



Motion control, CNC & robotics  
Smart. Small. Safe.

PERFECTION IN AUTOMATION  
[www.br-automation.com](http://www.br-automation.com)





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## Smart

Intelligent motion control for superior performance.



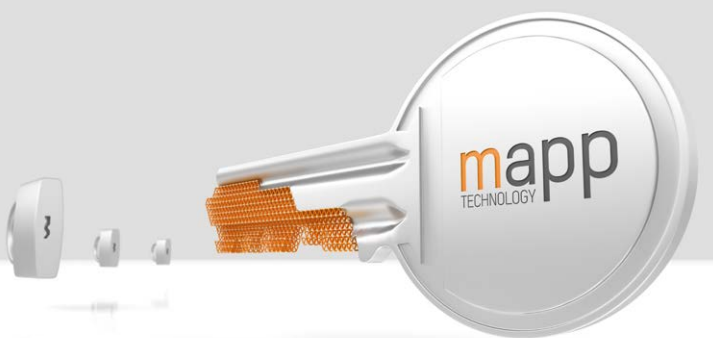
## Small

Enormous power density for compact machines.



## Solid

Uncompromising quality for unimpeded operation.



## Simple

Effortless programming with mapp technology.



## Safe

Integrated safety for maximum productivity.





## Your bonus package

**The incredible effort that B&R invests in perfecting its integrated automation technology is inspired by an unwavering commitment to making manufacturing systems smarter and easier to use.**

It therefore comes as no surprise that B&R's motion control solutions fit so harmoniously into its overall system landscape. This holistic approach to motion software is embodied in Generic Motion Control, which unites single-axis positioning, electronic cams, gearing functions, CNC and robotics on a common platform. Round that off with network-based safety and ultrafast response times, and it's time to start rethinking what you thought was possible for your machine.

### **Scalable**

Servo drives, motors and gearboxes with seamlessly scalable performance and a host of op-

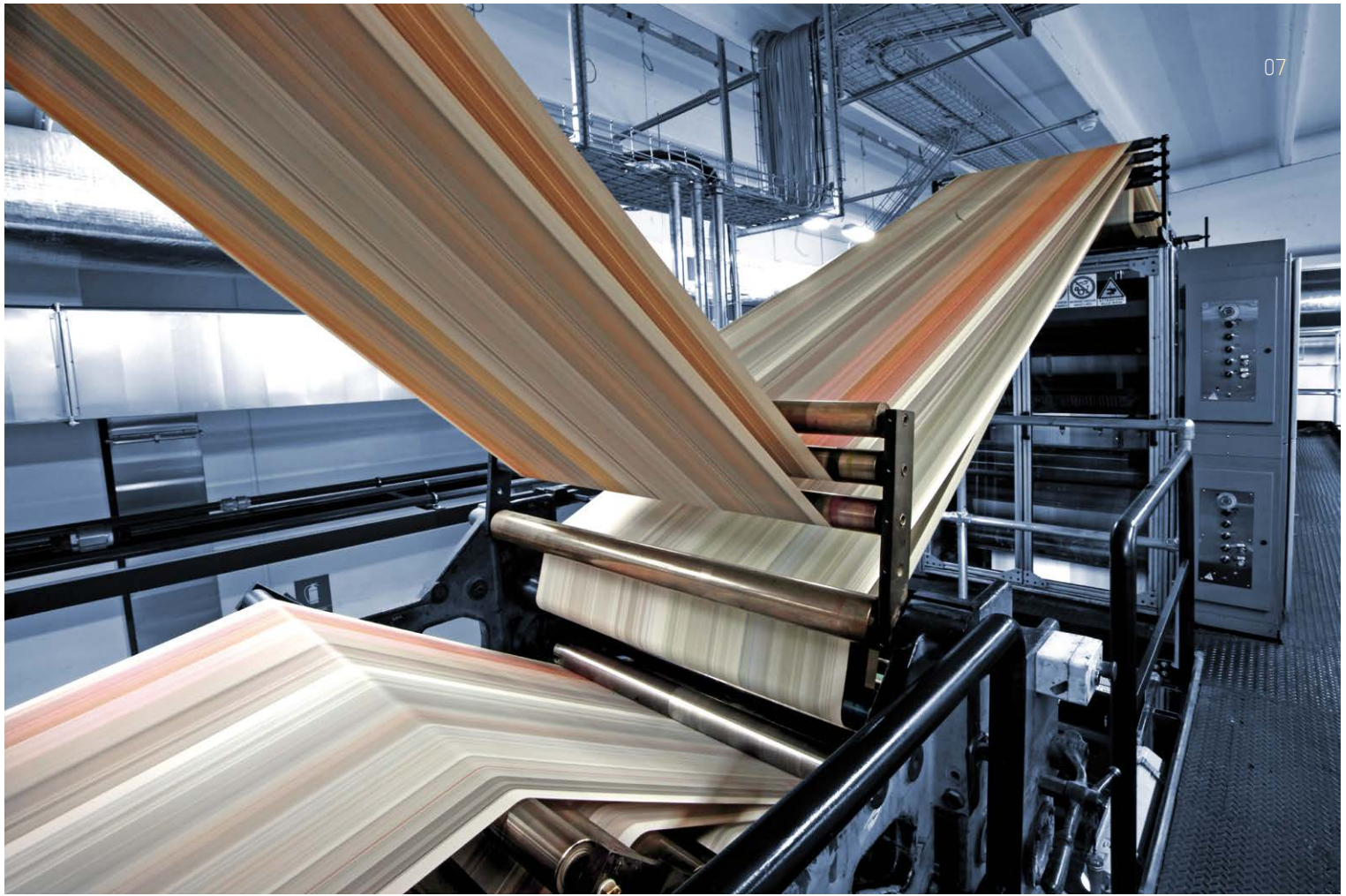
tions make it easy to fine-tune your solution to the needs of your application. B&R products are fully interchangeable, making it remarkably easy to design and program machine variants.

### **Safe**

B&R's advanced motion control solutions also make it easy to integrate sophisticated safety functions. The result is a machine that is not only faster to develop, but that also requires less downtime for changeovers and maintenance, boosting productivity substantially.

### **High-performance**

With a sampling rate of 50  $\mu$ s, B&R's servo drives pack enough reserves to handle even the most demanding multi-axis applications. They also make it possible reap the full benefits of virtual sensing technology.



### **Faster to market**

Creating software with mapp components and PLCopen function blocks is fast and easy, allowing you to take advantage of B&R's advanced motion control functionality without in-depth specialist knowledge. Using pre-programmed and thoroughly tested software blocks and technology functions significantly lowers investment risk and gives machine builders the freedom to focus on what they do best.

### **Robotics and CNC included**

Robotics and CNC are fully integrated in B&R's motion control environment. Machinery and equipment benefit from improved efficiency. Established CNC and robotics languages are supported.

### **Solid**

B&R products meet the highest demands with regard to robust design, reliable operation and long-term availability. Drive components are available with the protection ratings IP69K (hy-

gienic motors) and IP65 (gearboxes and distributed servo drives).

### **Smart**

A broad spectrum of software functions open up new design possibilities for motion control based on virtual sensing or predictive lag compensation. Of course, comprehensive simulation options are available to test the entire system in advance.

#### **The advantages**

- Safe
- Compact
- Solid
- Fast
- Easy to use
- Comprehensive functions
- Scalable from 50 W – 120 kW

## 3-axis servo drive ACOPOS P3

With the ACOPOS P3, B&R is setting new standards for motion control. This 3-axis servo drive offers a power density of 5 amps per liter, making it one of the most efficient servo drives with integrated safety functions on the market. It also tops the charts with regard to dynamics and precision with an impressive 50  $\mu$ s sampling time for the entire controller cascade.

The ACOPOS P3 is offered as a 1-, 2- or 3-axis drive and covers a power spectrum ranging from 0.6 to 24 kW, or 1.2 to 48 amps. With a housing as compact as a conventional 1-axis drive, the 3-axis drive reduces cabinet space requirements by 69%.

### A new dimension in virtual sensing

With a short cycle time of 50  $\mu$ s for current, speed and position control, the ACOPOS P3 opens up new opportunities for advanced motion control. For highly dynamic and precise processes like those in the printing and packaging industries, extremely fast movements must be controlled with absolute precision. With the short cycle times of the ACOPOS P3 and the bandwidth and precision of the POWERLINK real-time Ethernet network, this is no problem.

### Increased productivity

To strike a balance between increased productivity and decreased energy consumption, machine manufacturers are shifting to lightweight construction. This reduces the masses being moved – and thus the moment of inertia – in addition to making the machines less rigid and

more elastic. Virtual sensing makes it possible to control these elastic systems while retaining a high level of quality without having to use additional position sensors at the process intervention point.

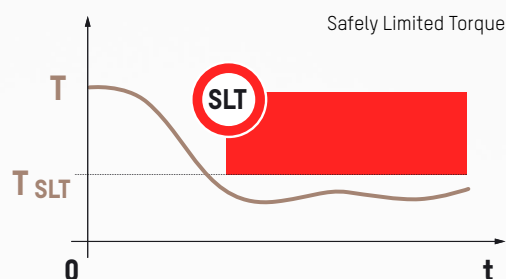
### Encoderless control

The ability to use virtual position encoders eliminates the need for a position encoder, cable and evaluation unit in the servo drive while increasing availability at the same time.



ETHERNET  
**POWERLINK**

open  
**SAFETY**



ACOPOS P3

PLK  
R/E  
SE  
Ax3  
Ax2  
Ax1

### Maximum safety

Thanks to machinery directives in the EU and similar legal regulations in other parts of the world, the safety functions used in automation components are becoming increasingly important. The ACOPOS P3 provides a whole range of safety functions that satisfy SIL 3 / PL e / Cat 4 requirements. The new Safely Limited Torque (SLT) function, for example, monitors a defined torque threshold for violations.

### Lean automation with Scalability+

The compact design of the ACOPOS P3 is not the only way it helps reduce space requirements of an automation solution. Together with B&R's

other automation components, it is possible to implement an extremely lean automation solution. A Power Panel (operator panel and controller), ACOPOS P3 and X20 I/O modules are all that is needed for a complete solution with plenty of power. Since every aspect of the system is fully modular and scalable, there is no limit to the potential for upgrades and expansions – and existing software is guaranteed to be reused with maximum efficiency.



One ACOPOS P3 does the work of up to three conventional single-axis servo drives.

### Safety included

Even the most basic automation system can be equipped with a full-fledged safety solution. The SafeLOGIC-X virtual safety controller runs on an ordinary PLC – giving B&R customers the reliability they have come to expect without requiring a dedicated safety controller.

