# maxon EC motor iron-cored winding
## Technology – short and to the point

Characteristics of the **maxon EC motors** with iron winding:
- Brushless DC motor (BLDC)
- Long service life
- Comparatively high inertia
- Motor characteristics may vary from the strongly linear behaviour
- Hall sensor signals utilizable for simple speed and position control
- Multipole NdFeB permanent magnet
- Smaller commutation steps
- Winding with iron core and several teeth per phase in the stator
- Low detent torque
- Good heat dissipation, high overload capacity

Properties of the **maxon ECX TORQUE**-Programs:
- Highly dynamic due to internal, multipole rotor
- Mechanical time constants below one millisecond
- High torque density
- Easily configured online
- Fast delivery

Properties of the **maxon IDX** program:
- High continuous torque
- High power density
- IP65-protected design
- Easily configured online

Characteristics of the **maxon EC-i** program:
- Highly dynamic due to internal, multipole rotor
- Mechanical time constants below 3 ms
- High torque density
- Speeds of up to 15,000 rpm

Properties of the **maxon ECX-FLAT** and **EC-flat** programs:
- Attractive price-performance ratio
- High torques due to external, multipole rotor
- Excellent heat dissipation at higher speeds thanks to open design
- Variants with open rotor or fan for even higher torques
- Flat design for when space is limited

## Program

- **ECX TORQUE**
- **IDX**
- **ECX FLAT**
- **EC-i**
- **EC flat**

- **with Hall sensors**
- **sensorless**
- **with integrated electronics**

1 Flange, front
2 Housing
3 Laminated steel stack
4 Winding
5 Permanent magnet
6 Shaft
7 Print with Hall sensors
8 Ball bearing
9 Spring (bearing preload)
10 Flange, rear

## Electronical commutation

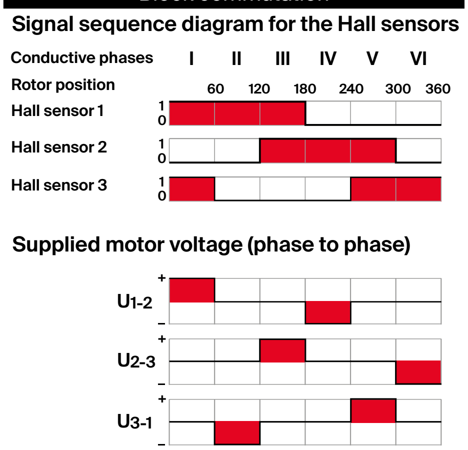
**Block commutation**
Rotor position is reported by three built-in Hall sensors which deliver six different signal combinations per commutation sequence. The three phases are powered in six different conducting phases in line with this sensor information. The current and voltage curves are block-shaped. The switching position of every electronic commutation lies symmetrically around the respective torque maximum.

**Properties of block commutation**
- Relatively simple and favorably priced electronics
- Controlled motor start-up
- High starting torques and accelerations possible
- Servo drives, start/stop operation
- Positioning tasks
- The data of the maxon EC motors are determined with block commutation.

**Sensorless block commutation**
The rotor position is determined using the progression of the induced voltage. The electronics evaluate the zero crossing of the induced voltage (EMF) and commute the motor current after a speed dependent pause (30°e after EMF zero crossing).
When stalled or at low speed, the voltage signal is too small and the zero crossing cannot be detected precisely. This is why special algorithms are required for starting (similar to stepper motor control). To allow EC motors to be commuted without sensors in a Δ arrangement, a virtual star point is usually created in the electronics.

**Properties of sensorless commutation**
- No defined start-up
- Not suitable for low speeds and for dynamic applications
- Continuous operation at higher speeds (Fans, pumps)

