# Technical data for roller, design, mounting

### General technical data and calculations

**Speed**

$$v_{max} = 5 \text{ m/s}$$

**Acceleration**

$$a_{max} = 15 \text{ m/s}^2$$

**Temperature resistance**

$$-10\ °C < \vartheta < 40\ °C$$

**Lubrication**

All cam roller guide bearings are delivered with built-in lubrication felts.

**Condition on delivery**

Ungreased (greasing with Klüber Isoflex Topas NCA 52; see assembly instructions **3 842 527 226**)
Lubricating felts with reservoir are not greased.
Guide rods are ungreased.

**Definition of dynamic load rating C**

The radial loading of constant magnitude and direction which a linear rolling bearing can theoretically withstand for a nominal service life of 100 km distance traveled (acc. to ISO 14728 Part 1).

**Note regarding maximum load $F_{max}$**

The maximum loads apply to individual loads. Combining loads decreases the expected service life.

**Definition and calculation of nominal service life**

The calculated service life which an individual linear rolling bearing – or a group of apparently identical rolling element bearings operating under the same conditions – can attain with a 90% probability, based on the materials of normal manufacturing quality that are generally used today and under usual operating conditions (acc. to ISO 14728 Part 1) and optimal installation conditions.

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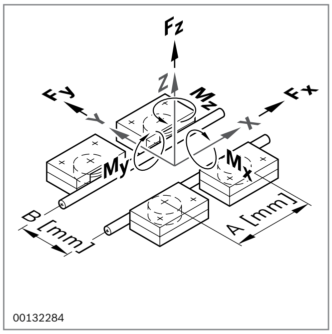
**Nominal service life at constant speed**

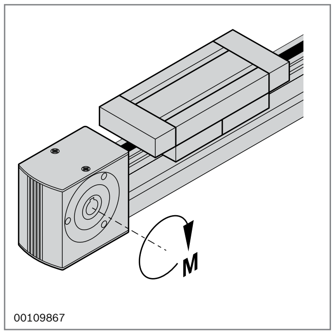
$$L = \left(\frac{C}{F}\right)^3 \cdot 10^5$$

$$L_h = \left(\frac{L}{2 \cdot s \cdot n_s \cdot 60}\right)$$

L = nominal service life (m)
$L_h$ = nominal service life (h)
C = dynamic load capacity (N)
F = equivalent load (N)
s = length of stroke* (m)
$n_S$ = stroke frequency (double stroke) ($min^{-1}$)

*) For s < 2 x $L_1$ (trolley length) load capacities are reduced.
Please consult us.




## Load-dependent design

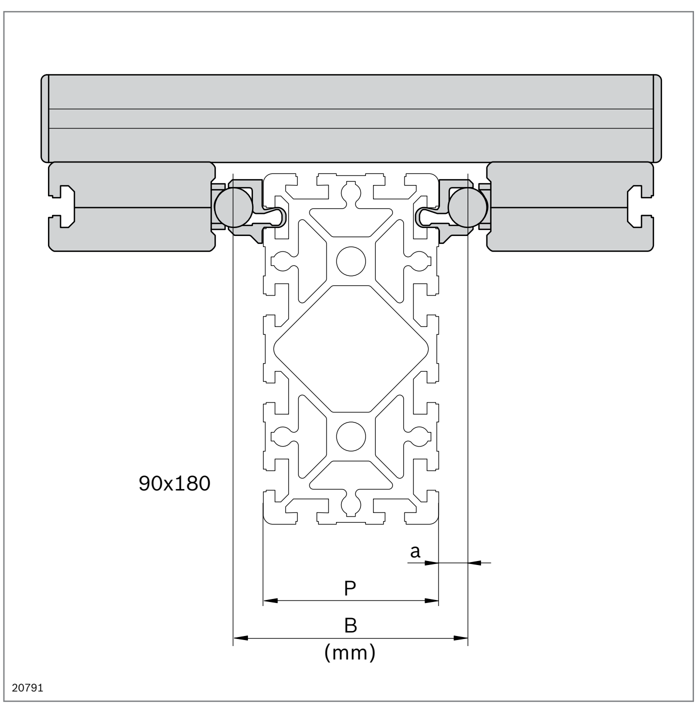
- The specified values are maximum single loads, which are reduced when loads are combined