### Completely compatible

The ACOPOS P3 can be combined with any of the drives in the ACOPOSmulti family. Additional space can be saved in the control cabinet, for example, by using the motor-mounted ACOPOSmotor or the machine-mounted ACOPOSremote.

### No energy left behind

When using an ACOPOS P3 together with an ACOPOSmulti drive, it is also possible to take

advantage of the power regeneration capabilities of the ACOPOSmulti. Instead of being converted to heat by braking resistors, braking energy from the ACOPOS P3 is passed on to an ACOPOSmulti via the DC bus, which feeds it back into the power grid.

### International

The ACOPOS P3 supports the world's most common power mains configurations, including TN, TT, IT and corner grounded TN-S systems. In some circumstances, only an additional line filter is needed to meet the necessary regulations. In addition, the ACOPOS P3 satisfies the machinery and equipment manufacturing requirements set forth in EN 55011, CISPR 11 and EN 61800-3 (first environment, category C2).



#### Highlights

- 69% smaller footprint
- 50  $\mu$ s sampling time
- Virtual sensors
- Use anywhere in the world





## Multi-axis servo drive ACOPOSmulti

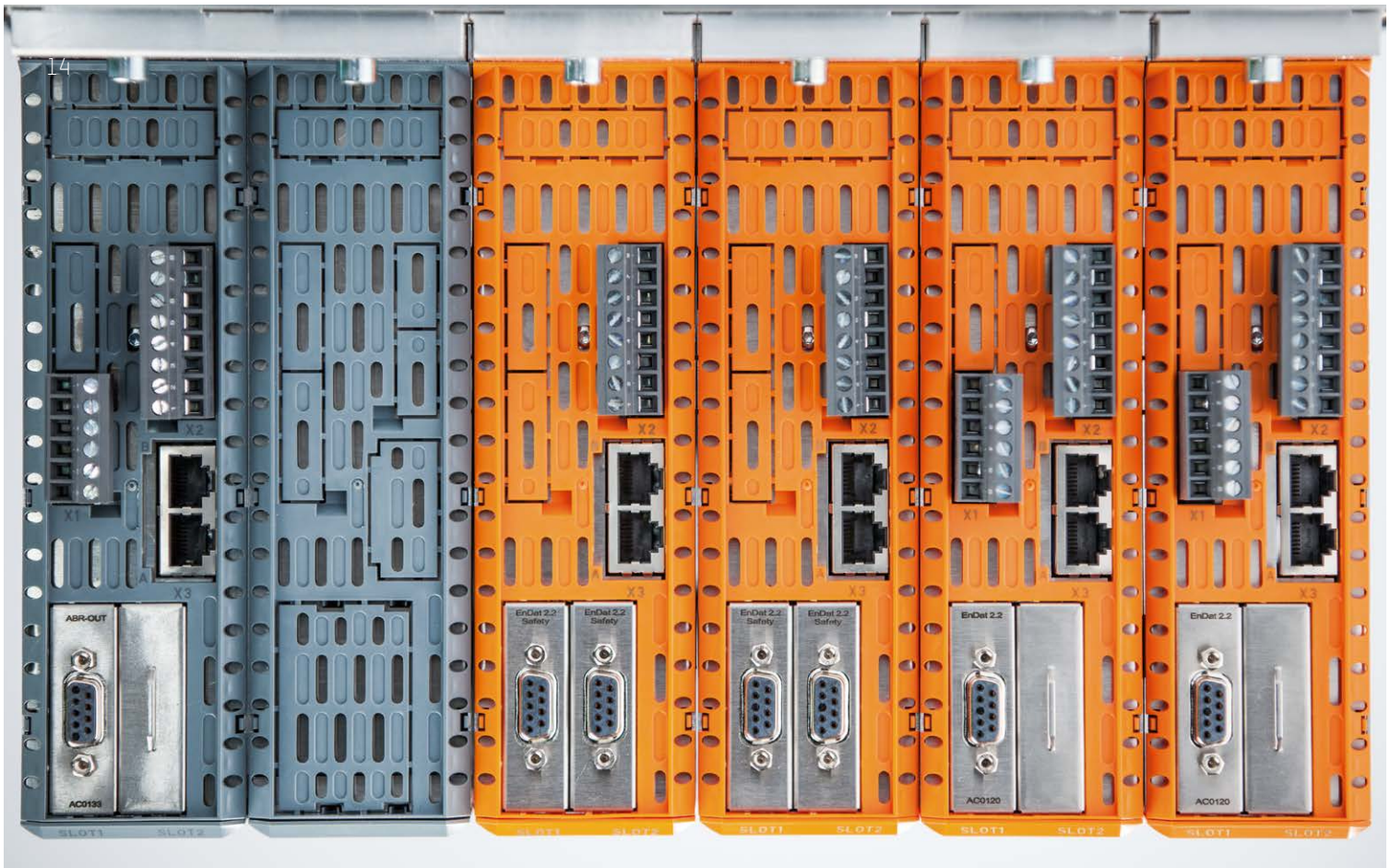
The modular ACOPOSmulti family of drives offers ideal solutions for multi-axis applications with maximum flexibility and minimum investment risk. Energy recovery, a variety of cooling systems and integrated safety technology are just some of the features that make ACOPOSmulti drives some of the most advanced, versatile and efficient on the market.

### **Compact, scalable performance**

Getting the most out of the limited space of production halls requires smaller machines, which in turn calls for high-performance drive technology with compact dimensions. This is why the ACOPOSmulti was developed with maximum performance and minimum space requirements in mind. This advanced system is able to handle an extensive range of applications, including those involving sensor-free induction motors, permanent magnet torque or linear servo motors and ultra-dynamic iron-less linear motors.

### **Modular cooling design**

ACOPOSmulti devices offer three cooling options: conventional heat dissipation in the control cabinet, an IP65-rated feed-through cooler or a cold plate variant that can be connected to a water or oil cooling circuit. This grants the designer maximum freedom and frequently eliminates the need for fans or air conditioning in the cabinet.



With their large selection of interface options, devices from the ACOPOSmulti series can be adapted perfectly for any application.

### **Innovative power supply**

Conventional drive systems convert only around half of the applied power from the mains into mechanical power. The ACOPOSmulti drive system is different. The integrated power factor correction ensures that only effective power is drawn from the mains. This cuts the connected load and current consumption of the machine almost in half and makes it possible to use smaller fuses and wire gauges.

### **Energy efficiency through regenerative braking**

All power supply modules support regenerative braking. Instead of being converted to heat as is generally the case, kinetic braking energy is converted to electrical energy and fed back into the mains. The DC bus voltage remains constant regardless of the mains supply voltage, which ensures maximum utilization of inverter modules and motors anywhere in the world.

### **Safe handling of power failures**

Electronic cam profile data is normally lost in the event of a power failure. Thanks to the integrated 24-volt auxiliary supply module,

ACOPOSmulti is able to retain this data until the machine has come safely to a stop.

### **Manage machine variants with ease**

An ACOPOSmulti mounting plate serves as the common platform for all machine variants, while the overall complexity of the machine determines exactly which devices are used. The software automatically recognizes the system configuration and provides all the necessary functionality.

### **Quick wiring, from 0.5 to 120 kW**

Whereas industrial control cabinets streamline production cycles, pre-wired cable trees make it much faster and easier to set things up directly at the machine. The sophisticated wiring and mounting technology of the ACOPOSmulti drive system means that the entire control cabinet can be wired in advance. Installation is reduced to simply hanging ACOPOSmulti drive components in the control cabinet and connecting them to the pre-wired cable trees. Put simply, ACOPOSmulti drastically reduces the amount of manual wiring.



#### Highlights

- Energy regeneration
- Scalable from 1.4 to 120 kW
- Modular cooling design
- Integrated safety technology

# Frequency inverter ACOPOSinverter



B&R's frequency inverter, the ACOPOSinverter, covers a power range from 180 W to 75 kW. With an installation width of only 45 mm (up to 1.5 kW) or 60 mm (up to 4 kW), the ACOPOSinverter P74 holds huge potential for space savings in the control cabinet. ACOPOSinverter modules are perfectly at home on conveyor belts, palletizers, packaging machines, industrial washers, milling machines, mixers, textile machines, pumps, fans, compressors and more.

## Integrated safety

All B&R frequency inverters feature the integrated Safe Torque Off (STO) safety function, while the ACOPOSinverter P74 additionally offers Safety Limited Speed (SLS) and Safe Stop 1 (SS1). Depending on the configuration and wiring, these safety functions satisfy the requirements of IEC/EN 61508-1 SIL 2/3 and ISO 13849-1 PL d/e.

## Simple commissioning

B&R's universal engineering environment, Automation Studio, is used to both configure the frequency inverters and to perform diagnostics – even if they are not receiving any power. Since all parameters are saved and transferred, the inverters can be commissioned without any specialist knowledge.

## ACOPOSinverter P74

The ACOPOSinverter P74 includes a selection of drive profiles for three-phase induction motors and synchronous motors with a voltage supply from 200 to 500 V and a power rating from 0.18 to 15 kW. The combination of an ACOPOSinverter P74 and an encoderless synchronous motor is very compact, contributing significantly to the reduction of the machine's overall size and cost.

## ACOPOSinverter P84

The ACOPOSinverter P84 is a frequency inverter for three-phase induction motors with a voltage supply from 200 to 480 V and a power rating from 0.37 to 75 kW. Because of its wide performance range and many integrated functions, the ACOPOSinverter P84 can fulfill the most challenging requirements of complex machines.

### Highlights

- Power classes from 180W to 75kW
- Seamlessly integrated into the automation system
- Automatic parameter download
- Integrated safety functions





## Compact motion control ACOPOSmicro, X20 and X67

**Compact ACOPOSmicro drives are available as conventional servo drives or specialized for controlling stepper motors with 256 microsteps. Stepper motor drives are also available in the form factors of the X20 (IP20) and X67 (IP67) series of I/O modules.**

Even here at the economy end of the spectrum, users have access to the full range of ACOPOS functionality. This is made possible by the Smart Device Controller (SDC), which provides the servo drive functionality on the controller. It gives compact drives access to electronic gears, cam profiles and advanced technologies such as the Cam Profile Automat. The Smart Device Controller is also able to provide these functions for frequency inverters and 3rd-party servo drives.

### Footprint smaller than 50 cm<sup>2</sup>

The 2-channel variant of the ACOPOSmicro requires an area of less than 50 cm<sup>2</sup> per axis. This not only saves space in the control cabinet for applications with multiple axes, but also provides advantages in wiring since the bus and supply voltage connection is only needed for every second motor.

