Linear Drive Nuts

Selection

Formulae and Related Units

d(mm) = shaft diameter
F(N) = side thrust required
FRS(N) = side thrust produced by Linear Drive Nut type RS
FR(N) = force of friction (FN•μ) only relevant when the associated mass is mounted on its own independent carriage
FN(N) = normal force of total weight of associated mass and carriage
μ = coefficient of friction
FZ(N) = additional force eg: component of the cutting force of a separator
f(mm) = shaft sag from diagram
g(m/s²) = acceleration due to gravity (9.81 m/s²). Note: for horizontal applications m•g=0
h(mm) = Drive nut pitch (travel per shaft revolution)
l(mm) = length of shaft between centre of bearing brackets
m(kg) = total mass to be moved, including Drive Nut, connections, etc.
Md(Ncm) = drive torque
Mo(Ncm) = idling torque
n(r.p.m.) = shaft speed
ncrit(r.p.m.) = critical shaft speed
P(kW) = drive power required
t(s) = acceleration or braking time
v(m/sec) = maximum speed of travel
C(N) = dynamic loading of Rolling Rings
PR(N) = radial loading of Rolling Rings

1. Side thrust

$$F = 2\left(\frac{m \bullet v}{t} + m \bullet g\right) + F_R + F_Z$$

A drive nut should be selected which has a greater side thrust than the value calculated.

$$F < FRS$$

Several similar Drive Nuts can be coupled together if available space so dictates. The total thrust available is the sum of the individual values.

2. Shaft speed

$$n = \frac{v \bullet 6 \bullet 10^4}{h_{max}}$$

2.1 Max. shaft speed

RS 3-10-4	=	10000 r.p.m.
RS 4-15-4	=	8000 r.p.m.
RS 4-20-4	=	7000 r.p.m.
RS 4-25-4	=	6000 r.p.m.
RS 4-35-4	=	4000 r.p.m.
RS 4-50-3	=	3400 r.p.m.
RS 4-60-3	=	2500 r.p.m.

2.2 Critical shaft speed

$$n_{crit} = 1.225 \bullet 10^8 \frac{d}{l^2}$$

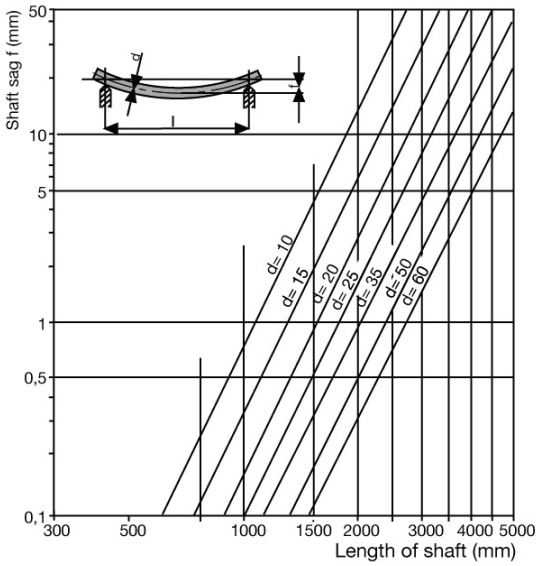
Note: Depending upon its quality, the shaft can go out of balance at a speed of up to 25% lower than that specified above.
If it is necessary to go through a critical range in order to reach the operational speed, this can lead to short term shaft vibration. This has no effect on the operation of the Drive Nut.
If the operational speed is in the critical speed range, this can be rectified as follows:
1. With a double bearing support at one end, increase factor approx 1.5
2. With double bearing supports at both ends, increase factor approx 2.2
The distance between the bearing support brackets should be at least 2.5 x the diameter of the shaft.

3. Drive torque

$$M_d = \frac{F_{RS} \bullet h}{20 \bullet \pi} + M_O$$

Values for MO to be taken from the technical detail tables.

4. Shaft sag (Diagram)



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5. Calc. of the operational life of Rolling Rings

a. Select C

Type	C(N)
RS 10	4620
RS 15	5590
RS 20	9360
RS 25	11200
RS 35	15900
RS 50	21600
RS 60	29600

b. Calculate P_R

RS 10 : $P_R = 5 \bullet F_{RS}$*

RS 15 - 60 : $P_R = 2.5 \bullet F_{RS}$*

*F = Calculated value of the side thrust according to 1. Only if increasing of operational life time of the rolling rings is really necessary. In case of order it is an absolute must to mention.

