FAG Automotive

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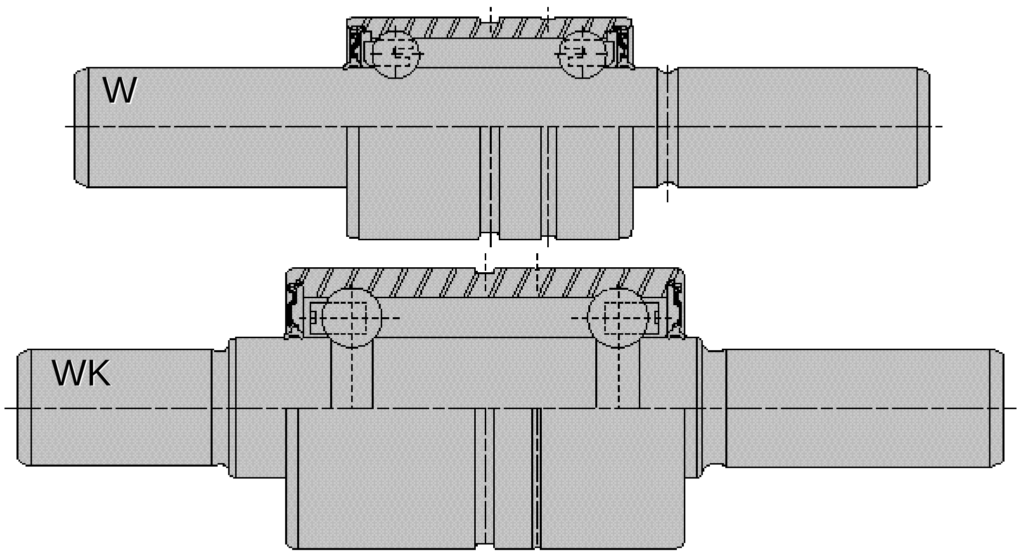
Dimensional interchange and application data has been carefully reviewed and is accurate to the best of our knowledge. FAG Automotive does not accept liability for errors or omissions. Additions or corrections would be appreciated.

FAG Code System



Bearing part numbers are arranged in this catalogue in numerical order. The part number coding is described below.

Example:
Standard Size Bearings
5/8" Shaft x 1.1811" Outer Ring Diameter

W 2 3 4 6 - 1 . T 1 5 4 4

- Special Features, contact FAG engineering for details
- Variation of Basic Part Number in terms of shaft Stickout or Stepdown length
- Shaft Overall length in inches
- O.E.M Shaft Diameter ("6" would indicate respective oversize aftermarket diameter)
- Ball/Ball Water Pump Bearing ("WN" = Ball/Roller)

Example:
King Size Bearings
3/4" Shaft x1.5000" Outer Ring Diameter

W K 2 4 5 4 - 1 . T 1 3 1 1

- Special Features, contact FAG engineering for details
- Variation of Basic Part Number in terms of shaft Stickout or Stepdown length
- Shaft Overall Length in Inches
- O.E.M. Shaft Diameter ("6" would indicate respective oversize aftermarket diameter)
- Ball/Ball Water Pump Bearing ("WKN" = Ball/ Roller)

Non-standard bearings with different shaft diameters and/or different outer ring diameters or outer ring lengths are prefixed "WS" for ball/ball units or "WNS" for ball/rollers units.

Engineering Details

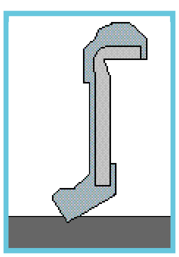
Materials

In a water pump bearing, very high local stresses can occur in the rolling element raceways. They are generally in the range of 1050 MPa to 4200 MPa. Interference fits further increase the stresses. Under standard operating conditions, wear of the sliding and rolling surfaces must be taken into account. Cantilever loads on the shaft necessitate excellent bending strength. As such our outer ring, balls, and rollers are made of through hardened SAE 52100 or its European equivalent DIN 100Cr6. The Shaft is made of SAE 1070 which is induction hardened in order to maintain a soft, flexible core. All rolling surfaces are hardened to a range of HRC 58 to 64.

