DC CORELESS MOTORS AND GEARHEADS

Selection Guide

Coreless motor selection

EXAMPLE OF SELECTION IN CONTINUOUS OPERATION

Application requested data:
- Operating speed : N_R = 4000 rpm (working point)
- Operating torque : T_R = 1.4 mNm (working point)
- Max. voltage supply : U_{max} = 10 VDC
- Max. current supply : I_{max} = 0.2 A
- Ambient temperature : T_a = 25 °C
- Motor type : DC coreless motor
- Max. motor length : L_{max} = 35 mm
- Max. motor diameter : ϕ_{max} = 13 mm

Step 1. Motor type and physical dimensions
Consider motor technology and physical dimensions when selecting the potential candidates from the catalog. In this example coreless motors up to SCL12-30 series (ϕ = 12.5 x L = 32 mm) will be considered.

Step 2. Working point and max. continuous values
Knowing the motor working point, NR = 4000 rpm and TR = 1.4 mNm, select from datasheets all motors where working point is inside of the continuous operating area. In this example SCL12-22 (max. continuous torque 1.6 mNm) and SCL12-30 series will be considered (max. continuous torque 2.09 mNm).

Step 3. Voltage and current supply
Verify if selected motors are able to operate at the working point with the available max. current and voltage supply.

- Current absorbed at working point, I_R [A]

$$I_R = \frac{1}{k_M} \cdot (T_F + T_R) \qquad \text{[eq. 1]}$$

T_F = Motor friction torque [mNm], K_M = Motor torque constant [mNm/A]

- Motor voltage at woring point, U_R [VDC]

$$U_R = \frac{N_R \cdot k_E}{1000} + R \cdot I_R \qquad \text{[eq. 2]}$$

R= Motor terminal resistance at 25 ° C [Ω], K_E = Back-EMF constant

Result of calculation
SCL12-2204 ⏩ I_R = 0.46 A, U_R = 3.1 VDC ⏩ I_R too high
SCL12-2222 ⏩ I_R = 0.18 A, U_R = 7.4 VDC ⏩ Ok
SCL12-3005 ⏩ I_R = 0.30 A, U_R = 3.4 VDC ⏩ I_R too high
SCL12-3020 ⏩ I_R = 0.15 A, U_R = 7.1 VDC ⏩ Ok
SCL12-3043 ⏩ I_R = 0.14 A, U_R = 10.4 VDC ⏩ U_R too high

In red where motor current and/or voltage exceed power supply limits.

Note: In this catalog only standard coils are shown. If desired, Namiki can provide different coils to meet specific working points. Please consult our sales section for details.

Step 4. Motor performance analysis
Once the motors operatable at the working point have been defined performance around the working point can be calculated.

- Motor output power at working point, Pout [W]

$$P_{out} = \frac{\pi}{30000} \cdot T_R \cdot N_R \qquad \text{[eq. 3]}$$

- Motor efficiency at working point, η [%]

$$\eta = \frac{P_{out}}{U_R \cdot I_R} \cdot 100 \qquad \text{[eq. 4]}$$

Result of calculation
SCL12-2222 ⏩ Pout = 0.59 W, η = 43 % ⏩ Second choice
SCL12-3020 ⏩ Pout = 0.59 W, η = 55 % ⏩ First choice

Step 5. Thermal considerations
The described procedure is generally suitable for most of the cases. However, if more accurate calculation is required then thermal behavior at working point can be considered.

- Motor coil temperature at working point, Tc [°C]

$$Tc = \frac{R \cdot (R_{th1} + R_{th2}) \cdot I_R^2 \cdot (1 - \alpha \cdot 25°C) + Ta}{1 - \alpha \cdot R \cdot (R_{th1} + R_{th2}) \cdot I_R^2} \qquad \text{[eq. 5]}$$

α = 0.004 [K^{-1}], R_{th1} & R_{th2} = thermal resistances [K/W]

- Motor coil resistance at working point, R_{wp} [Ω]

$$R_{wp} = R \cdot [1 + \alpha \cdot (Tc - 25\,°C)] \qquad \text{[eq. 6]}$$

By replacing R in [eq. 2] with R_{wp} repeat steps 3 & 4 considering the motor coil temperature. For safety operations coil temperature at working point must not exceed the maximum coil temperature indicated in the catalog.

Gearhead selection
If a motor-gearhead combination is requested, before proceeding with step 2, calculate working point at motor output shaft. For gearhead selection, where life expectancy is concerned, it is important to choose a product with an output torque higher than that required by the application and to operate the motor, by selecting the appropriate reduction ratio, at a continuous speed lower than the gearhead maximum recommended input speed.

- Speed and torque calculated at motor output shaft

$$N_{in} = N_{out} \cdot i \qquad T_{in} = \frac{T_{out}}{i \cdot \eta} \cdot 100$$

N_{out} = gearhead output speed, N_{in} = motor output speed (gearhead input speed), T_{out} = gearhead output torque, T_{in} = motor output torque (gearhead input torque), i = gearhead reduction ratio, η = gearhead efficiency [%]

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