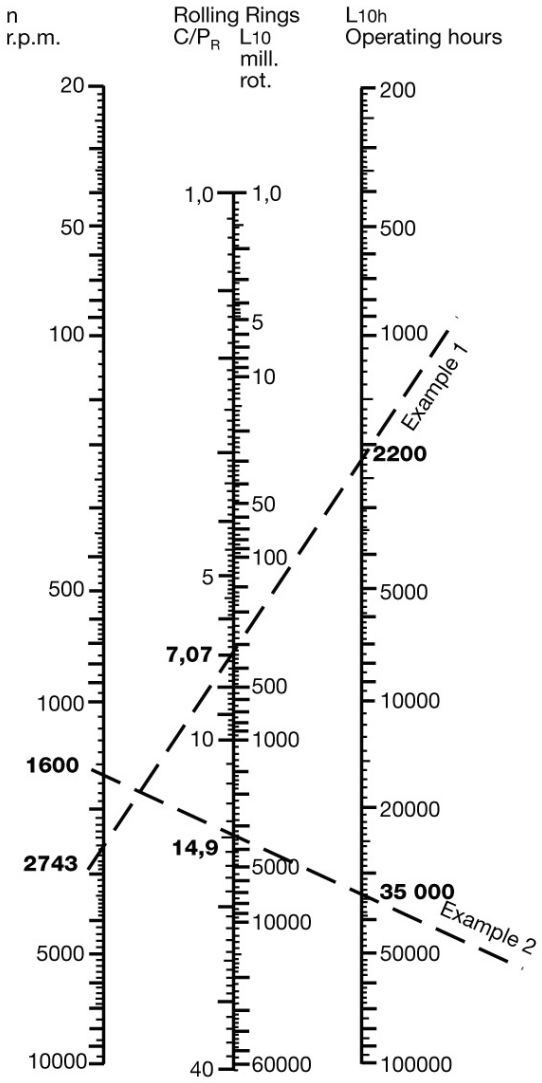
c. Divide C by P_R

d. Calculate the required shaft speed

$$n = \frac{v \bullet 6 \bullet 10^4}{hmax}$$

5. Determine the operation life in hours from the nomogram

Diagram shown on right.



Example 1	Example 2
RS4-35-4R17.5 speed 0.8 m/s	RS4-35-4R7.5 **Reduced side thrust 150 N** speed 0.2 m/s
1. C = 15900	1. C = 5590
2. $P_R = 2.5 \bullet 900\ N = 2250\ N$	2. $P_R = 2.5 \bullet 150\ N = 375\ N$
3. $\frac{C}{P_R} = \frac{15900}{2250} = 7.07$	3. $\frac{C}{PR} = \frac{5590}{375} = 14.9$
4. $n = \frac{0.8 \bullet 6 \bullet 10^4}{17.5} = 2743$ rpm	4. $n = \frac{0.2 \bullet 6 \bullet 10^4}{7.5} = 1600$ rpm
5. L_{10h} = 2200 operating hours	5. L_{10h} = 35000 operating hours

TECHNICAL

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1. Shaft material

1.1 Basic requirements

Rino Linear Drives should only be used in conjunction with steel shafts manufactured from induction surface hardened, ground and finished bar of the following quality, minimum:

- surface hardness: 50 HRC
- tolerance on diameter: h6
- out of roundness: maximum one half of the diameter variation permitted by ISO tolerance h6
- true running tolerance (DIN ISO 1101): ≤ 0.1 mm/m

1.2 Precision shaft

Standard: Material similar to Cf53, Mat. –Nr. 1.1213, induction surface hardened, 60-64 HRC
Rust resistant: Material X40 Cr 13, Mat – Nr. 1.4034, induction surface hardened, 51-55 HRC
Rust & acid resistant: Material X 90 CrMoV 18, Mat – Nr. 1.4112, induction surface hardened, 52-56 HRC

- all ground and super finished
- surface roughness: mean value (DIN 4768 T.1) Ra:≤0.35µm
- tolerance on diameter: h6
- out of roundness: maximum one half of the diameter variation permitted by ISO tolerance h6
- true running tolerance (DIN ISO 1101): ≤0.1 mm/m

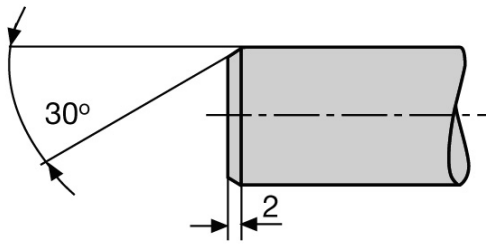
1.3 Precision shafts with enhanced true running tolerance

Available in the above styles, but

- true running tolerance (DIN ISO 1101): 0.03mm/m

1.4 Leading end chamfer

The leading end of the shaft should be chamfered to avoid damage to the Rolling Rings when screwing the unit onto the shaft.



