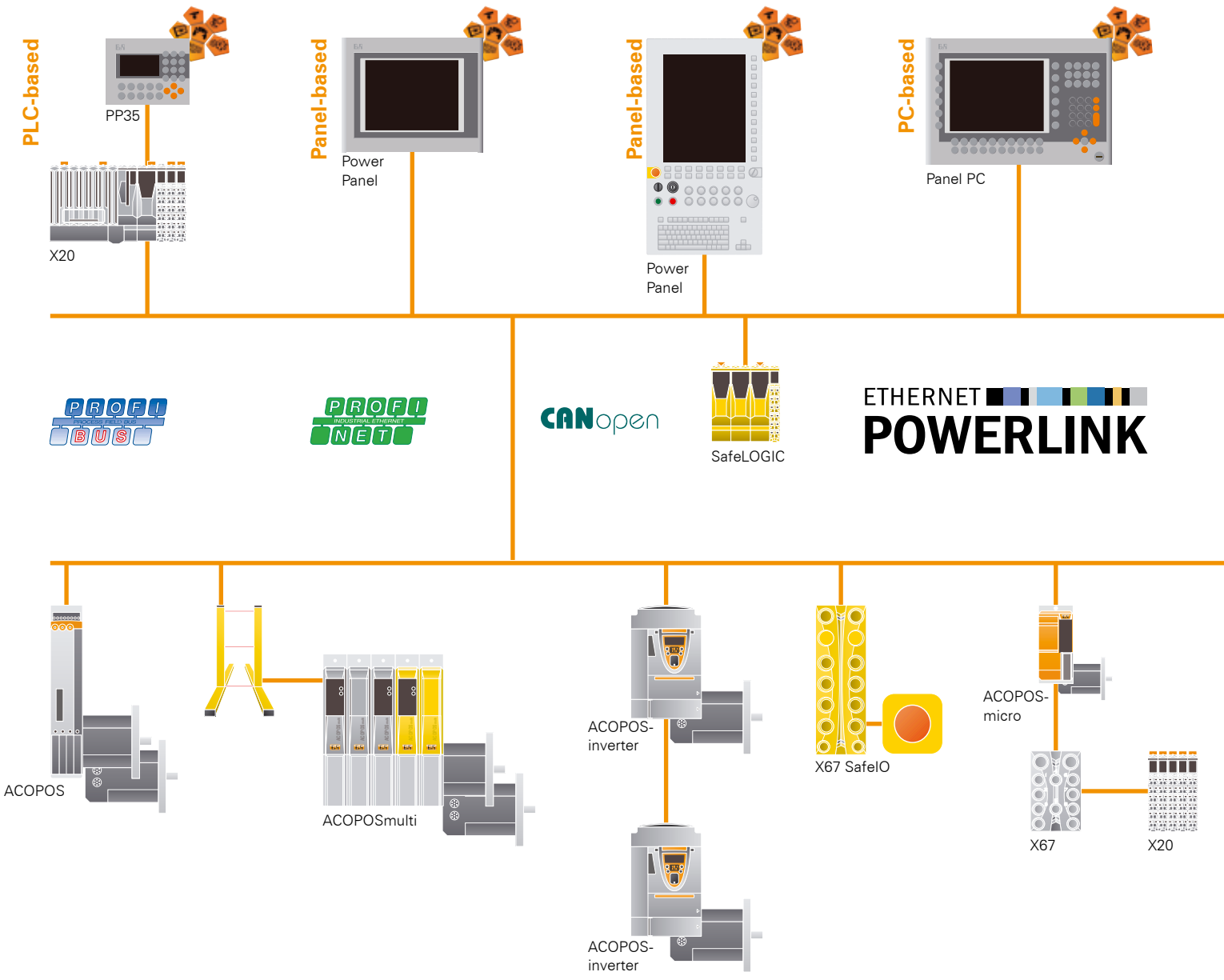
Features

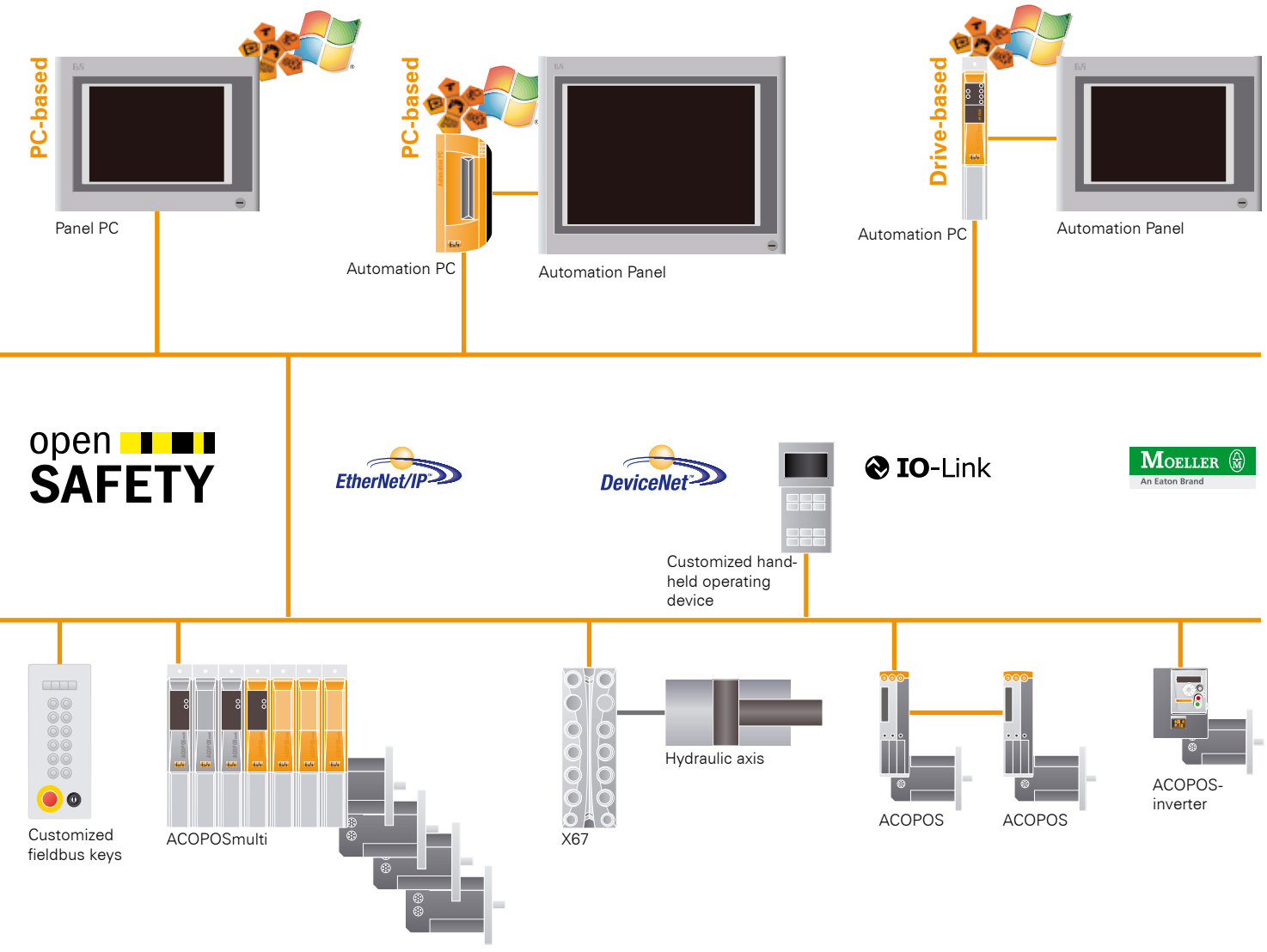
- PLCopen programming interface
- Free template for the operator interface
- Uniform interface between the visualization and NC/PLC kernel
- Easy for the application programmer to adapt to machine processes at any time

Highlights:

- Accelerated machine commissioning
- Machine manufacturer can focus more on programming the core process
- Adherence to international standards

CNC system variants




PC-based
Panel PC
PC-based
Automation PC
Automation Panel
Drive-based
Automation PC
Automation Panel
open SAFETY
EtherNet/IP
DeviceNet
IO-Link
MOELLER
An Eaton Brand
Customized hand-held operating device
Customized fieldbus keys
ACOPOSmulti
X67
Hydraulic axis
ACOPOS
ACOPOS
ACOPOS-inverter

Integrated Safety Technology

The future of safety technology on machines has begun. Fixed wiring is being replaced by safe data transfer via openSAFETY. Flexibly configured or programmed safety behavior adapts optimally to various E-stop situations. In accordance with IEC 61800-5, SafeMC makes it possible for the entire drive system to be tailored to the situation at hand, whatever it may be. And it goes without saying that comprehensive diagnostics are available for the safety components themselves as part of the total automation solution.

