Engineering information

Selection of antifriction airframe control bearings

In selecting a bearing for a given application various aspects have to be taken into account in addition to bearing size, speed and capacity. Airframe bearing users should consider the following conditions:

- The type of load, either imposed by oscillating or rotating motion.
- Operating temperature range.
- Exposure to hostile environments (dust, dirt, wetness etc.)

Successful bearing applications are dependent on how well provision has been made to meet the operating conditions.

Please note the following guidelines for airframe control bearing applications:

1. The antifriction control bearings listed in this catalogue are mainly full-type without cage, i.e. the bearings are primarely suited to slow, oscillating motions. Our engineering department should be contacted before selecting a full-type bearing for rotational service.

2. Only sealed bearings should be exposed to contamination. Bearings without shields or seals should be mounted so that contaminants cannot enter into the bearing.

3. To ensure a long bearing life we strongly recommend observance of the shaft and housing tolerances given alongside.

Recommended shaft and housing fits for RWG Frankenjura-metric-size-bearings

Bearing Series	Housing Steel	Housing Aluminium	Shaft Steel or Aluminium
All metric-size-bearings	J 6	K 6	g 6
EN 3281, EN 3282, EN 3283, FT..., FT...E	H 6	H 6	

Recommended shaft and housing fits for RWG Frankenjura-inch-size-bearings

Dimensions in µm

Bearing Series			Housing Steel	Housing Aluminium	Shaft Steel or Aluminium
K...	DP...	DSR...			
KP...	DPP...	DSRP...			
K...A	DP...W	DW...	- 13	- 18	- 13
KP...A	DPP...W	P...	- 25	- 31	- 25
KS...	DS...	AW...AK			
KSP...	DSP...				
K...B	K...BS				- 25
KP...B	KP...BS				- 51
			+ 25	+ 25	
			+ 0	+ 0	
K 16 B	K 16 BS				- 13
KP 16 B	KP 16 BS				- 25
B 538 DD - B 543 DD			+ 25	+ 25	- 18
			+ 0	+ 0	- 48
B 544 DD - B 546 DD			+ 30	+ 30	- 25
			+ 0	+ 0	- 63
MB 538 DD - MB 543 DD			+ 0	+ 0	- 13
			- 13	- 13	- 25
MB 544 DD - MB 546 DD			+ 0	+ 0	- 20
			- 18	- 18	- 33

Shaft and housing fits shown above are also applicable for antifriction bearings in stainless steel (1.3544.9).

Admissible out-of-roundness of the housing bore within the tolerance. Admissible taper of the housing bore 50 % of the tolerance.

Load ratings

Two types of load ratings are listed in this catalogue.

1. Static limit load ratings
1.1 Radial
1.2 Thrust (axial)
1.3 Moment

2. Oscillating radial load ratings (for average life of 10.000 complete 90° cycles).

1.1 The static radial load rating is based on the calculation according to standard ISO 1002. The value C_{or} according to ISO 76 for full type control bearings is to be multiplied by the factor K to get the applicable load ratings C_s.

Static radial loads applied on the bearings should not exceed the load rating values shown in the dimensional tables. The minimum static fracture strength is 1,5 times the limit load rating C_s of the bearing.

1.2 The thrust load ratings are shown in the dimensional tables for the inch series bearings. As to antifriction bearings in metric sizes, the table contains the Y_s factor for the calculation of the axial limit load ratings (Radial limit load rating divided by Y_s factor = Thrust limit load rating).

2. The oscillating radial load ratings are based on 10.000 complete 90° oscillatory cycles.

Two cases must be taken into consideration depending on the bearing operation:

Case I: load fixed with respect to the outer race.

Case II: load fixed with respect to the inner race.

NB: Values in the tables apply to inch sizes only as metric sizes are awaiting final standardisation.

Bearing type	Factor K	Radial load	Axial load
Ball bearings single and double row	5,6	$F_r=5,6\ C_{or}$	$F_a= 2,5\ C_{or}$
Ball bearings self aligning double row	8	$F_r=8\ C_{or}$	$F_a=\frac{8\ C_{or}}{0,44\ \cot \alpha}$
Roller bearings self aligning single row	5	$F_r=5\ C_{or}$	$F_a= 1,5\ C_{or}$
Roller bearings self aligning double row	5	$Fr=5\ C_{or}$	$F_a=\frac{5\ C_{or}}{0,44\ \cot \alpha}$

Combined loading

Equivalent limit load ratings

In case of combined loadings (radial and axial) one has to proceed as follows:

1. Metric series

   Calculation of the ratings according to ISO-1002 page 19.

   Radial deep groove bearings (single row and double row)

   The admissible radial and axial load can be applied simultaneously.

   Self-aligning bearing
   $C_s = F_r + 3{,}2\ F_a$

   Roller bearings
   $C_s = F_r + 3{,}3\ F_a$

2. Inch series

   Calculation of the ratings according to the formulas indicated in the tables. The values apply for operation under static conditions.

Qualification and Acceptance

Qualification and acceptance takes place according to the following technical specifications:

EN 3280 : metric series
MIL-B-7949 : inch series.

The specifications define requirements, test and acceptance conditions for airframe bearings in detail. These specifications can be referred to in case of special bearings according to customer´s drawings, if required.

Torque

Torque in the bearing can be analysed by a two fold approach:

inherent torque and imposed torque.

a) Inherent torque is the cumulative effect of the following factors:

- Geometry of the bearings:
  Surface finish of mating parts, deviations of roundness in the races, ball sphericity.
- Internal fit:
  Race curvatures contact angle, radial play, number of rolling members.
- Bearing type:
  Full complement, retainer type, radial or angular contact. Shields or seals.
- Lubricant:
  Type and quantity.

The inherent torque is very low in comparison to the imposed torque and is a indication for the high quality of the bearings.

b) Imposed torque
is the result of external factors such as load magnitude and direction, speed, shaft and housing fits, ambient temperature and contamination. The imposed torque can exceed the inherent torque significantly. Where low torque values are necessary, special consideration must be given to the mounting of the bearing. It is essential to maintain close control on shaft and housing dimensions, the concentricity, taper and angular alignment. RWG Frankenjura will be pleased to assist in resolving problems of this nature.

Starting torque

This feature is significant in aircraft controll bearings. The easy and exact handling of control systems from the hand lever to the actuators depends on the starting torque of the mounted bearings.

The starting torque is measured at no load condition and ten rotations per minute.