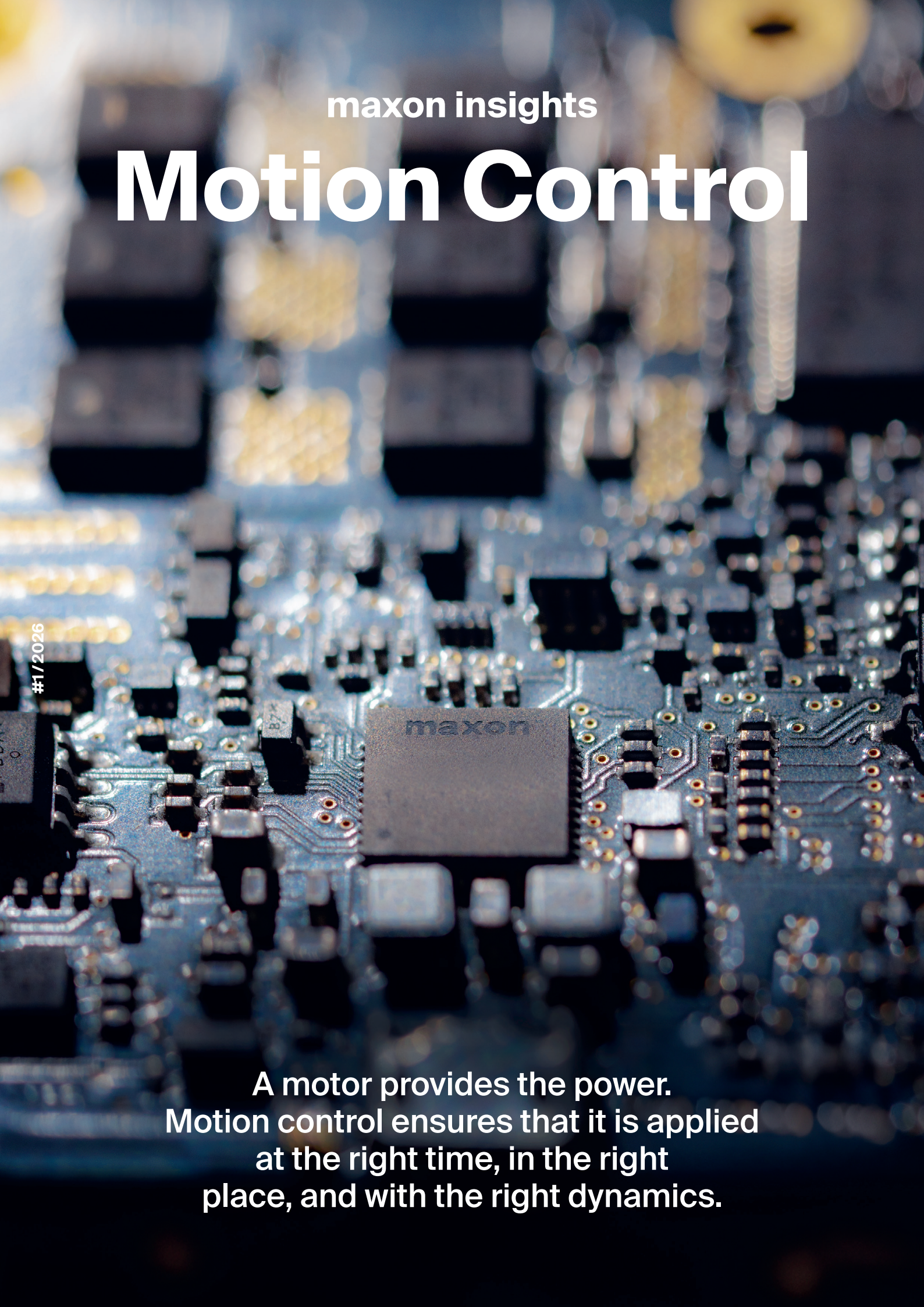




maxon insights

Motion Control

#1/2026

A motor provides the power.
Motion control ensures that it is applied
at the right time, in the right
place, and with the right dynamics.

maxon insights #1

maxon insights is a series of themed publications on drive technology. Each issue focuses on a specific field and provides insights into technologies, new developments, and real-world applications. Contributors include specialists from maxon as well as external experts from research and industry.

Motion control as a core capability



Patrik Gnos, Director
R&D Motion Control and
Head of the Corporate
Center Motion Control at
maxon's headquarters
in Sachseln

In 1994, we began building the Corporate Center Motion Control at maxon as a small team. We had already gained initial experience with controllers in the preceding years and our task was clear: not only to provide our customers with the right drive, but also to make motion in their applications easier to control. At first, we developed, sold and supported analog servo controllers. It soon became obvious that the future would be digital. maxon invested early in digital servo controllers, embedded software, and graphical commissioning tools.

This step brought us closer to our customers' applications and opened up new possibilities in control engineering, parameterization, diagnostics, and software. We continued to learn – from successes, mistakes, and many conversations with customers. Over the years, this success gave rise to a center of expertise at maxon's headquarters in Sachseln, closely linking electronics development, firmware, software, control engineering, and customer support. Questions from the market thus feed directly into development.

The strategic importance of motion control continued to grow. Where individual components often took center stage in the past, the quality of the overall system is what matters today. Customers expect reliable solutions that are easy to integrate and remain available over the long term. Motion control brings the motor, gearhead, sensors, electronics, software, and application expertise together in a compelling drive solution.

For maxon, the decisive strength increasingly lies in matching individual technologies to specific requirements. Motion control bridges the gap between products and our customers' applications. It helps us assess technological developments at an early stage, apply innovations selectively and develop solutions that will also meet future requirements.

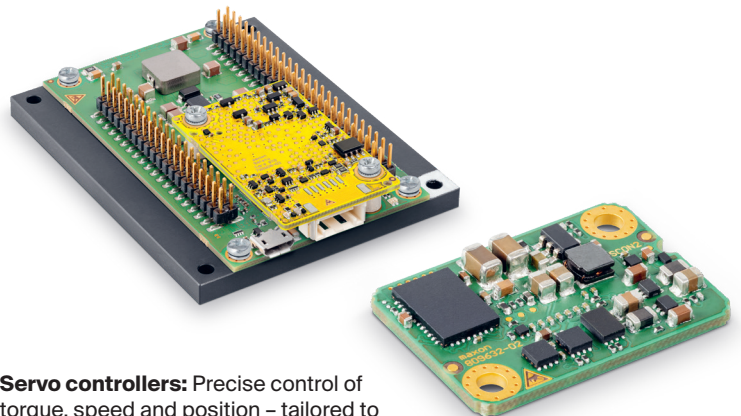
This importance will continue to grow. Conventional micro-controller miniaturization is reaching its limits. At the same time, multi-core architectures, specialized processors, connected systems, and artificial intelligence are opening up new possibilities. Taking advantage of them requires a deep understanding of systems and the ability to translate technology into tangible customer value.

The journey continues – our ambition remains the same: to make motion more precise, safer, and easier for our customers to use. This publication shows how we are doing that in practice today.

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CTO Stefan Müller talks about the future of motion control, close customer collaboration, and how experience leads to new solutions. **Page 6**



Servo controllers: Precise control of torque, speed and position – tailored to the drive and application. **Page 18**



Motion controllers: When several axes work together, the higher-level controller coordinates their motion sequences. **Page 28**



The goal is clear, but the path is complex: For a transport robot to reach its destination accurately, navigation, control, and drives must work closely together. **Page 46**

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“Customer-specific solutions are in our DNA”

Stefan Müller is responsible for maxon's technological direction. In this interview, he explains why systems thinking, close customer collaboration, and technological depth are inseparable – and why motion control is increasingly becoming a core capability.

Text **Urs-Ueli Schorno** Photos **Philipp Schmidli**

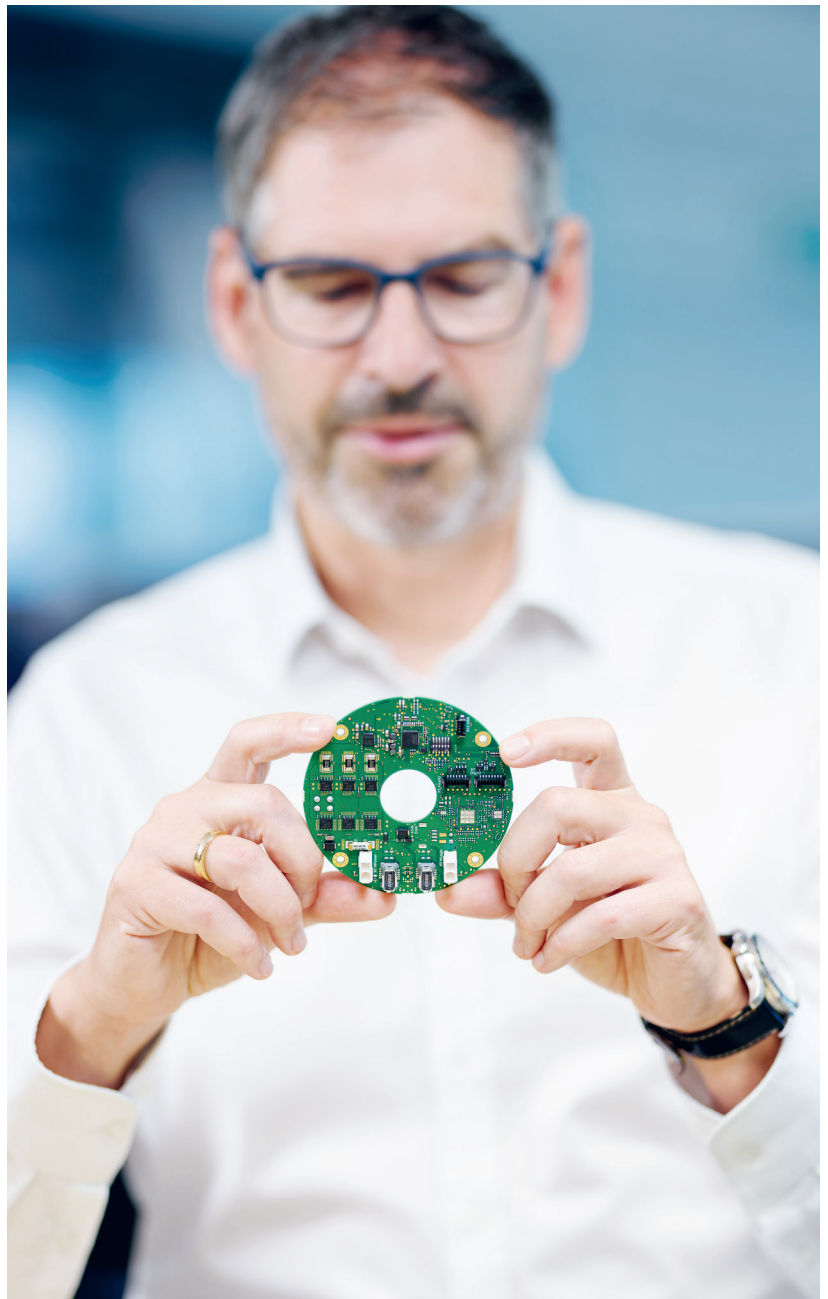


Stefan Müller, if you were introducing maxon today to someone who does not yet know the company, how would you describe the essence of what we do?

At our core, we develop drive solutions comprising compact, highly efficient motors and gearheads, generally for highly demanding applications. Our solutions are used in medical technology, robotics, automation and aerospace. The easiest way to explain this is through applications. In laboratory automation, we move samples. In intralogistics, our drive solutions enable mobile robots to store and retrieve goods precisely and safely. In medical technology, we ensure the reliable delivery of insulin. Examples like these help most people understand what we actually do. Ultimately, all these applications are about motion control: adapting movement precisely to the task at hand and meeting the customer's requirements as effectively as possible.

How has maxon's approach changed in recent years?

What has not changed is the way we work. We are at our best when we collaborate very closely with our customers and develop solutions together. That has been part of maxon's DNA for many years. What has changed most is the applications – and, with them, our products. They have become more powerful and more complex. Today, we deliver far more highly integrated mechatronic solutions in which the motor, gearhead, encoder, electronics, and software work together. We are clearly moving toward integrated systems that include control electronics – solutions in which mechanics, electronics and software are considered as a single unit. We are increasingly taking responsibility for the integration ourselves. This brings maxon closer to the customer's actual application, making close collaboration with the customer even more important.



“Applications are becoming more connected and more complex. Motion control is becoming a key technology.”

Stefan Müller, CTO maxon Group

What personally excites you about technology and development at maxon?

My background is in electrical engineering, and I have worked with electric drives for many years. What particularly fascinates me is the interaction between the motor, electronics, gearhead and control system. Truly optimal solutions can only be created when these disciplines are considered together – and that is something we place great importance on at maxon.

maxon has a very broad portfolio. From a developer's perspective, what is the real strength of that breadth?

The strength lies in our strong technology base. Depending on the application, we can select precisely the right technology – from different motor concepts and gearheads to electronics. This breadth allows us to think freely and choose the solution that makes the most sense, both technically and commercially. It also enables us to develop system solutions without being constrained by a particular technology from the outset.

Where does a component end and motion control begin?

That depends very much on the customer and the application. Some customers deliberately want components only, while others are looking for integrated solutions. Both approaches have their place. The important point is that systems only perform well when the underlying components are first-class. Motion control becomes the central element precisely at this interface – where individual components become a functioning system. That is why we continue to invest heavily in the development of key technologies and develop systems wherever they provide clear added value for the customer. It is not an either-or choice, but a deliberate balance.

What role do platforms and customization play in this combination?

Platforms provide the foundation for implementing customer-specific solutions efficiently and with manageable risk. Once the core technology and production processes have been established, we can respond more quickly and make targeted adaptations. Not every project can be based entirely on existing platforms. In such cases, it is important to communicate development risks openly – particularly with highly integrated systems.

How do you balance innovation and stability in development?

It is a classic trade-off. That is why we have dedicated advanced development teams that focus on new technologies while working closely with customers, universities, and partners. For us, innovation does not mean immediately pursuing every new idea. It means deliberately deciding which technologies offer genuine added value and are mature enough to be integrated into products and platforms for the long term.

Many current trends revolve around AI, robotics and automation. What role does motion control play here?

These topics are closely connected. AI is fundamentally changing robotics. Robots are leaving protected areas and moving into unstructured environments. They are also interacting increasingly with people, for example in logistics or industrial applications. In these applications, motion control becomes a key technology because systems are becoming more complex, more connected, and more dependent on context. This requires functional safety, as humans and machines work in increasingly close proximity. This development is not a short-term hype. It will remain with us for many years. Alongside these visible

trends, there are also topics that may seem less exciting, such as new regulatory requirements and ensuring robust production processes and supply chains. However, these are crucial if innovative technologies are to be used reliably in practice.