Sealing

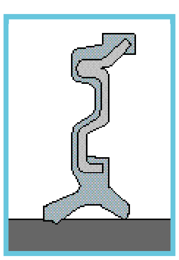
The function of the waterpump bearing seals is to exclude contaminants, such as dust or coolant vapour, while retaining the lubricant. It is normal for a small quantity of grease to come out of the seal lip, as part of the lubrication of the seal lip interface. This quantity should not exceed 0.2g. The seal performance is determined by the material properties and the lip design, as detailed below.

Conventional Single Lip Snap Type Design



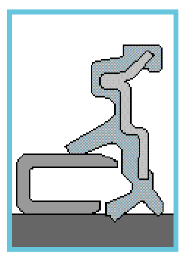
- For normal automotive applications
- Vulcanized elastomer sealing element
- Ease of assembly
- Economical

Standard Double Lip Interlocking Design



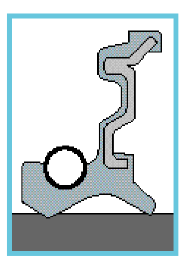
- For demanding applications
- Inward facing seal lip for improved grease retention
- Upgraded rubber material for better sealing against coolant
- Positive lock in outer ring, reduces possibility of seal spinning
- Optimized lip cross-section for torque and sealing performance

Triple Lip Interlocking Design



- For severe applications
- Inward facing seal lip for improved grease retention
- Upgraded rubber material for better sealing against coolant
- Positive lock in outer ring, reduces possibility of seal spinning
- Optimized lip cross-section for torque and sealing performance
- Additional stainless steel slinger and third lip for increased sealing protection

Spring Loaded Double Lip Interlocking Design



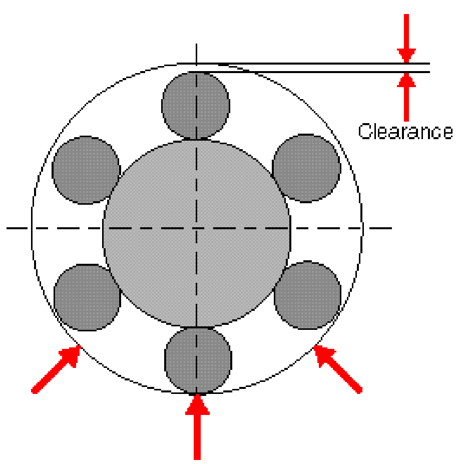
- For applications exposed to engine oil
- Inward facing seal lip for improved grease retention
- Fluoroelastomer material for better sealing against hot oil
- Positive lock in outer ring, reduces possibility of seal spinning
- Optimized lip cross-section for torque and sealing performance
- Additional stainless steel garter spring to guarantee protection from oil ingress into the bearing