### Up to 15 A

A continuous current of 10 A and a peak current of 15 A are possible for each stepper motor. This is sufficient to run even the largest stepper motors. For servo motors, a continuous current of 8 A and a peak current of 15 A are

permitted. All ACOPOSmicro drives feature over-current and overtemperature protection. Appropriate warnings and error messages are output via the fieldbus.

### Variable nominal voltage ranges

To achieve high torque values at high speeds, ACOPOSmicro drives can be used up to a nominal voltage of 80 VDC. Surge withstand capability is provided up to 95 VDC. Nevertheless, ACOPOSmicro drives can also be utilized in the low voltage range with nearly no limitations – even as low as 18 VDC.

### Integrated I/O

In addition to trigger inputs, the ACOPOSmicro also includes a 24 VDC output. This can be used to control external brakes, for example. With countless other options available, the ACOPOSmicro can be adapted to any requirement. All commonly used encoder systems are supported.

#### Highlights

- Access to all ACOPOS functions
- Maximum space savings
- Seamless integration of PLCopen
- Stepper motor modules in I/O format (IP20 or IP67)
- Integration of drives via analog interfaces



Variants of the compact ACOPOSmicro drive are available for either servo motors or stepper motors.

Smart. Small. Safe.



## Distributed motion control ACOPOSmotor & ACOPOSremote

If you take the modularity of the ACOPOSmulti drive system to the next level, what you get are inverters that fuse with the motor and deliver their power as a servo actuator right where it is needed. This opens up a whole new world of possibilities for modular machine design. Delivery time, footprint and commissioning effort can all be reduced.

With ACOPOSmotor, B&R frees up cabinet space by fusing the motor and inverter into a single unit. Even more space can be saved by adding an optional gearbox. The entire unit has IP65 protection.

### Maximum performance

The ACOPOSmotor delivers maximum performance by using the state-of-the-art power devices with minimal power loss as well as a motor

series that has been optimized for this application. Available in three different sizes, these servo actuators cover a torque range of 2.4 to 12 Nm and a power range of 500 W to 4 kW. For applications that demand even more power, an optional fan assembly can be added for a performance boost of up to 100%.

### Highlights – ACOPOSmotor

- Servo actuator available in three sizes ranging from 2.4 Nm to 12 Nm
- With or without gearbox
- 100% compatible with ACOPOSmulti
- Reduced wiring
- Integrated safety technology



### Decentralized and flexible

In terms of topology, the ACOPOSmotor servo actuator can be employed in a simple line or tree structure. In a line structure, node numbers are assigned automatically, but if a manual setting is required – to leave room for options or expansions, for example – this can be done without opening the housing. The ACOPOSmotor is connected to the drive network using a hybrid cable that carries the power, control signals and POWERLINK communication.

### Robust and well-protected

Highly effective IP65 protection allows ACOPOSmotor modules to be mounted directly on the machine. The control cabinet then only has to contain the power supply, high-powered inverter modules and other necessary electro-

mechanical components. This makes it much easier to implement modular machine architectures and optional machine functions since they can be easily connected – with the requisite dimensioning of the power supply – to the machine's main line using hybrid cables. Also ideal for modular machine designs is the ability to connect IP67-rated X67 modules directly to the ACOPOSmotor. This paves the way for implementing machine modules as self-contained production units ready for testing and operation.

### Integrated safety

In addition to the proven hardwired safety functions STO (Safe Torque Off) and SOS1 (Safe Operating Stop 1 time-monitored), a network-based variant of the ACOPOSmotor servo actuator is also available based on the open source openSAFETY protocol. This will allow users to access the functions that have already been certified for ACOPOSmulti: STO, SOS, SS1, SS2, SLS, SMS, SLI and SDI.

For even more freedom in the selection of motors, there is B&R's machine-mounted servo drive, the ACOPOSremote. This type of installation is particularly well suited for the increasingly prevalent linear and torque motors. It ensures maximum utilization of these motors' dynamic performance. The IP65-rated ACOPOSremote can be mounted directly on the machine. The robust housing makes it ideal for use in tough environments and gives the user the freedom to position the device wherever it best serves the application at hand.

### Highlights – ACOPOSremote

- High continuous power up to 8 kW
- Integrated connections for local I/O nodes
- Easy expansion (daisy chain)
- Integrated safety technology

# The safest path to more productivity SafeMOTION & SafeROBOTICS

Isolated from the main control system, conventional safety technology is crudely inflexible. In the absence of more sophisticated options, machine designers must resort to restrictive mechanisms that force workers into frustrating, time-consuming procedures. This choke-hold on productivity makes it extremely tempting to tamper with safety equipment. Although there are many new approaches to safe fieldbus systems, most of them are restricted by proprietary standards and sluggish response times. B&R's drives are a different story. All ACOPOS models offer ultrafast response times based on the open source openSAFETY protocol.

Drive functions such as Safely Limited Speed (SLS) are activated directly over the network. No hardwired safety circuits are needed. Signals are collected directly from their source via safe digital I/O modules, then distributed via the SafeLOGIC controller to the appropriate sensors and actuators. Safety relays are implemented in the form of function blocks that run on the safety controller.

All safety functions comply with EN ISO 13849-1: 2010 and EN IEC 62061: 2005 and certified up to SIL 3 / PL e CAT 4 depending on the function.

## Safe Brake Test (SBT)

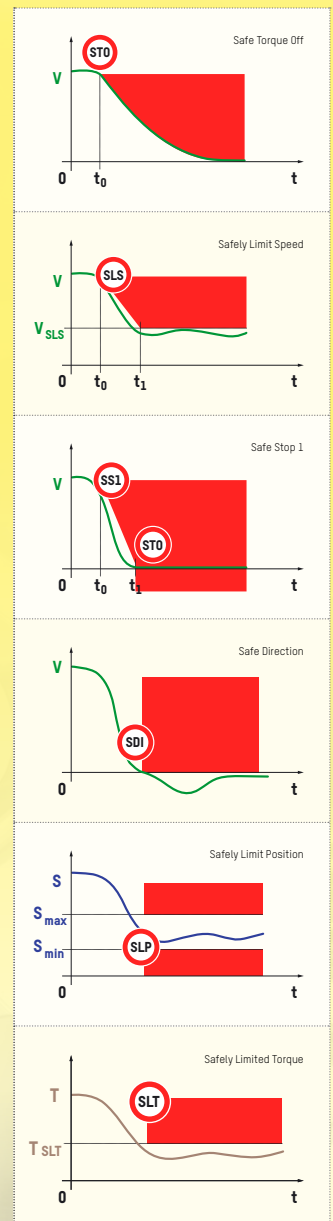
The SBT safety function allows an engaged brake to be tested by applying a configurable stator current for a specified period of time. This monitoring ensures that the tested brake is able to hold a defined torque. The function can also be configured to account for an external load or repeat the test at a defined interval.

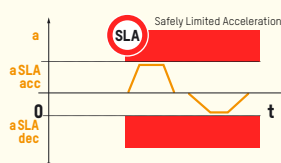
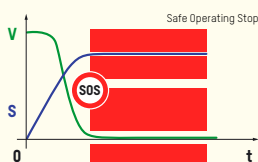
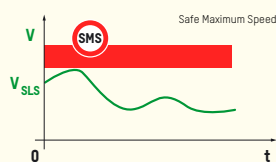
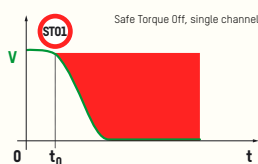
## Safely Limited Torque (SLT)

The SLT safety function is used to monitor a defined motor torque or – in the case of linear mo-

### Safety functions

- ST0, ST01, SBC, SS1
- SOS, SS2, SLS, SMS, SLA
- SDI, SLI, SBT, SLT
- Safe Homing, SLP, SMP, Remanent Safe Position





tors – a defined force. Paired with Safely Limited Speed (SLS), it provides a high level of protection for machine operators.

### Safe Homing

The Safe Homing function provides a way to establish a reference between the encoder position and the machine position. Depending on the homing mode, it may be necessary for the drive to perform a homing procedure. A homing procedure requires the control functions between the electronic controller and the drive motor to be active. Other safety functions might have to be selected in order to prevent a hazardous state during the homing procedure.

### Remanent Safe Position (RSP)

Since no encoder on the market offers a safe multi-turn range, axes must be homed every time they are powered on. The RSP safety function makes it possible to store a Safe Homing position in nonvolatile memory. As long as all the requirements are met within the application, there will be no need to home the axis again after it is restarted.

#### Highlights

- Fully integrated safety
- Fast response times
- Easy to use
- Comprehensive functions

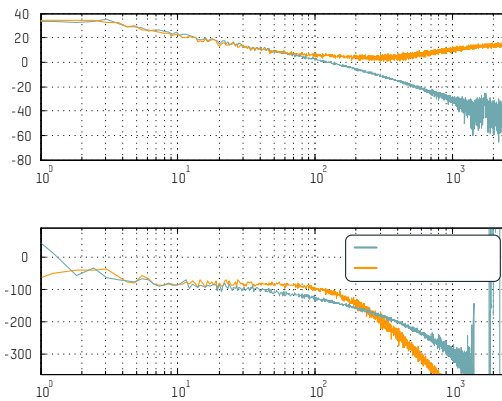
# Software functions for increased efficiency

## Virtual axes

In addition to real axes, the Automation Studio engineering environment also allows you to program virtual axes. This greatly simplifies implementation of complex positioning tasks and axis couplings. A virtual axis has all the functionality of a real axis, without the controller cascade for a motor. Functions such as electronic gears and cam profiles, or even the Cam Profile Automat, are just as easy to use on the virtual axis. It becomes much easier to design structures for machine operations.

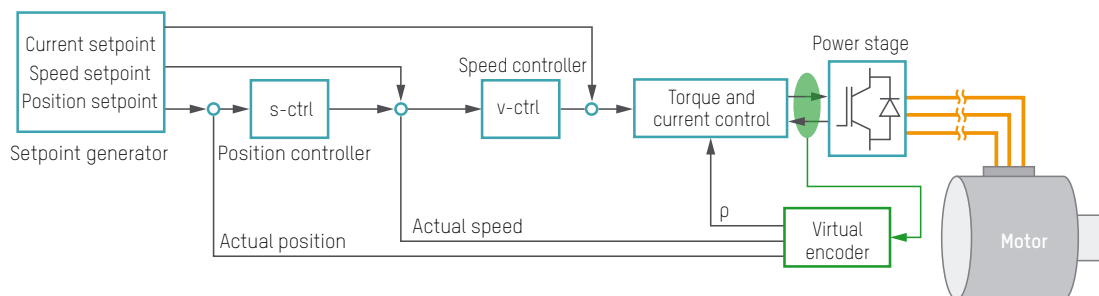
## Control loops without encoders

Today's motion control applications are making increasing use of motors that have neither a position sensor nor a rotary encoder (encoderless control). This is a popular way to cut down on costs, weight and space, and is good for the environment as well. B&R servo drives offer enough processing power to calculate speed and position values from the available data (stator current and voltage).