What advice would you give young engineers starting at maxon today?

Find what genuinely interests you and become good at it – without allowing yourself to be guided too much by short-term trends. I have seen for myself how hypes change. Ultimately, what matters is doing something that continues to give you satisfaction over the long term.

What distinguishes a good technical solution from a truly compelling one?

A truly compelling solution does not only work under ideal conditions. It is well thought out, stable, and reliable in everyday use. That is where genuine technological depth and systems understanding become apparent.

Profile

Dr Stefan Müller has been Chief Technology Officer of the maxon Group since 2022 and is responsible for the company's technological strategy. He joined maxon in 2017 and holds a doctorate in electrical engineering from the University of Stuttgart.

The six key questions about motion control

Motion control ensures that movements are executed precisely, efficiently, and reliably. Today, it is no longer just about the motor, but about the interaction between mechanics, sensors, electronics and software. The following questions provide a concise introduction to the key principles.

1

What does motion control mean?

Motion control means tailoring motion to the requirements of a specific application. A motor in a robot joint must meet different requirements from a drive in a laboratory instrument or packaging machine. What matters, therefore, is not the motor alone, but how the motor, sensors, electronics, software, and mechanics work together.

2

What distinguishes motion control from conventional drive technology?

A motor provides the power. Motion control ensures that it is applied at precisely the right time, in the right place, and with the right dynamics. Beyond closed-loop control itself, this includes aspects such as dynamics, energy efficiency, the synchronization of multiple axes, and behavior under changing loads.

3

What sets maxon apart from other motion control providers?

Many providers specialize in individual components. maxon can provide motors, gearheads, sensors, electronics, and software from a single source, allowing the system as a whole to be optimized. The aim is not to maximize the performance of every individual component, but to achieve the best possible interaction between them. This creates added value that is greater than the sum of its parts.

4

Why must motion control systems be predictable?

In robotics, medical technology, and industrial automation in particular, motion systems must behave predictably and repeatably at all times. Only then can safety, quality, and trust be ensured. New technologies such as data-driven analysis or artificial intelligence do not alter this basic principle: the motion itself must remain under control at all times.

5

What role does software play in today's motion control systems?

Software is often where the decisive added value is created. Modern control algorithms, diagnostic functions, and the synchronization of multiple axes significantly expand the capabilities of a drive system. At the same time, straightforward commissioning and operation are becoming increasingly important. Engineers should be able to focus on their application – not on the fundamentals of drive control.

6

Which development will have the greatest impact on motion control in the future?

Motion systems will become even more interconnected and take more information from their surroundings into account. At the same time, demands on software, usability, and functional safety will increase. The challenge is to add intelligence to the system without compromising its stability and predictability.



A mobile robot uses a robotic arm to retrieve a package from a shelf – a complex motion task in intralogistics.

Experience that shortens the path to a solution

New motion control approaches do not start from scratch.
Proven platforms make expertise built
up over many years available from the outset.

Text **Daniel Hug**

Developing a servo drive or motion controller may not seem particularly complicated at first glance. Many microcontroller manufacturers offer extensive software development kits (SDKs) and libraries for controlling brushed and brushless DC motors. Today, a wide range of highly integrated components is also available to handle various motor control functions.

A skilled engineer can use these resources to develop functional control solutions in a relatively short time, even without in-depth expertise in control engineering and power electronics. This may be entirely sufficient for simple applications. As requirements become more complex, however, this approach soon reaches its limits.

The demanding requirements of highly dynamic ironless motors, uncompromising miniaturization, and stringent efficiency targets combined with sophisticated thermal design require specialist expertise and experience. The same applies to clock synchronization across a wide range of communication interfaces and modern sensor systems. If high production volumes and availability over several decades are also required, it becomes clear why maxon decided to develop its own electronics as well.

The crucial point, however, lies elsewhere: a drive system reaches its full potential only when

Image: Getty Images/imaginima

all its components are optimally matched – from the gearhead and motor to the sensors and controller. This is essential, particularly in highly integrated solutions. Getting the most out of a system requires a holistic approach to system optimization and an in-depth understanding of every component.

Development starts with the customer

A new platform starts not with the technology, but with the application. The central question is how to create genuine value for customers that gives them a competitive advantage. This may sound simple, but the enormous variety of applications makes it a challenging task. maxon's activities span medical technology, robotics, and industrial automation as well as mobility applications. The requirements vary accordingly.

Time is another factor. The typical life cycle of a servo drive or motion control platform is seven to ten years. A platform therefore cannot be developed solely for today's requirements. The more important question is how customers, applications, and markets will change over the coming years.

The real skill lies in identifying the broadest common denominator across these sometimes very different requirements – one that makes sense both technically and commercially. Only then does the actual evaluation of possible technical solutions begin.

Many perspectives, one goal

A platform is not created within a single development department. "Wisdom of the crowd" is not just a catchphrase here, but a guiding principle. We are convinced that an interdisciplinary approach leads to better solutions.

Product Management takes the lead. It sets the direction and drives the product's continued development together with the specialist departments involved. Global Sales specialists maintain close contact with customers and help to understand users' actual needs and pain points.

Business Development teams know the applications and markets, identify synergies, and recognize opportunities for new products. R&D, in turn, develops the appropriate technical solutions – from electronics hardware and embedded application software to control algorithms. Actual development begins only when these perspectives come together.

Proven foundation, customized solution

Platforms provide the basis for customer-specific solutions. Not every application can be optimally served by a standard product. At the same time, developing every solution from scratch would make sense neither technically nor economically. This is precisely where the strength of a platform lies.

It provides a proven basis on which customer-specific adaptations can be implemented efficiently. Customers benefit from shorter develop-

ment times, predictable risks, and technology that has already been proven in numerous applications. At the same time, sufficient flexibility remains to meet specific requirements and create genuine points of differentiation.

Innovation without disruption

The development of a platform does not end with its market launch. It is continuously enhanced throughout its life cycle. The motion control world evolves through incremental innovation. Customers expect stable products and long-term availability. At the same time, requirements continue to grow – in areas such as miniaturization, connectivity, safety, and software functionality.

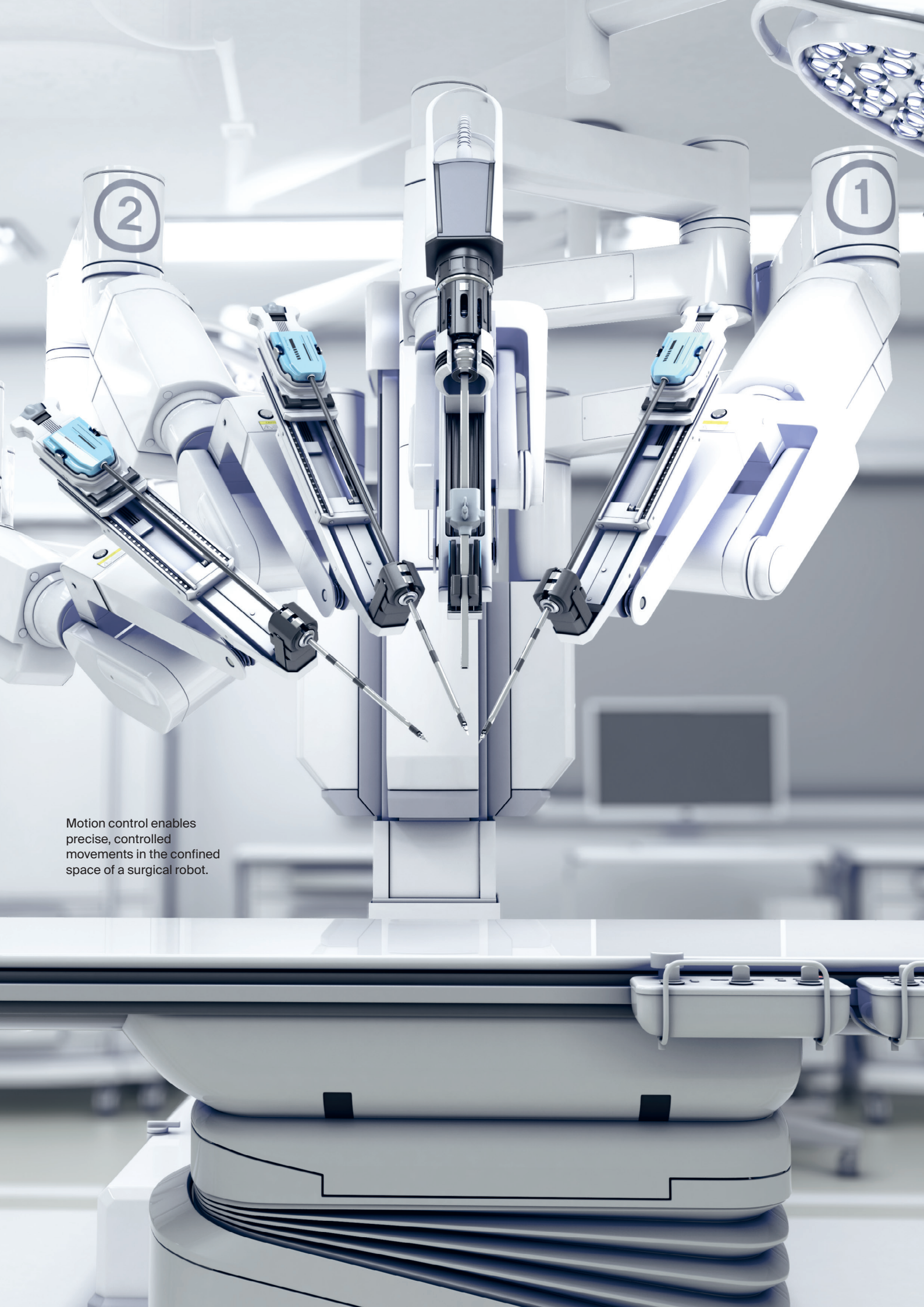
The challenge is to combine innovation with stability. New functions and technologies must be incorporated into the platform, while customers expect transitions between product generations to be as seamless as possible and their investments to remain protected over the long term.

maxon therefore relies on regular firmware and software updates. These make it possible to introduce new functions and improvements without jeopardizing the stability of existing applications. This keeps a platform relevant for many years and allows it to evolve with the requirements of its users.



About Daniel Hug

Daniel Hug heads Motion Control Services at maxon. In this role, he is responsible for the development of motion control platforms such as ESCON2 and EPOS4.



Motion control enables precise, controlled movements in the confined space of a surgical robot.

Control electronics perform different functions within a drive system. Servo controllers regulate individual drives, while motion controllers coordinate multiple axes at the higher system level. The solution used depends on the control task, system architecture, and level of integration. The available platforms, form factors, and power ratings provide the basis for customer-specific adaptations and developments. On the following pages, we introduce the ESCON2, EPOS4 and MACS platforms – from typical applications to selected products.

Our products

Servo controllers

From page 18

ESCON2

Easy Speed Controller

From page 20

EPOS4

Easy to use Positioning System

From page 24

Motion controllers

From page 28

MACS

Multi-Axis Controller System

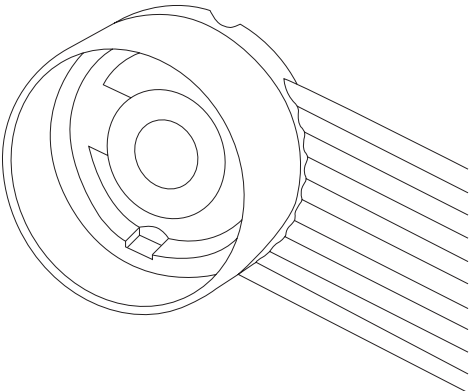
From page 30

Servo controllers

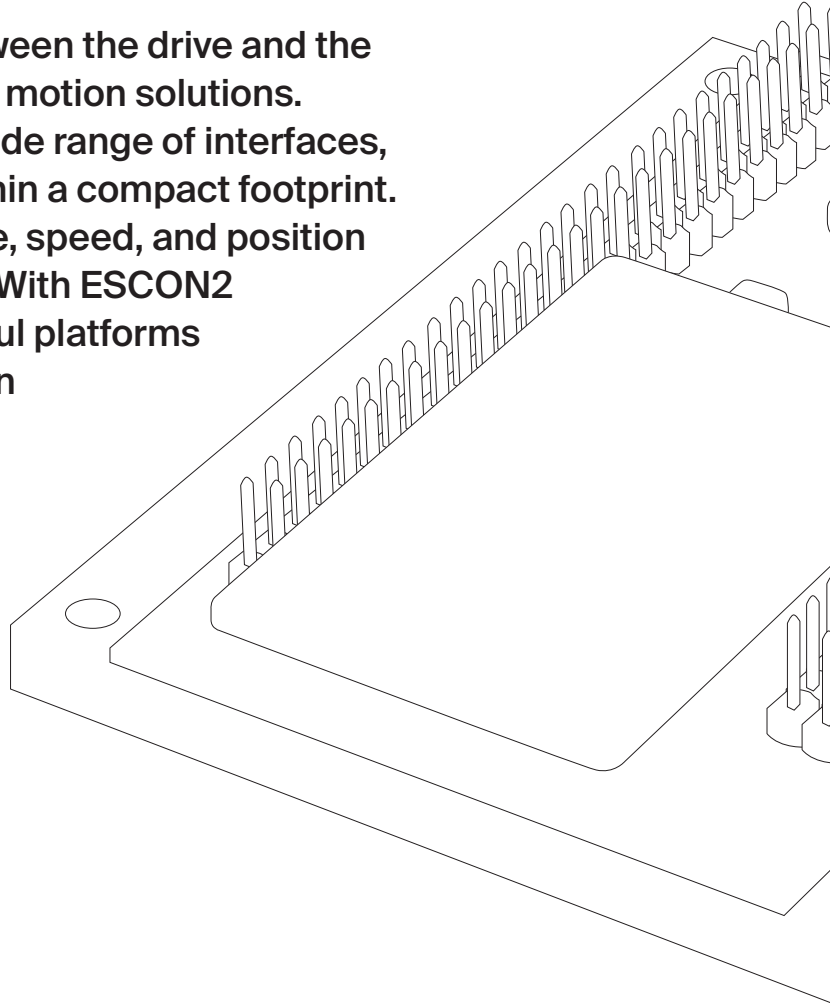
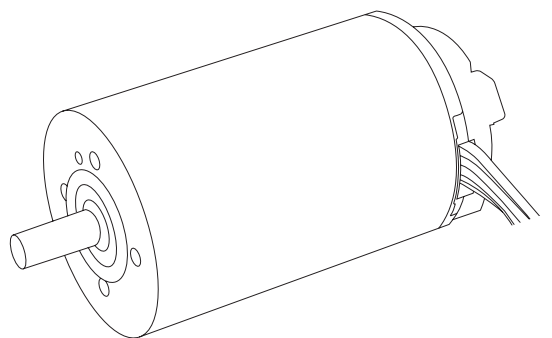
Servo controllers are the key link between the drive and the application control system in modern motion solutions. They combine power electronics, a wide range of interfaces, and intelligent control algorithms within a compact footprint. This enables optimal control of torque, speed, and position across a wide variety of applications. With ESCON2 and EPOS4, maxon offers two powerful platforms that cover the full spectrum of modern motion control applications.