openSAFETY
- Safe communication via a network

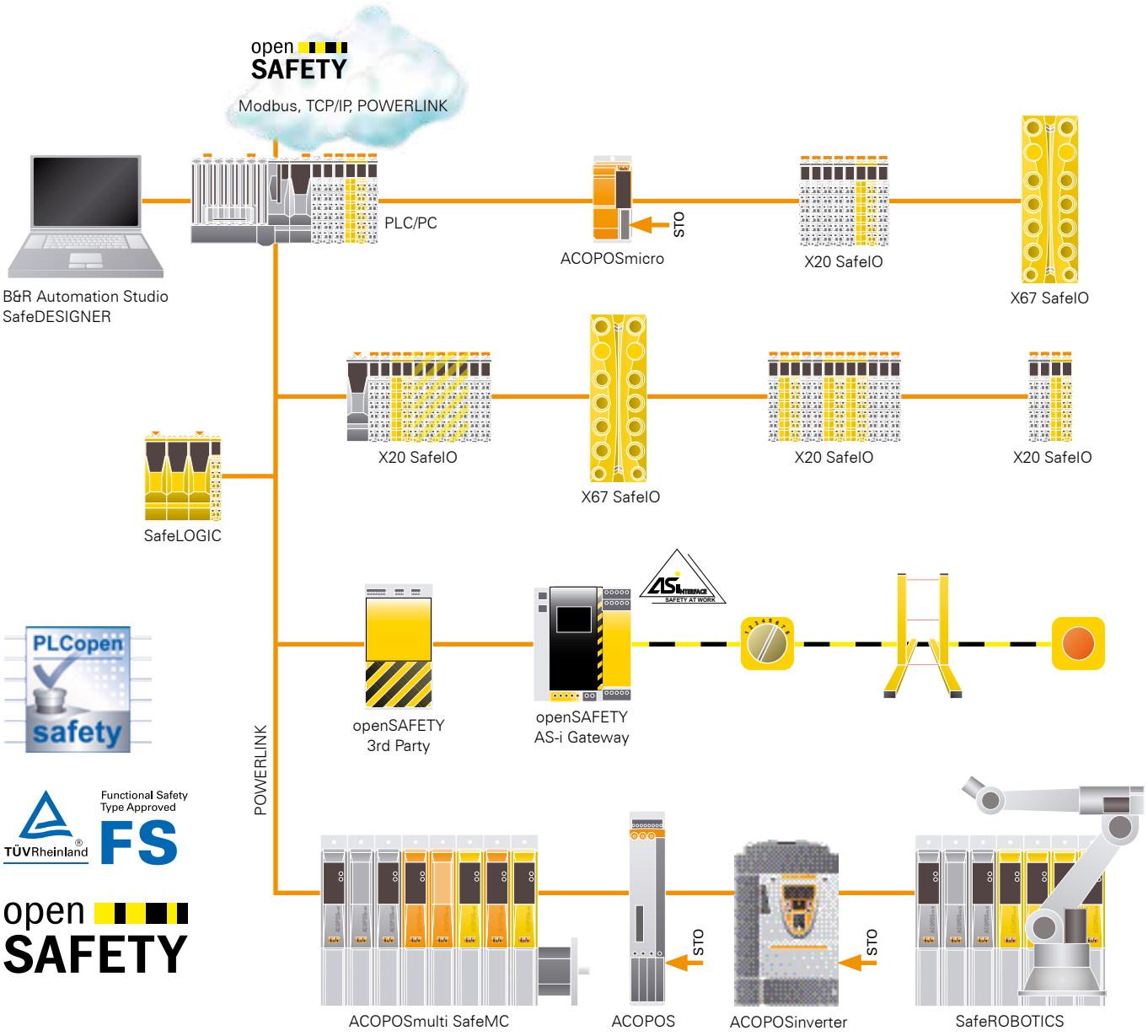
SafeLOGIC
- Programming
- Editor

SafeIO
- Equivalent
- Antivalent
- Mode selector
- Emergency stop
- Two-hand control Type II/Type III
- Safety guard monitoring
- Testable safety sensors
- Enable switch

SafeMC
- STO - Safe Torque Off
- STO1 - Safe Torque Off - one channel
- SBC - Safe Brake Control
- SS1 - Safe Stop 1 - Time monitored/ Ramp-based monitored
- SS2 - Safe Stop 2 - Time monitored/ Ramp-based monitored
- SOS - Safe Operating Stop
- SLS - Safely Limited Speed
- SSM - Safe Speed Monitor
- SDI - Safe Direction
- SLI - Safely Limited Increment
- SMS - Safe Maximum Speed (configuration)
- SLP - Safely Limited Position
- SMP - Safe Maximum Position (configuration)
- SPM - Safe Position Monitor
- Configurable limits
- Very short error response times

