BEARINGS FOR MACHINE TOOLS

EVOLMEC®
EVOLUZIONE MECCANICA

INDEX

AXIAL/ RADIAL BEARINGS, AXIAL ANGULAR CONTACT BALL BEARINGS

THRUST CROSSED ROLLER BEARINGS

Catalog **EVMU-01-2015**, JUNE 2015

FEATURES

Axial/radial bearings **EVRT** and **EVRTS** and axial angular contact ball bearings **EVLDF** are ready-to-fit high precision bearings for high precision applications with combined loads.
They can support radial loads, axial loads from both sides and tilting moments without clearance and are particularly suitable for bearing arrangements with high requirements for running accuracy.
Due to the fixing holes in the bearing rings, the units are very easy to fit.
The bearings are radially and axially preloaded after fitting.
The mounting dimensions of all series are identical.

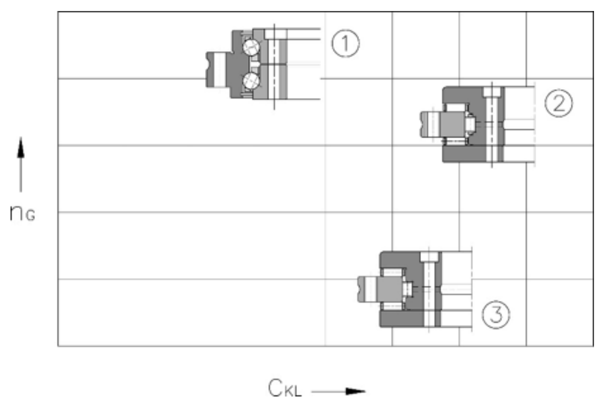
AREAS OF APPLICATION

For standard applications with low speeds and small operating durations, such as indexing tables and swivel type milling heads, the most suitable bearing is generally series **EVRT**.
For the bearing arrangements of direct drive axes, there is the series **EVRTS**. Due to their high limiting speeds and very low, uniform frictional torque across the whole speed range, these bearings are particularly suitable for combination with torque motors.
For higher accuracy requirements, these bearings are also available with restricted axial and radial runout accuracy.
Axial angular contact ball bearings **EVLDF** are particularly suitable for high speed applications with long operating duration. They are characterised by high tilting rigidity, low friction and low lubricant consumption.

EVRT Series...

EVRTS Series...

EVLDF Series...



n_G = Limiting speed
C_{KL} = Tilting rigidity

1 - EVLDF
2 - EVRTS
3 - EVRT

Figure 1
Speed and tilting rigidity

AXIAL/RADIAL BEARINGS

Axial/radial bearings **EVRT** and **EVRTS** have an axial component and a radial component.
The axial component comprises an axial needle roller or cylindrical roller and cage assembly, an outer ring, L-section ring and shaft locating washer and is axially preloaded after fitting.
The radial component is a full complement cylindrical roller set in **EVRT** and a cage-guided, preloaded cylindrical roller set in **EVRTS**. The outer ring, L-section ring and shaft locating washer have fixing holes.
The unit is located by means of retaining screws for transport and safe handling.

Sealing
Axial/radial bearings are supplied without seals.

Lubrification
The bearings are provided with SHELL grease. The bearings can be lubricated via the outer ring and L-section ring.

Operating temperature
EVRT & **EVRTS** axial/radial bearings are suitable for use at temperatures between -30°C & +120 °C.

AXIAL ANGULAR CONTACT BALL BEARINGS

Axial angular contact ball bearings ZKLDF comprise a single-piece outer ring, a two-piece inner ring and two ball and cage assemblies with a contact angle of 60°. The outer ring and inner ring have fixing holes for screw mounting of the bearing on the adjacent construction.
The unit is located by means of retaining screws for transport and safe handling.

Sealing
Axial angular contact ball bearings have sealing shields on both sides.

Lubrification
The bearings are provided with SHELL grease. The bearings can be relubricated via the outer ring.

Operating temperature
EVLDF axial angular contact ball bearings are suitable for use at temperatures between -30°C & +120 °C.

SUFFIXES for available designs (see table).

Suffix	Description	Design
H_1	For **EVRT**, closer tolerance on mounting dimension **H_1** (For restricted tolerance value, see table, page 23)	Special design, available by agreement only
H_2	For **EVRT**, closer tolerance on mounting dimension **H_2** (For restricted tolerance value, see table, page 23)	
RT	For **EVRT**, axial and radial runout tolerance restricted by 50% (For restricted tolerance value, see table, page 23) For **EVRTS**, axial and radial runout tolerance of the rotating inner ring restricted by 50% (For restricted tolerance value, see table, page 23)	
VSP	For mounting with an axially supported L-section ring in series **EVRT**, see pages from 25 to 28, for **EVRTS**, see pages 29 and 30	

Basic rating life

The load carrying capacity and life must be checked for the radial and axial bearing component.
Please contact us in relation to checking of the basic rating life.
The speed, load and operating duration must be given.

Static load safety factor

The static load safety factor **f_0** indicates the security against impermissible permanent deformations in the bearing:

$$f_0 = \frac{C_{0r}}{F_{0r}} \text{ e/o } \frac{C_{0a}}{F_{0a}}$$

f_0 - Static load safety factor

C_{0r}, C_{0a} - Basic static load rating according to dimension tables

F_{0r}, F_{0a} - Maximum static load on the radial or axial bearing.

In machine tools and similar areas of applicaation, f_0 should be > 4.

Static limiting load diagrams

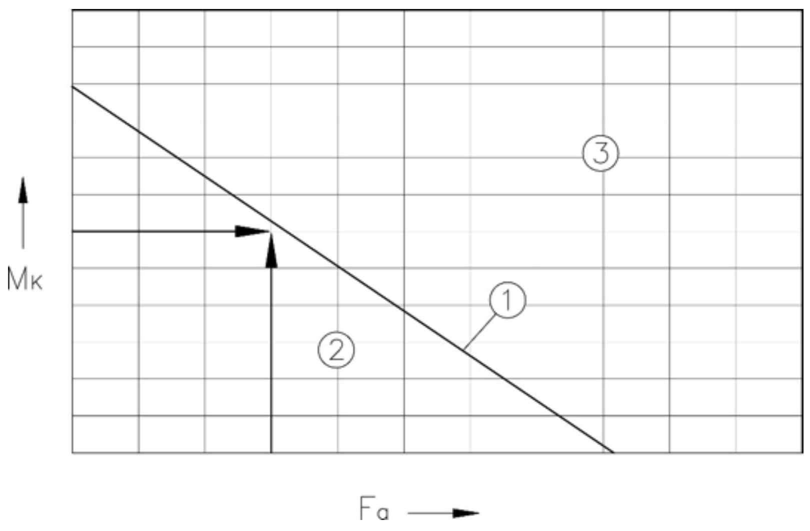
The static limiting load diagrams can be used:

• For rapid checking of the selected bearing size under predominantly static load

• For calculation of the tilting moment Mk that can be supported by the bearing in addition to the axial load.

The limiting load diagrams are based on a rolling element set with a static load safety factor **f_0** ≥ 4, as well as the screw and bearing ring strenght.

Il carico statico limite non deve essere superato quando si dimensiona il cuscinetto (Figure 2 to Figure 9).



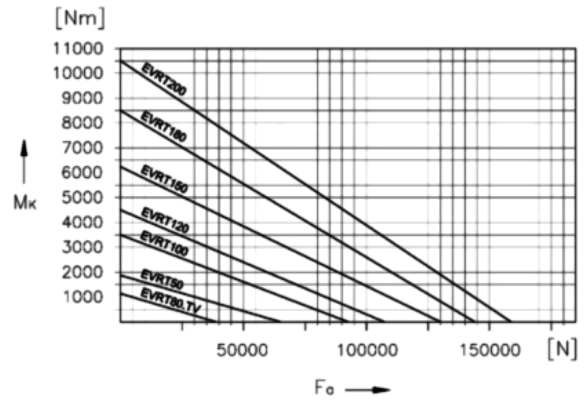
M_k = Maximum tilting moment
F_a = Axial load

1 - Bearing, size

2 - Permissible range

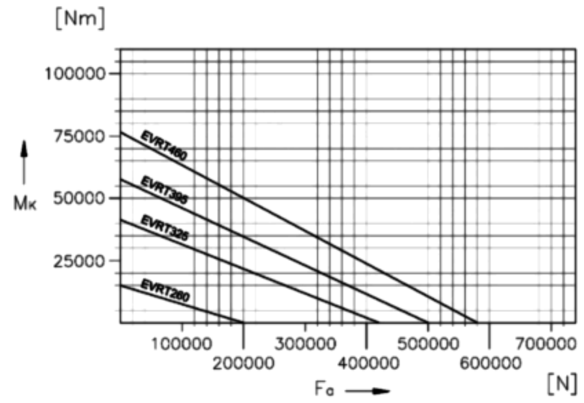
3 - Impermissible range

Figure 2
Static limiting load diagram (example)



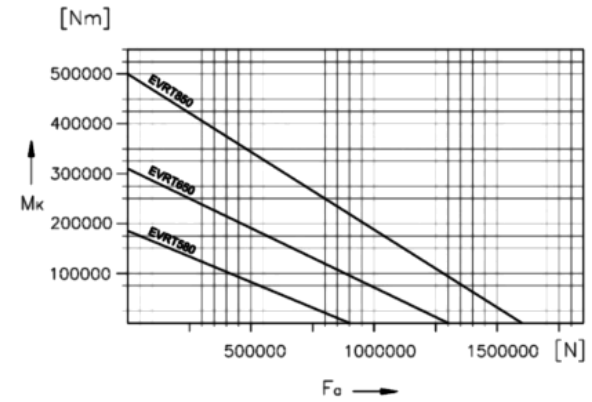
M_k = Maximum tilting moment
F_a = Axial load

Figure 3
Static limiting load diagram for EVRT 50 to EVRT 200



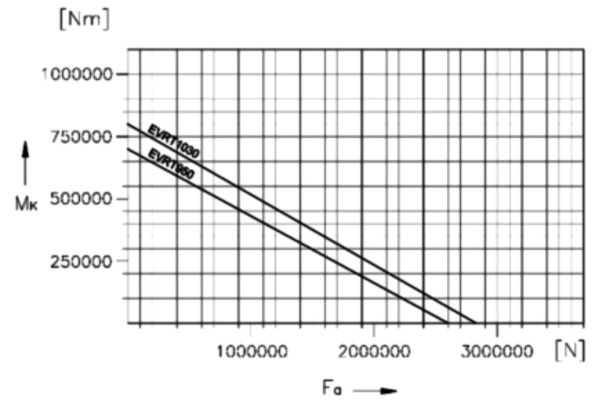
M_k = Maximum tilting moment
F_a = Axial load

Figure 4
Static limiting load diagram for EVRT 260 to EVRT 460



M_k = Maximum tilting moment
F_a = Axial load

Figure 5
Static limiting load diagram for EVRT 580 to EVRT 850



M_k = Maximum tilting moment
F_a = Axial load

Figure 6
Static limiting load diagram for EVRT 950 to EVRT 1030

M_k = Maximum tilting moment
F_a = Axial load

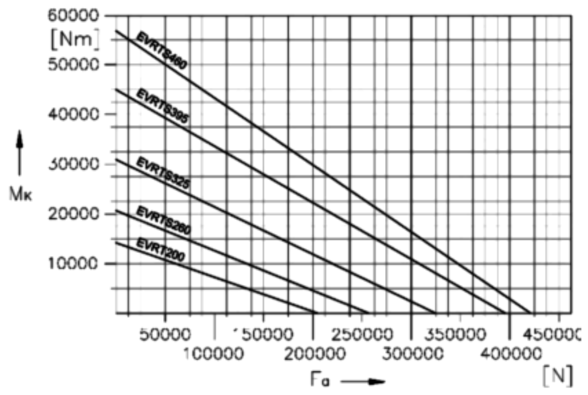


Figure 7
Static limiting load diagram for EVRTS 200 to EVRTS 460

M_k = Maximum tilting moment
F_a = Axial load

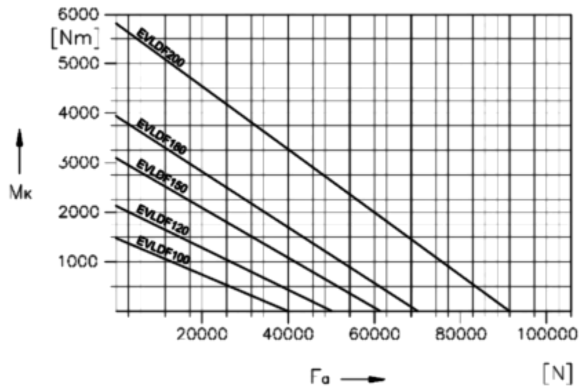


Figure 8
Static limiting load diagram for EVLDF 100 to EVLDF 200

M_k = Maximum tilting moment
F_a = Axial load

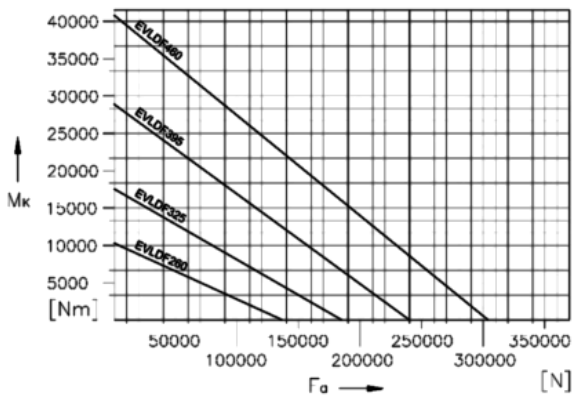


Figure 9
Static limiting load diagram for EVLDF 260 to EVLDF 460

Limiting speeds
In bearing selection, the following guidelines and the limiting speeds must be observed, see dimension tables. If the environmental conditions differ from the specifications in relation to adjacent construction tolerances, lubrication, ambient temperature, heat dissipation or from the normal operating conditions for machine tools, the stated limiting speeds must be checked. Please contact us.

Axial/radial bearing EVRT
Axial/radial bearings **EVRT** are designed, by means of the full complement radial roller bearing component for high rigidity, for rapid positioning and operating at low speed. Low speeds are normally required for multiple-axis simultaneous machining.
The limit value nG stated in the dimension tables relates to the maximum swivel speed and a maximum speed applied for a short period.Nelle applicazioni con periodi di lavoro ED di lunga durata o con lavoro continuo a velocità maggiori di nxd = 35.000 rpm x mm at an ED>10%, the series **EVRTS** or **EVLDF** should be selected.

Axial/radial bearings EVRTS and axial angular contact ball bearings EVLDF
The limiting speeds n_G stated for these two bearing series were determined on test rigs.
During the test, the following conditions apply:

- Grease distribution cycle according to the defined data, see **Figure 14.**
- Maximum increase in bearing temperature of 40 °C in the area of the raceway.
- Operating duration ED = 100%, which means continuous operation at the limiting speed n_G.
- Bearing fully screw mounted on solid fixtures.
- No external load, only preload and mass of the fixtures.