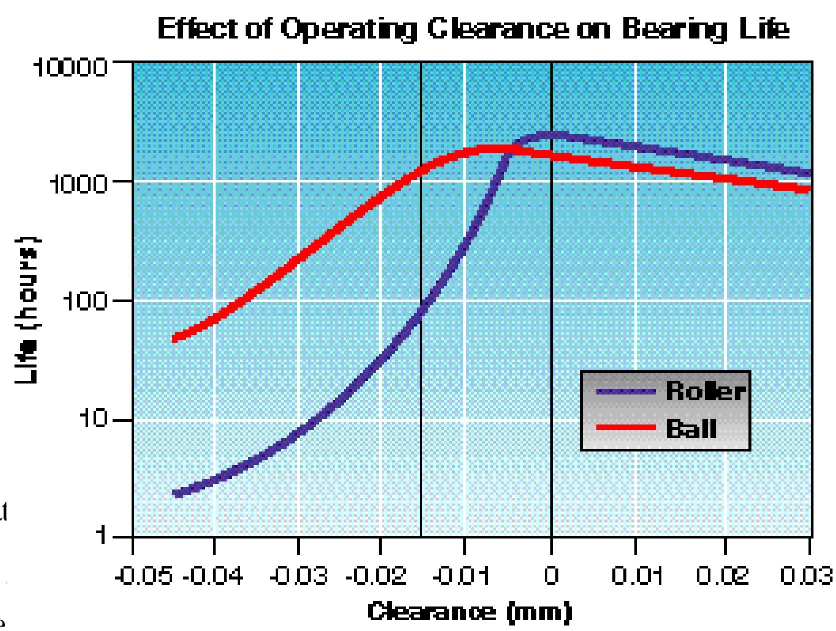
Steel Chemistry

TYPE	COMPOSITION %					
	C	Si	Mn	P	S	Cr
DIN 100Cr6 or SAE 52100	0.90 - 1.10	0.15 - 0.35	0.25 - 0.45	0.025 Max	0.015 Max	1.30 - 1.60
SAE 1070	0.65 - 0.75	0.15 - 0.30	0.60 - 0.90	0.025 Max	0.020 Max	.20 Max

Both steels are melted in basic open-hearth or electric furnaces. The introduction of vacuum degassing for SAE 52100 improves the inclusion cleanliness of the product. SAE 1070 is processed by means of bloom continuous casting or ingot casting. Both methods are accurately controlled maintaining inclusion levels more stringent than ASTMA295 for bearing steel.

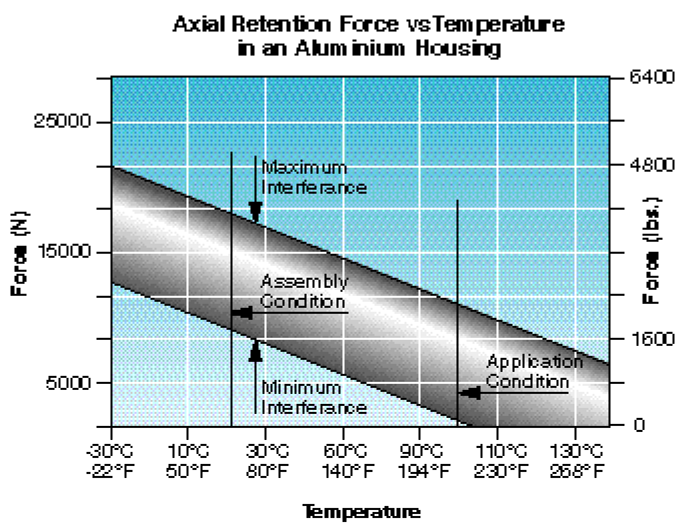
Bearing Clearance

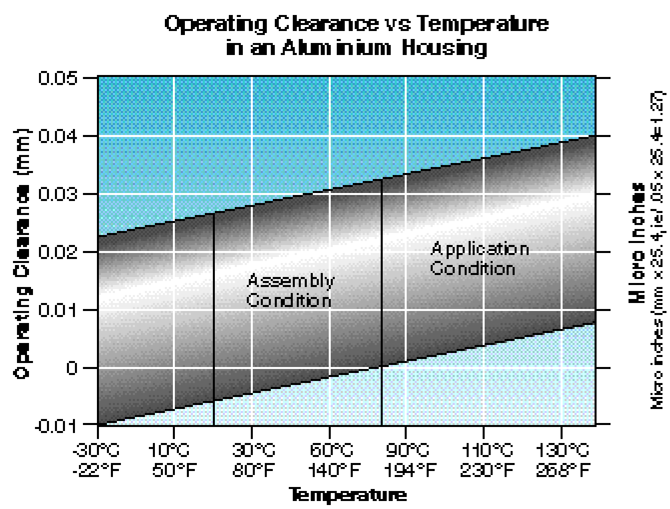




Operating clearance affects the bearing life. High clearance results in a loose assembly, and low operat clearance results in bearing pre-load. The predicted on life is shown in the chart at right. As can be seen, roller raceway is much more sensitive to bearing pre when a moderate pre-load such as 15 microns is present. Operating clearance depends on the bearing manufactured clearance, temperature of operation, housing material and press fit. See standard housing to bearing outer ring fit chart on the next page.