SafeROBOTICS/SafeCNC
- SLS@TCP - Safely Limited Speed at Tool Center Point

Highlights:
- Open standard
- Fastest real-time safety bus system on the market
- SIL 3 at bus cycle times of 200 µs
- Smart-safe reactions
- No additional wiring
- Decentralized safety technology
- Fully integrated in existing topologies
- Scaleable solution for simple and complex machines


open
SAFETY
Modbus, TCP/IP, POWERLINK
PLC/PC
B&R Automation Studio
SafeDESIGNER
ACOPOSmicro
STO
X20 SafeIO
X67 SafeIO
X20 SafeIO
X67 SafeIO
X20 SafeIO
X20 SafeIO
SafeLOGIC
POWERLINK
openSAFETY
3rd Party
openSAFETY
AS-i Gateway
PLCopen
safety
Functional Safety
Type Approved
TÜVRheinland
FS
open
SAFETY
ACOPOSmulti SafeMC
ACOPOS
STO
ACOPOSinverter
STO
SafeROBOTICS

Motors

B&R offers a broad spectrum of drive technologies across a wide range of performance classes. Being able to mix different types of drives not only results in more flexibility during production, but also leads to reduced costs at the same time.

Stepper motors
B&R stepper motors are available with a multitude of different options such as varying speeds, holding brakes, increased IP65 protection and encoder feedback. These motors can be operated in series or in parallel. To achieve the highest levels of reliability, B&R is extremely selective when it comes to choosing the right ball bearings; experience gained working with servo drives over the years as well as customer feedback are key to this process.

- 80MP
  Three sizes are available, from 1.1 Nm to 13.6 Nm. 80MP stepper motors excel due to their extremely high power density combined with excellent handling speeds.

Servo motors
B&R offers four different servo motor series, each with specific characteristics, so that it is possible to use the most suitable motor for any application. If an EnDat encoder is used, motor data is stored in an embedded parameter chip where it can be retrieved when the machine is started from the drive. This makes it possible to clearly

identify the motor while ensuring increased safety, in particular when replacing the motor in the field.

- 8LVA
  8LVA servo motors are some of the most compact motors on the market today and are distinguished by their astonishingly high self-acceleration capabilities. Three different sizes are available with flange sizes measuring from 40-80 mm. In addition, each comes equipped with either a resolver or an absolute multi-turn encoder. Stall torque ranges from 0.36 Nm to 2.6 Nm with a power range between 100 and 550 W.

- 8LSA
  8LSA AC servo drivers have been designed to be extremely dynamic while retaining the lowest possible moments of inertia. Seven different sizes are available with flange sizes ranging from 55-240 mm. Several different options are available for this series, including three different encoder systems and up to four speed variants.

- 8LSN
  8LSN series motors are flange compatible with the 8LSA series. When compared with the 8LSA series, however, these motors are distinguished by a moment of inertia that is 250% higher although power ratings and dimensions are the same. This represents an optimal moment of inertia ratio for CNC applications and allows the highest degree of quality to be reached during CNC processes. Two different variants are available, with flange sizes either 115 mm or 142 mm.

- 8JSA
  Motors in the 8JSA series stand out due to their extremely high power density. Through the systematic use of pole winding technology, the reduced outer dimensions in no way limit the substantial increases in torque that can be achieved. Several different sizes are available with flange sizes ranging from 58-188 mm. The flanges themselves are geometrically compatible with Siemens 1FK motors.

Direct drive systems

- 8LT
  When it comes to positioning applications, 8LT rotating direct drives boast the highest precision among all drives in the B&R motor spectrum. The motor's high drive torque makes it possible to eliminate gears, which results in excellent dynamics and precision as well as a long lifespan. 8LT drives are available with either surface cooling or liquid cooling with a stall torque that ranges from 50 to 240 Nm. The liquid cooling variant is able to achieve continuous torque values that are 70% higher than the self-cooling design.

cHMI solutions for NC processing

Milling, spinning, eroding, grinding, you name it. The more varied the application, the better your custom CNC control unit from B&R can be adapted to handle it.

