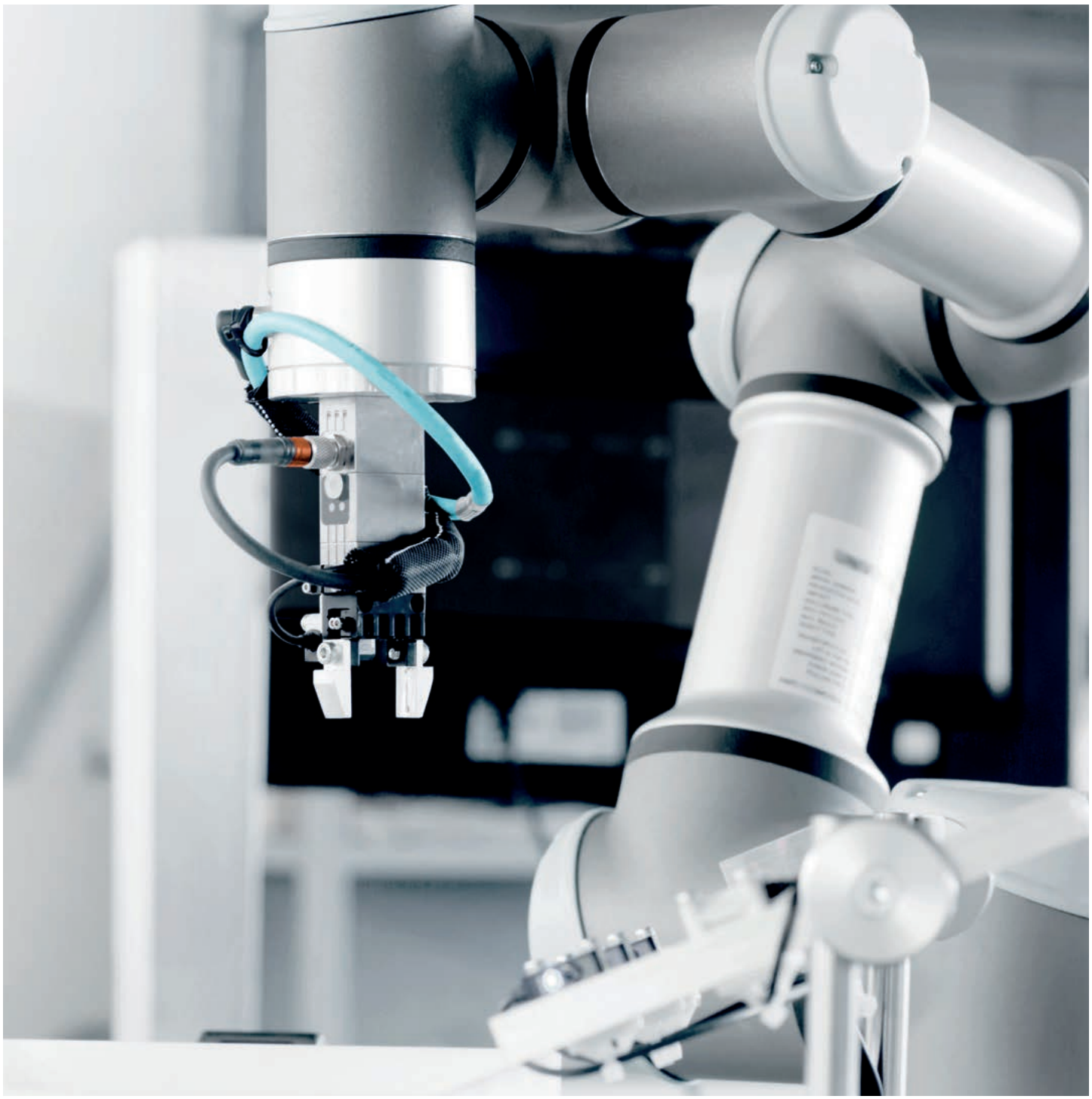
maxon

# Drive systems for robotics.
# High torque, compact and efficient.



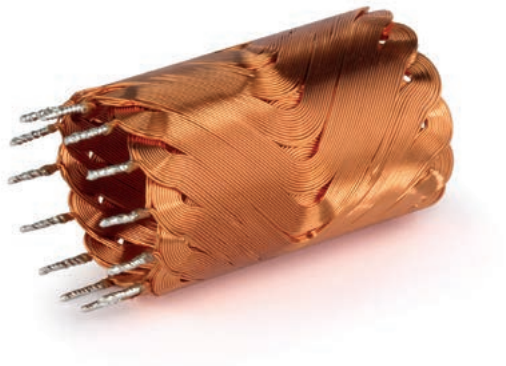
# Founded in Switzerland. Available worldwide.

