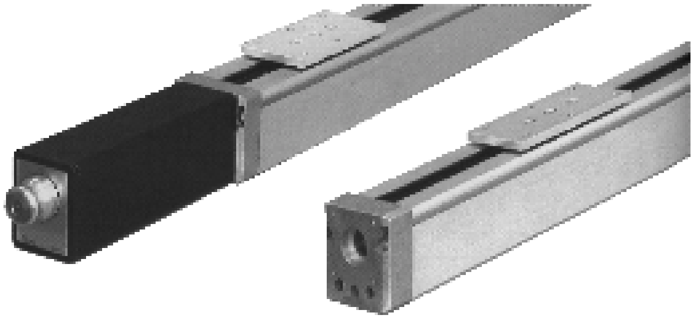
Selecting a Ball Screw Slide

First, you must determine...

Travel Distance
Load
Orientation of Load
Cycle Time
Max rpm of Screw
Max Speed
Max Acceleration
Required Torque to Drive Load



With this information, you can start to determine which ball screw slide is suitable for your application.

Loading Capacity and Life Expectancy

Fundamental Principle

The specification of a linear guide is based on the loading capacity of the individual element. The loading capacity is described by:

- the dynamic load data **C**
- the static load data C_0
- the static moments M_x, M_y, M_z

The basis of the dynamic load data, according to DIN standards, is a nominal life expectancy of 100,000 m travel. For a nominal life expectancy of 50,000 m, the load data is 20% higher than those values supplied in this catalog.

Dynamic Loading Capacity

The fatigue behavior of the materials determines the dynamic loading capacity. The life expectancy is dependent on:

- the load on the linear guide
- the travel speed of the linear guide
- the statistical contingency of the first defect taking place

Nominal Life Expectancy

The nominal life expectancy is achieved, or exceeded 90% of the time before the first indication of fatigue appears.

$$L = \left(\frac{C}{P}\right)^p \times 1 \times 10^5 m \quad (1)$$

$$L_h = \frac{833}{H \times n} \times \left(\frac{C}{P}\right)^p \quad (2)$$

$$L_h = \frac{1666}{V} \times \left(\frac{C}{P}\right)^p \quad (3)$$

L [m]	nominal life expectancy in meters
L_h [h]	nominal life expectancy in operating hours
C [N]	dynamic load
P [N]	dynamic equivalent load
p	Life expectancy index: ball-bearing linear guides: **p** = 3 roller bearing linear guides: **p** = 10/3

H [m] single stroke length

n [min] number of complete strokes per minute

v [m/min] average travel speed

Usable Life

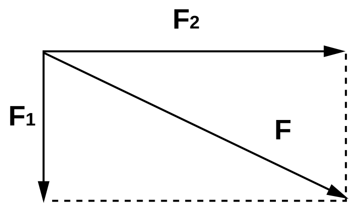
The actual life expectancy achieved by a linear guide is known as usable life. The usable life can deviate from the calculated life expectancy.

These conditions can lead to early defects:

- alignment error between guide rails or guide elements
- insufficient lubrication
- oscillatory motion with very small strokes (rippling)
- vibration during standstill (rippling)

Due to the variation in installations and operating conditions, it is not possible to determine the exact usable life of a linear guide in advance. The safest method to obtain a correct assessment of the usable life is to compare cases with similar installations.

Combined Loading Capacity



(4)

When the loading direction of an element does not coincide with one of the loading directions, this is the way the equivalent load is calculated as follows:

$$\mathbf{P} = |\mathbf{F_1}| + |\mathbf{F_2}| \qquad (5)$$

for a force **F** and a moment **M** at the same time, the dynamic equivalent load is:

$$\mathbf{P} = |\mathbf{F}| + |\mathbf{M}| \times \frac{\mathbf{C_0}}{\mathbf{M_0}} \qquad (6)$$

P [N] dynamic equivalent load

F [N] applied force = $\sqrt{\mathbf{F_1}^2 + \mathbf{F_2}^2}$

$\mathbf{F_1}$ [N] vertical components, see sketch (4)

$\mathbf{F_2}$ [N] horizontal components, see sketch (4)

$\mathbf{C_0}$ [N] static load in the direction of the applied force

M [N·m] applied moment

$\mathbf{M_0}$ [N·m] static moment in the direction of the applied moment

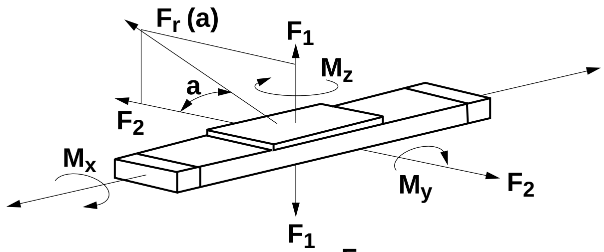
According to DIN standards, the dynamic equivalent load should not exceed the value **P** = 0.5 x **C**.