Stop button
- Emergency stop
- Stop button
- Different manufacturers and designs

Key switch
- Different manufacturers and designs
- As many switch positions as needed
- Labeled according to specifications

Selection switch
- Various designs, colors and sizes
- As many switch positions as needed
- Labeled according to specifications

Direct keys
- Start/stop functionality for safety functions wired directly
- Different manufacturers and designs

Customer logo
- Adapted to your specifications

Complete layout
- Key labeling and color according to customer preference

Keyboard
- Adapted to your country, language or layout requirements

Screen
- With or without touch capability for an intuitive operator interface
- Different touch technologies: resistive, surface wave, capacitive, infrared

Function keys
- Alterable position, shape and number
- Labeled according to your specifications
- Flexible labeling using legend strips if desired

Interfaces
- USB
- Ethernet

B&R illuminated ring keys
- Perfect signal effect
- Round oder square
- With different colors and illumination
- Up to 4 colors for one key
- Flexible labeling using legend strips

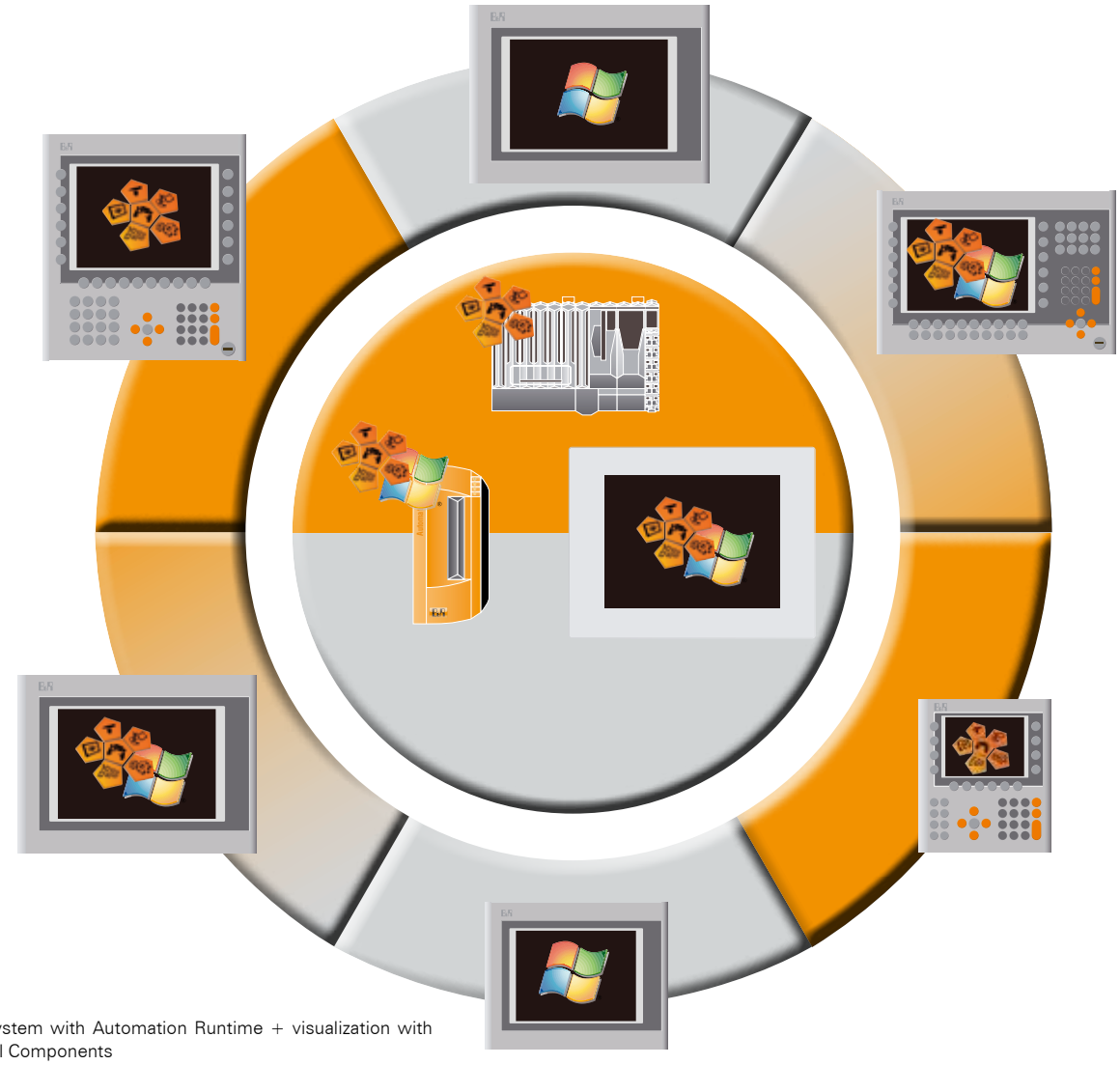
RFID module
- Read/write unit
- 125 kHz
- 13.56 MHz
- Legic