**Note:** If cumulative forces and moments arise in your application, please use the Linear Motion Designer LF-MGE linear guide calculation program to recalculate your design (p. 13-57)

| | $A_{min}$ 1) (mm) | $F_z$ (N) | $F_y$(N) | $M_x$ (Nm) | $M_z$ (Nm) | $M_y$ (Nm) | $v_{max}$ (m/s) | $M_{max}$ (Nm) |
|---|---|---|---|---|---|---|---|---|
| **LF6S** | 75 | 850 | 1400 | 13.6 | 0.7 x A 2) | 0.4 x A 2) | 5 | 9.5 / 7.6 |
| **LF6C** | 75 | 850 | 1400 | 0.4 x B 2) | 0.7 x A 2) | 0.4 x A 2) | 5 | 15 |
| **LF12S** | 90 | 2000 | 3500 | 78.0 | 1.7 x A 2) | 1.0 x A 2) | 5 | 30 |
| **LF12C** | 90 | 2000 | 3500 | 1.0 x B 2) | 1.7 x A 2) | 1.0 x A 2) | 5 | 30 |
| **LF20S** | 135 | 6000 | 12500 | 240.0 | 6.2 x A 2) | 3.0 x A 2) | 5 | 100 |
| **LF20C** | 135 | 6000 | 12500 | 3.0 x B 2) | 6.2 x A 2) | 3.0 x A 2) | 5 | 100 |

1) $A_{min}$ = Length guide bearing
2) Note: A (spacing of support wheels, see image above) in mm; see below for calculation of B (track width)

Do not exceed the maximum loading of the screwed connections for rails, carriages and fastenings.
Take account of the general service life of lubricants!




### Calculating the track width B

$$B = P + 2 \times a$$

B = track width (in mm)
P = profile width (in mm)
a = rod spacing (in mm)

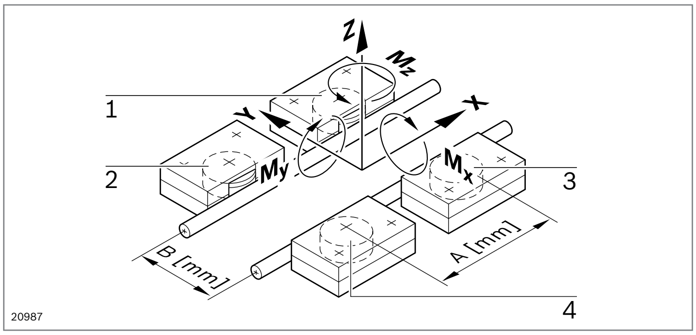
**LF ... C**

Values for a: for LF6C = 9.5 mm (p. 13-13)
for LF12C = 9 mm (p. 13-25)
for LF20C = 15 mm (p. 13-39)

**LF ... S**

Values for a: for LF6S = 40 − 6 = 34 mm (p. 13-8)
for LF12S = 90 − 12 = 78 mm (p. 13-18)
for LF20S = 100 − 20 = 80 mm (p. 13-32)

## Calculation of load on bearing for a trolley




Roller 1:

$$F_r = -(\frac{F_y}{2}) - (\frac{M_z}{A})$$

$$F_a = (\frac{F_z}{4}) + (\frac{M_x}{2 \cdot B}) - (\frac{M_y}{2 \cdot A})$$

Roller 3:

$$F_r = +(\frac{F_y}{2}) + (\frac{M_z}{A})$$

$$F_a = (\frac{F_z}{4}) - (\frac{M_x}{2 \cdot B}) - (\frac{M_y}{2 \cdot A})$$

Roller 2:

$$F_r = -(\frac{F_y}{2}) + (\frac{M_z}{A})$$

$$F_a = (\frac{F_z}{4}) + (\frac{M_x}{2 \cdot B}) + (\frac{M_y}{2 \cdot A})$$

Roller 4:

$$F_r = +(\frac{F_y}{2}) - (\frac{M_z}{2})$$

$$F_a = (\frac{F_z}{4}) - (\frac{M_x}{2 \cdot B}) + (\frac{M_y}{2 \cdot A})$$

### Loading of the individual rollers

- A mm: spacing of the rollers' rotational axes
- B mm: center-to-center distance between the guide rods
- Only compressive forces can be transferred between rollers and guide rods in the radial direction. The following therefore applies in respect of radial forces: $F_r \leq 0$: $F_r = 0$
- Rollers can be loaded equally in both directions. Therefore force $F_a$ is sufficient for calculating P and $P_0$