Standard Housing to Bearing Outer Ring Fits





Recommended Fit and Mechanical Properties of Housing Material

MATERIAL	ELASTIC MODULUS (MPa)	YIELD STRESS (MPa)	THERMAL EXPANSION COEFFICIENT [μ/mm°C]	RECOMMENDED FIT (mm)			
				BORE DIAMETER			
				30.000mm	38.100mm	47.625mm	55.000 mm
Steel	207,000	300	11	29.972 29.946	38.072 38.046	47.600 47.574	
Aluminum	70,000	180	22	29.949 29.924	38.029 38.003	47.554 47.528	54.923 54.898
Cast Iron G30	114,000	275	11	29.967 29.947	38.067 38.047	47.587 47.562	54.946 54.919
Cast Iron G55	140,000	275	11	29.967 29.947	38.067 38.047	47.587 47.562	54.946 54.919

Material properties may vary significantly for some alloys. To determine the correct fit, the actual properties of the housing material in question should be considered.

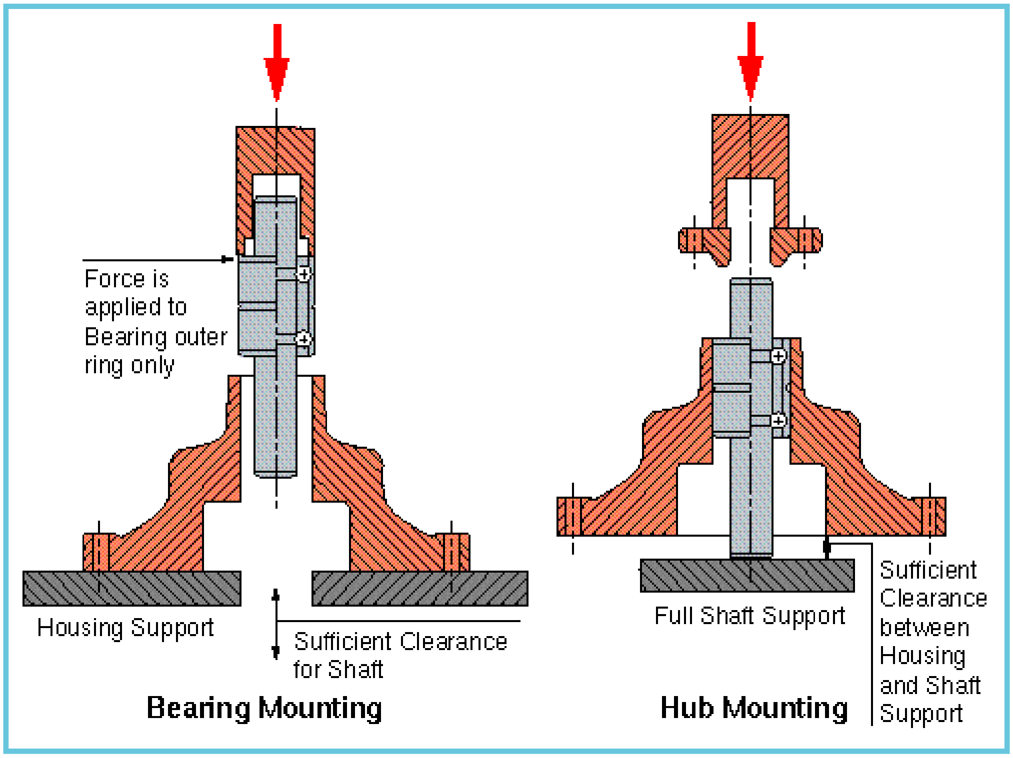
Water Pump Bearing Mounting Recommendations

When mounting the bearing into the housing, care must be taken to prevent the transmitting of forces through the ball complement. In order to avert this, a sleeve should be used that contacts the outer ring face only. A mechanical press should be used.

The hub, impeller and mechanical seal bores must be aligned with the shaft axis during their mounting. Again a press should be used and the opposite shaft end must be supported to prevent transmission of forces through the ball complement.

Bearing Housing Fit

The function of the outer ring interference fit is to retain the bearing in the housing over the intended service temperature range. It also must provide adequate bearing support without inducing ovality into the raceways. If the interference fit is too light, the bearing could walk out of the housing. If the fit is too heavy, pre-load of the bearing may occur.



Housing Requirements

Bore circularity <0.010mm.
Bore taper < .007 mm per 25 mm bore length.