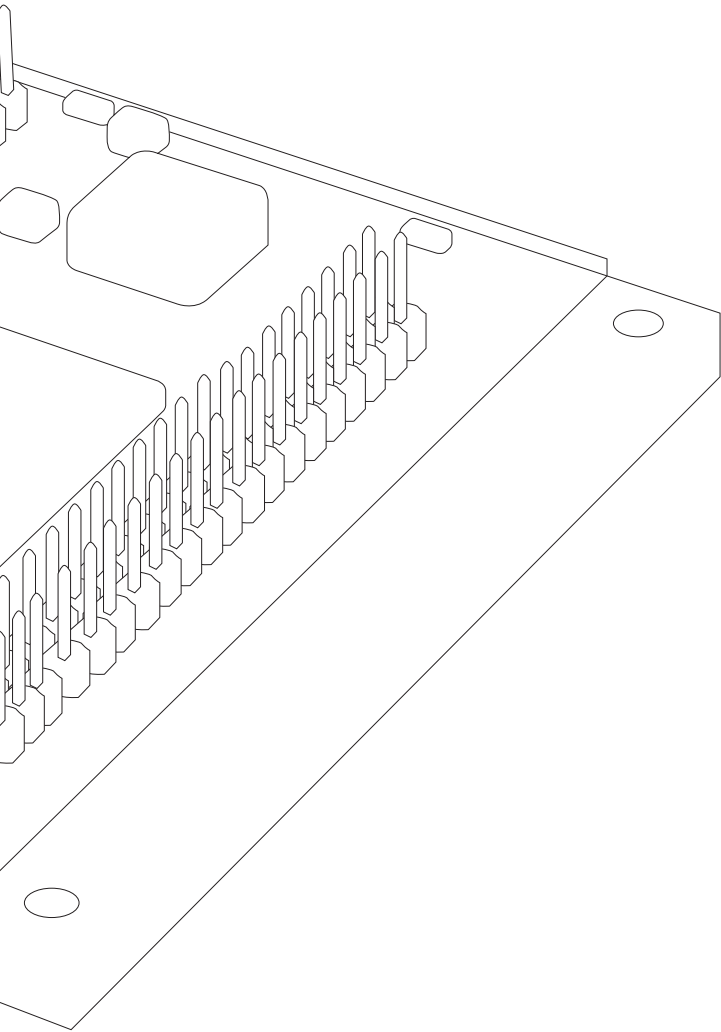
■ Servo controllers and Motion Studio engineering software

+ Sensors

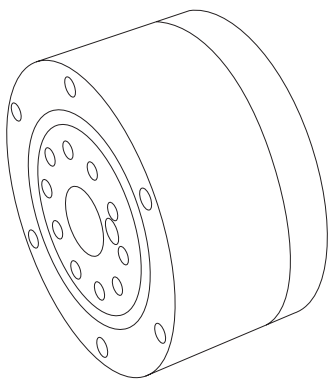


+ Motor





+ Gearhead



Drive systems, for example for:

Industrial robotics

Humanoid robotics

Mobile robotics

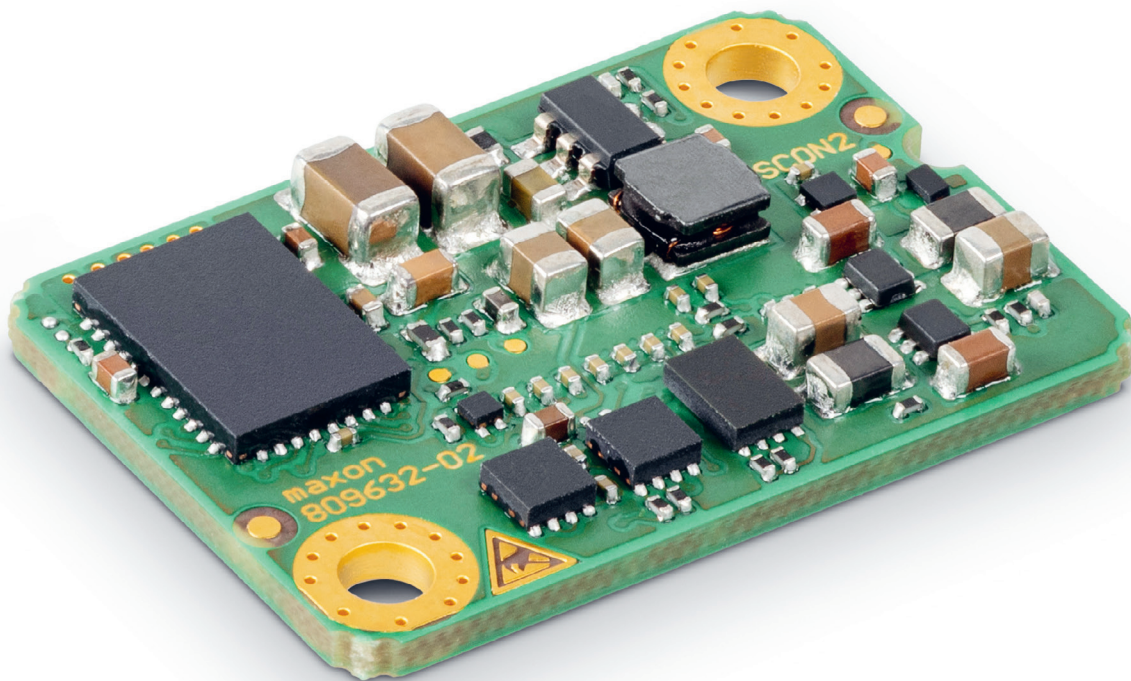
Medical technology

**Semiconductor
manufacturing**

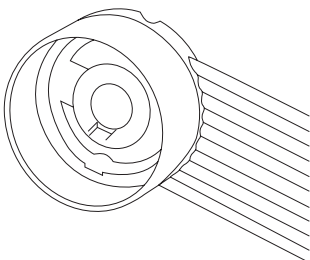
Power tools

The ESCON2 servo controllers in the Value Line are designed for a broad range of applications and flexible system integration. Field-oriented control (FOC) is possible using only the motor's Hall sensors; commands can be issued via CANopen as well as digital and analog I/Os. The ESCON2 platform thus provides an easy entry point into modern motion control – now also for positioning tasks.

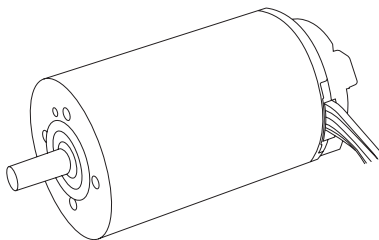
ESCON2



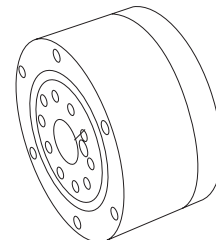
+ Sensors



+ Motor



+ Gearhead



Drive systems, for example for:

Packaging



In compact handheld tools for the packaging industry, every minute of battery life counts. The ESCON2 platform allows application logic and motor control to be integrated within a compact footprint. Field-oriented control (FOC) helps to use the available energy efficiently.

Mobile robotics



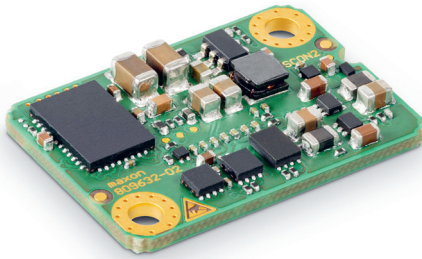
In mobile robots, drive and steering axes are controlled individually or in combination. ESCON2 can, for example, control individual drives and be integrated compactly and easily into the higher-level control system via CANopen.

Drones



For drones, weight and available installation space are key considerations. Thanks to their high power density and speed control up to 120,000 rpm, compact ESCON2 modules are particularly well suited to such applications.

Three examples. Many possibilities.

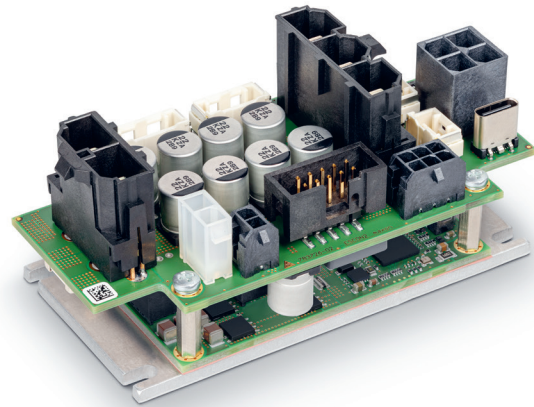


ESCON2 Nano 24/2

The OEM module can be integrated directly into customer-specific electronics and requires very little installation space.

Technical Highlights

- 24 V / 2 A
- OEM module
- For space-constrained integration

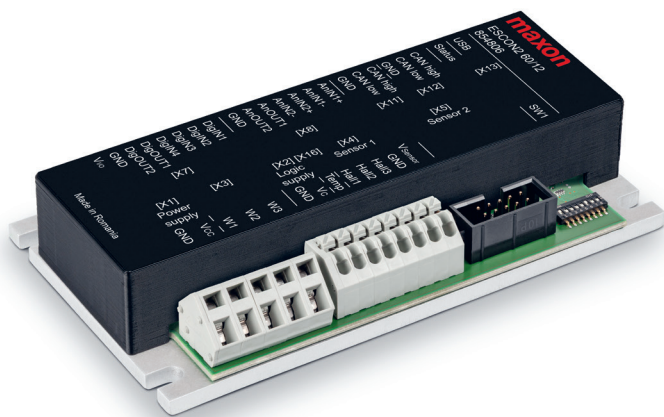


ESCON2 Compact 60/30

The ready-to-connect servo controller is designed for 60 V and 30 A, making it suitable for drive applications with higher power requirements.

Technical Highlights

- 60 V / 30 A
- Ready-to-connect design
- For drives with higher current requirements



ESCON2 60/12

The enclosed servo controller is designed for 60 V and 12 A and intended for integration into industrial machinery and systems.

Technical Highlights

- 60 V / 12 A
- Enclosed design
- Ready-to-connect integration

New: Positioning with ESCON2

ESCON2 is being expanded to include positioning functions. In addition to current/torque and speed control, ESCON2 will also support positioning tasks in the future.

For information on availability and supported variants, please contact us.

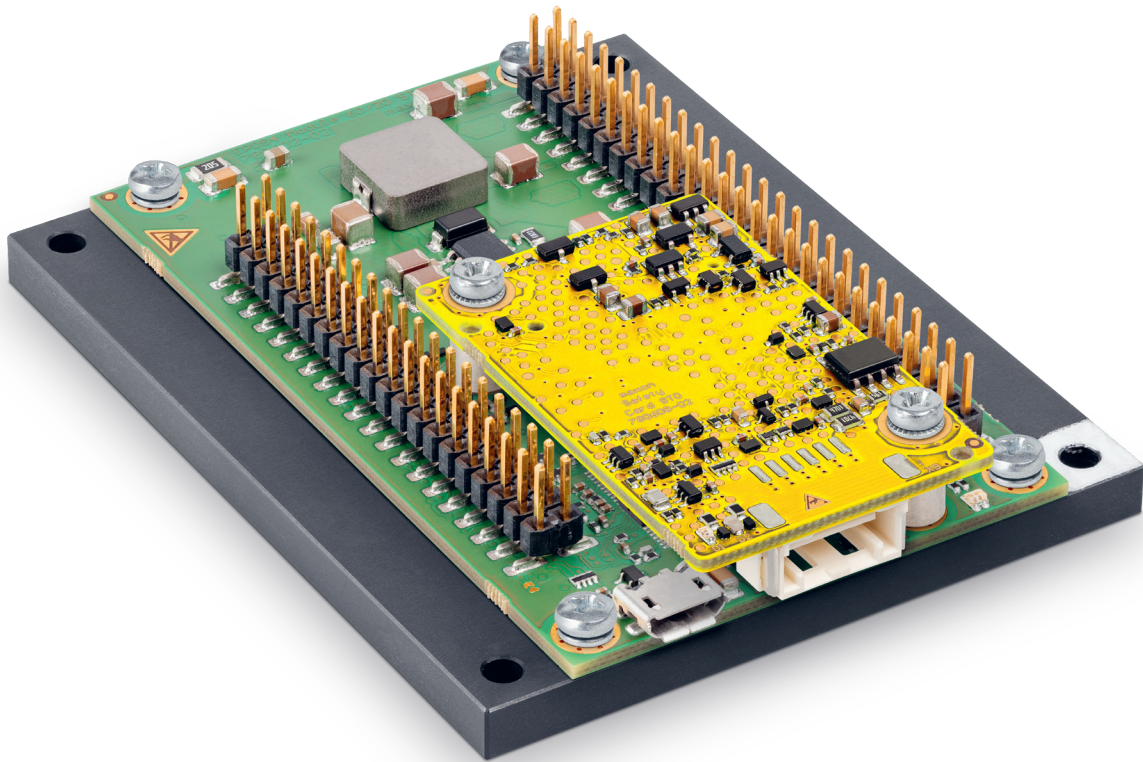
The complete ESCON2 portfolio: find all products, variants, and technical data online.



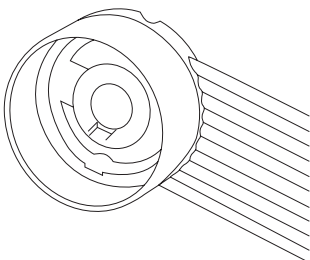
Discover all ESCON2 products.

The EPOS4 servo controllers in the Performance Line are designed for demanding positioning and motion tasks. A variety of control, feedback, and communication options allows them to be integrated into different drive and automation architectures – whether the application calls for dual-loop control or Functional Safety.