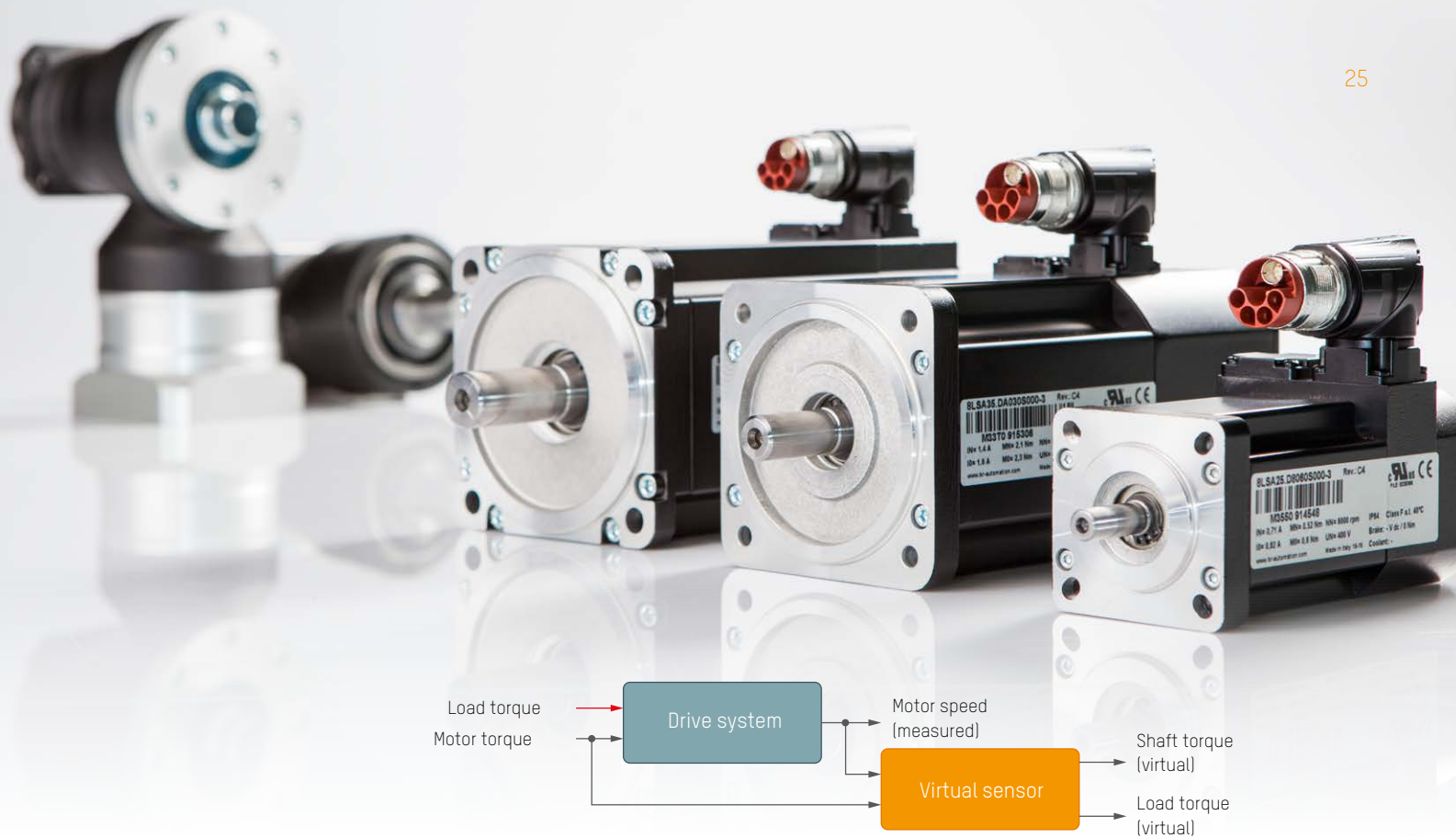


Frequency response of speed-controlled system for physical encoder (blue) and virtual encoder (orange).

Without the precision of a positioning sensor, there are certain restrictions on accuracy, usable torque, efficiency and other characteristics. At the same time, however, a multitude of new applications open up that were previously too demanding for a conventional frequency inverter.



Standard controller cascade in servo drives with virtual encoder

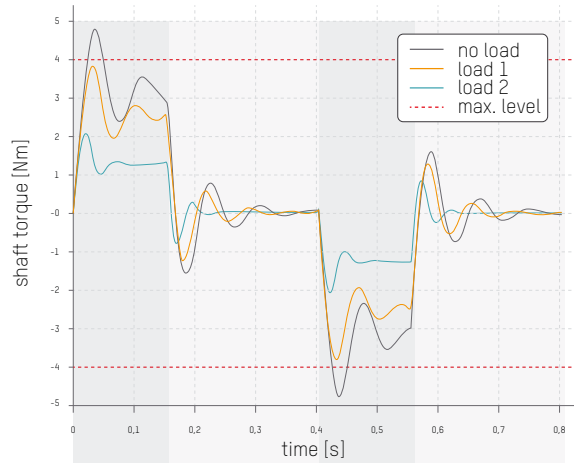


A virtual sensor can be used to precisely determine shaft and load torque in dynamic conditions.

And you still have access to all the well-proven ACOPOS functions such as homing, phasing, 2-encoder control, offsets, setpoint generation, set current filter and torque limitation. When using a position sensor, the observed actual position can also be used as an additional source of information for monitoring purposes.

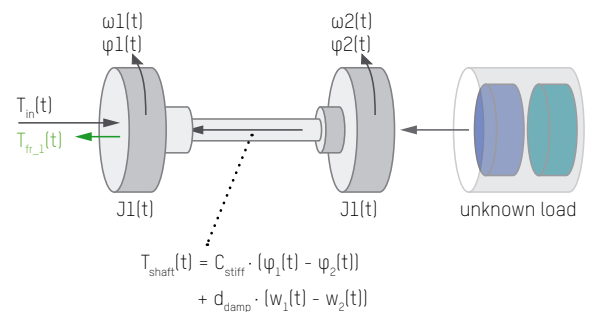
### Virtual sensing

In mechanical systems with a tendency toward oscillation, often the only solution is to throttle the performance. Load encoders could help, but can be difficult to integrate. That's why B&R's ACOPOS drives support virtual sensors. Using readily available system data such as the speed and position of the motor, the drive calculates the output of a virtual load encoder. This is used to actively suppress oscillations to reduce lag error and accelerate settling times.

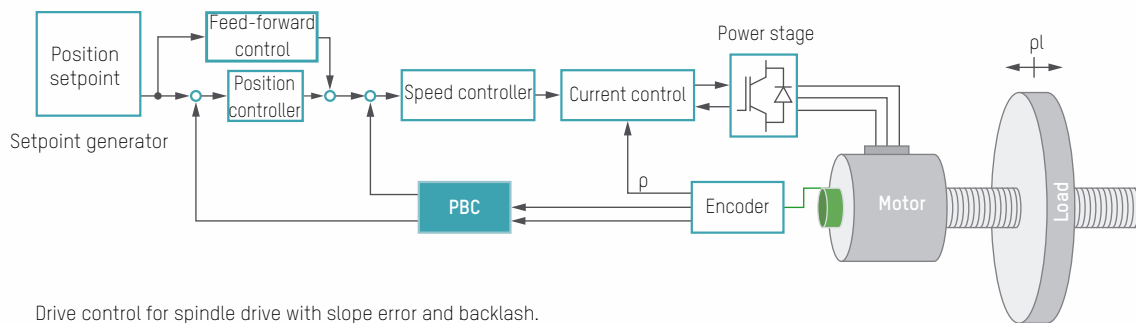


acceleration const. speed deceleration stop

If the shaft torque exceeds the defined limits, then parameters can be changed to prevent damage.



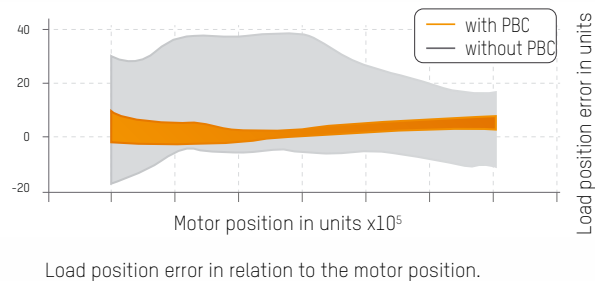
Mathematic models make it possible to replace physical encoders with virtual encoders.



Drive control for spindle drive with slope error and backlash.

### Simple backlash compensation

The standard controller cascade for the B&R ACOPOS servo drive family provides compensation for spindle pitch and backlash. The positioning precision of spindle drives with and without backlash can be increased through compensation without requiring an extra encoder on the load side. Control quality can also be significantly improved in other applications with mechanical play using pitch and backlash compensation (PBC).



Load position error in relation to the motor position.

Compared to conventional handling of mechanical play in the setpoint generator, spindle pitch and backlash compensation provides substantial benefits. With condition-based closed-loop control, backlash that occurs on a changing edge is overcome quickly and reliably, and the transition to the new edge is as smooth as possible. A smooth transition reduces the likelihood of damage to the mechanical components caused by continually changing edges.

The entire control loop can be configured as if there were no backlash. This can be achieved using the new closed-loop control approach for stabilizing the speed controller for the motor position within the range of mechanical play. A further advantage of spindle pitch and backlash compensation is that the currently displayed position corresponds to the actual position of the load. All that is necessary is to carry out a reference measurement that defines the relationship between the motor position and the actual load position.

