maxon EC frameless motor Technology – short and to the point

In **EC frameless motor** kits, rotor and stator are delivered separately, without bearings and motor shaft. The motor is operational only when the two components are assembled

Characteristics of the **maxon EC frameless motors:**
- Brushless DC (BLDC) direct drive motor
- Long service life
- High torque grace to multi-pole motor design with NdFeB permanent magnet
- Winding with iron core and several teeth per phase in the stator
- Low detent torque
- Motor characteristics may vary from the strongly linear behavior
- Good heat dissipation, high overload capacity
- Sensor for supervising the temperature (NTC hot conductor)
- Space-saving integration into the application
- Hall sensor signals utilizable for simple speed and position control
- Flat design for space saving application integration
- Hollow shaft for transfering cables, vacuum lines, light, ...

Characteristics of the **maxon EC frameless flat** program:
- High torques due to external, multipole rotor
- Speeds of up to 10 000 rpm
- Hall sensor signals for simple speed and position control.

Properties of the maxon **EC frameless Dynamic Torque (DT)** Programs:
- Highly dynamic due to internal, multipole rotor
- Mechanical time constants below one millisecond
- High torque density
- Speeds of up to 5000 rpm
- optional TSX encoder with additional commutation signals

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 commutation rotor position is identical to the motor shaft position for motors with 1 pole pair. The values of the shaft position are halved for motors with 2 pole pairs.

Program

- **EC frameless flat**
- **EC frameless DT**

- **with Hall sensors**
- **sensorless**

1 Stator packet
2 Winding
3 Rotor
4 Permanent magnet
5 Circuit board with Hall sensors

Electronical commutation

Block commutation with Hall sensors
The rotor position is reported by three built-in Hall sensors or by the optional TSX encoder. The Hall sensors are set at an angle of 120° to one another and provide six different signal combinations per turn. The three partial windings are now powered in six different conductive phases, depending on the sensor information. The current and voltage supply are block-shaped. The switching position of each electronic commutation is offset 30° from the respective torque peak.

Properties of block commutation
- Relatively simple and favorably priced electronics
- Torque ripple of 14%
- 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.

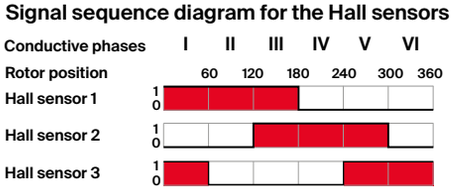
Sinusoidal commutation
Sinusoidal commutation or field-oriented control (FOC) for frameless EC motors with slotted winding is possible. However, the main benefit of sinusoidal commutation – the smooth operation – only comes into play to a limited degree due to the detent.

The high-resolution signals from the encoder are used for generating sine-shape motor currents in the electronics. The currents through the three motor windings are related to the rotor position and are shifted at each phase by 120° (sinusoidal commutation). This results in the theoretically very smooth, precise running of the motor and, in a very precise, high quality control.

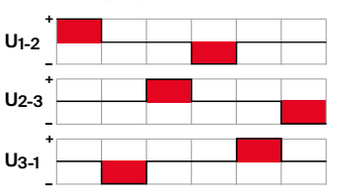
Properties of sinusoidal commutation
- More expensive electronics
- Requires an encoder
- Precise, high quality field-oriented control (FOC)
- Approx. 5% more continuous torque compared to block commutation
- Highly dynamic servo drives
- Positioning tasks

Block commutation

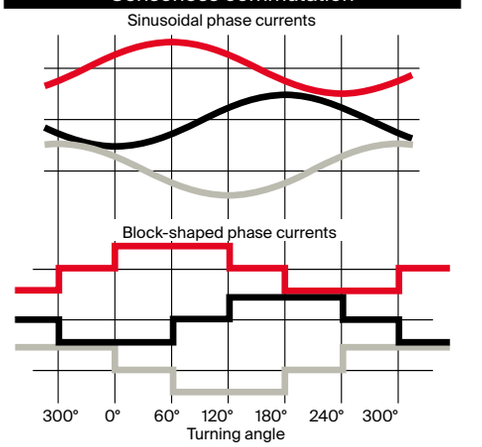
Signal sequence diagram for the Hall sensors

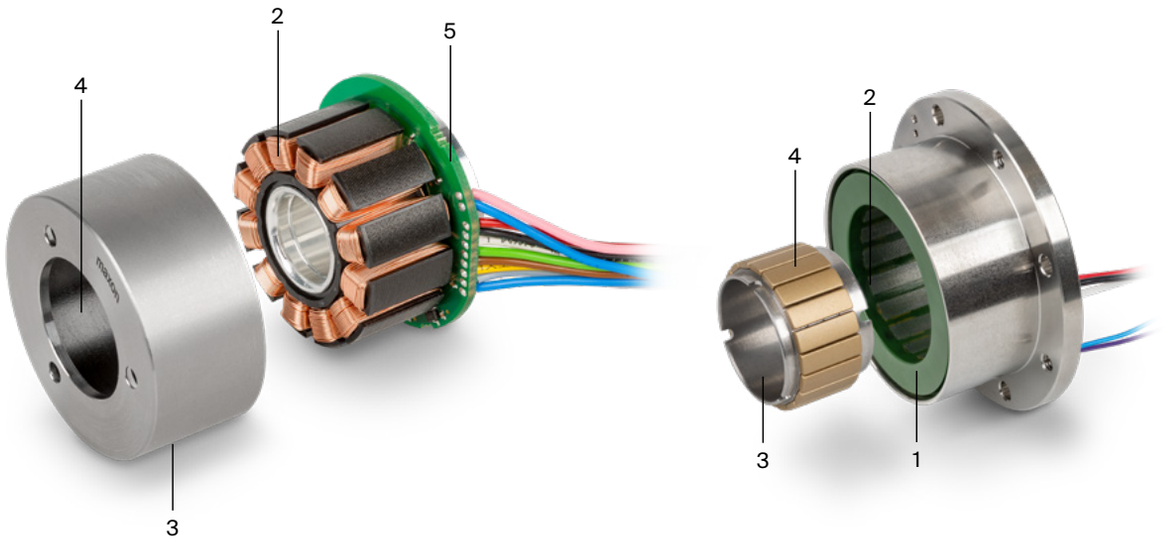


Supplied motor voltage (phase to phase)



Sensorless commutation



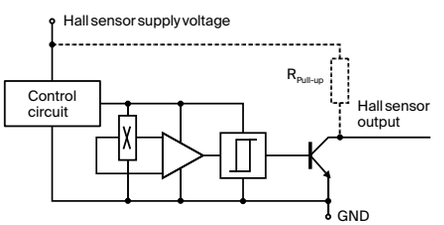


TSX MAG encoder
The optional TSX MAG encoder module can be combined with the EC frameless DT motors. The rotor of the motor needs to be equipped with an additional magnetic target ring.
The TSX MAG module will be placed on the stator leaving the hollow rotor shaft free and programmed to deliver proper commutation signals as well. Hence, rotor and stator need to be paired.
The TSX MAG encoder resolution can be freely configured up to 2560 counts per turn.

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”).

Integration and service life

Frameless motors are direct drives that are integrated in the application. The installation instructions available on the maxon website give detailed specification for optimum assembly.
The service life will be mainly defined by the chosen bearing assembly and the operational conditions (bearing load, speed).