Rexroth – Precision Ball Screw Assemblies
Design Calculations

Critical Speed n_k

The critical speed n_k depends on the diameter of the screw, the type of end fixity and the free length l_n. No allowance must be made for guidance by a nut without preload.

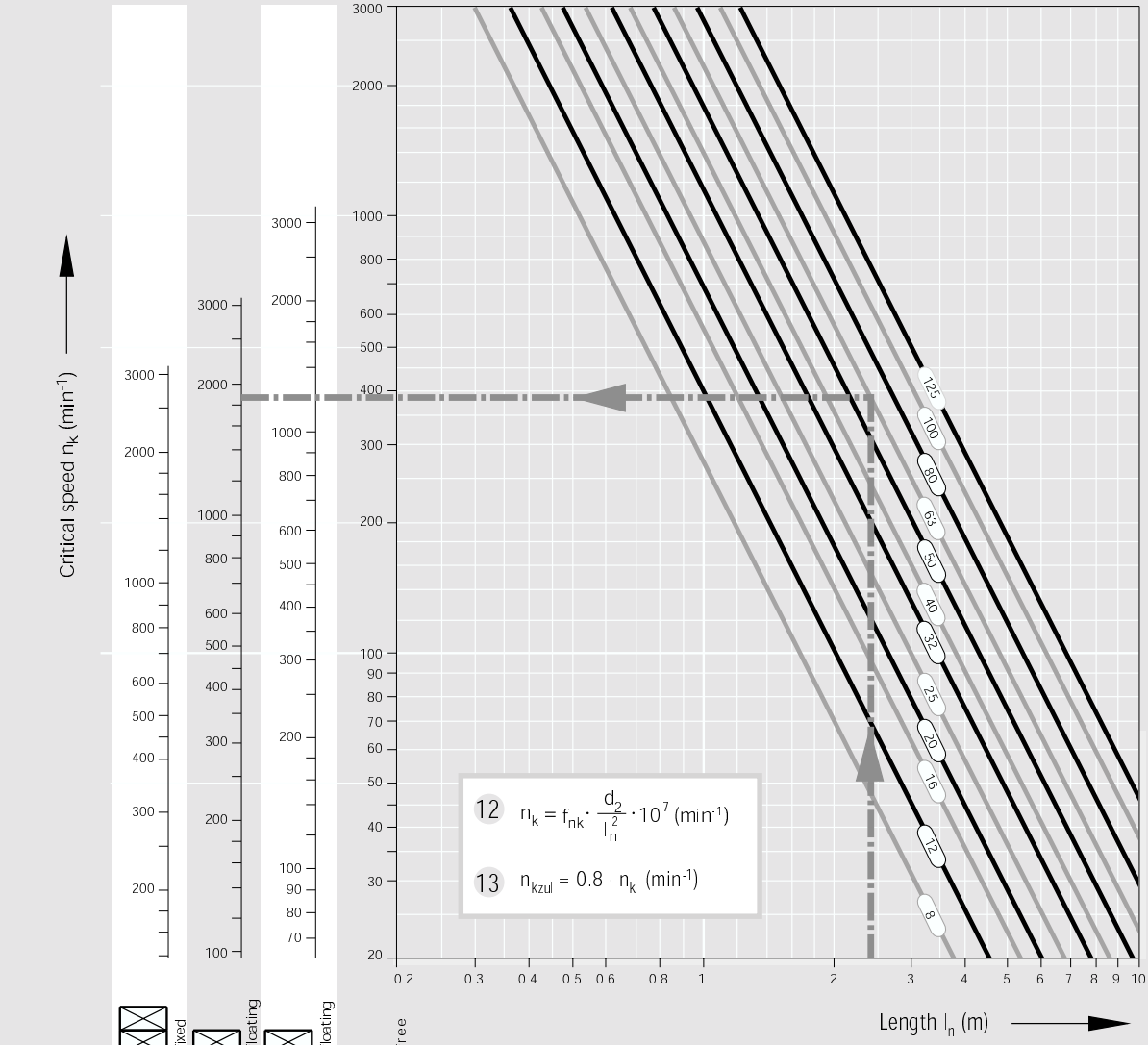
The operating speed should not reach more than 80% of the critical speed. The characteristic speed and the max. permissible linear speed must be taken into account, see "Technical Notes" P.95

Example

Screw diameter = 63 mm
Length l_n = 2.4 m
End fixity II (fixed - supported)

According to the graph, the critical speed is 1850 min^{-1}.
The permissible operating speed is thus 1850 min^{-1} x 0.8 = 1480 min^{-1}.

The maximum operating speed in our calculation example of n_4 = 1000 min^{-1} is therefore below the permissible operating speed.



End fixity	I	II	III	IV
f_{nk} value	27.4	18.9	12.1	4.3

n_k = critical speed (min^{-1})
n_{kzul} = permissible operating speed (min^{-1})
f_{nk} = corrector value determined by bearing
d_2 = root diameter (mm), see Dimension Tables
l_n = critical length (mm) for preloaded nut systems
l_1 = threaded length (mm)

Where $l_n = l_1$ for non-preloaded nut systems

For screw ends form 31 (P. 62) the end fixity can be assumed to be "fixed".