### Table 1: Load factors for rollers

| | Load case: $F_r \geq \lvert F_a \rvert$ | | | | Load case: $F_r < \lvert F_a \rvert$ | | | |
|---|---|---|---|---|---|---|---|---|
| | x | y | $x_0$ | $y_0$ | x | y | $x_0$ | $y_0$ |
| **LF6** | 1 | 3.1 | 1.2 | 3.5 | 0.5 | 3.6 | 1 | 3.7 |
| **LF12** | 1 | 4.2 | 1.2 | 5.2 | 0.5 | 4.7 | 1 | 5.4 |
| **LF20** | 1 | 4 | 1.2 | 4.9 | 0.5 | 4.5 | 1.1 | 5 |

### Table 2: Rollers - load capacities

| | C for $10^5$ m (N) | $C_o$ (N) |
|---|---|---|
| **LF6** | 3670 | 2280 |
| **LF12** | 8300 | 5000 |
| **LF20** | 23400 | 16600 |

### Equivalent dynamic and static loads

To calculate the service life of a cam roller guide, the roller with the greatest load has to be considered.
The following must be determined:
$P = \max (P_1,....,P_4)$
$P_0 = \max (P_{01},...,P_{04})$

Equivalent dynamic load P

$$P = x \cdot |F_r| + y \cdot |F_a|$$

Equivalent static load $P_0$

$$P_0 = x_0 \cdot |F_r| + y_0 \cdot |F_a|$$

$F_r$ (N): radial load of the roller
The following applies: $F_r \leq 0$: $F_r = 0$

$F_a$(N): axial load of the roller

x, $x_0$: radial factor (Table 1)
y, $y_0$: axial factor (Table 1)

C: dynamic load capacity (Table 2)
$C_0$: static load capacity (Table 2)

Static safety values:

$$S_0 = (\frac{C_0}{P_0})$$

$S_0 \geq 4$ recommended!

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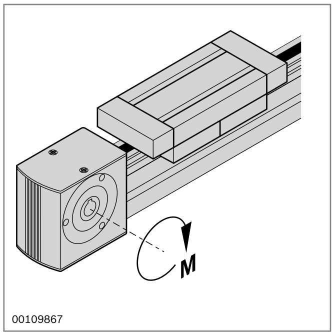
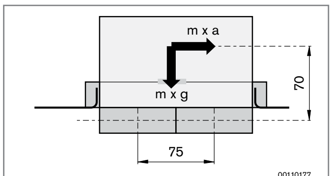
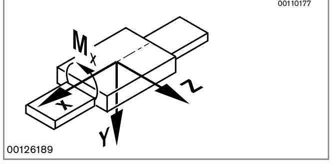
## Size selection




### Determining the forces and moments which arise

| |
|---|
| $F_{xdyn}$, $F_{ydyn}$, $F_{zdyn}$ 1) |
| $M_{xdyn}$, $M_{ydn}$, $M_{zdyn}$ |

1) $F_{Z\ dyn}$ includes the weight of the trolley

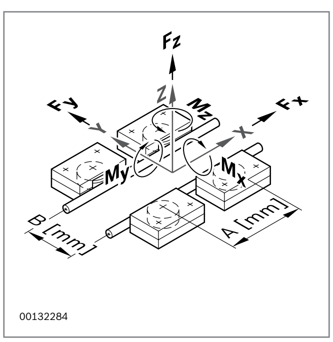
All the influences must be considered, e.g.:

- net mass and load
- acceleration forces and moments
- process forces and moments
- loads caused by dampers and/or stops

