maxon motor control Technology – short and to the point

Controllers

The **maxon motor control** program contains servo amplifiers for controlling the fast reacting maxon DC and EC motors.
Special characteristics:
- built-in additional inductance for operation with low-inductance motors.
- high PWM frequencies (>50 kHz)
- high efficiency

The **zub machine controllers** are programmable master controllers for sophisticated multi-axis systems
- EtherCAT and/or CANopen master (and/or slave)
- Highly dynamic drive synchronization
- Curve interpolation (camming)

Program

- **DEC module: 1-Q speed controller (closed loop) for brushless (maxon EC) motors**
- **ESCON: 4-Q speed and current controller for DC and EC motors**
- **EPOS: Position controller for DC and EC motors**
- **MACS5, MiniMACS, MasterMACS: Programmable multi-axis masters**

Motor type
- maxon DC motor
- maxon EC motor with or without sensor

Control variables
- Speed
- Position
- Current

Feedback
- Encoder
- DC Tacho
- IxR compensation
- Hall sensors

Set value specification
- Analog voltage
- Digitally via field bus

Set value specification

Servo controllers (speed and current controllers) are usually designed for analog specification of set values. Alternatively, PWM signals or fixed set values are also possible.

maxon positioning controllers (EPOS) require a higher-level master, which takes care of process control and sends individual commands to the positioning controller and to other slave modules in the system via the bus system (RS232, USB, CANopen, EtherCAT). Typically, the master reads the parameters of the slave modules (e.g., the current position or the status of an input), and uses them to generate new commands (e.g., a new target position or setting of an output). The master runs an application specific program.

Possible master systems
- zub motion control
- PLC
- Microcontroller
- PC

CANopen

EtherCAT

USB

RS232

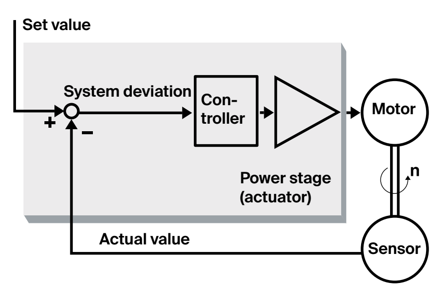
Controlled variables

Speed control
The function of the speed servo amplifier is to keep the prescribed motor speed constant and independent of load changes. To achieve this, the set value (desired speed) is continuously compared with the actual value (actual speed) in the control electronics of the servo amplifier. The controller regulates the power stage of the servo amplifier to eliminate this difference as much as possible. The control loop is closed.

Position control
The position controller ensures that the currently measured position matches a set position, by sending appropriate correction values to the power stage, just like the speed controller. The required position information is usually received from a digital encoder.

Current control
The current control provides the motor with a current proportional to the set value. Accordingly, the motor torque changes proportionally to the set value. The current controller improves the dynamics of a higher-level position or speed control loop.

Principle of a control circuit



Feedback sensors

Digital encoder control
The motor is equipped with a digital encoder that provides a certain number of pulses per revolution. Incremental or absolute encoders can be used (cf. p. 74: Encoder signals).
- Digital encoders are often found in positioning controls, in order to derive and measure the travel or angle.
- Digital encoders are not subject to mechanical wear.
- If an EC motor's Hall sensor signals are used for control, then the result is similar to using an incremental encoder with a low resolution.

Control concepts

DC tacho control
The motor must be equipped with a DC tacho-meter that provides a speed proportional signal. In the maxon modular system, the tachometer rotor is mounted directly on the through motor shaft, resulting in a high resonant frequency.
- Limited service life of the DC tacho generator
- For speed control only
- Analog feedback signal

IxR compensation
The motor is provided with a voltage that is proportional to the applied speed set value. The speed would drop with increasing motor load. The compensation circuitry increases the output voltage with increasing motor current. The compensation must be adjusted to the terminal resistance of the motor which depends on temperature and load.

The attainable speed precision of such a system is subject to limits in the percent range.
- Favorably priced and space-saving
- No tacho-generator or encoder required
- Only analog speed control possible
- Less precise control when there is a load change
- Ideal for low-cost applications without high demands on speed accuracy

Traditional PI or PID controllers often additionally use a feed forward that is proportional to speed and acceleration in order to compensate for friction and inertia.

More sophisticated control concepts may also be used on a case-by-case basis. These include
- Observer-supported control
- Sensorless control through evaluation of motor parameters (EMF, impedance)
- Dual loop control for load-side control with compensation of backlash and elasticity
- Gain scheduling

One key aspect for users is automatic controller tuning, which is available as standard for all maxon motor control products and ensures optimum system adjustment.

Multi-axis motion controllers

Multi-axis motion controllers are freely programmable controllers that make it possible to easily synchronize coordinated movements of several axes. Powerful commands are provided, for example for completing the following tasks (among others)

- PLC functionality as a sequential program (cyclical processing) or as state machines that work in parallel
- Coordinated time or path-synchronous multi-axis positioning
- Synchronous execution of CAM profiles (cam disks) on several axes
- Control of freely definable path trajectories with different kinematics (X-Y tables, 3D plotters, Scara robots, Delta robots…)
- Master-slave synchronization of several axes with marker comparison.

Principle: Multi-axis motion controllers