Temperature distribution in the rotary axis system
Rotary axes with a main spindle function, such as those used for combined milling and turning and with direct drive by a torque motor, are systems with complex thermal characteristics.
The temperature distribution in the rotary axis system must be considered in greater detail during the design process:

- Asymmetrical rotary axis housings can undergo asymmetrical deformation due to heating.
- In turn, out-of-round bearing seats lead to additional bearing load, reduced life and a negative influence on running behaviour and running accuracy.
- Temperature management of the rotary axis in the form of targeted cooling and heating is generally necessary for high performance rotary axes.

Design regulations
Proven design regulations based on practical experiences, **Figure 10**:

• The contact face between the stator of the torque motor and the rotary table housing should be as small as possible, in order to minimise the flow of heat between stator and rotary table housing.
• Where possible, do not connect the casing of the stator cooling system to the rotary table housing.
• In preference, flange mount the rotor of the torque motor on the rotary table plate rather than on the bearing, to keep the flow of heat through the bearing to a minimum.
• The distance between the motor and the bearing should be as large as possible. A large distance reduces the transfer of heat from the rotor to the bearing. The stresses occurring between the components as a result of varying thermal expansion are reduced by the increased elasticity of the system.
• The rotary table plate bearing must be centered with sufficient rigidity to allow the overall system to attain a high level of rigidity.
The risk of deformation to the bearing seat due to the increase in the temperature of the rotor is also reduced.

Regulated cooling of the stationary and rotating components may be required in order to limit the temperature variations between the bearing inner and outer ring.

Q = Heat flow
X = Distance from torque motor to bearing

1 - Stator of the torque motore
2 - Rotary table housing
3 - Stator cooling
4 - Rotor of the torque motor
5 - Rotary table plate

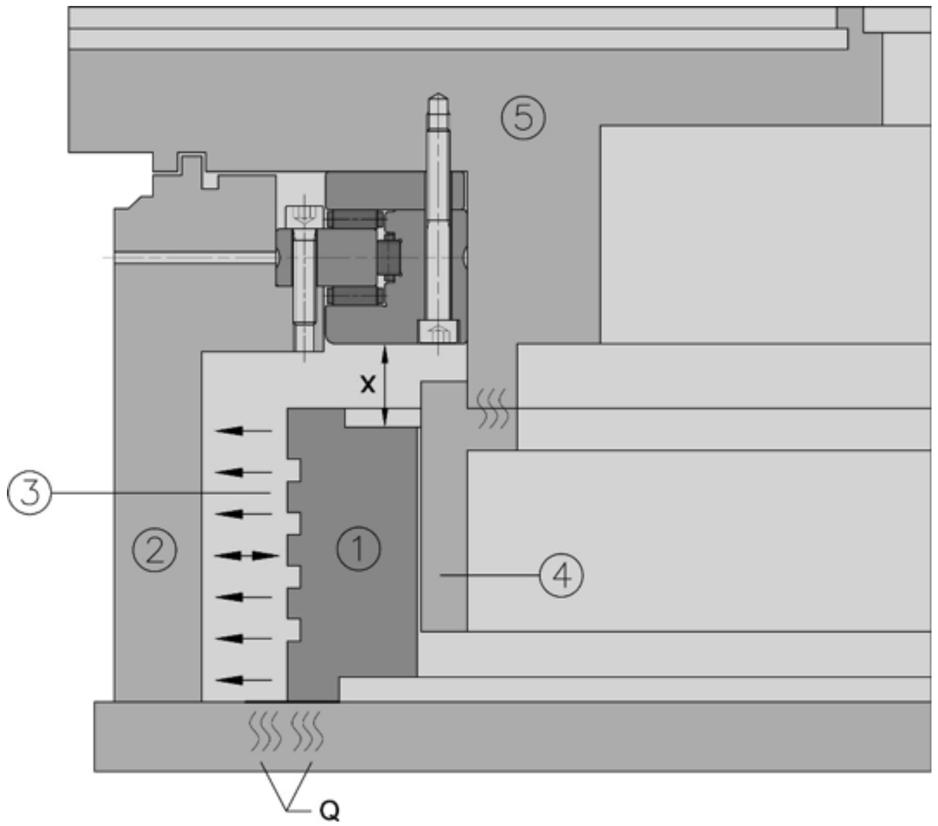


Figure 10
Ideal rotary table, taking account of the occurring heat

Bearing preload
Once the bearings have been fitted and fully screw mounted, they are radially and axially clearance-free and preloaded.

Temperature differences
Temperature differences between the shaft and housing influence the radial bearing preload and thus the operating life of the bearing arrangement.
If the shaft temperature is higher than the housing temperature, the radial preload will increase proportionally, so there will be an increase in the rolling element load, bearing friction and bearing temperature, while the operating life will be reduced.
If the shaft temperature is lower than the housing temperature, the radial preload will decrease proportionally, so the rigidity will decrease to bearing clearance. There will be an increase in wear, the operating life will be reduced and noise due to slippage may occur.

Frictional torque
The bearing frictional torque M_{RL} is influenced primarily by the viscosity and quantity of the lubricant and the bearing preload:

1 - The lubricant viscosity is dependent on the lubricant grade and operating temperature.
2 - When relubrication is carried out, the lubricant quantity is increased for a short time until the grease is distributed and the excess quantity has left the bearing.
3 - During initial operation and after relubrication, bearing friction is increased until the lubricant has been distributed within the bearing.
4 - The bearing preload is dependent on the the mounting fits, the geometrical accuracy of the adjacent parts, the temperature difference between the inner and outer ring, the screw tightening torque and mounting situation (bearing inner ring axially supported on one or both sides).

Guide values for frictional torque M_R

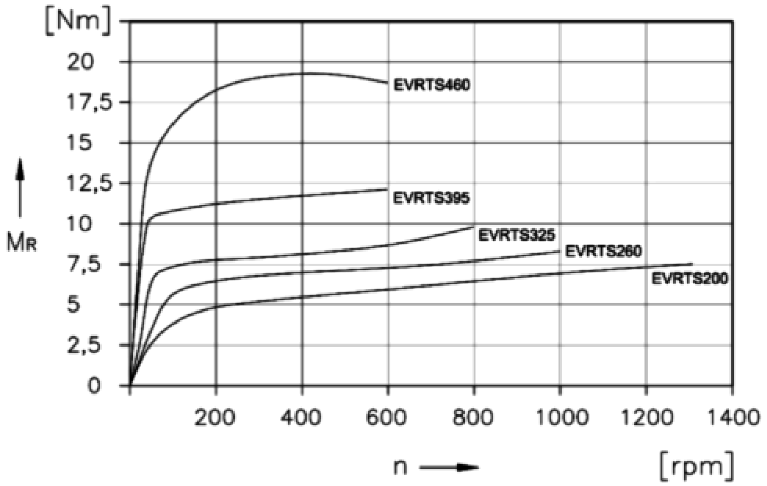
The stated frictional torques M_R are statistically determined guide values for bearings with grease lubrication after a grease distribution cycle (**Figure 14** - pagina 13). **Figure 11** shows measured frictional torque for mounting with an unsupported L-section ring.

In the mounting variant with an L-section ring supported over its whole surface, these values are increased as a function of the washer thickness and the geometrical accuracy of the supporting ring by an average of 10% to 20%. The guide values for the frictional torque for axial/radial bearings **EVRT** were determined at a measurement speed n = 5 rpm, see dimension table.

Deviations from the tightening torque of the fixing screws will have a detrimental effect on the preload and the frictional torque. For **EVRT** bearings, it must be taken into consideration that the frictional torque can increase by a factor 2 to 2,5 with increasing speed.

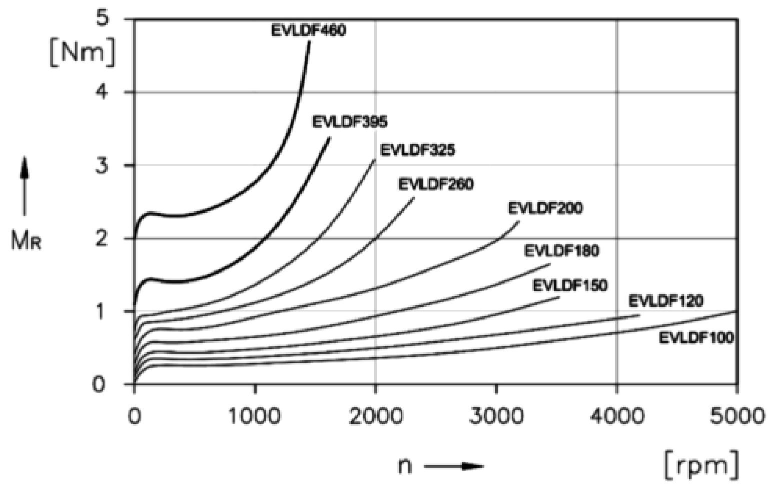
M_R = Frictional torque
n = Speed

Figure 11
Frictional torques as guide values for **EVRTS**, statistically determined values from series of measurements



M_R = Frictional torque
n = Speed

Figure 12
Frictional torques as guide values for **EVLDF**, statistically determined values from series of measurements



Relubrifcation and initial operations

The speed capability, friction, rating life, functional capability and the durations of relubrication intervals are essentially influenced by the grease used, see table.

Axial/radial bearings **EVRT** and **EVRTS** can be relubricated via a lubrication groove in the L-section ring and the outer ring.

Axial angular contact ball bearings **EVLDF** can be relubricated via a lubrication groove in the outer ring.

The new generation bearing series **EVRTS** and **EVLDF**, both of which are suitable for high speeds, can now have an additional lubrication connector in the screw mounting face of the outer ring (on request).

This allows reliable feed of lubricant even where there is a large fit clearance in the bearing seat or the outer ring is free (**Figure 13**).

For calculation of the relubrication quantities and intervals based on a stated load spectrum (speed, load, operating duration) and the environmental conditions, please contact us.

Relubrifcation

Series	*Grease type*
EVRT	*Shell S3 V220 C2*
EVRTS	*Shell S3 V220 C2*
EVLDF..-B	*Shell S3 V220 C2*

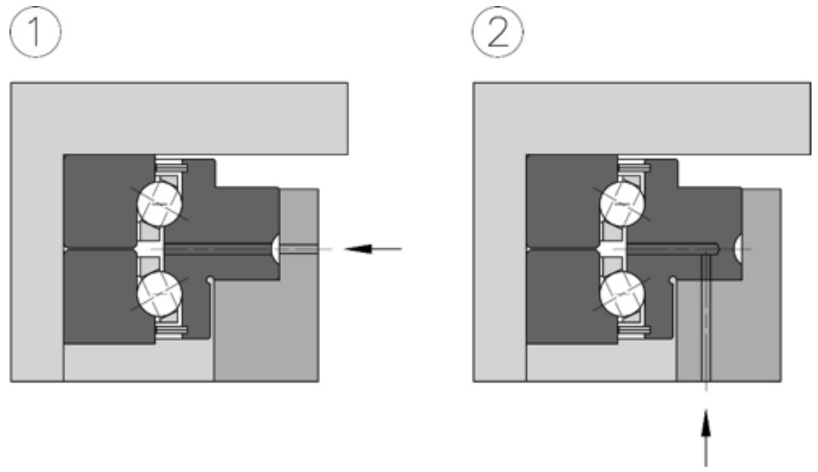


Figure 13
Options for relubrification

1 -Relubrication via the lubrication groove in the outer ring
2 - Relubrication via the outer ring screw mounting face

Initial operations

Rolling bearings may exhibit increased frictional torque during initial operation, which can lead to overheating in the high speed series **EVRTS** and **EVLDF** where there is immediate operation at high speeds.

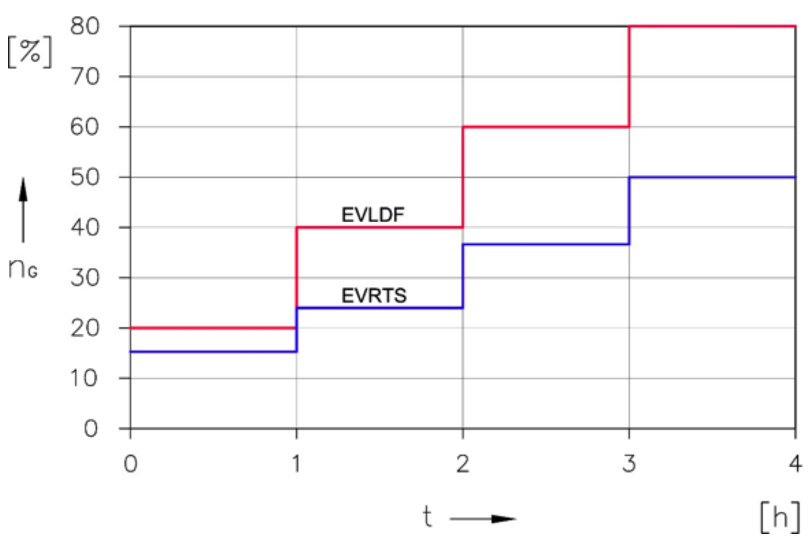
In order to prevent overheating of the bearing, the running-in cycle must always be carried out, **Figure 14**. The cycle may be shortened if there is appropriate monitoring of the bearing temperature.
The bearing ring temperature must not exceed 60 °C.

Overlubrification

The two high speed bearing series **EVRTS** & **EVLDF** may be damaged by overheating as a result of increased frictional torque when operating at high speeds if they have been accidently overlubricated. In order to achieve the original frictional torque again, the running-in cycle in accordance with **Figure 14** should be carried out.

nG = Limiting speed according to dimension tables
t = Time

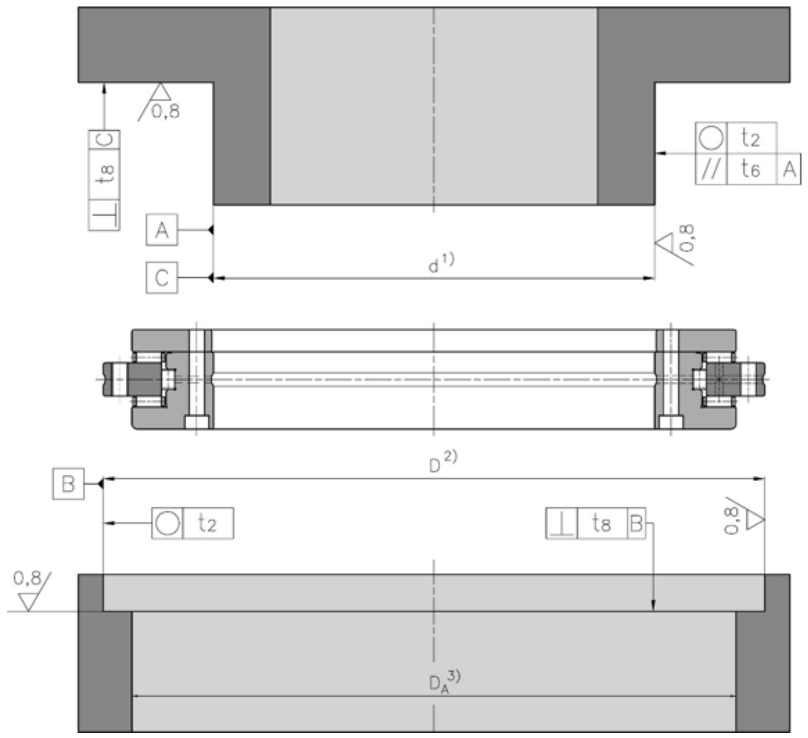
Figure 14
Running-in cycle for initial operation and after overlubrication



Design of adjacent construction

Geometrical defects in the screw mounting surfaces and fits will influence the running accuracy, preload and running characteristics of the bearing arrangement. The accuracy of the adjacent surfaces must therefore be matched to the overall accuracy requirement of the subassembly. The tolerances of the adjacent surfaces must lie within the running tolerance of the bearing.
The adjacent construction should be produced in accordance with **Figure 15** and the tolerances must be in accordance with the relative tables (pages 17 & 18) . Any deviations will influence the bearing frictional torque, running accuracy and running characteristics.