Smoothing

During press in, material from the housing bore is removed resulting in less holding force. In cold conditions, material removal increases. This depends on the housing material and the housing bore surface finish.

Lubrication

The highest life values are obtained with hydrodynamic state of lubrication, that is where no metal to metal contact exists between the rolling elements and their respective raceways. For this, high cleanliness is also a necessity. With the increase of operating temperature thinner lubricating films result causing metal to metal contact. This causes a decrease in bearing life. FAG has developed lubricants which can be selected to suit specific application needs. Our standard NLG1 3 lubricant has a temperature capability better than 120°C (255°F). Special customer requirements will require the input of FAG Engineering.

Bearing Life

Static Load Rating (Co)

This load causes a total permanent deformation of 0.0001% of the rolling element diameter at the most heavily loaded element/raceway contact. For the usual curvature ratios, this value corresponds to a contact pressure of approximately 4200 MPa.

Rating Lifetime

The rating life is determined by the formula:

$$L_{10} = \left(\frac{C}{P}\right)^{P} \ (10^{6} \text{ revolutions})$$

P is the equivalent dynamic load. It is a combination of radial and axial loads which can act on the bearing simultaneously.

$$P = X \cdot F_r + Y \cdot F_a$$

where: F_r = Radial Load
F_a = Axial load
X = Radial Factor
Y = Thrust Factor

C is the dynamic load rating. It is indicated in the included chart per the latest ABMA regulations.

Basic Dynamic Load Rating C kN (lbF)

BEARING TYPE	COMPONENTS	
	BALL	ROLLER
5/8" Standard Ball/Ball	6.5 (1470)	—
5/8" Standard Ball/Roller	6.5 (1470)	15.8 (3550)
3/4" Standard Ball/Ball	9.7 (2180)	—
3/4" Standard Ball/Roller	9.7 (2180)	26.3 (5900)

L_{10} is the lifetime expressed in millions of revolutions. It is reached or exceeded by at least 90% of a large group of identical bearings.
P is the life exponent. For a ball bearing it is 3, and for a roller bearing, 10/3. For a constant speed, the life in hours is calculated:

$$L_{10} = L_h = \frac{L_{10} \bullet 10^6}{n \bullet 60} \text{ (hours)}$$

where n = speed in rpm

Improvements in bearing materials and bearing greases can add further adjustment factors to the bearing life. FAG Engineering should be contacted in order to define the factors applicable for each application.

Reduction of Water Pump Bearing Lifetime Due to Improper Assembly

Lack of attention to proper installation of pulleys, fans, fan spacers or viscous clutches will cause increased bearing loading during operation.

Typically, the water pump belt forces and weights of rotating components on the bearing shafts will load the outer ring raceways over only one-half of its circumference. This is called a point loaded condition.

Because of rotation with respect to the loads, the shaft raceways are loaded over their full circumference or, circumferentially loaded.

If the assembly procedure or mounted components contain or induce eccentricities at the mating surfaces, imbalance loads will be generated. If angularity occurs, gyroscopic moments are created due to the tilted, wobbling motion of the misaligned components during rotation. Angularity may also contribute to the eccentric imbalance loads. All eccentric and gyroscopic load components are non-stationary in direction and rotate with the shaft. This situation, if severe, will reverse the raceway loading patterns to that of point loaded shaft raceways and 360 degree circumferentially loaded outer ring raceways. The magnitudes of these loads increases with the square of the rotational speed.

Other conditions generated under these circumstances are roller edge stressing and misaligned ball row tracking. This acts to elevate cage and lubricant stressing and increase bearing operating temperatures. As well, the L_{10} bearing fatigue life becomes shorter due to the increased equivalent load on each row.

Taken to extremes, imbalance and gyroscopic loads may become so high reaching the strength limitations of the shaft material. The dynamic stress reversals may initiate tiny micro-cracks in the hardened case layer. If operation such as this continues, the cracks will propagate across the entire shaft cross section and cause the shaft to fracture, often with catastrophic results.

As an assist to determining the severity of these effects, FAG Applications Engineering can provide computer calculation services to assess the extent of imbalance and gyroscopic loads and their influence on bearing L_{10} life.