## maxon – a strong global brand

maxon, with headquarters in Sachseln/Central Switzerland, has production sites in Switzerland, Germany, Hungary, South Korea, USA, France, Netherlands and China as well as sales companies in more than 30 countries. Our machines and product lines are developed in-house to guarantee cost-effective manufacturing of our products and enabling us to create custom solutions to fit your specific application needs.

## Precision Drive Systems

maxon develops and builds precision drive systems. Our brushless and brushed DC motors with ironless windings are among the best in the world. Flat motors with iron cores complete our modular product portfolio. maxon's modular system includes planetary and spur gearheads, spindle drives, as well as encoders and control electronics.

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# Drive systems for robotics

In the coming years, robots will noticeably change our daily lives. Millions of them will handle monotonous, dirty, and dangerous jobs.

Robots handle assembly tasks, provide support, automate processes, explore space and perform surgery on humans. They rely on powerful, highly integrated drive systems to achieve human-like motion and capabilities.

maxon develops and manufactures drive systems for autonomous mobile and industrial robots, including humanoid and quadruped robots, agricultural robots, collaborative robots, mobile manipulators, and service robots.

**Our knowledge makes a difference**
Backed by more than 60 years of expertise in drive system development – from motors and gearheads to encoders and electronics – we are leaders in crafting innovative, adaptable systems optimized for power and scalability. Our in-depth knowledge of modern robotics allows us to create drive systems ranging from advanced robotic simulations to precise actuator control and robust hardware.

We enable robotics engineers to focus on their key tasks while we take care of the challenges surrounding actuators. Our focus is on the following core values:

- → **Production scalability:** Rapid scaling for complex robotic drive systems with annual quantities in the high tens of thousands.
- → **Reliability:** Our drive systems are designed for harsh, unstructured environments and meet the highest quality and reliability standards.
- → **Reduction of complexity:** We simplify complex drive subsystems – including electronics, motors, and gearheads – to ensure seamless integration.
- → **Total cost analysis:** By leveraging vertical integration, we lower costs, accelerate the time to market, and maximize the operating time of robots with highly reliable systems.

**robotics.maxongroup.com**

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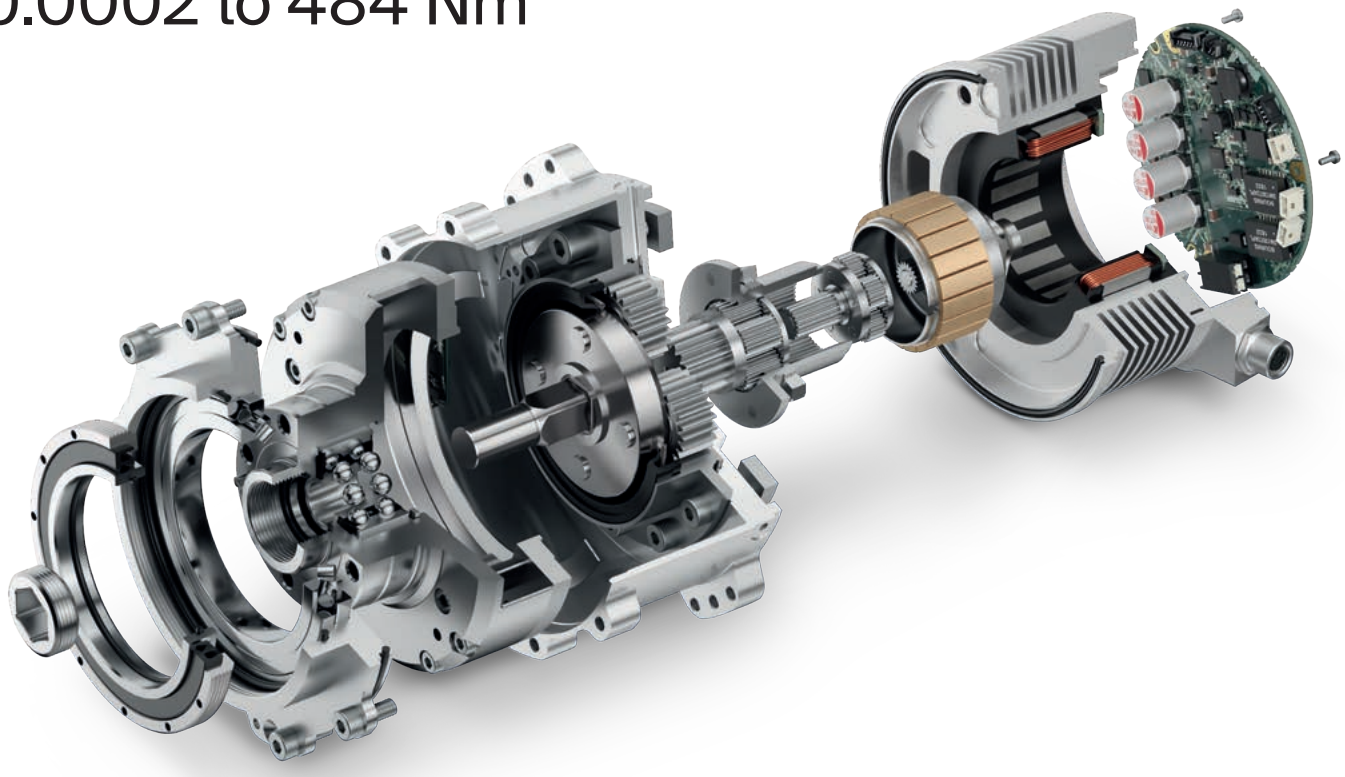
# Drive solutions from 0.0002 to 484 Nm