Integration
- For installation in a switching cabinet
- For swing arm mounting
- Complete integration with a sleek IP65-protected housing

Outer dimensions
- Adapted to your specifications and installation requirements

Navigation wheel
- Various colors and designs
- Includes enable switch for easy navigation

System variants



Variant 1: X20 System with Automation Runtime + visualization with Windows or Visual Components
Variant 2: Automation PC or Panel PC with AR010 and Windows + visualization with Windows or Visual Components

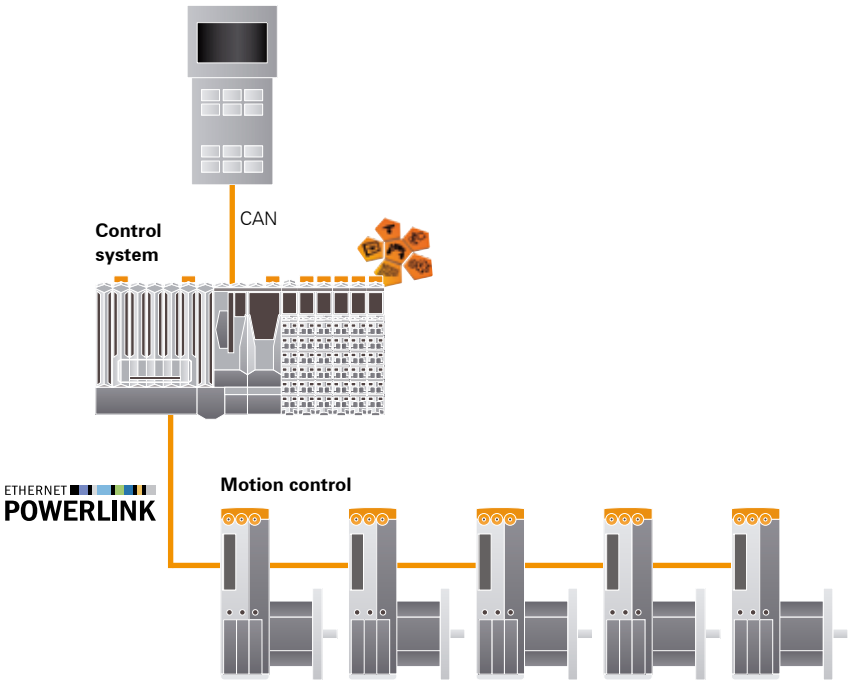
Woodworking

Special requirements:
- Compact design
- Operation using a customized handheld operating device
- Inexpensive
- Flexibility and scalability for different machine variants

Selected system architecture
Visual Components for the visualization:
- Direct connection of variables
- Unit switching
- Integrated visual programming in AS
- Individual design options
- Simple and fast page design

PLC-based CPU/Embedded HMI:
- Compact design
- Direct connection of I/O
- Direct integration of VC
- Scalability
- Visualization via Power Panel
- Flexible networking using X20 IF cards
- Onboard interfaces: Ethernet TCP/IP, POWERLINK

Customized handheld operating device

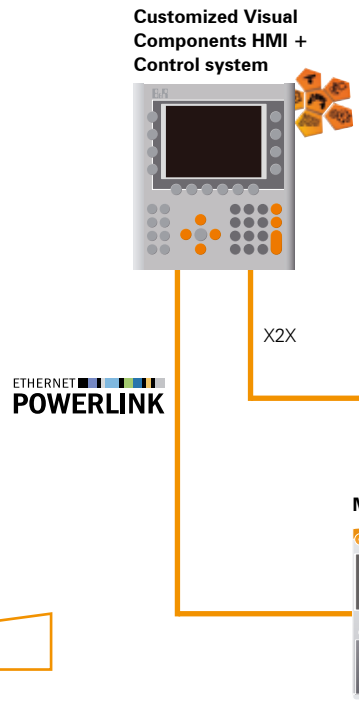


Complexity/Performance

Precision optics

Special requirements:
- Compact design
- Integrated visualization
- Operation using panel keys
- Inexpensive

Selected system architecture
Panel-based CPU/Embedded:
- Compact design
- Direct connection of I/O
- Direct integration of VC
- Scalability
- Visualization via Power Panel
- Flexible networking using X20 IF cards
- Onboard interfaces: Ethernet TCP/IP, POWERLINK