### Compensate for motor-specific disturbance

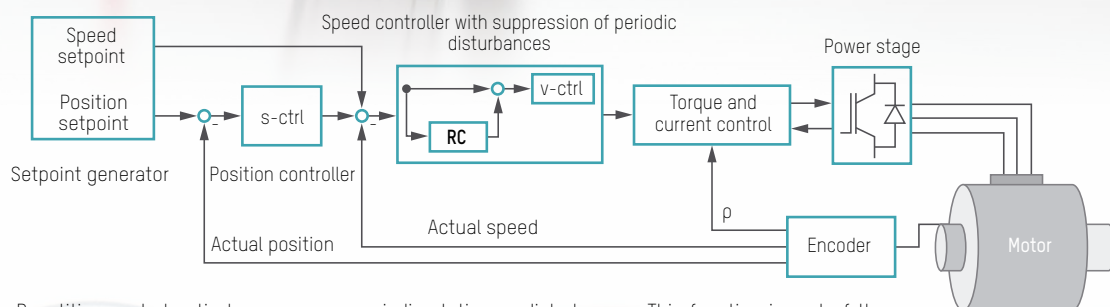
Inadequacies in the mechanical structure and electrical asymmetry can cause undesired

disturbance torque in the power transmission system. The majority of these disturbances are strongly dependent on the load, and change with the operating point of a permanently excited synchronous motor. Disturbance torque has a negative effect on the application, especially for direct drives, and results in additional position lag error.

The clear correlation between the encoder position and the disturbance that occurs allows us to identify the motor-specific disturbance torque values. During the identification process, the disturbance torque is recorded over at least one mechanical revolution. This process is fully automatic. Based on this signal curve, intelligent algorithms then generate a data record specially for the motor, which can then be used for compensation.

### Automatic lag error compensation

Repetitive control considerably improves the accuracy of production processes with stationary disturbances by using predictive lag error compensation. Performance is increased considerably without a great deal of additional effort.

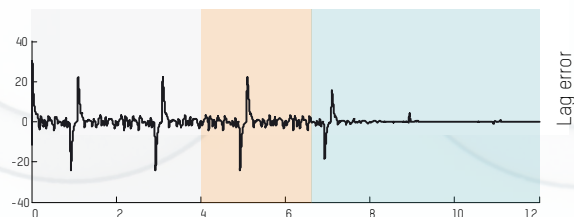


Repetitive control actively suppresses periodic stationary disturbances. This function is part of the ACOPOS drive system controller cascading.

When position-controlled drives run at constant speed, mechanical conditions can cause stationary disturbing torque fluctuations, which are generally observed as lag error localized to a certain area. Fine-tuning the drive parameters can minimize the lag error, but will not be able to completely prevent the disturbance.

Embedded in the standard speed control loop for the ACOPOS drive family, the repetitive control function adjusts the drive's torque setpoint to drastically reduce the periodic portions in the speed and lag error. The algorithm undergoes a constant learning process so that changes to

the load profile – caused by wear, for example – have no effect whatsoever on the drive due to predictive compensation for disturbances.



Active disturbance suppression increases the performance of a drive system many times over, reduces the lag error and increases the speed consistency.

# Realistic drive simulation

## Virtual motion

### Virtual Motion

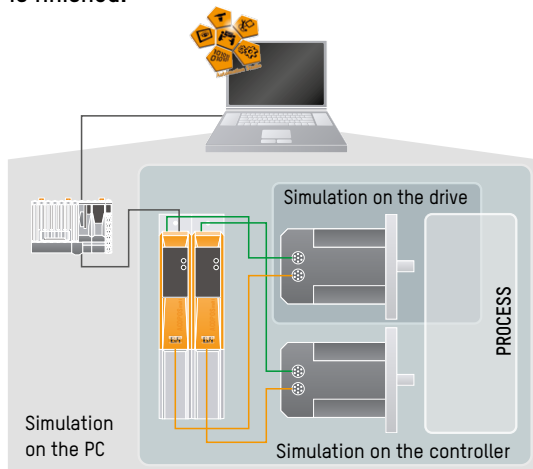
Specification

Conceptual design

Prototype construction

Verification

Tests on real machines are costly in terms of both time and money. With machinery and equipment growing more complex by the day, the topic of simulation is rapidly gaining significance. B&R's virtual motion allows you to realistically simulate machine behavior under specified, configurable environmental conditions. Even while still in development, you can have a highly accurate representation of how the machine will behave when it is finished.



With virtual motion you can simulate a single drive system with hardware-in-the-loop (HIL) functionality, as well as complex machine elements or even an entire machine. Access to a realistic simulation before the machine is even

built lets you identify potential weaknesses and correct them early on. Virtual motion is also a fast and convenient way to tune the parameters of existing drive systems.

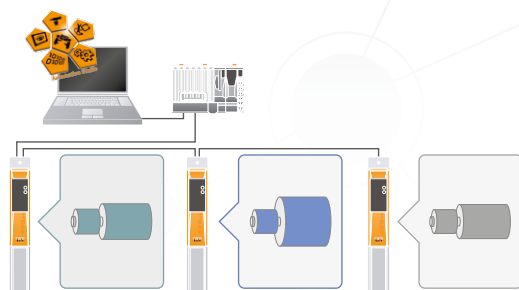
#### Avoiding damage to the machine

During simulation, it is easy to change system parameters and test the behavior of the machine at its limits. There's no need to worry about damaging the machine, and the influence of external forces can be clearly depicted.

Virtual motion can be used on three different levels: to simulate the motor and load; to simulate the drive, motor and load; or for purely software-based simulation that runs entirely on the computer. Complex multi-body systems and drive systems can also be simulated in the design or prototyping phase, as can complete machine elements where all that remains is fine-tuning.

#### Simulation on the drive

The first level of virtual motion is simulating a single axis. In addition to the behavior of the motor itself, the simulation also accounts for the corresponding loads. This type is particularly useful in analyzing the behavior of the drive controller. It can be used to evaluate how the system reacts to different parameters and load scenarios. It is also possible to estimate

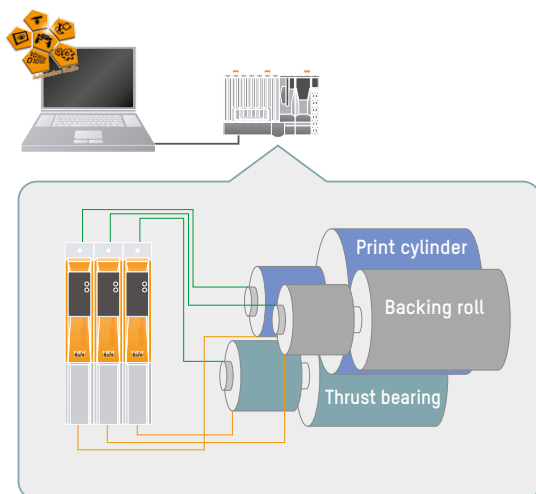


Simulation on the drive including load simulation

performance levels for specific controller configurations.

#### Simulation on the controller

On the controller it is possible to simulate larger processes with greater complexity or processes involving coupled axes. This allows you to develop and test sequential controls and complex processes without having to rely on the physical drive and the machine. Coupled axes can also be analyzed together in order to assess how they influence each other and the performance of the machine as a whole. With this type of simulation, the process, the behavior of the motors and the behavior of the drives are simulated on the controller. Libraries of PLCopen modeling

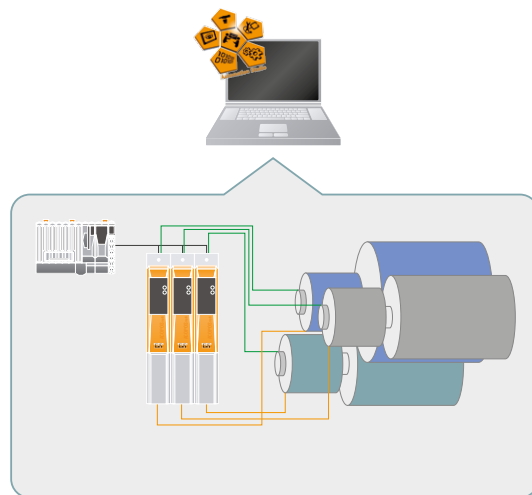


Simulation on the controller

components make it possible to configure process models of varying complexity.

#### Simulation on the PC

The most comprehensive level of virtual motion simulation is performed on the PC. It provides a realistic representation of the overall system without a single component of actual

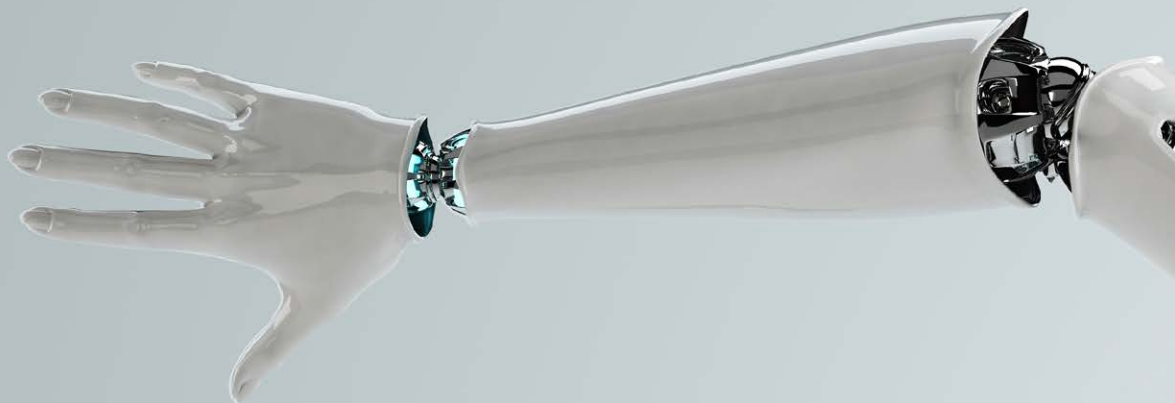


Simulation on the PC

hardware. Sequential controls and their impact on the machine are simulated and analyzed directly in B&R Automation Studio, enabling faster product development without any loss of quality.

