



(Source: Maxon)

## *Robotics, analysis, and handling systems with CANopen*

*Robotics, analysis, and handling systems require a compact integration of a large number of energy-efficient drives, combined with dynamic controllers and a serial network system. Maxon provides solutions with CANopen.*

In particular, surgical robots, analysis devices in medical and laboratory technology, and multileaf collimators in radiation technology rely on miniaturized drive systems which can be installed densely packed due to their efficiency. In addition to motors, the ideal "drive package" also includes motor controllers that can be integrated directly in the device close to the motors and sensors. The requirements are compact multi-axis system concepts. An operation robot is a typical application with multi-axis systems (see photo above).

The most important features of the motor controllers are energy efficiency and power density for the space-saving integration of all components. The motor controller should be able to provide its rated power without the need for any additional cooling measures like heat sinks or fans which would increase the overall dimensions strongly again. Equally important are connections for various sensors and actuators as well as a fast network interface. The Epos Micro modules offer a standardized range of functions, control algorithms, a compact power stage, and a CANopen interface – while being similar in size to a postage stamp (from 32 mm x 22 mm). Device manufacturers can integrate the plug-in modules in their own electronics in the required number of axes. This makes cost-optimized multi-axis systems with compact dimensions possible. The Epos4 Micro

24/5 digital positioning controller for example, provides a CANopen (responder) interface. It complies with the CANopen application layer and communication profile CiA 301, CiA 305 CANopen layer setting services (LSS) and protocols, as well as the CiA 402 CANopen device profile for drives and motion control.

### **CANopen: The backbone of the overall system**

Each drive unit exchanges command and status data with the commander controller (e.g. programmable logic controller or Maxon Mastermacs) by its network interface in a ▶

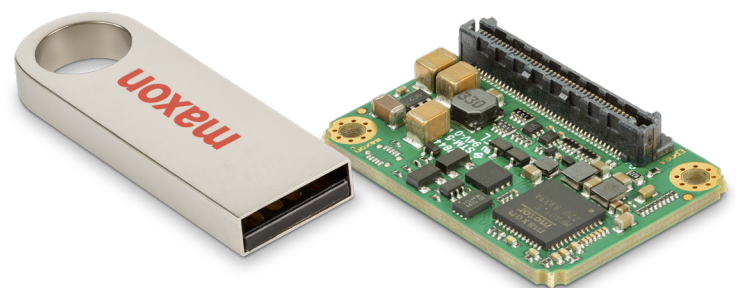


Figure 1: The size of the Epos4 Micro compared with an USB stick (Source: Maxon)

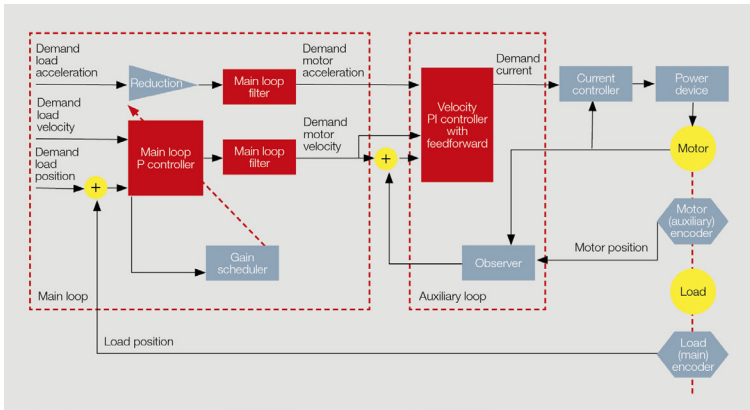


Figure 2: Detailed view of all components of Epos4 dual-loop control (Source: Maxon)

tol. The standardized operating modes PPM – profile position mode, PVM – profile velocity mode, HM – homing mode, CSP – cyclic synchronous position, CSV – cyclic synchronous velocity, and CST – cyclic synchronous torque, are supported. As a standardized motion control responder, Epos4 Micro (like all Epos4 product types) can be integrated by the system manager tools and motion libraries of different PLC (programmable logic controller) manufacturers. Applications commanded by a PC or Raspberry Pi and Maxon's Epos Command Library are possible too.

Epos4 Micro supports brushed and brushless DC motors with hall sensors, digital

fast cycle rate. One commonly used serial network system is CANopen. It has been industry-proven by an endless number of medical and industrial applications. It is the backbone of any reliable real-time data exchange of multi-axis applications, e.g. drives or robotic joints which demand for some coordinated or synchronized motion.