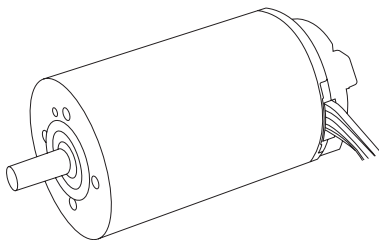
EPOS4



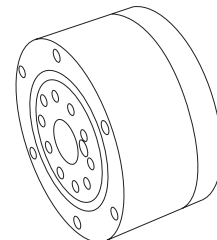
+ Sensors



+ Motor



+ Gearhead



Drive systems, for example for:

Industrial robotics



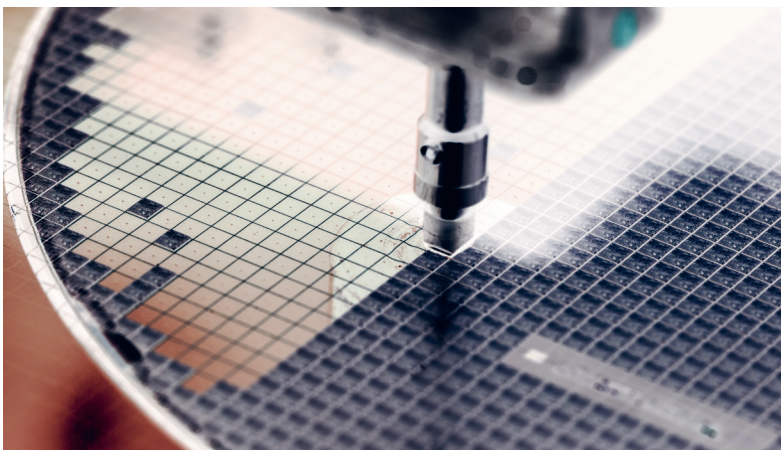
Robot axes continuously execute changing motion profiles. EPOS4 dynamically controls the individual drives, implementing the setpoints received from the robot or machine controller via EtherCAT or CANopen.

Humanoid robotics



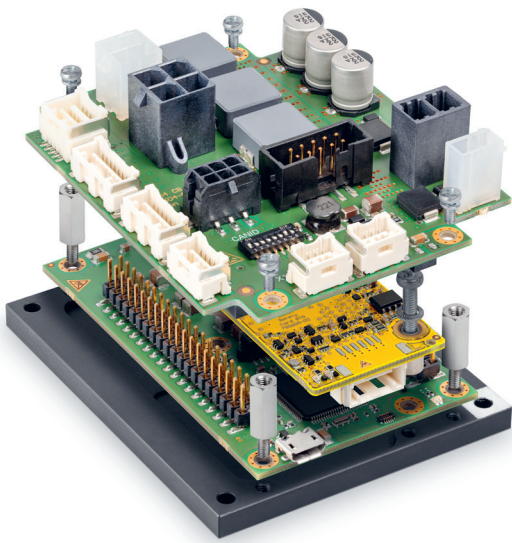
Humanoid robots combine numerous joint axes. A higher-level motion controller coordinates their trajectories, while EPOS4 controls the individual drives close to the motors and sensors – regardless of the chosen control structure or whether Functional Safety is required.

Semiconductor manufacturing



In semiconductor manufacturing, positioning axes must execute movements precisely and repeatably. EPOS4 supports a wide range of sensor interfaces and various control algorithms for this purpose.

Three examples. Many possibilities.

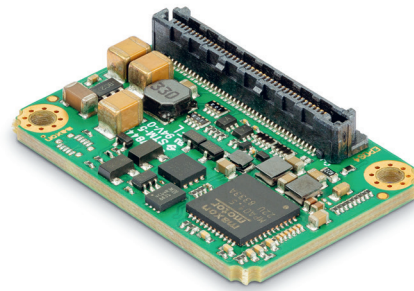


EPOS4 Compact 60/20 CAN STO

The ready-to-connect servo controller features an integrated STO function, making it suitable for machinery and automation solutions with corresponding functional safety requirements.

Technical Highlights

- 60 V / 20 A
- Integrated STO function
- CANopen interface

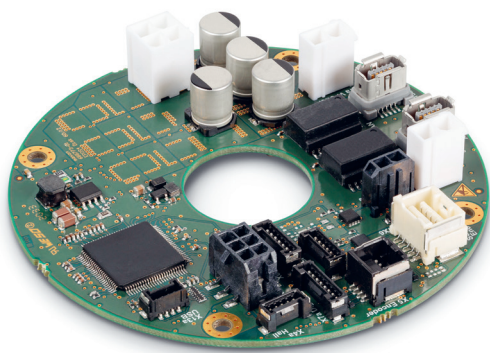


EPOS4 Micro 24/1.5 CAN

The compact form factor allows EPOS4 control to be integrated where installation space is limited.

Technical Highlights

- 24 V / 1.5 A
- OEM module
- CANopen interface



EPOS4 Disk 60/12 EtherCAT SSC

The disk-shaped design allows the control electronics to be integrated close to the motor.

Technical Highlights

- 60 V / 12 A
- EtherCAT interface
- Near-drive integration

The complete EPOS4 portfolio: find all products, variants, and technical data online.

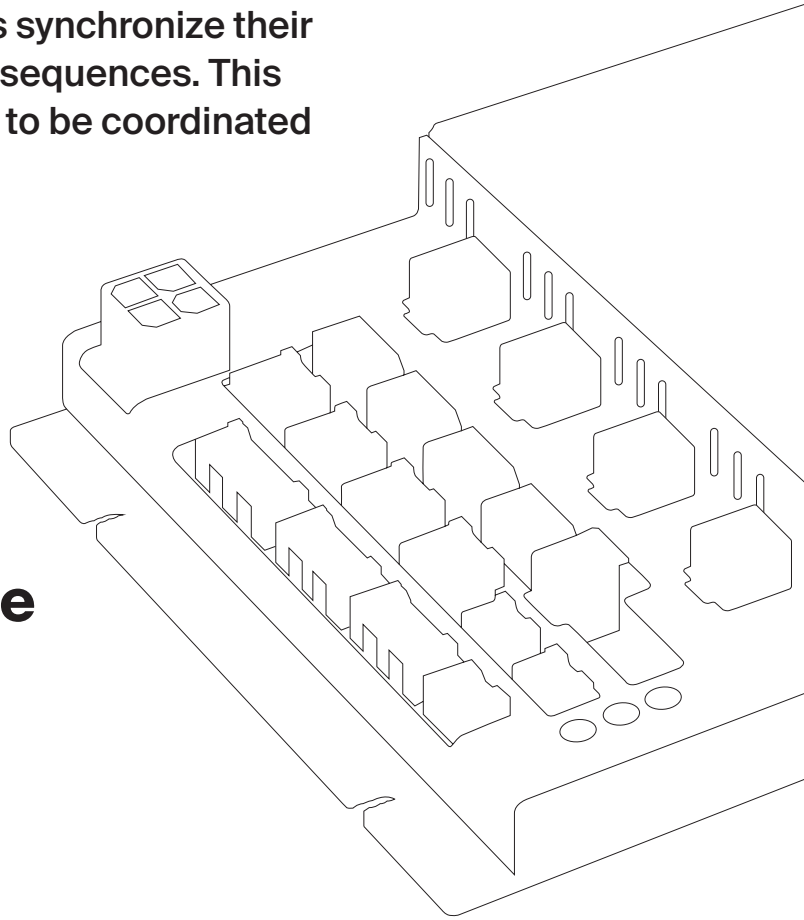


Discover all EPOS4 products.

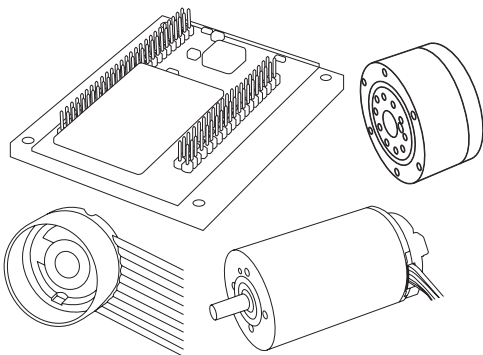
Motion controllers

Motion controllers provide higher-level coordination of multiple drive axes. While servo controllers regulate the individual drives, motion controllers synchronize their movements and execute programmed sequences. This allows the movements of multiple axes to be coordinated in terms of timing and function.

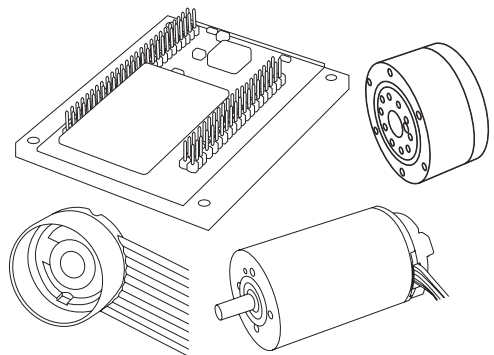
■ Motion controller and Motion Studio engineering software



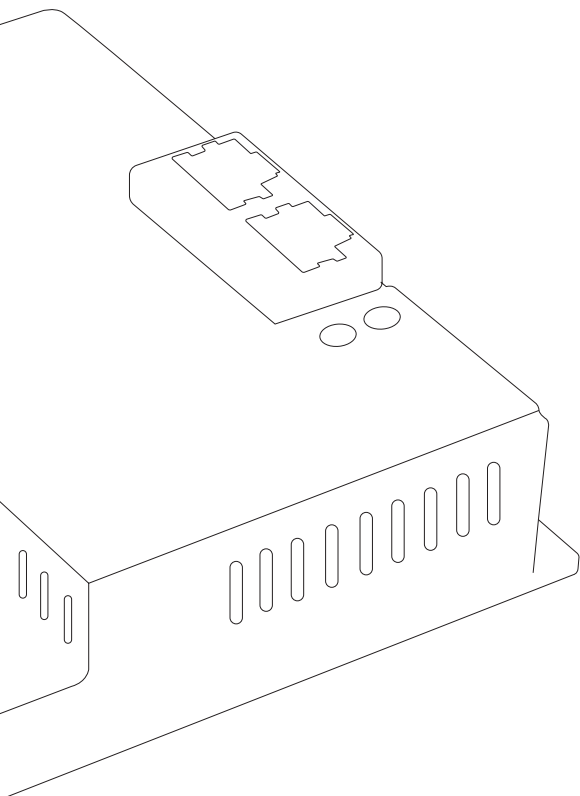
+ Axis 1*



+ Axis 2



*Axis = drive system consisting of servo controller + sensors + motor + gearhead



**Coordinated movements,
for example for:**

Gantry systems

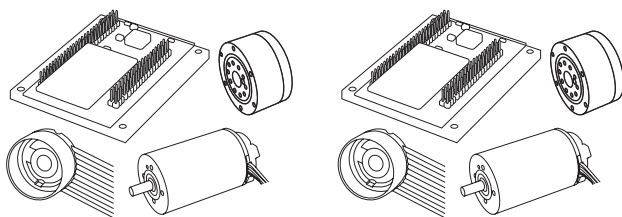
Pick-and-place

Machine tools

**Printing and
processing machines**

Robotics

+ Additional axes

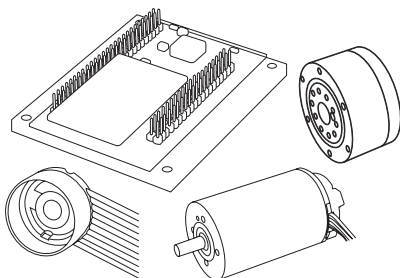


The MACS motion controllers in the Performance Line are freely programmable and coordinate multiple axes, including kinematic groups. Depending on the version, the platform ranges from compact six-axis solutions to the MasterMACS with up to 32 axes.

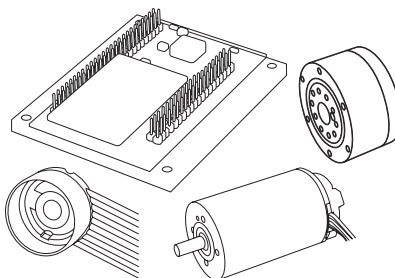
MACS



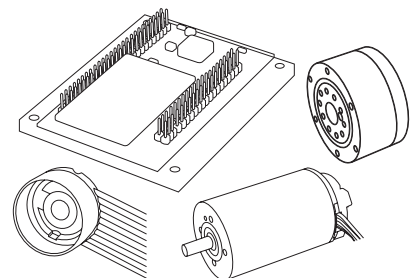
+ Axis 1*



+ Axis 2



+ Additional axes



* Axis = drive system consisting of servo controller + sensors + motor + gearhead

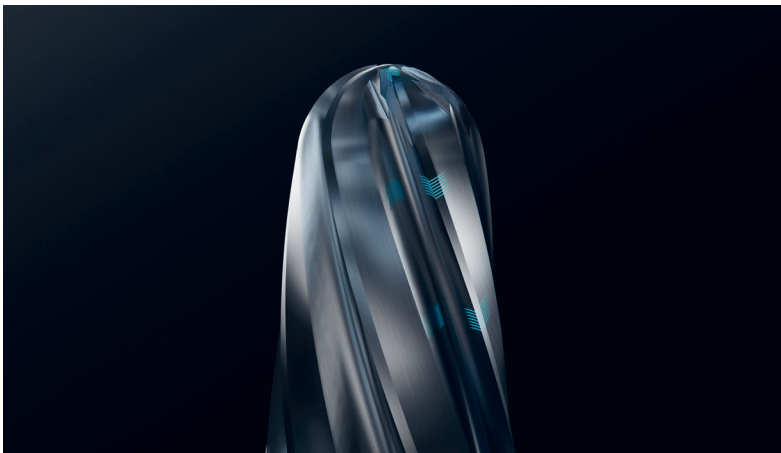
Drive systems, for example for:

Pick-and-place



Pick-and-place systems require synchronized movement across multiple axes. MACS combines them into a kinematic group and controls the required motion sequences.

Metrology



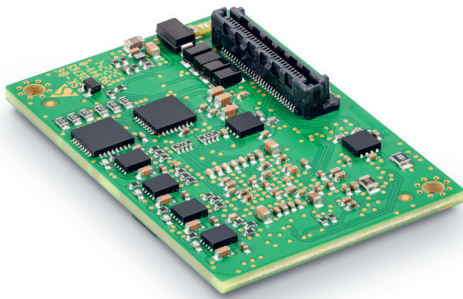
Measurement systems may require several moving axes whose positions must be aligned throughout a measurement sequence. MACS synchronizes these axes within the process.

Door automation



In automatic door systems, multiple drives work together within a shared motion sequence. MACS controls how these axes interact.

Three examples. Many possibilities.

