Matching CANopen drives for DC micro-motors

Small and powerful DC-motors are critical to the development of highly-integrated systems. Making the right choice is fundamental for reliable operation.

The DC micro-motors are a driving technology in many different sectors, from medical and laboratory technology to aerospace, robotics, optics, and photonics as well as industrial machinery and equipment in general. But the small motors only mature to an application-relevant drive or positioning system when combined with other components, such as gearheads, encoders, and motion controllers. Making the right choice is fundamental for reliable operation. All components must be compatible with the motor and meet its requirements. In the worst case, selecting the wrong controller can destroy a motor in no time.

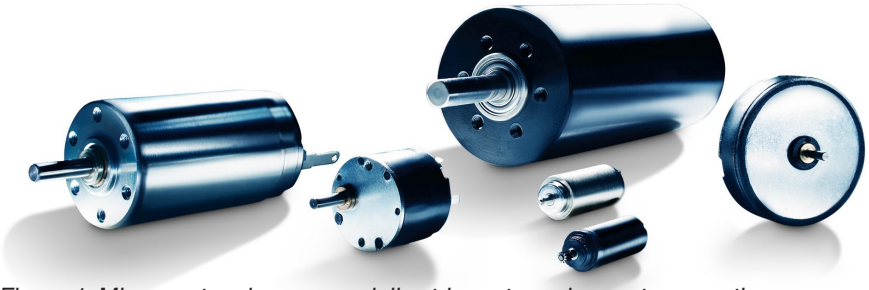

Figure 1: Micro-motors have especially stringent requirements on motion controllers (Source: Faulhaber)

Fundamental questions

When selecting a suitable motion controller for a drive system, it is important to answer a few questions first. For example, the movements that are to be carried out must be established, and it must be defined what this means in terms of motor control requirements. Is the drive working continuously or in start-stop mode? Is precise positioning required? What type of load will the drive be moving? What are the load cycles? Is a gearhead required? Which motor is best suited for the application? The motion controller is then selected based on the answers. And it may get interesting, because not every motion controller suits every motor. DC-micro-motors in particular have unique requirements due to their design.

Figure 2: At the heart of the DC miniature and micro-motors is the patented, self-supporting, coreless rotor coil with skew-wound design, which rotates around a fixed magnet (Source: Faulhaber)

Risk of overheating

At the heart of the DC miniature and micro-motors from Faulhaber is the patented, self-supporting, core-less rotor coil with skew-wound design and brush commutation, which rotates around a fixed magnet. This motor is also often referred to as a bell-type armature motor due to its look. Its design not only has many practical benefits, it also influences the selection of the motion controller.

No cogging torque forms due to the symmetrical air gap, which enables precise positioning and excellent speed control. The ratio of load to speed, current to torque, and voltage to speed is linear. And as almost the entire motor diameter can be used for the winding, the motors achieve higher power and torques for their size and weight compared with conventional designs. The rotor's low inertia also guarantees an extremely low electrical time constant. The motors can thus be operated very dynamically and heavily overloaded. Triple continuous torque in overload mode is quite common and easily possible for servo applications, as long as the temperature of the motor winding is monitored. But motors with a diameter of only 22 mm or less do not have an integrated temperature sensor. There simply is not enough space. So, if just any controller is connected to a micro-motor, in the worst case the coil may be completely burnt up before any heat is even noticed on the outside.

