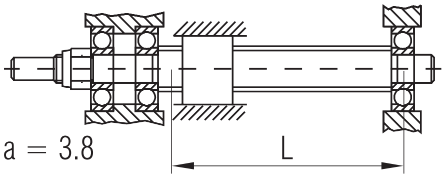
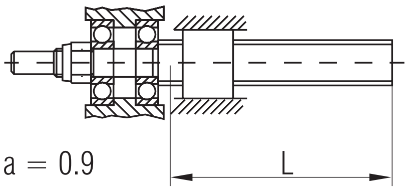
Theoretically Critical Speed





Definitions

n_{zul}	[min^{-1}]	Maximum permissible speed
a		Installation coefficient
d_2	[mm]	Core diameter of the spindle
L	[mm]	Centre-to-centre distance between the spindle bearings and the nut

Critical Speed

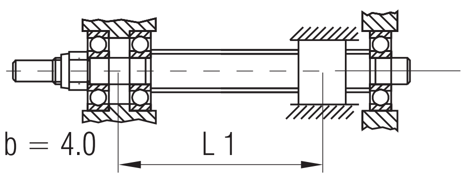
In most application cases, it is necessary to check the threaded spindles with regard to their critical speed.

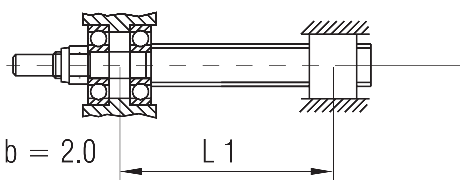
The critical speed of a threaded spindle is that speed which is caused by the spindle's resonance vibration.

This critical speed depends on the spindle's core diameter, self-supporting length and on the installation mode.

Considering the general safety factor of 0.8, the maximum permissible speed can be calculated as follows:

$$n_{zul} = 392 \frac{a \cdot d_2}{L^2} 10^5$$





Definitions

F_{zul}	[N]	Permissible pressure load
d_2	[mm]	Core diameter of the thread
L_1	[mm]	Free effective length, i.e. the maximum distance between bearing's and the nut's centre
b		Installation coefficient

Buckling Load

Under load, the ball screw spindle should only be strained subject to tension. In case pressure loads occur, the spindle's buckling has to be included into the calculation.

Considering a safety factor of 3.0, the following results:

$$F_{zul} = \frac{34{,}000 \cdot b \cdot d_2^4}{L_1^2}$$

Drive Dimensioning

Calculation of the Drive Torque

The necessary drive torque consists of:
- load torque M_{last}
- acceleration torques M_{trans} and M_{rot}
- nominal torque M_{leer}

$$M_A = M_{last} + M_{trans} + M_{rot} + M_{leer}$$

Load Torque

$$M_{last} = \frac{F_X \bullet p}{2 \bullet \pi \bullet 1000}$$

With feed force $F_X = m \bullet g \bullet \mu$

Translator. Acceleration Torque

$$M_{trans} = \frac{F_a \bullet p}{2 \bullet \pi \bullet 1000}$$

With feed force $F_a = m \bullet a$

At vertical operation, the gravity $g = 9{,}81 m/s^2$ has to be added to the mass acceleration a.

Rotator. Acceleration Torque

$$M_{rot} = \frac{J_{sp} \bullet L \bullet n_{max} \bullet a \bullet 2 \bullet \pi}{V_{max} \bullet 60 \bullet 1000}$$

Rotator. Acceleration torque

$$P = \frac{M_A \bullet n_{max}}{9550}$$

Definitionen

M_A	[Nm]	Necessary drive torque
M_{last}	[Nm]	Moment resulting from the different loads
M_{leer}	[Nm]	Rotatory acceleration torque
M_{trans}	[Nm]	Translatory acceleration torque
Fx	[N]	Feed force
g	[m/s^2]	Gravity
v_{max}	[m/s]	Maximum traverse speed
m	[kg]	The mass to be transported
a	[m/s2]	Acceleration
p	[mm]	Spindle pitch
P	[kW]	Power
L	[mm]	Length
n_{max}	[min-1]	Maximum speed
μ		Coefficient of friction
J_{sp}	[kgm^2/m]	The spindle's mass moment of inertia per metre
F_a	[N]	G force