**Block commutation**




**Sensorless commutation**

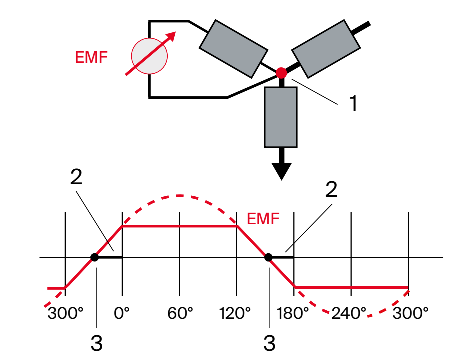
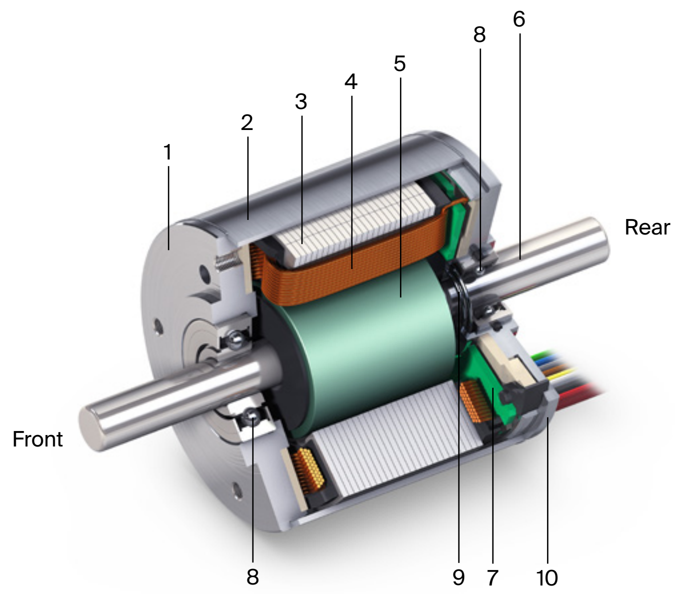
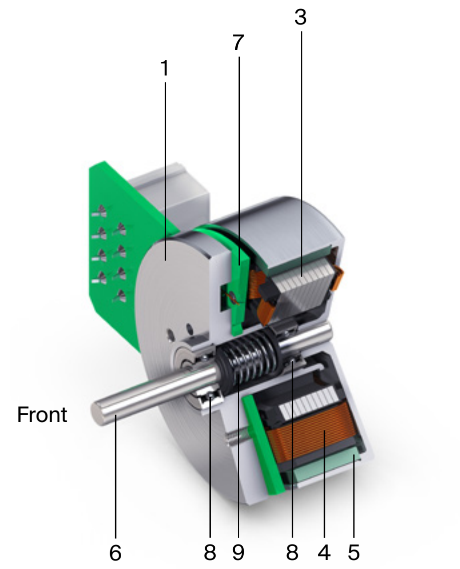



Diagram applies to phase 1

**Legend**
The commutation angle is based on the length of a full commutation sequence (360°e). The length of a commutation interval is therefore 60°e.
The values of the shaft position can be calculated from the commutation angle divided by the number of pole pairs.



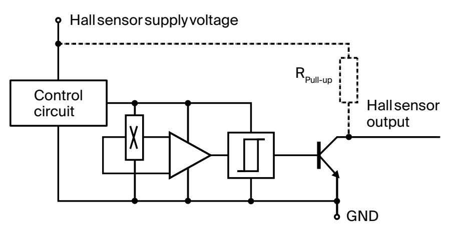




**Sinusoidal commutation**
Sinusoidal commutation or field-oriented control (FOC) for EC motors with grooved winding is possible. The main benefit of sinusoidal commutation – the smooth operation – only comes into play to a limited degree due to the detent.

## Hall sensor circuit

The open collector output of Hall sensors does not normally have its own pull-up resistance, as this is integral in maxon controllers. Any exceptions are specifically mentioned in the relevant motor data sheets.

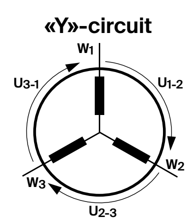
Wiring diagram for Hall sensors

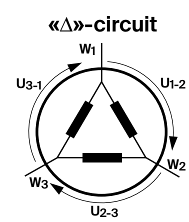



The power consumption of a Hall sensor is typically 4 mA (for output of Hall sensor = "HI").

## Winding arrangement

The winding is divided into 3 partial windings which have several stator teeth each. The partial windings can be connected in two different manners - "Y" or "Δ". This changes the speed and torque inversely proportional by the factor $\sqrt{3}$.
However, the winding arrangement does not play a decisive role in the selection of the motor. It is important that the motor-specific parameters (speed and torque constants) are in line with requiremenats.




## Bearings and service life

The long service life of the brushless design can only be properly exploited by using preloaded ball bearings.
- Bearings designed for tens of thousands of hours
- Service life is affected by maximum speed, residual imbalance and bearing load

**Legend**
**1** Star point
**2** Time delay 30°
**3** Zero crossing of EMF

For further explanations, please see page 188 or "The selection of high-precision microdrives" by Dr. Urs Kafader.