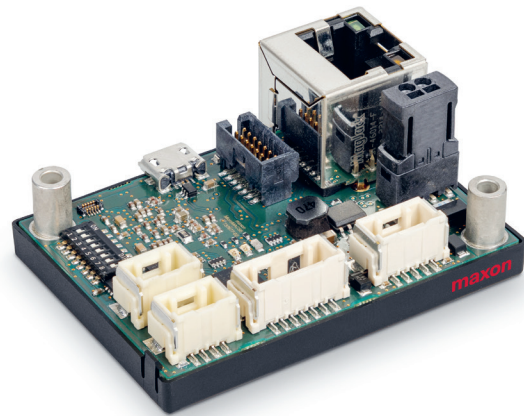


MicroMACS6 Module

The programmable module can be integrated directly into customer-specific motherboards. Combined with ESCON2 or EPOS4 modules, it enables compact multi-axis solutions.

Technical Highlights

- Control of up to 6 axes
- Freely programmable OEM module
- Can be combined with ESCON2 and EPOS4 modules



MicroMACS6

The freely programmable motion controller can control up to six external power stages via Ethernet and two independent CANopen interfaces. Four PWM outputs are also available for controlling servo controllers.

Technical Highlights

- Up to 6 axes
- Ethernet and 2× CANopen
- 4× PWM outputs



MiniMACS6 AMP-4/50/4-IF1

The motion controller features four integrated power stages, each providing 211 W of continuous power and 370 W of peak power. The current measurement circuitry is optimized for controlling smaller motors.

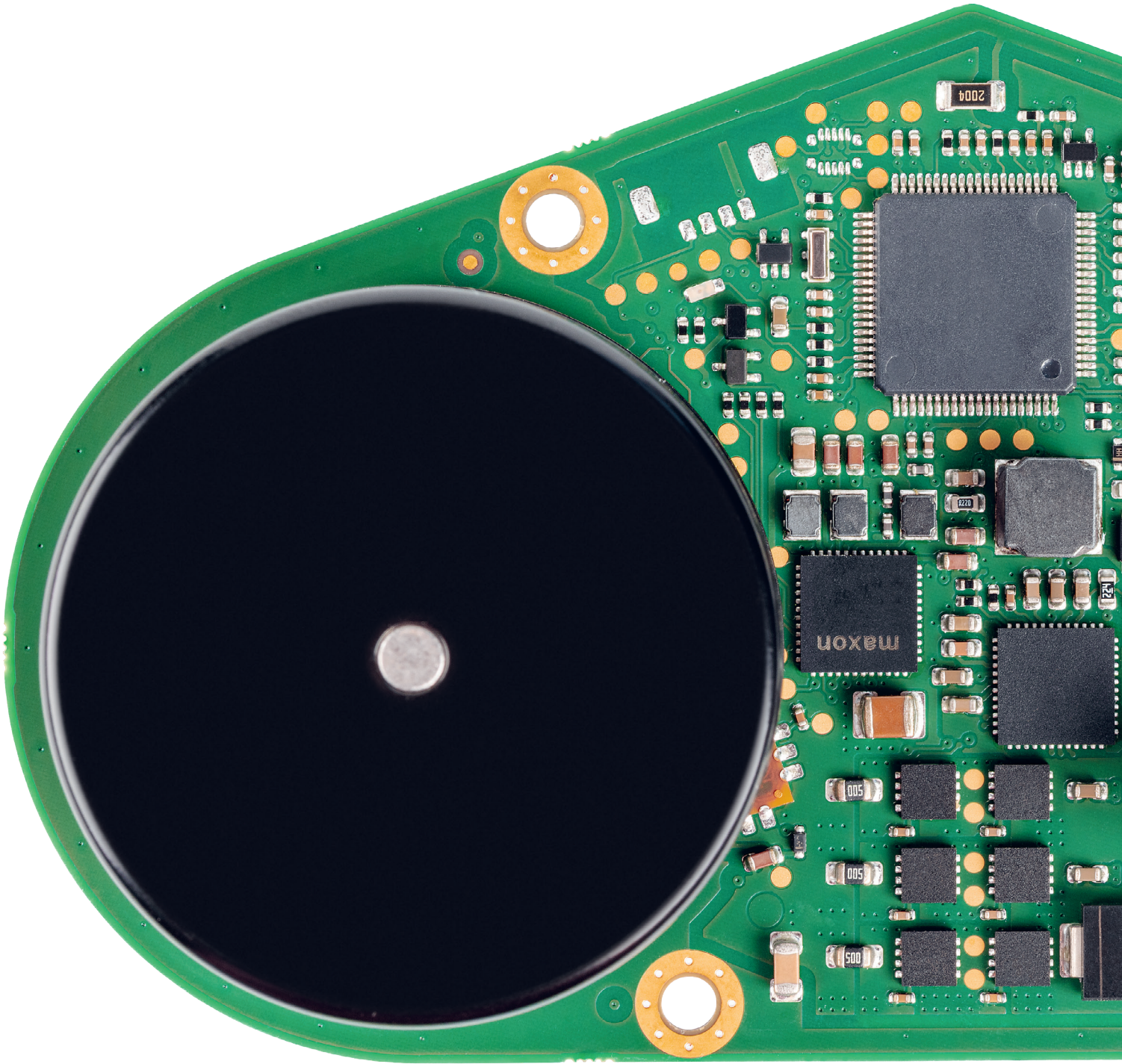
Technical Highlights

- 4 integrated power stages
- 211 W continuous / 370 W peak power per power stage
- Current measurement optimized for smaller motors

The complete MACS portfolio: find all products, variants, and technical data online.



Discover all MACS products.

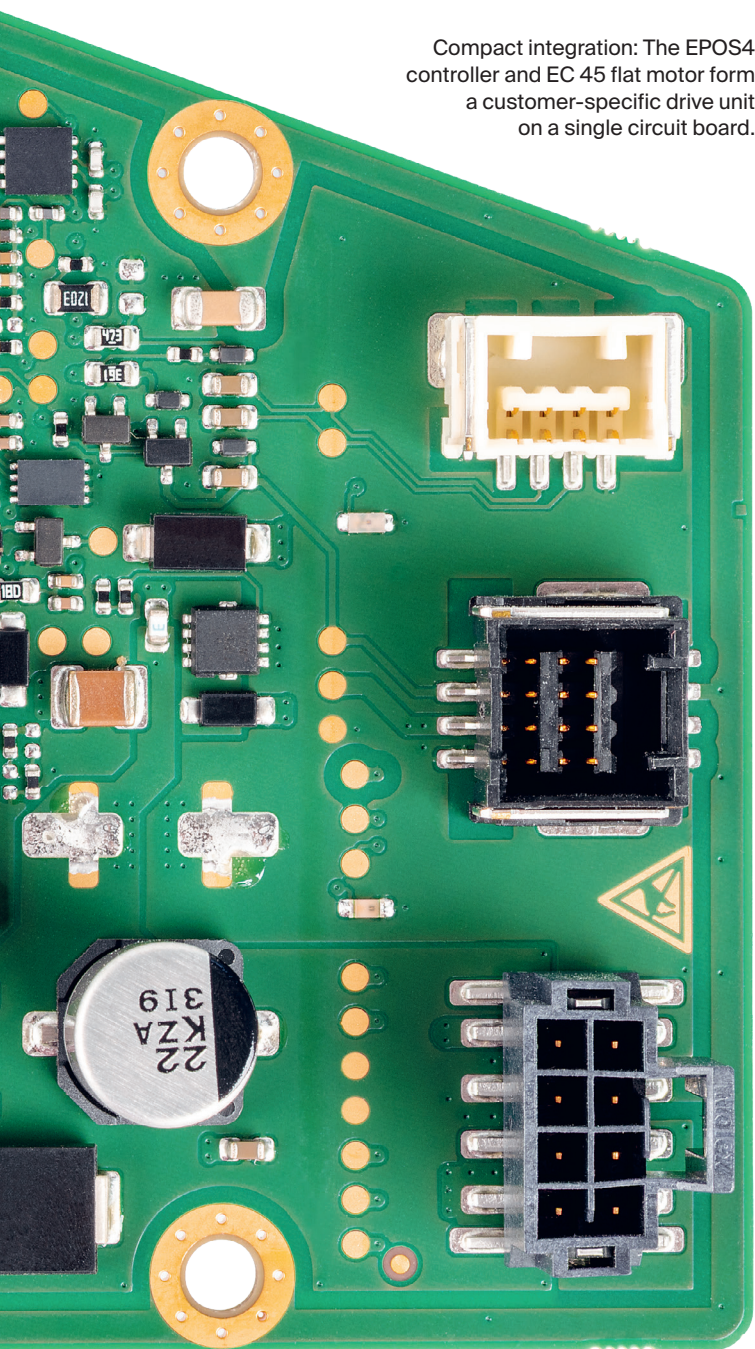


When standard isn't enough

An off-the-shelf product is not always sufficient. Requirements change, new ideas emerge, and products evolve. This is where existing platforms prove their flexibility: they can be adapted and developed into a customer-specific solution.

As told to **Urs-Ueli Schorno**

Compact integration: The EPOS4 controller and EC 45 flat motor form a customer-specific drive unit on a single circuit board.



A typical day at maxon – and an example of how customer-specific solutions are created: a customer selects a new motion control architecture for the project. This changes the requirements for the drive solution. “The drive intelligence was originally located centrally in one place,” explains Roman Berger, Business Development Manager at maxon. “Later, the customer wanted to move motion control directly into the individual units.” The new architecture offered advantages in service and maintenance while placing new demands on the integration of the drive electronics.

The higher-level unit now primarily handles communication via CAN, while motion control itself is performed locally on each individual axis.

The new architecture also changed the requirements for the technical implementation. Components, interfaces, and form factors had to be re-aligned. However, there was no suitable off-the-shelf solution combining a compact design, integrated motion control and CAN-based communication.

Two platforms become one solution

There was no need to develop a solution entirely from scratch. Instead, proven platforms from the maxon portfolio could be combined in a targeted way. This reduced development time and built on processes that had already been validated.

The customer-specific solution was based on an EC 45 flat motor and an EPOS4 positioning controller. Both are already available as standalone products in the maxon portfolio. The customer-specific adaptation consisted of integrating them on a single hardware platform.

To achieve this, maxon’s EPOS4 controller was integrated directly into the motor’s electronics platform. At the same time, the form factor was adapted to the available installation space – or, as Roman Berger puts it, the solution was “designed into the available space.”

The aim was not maximum miniaturization for its own sake. What mattered was bringing the electronics and motor together in a well-engineered package. “One PCB costs less than two,” says Roman Berger. At the same time, integration reduces the effort required for cabling and interfaces.

Depending on the application, a decentralized approach can offer advantages in terms of integration, modularity, or cabling. Other applications continue to rely deliberately on centralized control architectures. In this project, the decisive factor was therefore not choosing the “right” approach, but the ability to implement a demanding customer-specific solution quickly and in a technically sound way.

More than a one-off project

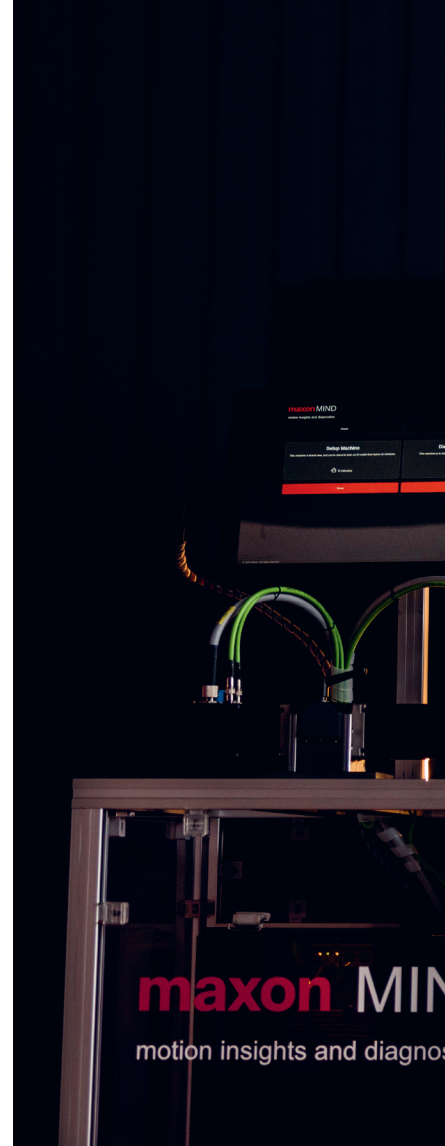
The result is a versatile unit suitable for applications such as compact conveyor modules, diverter drives, and small autonomous logistics vehicles. The solution is already being evaluated for further applications.

Each new application will, of course, require further adaptations – such as different form factors, motor sizes, or interfaces. This is precisely the strength of the platform approach: existing technologies can be adapted quickly to new requirements and provide the basis for further customer-specific developments.

The motor as a sensor

The motor as a source for monitoring the condition of a machine: that is the goal of maxon MIND (Motion Insights and Diagnostics). The foundation is machine learning, physical expertise, and an open architecture.

Text **Claude Jaquemet** Photo **Jeremias Wieland**



In industrial drive technology, the motor has long been more than just an actuator. It provides valuable information about the condition of the entire system – provided you know how to interpret the data correctly. This is exactly where maxon MIND comes in. The system uses motor signals to draw conclusions about the condition of the drive system and its environment. This turns the motor into a sensor in the machine.

maxon MIND analyzes data read from the controller during machine operation and detects patterns that indicate wear or malfunctions. It is not just about monitoring the motor itself, but the entire drive system and the associated mechanical components. This allows deviations to be detected early.

The solution is particularly suitable for applications where potential failures must be detected early – for example, to increase personnel safety or minimize downtime. It also identifies problems

that remain hidden in conventional tests. In production lines with multiple machines in sequence, maxon MIND detects even the smallest deviations before they affect downstream processes. The system also adds value in service operations when the actual condition of the equipment is critical for maintenance planning.

Explainable, optimized AI

Technologically, maxon MIND is based on explainable artificial intelligence. This makes diagnoses and predictions traceable – a key requirement for safety-critical and highly regulated applications. The machine learning model developed by maxon requires only small amounts of data and can run on simple hardware. This enables minimally invasive integration and reduces the effort required for model training. As no computing infrastructure with graphics processing units (GPUs) is required, it can also offer significant cost advantages.

Existing applications can also be retrofitted.

Data processing follows a clearly structured workflow. During machine operation, raw data is collected, preprocessed, and fed into the machine learning model. The model analyzes deviations from a healthy operating state. The results are made available to customers via an Application Programming Interface (API). Glassbox instead of black box: every processing step remains traceable.

High prediction quality

A key feature of maxon MIND is the integration of domain-specific expertise into the model. The physical relationships within a mechatronic system flow directly into the modeling process. This achieves high prediction quality with minimal data requirements.