2. Pitch

The standard pitch is 0.5 x d. This can be ordered as either a right or left-handed pitch. Unless otherwise specified, units having a right-handed pitch will be supplied. Subsequent alterations to the pitch are possible with units having a design category –4 reference by changing the associated pitch control wedges.
Non-standard pitches 0.1 –0.2 – 0.3 and 0.4 x d are available. In this version reduction of the side thrust is recommended to improve the smooth running.

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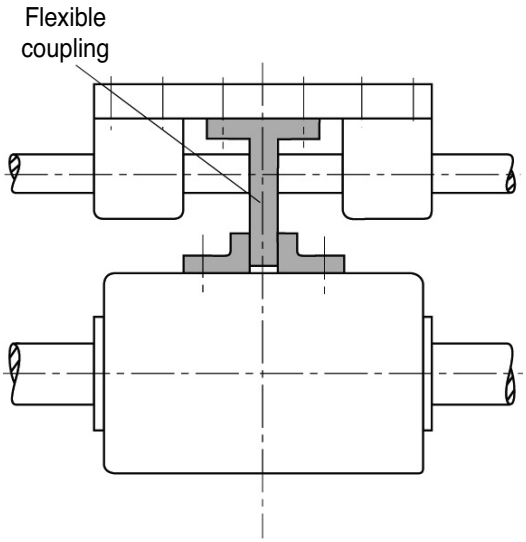
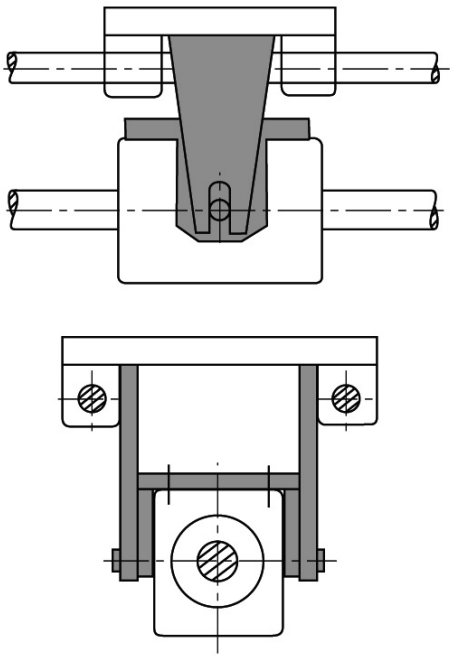
3. Separately carried loads

If Rino Linear Drive Nuts are used to move separately carried loads, allowance should be made in the coupling to compensate for any misalignment between the drive shaft and the carriage. The available side thrust will otherwise be affected. If the application so permits, we recommend the use of our twist-free coupling system.



Twist-free coupling system



4. Vertical applications

For vertical applications we advise the use of a directly braked motor so as to avoid the possibility of the shaft rotating backwards and the Drive Nut falling due to the high efficiency of the drive.
Depending upon the application (safety considerations and value of the installation) a reserve of side thrust should be built in (using a second Drive Nut).
With units having a free-movement lever, care must be taken before its operation to ensure that they are unable to drop in an uncontrolled manner – danger of injury!

5. Temperature range

Linear Drive Nuts are suitable for operation at temperatures from -10°C to +70°C.
Please enquire for other temperatures.

6. Maintenance

For the lubrication of the shaft, commercially available MoS2-free ball bearing greases can be used, eg: SKF Alfalub LGMT2, Shell Alvania R2 or G2, Esso Beacon 2, BP Energrease LS2.

Procedure: Clean the shaft and spread the grease as thinly as possible with a rag.
Frequency: Once every ten weeks.

7. Symmetry

The maximum difference in pitch for the two directions of travel is 2%.
We therefore recommend the use of positional sensors for positioning applications.

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