Permissible axial load on screw F_k (buckling load)

The permissible axial load on the screw F_k depends on the diameter of the screw, the type of end fixity and the effective free (unsupported) length l_k. A safety factor of $g \geq 2$ should be taken into consideration when determining the permissible axial load.

Example

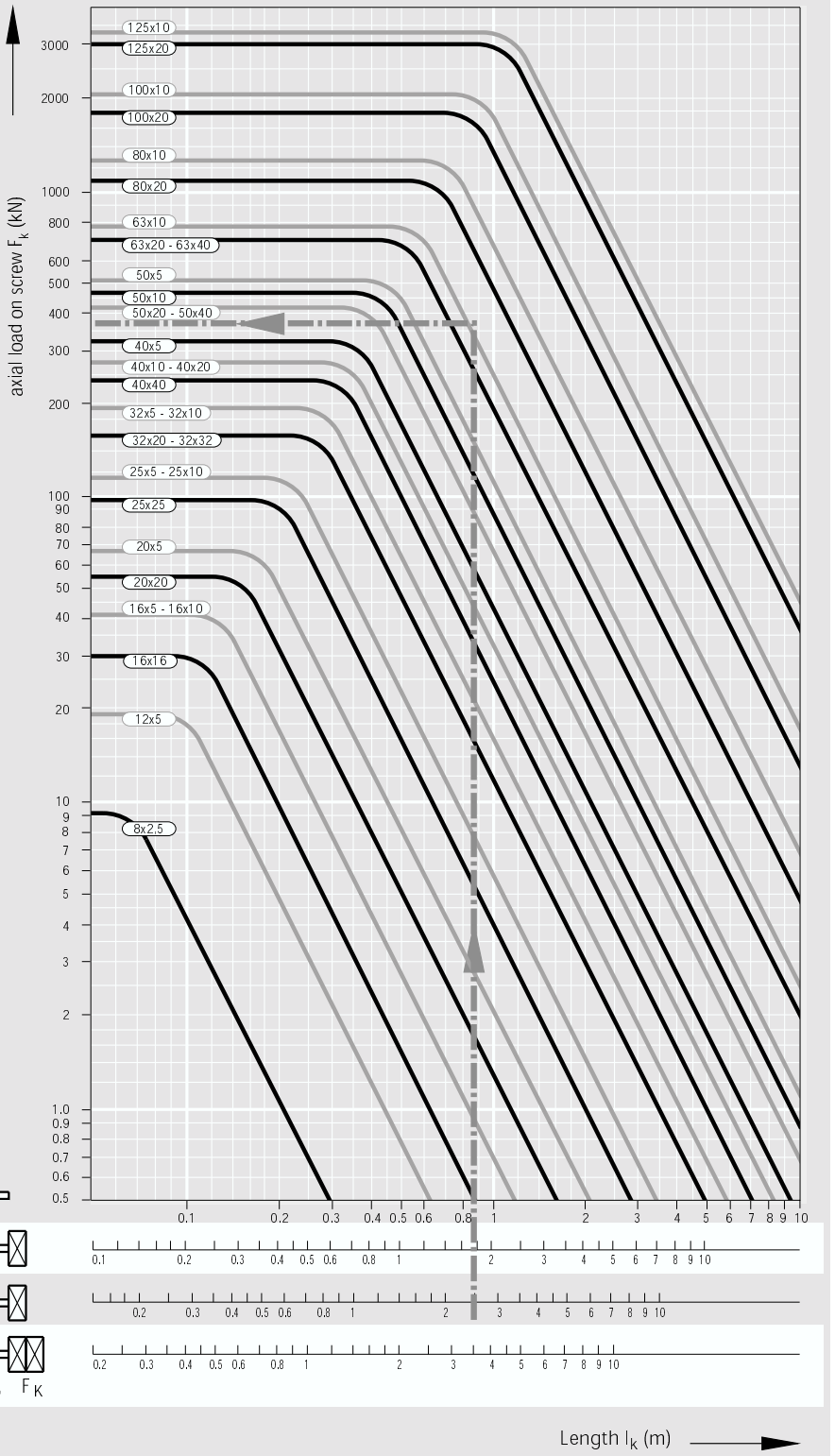
Screw diameter = 63 mm,
lead = 10 mm,
Length l_k = 2.4 m
End fixity II (fixed - supported)

According to the graph, the theoretically permissible axial load is 360 kN. A permissible axial load on the screw of 360 kN : 2 = 180 kN is achieved when applying the safety factor 2. This therefore lies above the maximum operating load of F_1 = 50 kN used in our calculation example.

14 $$F_k = f_{Fk} \cdot \frac{d_2^4}{l_k^2} \cdot 10^4 \text{ (N)}$$

15 $$F_{kzul} = \frac{F_k}{2} \text{ (N)}$$

F_k = theoretically permissible axial load on screw
F_{kzul} = permissible axial load during operation
f_{Fk} = corrector value determined by bearing
d_2 = root diameter (mm) see Dimension Tables
l_k = unsupported threaded length (mm)



f_{Fk} value	End fixity	
2.6	IV	
10.2	III	
20.4	II	
40.6	I	l_k F_K