The system also learns from real-world applications. During commissioning, an initial state is recorded that de-



About the author

Claude Jaquemet is Business Development Manager Digital Business at maxon Group. His work focuses on digital solutions that use drive data to generate insights into the condition of machines and systems.

scribes the motor in the context of its environment. During operation, new data is regularly fed in and compared with the model – hourly, daily or as needed.

Data quality plays a central role. To achieve valid results, the recorded signals must sufficiently represent the machine's operating state. That is why maxon works closely with customers to define suitable measurement cycles. These may include standardized motion sequences that reflect typical load situations. This creates a robust model tailored to the specific application.

An open platform

By default, data processing takes place in the cloud. Customers can view and download their data. No personal data is required. All data can be anonymized by the customer, apart from the drive's item and serial numbers.

The platform has an open design and can be integrated into existing system

environments via an API. Motors, electronic components, and controllers remain unchanged. The only requirement is the installation of a software package on the master controller that transmits the data using the standardized MQTT communication protocol. If the machine is already connected to the internet and the controller can acquire data, the system can be operational within a few days.

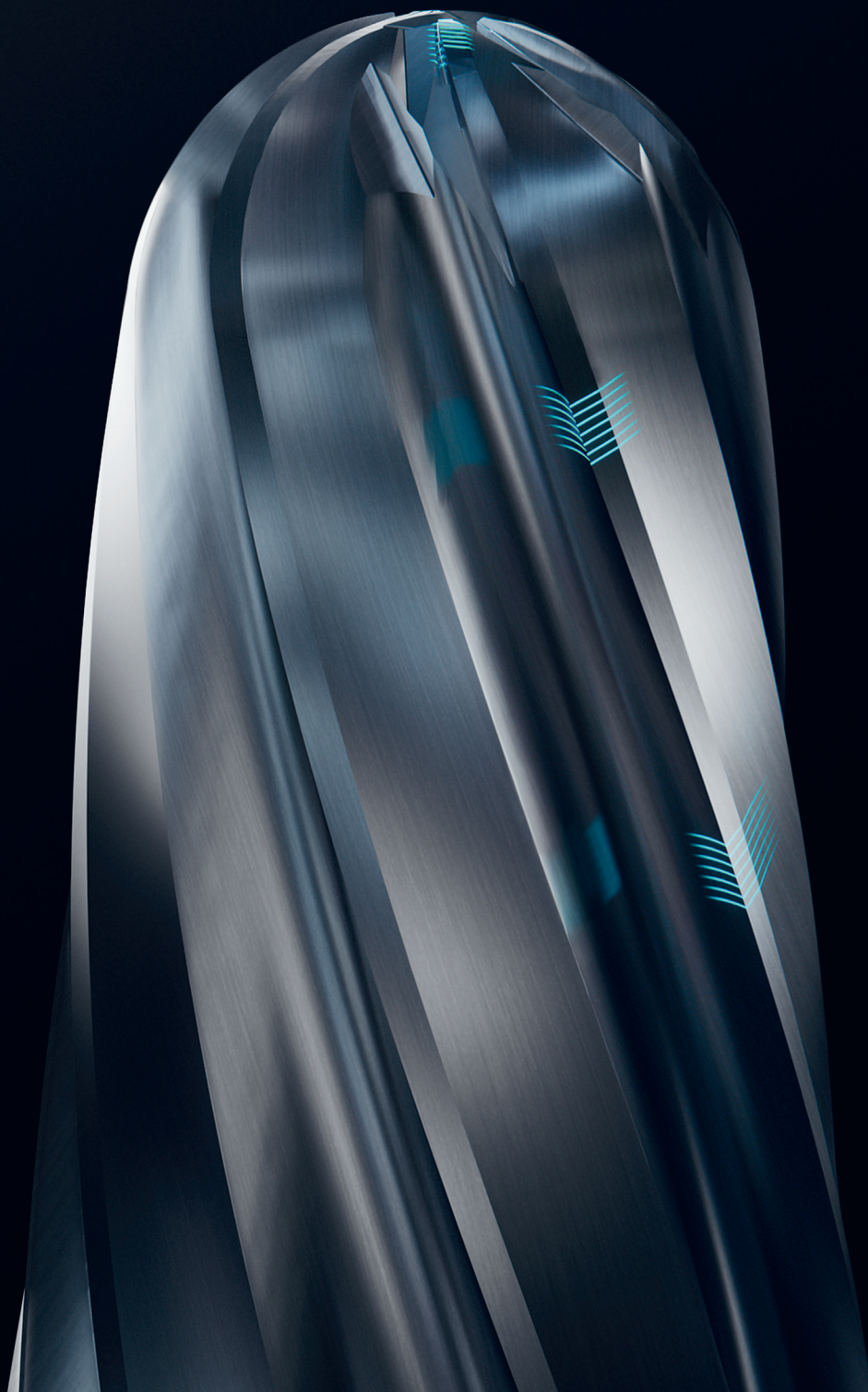
maxon MIND is positioned as a specialized solution for demanding applications. It focuses on an in-depth analysis of the physical properties of the drive system. The combination of technical focus, industrial robustness, and an open architecture delivers not just data, but tangible insights.

This turns the motor into not only a drive, but also a central element of condition monitoring – and the key to greater efficiency, safety, and availability in connected production environments.

Tool measurement with micrometer precision

Whether a tool will machine accurately is often determined at the measurement stage. This requires axes, optics, and image processing to work together perfectly – with motion control providing the foundation.

Text **Annalisa Isler**



Laser markings
serve as reference
points for precise
tool measurement.

At the limits of human vision, high-accuracy metrology takes over: the measuring head positions itself with a precision well below 1 µm, reliably captures tool geometries, and transfers exact correction values to the CNC machine. The result is reproducible manufacturing quality at the micrometer level.

For 80 years, E. ZOLLER GmbH & Co. KG has been synonymous with measurable precision. Today, the company manages a global network from the German town of Pleidelsheim, with its own subsidiaries and representatives at 85 locations in 62 countries. ZOLLER measures tools for CNC machining at the micrometer scale. The long-standing collaboration between ZOLLER and maxon shows how this interaction works.

“For us, precision at the micrometer level is what counts,” says Manuel Walter, Head of Purchasing at ZOLLER. This standard shapes the entire measurement architecture – from the mechanical design to motion control. The company began as a workshop and is now an established name in the world of tool measurement. Industries including automotive, aerospace, medical technology, and mechanical engineering rely on the company’s measuring machines.

What often remains unseen is that optics, image processing, and motion must work together perfectly to turn individual pieces of image information into usable data. This is where the real technical challenge begins.

In systems like these, motion control does far more than simply control a motor. It ensures that movements take place at the right moment, with the right dynamics, and in exactly the right position. Only the carefully coordinated interaction of closed-loop control, synchronization, and application logic turns motion into a precise measurement result.

Precise axis positioning

The systems use multi-axis controllers from maxon’s MACS platform. They coordinate the control of multiple axes, capture position data in real time, and provide the basis for synchronizing motion with image acquisition. Over the years, the controllers have been continuously developed together with ZOLLER. They have also been specifically tailored to the requirements of the measurement application.

ZOLLER’s measuring and inspection equipment relies on a highly precise interaction between optics, image processing, and finely controlled motion. At the heart of this process are powerful multi-axis motion controllers, which provide the timing for the entire measurement architecture. They control the axes, synchronize image acquisition, and ensure that tool contours are captured at the micrometer level with maximum repeatability.

For Georges Pappas, Head of Electrical Design at ZOLLER, this interaction is crucial: “Our systems

must be able to move quickly while also positioning with high precision and holding positions with absolute stability.”

The measuring devices move the tool, camera, and optical system along multiple axes. These axes must be positioned with micrometer accuracy, and their positions must be monitored continuously. The challenge is that positioning the measuring head along the X, Y and Z axes requires an accuracy of better than 1 µm.

“We rely on accuracy down to the last micron.”

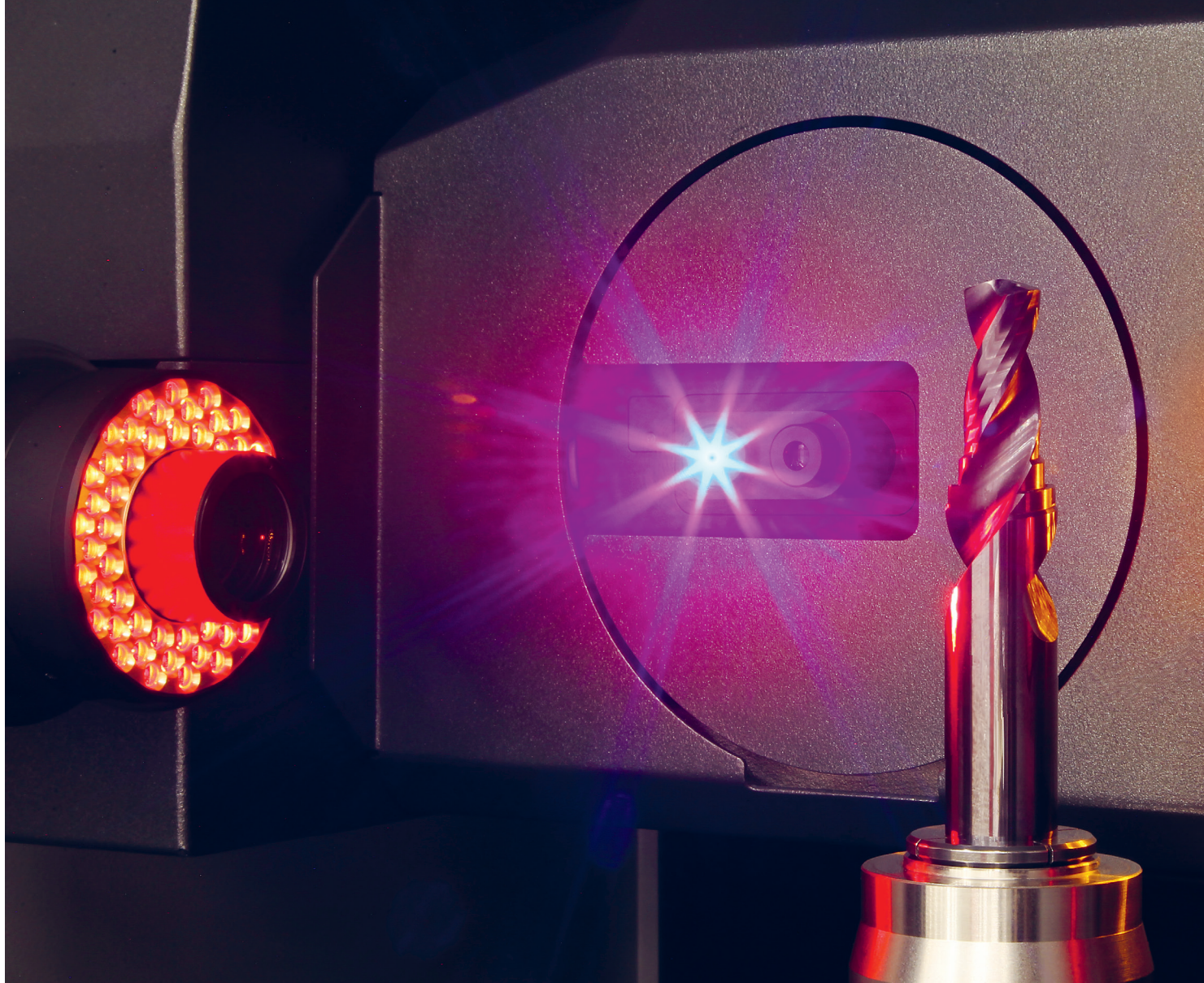
Manuel Walter, Head of Purchasing
E. ZOLLER GmbH & Co. KG

The maxon multi-axis controller precisely positions the axes and moves them to defined measuring points, coordinates dynamic acceleration and deceleration for different measurement methods, and stabilizes the holding positions during image acquisition. This combination of functions is essential because even minimal vibrations or positioning errors would distort the measurement result.

Georges Pappas sums up the requirement: “During image acquisition, the position must remain absolutely stable. Even the smallest movement or control deviation would distort the measurement result.” Particularly during the holding phase, this stability determines whether measurements remain highly accurate and repeatable.

Synchronizing image acquisition and motion

Another key technical element is interrupt-driven position latching. Each of the approximately 30 camera images per second triggers an interrupt in the controller. At the same time, the exact position



Precision in every detail: ZOLLER develops measuring and inspection systems for demanding manufacturing processes.

of the axes is latched – in other words, captured and linked to the corresponding image.

Only by combining the pixel data with the precise mechanical position can a usable measurement value be obtained. The motion controller therefore acts as the link between image processing and mechanics. Without this synchronization, measurements at the micrometer level would not be possible.

Georges Pappas explains how this principle works in practice: “Every time the camera captures an image, a trigger signal is sent to the motion controller.” Because the camera operates continuously, the corresponding position values must be captured and buffered in real time so that the image and motion data can be correctly matched in the next step.

Fabian Vogel, Managing Director of the Multi-Axis Controllers Competence Center at maxon, also sees this as the core of the application: “For us, it is essential to understand the application in detail – how the customer uses the measuring devices and what requirements arise during actual

operation. Only then can we tailor the control behavior and synchronization precisely to this specific application.” Capturing and temporarily storing the current axis position at exactly the right moment is crucial for reliable measurement results.

Control behavior and dynamics for different measurement methods

ZOLLER uses various measurement methods, including the measurement of contours, cutting edges and runout, as well as the determination of heights and angles. The multi-axis controllers must switch between rapid movements and highly stable stand-still phases. This combination of dynamics and stability places extreme demands on control tuning, drive performance, and real-time behavior.

It is precisely this range – from rapid movement to an absolutely stable holding position – that makes the application so demanding. The challenge is not simply to set an axis in motion, but to ensure that it responds exactly as required by each measurement method.



Integrated kinematics allow complex 3D measurement programs to be executed precisely. The position values of the individual axes are synchronized with image acquisition via latching inputs. MACS controllers can generate trigger signals or respond to them, allowing image data to be captured during every movement. This produces high-resolution three-dimensional images during scanning and inspection processes.

To achieve maximum performance, the captured position values are buffered first. The measurement software then reads them continuously and assigns them to the corresponding camera images. By separating acquisition from processing in this way, the system remains stable even at high speeds.

The combination of dual encoder evaluation, real-time control, and synchronized image data acquisition makes maxon's MACS controller an ideal solution for high-precision measurement and inspection applications. Applications that demand maximum accuracy and performance, even with complex motion sequences, require a solution that integrates seamlessly into sophisticated systems.

Working together for precise results

The high standard of quality is evident not only in the technology, but also in the collaboration. "Quality is non-negotiable for us," emphasizes Manuel Walter, Head of Purchasing at E. ZOLLER GmbH & Co. KG.