Figure 15
Requirements
for the adjacent construction,
EVRT, EVRTS, EVLDF



1 - Tolerance class: see tables, pages 17 & 18. Support over whole bearing height. It must be ensured that the means of support has adequate rigidity.
2 - Tolerance class: see tables, pages 17 & 18. A precise fit is only necessary if radial support due to the load or a precise bearing position is required.
3 - Note the bearing diameter D1 in the dimension tables. Ensure that there is sufficient distance between the rotating bearing rings and the adjacent construction.
4 - Values, see table Maximum corner radii of fit surfaces for **EVRT, EVRTS** & **EVLDF** (from page 18).

Fits

The selection of fits leads to transition fits, i.e. depending on the actual dimensional position of the bearing diameter and mounting dimensions, clearance fits or interference fits can arise.
The fit influences, for example, the running accuracy of the bearing and its dynamic characteristics.
An excessively tight fit will increase the radial bearing preload.
As a result:
1 - There is an increase in bearing friction and heat generation in the bearing as well as the load on the raceway system and wear.
2 - there will be a decrease in the achievable speed and the bearing operating life.

For easier matching of the adjacent construction to the actual bearing dimensions, each bearing of series **EVRT** and **EVRTS** is supplied with a measurement record (this is available by agreement for other series).

Axial and radial runout accuracy of the bearing arrangement

The axial and radial runout accuracy is influenced by:
1 - The running accuracy of the bearing
2 - The geometrical accuracy of the adjacent surfaces
3 - The fit between the rotating bearing ring and adjacent component.

For very high running accuracy, the rotating bearing ring should ideally have a fit clearance **0** and it should be ensured that the bearing has preload in operation (see page 10).

Recommended fits for shafts

The shaft should be produced to tolerance zone h5 and for series **EVRTS**, in accordance with table, page 18.
If there are special requirements, the fit clearance must be further restricted within the stated tolerance zones:

1 - **Requirements for running accuracy:**
Where maximum running accuracy is required and the bearing inner ring is rotating, the aim should be to achieve as close as possible to a fit clearance **0**. The fit clearance may otherwise increase the bearing radial runout. With normal requirements for running accuracy or a stationary bearing inner ring, the shaft for axial/radial bearings **EVRT** and **EVLDF** should be produced to h5. For axial/radial bearing **EVRTS**, the recommended fits for shaft and housing bore must be observed

2 - **Requirements for dynamic characteristics:**

- For swivel operation (n x d < 35.000 rpm x mm, operating duration ED < 10%) the shaft should be produced to h5. The tolerance field h5 can be used under these operating conditions for axial/radial bearings **EVRT**, **EVLDF** e **EVRTS**.
- For higher speeds and longer operating duration, the fit interference must not exceed 0,01 mm. For series **EVRTS**, the fit interference must not exceed 0,005 mm.

For series **EVLDF**, the fit clearance should be based on the inner ring with the smallest bore dimension.

Recommended fits fo rhousings

The housing should be produced to tolerance zone J6 and for series **EVRTS** in accordance with table at page 18.

If there are special requirements, the fit clearance must be further restricted within the stated tolerance zones:

1 - **Requirements for running accuracy:**
For maximum running accuracy and with a rotating bearing outer ring, the aim should be to achieve as close as possible to a fit clearance of **0**. With a static bearing outer ring, a clearance fit or a design without radial centring should be selected.

2 - **Requirements for dynamic characteristics::**

- For predominantly swivel type operation (n x d < 35.000 rpm x mm, operating duration ED < 10%) be produced to tolerance zone J6. The tolerance field J6 can be used under these operating conditions for axial/radial bearings **EVRT**, **EVLDF** and **EVRTS**.
- For axial/radial bearing YRTS with a higher speed and operating duration, the bearing outer ring should not be radially centred or the housing fit should be produced as a clearance fit with at least 0,02 mm clearance. This will reduce the increase in preload that occurs where there is a temperature differential between the inner ring and outer ring of the bearing.

Fit selection depending on the screw connection of the bearing rings

If the bearing outer ring is screw mounted on the static component, a fit seating is not required or a fit seating can be produced as stated, see tables, pages 17 & 18. If the values in the table are used, this will give a transition fit with a tendency towards clearance fit.
This generally allows easy fitting.

If the bearing inner ring is screw mounted on the static component, it should nevertheless for functional reasons be supported by the shaft over the whole bearing height. The shaft dimensions should then be selected accordingly, see tables, pages 17 & 18. If these values in the table are used, this will give a transition fit with a tendency towards clearance fit.

Geometrical and positional accuracy of the adjacent construction
The values given in the following tables for geometrical and positional accuracy of the adjacent construction have proved effective in practice and are adequate for the majority of applications.

The geometrical tolerances influence the axial and radial runout accuracy of the subassembly as well as the bearing frictional torque and the running characteristics.

EVRT & EVLDF
Diameter and geometrical tolerances for shafts

Nominal shaft diameter d (mm)		*Deviation d for tolerance zone h5 µm*		*Roundness Parallelism Perpendicularity t2, t6, t8 µm*
over	*incl.*	*high*	*low*	*max*
50	80	0	-13	3
80	120	0	-15	4
120	180	0	-18	5
180	250	0	-20	7
250	315	0	-23	8
315	400	0	-25	9
400	500	0	-27	10
500	630	0	-32	11
630	800	0	-36	13
800	1.000	0	-40	15
1.000	1.250	0	-47	18

EVRT & EVLDF
Diameter and geometrical tolerances for housing

Nominal housing bore diameter D (mm)		*Deviation D fo tolerance zone J6 µm*		*Rotondità Perpendicolarità t2, t8 µm*
over	*incl.*	*high*	*low*	*max*
120	180	+18	-7	5
180	250	+22	-7	7
250	315	+25	-7	8
315	400	+29	-7	9
400	500	+33	-7	10
500	630	+34	-10	11
630	800	+38	-12	13
800	1.000	+44	-12	15
1.000	1.250	+52	-14	18

EVRTS
Recommended fits for shaft and housing bore

Axial/radial bearing	*Shaft diameter d mm*	*Housing bore D mm*
EVRTS 200	$200^{-0,01}_{-0,024}$	$300^{+0,011}_{-0,005}$
EVRTS 260	$260^{-0,013}_{-0,029}$	$385^{+0,013}_{-0,005}$
EVRTS 325	$325^{-0,018}_{-0,036}$	$450^{+0,015}_{-0,005}$
EVRTS 395	$395^{-0,018}_{-0,036}$	$525^{+0,017}_{-0,005}$
EVRTS 460	$460^{-0,018}_{-0,038}$	$600^{+0,018}_{-0,005}$

EVRT & EVLDF
Geometrical and positional accuracy for shafts

Axial/radial bearing	*Roundness* t_2 µm	*Parallelism* t_6 µm	*Perpendicularity* t_8 µm
EVRTS 200	6	5	5
EVRTS 260 a EVRTS 460	8	5	7

EVRT & EVLDF
Geometrical and positional accuracy for housings

Axial/radial bearing	*Roundness* t_2 µm	*Perpendicularity* t_8 µm
EVRTS 200 a EVRTS 460	6	8

EVRT, EVRTS & EVLDF
Maximum corner radii of fit surfaces

Bore diameter d mm		*Maximum corner radius* R_{max} *mm*
over	*incl.*	
50	150	0,1
150	460	0,3
460	950	1

Mounting dimensions H1 & H2

If the height variation must be as small as possible, the H_1 dimensional tolerance must conform to the tables, pages 23 & 24, and **Figure 16**.

The mounting dimension H_2 defines the position of any worm wheel used, **Fig. 16** e **Fig. 17**, page 20, L-section ring with support ring.

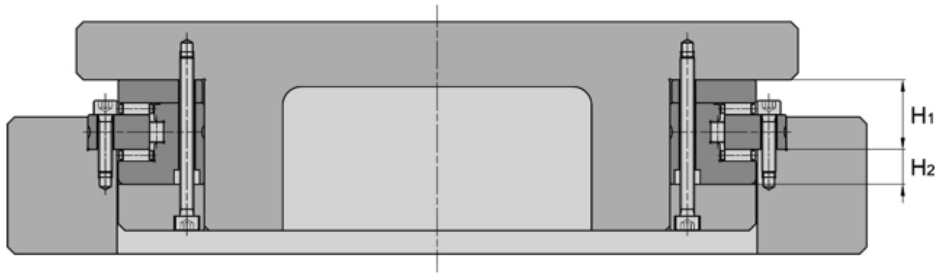


Figure 16
Mounting dimension

L-section ring without support ring or with support ring

The L-section ring of bearings **EVRT**, **EVRTS** and **EVLDF** can be mounted unsupported or supported over its whole surface as an inner ring, **Figure 17**, page 20.
The support ring (for example a worm wheel or torque motor) is not included in the scope of delivery.
For series **EVRTS** and **EVLDF**, there is only one preload match.
The increase in rigidity and frictional torque in **EVRTS** bearings is slight and can normally be ignored.
In bearings of series **EVLDF**, the rigidity and frictional torque are not influenced by the support ring.
In fitting of the series EVRT with an L-section ring supported axially over its whole surface, there is an increase in the axial rigidity in the direction of the support ring as a function of the support ring rigidity and in the tilting rigidity of up to 20%. In this case, delivery with a different preload match is necessary, suffix **PRL**.
If the normal design of series **EVRT** (without suffix **PRL**) is mounted with a supported L-section ring, there will be a considerable increase in the bearing frictional torque.
The shaft locating washer must be supported axially over its whole surface by the adjacent construction. In the case of **EVRT...PRL**, the L-section ring must also be axially supported over its whole surface in order to achieve the stated rigidity values.

L-section ring without support ring

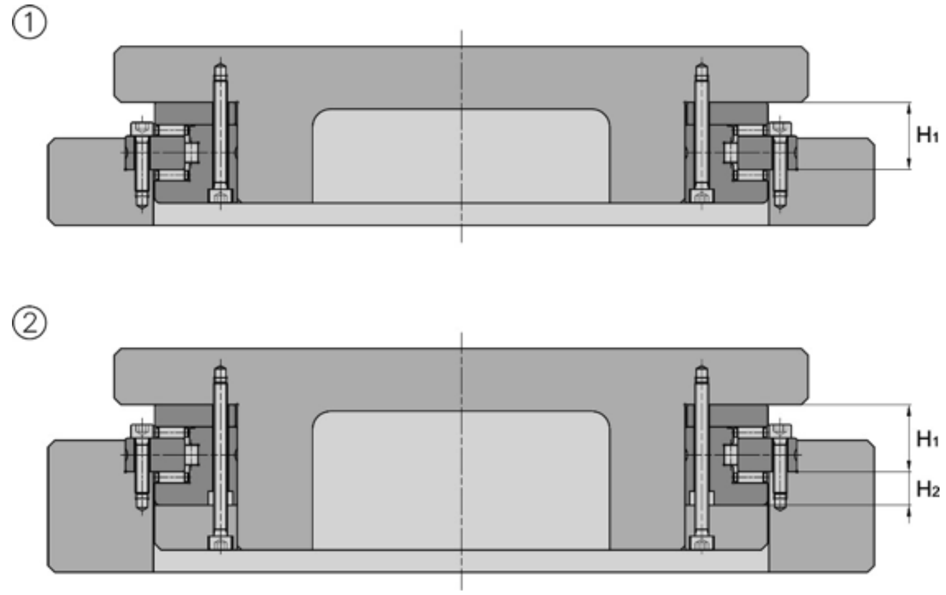
In the case of "L-section ring without support ring", the bearing designation is:
EVRT (bore diameter)

L-section ring with support ring

For the case "L-section ring with support ring", the bearing designation is:
EVRT (bore diameter) **PRL**

In the case of series **EVRT**, the height of the support ring should be at least as large as the dimension H_2 of the bearing.

Any mounting conditions that deviate from our suggestions, **Figure 17**, may impair the function and the performance data of the bearings. For different designs, please contact us.



EVRT
1 - Unsupported L-section ring

EVRT...PRL
2 - Supported L-section ring

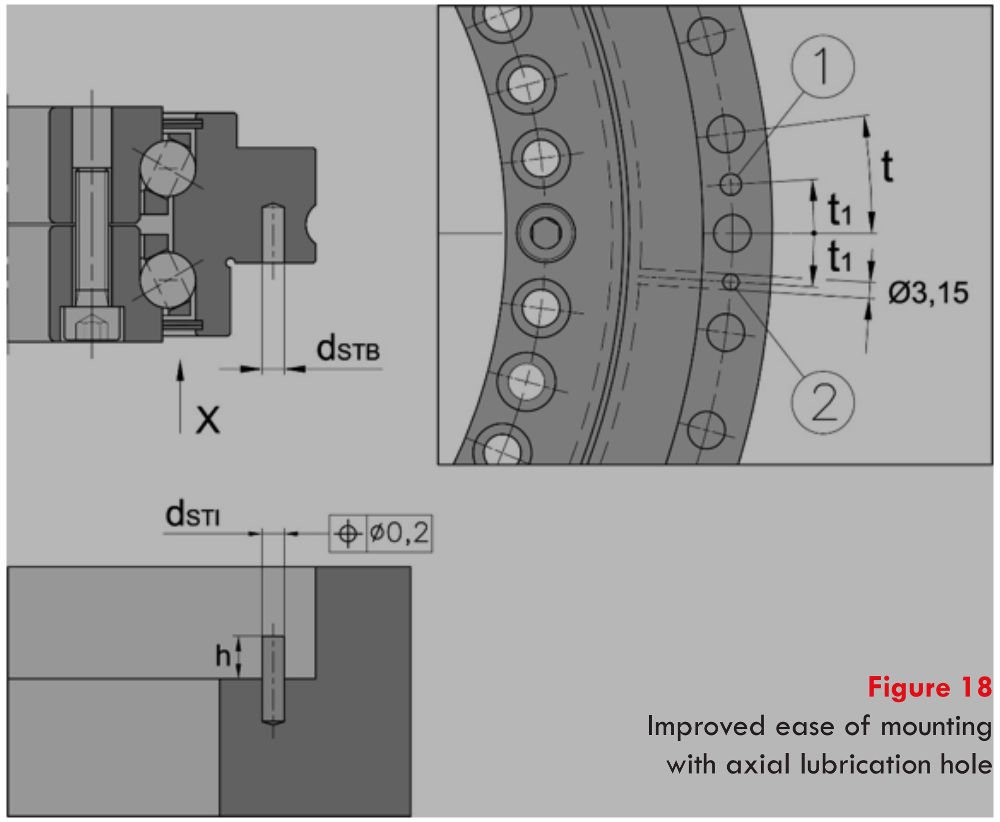
Figura 17
Mounting variants

Improved ease of mounting

In order to ensure that the lubrication hole in the bearing is correctly positioned relative to the lubrication hole in the machine housing, the bearings **EVRTS** and **EVLDF** have a so-called pilot pin hole, see table and **Figure 18**.

	h mm max.	d_{STI}	d_{STB} mm min.
Pilot pin hole	4	4	5

EVRT
EVLDF



1 - Pilot pin hole for positioning of lubrication hole
2 - Lubrification hole
t_1 = 0,5xt

Figure 18
Improved ease of mounting with axial lubrication hole

Fitting

Retaining screws secure the bearing components during transport. For easier centring of the bearing, the screws should be loosened before fitting and either secured again or removed after fitting.
Tighten the fixing screws in a crosswise sequence using a torque wrench in three stages to the specified tightening torque M_A, while rotating the bearing **EVLDF**, **Figure 19**.