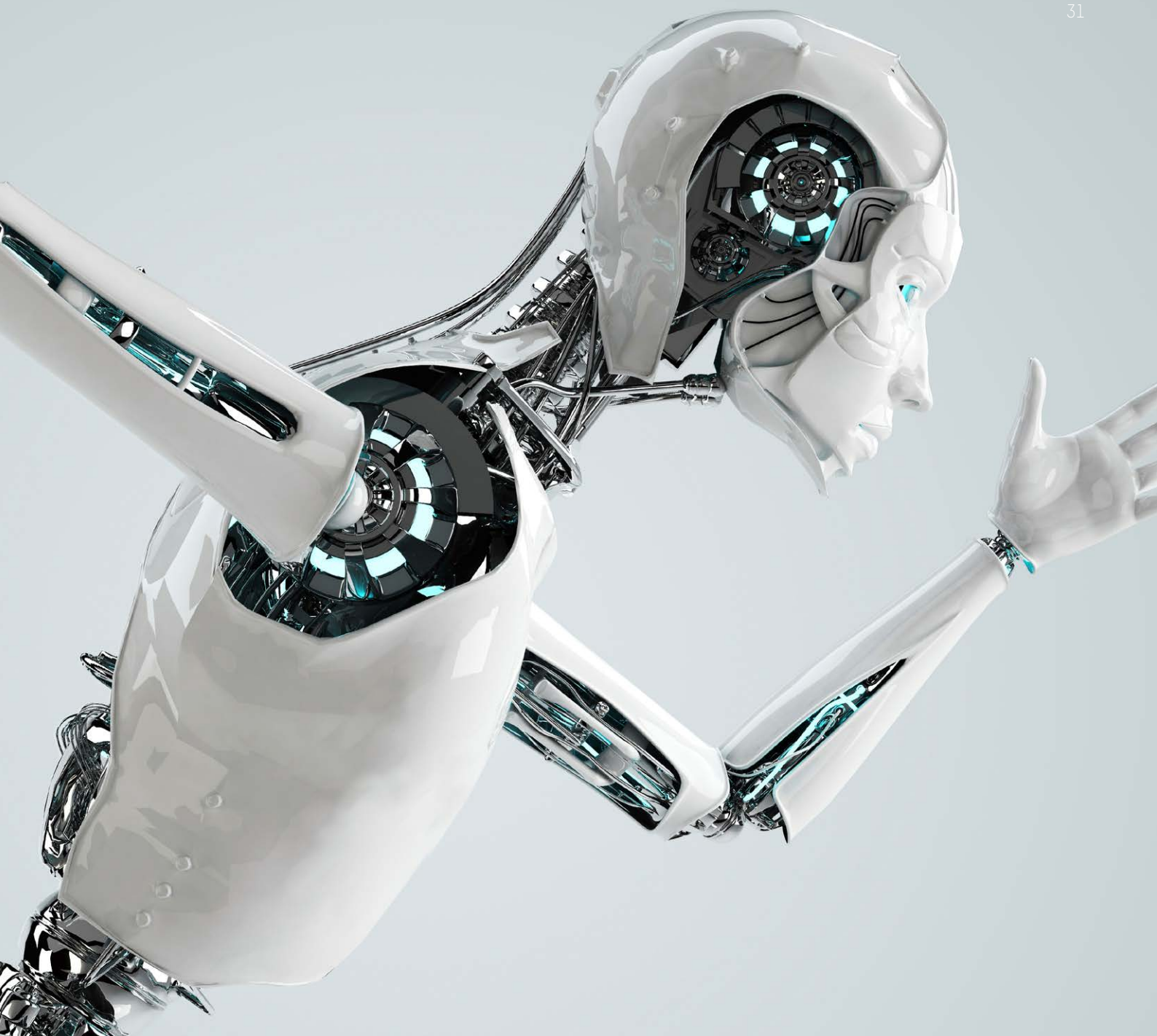
#### Highlights

- Faster development
- More precise configuration
- Damage avoided



Fully integrated for  
maximum performance  
CNC & Robotics

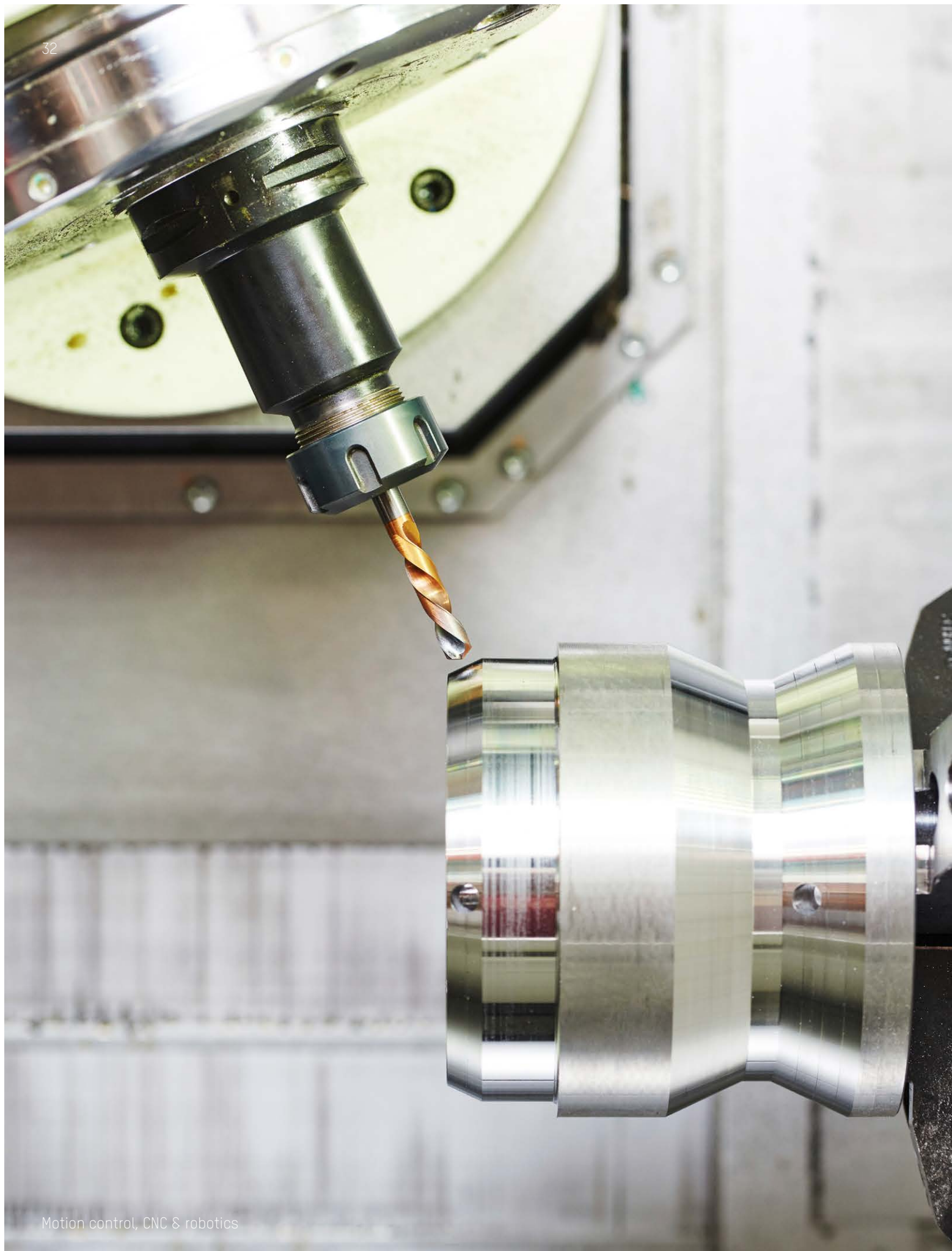




The concept of Generic Motion Control combines the worlds of robotics, CNC, coupled axis movements and single axis positioning in one homogeneous platform that is fully integrated in the BSR automation landscape. With path control for CNC machines and robots no longer isolated from the rest of the controls, the machine's various processes can be synchronized with much greater precision.

#### **Fast sampling**

Sampling times of 50  $\mu$ s allow path precision in the submicron range. Generated position set-points are transferred to the drive jitter-free via POWERLINK. Processing of over 2,500 motion control blocks per second guarantees that free-form surfaces are processed without thinning out of coordinates.





With robotics and CNC fully integrated in the B&R automation system, machine processes can be synchronized with much greater precision.

#### **Simultaneous interpolation**

Up to 15 axes can be programmed for simultaneous interpolation in one channel. In addition to the position and orientation of the tool center point, it is also possible to program individual joint positions directly. Linear and rotary auxiliary axes are also interpreted path-synchronously.

#### **GMC speaks many languages**

B&R offers an array of options for programming robotic and CNC applications. Depending on the task, the versatile programming interface allows both high-level language programming as well as DIN 66025 programs or simple coordinate tables. It is even possible to integrate customer-specific programming languages.

#### **Kinematic transformations**

B&R's robotics library contains all the most commonly used kinematic structures and can easily be expanded or modified without having to change the system.

#### **Examples of kinematic structures**

- 6-axis SCARA robot
- 5-axis processing machine
- SCARA
- Tripod

67% faster development  
with mapp technology





# mapp

## TECHNOLOGY

mapp technology accelerates the development of application software by an average of 67%. With mapp, developers no longer have to spend time programming basic functionality and instead are free to focus on their primary task: implementing machine or system processes in the application software.

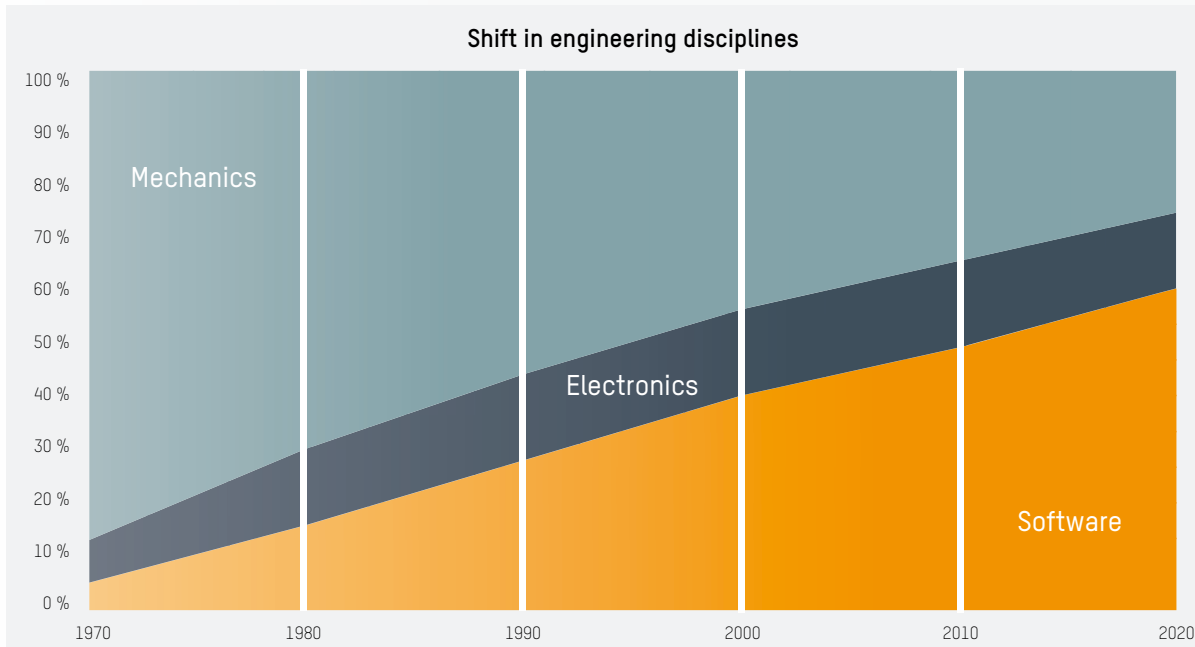
mapp technology is not a separate software tool, and there is virtually no learning curve. The software blocks are seamlessly integrated in the B&R Automation Studio environment. Users who are already familiar with Automation Studio can start using mapp blocks today. mapp components are configured and diagnosed via an easy-to-use web interface.