The application's technical capabilities are the result of many years of collaboration. ZOLLER and maxon have worked closely together on development for around 15 years – not only integrating components, but also building a shared understanding of the application.

"I have never experienced being unable to reach a development engineer at maxon or having a problem remain unresolved," says Georges Pappas, Head of Electronics at ZOLLER. Particularly when requirements are complex, it is essential to analyze issues together and implement solutions efficiently.

At maxon, understanding the application is equally important: "For us, it is essential to understand exactly how the customer uses the application. Only then can we make the system behave exactly as the application requires," explains Fabian Vogel, Managing Director of the Multi-Axis Controllers Competence Center at maxon.

Reliability in day-to-day project work is just as important: "The best suppliers are those that work reliably, honor their commitments, and make processes noticeably easier," says Georges Pappas.

Over the years, this creates more than a technical solution: it creates a shared understanding of the system – the foundation for stable, precise applications that can continue to evolve.



Discussing technical details: ZOLLER experts Georges Pappas (left), Head of Electrical Design, and Manuel Walter, Head of Purchasing.

A proven tool, reimagined

With the BXT4, Signode continues to advance its hand strapping tools.
A new mechanical concept and the interplay between
mechanics and motion control make the new generation more
ergonomic, more powerful, and easier to use.

Text **Urs-Ueli Schorno** Photos **Sven Gallinelli**

Andreas Keller managed the BXT4 project from the outset. Today, he is Head of Development at Signode Switzerland.





A compact overall system: Signode's BXT4 hand strapping tool.

Signode

Signode is one of the world's leading providers of packaging and transit protection solutions. At its Swiss site in Dietikon, the company develops and assembles hand strapping tools for industrial applications. It also operates a mechanical manufacturing facility in Merenschwand.

Locations: Dietikon and Merenschwand, Switzerland

Employees: Around 200, including 16 in Research & Development

Focus: Development and production of battery-powered hand strapping tools for plastic and steel strapping

Hand strapping tools tension and seal plastic straps to secure packages for transport and storage. They are among the tools used thousands of times every day in industry and logistics – yet they rarely attract any attention. Insert the strap, pull the trigger and, a few seconds later, the strapping is secure. That is exactly how it should be.

Signode is one of the world's leading manufacturers of these tools. At its Swiss sites in Dietikon and Merenschwand, the company has been developing and producing hand strapping tools for industrial applications for decades. Around 200 people work at the two sites, 16 of them in Research & Development. The collaboration with maxon also has a long tradition: maxon drive solutions have been used since the first generations of tools. With the BXT4, the partnership now extends to the latest motion control technology.

The focus was not on reinventing a successful product. Instead, the aim was to consistently develop a proven hand tool

further. “Our goal was to make the tool more ergonomic and even easier to use – without compromising performance or robustness,” says Andreas Keller, Head of Development at Signode Switzerland. Before taking on his current role, he managed the development of the BXT4 as project manager.

A new concept

One of the most important innovations concerns the mechanical concept. In previous generations of the tool, the drive, gearhead, and tensioning wheel that acts on the strap formed a fixed assembly. With the BXT4, Signode chose a new approach: part of the gearhead and the tensioning wheel move to allow the strap to be inserted. This enlarges the opening, makes it easier to insert the strap, and changes the load distribution within the mechanism.

The effects extend beyond ergonomics. The new concept changes the forces within the mechanism, allowing individual components to be made lighter and new materials to be used. At the same time, the additional weight of the new, more powerful battery generation could be offset elsewhere.

The result is a tool that remains comfortable to hold despite its greater performance and places noticeably less strain on the operator during everyday use.

Where motion control comes in

The new mechanical concept also changed the requirements placed on the drive and control system. For maxon, this marked the beginning of a new development phase in the project. Inside the BXT4, a single drive performs several tasks. It precisely positions kinematic elements, delivers high torque for tensioning and maintains a constant speed when welding the strap. For Kim Zimmermann, Key Account Manager at maxon, it is precisely this interplay that makes the project so compelling: “For us, the BXT4 is an exciting project because we can supply the complete drive system – from the motor and controller to the application control system. This allows the individual components to be optimally matched.”

While Signode is responsible for the overall mechanical concept and integration, maxon contributes its full motion control and application expertise, along with perfectly matched components.

Advancing the solution together

One example is the switch to maxon’s ESCON2. During development, Signode decided to adopt maxon’s new platform at an early stage – even before it was officially launched.

“Using the new platform certainly involved a degree of risk. We decided to go ahead nevertheless – partly because experience had shown us how effectively we could work with maxon.”

The new motion control platform opened up additional possibilities for the design of the overall system. Among other things, the ESCON2 platform enables precise field-oriented control using only the motor’s Hall sensors. The overall system therefore requires no separate encoder, without compromising dynamics, torque control, or process stability. The design is also simplified because display control is integrated into the controller electronics. This eliminates additional components, reducing space requirements and complexity while keeping the tool compact, robust, and cost-optimized

despite its expanded functionality. Decisions like these are not made in isolation. They are the result of close collaboration between the development teams at both companies.

“The collaboration is very straightforward,” says Andreas Keller. “We are geographically close, speak the same language, and can discuss technical questions directly. That makes many things easier.”

For maxon, the project is also interesting because it brings together several areas of expertise. In addition to the motor, the motion control platform also comes from maxon. Specialists from various disciplines supported the development over many years. Today, Kim Zimmermann coordinates the collaboration between Signode and the maxon sites and competence centers involved.

The next stage of evolution

The collaboration between Signode and maxon extends across several generations of tools. maxon motors were used in the hand strapping tools from an early stage. Another important step came later with the switch to brushless drives. The BXT4 now represents the next stage of evolution – shaped by the close interplay between mechanics and motion control.

For the operator, all this technology remains largely invisible. They insert the strap, pull the trigger, and the tool handles the rest reliably and precisely.

Developed together

Signode

- Overall mechanical concept
- Ergonomics and operating concept
- Tool and product development
- Integration of all components

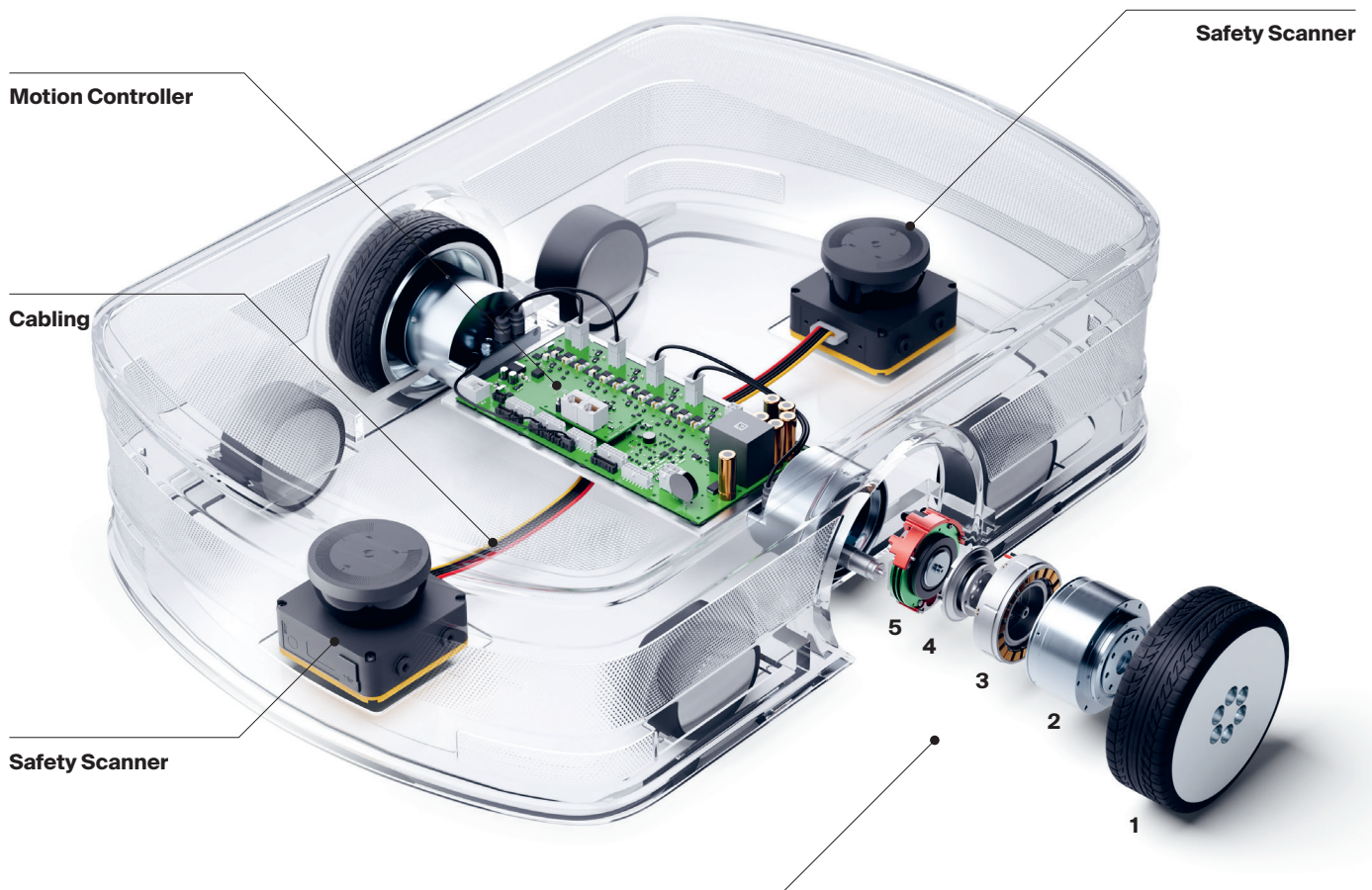
maxon

- EC-i motor
- ESCON2 servo controller
- Firmware and drive control
- Motion control expertise
- Packaging Technology Studio as a service tool

The result: an overall system in which mechanics, drive, electronics, and application were coordinated from the outset.

What happens when a transport robot travels from A to B?

A transport robot begins its mission to retrieve goods from the warehouse. This initiates a complex interplay of software, electronics, and mechanics. Let's take a look behind the scenes.



maxon Wheel Drive

- 1 Wheel
- 2 Gearhead or direct drive
- 3 Motor
- 4 Servo controller (safety)
- 5 Brake

An Automated Guided Vehicle (AGV) begins to move in a warehouse. It sets off, accelerates, avoids an obstacle, and reaches its destination shortly afterwards. To an observer, this is nothing remarkable. The vehicle simply drives. Yet that is rarely as straightforward as it appears – and that is why hardly any two of these movements are exactly alike.

Before the vehicle even begins to move, its journey has already been defined. A modern logistics center generates transport orders, prioritizes flows of goods, and calculates routes. Navigation often relies on software frameworks such as the Robot Operating System 2 (ROS 2). These specify not only where the vehicle should go, but also how it should get there. The planning process produces a motion profile containing position, velocity, and acceleration.

This planned motion is known as a trajectory. It is precise and fully calculated – and it works, at least on screen.

Turning a trajectory into motion

For the vehicle to actually move, this description must be translated into action. Motion control begins where a setpoint – for position, velocity, or current, for example – is converted into controlled, dynamically stable motion.

The motion controller receives the setpoints from the navigation system and translates them into specific control signals for the drive. A geometric description becomes a time-dependent reference signal that must match the dynamics of the entire system. This information is often transmitted via standardized interfaces such as CANopen. A path through space thus becomes target values for speed, position, or torque.

Inside the drive, a process begins that continues throughout the entire journey. The controller operates continuously, comparing the specified setpoints with the measured actual values. Encoders capture the motor's current motion, while sensors provide additional information.

Based on the deviation, the controller calculates the required motor response for the next instant. It responds not only to the current deviation, but also takes into account how the system will behave next. This process runs continuously, many thousands of times per second. Motion is not generated all at once, but adjusted continuously.

From setpoint to torque

At the end of this control chain is an electrical value. The controller specifies a current setpoint, which the power electronics apply to the motor phases. In the brushless DC motor, this creates a rotating magnetic field that interacts with the rotor. The resulting torque at the motor shaft is transferred to the wheel through a gearhead.

In the calculated model, the vehicle follows the trajectory exactly. Reality is different. A wheel briefly loses traction, the load changes or the surface varies. The measured motion then no longer fully matches the planned motion. The vehicle begins to deviate from its intended trajectory.

What matters is not the deviation itself, but how quickly and reliably the system responds. The controller detects and corrects the deviation in real time, keeping the motion stable.

Where it gets complex

Each individual step is understandable on its own. In practice, however, they are closely interconnected. Navigation, trajec-

tory planning, closed-loop control, and physical execution take place simultaneously and influence one another. What happens within the system is not a linear sequence, but an interplay.

Why there is no off-the-shelf solution

This is where it becomes clear why such systems cannot simply be transferred from one application to another. An AGV in a logistics center behaves differently from a mobile robot in a production environment. The differences result from weight, dynamics, surroundings, and precision requirements. As a result, the requirements placed on the drive also change.

A path through space becomes target values for speed, position or torque.

The motion calculated at the beginning must be tailored to that specific application. This concerns not only individual parameters, but the design of the entire system – from closed-loop control to mechanics. The mechatronic behavior of the system must therefore be understood in detail. Only this understanding makes it possible to tailor the drivetrain and control system specifically to the application.

In the end, the vehicle completes its route. From the outside, the process appears simple. Inside, the motion has been planned, translated, executed and continuously corrected.



About the author

Fabian Vogel is Managing Director of maxon zub machine control AG.

Together with his team, he develops motion control solutions for complex mechatronic drive systems and supports customers in implementing

demanding automation and robotics applications.

Safety that keeps pace

Modern motion control systems perform increasingly demanding motion tasks. With every additional axis, the requirements for dynamics, precision, and functional safety increase.

Whether automated guided vehicles, cobots, or humanoid robots – wherever machines work alongside people or other machines, motion must remain under control even in the event of a fault.

The requirements vary depending on the application. For many industrial systems, basic safety functions such as Safe Torque Off (STO) or Safe Brake Control (SBC) are sufficient. They ensure that a drive is safely disabled or a brake is actuated in a controlled manner in the event of a fault.

As autonomy and dynamics increase, however, so do the demands placed on motion control. Modern robotic systems must not only stop motion safely, but in some cases also monitor it safely during operation. This is where safe motion functions such as Safe Limited Speed (SLS) and Safe Operating Stop (SOS) come into play. Safety-related communication is often handled via Fail Safe over EtherCAT (FSoE).