Possible solution

Such problems can be avoided with motion controllers from Faulhaber, which were developed for the requirements of mini- and micro-drives and tested under real operating conditions. They estimate the winding temperature for the respective motor type using models of varying complexity. This means that the full dynamic range of the motor can be exploited, for example for fast positioning processes. The current is also limited before the winding overheats. The parameters required are transmitted to the drive controller with the "Motor selection dialogue" of the company's Motion Manager software. ▷

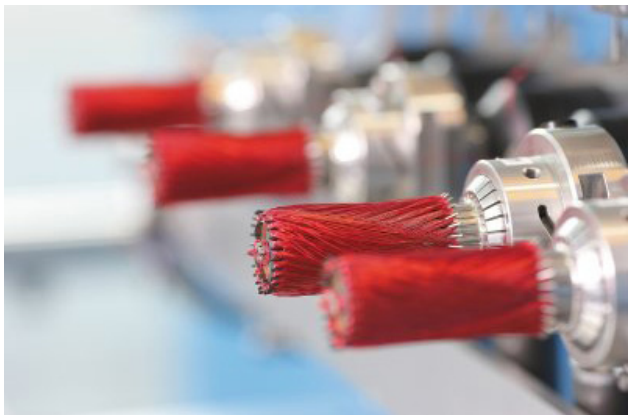

Figure 3: Motors with a diameter of 22 mm or less do not have an integrated temperature sensor. Without a matching motion controller, the coil may be burnt up before any heat is noticed on the outside. (Source: Faulhaber)

Additional information about thermal integration in the application can be used in the models that are stored in the controllers for further improvement. How well is the motor cooled? Is it necessary to limit power due to high ambient temperatures? Is a gearhead and encoder used? With such additional information, maximum motor power can also be used with, e.g. a drive that works cyclically in a climatic chamber, in that the motor controller keeps track of the ambient temperature parameters from the climatic chamber control within the models stored. The same applies if the load cycles are known. The motor can then often be smaller in design, which is an advantage especially when used in mobile devices.

Due to the low electrical time constant, which benefits dynamic processes, additional losses may occur due to the pulse width modulation (PWM) that is common in drive controllers. The typical electrical time constants of manufacturer's cbell-type armature motors are about 10 µs. For PWM frequencies below 50 kHz, the continuous torque specified in the data sheet is no longer achievable in many cases, or the motor may overheat. That is why it is important that the PWM frequency is sufficiently high when selecting a motor controller. For Faulhaber motion controllers, this is ▷

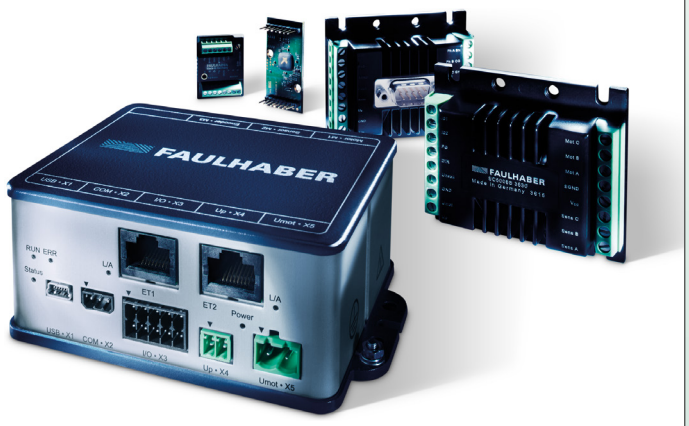

Figure 4: The motion controllers 'estimate' the winding temperature of the respective motor type using models. The required parameters are transmitted to the drive controller using the Motion Manager software. (Source: Faulhaber)

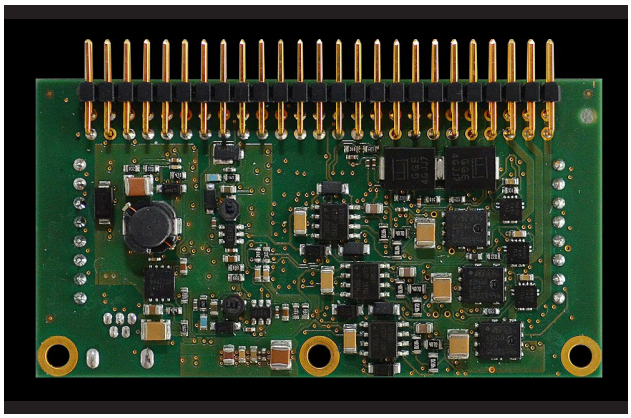

Figure 5: The MC 3001 B/P motion controllers are suited to smaller servo drives in terms of size and current measurement resolution (Source: Faulhaber)

between 78 kHz to 100 kHz, depending on the type. Due to the type of modulation, up to 200 kHz act on the motor, which suits the requirements of the small motors.