## Impressive performance data

**Torque:** Our strongest robotic drives generate up to

**484 Nm**

of torque.

**Service life:** Our most robust drives can handle ove

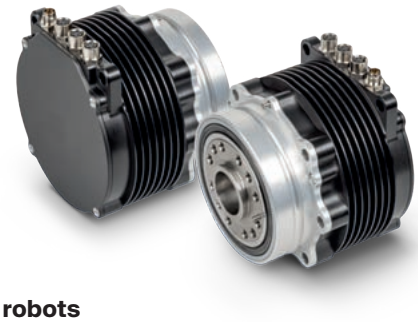
**12 million**

load cycles.

**Efficiency:** Our powerful robotic actuators achieve around

**93 %**

gearhead efficiency.



**Solutions for autonomous mobile robots**

## Highly efficient joints

Our growing family of quasi-direct drives ensures reliable locomotion and mobile manipulation in unstructured environments. A high torque density ratio, full integration, protection against environmental influences, sophisticated impedance control with an integrated torque sensor, and planetary gearheads with overload capability make these systems ideal for modern, dynamic robots.



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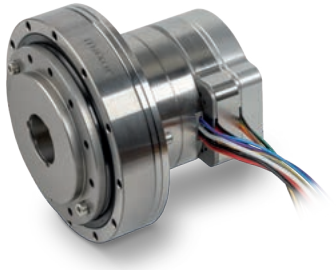
**Industrial building blocks**

## Precision parts

A versatile range of torque-dense actuators with high-resolution absolute output encoders, large hollow shafts, and backlash-free drives. These systems are ideally suited for custom robotic and industrial motion solutions, from surgical robots to pan/tilt applications.

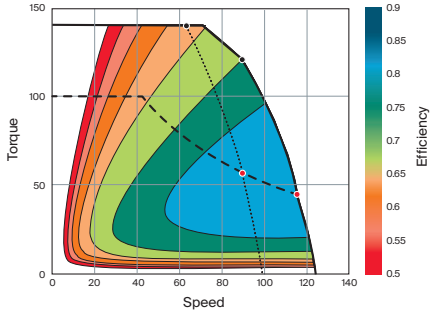


**For the optimal system**

## Simulation and design

We offer comprehensive system simulations and optimization services to ensure you get the right solution for your problem. Our offering includes:

- Simulation models for complete drive systems
- Kinematics simulations
- Integrated system engineering and optimization
- Consultation on functional safety and risk assessments




**More than actuators**

## Subsystems and customization

We merge our manufacturing expertise with the development of complete subsystems – in close collaboration with you. This allows us to achieve maximum integration density and scalability – crucial factors for success in robotics.