“From humanoid and quadruped robots to mobile manipulators, these systems herald significant advances for society and industry,” says maxon robotics expert Mario Maurer. At the same time, sensors, computing power, and drive technology are becoming increasingly integrated – and the requirements for functional safety are continuing to evolve with them.

The two examples on the right show how maxon supports customers across this spectrum – from Basic Functional Safety to advanced Safe Motion solutions.

IDX 70 M Safe

Basic Functional Safety



Compact integrated drive unit for mobile robotics, intralogistics, and industrial automation.

Safety

- Safe Torque Off (STO)
- Safe Brake Control (SBC)

Technical highlights

- Up to 9.4 Nm peak torque
- Up to 960 W power
- IP65 protection rating

High Efficiency Joint HEJ 90

Advanced Functional Safety



Integrated joint drive for modern robotics and highly dynamic multi-axis systems.

Safety

- Safe Motion
- FSoE (Fail Safe over EtherCAT)
- Roadmap for future safety functions

Technical highlights

- 140 Nm peak torque
- 75 Nm continuous torque
- 2 kg weight

Glossary

Basic Functional Safety

Covers fundamental safety functions such as STO and SBC.

STO

Safe Torque Off

Safely disables torque generation in the drive.

SBC

Safe Brake Control

Safely controls the holding brake.

Advanced Functional Safety

Adds safe motion functions and provides the foundation for the next generation of robotics.

SLS

Safe Limited Speed

Monitors a defined maximum speed.

SDI

Safe Direction

Monitors the permitted direction of motion.

SSM

Safe Speed Monitor

Continuously monitors the actual speed.

SOS

Safe Operating Stop

Safely holds the axis in position without disabling the controller.

FSoE

Fail Safe over EtherCAT

Safety-related communication via the EtherCAT network.

Assistance that adapts to every step

The BEAR-H rehabilitation exoskeleton detects how actively patients participate in gait training and adjusts its assistance accordingly. Compliant joint actuators, a combination of different sensors, and motion control technology make this possible.

Text **Fiona Zhang**

For people recovering from a stroke, living with spinal cord injuries, or undergoing rehabilitation after orthopedic surgery, relearning to walk can be a long process. Regular, repeatable gait training plays an important role. Conventional therapy, however, depends heavily on the experience and physical effort of therapists. Robotic rehabilitation systems can complement their work by supporting repeatable movement patterns and adapting the level of assistance to the individual patient.

MileBot Robotics, based in Shenzhen, China, develops robotic rehabilitation systems. Its portfolio includes exoskeletons and gait assistance systems for adults and children. The BEAR-H series is designed for gait training with patients who have impaired lower-limb mobility.

Controlled transmission of force

At the heart of the system are MileBot's own Series Elastic Actuators, or SEAs. These actuators incorporate maxon technology. Unlike rigid actuators, they use an elastic element between the motor and the joint. This allows them to absorb forces rather than transmitting them directly to the patient's body.

This is particularly relevant for stroke patients, who may experience a sudden increase in muscle tone or spasticity. In such situations, the elastic structure deforms reversibly, reducing the force acting on the joint. Integrated torque sen-

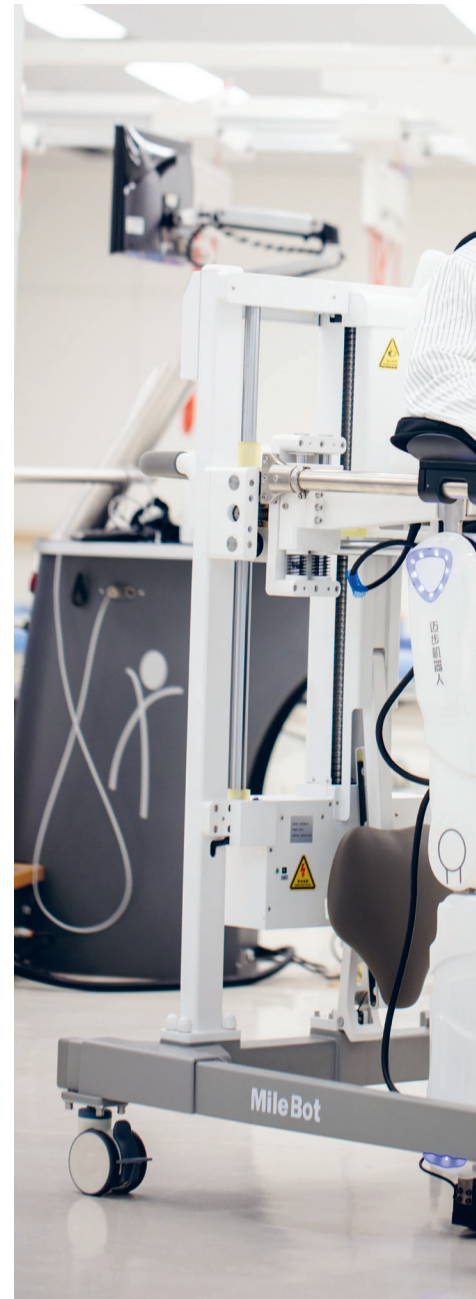
sors also measure how actively the patient contributes to the movement. The system supplies only the additional force required: the more actively the patient moves, the less assistance the exoskeleton provides.

Detecting movement intention

To detect the patient's movement intention, the BEAR-H combines data from several sensors. Plantar pressure sensors identify the different phases of the gait cycle, while encoders and inertial measurement units capture the position and movement of the legs. Together with torque measurements from the joint actuators, these signals allow the control system to recognize when a step is initiated and adjust the assistive torque in real time. A dedicated training mode for stroke patients with hemiplegia allows their own movement to trigger the next step.

The drive system uses maxon DCX 35 L and RE 40 motors, controlled by maxon EPOS4 Module 50/15 units. Precise current control allows the motor torque to be adjusted dynamically, enabling the system to respond quickly and in a controlled manner to the patient's movements.

By combining compliant joint actuators, integrated sensing and adaptive motion control, the BEAR-H supports intensive gait training while encouraging patients to participate actively.



In rehabilitation, exoskeletons such as BEAR-H help patients rebuild muscle strength.



Image: Courtesy of MileBot Robotics



Image: Courtesy of Pegatron Corporation

Pegatron's SIMBA II quadruped robot uses maxon High Efficiency Joints.

A platform for intelligent robotics

Modern robots are placing ever greater demands on motion control. Through their partnership, Pegatron and maxon aim to develop technologies for the robotic platforms of the future.

Text Flora Lin

Pegatron Corporation, based in Taiwan, and maxon have announced a strategic partnership in robotics. Together, the two companies will develop technologies for robotic joint drives, motor modules, and integrated robotic systems. The collaboration focuses on motion control, sensor integration, and edge AI applications for autonomous systems. It covers technologies that can be flexibly adapted to different applications and operating environments.

A first result was unveiled at Computex in Taipei, Taiwan: the quadruped robotic platform SIMBA II features maxon's High Efficiency Joint 90 (HEJ 90).

Pegatron's decision to use an integrated joint module reflects a broader trend. Modern robots feature an increasing number of degrees of freedom. Every additional axis increases the demands on motion control, cabling, and system integration. At the same time, sensing, computing, and drive

technology are becoming ever more closely integrated.

Combining expertise

Robotic platforms such as SIMBA II combine sensing, artificial intelligence, software, and precision drive technology into a complete system. While higher-level motion planning and autonomy are implemented in the robotics software, integrated joint actuators ensure the precise and dynamic movement of each individual axis.

With the High Efficiency Joint 90, maxon contributes a key building block for the robotic platform. Pegatron brings its expertise in system development, edge AI and industrial manufacturing.

SIMBA II marks the beginning of this partnership. Going forward, the collaboration aims to further advance the use of intelligent mobile robotic systems in industrial, commercial, and specialized applications.

From question to solution

How maxon Motion Control Support guides customers from initial analysis to the right answers.

Text **Urs-Ueli Schorno**

A fast response matters. But in motion control applications, a precisely framed question and a correct understanding of the system are essential first steps. Only once the system setup and requirements are understood can optimizations be made, potential causes of errors narrowed down, and suitable solutions found. This is precisely the role of Motion Control Support.

The team handles around 3,000 to 4,000 technical inquiries every year. Some can be answered within minutes, while others occupy the team for several days. The tasks vary accordingly, ranging from commissioning and configuration guidance to analyzing complex systems and the interaction of their components.

Jürgen Wagenbach leads Motion Control Support at maxon's headquarters. Together with his team, he supports customers worldwide with questions relating to drive solutions incorporating maxon motors, ESCON and EPOS controllers, as well as their integration into higher-level systems. A prompt initial response to the customer is particularly important to him. "It doesn't have to be the solution straight away," he says. "But the customer should know that we are working on it."

Gaining an accurate understanding

Customers who contact Motion Control Support will often receive some questions first: Which components are installed? What is not working as expected? What has already been tested?

This may initially seem unusual to customers. In fact, this information helps the team gain an accurate understanding of the drive system in all its complexity and narrow down the relevant factors more quickly. Many of these questions would arise later in the consultation process anyway. The more complete the initial picture, the more precisely the team can provide support.

At the same time, the team deliberately looks beyond the immediate problem and, as Jürgen Wagenbach puts it, "thinks outside the box." Point-

ers to additional aspects and potential follow-up issues broaden the view of the application and may reveal further opportunities for optimization. Customers benefit from the experience of maxon's specialists and can avoid common pitfalls.

The cause often lies elsewhere

"The controller reports an error. But that does not necessarily mean that the controller is also the cause," explains Jürgen Wagenbach. Motion control applications rely on the interaction between controllers, motors, sensors, electronics, software, and mechanical components – as well as, in most cases, components from third-party suppliers. An error message can therefore have many possible causes, from a damaged cable or faulty sensor to incorrect parameterization or disrupted data exchange between the motor controller and a higher-level controller, such as a PLC. Understanding the entire system setup is therefore essential in order to narrow down the possible causes.

One team, many areas of expertise

Every inquiry is recorded in a ticketing system and handled in a structured process. The goal is to provide an initial response within 24 hours. In many cases, the first response arrives within two hours and may already contain either an answer or follow-up questions.

If a question cannot be answered immediately, the appropriate specialist teams are involved – for example Development, Application Engineering, or the maxon Academy training team. The maxon Academy not only shares knowledge through training courses, but also provides self-study materials, video tutorials, and practical know-how.

For customers, however, the process remains as straightforward as possible. "We don't pass customers from one department to another," says Jürgen Wagenbach. Instead, Support coordinates the process and brings together the relevant information for the specific application. The technical

“The controller reports an error. But that does not necessarily mean that the controller is also the cause.”

**Jürgen Wagenbach,
Head of Motion Control Support at maxon**



background and necessary measures are communicated “in the customer’s language,” as Jürgen Wagenbach puts it, so that the proposed solution is easy to understand and can be implemented successfully.

Questions become knowledge

Some fundamental questions recur in similar forms. Where useful, the insights gained are incorporated into updates to technical documents or made available as FAQs in the Support Center. They help customers solve similar tasks more quickly in the future while also supporting the team’s day-to-day work.

In this way, every support inquiry does more than help answer a technical question: it also makes knowledge available for future customers and applications.

Motion Control Support at a glance

- Around **3,000–4,000** technical inquiries per year
- Goal: **initial response within 24 hours**
- Support with commissioning, parameterization, system design, and troubleshooting
- Structured processing through a ticketing system
- Collaboration with Development, Product Management, Application Engineering and other specialist teams
- Focus on technical advice and helping customers help themselves

Contact: support@maxongroup.com
or support.maxongroup.com



A view of maxon's headquarters in Switzerland: idyllically situated on the outskirts of Sachseln, with Lake Sarnen on the left.

We are maxon

maxon's story began in Switzerland in 1961 with eight employees.

The company soon invested in its first premises and a small production facility of its own. Today, 3,200 people work for maxon.

Every journey has a beginning, and maxon's began with an order from the authorities.

The German company Braun operated a sales subsidiary in Switzerland. In the 1950s, the Swiss authorities approached Braun with an ultimatum: if the company wanted to distribute its products in Switzerland, it would also have to operate a production facility here. Ideally, this facility was to be established in an economically disadvantaged region of the country.

The Braun family complied, choosing the canton of Obwalden in the heart of Switzerland. Interelectric AG, later renamed maxon, was founded in 1961 with eight employees. Production began

soon afterwards, initially with shaving foils for Braun electric shavers.

Then the future of the young company was suddenly at stake. In 1967, Braun was sold to the American Gillette Company. Gillette wanted to manufacture the shaving foils itself, but granted maxon a transition period.

The ironless winding

A new idea was needed, and maxon's pioneering era began. The management team at the time saw a future in manufacturing small, precise electric motors. Following a period of research, an entire range of DC motors was developed in a remarkably short time.



These motors featured a special patented innovation: the ironless winding. This enabled them to achieve high efficiency, while their long service life set new standards.

This first range of motors was only the beginning. Innovation has always remained a top priority at maxon. The small pioneering company grew into a global organization. Today, maxon employs 3,200 people worldwide, operates ten production and assembly facilities, and has more than 40 sales locations.

The company remains owned by the Braun family. Five million drive units leave its production facilities every year. The range of applications for our motors is vast: from insulin pumps and logistics robots to a NASA rover on Mars, they perform their work reliably.

It began with pressure from the authorities. Today, maxon is an innovative company that has grown and flourished – without ever abandoning the pioneering spirit of 1961. That legacy remains deeply rooted in the company.

What we do

Drive systems from a single source

maxon develops compact, precise and reliable drive systems. Motors, gearheads, sensors, control electronics, and software are treated as a complete system and optimally matched to one another – from individual components to fully integrated drive solutions.

Customized solutions

Where standard products are not enough, we adapt existing components or develop customer-specific solutions. Our modular product portfolio provides a versatile foundation, even for demanding applications in medical technology, robotics, industry, and aerospace.

Motors

The portfolio includes brushed and brushless DC motors, servo motors, and frameless motors for direct integration. They combine high power density with dynamic response, smooth operation, and long service life and can be flexibly adapted to different applications and installation requirements.

Gearheads

Planetary, right-angle, and strain wave gearheads complement the motors to create compact drive units. They provide high torque, precise motion, and flexible gear ratios in a small footprint.

Sensors and control electronics

Encoders and Hall sensors provide the feedback required for precise control of position, speed, and torque. The appropriate control electronics combine the drive and software to create an intelligent, powerful, and safe system.

Whether in surgical robots, on Mars, or 10,000 meters underwater, our drives and controllers deliver precise, reliable motion.

Want to set something in motion – but not yet sure how?

At maxon, we know motion control. Our team looks forward to working with you to find the right solution for your application.

Get in touch:
contact.maxongroup.com

maxon