SKF dry lubricated bearings

Reliable performance in high temperature applications

Dry lubricant solves lubrication problems

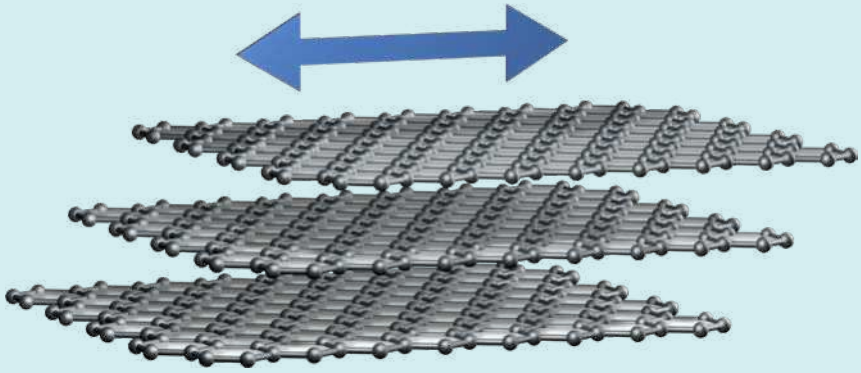
Equipment that must operate in environments with very high temperatures can be difficult and expensive to lubricate effectively. Inadequate lubrication limits bearing service life – and with it, machine performance and productivity.

While alternative, extreme temperature lubrication solutions exist, many cause additional problems. Lubricants used to reduce friction can dissipate, evaporate or carbonize at extremely high temperatures.

This not only creates environmental issues, but increases the costs associated with the purchase and disposal of grease as well as the time and manpower to continually relubricate the bearings.

SKF has engineered a range of bearing and lubricant solutions designed specifically to address the challenges of extreme operating conditions. Combining SKF's expertise in advanced materials, bearing design, machine reliability and application know-how, these solutions can help you achieve new possibilities in machine performance, bearing service life, productivity and cost control.

Introduction to dry lubricant(s)



Graphite orients in a lamella structure under load. The weak binding forces between the layers result in very low shear forces and friction in the bearing during operation.

The assortment of dry lubricated bearings from SKF constitutes SKF DryLube bearings and extreme temperature bearings.

These bearings are dry lubricated with graphite and molybdenum disulfide, where the lubricating properties are the result of the formation of a lamella layer structure that is created under load, when the lubricant adheres to the contact surfaces in the bearing.

The binding forces are much stronger within the layers than the van der Waals forces acting between the layers. Therefore, when used in bearings, the layers shear relative to each other resulting in very low friction in the bearing during operation.

The lubricating properties of graphite are further enhanced in the presence of vapour, as the vapour introduced between the graphite layers reduces shear forces and friction.

Molybdenum disulfide does not show the same lubricating characteristics in the presence of vapour and is preferred for extremely dry operating conditions. The lubricant in SKF DryLube bearings contains both graphite and molybdenum disulfide.

The graphite-based lubricant in SKF DryLube bearings is effective at temperatures up to 350 °C *(660°F)*.

To further increase the speed rating and extend bearing service life, SKF DryLube bearings can be supplied with perfluoro polyether (PFPE) oil additives and nanoparticles. These additives further enhance the performance of the bearing.

SKF DryLube bearings

SKF DryLube bearings are designed to reduce machine operating costs, extend maintenance intervals and provide a high degree of operational reliability even in extremely high temperature applications. SKF DryLube bearings are filled with a dry lubricant, based on graphite, molybdenum disulfide (MoS_2) and a resin binder. The dry lubricant is injected into the free space of the bearing and cured until it solidifies (→ **figs. 1** and **2**). The dry lubricant can protect the rolling elements and raceways from damage caused by solid contaminants.

During operation, a very thin layer of dry lubricant is maintained on the raceways and rolling elements to avoid metal-to-metal contact. After a while, small fragments of solid lubricant may break free and temporarily increase noise and vibration levels. This does not affect the performance or service life of the bearing.