**View the entire range of products online**

shop.maxongroup.com

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# Max out your motor

## maxon EC motors designed for you as a frameless kit

In order to achieve the optimum of high torque density and minimum installation volume, maxon offers the EC flat motors in a frameless kit version. Rotor and stator are delivered separate without bearings or motor shaft. This allows the motor to be integrated optimally in the structure of the robot.

**High torque density**
The EC flat motors are part of our BLDC series of motors with iron windings. Due to their large number of pole pairs, they have a very high torque.

**Compact, with plenty of space inside**
Due to their flat construction, EC flat motors can be integrated into robot joints in a way that is very economical in terms of space. With outer diameters of 32 – 90 mm, the brushless DC motors are extremely compact. Designed as external rotor motors, they offer plenty of space inside for cable glands.

**Low operating voltage**
maxon BLDC motors typically operate at voltages from 12 to 48 V, easily fulfilling applicable safety regulations. Take full advantage of the great selection of available windings for the standard versions.

**Complete control**
To easily control the motors, maxon offers frameless kits with and without Hall sensors. To monitor motor temperature, a heat-sensitive NTC resistor can also be installed on the circuit board.

**Proven design**
maxon EC flat motors are used daily in thousands of applications with excellent reliability. High production quantities and automated manufacturing lines guarantee consistently high quality. Get the best out of your robots. We look forward to working with you to find the perfect frameless kit for your application.


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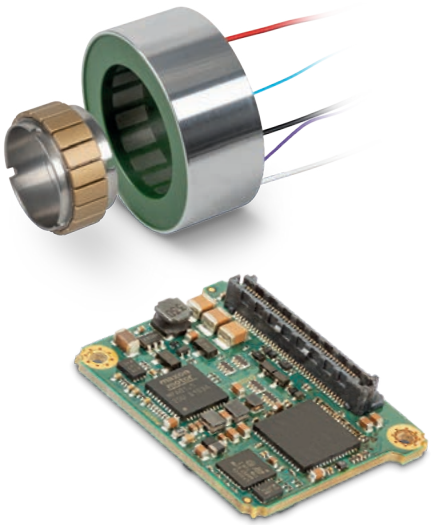
# Frameless motors in robotics

Stator and the rotor are delivered individually without housings, to be connected only when the limbs are assembled.

Applications in robotics often require high torque in order to not only move joints, but also do so with sufficient force. In some cases, minimizing the weight of each component is also crucial, for example when a robotic arm is mounted on a wheelchair. A frameless solution should be considered in such cases. This means that the stator and the rotor are delivered individually without housings, to be connected only when the limbs are assembled. This saves space and weight. If these are among the primary criteria, then maxon engineers will work with customers to find out whether a frameless solution is suitable.



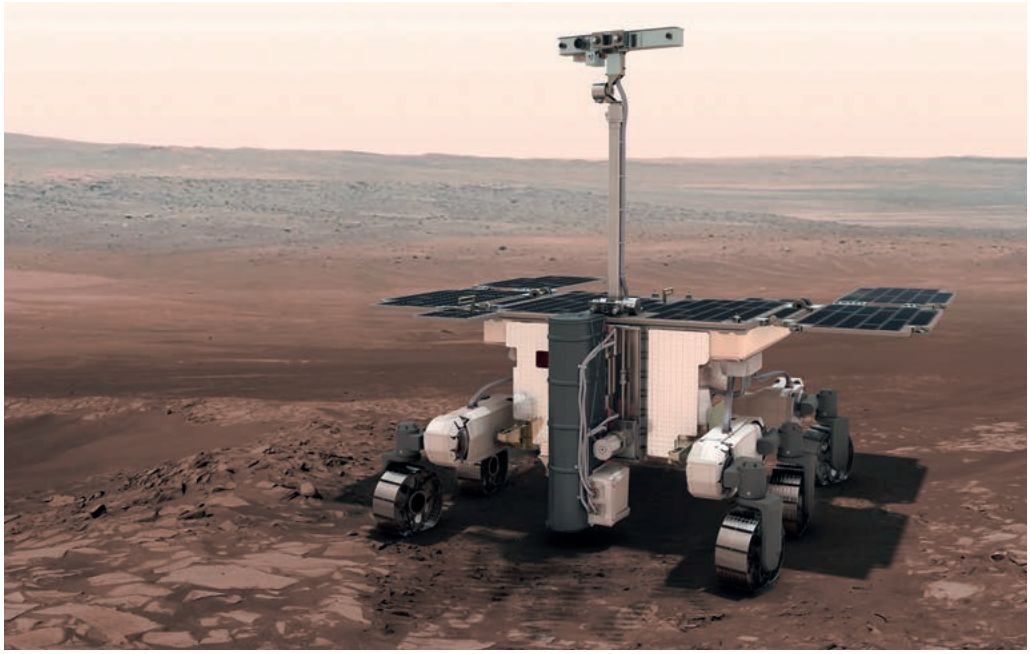
Brushless DC motors from the EC flat series.
EC 45 frameless DT 50.