- Stage 1 40% di M_A
- Stage 2 70% di M_A
- Stage 3 100% di M_A

Observe the correct grade of the fixing screws.

Mounting forces must only be applied to the bearing ring to be fitted, never through the rolling elements.
Bearing components must not be separated or interchanged during fitting and dismantling.
If the bearing is unusually difficult to move, loosen the fixing screws and tighten them again in steps in a crosswise sequence.
This will eliminate any distortion.

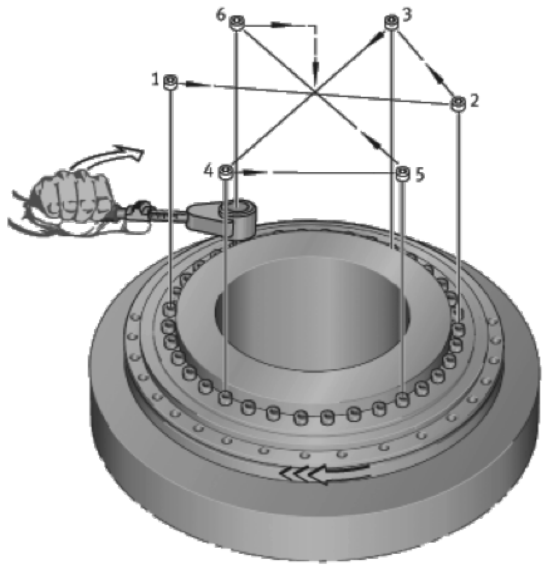


Figure 19
Tightening of fixing screws

Static rigidity

The overall rigidity of a bearing position is a description of the magnitude of the displacement of the rotational axis from its ideal position under load. The static rigidity thus has a direct influence on the accuracy of the machining results. The dimension tabls give the rigidity values for the complete bearing position. These take account of the deflection of the rolling element set as well as the deformation of the bearing rings and the screw connections.
The values for the rolling element sets are calculated rigidity values and are for information purposes only.
They facilitate comparison with other bearing types, since rolling bearing catalogues generally only give the higher rigidity values for the rolling element set.

Accuracy
The dimensional tolerances are derived from tolerance class **P5**.
The diameter tolerances stated are mean values in accordance with **DIN 620**.
The geometrical tolerances correspond to **P4** in accordance with **DIN 620**, see table.
The bearing bore in series **EVRT** and **EVRTS** may be slightly conical in the delivered condition.
This is typical of the bearing design and is a result of the radial bearing preload forces. The bearing will regain its ideal geometry when fitted.

Dimensional tolerances and mounting dimensions for axial/radial bearing **EVRT**

Dimensional tolerances 1)				*Mounting dimensions*					
Bore		*Outer diameter*		*Normal*		*Restricted* 2)	*Normal*		*Restricted* 2)
d mm	*Δ ds* mm	*D* mm	*Δ Ds* mm	*H 1* mm	*Δ H1s* mm	*Δ H1s* mm	*H 2* mm	*Δ H2s* mm	*Δ H2s* mm
50	-0,008	126	-0,011	20	±0,025	-	10	±0,020	-
80	-0,009	146	-0,011	23,35	±0,025	-	11,65	±0,020	-
100	-0,010	185	-0,015	25	±0,025	-	13	±0,020	-
120	-0,010	210	-0,015	26	±0,025	-	14	±0,020	-
150	-0,013	240	-0,015	26	±0,030	-	14	±0,020	-
180	-0,013	280	-0,018	29	±0,030	-	14	±0,025	-
200	-0,015	300	-0,018	30	±0,030	-	15	±0,025	-
260	-0,018	385	-0,020	36,5	±0,040	-	18,5	±0,025	-
325	-0,023	450	-0,023	40	±0,050	-	20	±0,025	-
395	-0,023	525	-0,028	42,5	±0,050	-	22,5	±0,025	-
460	-0,023	600	-0,028	46	±0,060	-	24	±0,030	-
580	-0,025	750	-0,035	60	±0,250	±0,075	30	±0,250	±0,030
650	-0,038	870	-0,050	78	±0,250	±0,100	44	±0,250	±0,030
850	-0,050	1095	-0,063	80,5	±0,300	±0,120	43,5	±0,300	±0,030
950	-0,050	1200	-0,063	86	±0,300	±0,120	46	±0,300	±0,030
1030	-0,063	1300	-0,080	92,5	±0,300	±0,150	52,5	±0,300	±0,030

1) The diameter tolerances stated are mean values (**DIN 620**)
2) Special design with suffix, see table, page **4**

Dimensional tolerances and mounting dimensions for axial/radial bearing **EVRTS**

Dimensional tolerances 1)				*Mounting dimensions*		
Bore		*Outer diameter*				
d mm	*Δ ds* mm	*D* mm	*Δ Ds* mm	*H 1* mm	*Δ H1s* mm	*H 2* mm
200	-0,015	300	-0,018	30	+0,04 -0,06	15
260	-0,018	385	-0,020	36,5	+0,05 -0,07	18,5
325	-0,023	450	-0,023	40	+0,06 -0,07	20
395	-0,023	525	-0,028	42,5	+0,06 -0,07	22,5
460	-0,023	600	-0,028	46	+0,07 -0,08	24

1) The diameter tolerances stated are mean values (**DIN 620**)

Dimensional tolerances and mounting dimensions for axial/radial bearing **EVLDF**

Tolleranze dimensionali 1)				*Dimensioni di montaggio*	
Foro		*Diametro esterno*			
d mm	*Δ ds* mm	*D* mm	*Δ Ds* mm	*H 1* mm	*Δ H1s* mm
100	-0,010	185	-0,015	25	±0,175
120	-0,010	210	-0,015	26	±0,175
150	-0,013	240	-0,015	26	±0,175
180	-0,013	280	-0,018	29	±0,175
200	-0,015	300	-0,018	30	±0,175
260	-0,018	385	-0,020	36,5	±0,200
325	-0,023	450	-0,023	40	±0,200
395	-0,023	525	-0,028	42,5	±0,200
460	-0,023	600	-0,028	46	±0,225

1) The diameter tolerances stated are mean values (**DIN 620**)

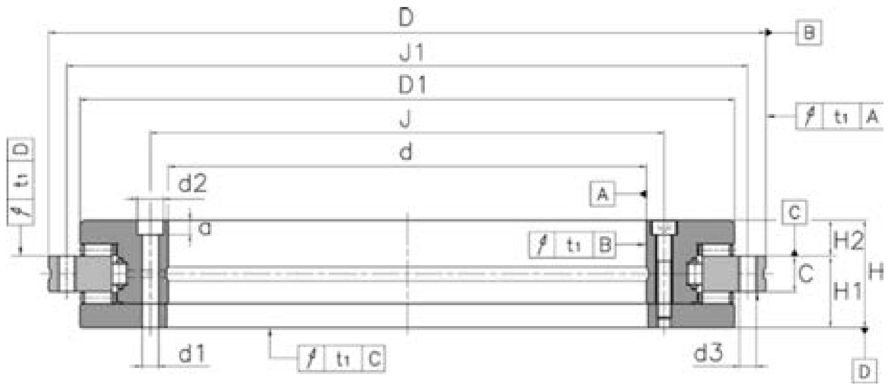
Axial and radial runout for axial/radial bearings **EVRT, EVRTS & EVLDF**

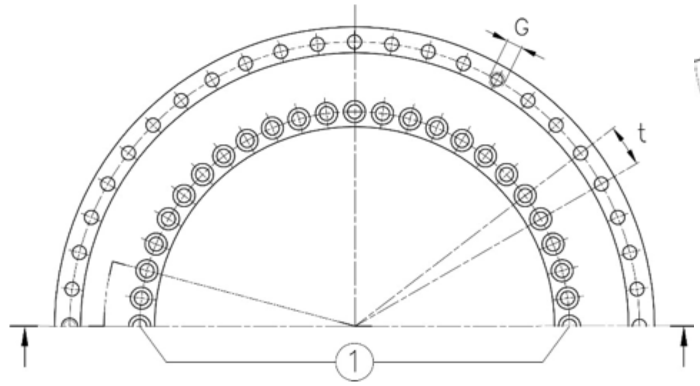
Bore d	*Axial and radial runout* 1) *t 1*				
	EVRT		*EVRTS*		*EVLDF*
	Normal 2)	*Restricted* 2)	*Normal* 2)	*Restricted* 2)	*Normal* 2)
mm	*µm*		*µm*		*µm*
50	2	1	-	-	-
80	3	1,5	-	-	-
100	3	1,5	-	-	3
120	3	1,5	-	-	3
150	3	1,5	-	-	3
180	4	2	-	-	4
200	4	2	4	2	4
260	6	3	6	3	6
325	6	3	6	3	6
395	6	3	6	3	6
460	6	3	6	3	6
580	10	5 4)	-	-	-
650	10	5 4)	-	-	-
850	12	6 4)	-	-	-
950	12	6 4)	-	-	-
1030	12	6 4)	-	-	-

1) Measured on fitted bearing with ideal adjacent construction.
2) For rotating inner and outer ring.
3) For rotating inner ring only.
4) Available by agreement.

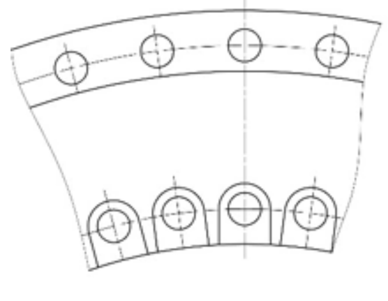
Axial/radial bearings
Double direction

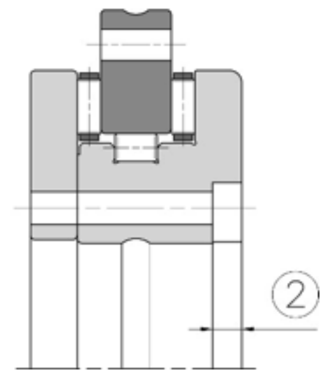
EVRT… Series





Hole pattern
1 - Two retaining screws





For EVRT 80 & EVRT 100:
2 - Screw counterbores open[5)]

bore Ø	Designation	Weight	Dimensions (mm)									Fixing holes					
												Inner ring				Outer ring	
		Kg	d	D	H	H_1	H_2	C	D_1 max	J	J_1	d_1	d_2	a	Q.ty[4)]	d_3	Q.ty[4)]
50	**EVRT 50**	1.6	50	126	30	20	10	10	105	63	116	5.6	9	4.2	10	5.6	12
80	**EVRT 80**	2.4	80	146	35	23.35	11.65	12	130	92	138	5.6	10	4	10	4.6	12
100	**EVRT 100**	4.1	100	185	38	25	13	12	161	112	170	5.6	10	5.4	16	5.6	15
120	**EVRT 120**	5.3	120	210	40	26	14	12	185	135	195	7	11	6.2	22	7	21
150	**EVRT 150**	6.2	150	240	40	26	14	12	214	165	225	7	11	6.2	34	7	33
180	**EVRT 180**	7.7	180	280	43	29	14	15	244	194	260	7	11	6.2	46	7	45
200	**EVRT 200**	9.7	200	300	45	30	15	15	274	215	285	7	11	6.2	46	7	45
260	**EVRT 260**	18.3	260	385	55	36.5	18.5	18	345	280	365	9.3	15	8.2	34	9.3	33

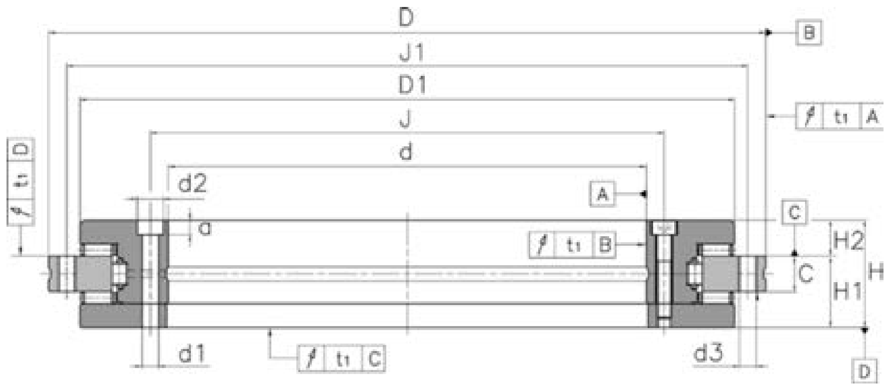
Designation	Pitch t[1)]	Threaded extraction hole		Screw tightening torque	Basic load ratings				Limiting speed[6)]	Bearing frictional torque[7)]
					Axial		Radial			
	Q.ty x t	G	Q.ty	M_A[2)] Nm	$C_{a\,din}$ KN	$C_{0a\,stat}$ KN	C_{din} KN	C_{0stat} KN	n_G min^{-1}	M_{RL} Nm
EVRT 50	12x30°	-	-	8.5	56	280	28.5	49.5	440	2.5
EVRT 80	12x30°	-	-	8.5	38	158	44	98	350	3
EVRT 100	18x20°	M5	3	8.5	73	370	52	108	280	3
EVRT 120	24x15°	M8	3	14	80	445	70	148	230	7
EVRT 150	36x10°	M8	3	14	85	510	77	179	210	13
EVRT 180	48x7,5°	M8	3	14	92	580	83	209	190	14
EVRT 200	48x7,5°	M8	3	14	98	650	89	236	170	15
EVRT 260	36x10°	M12	3	34	109	810	102	310	130	25

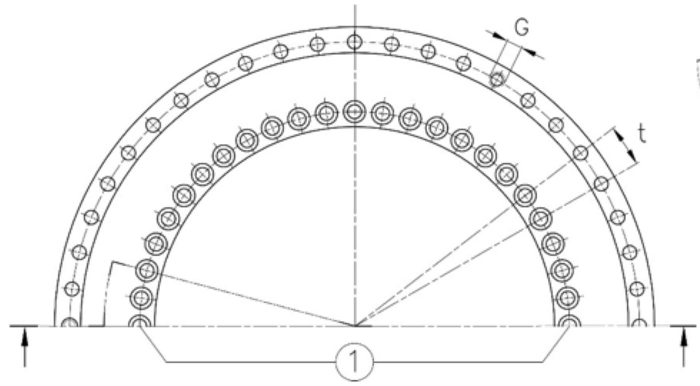
1) Including retaining screws or threaded extraction holes.
2) Tightening torque for screws to **DIN 912** (UNI 5931), grade 10.9.
3) Rigidity values taking account of the rolling element set, the deformation of the bearing rings and the screw connections.
4) **Attention!!!**
For fixing holes in the adjacent construction observe the pitch of the bearing holes.
5) Screw counterbores in the L-section ring open to the bearing bore. The bearing inside diameter is unsupported in the area 2.
6) For high operating durations or continuous operation, please contact us.
7) Measurement speed = 5 rpm.