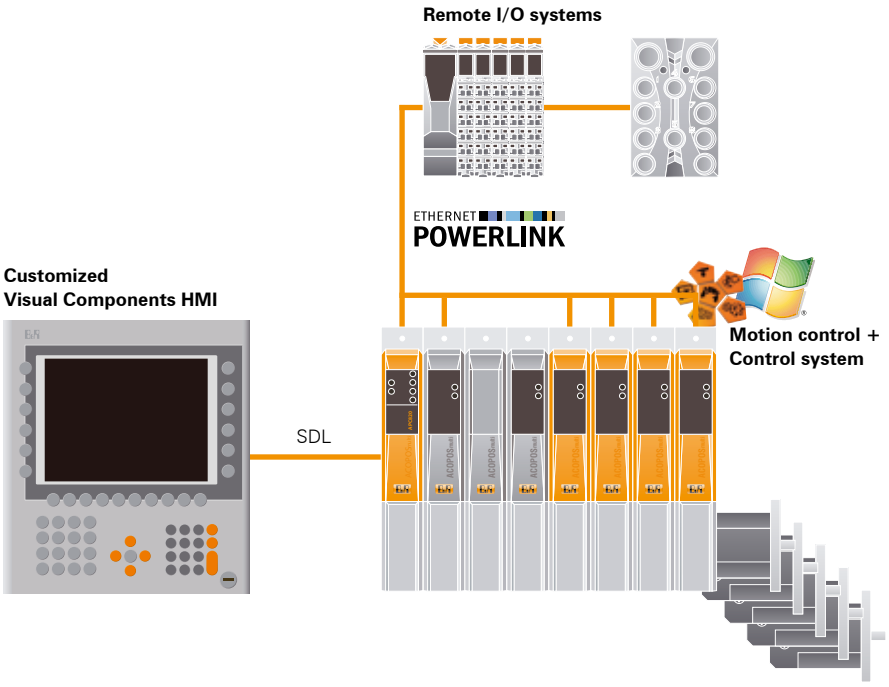


Complexity/Performance

Portal welding systems

Special requirements:
- Many axes
- Fast interpolation cycles
- Integrated visualization
- Operation using panel keys

Selected system architecture
Drive-based CPU/Embedded or Windows:
- Fast interpolation cycles
- Compact design
- High degree of flexibility through optional use of Windows
- Scalability
- Visualization via Automation Panel
- Onboard interfaces: Ethernet TCP/IP, POWERLINK, USB
- Onboard graphics card

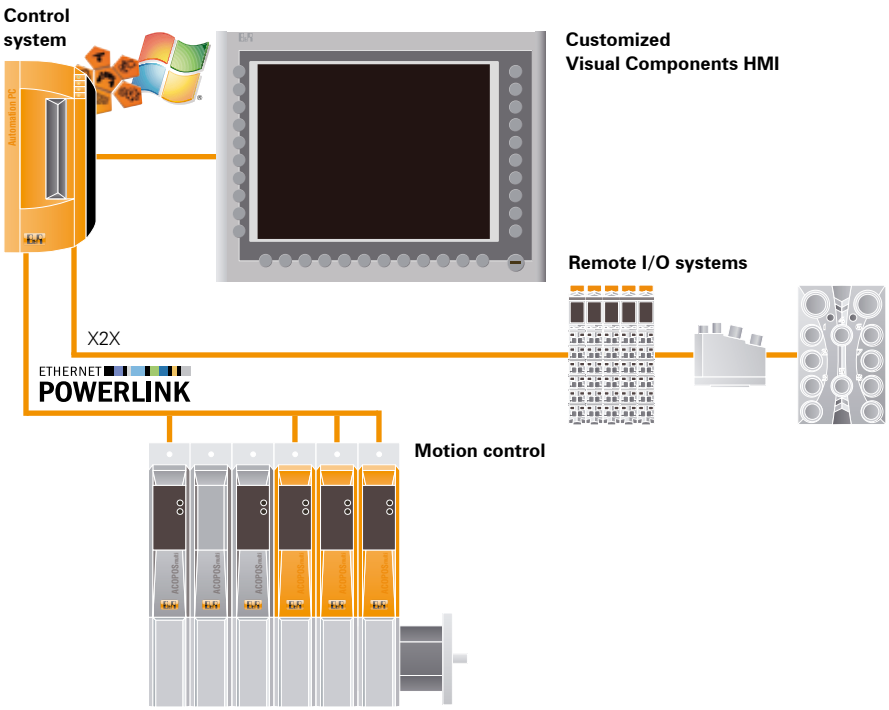


Complexity/Performance

Ski grinding machine

Special requirements:
- Path and auxiliary axes
- Fast interpolation cycles
- Fast response times for technology functions
- Customized transformation functions
- Windows visualization
- Touch screen operation