- → High level of integration in the structure of the machine
- → High torques through multi-pole external rotor
- → Plenty of space for cable glands
- → High overload capacity
- → Hall sensors
- → Thermal sensors (NTC)

You can find additional application stories at
**www.maxongroup.com**

# Unmanned vehicles

## Reliable components are indispensable.



Strange planets, narrow shafts, or dangerous locations: Wherever people can't go, unmanned robotic vehicles stand ready to do the work. They need to maneuver independently, overcome obstacles, and perform a variety of tasks. Reliable components are indispensable because intervention or repair are often impossible. Many engineers prefer maxon drives, because they are robust, lightweight, and durable. The energy efficiency of micromotors is also a decisive factor when running on batteries.


Brushed DC motor, planetary gearheads, and X-series encoders. DCX 22 with graphite brushes combined with a GPX 22 HP and ENX 16 EASY. Configurable online.

- → High energy efficiency
- → High power packed into extremely small spaces
- → Precise speed or position control
- → Very high output torques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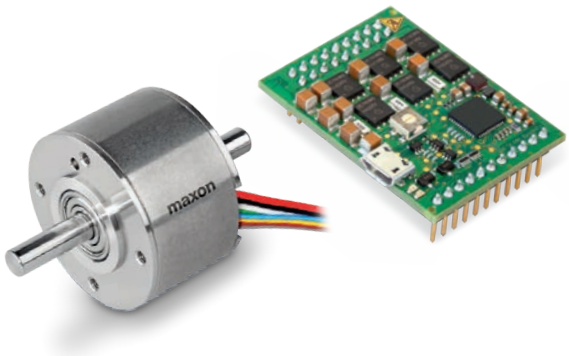
# Humanoid robots

## Lightweight, compact, and powerful components.

Brushless DC motor EC-i 40 with Encoder 16 EASY.

- → Compact design and high torque density
- → Over 10,000 hours of service life
- → High precision due to high-resolution encoders with up to 1024 pulses per turn
- → Dust and oil resistant




Humanoid robots will soon be part of our daily lives, performing as service or caretaker machines, as teaching aids, or as rescuers in disaster areas. Such robots require lightweight, compact, and powerful components. Especially the legs need high-torque actors. With its brushless DC motors, maxon has just the right solution. Especially the multi-pole motors offer excellent torque-to-size ratios.

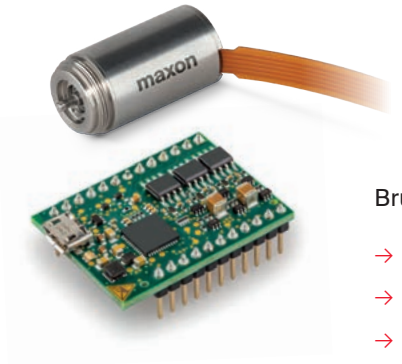
You can find additional application stories at
**www.maxongroup.com**

# Industrial grippers

## Precise interaction between motors and encoders is crucial.


© Schunk

Grip it firmly, don't drop it... and please, please don't crush it! Grippers for industrial apparatus, humanoid robots, or robotic arms have to meet high requirements. Proper gripping is a challenge, not least for the electric motors that have to execute the movement. Precise interaction between motors and encoders is crucial. Moreover, engineers demand drives with a high power density to generate maximum torque in very small installation spaces. With its motors, maxon is offering the right solutions. Their special winding makes maxon motors efficient and precise.




Brushless DC motor EC 13 with Hall sensors.