Designation	Rigidity					
	of bearing position[3)]			of rolling element set		
	Axial	Radial	Tilting rigidity	Axial	Radial	Tiliting rigidity
	C_{aL} KN/µm	C_{rL} KN/µm	C_{kL} KNm/mrad	C_{aL} KN/µm	C_{rL} KN/µm	C_{kL} KNm/mrad
EVRT 50	1,3	1,1	1,25	6,2	1,5	5,9
EVRT 80[5)]	1,6	1,8	2,5	4	2,6	6,3
EVRT 100[5)]	2	2	5	6,8	2,4	15
EVRT 120	2,1	2,2	7	7,8	3,8	24
EVRT 150	2,3	2,6	11	8,7	4,6	38
EVRT 180	2,6	3	17	9,9	5,3	57
EVRT 200	3	3,5	23	11,2	6,2	80
EVRT 260	3,5	4,5	45	13,7	8,1	155

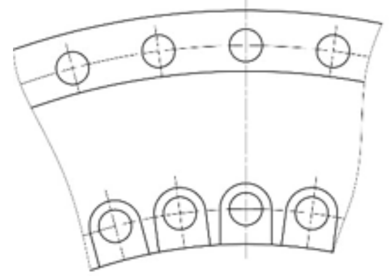
Axial/radial bearings
Double direction

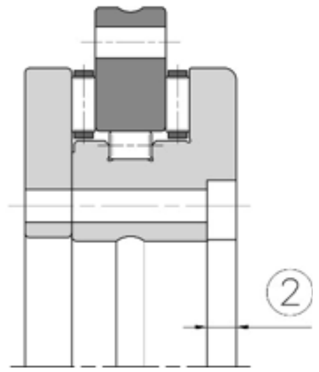
EVRT… Series





Hole pattern
1 - Two retaining screws





For EVRT 325:
2 - Screw counterbores open[5]

bore Ø	Designation	Weight Kg	Dimensions (mm) d	D	H	H_1	H_2	C	D_1 max	J	J_1	Fixing holes, Inner ring d_1	d_2	a	Q.ty[4]	Outer ring d_3	Q.ty[4]	Pitch t[1] Q.ty x t	Threaded extraction hole G	Q.ty	Screw tightening torque M_A[2] Nm	Basic load ratings, Axial $C_{a\,din}$ KN	$C_{0a\,stat}$ KN	Radial C_{din} KN	C_{0stat} KN	Limiting speed[6] n_G min^{-1}	Bearing frictional torque7) M_{RL} Nm
325	***EVRT 325***	25	325	450	60	40	20	20	415	342	430	9.3	15	8.2	34	9.3	33	36x10°	M12	3	34	186	1710	134	415	110	48
395	***EVRT 395***	33	395	525	65	42.5	22.5	20	486	415	505	9.3	15	8.2	46	9.3	45	48x7,5°	M12	3	34	202	2010	133	435	90	55
460	***EVRT 460***	45	460	600	70	46	24	22	560	482	580	9.3	15	8.2	46	9.3	45	48x7,5°	M12	3	34	217	2300	187	650	80	70
580	***EVRT 580***	89	580	750	90	60	30	30	700	610	720	11.4	18	11	46	11.4	42	48x7,5°	M12	6	68	390	3600	211	820	60	140
650	***EVRT 650***	170	650	870	122	78	44	34	800	680	830	14	20	13	46	14	42	48x7,5°	M12	6	116	495	5200	415	1500	55	200
850	***EVRT 850***	253	850	1095	124	80.5	43.5	37	1018	890	1055	18	26	17	58	18	54	60x6°	M16	6	284	560	6600	475	1970	40	300
1030	***EVRT 1030***	375	1030	1300	145	92.5	-	40	1215	1075	1255	18	26	17	70	18	66	72x5°	M16	6	284	1080	11000	620	2650	35	800

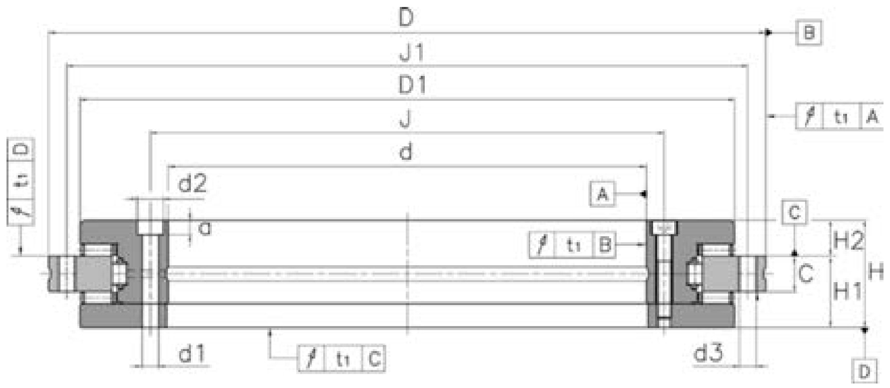
1) Including retaining screws or threaded extraction holes.
2) Tightening torque for screws to **DIN 912** (UNI 5931), grade 10.9.
3) Rigidity values taking account of the rolling element set, the deformation of the bearing rings and the screw connections.
4) **Attention!!!**
For fixing holes in the adjacent construction observe the pitch of the bearing holes.
5) Screw counterbores in the L-section ring open to the bearing bore. The bearing inside diameter is unsupported in the area 2.
6) For high operating durations or continuous operation, please contact us.
7) Measurement speed = 5 rpm.

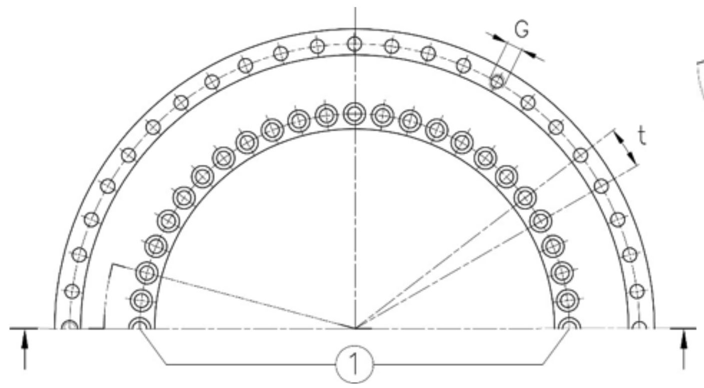
Designation	Rigidity of bearing position[3] Axial C_{aL} KN/µm	Radial C_{rL} KN/µm	Tilting rigidity C_{kL} KNm/mrad	of rolling element set Axial C_{aL} KN/µm	Radial C_{rL} KN/µm	Tilting rigidity C_{kL} KNm/mrad
EVRT 325[5]	4,3	5	80	26,1	9,4	422
EVRT 395	4,9	6	130	30,3	11,3	684
EVRT 460	5,7	7	200	33,5	13,9	1049
EVRT 580	6,9	9	380	42,1	17,4	2062
EVRT 650	7,6	10	550	58,3	19,7	3669
EVRT 850	9,3	13	1100	73,4	20,2	7587
EVRT 1030	11,2	16	1900	79,7	18,8	12025

Axial/radial bearings

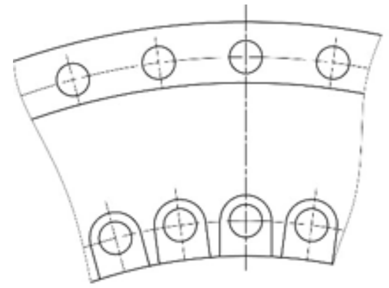
Double direction

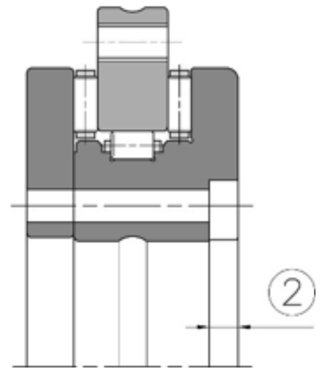
EVRTS… Series





Hole pattern
1 - Two retaining screws





For EVRT 325:
2 - Screw counterbores open[5)]

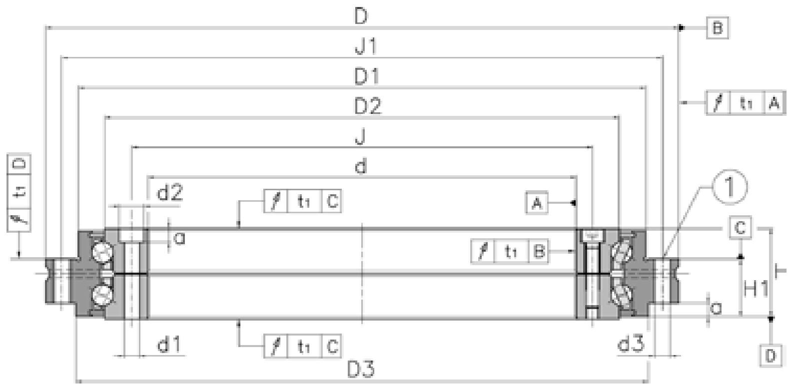
bore Ø	Designation	Weight	Dimensions (mm)									Fixing holes						Pitch t[1)]	Threaded extraction hole		Screw tightening torque	Basic load ratings				Limiting speed	Mass moment of intertia for rotating[7)]	
												Anello interno				Anello esterno						Axial		Radial			Inner ring	Outer ring
			d	D	H	H_1	H_2	C	D_1 max	J	J_1	d_1	d_2	a	Q.ty[4)]	d_3	Q.ty[4)]	Q.ty x t	G	Q.ty	M_A[2)]	$C_{a\ din}$	$C_{0a\ stat}$	C_{din}	C_{0stat}	n_G	M_M	
		Kg																			Nm	KN	KN	KN	KN	min^{-1}	$Kg{*}cm^2$	
200	**EVRTS 200**	9.7	200	300	45	30	15	15	274	215	285	7	11	6.2	46	7	45	48x7,5°	M8	3	14	155	840	94	226	1160	667	435
260	**EVRTS 260**	18.3	260	385	55	36.5	18.5	18	345	280	365	9.3	15	8.2	34	9.3	33	36x10°	M12	3	34	173	1050	110	305	910	2074	1422
325	**EVRTS 325**	25	325	450	60	40	20	20	415	342	430	9.3	15	8,2[5)]	34	9.3	33	36x10°	M12	3	34	191	1260	109	320	760	4506	2489
395	**EVRTS 395**	33	395	525	65	42.5	22.5	20	486	415	505	9.3	15	8.2	46	9.3	45	48x7,5°	M12	3	34	214	1540	121	390	650	8352	4254
460	**EVRTS 460**	45	460	600	70	46	24	22	560	482	580	9.3	15	8.2	46	9.3	45	48x7,5°	M12	3	34	221	1690	168	570	560	15738	7379

1) Including retaining screws or threaded extraction holes.
2) Tightening torque for screws to **DIN 912** (UNI 5931), grade 10.9.
3) Rigidity values taking account of the rolling element set, the deformation of the bearing rings and the screw connections.
4) **Attention!!!**
For fixing holes in the adjacent construction observe the pitch of the bearing holes.
5) Screw counterbores in the L-section ring open to the bearing bore. The bearing inside diameter is unsupported in the area 2.
6) For high operating durations or continuous operation, please contact us.
7) Measurement speed = 5 rpm.

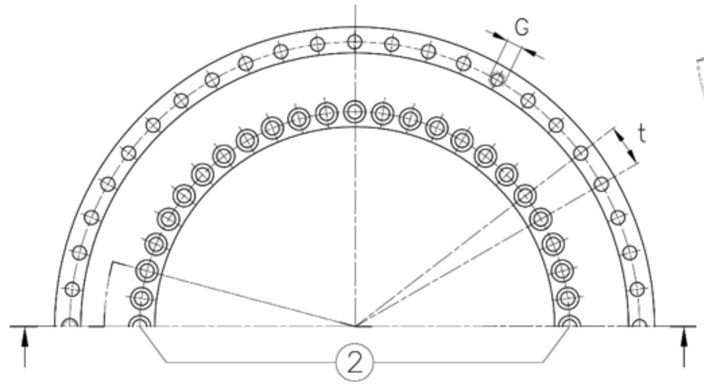
Designation	Rigidity					
	of bearing position[4)]			of rolling element set		
	Axial	Radial	Tilting rigidity	Axial	Radial	Tilting rigidity
	C_{aL}	C_{rL}	C_{kL}	C_{aL}	C_{rL}	C_{kL}
	KN/μm	KN/μm	KNm/mrad	KN/μm	KN/μm	KNm/mrad
EVRTS 200	4	1,2	29	13,6	3,9	101
EVRTS 260	5,4	1,6	67	16,8	5,8	201
EVRTS 325[5)]	6,6	1,8	115	19,9	7,1	350
EVRTS 395	7,8	2	195	23,4	8,7	582
EVRTS 460	8,9	1,8	280	25,4	9,5	843

Axial angular contact ball bearings
Double direction

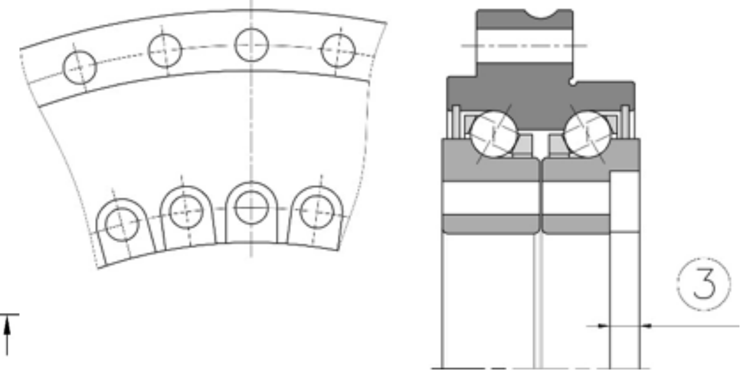
EVLDF… Series



1 - Contact surface/centring diameter



Hole pattern
2 - Two retaining screws



For EVLDF 100, EVLDF 325:
3 - Screw counterbores open[5]

bore Ø	Designation	Weight	Dimensions (mm)										Fixing holes Inner ring			Fixing holes Outer ring		Retaining screws	Pitch t[1]	Threaded extraction hole		Screw tightening torque	Basic load ratings		Limiting speed
		Kg	d	D	H	H_1	D_1	D_2	D_3	J	J_1	a	d_1	d_2	Q.ty[4]	d_3	Q.ty[4]	Q.ty	Q.ty x t	G	Q.ty	M_A[2] Nm	$C_{a\ din}$ KN	$C_{0a\ stat}$ KN	n_G min^{-1}
100	**EVLDF 100**	3.8	100	185	38	25	161	136	158	112	170	5.4	5.6	10	16	5.6	15	2	18x20°	M5	3	8.5	71	265	5000
120	**EVLDF 120**	4.8	120	210	40	26	185	159	181	135	195	6.2	7	11	22	7	21	2	24x15°	M8	3	14	76	315	4300
150	**EVLDF 150**	5.6	150	240	40	26	214	188	211	165	225	6.2	7	11	34	7	33	2	36x10°	M8	3	14	81	380	3600
180	**EVLDF 180**	7.7	180	280	43	29	244	219	246	194	260	6.2	7	11	46	7	45	2	48x7,5°	M8	3	14	85	440	3500
200	**EVLDF 200**	10	200	300	45	30	274	243	271	215	285	6.2	7	11	46	7	45	2	48x7,5°	M8	3	14	121	610	3200
260	**EVLDF 260**	19	260	385	55	36.5	345	313	348	280	365	8.2	9.3	15	34	9.3	33	2	36x10°	M12	3	34	162	920	2400
325	**EVLDF 325**	25	325	450	60	40	415	380	413	342	430	8.2	9.3	15	34	9.3	33	2	36x10°	M12	3	34	172	1110	2000
395	**EVLDF 395**	33	395	525	65	42.5	486	450	488	415	505	8.2	9.3	15	46	9.3	45	2	48x7,5°	M12	3	34	241	1580	1600
460	**EVLDF 460**	47	460	600	70	46	560	520	563	482	580	8.2	9.3	15	46	9.3	45	2	48x7,5°	M12	3	34	255	1860	1400

1) Including retaining screws or threaded extraction holes.
2) Tightening torque for screws to **DIN 912** (UNI 5931), grade 10.9.
3) Rigidity values taking account of the rolling element set, the deformation of the bearing rings and the screw connections.
4) **Attention!!!**
For fixing holes in the adjacent construction observe the pitch of the bearing holes.
5) Screw counterbores in the L-section ring open to the bearing bore. The bearing inside diameter is unsupported in the area 3.
6) For high operating durations or continuous operation, please contact us.
7) Measurement speed = 5 rpm.