Selected system architecture
PC-based CPU/Embedded or Windows:
- Application of existing visualizations
- Predefined interface in real time using PVI library functions
- Simple connection of peripheral devices such as printers, scanners, image processors, etc.
- Look and feel of existing visualizations preserved
- Simple implementation of 3D images using Windows-based graphics tools
- Simple connection of simulation tools



Complexity/Performance

Robmill casting design

Requirements:
- Path and auxiliary axes
- Fast interpolation cycles
- Robotics and CNC functions on one system
- Customized expansion of kinematic standard transformation
- Integrated compensation functions
- Windows visualization
- Touch screen operation

Selected system architecture
PC-based CPU/Embedded or Windows:
- Application of existing visualizations
- Predefined interface in real time using PVI library functions
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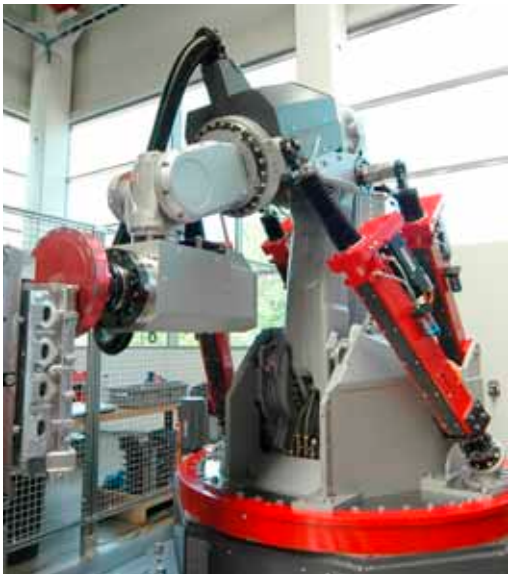
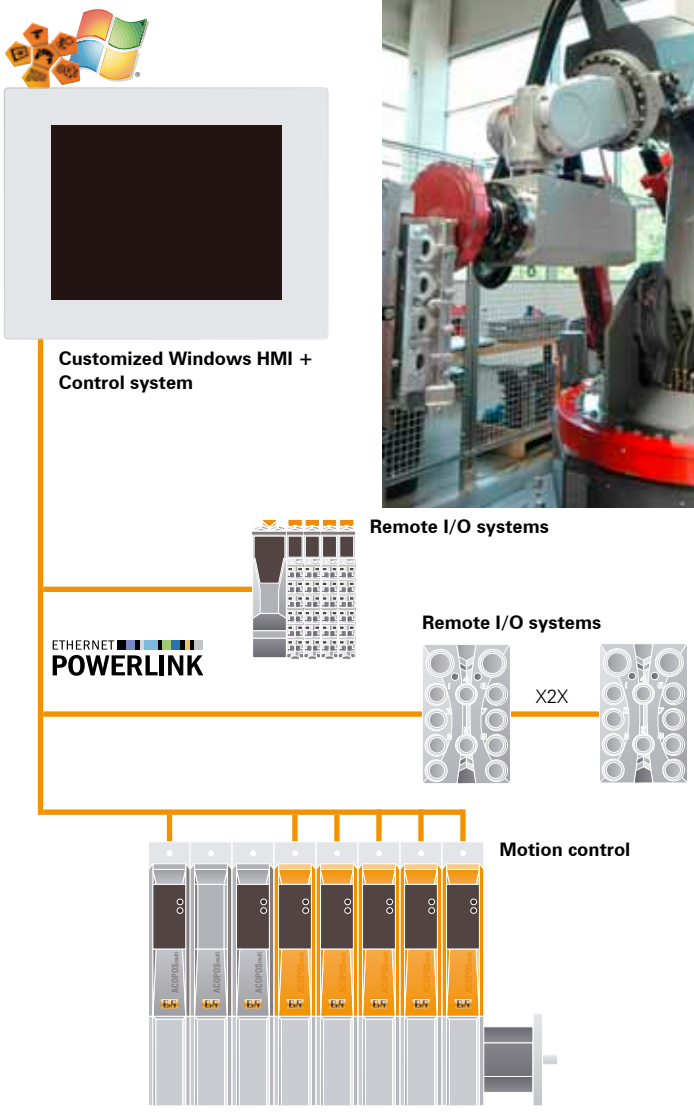
- Simple connection of simulation tools





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