### Integration based on CiA 402

Any data exchange and commanding of the Epos4 Micro complies with the CiA 402 pro-

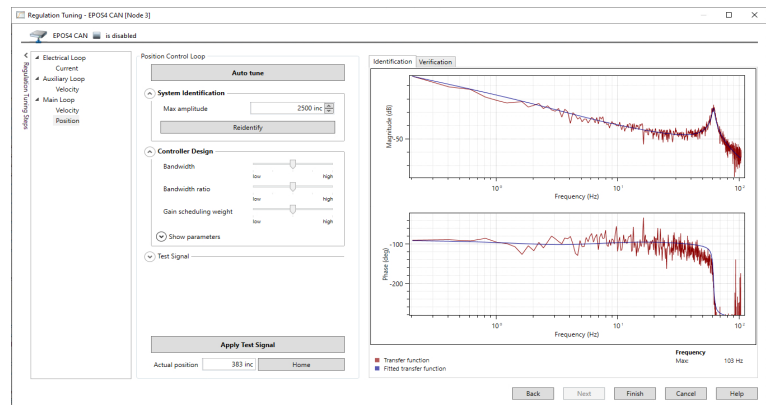


Figure 3: Epos Studio: dual-loop regulation tuning (Source: Maxon)

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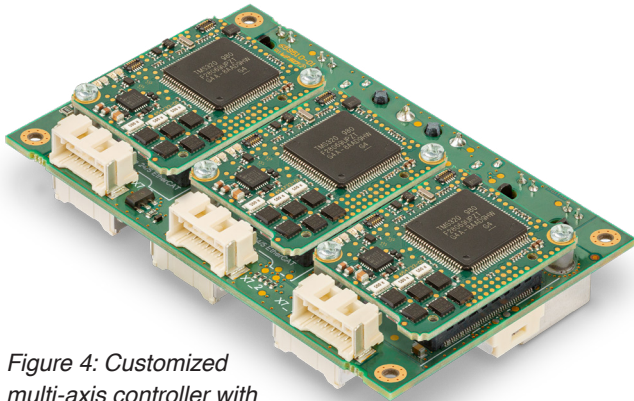


Figure 4: Customized multi-axis controller with three Epos4 Micro (Source: Maxon)

incremental encoders, and SSI absolute encoders. A total of five digital inputs, three digital outputs, two analog inputs ( $\pm 10$  V), and one analog output ( $\pm 4$  V) allow the connection and processing of add-on actuators and sensors. The product series offers a power density of over 50 W peak power per  $\text{cm}^2$  mounting surface without additional cooling at an environmental temperature of  $-30$  °C to  $+45$  °C. This means a continuous output power of 120 W and peak of 360 W for 10 seconds based on a footprint for controller and power stage of only 32 mm x 22 mm and 7 mm thickness.

With its 25-kHz current control cycle and 2,5 kHz speed/position control cycle, the product series has identical cycle rates like all other Epos4 product types. Modern controller concepts such as field-oriented control (FOC), feed forward, and observer control also mean that the Epos4 Micro can provide a maximum motor performance and movement precision.

### Dual-loop control included

Quite often mechanics is not “perfect” and there is some backlash (by gears) or elasticity (by belts) present. The position accuracy of the moved load is the one that finally counts in practice for the user of a machine or robot. The Epos4 offers dual-loop control for such mechanical systems. Dual-loop control is based on an encoder mounted on the motor shaft and another additional encoder mounted on the output shaft. The motor encoder is in use for sinusoidal commutation (so-called FOC) and velocity control. The encoder mounted on the output shaft is the feedback device of the position control loop. This so-called dual-loop control and all encoder data is fully processed by the Epos4 and ensures smooth highly dynamic motion and precise positioning of the load. Dual-loop control is integrated in the Epos4 Micro with the same functionality and performance like for all other Epos4 product types. The compact size of the Epos4 Micro means no restriction at all.

One challenging point of most motor controllers and especially dual-loop control is often initial commissioning demanding for the configuration of a lot of control parameters of complex cascaded modern control loop algorithms. A wrong manual configuration of control settings often results in disappointing control performance even in case of a highly sophisticated motor controller. Maxon offers a comprehensive set of software tools by the

Epos Studio PC software which can be downloaded free of charge. The technical data of the motor and sensors in use are configured by Epos Studio’s “startup” wizard based on the component’s data sheets. Epos Studio’s “regulation tuning” reduces perfect tuning results to the press of a button even in case of dual-loop control by a next step. An optimized motion control configuration can be realized by tools like Epos Studio.

The Epos4 is the lowest-level information supplier in the IIoT (Industrial Internet of Things) environment of a machine or drive train. Motor current and torque, speed, position, error states, temperature, and load values of the controller and motor, as well as sensor and actuator states can be accessed or periodically transmitted by its network interfaces. ◀



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