- → High overload capacity
- → Small diameter
- → Highly dynamic
- → Excellent control characteristics – linear curve



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# Collaborative robots

## High-torque motors are advantageous.

The times are gone when industrial robots needed to be locked away behind protective barriers. An increasing number of developers is introducing robots that work hand in hand with humans. These collaborative robots (cobots) perceive their environment and “sense”, by means of torque feedback, when they get too close to another robot or a human. High-torque motors are advantageous in such applications, to keep the gearhead units small. With their outstanding power-to-size ratio, maxon flat motors come into their own here.

Brushless DC motor EC-flat 90 with integrated Mile encoder.

- → Compact, flat design and high torque density
- → Robust design
- → High precision due to high-resolution encoders with up to 6400 pulses per turn
- → Dust and oil resistant


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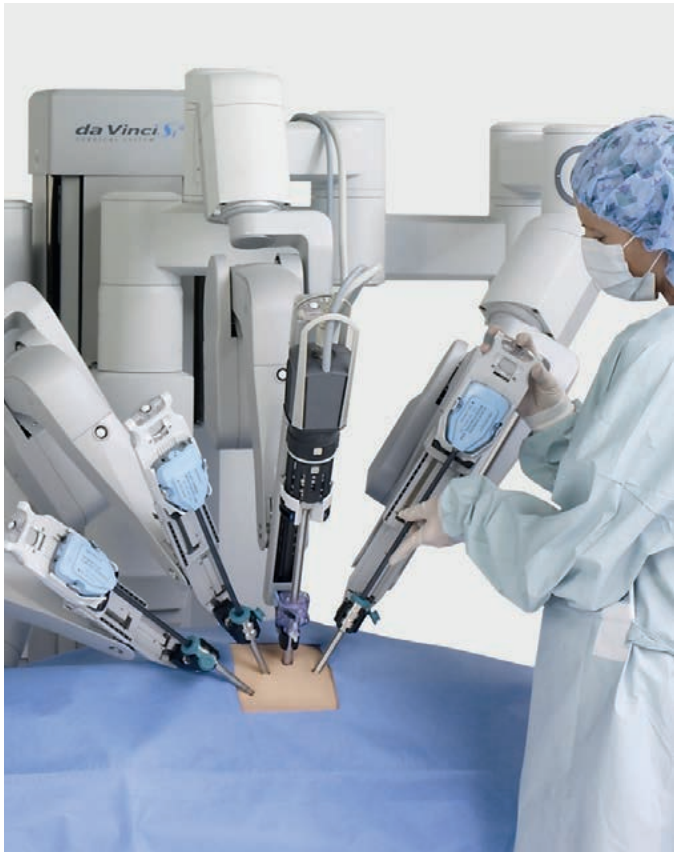
**www.maxongroup.com**

# Surgical robots




What was unimaginable a few decades ago is now reality in operating rooms all over the world: Robots support surgeons during difficult prostate removal surgery or other operations on the torso. During the operation, the surgeons sit at a control console, from where they control the four-arm robot. Its instruments are laparoscopically inserted into the patient through small openings, where they can be maneuvered with more flexibility and precision than would be possible with any human hand. This prevents nerve damage or major bleeding during the operation. Additionally the small incisions make the healing process much faster. To accurately transmit the movements of the surgeon to the robot and have the robot execute them, several dozen maxon DC motors are needed. These have no cogging torque and are therefore ideal for use in surgical robots.

DC motors. No cogging torque and are therefore ideal for use in surgical robots.

Brushed DC motors of the DCX series. DCX 22 with graphite brushes, DCX 10 combined with a GPX 10 planetary gearhead and an ENX encoder. Configurable online.

- → Ironless maxon winding provides smooth running
- → Linear characteristic, excellent control properties
- → High energy efficiency
- → Minimal heat build-up
- → Very quiet
- → Backdrivable gearhead