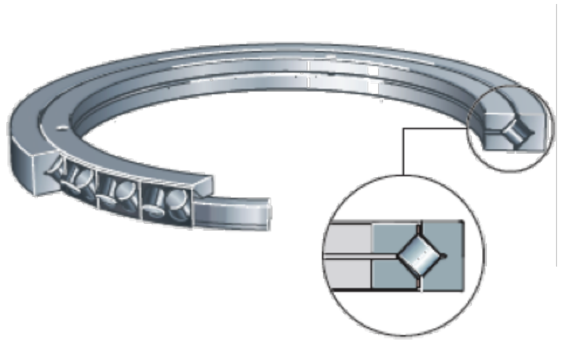
Designation	Rigidity of bearing position[3]			Rigidity of rolling element set		
	Axial	Radial	Tilting rigidity	Axial	Radial	Tilting rigidity
	C_{aL} KN/µm	C_{rL} KN/µm	C_{kL} KNm/mrad	C_{aL} KN/µm	C_{rL} KN/µm	C_{kL} KNm/mrad
EVLDF 100[5]	1,2	0,35	3,6	2,2	0,35	5
EVLDF 120	1,5	0,4	5,5	2,5	0,4	6
EVLDF 150	1,7	0,4	7,8	2,9	0,4	12
EVLDF 180	1,9	0,5	10,7	2,8	0,5	16
EVLDF 200	2,5	0,6	17,5	3,7	0,6	26
EVLDF 260	3,2	0,7	40	4,7	0,7	54
EVLDF 325[5]	4	0,8	60	5,4	0,8	90
EVLDF 395	4,5	0,9	100	6,3	0,9	148
EVLDF 460	5,3	1,1	175	7,1	1,1	223

FEATURES

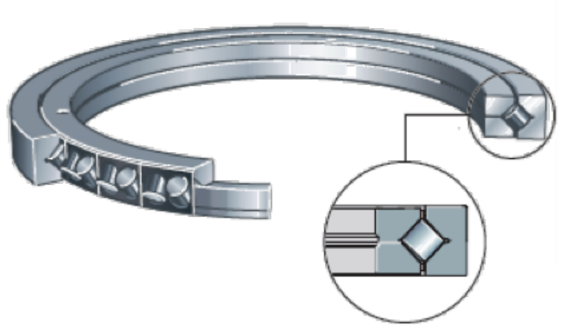
Thrust crossed roller bearings are highly rigid, have a running accuracy better than **P4** and the remaining tolerances to **P5**, and are preloaded.
The bearing outer rings are easily fixed to the adjacent construction using clamping rings.
The crossed roller bearings described here have a special internal construction that is designed for higher speeds and are optimised for use in vertical turret lathes. In comparison with the bearings described in the previous section, crossed roller bearings of the same size can offer a significantly higher basic dynamic load rating. Due to the smaller number of rolling elements, they have reduced rigidity.
The guidelines and values in this chapter relate only to the crossed roller bearings listed in the tables.
The bearings are operated with a rotating outer ring.

For axial, radial and moment loads
Due to the O arrangement of the cylindrical rollers, these bearings can support axial forces in both directions as well as radial forces, tilting moment loads and any combination of loads by means of a single bearing position. As a result, designs involving two bearing positions can be reduced to a single bearing position, **Figure 1** and **Figure 2**.

Adjustable axial preload



Defined preload



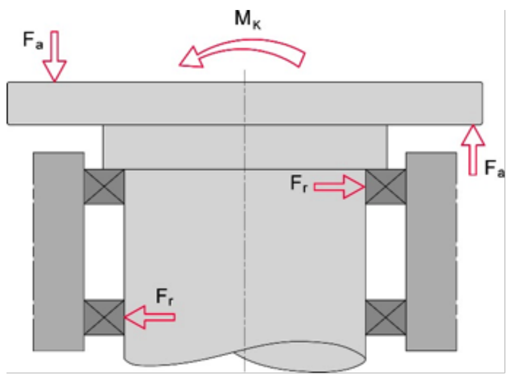


Figure 1
Bearing arrangement
with two bearing positions

F_a = Axial load
F_r = Radial load
M_k = Tilting moment

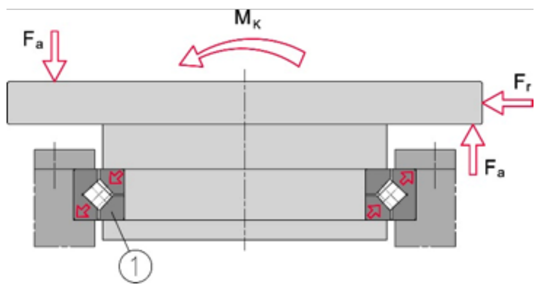


Figure 2
Bearing arrangement
with one crossed roller bearing

1 – Crossed roller bearing

Limiting speed

The limiting speed is dependent on the lubrication (grease or oil), see dimension tables.
If other limiting speeds are required, please contact us.

Standard clearance	***Preload***	***Peripheral speed***
Oil lubrification		up to 8 m/s ($n*D_M$ = 152.800)
Grease lubrification		up to 4 m/s ($n*D_M$ = 76.400)
	Oil lubrification	up to 4 m/s ($n*D_M$ = 76.400)
	Grease lubrification	up to m/s ($n*D_M$ = 38.200)

Preload

In the case of crossed roller bearings **EVZ 69...** & **EVZ 26…** the preload is set at the manufacturing plant and the bearing rings are located by means of appropriate covers and screw connections.
In the case of crossed roller bearings **EVZ 98…**, **EVXR…** & **EVJXR…** the actual height of the inner rings is stated in the record supplied with the bearing.
The required preload of crossed roller bearings with a gap is set by adjustment of the inner rings. This is carried out by means of shims or shim segments that are inserted between the journal and the clamping element on the upper inner ring. It is recommended that the shim thickness is determined according to the following procedure.
The first step is to produce a thicker shim of approx. 0,25 mm to 0,5 mm, which will then give a measurable axial internal clearance.
The provisional shim thickness **X_1** is calculated as follows:

$$X_1 = B_i - L + s$$

X_1 [mm]
Provisional shim thickness
B_i [mm]
Total width of inner ring according to inspection record
L [mm]
Measured seat length of shaft
s [mm]
Thickness of the shim produced,
s = 0,25/0,30/0,35/0,40/0,45/0,5 mm

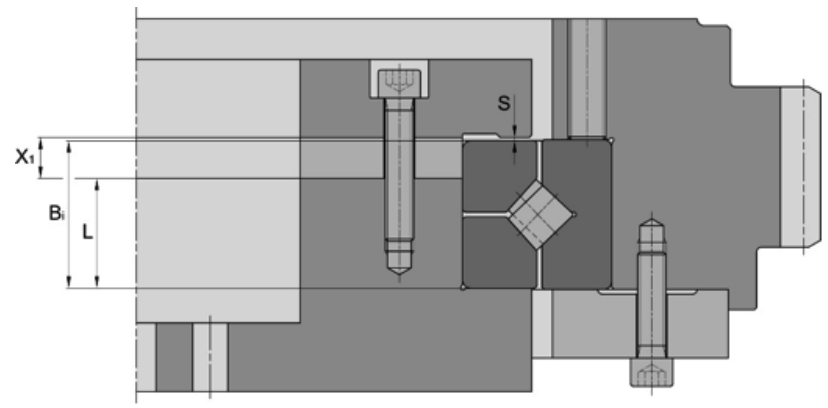


Figure 3
Bearing arrangement with provisional shim thickness **X_1**

Determining the required shim thickness

After the axial internal clearance has been measured, the final shim thickness X is then determined. The axial internal clearance can be determined by lifting the outer ring together with the adjacent parts.

Determining the required shim thickness:

$$X = X_1 - A - V$$

Determining the preload:

$$V = 2 * \frac{\sqrt[1,08]{F_v}}{C_s}$$

X [mm]
Required shim thickness
X_1 [mm]
Provisional shim thickness
A [mm]
Measured axial internal clearance
V [mm]
Preload
F_v [KN]
Preload force, recommended value approx. 3,5% of the basic dynamic load rating C
C_s [$KN^{0,926}$/mm]
Axial spring constant

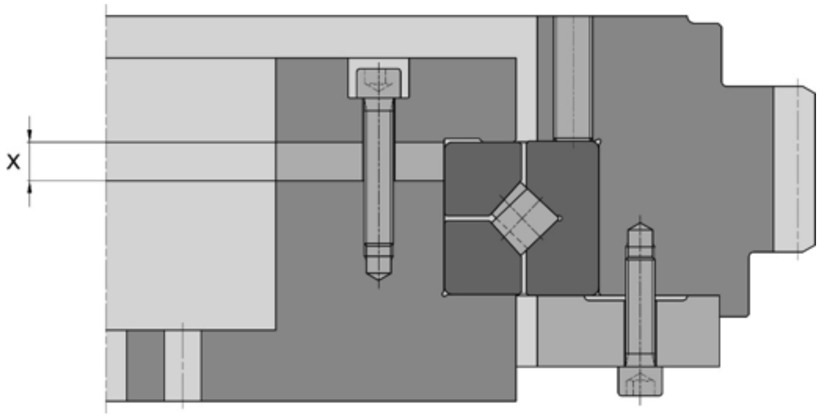


Figure 4
Bearing arrangement with required shim thickness X

Rigidity

Due to the large number of cylindrical rollers, the bearing has a high axial and radial load carrying capacity. The line contact between the rollers and the raceways also gives high rigidity that is increased further by the preload when the bearing is fitted. The axial displacement **δ_a** of the crossed roller bearings under a concentric axial force **K_a** can be determined using the following formulae:

Axial deflection for **$K_a \leq 2,114 * F_v$**

$$\delta_a = \frac{K_a}{2,114 * F_v^{0,071} * C_s}$$

Axial deflection for **$K_a > 2,114 * F_v$**

$$\delta_a = \frac{\sqrt[1,08]{K_a} - \sqrt[1,08]{F_v}}{C_s}$$

δ_a [mm]
Axial displacement between shaft locating washer and housing locating washer
K_a [KN]
Internal axial force
F_v [KN]
Bearing preload
C_s [$KN^{0,926}$/mm]
Axial rigidity factor.

The calculation result only gives the bearing deflection.
The elasticity of the adjacent construction must additionally be taken into consideration.

Sealing

The bearings are of an open design. The sealing arrangement can be designed anywhere within the adjacent construction.

Lubrication

The crossed roller bearings can be lubricated with oil or grease.

Grease lubrication

For grease lubrication, a high quality lithium soap grease KP2N–20 to **DIN 51825** is suitable, such as SHELL GADUS S3 V220C 2.
For low speeds, and especially for horizontal axes, the simple grease lubrication method should be used. In vertical axes with grease lubrication, a baffle plate should be fitted under the bearing to minimise the escape of grease. We recommend the use of a grease with a lithium soap base and EP additives. When initial greasing is carried out, the space between the rollers should be filled with grease. A relubrication quantity of 20% to 30% of the initial grease quantity is recommended.

Oil lubrication

For oil lubrication, oils CLP to **DIN 51517** or HLP to **DIN 51524** of viscosity classes ISO VG 46 a ISO VG 68 are suitable.

Recirculating oil lubrication

In general, the recirculating oil lubrication for the crossed roller bearings can also be used for the drive system.
If lubrication is to provided for the bearing only, a smaller quantity is sufficient.
If the oil must also provide cooling, as is the case at higher speeds, larger quantities of oil are required, **Figure 5**. In each individual case, the oil quantity actually required can be determined by measuring the temperature of the bearing.