**Example:**

m = 30 kg a = 2.5 m/s²;
$L_1$ = 150 mm $L_2$ = 5000 mm
g = 9.81 m/s²

$F_{z\ dyn} = m \cdot g = 294$ N
$M_{y\ dyn} = m \cdot a \cdot 70$ mm = 5.25 Nm




### Determining the permissible forces and moments

For values see p. 13-51

**Example of LF 6 S, LF 6 C**

$F_{z\ dyn\ perm}$ = 850 N > $F_{z\ dyn}$ = 294 N
$M_{y\ dyn\ perm} = 0.4 \cdot A = 0.4 \cdot 75$ mm
= 30 Nm > $M_{y\ dyn}$ = 5.25 Nm

### Selection of the suitable size

| |
|---|
| $F_{x,\ y,\ z\ dyn} < F_{x,\ y,\ z\ dyn\ perm}$ ! |
| $M_{x,\ y,\ z\ dyn} < M_{x,\ y,\ z\ dyn\ perm}$ ! |

If F and M are cumulative:
recalculate using linear guide calculation program.
Note: When using the program, account must be taken of the directions of the respective forces and moments, i.e. the plus/minus sign, in order for the program to be able to calculate correctly.

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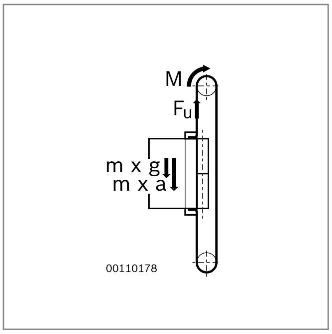
**Example:**

$F_{z\ dyn}$ = 294 N < $F_{z\ dyn\ perm}$ = 850 N !

$M_{y\ dyn}$ = 5.25 Nm < $M_{y\ dyn\ perm}$
= 30 Nm !

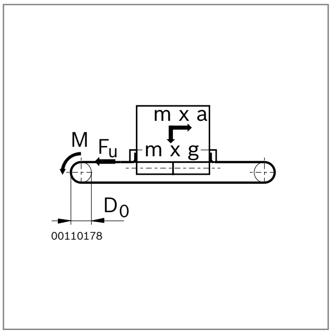
## Calculating the drive




**Peripheral force $F_u$**

$$F_u = m \cdot a + m \cdot g + F_0 + \mu \cdot m \cdot g$$
$$F_u \leq F_{u\ perm}\ !$$

$F_0$: frictional force on return units
μ : coefficient of friction of the guide
see table below.




Alternative calculation formula

$$F_u = m \cdot a + F_0 + \mu \cdot m \cdot g \leq F_{u\ perm}\ !$$

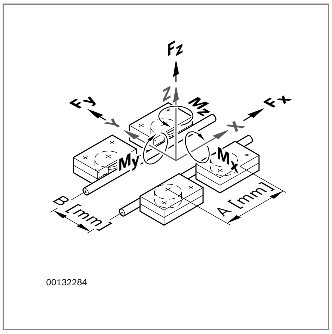
**Example of LF6C**

m = 30 kg; a = 2.5 m/s²

$F_u$ = (30 · 2.5)N + 10 N
+ (0.025 · 30 · 9.81)N

$F_u$ = 75 N + 10 N + 0.025 · 294 N

$F_u$ = 92.35 N < $F_{u\ perm}$ = 600 N !




**Required drive torque M**

$$M = ½ \cdot D_0 \cdot F_u \leq M_{perm}\ !$$

**Example:**

M = ½ · 50.94 mm · 92.35 N
= 2.4 Nm

M = 2.35 Nm ≤ $M_{perm}$
= 15 Nm !

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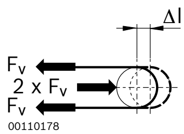
| | **v** (m/s) | $F_{u\ perm}$ (N) | $M_{perm}$ (Nm) | $F_0$ (N) | **μ** | $D_0$ (mm) | $D_0 \cdot \pi$ (mm) |
|---|---|---|---|---|---|---|---|
| **LF6S** | ≤ 2.0 | 500 | 9.5 | 10 | 0.025 | 38.21 | 120 |
| **LF6S** | 2.01 ... 5.0 | 400 | 7.6 | 10 | 0.025 | 38.21 | 120 |
| **LF6C** | ≤ 5.0 | 600 | 15.0 | 10 | 0.025 | 50.94 | 160 |
| **LF12S** | ≤ 5.0 | 820 | 30.0 | 30 | 0.020 | 73.20 | 230 |
| **LF12C** | ≤ 5.0 | 820 | 30.0 | 30 | 0.020 | 73.20 | 230 |
| **LF20S** | ≤ 5.0 | 2000 | 100.0 | 35 | 0.015 | 101.86 | 320 |
| **LF20C** | ≤ 5.0 | 2000 | 100.0 | 35 | 0.015 | 101.86 | 320 |