SKF DryLube bearings provide the following benefits:

- effective lubrication for high temperature applications
- low start-up torque at any temperature and low frictional moment during operation
- higher speed capabilities than extreme temperatures bearings with a graphite cage
- lubricated for the life of the bearing
- minimal lubricant loss
- suitable for extremely slow rotating speeds and oscillating movements
- improved worker safety
- environmentally friendly compared to many oils and greases

Fig. 1

SKF spherical roller bearing with dry lubricant encapsulated between inner ring and cage

SKF E-design spherical roller bearings with two dry lubricant executions. The larger bearing has its entire free space filled with dry lubricant. The smaller bearing has lubricant between the inner ring and cage only.

Fig. 2

SKF DryLube deep groove ball bearing with manganese phosphate coating to enhance corrosion protection

Assortment

Most SKF rolling bearings, bearing units and full compliment bearings with an internal clearance greater than Normal can be supplied as SKF DryLube bearings. Bearings fitted with a cage must have a metal cage.

The assortment of SKF DryLube bearings mentioned in this catalogue includes:

- deep groove ball bearings
- Y-bearings (insert bearings)
- angular contact ball bearings
- self-aligning ball bearings
- cylindrical roller bearings
- tapered roller bearings
- spherical roller bearings
- thrust ball bearings
- spherical roller thrust bearings

For additional information about spherical plain bearings, bushings or customized units equipped with dry lubricant, contact the SKF application engineering service.

Most SKF rolling bearings and bearing units can be supplied as SKF DryLube bearings

SKF DryLube bearings in the metal industry. *Spherical roller bearings or deep groove ball bearings in rolls of continuous casters.*

Typical applications

Typical applications where SKF DryLube bearings can be used include:

- metal industry (rolls in bloom and billet casters, cooling beds, roll out tables, guide rolls in bar mills, reheating furnace rolls)
- industrial ovens (kiln truck wheel bearings and bearings for hardening and annealing ovens)

SKF DryLube bearings in the metal industry. *Spherical plain bearings and roller bearings units in cooling beds in bar mills.*

SKF DryLube bearings in the metal industry. Spherical roller bearings and spherical plain bearings in walking beam mechanism and in rollers outside of reheating furnaces.

SKF DryLube bearings in the metal industry. Deep groove ball bearings in supporting rollers for cooling bed in hot rolling mill.

SKF DryLube bearings in the metal industry. Spherical roller bearings in roll-out tables of continuous caster.

Designs and variants

SKF DryLube bearings are available in three main variants based on the operating conditions of the application (→ **table 1**). The bearings are filled with a dry lubricant based on graphite and molybdenum disulfide. To further increase speed capabilities and extend bearing service life, nanoparticles and PFPE-oil additives are also available (→ **table 1**).

Some sizes of deep groove ball bearings and Y-bearings are available with a manganese phosphate coating on the bearing rings, rolling elements and cages to enhance adhesion of the dry lubricant to the metal and provide additional protection against corrosion (→ **fig. 3**).

Temperature limits

At temperatures above 250 °C *(480 °F)*, the resin binder begins to degrade. This does not have an affect on the effectiveness of the lubricant. However, for continuous operation at temperatures above 250 °C *(480 °F)*, SKF recommends using bearings with a shield on both sides (designation suffix 2Z), or bearing arrangements with Nilos rings (→ **fig. 4**) to keep the lubricant in the bearing. Bearings with dry lubricant only between the inner ring (or the shaft washer) and cage (→ *Bearing data*) may work at elevated temperatures without shields.

The recommended temperature limits are listed in **table 1**.

Maintenance

SKF DryLube bearings are lubricated for the life of the bearing.

Fig. 3

SKF DryLube bearings with and without phosphated rings.