### Increased machine availability

The mapp software blocks have been developed from the experience B&R has gained in implementing hundreds of thousands of automation solutions all around the world. This has made them extremely reliable. Using mapp also reduces the complexity of an application by up to 83%. The result is a boost in machine availability.

### Lower maintenance costs

Over the lifecycle of a machine, approximately 70% of the software costs go toward maintenance. Since you can count on B&R to maintain the mapp components, a large portion of these costs are eliminated. mapp's web-based maintenance and diagnostics functions provide further savings by eliminating costly on-site service calls.



Over the last few decades, the proportion of software engineering involved in the development of new machinery and systems has skyrocketed from 5 to over 50%.

Source: VDMA/ITQ

### Reduced investment risk

At many companies, the bulk of the engineering expertise is concentrated in only one or two developers. If one or even both leave the company, not only do new developments suffer, but it also becomes impossible to maintain and further develop applications that have already been deployed. This can't happen with mapp. The functions are extensively documented, B&R-maintained and absolutely reliable. Dead-end programming projects are a thing of the past.

### The concept

Object-oriented mapp technology consists of individually encapsulated components that streamline development of new software. The components provide basic functionality and are configured graphically. They drastically reduce the amount of programming required. All mapp components are connected via mapp links. Each mapp component retrieves the data it needs from other components using a client-server model, so very little glue code is required.

#### Highlights

- 67% faster development time
- Reduced investment risk
- Increased machine availability
- Lower maintenance costs

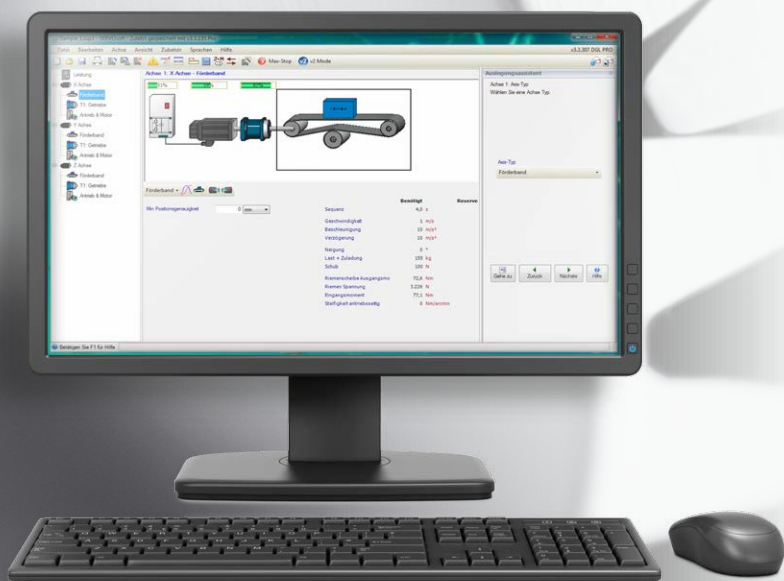
As a practical example, mapp's motion functions are able to provide energy data. As soon as mapp's central energy management component – mapp energy – is added to the application, it automatically collects and prepares this data. Just a few clicks of the mouse, and you've set up a comprehensive energy monitoring solution.

## Perfectly sized with SERV0soft

B&R customers are now better equipped than ever to select the perfect servo system for their automation solution – thanks to the SERV0soft sizing tool from ControlEng that comes integrated in Automation Studio.

This tool allows developers to efficiently and effortlessly select the B&R servo drives, motors and gearboxes that best meet their specific needs. Having a system perfectly coordinated with the masses it needs to move means no more under- or oversized drives and optimized energy consumption.

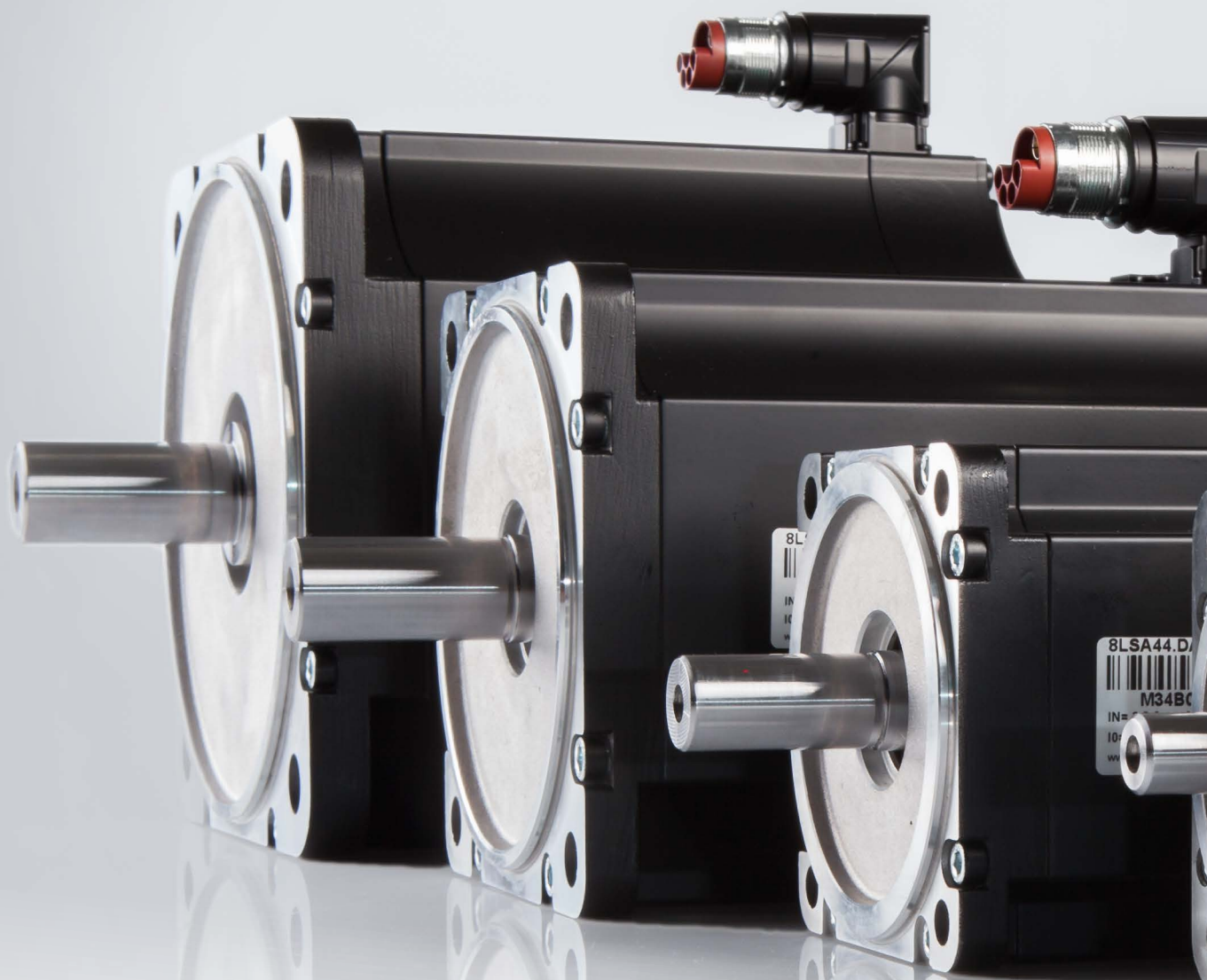
SERV0soft allows you to analyze highly complex machinery – with up to 40 axes in a single project – in order to find the perfect solution for any application.



### Highlights

- Fully integrated
- Up to 40 axes
- For drives, motors and gearboxes





## The right choice for every application B&R servo motors

B&R's permanent-magnet motors are compact, highly dynamic servo motors with a very high level of efficiency. They are fully scalable with regard to power, precision, size, options and for use in safety-related axes. Stepper motors round off the selection.

### Scalable performance, versatile application

From compact models with 100 W of continuous power to high-end models with 140 kW – B&R motors have the right dose of performance for any application. In direct-drive format for high-precision axes or as a cost-effective mo-



tor/gearbox assembly – you're sure to find a design that perfectly fits your needs.

The standard servo motors are available with a selection of flange dimensions, cooling systems, protection ratings and bearing options. In addition to highly dynamic low-inertia motors, B&R also offers high-inertia motors for applications

such as machine tools. Special-purpose motors are also available, such as IP69K-rated motors for hygienic applications in the pharmaceutical or food and beverage industries.

#### **Feedback systems made to measure**

B&R's 8LS three-phase synchronous motors are available with a selection of encoder systems.



#### Servo motors

- Highly dynamic
- Compact design
- Optimized torque ripple
- Excellent efficiency
- High power density
- Safety with inductive encoders
- Hybrid motor cable reduces costs

With a Heidenhain EnDat encoder, even the standard model is equipped for safety-related axes with high precision. Robust digital signal transmission ensures optimum integration and control quality.

For applications even higher precision requirements, the motors can instead be equipped with an optical encoder. Multi-turn encoder variants eliminate the need for tedious homing procedures and additional measurement instrumentation on the workpiece. The embedded parameter chip ensures optimum coordination with the servo drive and integration into the overall B&R system. The three-phase synchronous motors are also avail-

able with resolvers for machines with lower precision and speed requirements.

#### Future-proof connections

Thanks to the digital signal transmission, B&R's innovative and sturdy hybrid motor cables can be used, which combine servo feedback and power for streamlined installation.

#### Accelerated delivery of preferred motors

8LS servo motors include a number of preferred types. For our customers, this means an unbeatable price/performance ratio and reduced delivery times. If necessary, these motors can be ready within a few hours and dispatched using express delivery.