$F_0$: frictional force on return units; μ : coefficient of friction

## Checking the selected size




### Preload force $F_v$ of toothed belt

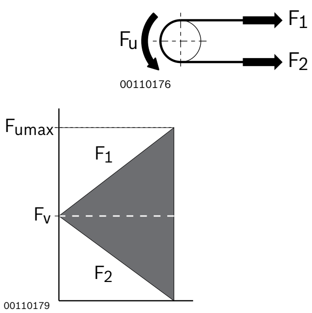
$$0.5 \cdot F_u \leq F_v \leq F_u$$

Recommendation: $F_v = 0.5 \cdot F_u$

**Example:**

$F_u$ = 92.35 N

$F_v$ = 50 N




### Maximum toothed belt force $F_{1\,max}$

$$F_{1\,max} = F_v + 0.5 \cdot F_u \leq F_{1\,perm}\ !$$

$$F_{2\,min} = F_v - 0.5 \cdot F_u > 0\ !$$

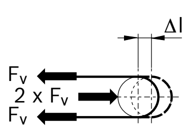
**Example of LF6C**

$F_{1\,max}$ = 50 N + 0.5 · 92.35 N

$F_{1\,max}$ = 96.18 N < $F_{1\,perm}$ = 900 N !

$F_{2\,min}$ = 50 N − 0.5 · 92.35 N

$F_{2\,min}$ = 3.825 N > 0 !




### Required preload length Δl

$$\Delta l = 0.5 \cdot F_v \cdot L\ /\ C_{spec} \leq \Delta l_{max}\ !$$

**Example:**

L = 2 · $L_2$ − $L_1$ + 400 mm

L = 10 250 mm

Δl = 0.5 · 50 N · 10 250 mm / 420 000 N

Δl = 0.8 mm < $\Delta l_{max}$ = 13 mm !

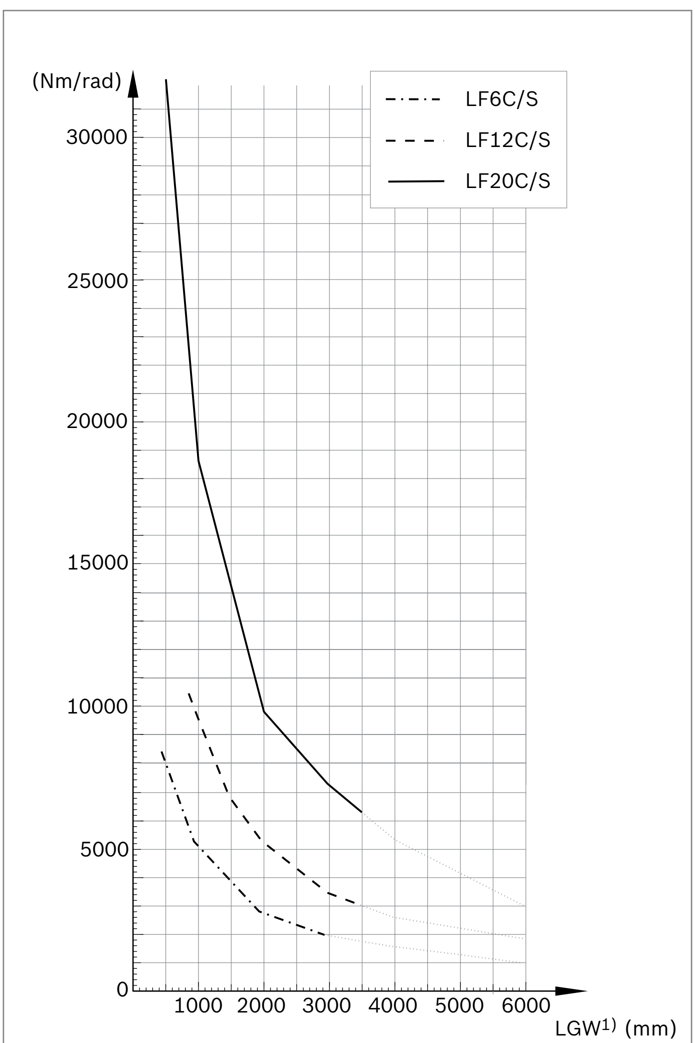
| | $F_{1\,perm}$ (N) | $C_{spec}$ (N) | $\Delta l_{max}$ (mm) | L (mm) | Page |
|---|---|---|---|---|---|
| **LF6S** | 750 | 315000 | 11 | 2 · $L_2$ − $L_1$ + 360 | 13-6 |
| **LF6C** | 900 | 420000 | 13 | 2 · $L_2$ − $L_1$ + 400 | 13-11 |
| **LF12S** | 1230 | 1250000 | 16 | 2 · $L_2$ − $L_1$ + 630 | 13-16 |
| **LF12C** | 1230 | 1250000 | 16 | 2 · $L_2$ − $L_1$ + 630 | 13-23 |
| **LF20S** | 3000 | 1870000 | 23 | 2 · $L_2$ − $L_1$ + 780 | 13-30 |
| **LF20C** | 3000 | 1870000 | 23 | 2 · $L_2$ − $L_1$ + 780 | 13-37 |