1 TECHNICAL INFORMATION

Load and Moment Data for Techno Ball Screw Driven Slides

Model	Standard-Duty	Heavy-Duty 2	Narrow Profile 1	Narrow Profile 2
# of carriages	**4 carriages**	**4 carriages**	**1 carriage**	**1 or 2 carriages**
Carriage type	**Series 1 Carriage 1**	**Bearing Carriage 4**	**Series 1 Carriage 1**	**Bearing Carriage 4**
F1 stat [N]	430	800	430	800
F1 dyn [N]	400	500	400	500
F2 stat [N]	430	800	430	800
F2 dyn [N]	400	500	400	500
Mx stat [N·m]	7.3	12.6	7.3	12.6
My stat [N·m]	3.7	22	3.7	22
Mz stat [N·m]	3.7	12.6	3.7	12.6
Mx dyn [N·m]	7.3	7.4	7.3	7.4
My dyn [N·m]	3.7	13	3.7	13
Mz dyn [N·m]	3.7	7.4	3.7	7.4

NOTE: See formulas in load bearing mechanisms' section of technical section.
Load and moment data are per carriage.



$$F_r(a) = \frac{F_2}{\cos a}$$

$$F_r(a) = \frac{F_1}{\sin a}$$

Drive Dimensioning and Calculation of Drive Torque

The nominal drive torque consists mainly of 'load torque', 'acceleration torque' and 'no-load torque'.

Definitions

M_A [N·m]	required drive torque	F_E [N]	external force
M_{Last} [N·m]	resulting load torque	**p** [mm]	screw lead
M_{NLT} [N·m]	no load torque*	**m**[kg]	total mass to be moved
M_{rot} [N·m]	rotary acceleration torque	**a** [m/s²]	acceleration
M_{trans} [N·m]	acceleration torque	**P** [kW]	driving power
F_X [N]	feed force	n_{max}[1/min]	max. speed
F_a [N]	acceleration force	μ	friction factor = 0.05
g [m/s²]	gravity = 9.81	M_E [N·m]	external load torque
V_{max} [m/s]	max feedrate	J_{syn}[Kgm²/m] = 0.0000325	

m = mass of load + mass of carriage(s)
*relevant data are given on the following data sheets for the Ball Screw Slides

Acceleration Force F_a

$$F_a = m \times a$$

with vertical loads, the acceleration to gravity g must be added to the mass acceleration (g=9.81 m/s²)

Feed Force F_x

$$F_x = m \times g \times \mu$$

External Torque M_E

$$M_E = \frac{F_E \times d_0}{2 \times 1000}$$

Resulting Torque M_{Last}

$$M_{Last} = \frac{F_x \times p}{2\pi \times 1000}$$

Driving Power P

$$P = \frac{M_A \times n_{max} \times 2\pi}{60 \times 1000}$$

Acceleration Torque M_{trans}

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

Rotary Acceleration Torque M_{rot}

$$M_{rot} = \frac{J_{syn} \times L \times n_{max} \times 9 \times 2\pi}{V_{max} \times 60 \times 1000}$$

Drive Torque Formula: $M_A = M_{Last} + M_{trans} + M_{rot} + M_{NLT} + M_E$

No-Load Torque Charts

Standard-Duty Slides

No-Load Speed (rpm)	No-Load Torque (N • m) Screw Pitch		
	5	10	20
500	0.18	0.2	0.21
1500	0.22	0.24	0.25
3000	0.26	0.29	0.3

Heavy-Duty 2 Slides

No-Load Speed (rpm)	No-Load Torque (N • m) Screw Pitch			
	2.5	5	10	20
500	0.18	0.2	0.21	0.22
1500	0.24	0.24	0.25	0.26
3000	0.26	0.29	0.3	0.32

Narrow Profile 1 Slides

No-Load Speed (rpm)	No-Load Torque (N • m) Screw Pitch		
	5	10	20
500	0.14	0.15	0.16
1500	0.17	0.19	0.2
3000	0.2	0.22	0.23

Narrow Profile 2 Slides

No-Load Speed (rpm)	No-Load Torque (N • m) Screw Pitch			
	2.5	5	10	20
500	0.15	0.16	0.17	0.18
1500	0.19	0.19	0.2	0.21
3000	0.23	0.24	0.25	0.26