V = Oil quantity
D = Bearing outside diameter
a = Oil quantity sufficient for lubrication
b = Oil quantity required for cooling and lubrication

1 - Lubrication and cooling
2 - Lubrication only

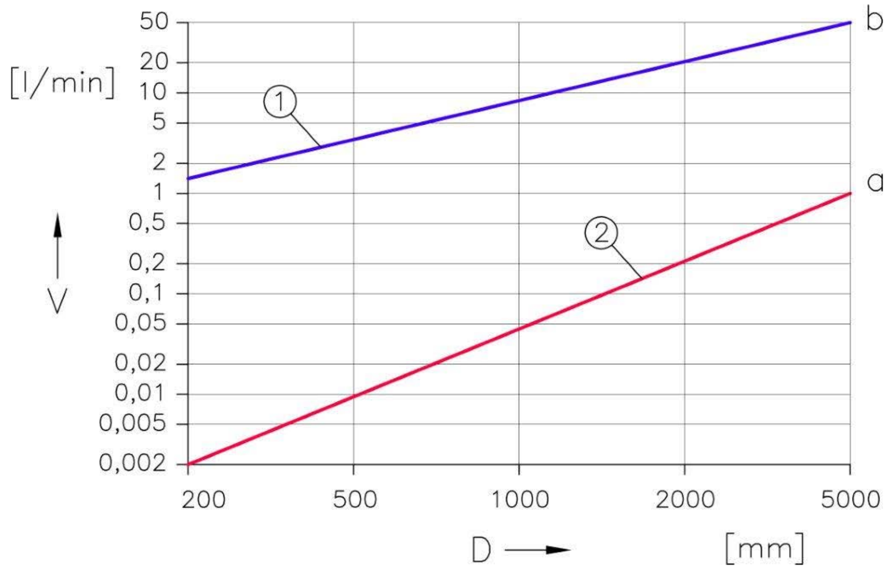
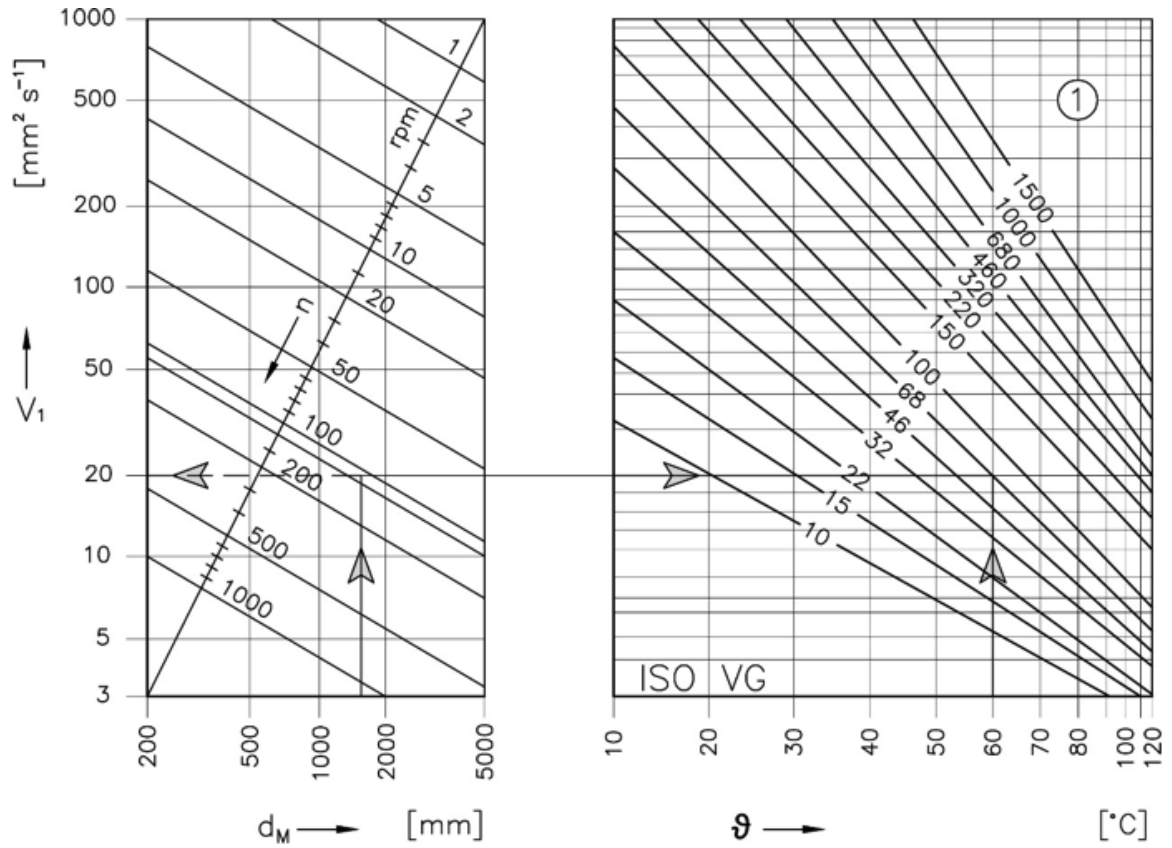


Figure 5
Oil quantities

Viscosità di riferimento per oli minerali

oils The kinematic oil viscosity required for adequate lubrication is determined from the reference viscosity V_1. In this case, it is assumed that the operating viscosity **V** of the oil (viscosity at operating temperature) is identical to the reference viscosity **V1**. The objective should be to achieve a ratio **k = V/V₁ = 2** , **Figure 6**).
The reference viscosity is dependent on the bearing diameter **dM = (D + d)/2** and the speed. The operating viscosity **V** is determined with the aid of the viscosity/temperature diagram, taking account of the assumed operating temperature and the nominal viscosity at 40°C. An oil with an operating viscosity higher than V_1 at operating temperature will have a positive effect on the fatigue life of the bearing. In addition, the EP additives give adequate lubricity at low speeds. They are also necessary at low **k** values.



n = Operating speed
V_1 = Reference viscosity
d_M = Mean bearing diameter (d+D)/2
ϑ = Operating temperature
1 - Viscosity mm^2s^{-1} at 40°C

Figure 6
Reference viscosity and
V/T diagram for mineral oils

Operating temperature

Crossed roller bearings are suitable for operating temperatures from -30°C e +80 °C.

Design and safety guidelines

Checking the static load safety factor

The static load safety factor can be checked in approximate terms if the load arrangement is present and all the requirements relating to clamping rings, location, fitting and lubrication are fulfilled, **Figure 2**, page 33.
In order to check the static load carrying capacity, the following equivalent static operating values must be determined:
• Bearing load F_{oq}
• Tilting moment load M_{oq}
Checking is possible for applications with or without radial load.

⚠ Where load arrangements are more complex or the conditions are not fulfilled, please contact us.

Safety factors

For smooth running, the objective should be a factor $f_s \geq 4$.

Calculation of the rating life

The methods for calculating the rating life are:
• The basic rating life L_{10} & L_{10h} to UNI-ISO 281 (Contact us for requesting the calculation)
• The simplified form of rating life calculation based on empirical values, see page 39.

Validity

The rating life formulae for L & L_h are only valid:
• With a load arrangement in accordance with **Figure 2**, page 33
• If all the requirements are fulfilled in relation to location (the bearing rings must be rigid or firmly connected to the adjacent construction), fitting, lubrication and sealing.
• If the load and speed in the duty cycle can be regarded as constant during operation.

Simplified form of rating life calculation

In order to provide evidence of the rating life, a simplified form of rating life calculation can be selected for crossed roller bearings within a duty cycle. Within such a duty cycle, the speed and load are regarded as constant. The dynamic factor f_L to be achieved in this calculation is an empirical value against which new designs and proven bearing arrangements are compared.

$$f_L = \frac{C}{P} * f_n$$

f_L [-]
Dynamic factor, see table, page 40
For use of crossed roller bearings in machine tools: $3,5 \leq f_L \leq 5$
C [KN]
Basic dynamic load rating
f_n [-]
Speed factor, see table, page 40
P [KN]
Equivalent dynamic bearing load.

Calculation of the equivalent dynamic load

The equivalent dynamic bearing load P comprises the relevant axial and radial forces, see formulae.

For $F_a/F_r \leq 1,4$:

$$P = 1,4 * F_r + 0,67 * F_a$$

For $F_a/F_r > 1,4$:

$$P = 0,93 * F_r + F_a$$

Preload force, decisive axial force for $K_a \leq 2,114 * F_V$

$$F_a = F_V + 0,5 * K_a$$

Preload force, decisive axial force for $K_a > 2,114 * F_V$

$$F_a = K_a$$

Axial preload:

$$V = 2 * \frac{\sqrt[1,08]{F_v}}{C_S}$$

P [KN]
Equivalent dynamic bearing load
F_r, F_a [-]
Axial or radial dynamic bearing load
F_v [KN]
Preload force

K_a [KN]
External axial force
V [KN]
Preload travel
C_s [$KN^{0,926}$/mm]
Axial rigidity factor

Speed factor f_n for roller bearings

The speed factor f_n is different for each speed value, see table.
Calculation of the speed factor:

$$f_n = \sqrt[\frac{10}{3}]{\frac{33\frac{1}{3}}{n}}$$

Speed n rpm	*Speed factor f_n*
1	2,86
2	2,33
3	2,06
4	1,89
5	1,77
6	1,6
7	1,53
8	1,48
9	1,44
10	1,27
15	1,17
20	1,03
30	0,947
40	0,885
60	0,838
70	0,8
80	0,769
90	0,742
100	0,719
150	0,637
200	0,584
300	0,517
400	0,475
500	0,444
600	0,42
700	0,401
800	0,385
900	0,372
1000	0,36
1100	0,35
1200	0,341

Dynamic factor f_L for roller bearings

The rating life L_h can be derived from the dynamic factor, see table.
Calculation of the rating life from the dynamic factor:

$$L_h = 500 * f_L^{10/3}$$

Dynamic factor f_L	*Rating life L_h h*
1,23	1000
1,39	1500
1,52	2000
1,71	3000
1,87	4000
2	5000
2,11	6000
2,21	7000
2,3	8000
2,38	9000
2,46	10000
2,77	15000
3,02	20000
3,42	30000
3,72	40000
3,98	50000
4,2	60000
4,4	70000
4,58	80000
4,75	90000
4,9	100000

Shaft and housing tolerances

The inner and outer rings should always have a tight fit. In order to give easier mounting and allow setting of the bearing preload, however, the ring under point load has a less tight fit. In the case of crossed roller bearings in machine tools, this is the inner ring. Crossed roller bearings are therefore mounted with a loose fit on the shaft.
When defining the diameters for the shaft and housing bore, the actual dimensions for the bearing bore and outside diameter are used. The actual dimensions are given in the inspection record included with each bearing.

Mounting tolerances for the shaft

Since the inner ring is subjected to point load, it has a loose fit.
As a guide value, it is recommended that the shaft should be machined to give a fit clearance, see formula and table.

$$P = \sqrt[3]{d}$$

P [µm]
Fit, fit clearance
d [mm]
Shaft diameter

Nominal dimension range		Roundness tolerance t_1	Total axial runout tolerance t_2
> mm	≤ mm	µm	µm
-	250	7	4
250	315	7	4
315	400	8	5
400	500	8	6
500	630	9	7
630	800	11	9
800	1000	12	10
1000	1250	14	12
1250	1600	16	13
1600	2000	20	17
2000	2500	23	20
2500	3150	28	23
3150	4000	34	27

Mounting tolerances

Mounting tolerances for the housing bore

Since the outer ring is subjected to circumferential load, it has a tight fit. When machining the housing bore, this should give the following fit interference, see formula and table.

$$P = 0{,}003 * D$$

P [µm]
Fit, fit interference
D [mm]
Housing diameter

Nominal dimension range		Roundness tolerance t_1	Total axial runout tolerance t_2
> mm	≤ mm	µm	µm
-	315	10	6
315	400	12	7
400	500	12	9
500	630	13	11
630	800	15	13
800	1000	18	15
1000	1250	20	18
1250	1600	23	20
1600	2000	27	25
2000	2500	33	30
2500	3150	39	35
3150	4000	47	40
4000	5000	57	50

Mounting tolerances

Roughness of bearing seats

The roughness of the bearing seats must be matched to the tolerance class of the bearings. The mean roughness value Ra must not be too high, in order to maintain the interference loss within limits. Shafts should be ground and bores should be precision turned.
Guide values: see table.

Guide values for roughnessof bearing seating surfaces

Diameter of bearing seat d (D) mm		*Recommended mean roughness values Ra [1] for ground bearing seats Corresponding diameter tolerance µm*		
over	*incl.*	*IT6*	*IT5*	*IT4*
80	500	1,6 (N7)	0,8 (N6)	0,4 (N5)
500	1600	1,6 (N7)	1,6 (N7)	0,8 (N6)
1600	4000	3,2 (N8)	3,2 (N8)	1,6 (N6)

1) The values in brackets are roughness classes to **DIN-ISO 1302**.

Location using clamping rings

For location of crossed roller bearings, covers or labyrinth covers have proved effective.
Bearing rings must always be rigidly and uniformly supported over their entire circumference and width.
The thickness of the clamping rings and the contact flanges must be matched to the requirements.

Fixing screws

For location of the bearing rings or clamping rings, screws of grade 10.9 are suitable.
Any deviations from the recommended size, grade and quantity of screws will considerably reduce the load carrying capacity and operating life of the bearings.
For screws of grade 12.9, the minimum strength of the clamping rings must be achieved or quenched and tempered seating washers must be used.

Securing of screws

Normally, the screws are adequately secured by the correct preload.
If regular shock loads or vibrations occur, however, additional securing of the screws may be necessary.
Not every method of securing screws is suitable for crossed roller bearings.
Never use spring washers or split washers. General information on securing of screws is given in **DIN 25201**, and securing by means of adhesive in particular is described in DIN **25203**.
If this is to be used, please consult the relevant companies.

Fitting of crossed roller bearings

The bores and edges of the adjacent components must be free from burrs. The support surfaces for the bearing rings must be clean.
The seating and locating surfaces for the bearing rings on the adjacent construction must be lightly oiled or greased.
Lightly oil the thread of the fixing screws in order to prevent varying friction factors (do not oil or grease screws that will be secured by means of adhesive).
Ensure that all adjacent components and lubrication ducts are free from cleaning agents, solvents and washing emulsions.
The bearing seating surfaces can rust or the raceway system can become contaminated.
Mounting forces must only be applied to the bearing ring to be fitted; they must never be directed through the rolling elements or seals.
Avoid direct blows on the bearing rings.
Locate the bearing rings consecutively and without application of any external load.

Once mounting is complete, the operation of the fitted crossed roller bearing must be checked.
If the bearing runs irregularly or roughly, or the temperature in the bearing shows an unusual increase, dismount and check the bearing and mount the bearing again in accordance with the fitting guidelines described.

Accuracy

The running tolerances are based on **DIN 620-2** and **DIN 620-3** and are in a range better than **P4**, see tables. The main dimensions are produced to tolerance **P5**.

Tolerances for inner rings and outer rings in metric sizes: see tables.