$C_{spec}$: Belt stiffness;
L: Long toothed belts, see also LF6S (p. 13-6), LF6C (p. 13-11),
LF12S (p.13-16), LF12C (p. 13-23),
LF20S (p. 13-30), LF20C (p. 13-37)

## Dimensioning of synchronous shafts

| | | LF6 | LF12 | LF20 |
|---|---|---|---|---|
| Support separation SW | horizontal | 215 ... 3000 mm | 275 ... 3500 mm | 325 ... 3500 mm |
| | vertical | 215 ... 2000 mm | 275 ... 2000 mm | 325 ... 1100 mm |
| Nominal torque | | max. 30 Nm | max. 60 Nm | max. 150 Nm |
| Permitted rpm | | Diagram 3 (p. 13-56)<br>**max. 0.7 · nk** | Diagram 3 (p. 13-56)<br>**max. 0.7 · nk** | Diagram 3 (p. 13-56)<br>**max. 0.7 · nk** |
| Elasticity | axial | max. 2 mm | max. 3 mm | max. 4 mm |
| | lateral | Diagram 4 (p. 13-56) | Diagram 4 (p. 13-56) | Diagram 4 (p. 13-56) |
| | torsion angle | Diagram 5 (p. 13-56) | Diagram 5 (p. 13-56) | Diagram 5 (p. 13-56) |