#### Compact servo motors

- Ultra-compact and highly dynamic
- Power range up to 1 kW
- 80 VDC and 320 VDC bus voltage
- Absolute multi-turn encoder with the same length
- Rotating self-locking connector system
- Optional direct gearbox mounting



#### Torque motors

- 2 sizes, 2 cooling types, 3 models
- Stall torque from 50 to 1020 Nm
- Speeds from 300 to 1000 rpm
- Low cogging
- High overload capability
- Optional hollow shaft or blind hole
- Optional safety encoders



#### Hygienic design

- 100% stainless steel (housing, flange and shaft)
- Complete hygienic design for optimal washdown
- Innovative IP69K-rated connections
- Food-safe and resistant to chemicals
- Satisfies EHEDG and FDA hygienic requirements
- Ideal for machines with an open design
- Alternative IM B14 mounting

# A perfect fit for perfect transmission B&R gearboxes



**B&R's modular gearboxes are optimized for use with its broad range of synchronous and stepper motors. The result is a high performance and economical drive program for all industrial fields that can be optimized to meet customers' needs and is provided from a single supplier.**

The permanently lubricated servo gearboxes can be mounted in any orientation. They are available in 3 classes with either IP54 or IP65 protection. Planetary gearboxes can be mounted to the small 8LV servo motors to create an exceptionally compact servo gear motor.

## **Modular system for maximum scalability**

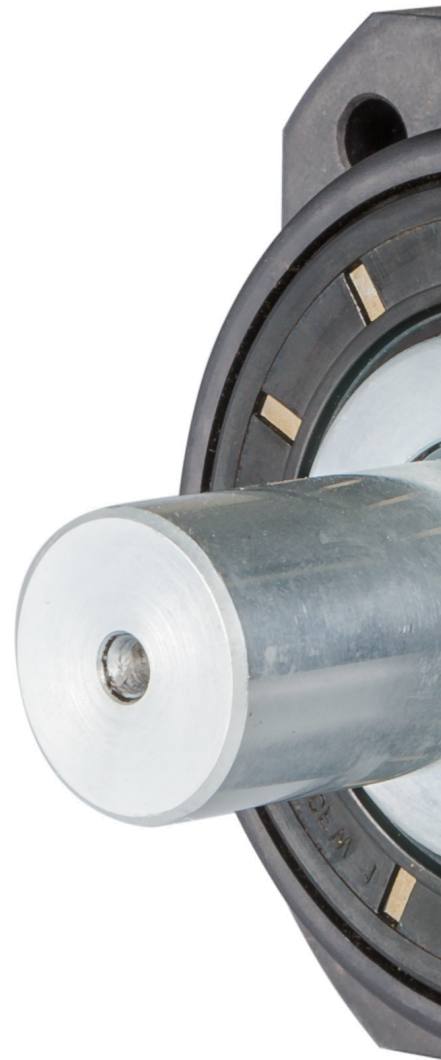
The servo gearboxes are available in all commonly available output shaft designs, and the universally modular system ensures maximum flexibility for integration into the architecture of

the machine. Whether coaxial, angular or with an output flange – each performance class has plenty of options to ensure that the gearbox integrates seamlessly into the overall machine design.

The motor coupling is optimized for use with B&R servo and stepper motors. The large range of gear ratios for 1-, 2-, and 3-level gearboxes provides a very fine-grained selection to choose from. An intuitive sizing tool helps ensure you select just the right combination for your needs.

## **Lowest backlash – highest loads**

Premium gearboxes feature very low backlash and high torsional rigidity. They are especially well suited for use in handling systems that run with high speeds and acceleration values





#### Output geometries

- Variety of output geometries for maximum scalability
- Optimum adaptability for output requirements

#### Highlights

- High precision
- Low backlash
- Quiet operation
- High bearing strength
- High output torque
- Minimal torsional rigidity
- Selection of output geometries
- Maximum scalability

and applications in which the optionally available backlash of <1 arcminute is of particular significance.

The honed gearing of this series ensures the lowest level of operating noise and reduces vibration. The use of special bearings enables high radial and axial forces. The model with angled teeth is optimally suited for applications that require particularly smooth and synchronous operation. The premium series includes

angular planetary gearboxes, planetary gearboxes with output flange and coaxial planetary gearboxes.

#### **Perfect for many applications**

Standard series planetary gearboxes are ideal for applications that don't require an extremely low level of backlash. This includes applications with high speed and acceleration requirements as well as toothed belt or rack applications. In combination with honed sun and



#### **Premium gearboxes**

- Backlash < 1 arcmin
- High output torque
- High efficiency
- Smoothed and honed gearing
- Optimized synchronization
- Precision clamping system
- Lifelong lubrication
- IP65 protection



planets, the straight-toothed and fully hardened gearing guarantee high output torque and high-precision positioning.

The unique building block principle used with this series makes it possible to handle all output geometries established on the market in the area of coaxial planetary gearboxes. The standard series gearboxes are available as angular planetary gearboxes, planetary gearboxes with output flange and coaxial planetary gearboxes.

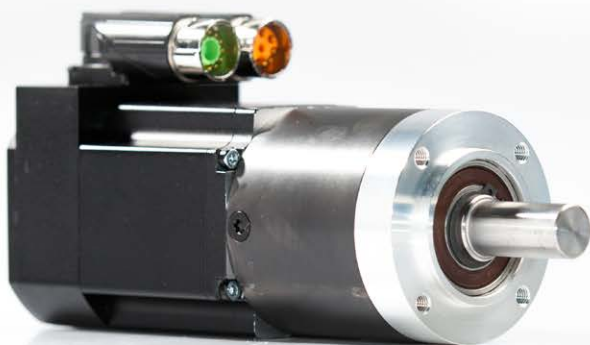
#### **The cost-effective alternative**

B&R optimized the cost of its economy gearboxes by simplifying the clamping system between motor shaft and gearbox, limiting the

#### **Standard gearboxes**

- High output torque
- Smooth operation
- Low backlash
- Large selection of gear ratios
- Precision clamping system
- IP54 or IP65 protection

available gear ratios and reducing the output torque to a market-standard level. This series is available with gear ratios of 5, 10 and 25. The drive shaft is only available with a keyway.



#### **Direct gearbox mounting**

- Highly dynamic
- Maximum power density
- High level of positioning precision
- High-resolution absolute encoder systems
- Low backlash
- High torque

# Optimize your system

B&R offers an extensive range of products for integrated automation solutions.

For a complete overview of all B&R system components, visit [www.br-automation.com](http://www.br-automation.com).



## Box PCs / Panel PCs

- **Automation PC 910 / Panel PC 900**
- Powerful Intel Core i3/i5/i7 processors
- Fanless operation
- Windows 7, Windows 8, Windows Embedded, Linux, real-time
- Uncompromising quality for operation over many years
- Direct fieldbus connection



## Automation Panels

- **Automation Panel 900**
- Widescreen from 7" to 24" Full HD
- 4:3 from 12.1" XGA to 19" SXGA
- Projected capacitive multi-touch and analog resistive single-touch
- Hygienic design (IP69K)
- Swing arm or cabinet mounting
- Remote operation up to 100 m with SDL3



## Ultrafast automation

- **reACTION TECHNOLOGY**
- 1 µs response time
- Cost-effective due to standard hardware
- IEC 61131 programming
- Significant reduction of CPU load
- Digital and analog signal preprocessing
- Comprehensive diagnostics and simulation
- Extensive function library



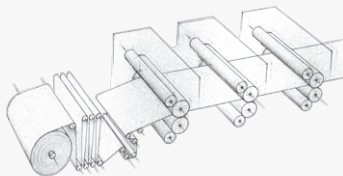
## Scalable PLC platform

- **X20 controller**
- Easy programming in IEC 61131-3, CFC, ANSI C, C++, PLCopen
- Open fieldbus options (POWERLINK, CANopen, DeviceNet, PROFIBUS, PROFINET, etc.)
- Intel Atom performance
- Fanless and maintenance-free
- Integrated CNC and robotics



## IP67 I/O system

- **X67 I/O**
- Open for all fieldbus systems
- Seamless integration
- Excellent EMC properties
- Diagnostics via PLC program and web interface
- Simple cabling



## Technology Solutions

- Integrated closed-loop control
- Hydraulics, temperature, winders, printing
- Profile generators, controllers, system identification, autotuning
- Virtual sensors
- Simulation models
- Model Predictive Control (MPC), Advanced Process Control (APC)



## Safe control platform

- **SafeLOGIC**
- Safety in accordance with CAT 4 / PL e / SIL 3
- PLCopen-certified function blocks
- Virtual wiring
- Management of machine options
- Easy IEC 61131 programming
- Openness through openSAFETY
- Integrated diagnostics



## Power Panels

- **Power Panel C-series**
- Control and HMI in a single device
- Easy programming in IEC 61131-3, CFC, ANSI C, C++, PLCopen
- 5.7" to 10.1"
- Widescreen and 4:3
- Open communication (FTP, VNC, OPC, web server, POWERLINK)

## ETHERNET POWERLINK

The high-performance POWERLINK real-time communication solution is based on the IEEE 802.3 Ethernet standard and designed to ensure real-time data transfer in the microsecond range.

### Flexibility

POWERLINK provides optimum flexibility for both centralized and decentralized architectures. Its hot plugging capability allows modules and components to be connected and disconnected as needed during operation. This has no impact on real-time behavior and does not require restarting the system, which saves time and money. Flexible cabling allows you to decide which topology best meets the needs of your system. Nothing stands in the way of upgrading your machine or system or continually expanding your machinery.

### Performance

Highly efficient cross-communication and network topologies with distributed intelligent sensors and actuators help minimize jitter and ensure fast response times. The efficiency of POWERLINK makes it possible to implement high-speed control loops

centrally via the bus, greatly simplifying engineering. The advantages are clear: save time, simplify systems and relieve the load on control tasks.

### Reliability

In safety-critical real-time applications, POWERLINK proves itself as an extremely robust system with a high level of immunity to electromagnetic disturbances. The most demanding field conditions require a system's mechatronic components to operate with utmost reliability, yet they also require the bus to ensure data transfer even if an error occurs.

### Return on investment

Based on IEC standards and supported by the internationally active Ethernet POWERLINK Standardization Group, POWERLINK guarantees compatibility anywhere in the world. As an open solution, POWERLINK is unpatented, software-based technology that is completely independent of proprietary hardware. Its scalability and ability to integrate all types of systems make POWERLINK a perfect solution for any industry.

Integrated automation  
Global presence  
Solid partnership



ETHERNET   
**POWERLINK**

open   
**SAFETY**

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