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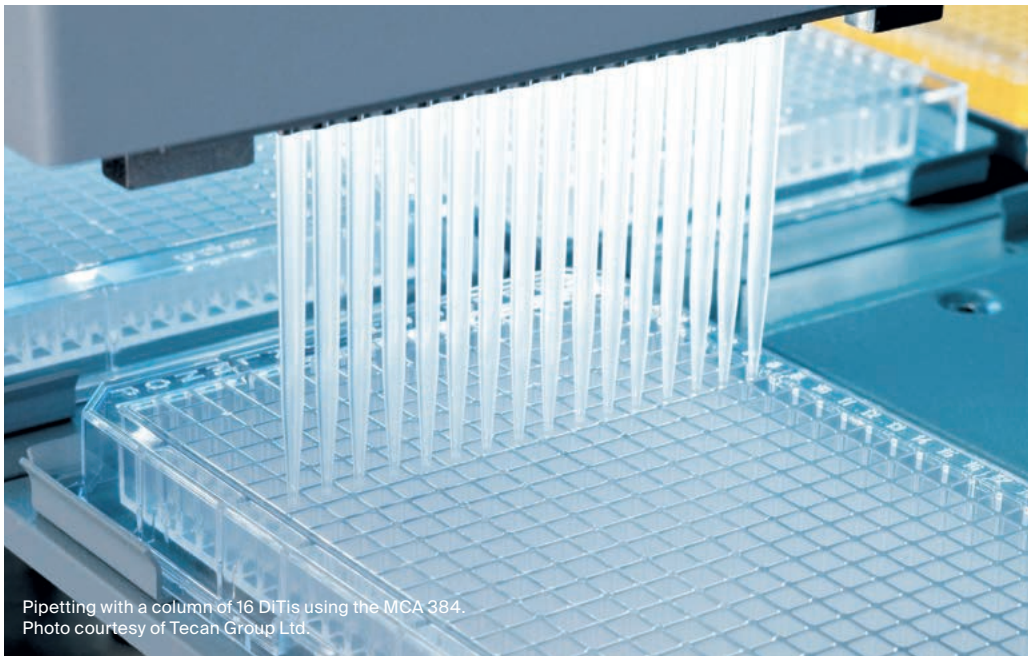
# Laboratory robots

## DC motors are especially suitable for this type of positioning task.

Pipetting robots perform an increasing variety of tasks while taking up less and less space. They are used for active ingredient screening by large pharmaceuticals companies, as well as by small molecular biology labs that require flexible liquid handlers. These robots are able to handle hundreds of samples simultaneously and can be equipped with multiple pipetting heads. Their speed is ever increasing as they dispense smaller and smaller fluid quantities. However, all this only works with highly dynamic and precise drives. maxon DC motors are especially suitable for this type of positioning task. These motors have a very low moment of inertia, and their ironless windings provide stutter-free movements. Together with encoders and a matching controller, perfect drive combinations become possible.



Pipetting with a column of 16 DiTis using the MCA 384.
Photo courtesy of Tecan Group Ltd.

Brushed DC motor DCX 12 with encoder ENX 10 EASY and planetary gearhead GPX 12.Configurable online.

- → High overload capacity
- → Small diameter
- → Highly dynamic
- → Excellent control characteristics – linear curve
- → High precision with up to 1024 pulses per turn


You can find additional application stories at
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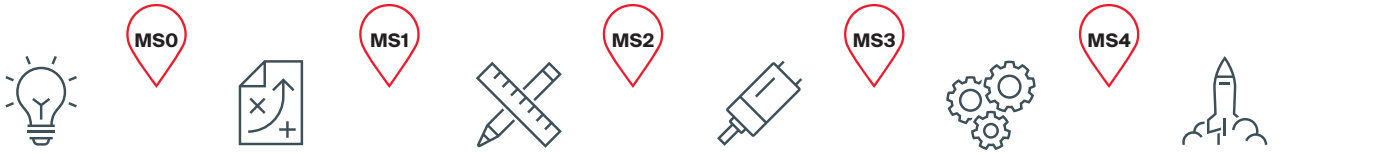
# There is always a solution

## From our mechatronics specialists

- Systems from a single source due to a wide range of in-house competencies: motors, gearheads, electronics, software, sensors, batteries, injection molding technology, and product design.
- In our products, we combine drive components from maxon into customer-specific mechatronic systems, tailor-made to your needs.
- Our battery solutions with intelligent BMS (Battery Management System) are integrated optimally into the application to make your system even more independent.
- You gain a competitive edge with customer-specific software, as well as agile and goal-focused research and development from our experienced mechatronics center.
- The proven maxon project process divides a project in three distinct phases. The milestone concept makes development progress easy to follow.

## Milestone diagram

Through clearly defined procedures with milestones, maxon guarantees a smooth-running project and constant transparency for the customer.