Bearings in metric sizes

Inner ring

Bore d mm		*Deviation Δ_{dmp} µm*		*Width deviation Δ_{Bs} µm*		*Radial runout K_{ia} µm*	*Axial runout S_{ia} µm*
over	*incl.*	*high*	*low*	*max*	*min*	*max*	*max*
-	250	0	-20	0	-300	5	5
250	315	0	-23	0	-350	7	7
315	400	0	-25	0	-375	7	7
400	500	0	-27	0	-400	9	9
500	630	0	-30	0	-450	11	11
630	800	0	-35	0	-525	13	13
800	1000	0	-40	0	-600	15	15
1000	1250	0	-46	0	-700	18	18
1250	1600	0	-54	0	-800	20	20
1600	2000	0	-65	0	-1000	25	25
2000	2500	0	-77	0	-1200	30	30
2500	3150	0	-93	0	-1400	35	35
3150	4000	0	-114	0	-1700	40	40

Outer ring

Outer diameter D mm		*Deviation Δ_{Dmp}, Δ_{Ds} µm*		*Width deviation Δ_{Bs} µm*		*Radial runout K_{ea} µm*	*Axial runout S_{ea} µm*
over	*incl.*	*high*	*low*	*max*	*min*	*max*	*max*
-	315	0	-20	0	-350	K_{ea} & S_{ea} are identical to the associated values of the inner ring	
315	400	0	-23	0	-375		
400	500	0	-25	0	-400		
500	630	0	-27	0	-450		
630	800	0	-30	0	-525		
800	1000	0	-35	0	-600		
1000	1250	0	-40	0	-700		
1250	1600	0	-46	0	-800		
1600	2000	0	-54	0	-1000		
2000	2500	0	-65	0	-1200		
2500	3150	0	-77	0	-1400		
3150	4000	0	-93	0	-1700		

Bearings in inch sizes

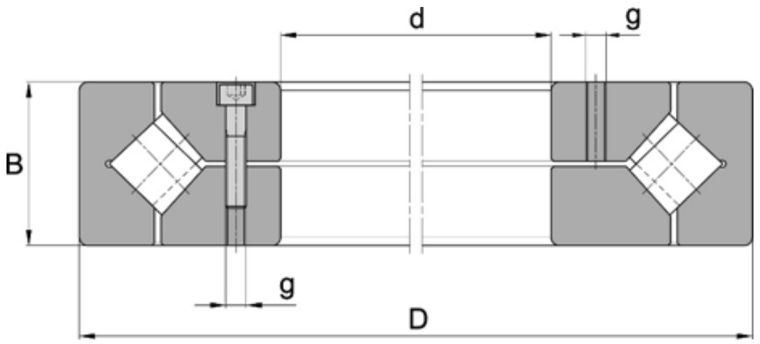
Inner ring

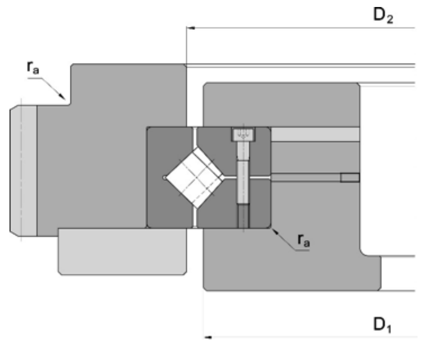
Bore d mm		*Deviation Δ_{dmp} µm*		*Width deviation Δ_{Bs} µm*		*Radial runout K_{ia} µm*	*Radial runout S_{ia} µm*
over	*incl.*	*high*	*low*	*max*	*min*	*max*	*max*
-	304,8	+13	0	Δ_{Bs}, K_{ia} & S_{ia} are identical to values for the metric sizes			
304,8	609,6	+25	0				
609,6	914,4	+38	0				
914,4	1219,2	+51	0				
1219,2	-	+76	0				

Outer ring

Outer diameter D mm		*Deviation Δ_{Dmp}, Δ_{Ds} µm*		*Width deviation Δ_{Bs} µm*		*Radial runout K_{ea} µm*	*Axial runout S_{ea} µm*
over	*incl.*	*high*	*low*	*max*	*min*	*max*	*max*
-	304,8	+13	0	Δ_{Bs}, K_{ea} & S_{ea} are identical to values for the metric sizes			
304,8	609,6	+25	0				
609,6	914,4	+38	0				
914,4	1219,2	+51	0				
1219,2	-	+76	0				

Crossed roller bearings
Adjustable preload
Metric sizes and inch sizes



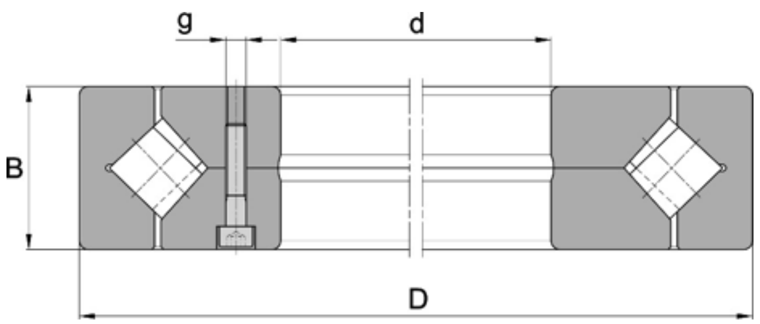


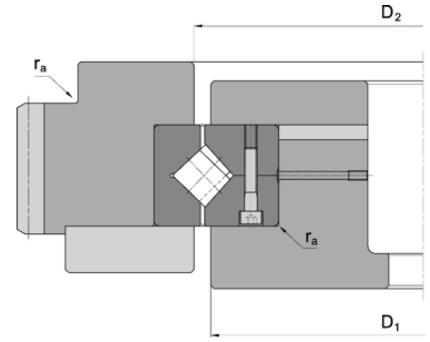
Mounting dimensions

Designation	Weight	Dimensions (mm)					Mounting dimensions			Basic load ratings		Limiting speeds[2)]		Axial spring constant	Initial grease
	D	d	D	B	r	g	D_1	D_2	r_a	dyn. C	stat. C0	n_G grease	n_G oil	C_S	Q.ty
	~Kg				min		min	max	max	KN	KN	rpm	rpm	$KN^{0,926}/mm$	Kg
EVZ-9800 1)	6.1	203.2	279.4	31.75	1.5	-	233	253	1.5	116	430	450	900	1110	0.07
EVZ-9801	14	300	400	38	1.5	-	343	367	1.5	190	815	300	630	1660	0.13
EVZ-9802 1)	33	330.2	457.2	63.5	4	-	383	417	3	320	1320	280	560	1880	0.3
EVZ-9803	43	380	520	65	4	-	437	477	3	455	1860	260	530	2180	0.46
EVZ-9804 1)	70	414.95	614.924	65	4	M8	500	540	3	490	2160	220	450	2490	0.51
EVZ-9805 1)	54	457.2	609.6	63.5	4	-	521	562	3	500	2280	220	430	2590	0.53
EVZ-9806	101	580	760	80	6	M10	654	704	5	735	3550	180	360	3230	0.96
EVZ-9807 1)	152	685.8	914.4	79.375	4	M10	784	839	3	930	4750	150	300	3810	1.4
EVZ-9808	150	740	940	85	5	M10	817	871	4	950	4900	140	280	3940	1.5
EVZ-9809 1)	189	901.7	1117.6	82.55	4	M12	987	1041	3	1060	6000	110	220	4720	1.7
EVZ-9810 1)	420	1028.7	1327.15	114.3	5	M16	1147	1221	4	1700	9300	85	170	5250	3.8
EVZ-9811	305	1100	1350	95	4	M16	1207	1268	3	1370	8150	80	160	5550	2.7
EVZ-9812 1)	354	1270	1524	95.25	4	M16	1379	1440	3	1460	9300	67	130	6250	3.1
EVZ-9813	400	1340	1600	100	4	M16	1449	1517	3	1760	11000	60	120	6600	3.9
EVZ-9814 1)	418	1384.3	1651	98.425	4	M16	1500	1562	3	1530	10200	60	120	6800	3.3
EVZ-9815 1)	503	1549.4	1828.8	101.6	4	M16	1669	1737	3	1900	12700	45	90	7500	4.5
EVZ-9816	573	1580	1870	110	4	M16	1697	1768	3	2080	14000	48	95	7600	5.5
EVZ-9817 1)	1850	1749.872	2219.874	190	7.5	M24	1933	2055	6	4500	27000	60	120	8450	17
EVZ-9818 1)	689	1879.6	2197.1	101.6	6	M16	1993	2088	5	2080	15600	36	70	9050	5.5
EVZ-9819	940	2100	2430	120	6	M20	2241	2322	5	2850	20800	34	70	9900	8.5
EVZ-9820 1)	1125	2463.8	2819.4	114.3	6	M20	2612	2686	5	2600	21200	28	56	11100	8.5
EVZ-9821	1652	3000	3380	130	6	M24	3165	3252	5	3600	31000	24	48	13200	14
EVZ-9822	2286	3500	3920	140	6	M30	3685	3777	5	4250	38000	20	43	15200	18
EVZ-9823	3161	4000	4460	155	6	M30	4202	4304	5	5300	49000	19	38	17400	25

1) Bearings in inch sizes
2) The speed limits stated are based on a preload FV 3,5% of C.
If a higher preload FV is present, the speed limits are lower

Crossed roller bearings
Specified, defined preload
Metric sizes and inch sizes



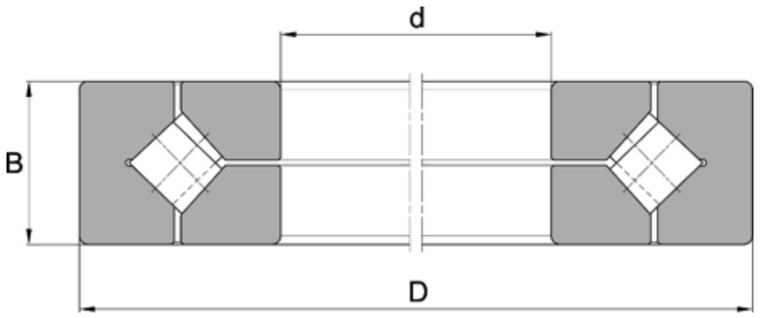


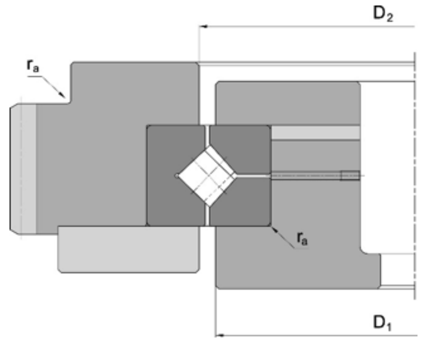
Mounting dimensions

Designation	Weight	Dimensions (mm)					Mounting dimensions			Basic load ratings		Limiting speeds[2]		Axial spring constant	Initial grease Q.ty	Preload force
	D ~Kg	d	D	B	r min	g	D_1 min	D_2 max	r_a max	dyn. C KN	stat. C0 KN	n_G grease rpm	n_G oil rpm	C_S $KN^{0.926}/mm$	Kg	F_V KN
EVZ-6904 [1]	6.1	203.2	279.4	31.75	1.5	-	233	253	1.5	122	455	450	900	1160	0.07	4.3
EVZ-6905	14	300	400	38	1.5	-	343	367	1.5	200	880	300	630	1770	0.13	7
EVZ-6906 [1]	33	330.2	457.2	63.5	4	-	383	417	3	340	1400	280	560	1990	0.3	12
EVZ-6907	43	380	520	65	4	-	437	477	3	480	2040	260	530	2350	0.46	17
EVZ-2601 [1]	70	414.95	614.924	65	4	M8	500	540	3	520	2360	220	450	2580	0.51	18
EVZ-6908 [1]	54	457.2	609.6	63.5	4	-	521	562	3	540	2450	220	430	2790	0.53	19
EVZ-6910	101	580	760	80	6	M10	654	704	5	800	3900	180	360	3480	0.96	28
EVZ-6911 [1]	152	685.8	914.4	79.375	4	M10	784	839	3	1000	5100	150	300	4080	1.4	35
EVZ-6912	150	740	940	85	5	M10	817	871	4	1020	5300	140	280	4220	1.5	36
EVZ-6913 [1]	189	901.7	1117.6	82.55	4	M12	987	1041	3	1140	6550	110	220	5050	1.7	40
EVZ-2602 [1]	420	1028.7	1327.15	114.3	5	M16	1147	1221	4	1800	10000	85	170	5600	3.8	60
EVZ-6916	305	1100	1350	95	4	M16	1207	1268	3	1460	9000	80	160	6000	2.7	50
EVZ-6917 [1]	354	1270	1524	95.25	4	M16	1379	1440	3	1560	10200	67	130	6750	3.1	55
EVZ-6918	400	1340	1600	100	4	M16	1449	1517	3	1860	12000	60	120	7050	3.9	65
EVZ-6919 [1]	418	1384.3	1651	98.425	4	M16	1500	1562	3	1630	11200	60	120	7350	3.3	55
EVZ-6920 [1]	503	1549.4	1828.8	101.6	4	M16	1669	1737	3	2000	13700	45	90	8050	4.5	70
EVZ-6921	573	1580	1870	110	4	M16	1697	1768	3	2200	15000	48	95	8050	5.5	75
EVZ-2603 [1]	1850	1749.872	2219.874	190	7.5	M24	1933	2055	6	4750	29000	60	120	8950	17	170
EVZ-6923 [1]	689	1879.6	2197.1	101.6	6	M16	1993	2088	5	2200	17000	36	70	9650	5.5	75
EVZ-6924	940	2100	2430	120	6	M20	2241	2322	5	3000	22400	34	70	10500	8.5	110
EVZ-6926 [1]	1125	2463.8	2819.4	114.3	6	M20	2612	2686	5	2750	22800	28	56	11800	8.5	95
EVZ-6928	1652	3000	3380	130	6	M24	3165	3252	5	3800	33500	24	48	14000	14	130
EVZ-6929	2286	3500	3920	140	6	M30	3685	3777	5	4500	41500	20	43	16100	18	160
EVZ-2604	3161	4000	4460	155	6	M30	4202	4304	5	5500	53000	19	38	18300	25	190

1) Bearings in inch sizes
2) The speed limits stated are based on a preload FV 3,5% of C.
If a higher preload FV is present, the speed limits are lower

Crossed roller bearings
Adjustable preload
Metric sizes and inch sizes





Mounting dimensions

Designation	Weight	Dimensions (mm)				Mounting dimensions			Basic load ratings		Limiting speeds 2)		Axial spring constant	Initial grease Q.ty
	D ~Kg	d	D	B	r min	D_1 min	D_2 max	r_a max	dyn. C KN	stat. C0 KN	n_G grease rpm	n_G oil rpm	C_S $KN^{0,926}/mm$	Kg
EVXR 496051 1)	6.1	203.2	279.4	31.75	1.5	233	253	1.5	116	430	450	900	1110	0.07
EVJXR 637050	14	300	400	37	1.5	343	367	1.5	190	815	300	630	1660	0.13
EVJXR 652050	21.5	310	425	45	2.5	357	384	2.5	270	1020	290	600	1730	0.15
EVJXR 678052 1)	33	330.2	457.2	63.5	3.3	383	417	3.3	320	1320	280	560	1880	0.3
EVJXR 699050	31	370	495	50	3	421	447	3	455	1190	270	540	2060	0.46
EVXR 766051 1)	54	457.2	609.6	63.5	3.3	521	562	3.3	310	2280	220	430	2590	0.53
EVXR 820060	101	580	760	80	6.4	654	704	6.4	735	3550	180	360	3230	0.96
EVXR 855053 1)	152	685.8	914.4	79.375	3.3	784	839	3.3	930	4750	150	300	3810	1.4
EVXR 882055 1)	189	901.7	1117.6	82.55	3.3	987	1041	3.3	1060	6000	110	220	4720	1.7
EVXR 889058 1)	420	1028.7	1327.15	114.3	3.3	1147	1221	3.3	1700	9300	85	170	5250	3.8
EVXR 897051 1)	503	1549.4	1828.8	101.6	3.3	1669	1737	3.3	1900	12700	45	90	7500	4.5
EVXR 903054 1)	689	1879.6	2197.1	101.6	6	1993	2088	5	2080	15600	36	70	9050	5.5
EVXR 912050 1)	1125	2463.8	2819.4	114.3	6	2612	2686	5	2600	21200	28	56	11100	8.5

1) Bearings in inch sizes
2) The speed limits stated are based on a preload FV 3,5% of C.
If a higher preload FV is present, the speed limits are lower

NOTES

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