Explanation of maxon EC motor terminology

maxon motor

Dimensional drawings
Presentation of the views according to the projection method E (ISO).
All dimensions in [mm].

Motor Data
The values in lines 2–15 are valid when using block commutation.

1   Nominal voltage U_N [Volt]
is the applied voltage between two powered phases in block commutation. See page 44 for the timing diagram of the voltage in the three phases. All nominal data (lines 2–9) refer to this voltage. Lower and higher voltages are permissible, provided that limits are not exceeded.

2   No load speed n_0 [rpm] ±10%
is the speed at which the unloaded motor runs with the nominal voltage applied. It is approximately proportional to the applied voltage.

3   No load current I_0 [mA] ±50%
This is the typical current that the unloaded motor draws when operating at nominal voltage. It increases with rising speed owing to bearing friction and iron losses. No load friction depends heavily on temperature. It decreases in extended operation and increases at lower temperatures.

4   Nominal speed n_N [rpm]
is the speed set for operation at nominal voltage and nominal torque at a motor temperature of 25°C.

5   Nominal torque M_N [mNm]
is the torque generated for operation at nominal voltage and nominal current at a motor temperature of 25°C. It is at the limit of the motor's continuous operation range. Higher torques heat up the winding too much.

6   Nominal current I_N [A]
is the current in the active phase in block commutation that generates the nominal torque at the given nominal speed (= max. permissible continuous load current). The maximum winding temperature is reached at 25°C ambient temperature in continuous operation with I_N. I_N decreases as speed increases due to additional losses in the lamination.

7   Stall torque M_H [mNm]
is the linearly calculated load torque for motors that causes the shaft to stall at nominal voltage. With EC-flat and EC-i motors, this torque often cannot be achieved due to saturation effects.

8   Stall current I_A [A]
is the quotient from nominal voltage and the motor's terminal resistance. Stall current is equivalent to stall torque. With larger motors, I_A cannot often be reached due to the amplifier's current limits.

9   Max. efficiency η_{max} [%]
is the calculated load torque that brings the shaft to standstill at nominal voltage. It also doesn't always denote the optimal operating point.

10   Terminal resistance phase to phase R [Ω]
is determined by the resistance at 25 °C between two connections of the standard resolution.

11   Terminal inductance phase to phase L [mH]
is the winding inductance between two connections. It is measured at 1 kHz, sinusoidal.

12   Torque constant k_M [mNm/A]
This may also be referred to as «specific torque» and represents the quotient from generated torque and applicable current.

13   Speed constant k_n [rpm/V]
indicates the theoretical no load speed per volt of applied voltage, disregarding friction losses.

14   Speed/torque gradient
Δ_n/Δ_M [rpm/mNm]
The speed/torque gradient is an indicator of the motor's performance. The smaller the value, the more powerful the motor and consequently the less motor speed varies with load variations. It is based on the quotient of ideal no load speed and ideal stall torque (tolerance ± 20%).
The real characteristic curve depends on the speed for EC motors with slotted winding (EC flat and EC-i); it is steeper at high speeds and flatter at slow speeds. The real gradient at nominal voltage can be approximated by a straight line between no load speed and the nominal operating point (see page 57).

15   Mechanical time constant τ_m [ms]
is the time required for the rotor to accelerate from standstill to 63% of its no load speed.

16   Rotor moment of inertia J_R [gcm^2]
is the mass moment of inertia of the rotor, based on the axis of rotation.

**17   Thermal resistance
        housing-ambient** R_{th2} [K/W]
and
**18   Thermal resistance
        winding-housing** R_{th1} [K/W]
Characteristic values of thermal contact resistance without additional heat sinking. Lines 17 and 18 combined define the maximum heating at a given power loss (load). Thermal resistance R_{th2} on motors with metal flanges can decrease by up to 80% if the motor is coupled directly to a good heat-conducting (e.g. metallic) mounting rather than a plastic panel.

19   Thermal time constant winding τ_w [s]
and
20   Thermal time constant motor τ_s [s]
These are the typical reaction times for a temperature change of winding and motor. It can be seen that the motor reacts much more sluggishly in thermal terms than the winding. The values are calculated from the product of thermal capacity and given heat resistances.

21   Ambient temperature [°C]
Operating temperature range. This derives from the heat reliability of the materials used and viscosity of bearing lubrication.

22   Max. winding temperature [°C]
Maximum permissible winding temperature.

23   Max. speed n_{max} [rpm]
is the maximum recommended speed based on thermal and mechanical perspectives. A reduced service life can be expected at higher speeds.

24   Axial play [mm]
On motors that are not preloaded, these are the tolerance limits for the bearing play. A preload cancels out the axial play up to the specified axial force. When load is applied in the direction of the preload force (away from the flange), the axial play is always zero. The length tolerance of the shaft includes the maximum axial play.

25   Radial play [mm]
Radial play is the bearing's radial movement. A spring is utilized to preload the motor's bearings, eliminating radial play up to a given axial load.

26/27 Max. axial load [N]
Dynamically: axial loading permissible in operation. If different values apply for traction and thrust, the smaller value is given.
Statically: maximum axial force applying to the shaft at standstill where no residual damage occurs.
Shaft supported: maximum axial force applying to the shaft at standstill if the force is not input at the other shaft end. This is not possible for motors with only one shaft end.

28   Max. radial load [N]
The value is given for a typical clearance from the flange; this value falls the greater the clearance.

29   Number of pole pairs
Number of north poles of the permanent magnet. The phase streams and commutation signals pass through per revolution p cycles. Servo-controllers require the correct details of the number of pole pairs.

30   Number of phases
All maxon EC motors have three phases.

31   Weight of motor [g]

32   Typical noise level [dBA]
is that statistical average of the noise level measured according to maxon standard (10 cm distance radially to the drive, no load operation at a speed of 6,000 or 50,000 rpm. The drive lies freely on a plastic foam mat in the noise chamber).
The acoustic noise level depends on a number of factors, such as component tolerances, and it is greatly influenced by the overall system in which the drive is installed. When the drive is installed in an unfavorable constellation, the noise level may be significantly higher than the noise level of the drive alone.
The acoustic noise level is measured and determined during product qualification. In manufacturing, a structure-borne noise test is performed with defined limits. Impermissible deviations can thus be identified.

33   Max. torque M_{max} [mNm]
Maximum torque the motor can briefly deliver. It is limited by the overload protection of the electronics.

34   Max. current I_{max} [A]
Surge current with which the peak torque is generated at nominal voltage. With an active speed controller, surge current is not proportionate to the torque, but also depends on the supply voltage. As a result, this value only applies at nominal voltage.

35   Type of control
«Speed» means that the drive is fitted with an integral speed controller. «Controlled» means that the drive is fitted with true commutation electronics.

36   Supply voltage $+V_{CC}$ [V]
Range of supply voltages measured in respect of GND at which the drive functions.

37   Speed set value input U_C [V]
Range of analog voltage for set speed value measured in respect of GND. For 2 wire solutions, the supply voltage acts as speed setting at the same time.

38   Scaling Set speed value input k_c [rpm/V]
Set speed value n_c is based on the product $n_c = k_c \cdot U_c$.

39   Speed range
Achievable speeds in the controlled range.

40   Max. acceleration
The set speed value follows a sudden set point change with a ramp. This value indicates the increase in the ramp.

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