**Product idea**

- Customer requirements
- Technical clarifications

**Concept**

- Systems outsourcing
- FSD
- Functional sample

**Design**

- Prototypes
- Qualification / tests
- Risk assessment

**Pre-series**

- Pre-series sample
- Tools and equipment making
- Tools and equipment validation

**Pilot series**

- Series sample
- Series validation
- Initial sample Test report

**Mass production**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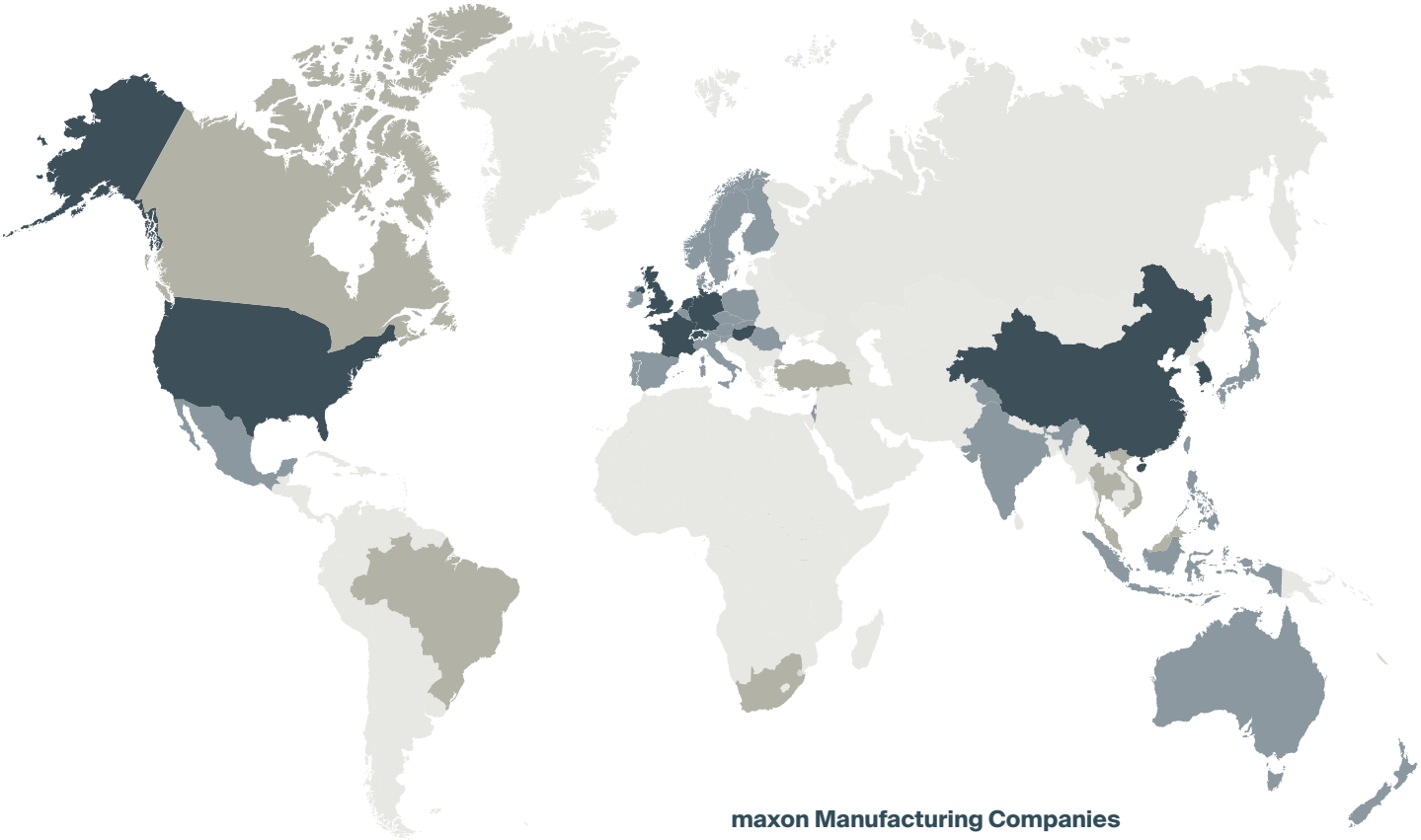
# A global network



**maxon Manufacturing Companies**

Switzerland (Headquarters)
Germany
Hungary
South Korea
France
Netherlands
USA
China
Great Britain

**maxon Sales Companies**

Austria
Australia
Benelux
Bulgaria
China
Croatia
Czech Republic
Denmark
Estonia
Finland
France
Germany
Great Britain
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Japan
Latvia
Lithuania
Mexico
New Zealand
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