**Diagram 1: Torsion stiffness**




1) Length synchronous shaft LGW

LF6 LGW = SW - 72
LF12 LGW = SW - 101
LF20 LGW = SW - 130

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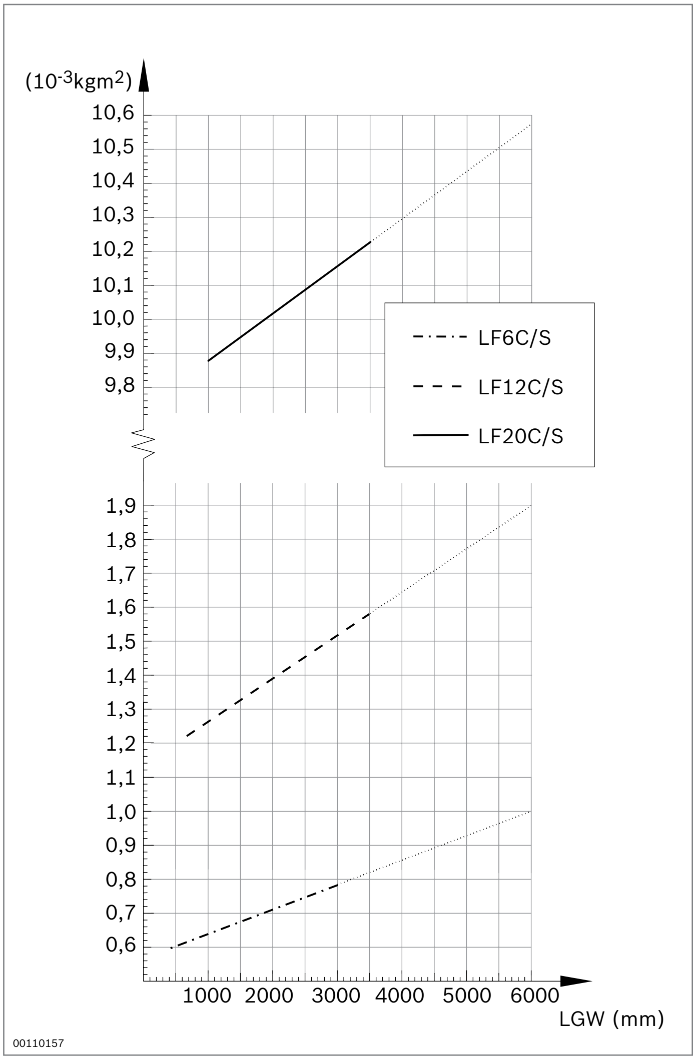
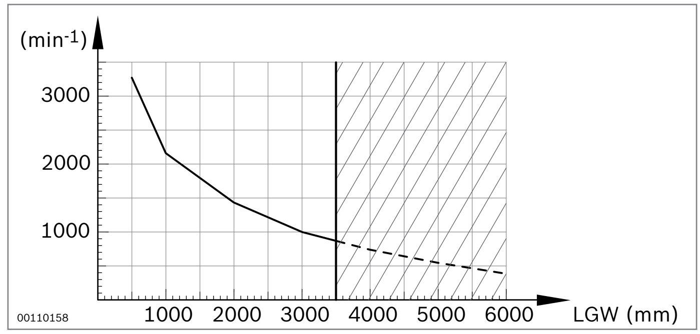
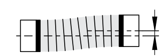
### Diagram 2: Mass inertia

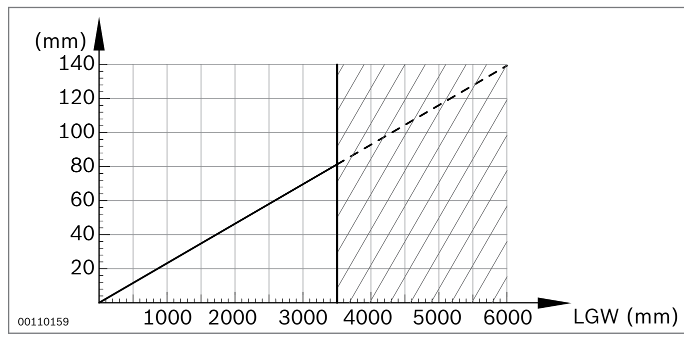



### Diagram 3: Critical rpm nk due to bending



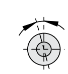

### Diagram 4: Lateral offset

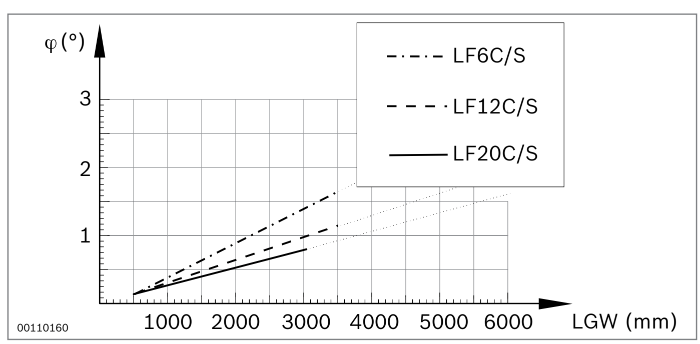





Aligned shafts are recommended.

### Diagram 5: torsion angle





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**Design program**
With the LF-MGE Linear Motion Designer we offer a professional planning tool for the quick and easy design of linear guides.

| LF-MGE | No. |
|---|---|
| | **3 842 540 900** |

**Performance characteristics**
- Calculation of the service life of the individual guide bearings
- Combination of up to 16 guide bearings
- Dynamic movement sequence input
- Checking of the selected size
- Quick and easy design
- Clear displaying and documenting of results

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