Miniaturized unhoused motion controllers

The motion controllers of the MC V3.0 family, which have been tried and tested for years, have limited usability for the company's micro-motors due to their size and the resolution of the integrated motor current measurement. This is where the recent MC 3001 B/P comes in: The first motion controller that is optimized for smaller servo drives, both in terms of its size and the resolution of the current measurement. With a maximum supply voltage of 30 V_{DC}, the motion controller sizing 16 mm x 27 mm x 2,6 mm achieves a continuous current of 1 A and a peak current of 5 A. At lower supply voltages, such as in 12- V_{DC} systems, continuous currents of up to 2 A can also be easily achieved. At the same time, they do not compromise on function compared with their large family members. The I/O options, and the encoder interface are the same as the rest of the product family. CANopen, USB, EIA-232, and optionally Ethercat are available as communication interfaces.

The controllers are designed for operation as CANopen devices with NMT (network management) server functionality. Via CANopen, they can be combined with a number of higher-level managing systems. Stand-alone operation using integrated sequence programs is possible. The devices support the profile position, profile velocity, and homing operating modes according to the CiA 402 profile for CANopen drives and motion controllers. CiA 402 is internationally standardized in IEC 61800-7-2/-3 and is further developed by CAN in Automation (CiA). Controllers' configuration can be performed with the Motion Manager software (version 6.8 and higher). Supported bit rates (up to 1 Mbit/s) and node-IDs are set via the CANopen layer setting services (LSS) as specified in CiA 305. Further, an SDO (service data object) server, four RPDOs (receive process data objects), and four transmit PDOs (TPDOs) with dynamic mapping are provided.

The controllers are available in two variants: The model with flat board-to-board connectors (MC 3001 B) is suitable when several drive controllers are combined on one carrier card. The MC 3001 P variant features a plug connector with a 2,54-mm grid over three sides. It is designed to be integrated into thecustomer's configuration, e.g. for multi-axis applications in laboratory automation. Thus, Faulhaber offers motion controllers for its smallest DC drives, matched to the micro-motors in terms of size and function.

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CAN Newsletter Online: CANopen drives

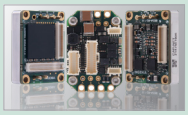
In the CAN Newsletter Online, CiA continuously informs about the recent drives and motion controller developments. A variety of drives with CANopen connectivity are available on the market:

CANopen motion controllers

Unhoused drives for space-limited applications

Miniaturized unhoused CANopen motion controllers can be embedded in small motors deployed in robot arms and other compact applications. These are available from diverse manufacturers.

Read on



Motion control

Servo drive series with CANopen

Celera Motion has announced the addition of the Capitan series to their line of Ingenia servo drives. The series offers CANopen communication with a bus latency down to two cycles.

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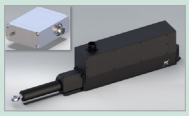

Several applications

CANopen actuators

The actuators from ISP System are designed for integration of mechanic and electronic hardware. They are suitable for aeronautics, defense, railways, medical, and spatial devices. They communicate via CiA 301 CANopen application layer and general communication profile.

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Servo-drive cylinder

For in-door, out-door, and under-water use

Ultra Motion's Servo Cylinders are available with CANopen and J1939 connectivity. The CANopen variant implements the CiA 402 CANopen device profile for drives and motion controllers.

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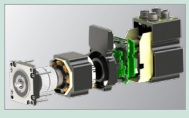

Stepper motors

With integrated CANopen drive functions

JVL (Denmark) offers the Servostep integrated stepper motors with an updated implementation of the CANopen protocol.

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