VA260
VA261
VA267

VA210
VA2101
VA237

Fig. 4

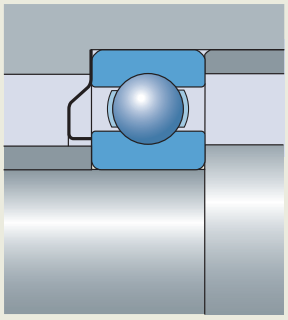


Table 1

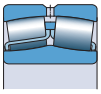
Characteristics of SKF DryLube bearings

	Variant					
	VA260	**VA210**	**VA261**	**VA2101**	**VA267**	**VA237**
Phosphated rings, rolling elements and cages[1]	Yes	–	Yes	–	Yes	–
Lubrication						
Graphite-based lubricant	Yes		Yes		Yes	
Perfluoro polyether (PFPE) oil additive	–		Yes		Yes	
Nanoparticles	–		–		Yes	
NSF H1 food grade	Yes		–		–	
Dry lubricant only	Yes		–		–	
Operating temperature						
Minimum	–60 °C *(–75 °F)*		–60 °C *(–75 °F)*		–60 °C *(–75 °F)*	
Maximum						
• open bearings	250 °C *(480 °F)*		250 °C *(480 °F)*		250 °C *(480 °F)*	
• bearings with a shield on both sides (designation suffix 2Z)[1]	350 °C *(660 °F)*		350 °C *(660 °F)*		350 °C *(660 °F)*	
Limiting speed [r/min]						
• Radial ball bearings	$\frac{15\,000}{d_m}$		$\frac{60\,000}{d_m}$		$\frac{120\,000}{d_m}$	
• Radial roller bearings	$\frac{7\,500}{d_m}$		$\frac{30\,000}{d_m}$		$\frac{60\,000}{d_m}$	
• Thrust bearings	$\frac{3\,750}{d_m}$		$\frac{15\,000}{d_m}$		$\frac{30\,000}{d_m}$	

d_m = bearing mean diameter [mm] =0,5 (d + D)

[1] The temperature range for reliable operation in accordance with the SKF traffic light concept is between 10 and 120 °C.

Bearing data

	Deep groove ball bearings	Y-bearings	Angular contact ball bearings	Cylindrical roller bearings	Tapered roller bearings	Spherical roller bearings	Thrust ball bearings	Spherical roller thrust bearings
								
Dimension standards	Refer to the product chapter of the relevant standard bearing. [1]							
Surfaces of rings, rolling elements and cages manganese phosphated	Optional		–					
Tolerances	Refer to the product chapter of the relevant standard bearing.[1] There may be slight deviations for phosphated bearings from the standard tolerances. These deviations do not have an influence on mounting or bearing operation.							
Radial internal clearance	Multiples of C5 (→ **table 6**, **page 17**) Check availability for C3, C4 or C5	Twice C5 of deep groove ball bearings (→ **table 6**, **page 17**)	–	C3, C4, C5	–	C3, C4, C5	–	–
	Guidelines for the initial clearance: (→ **diagram 1**, **page 10**)			Guidelines for the initial clearance: (→ **diagram 2**, **page 10**)		Guidelines for the initial clearance: (→ **diagram 3**, **page 10**)		
Stabilization	120 °C *(250 °F)*	120 °C *(250 °F)*	120 °C *(250 °F)*	150 °C *(300 °F)*	120 °C *(250 °F)*	200 °C *(390 °F)*	120 °C *(250 °F)*	200 °C *(390 °F)*
	The rings, rolling elements and cages of SKF DryLube bearings undergo the same heat stabilization process as the relevant standard bearing. As a result, for higher operating temperatures, a certain amount of dimensional change is to be expected and must be taken into account when determining the initial internal clearance of the bearing. For high-speed applications operating at very high temperatures, special stabilization of the bearing rings may be necessary. For additional information, contact the SKF application engineering service.							
Misalignment	Refer to the product chapter of the relevant standard bearing. [1]							
Filling grade of dry lubricant	Entire free space in the bearing				Free space between the inner ring and cage	• CC design and E design (d ≤ 65 mm): free space between the inner ring and cage • Other bearings: entire free space in the bearing	• 511 series (d ≥ 90 mm) and 514 series (d ≥ 50 mm): entire free space in the bearing • Other bearings: free space between the shaft washer and cage	Free space between the shaft washer and cage

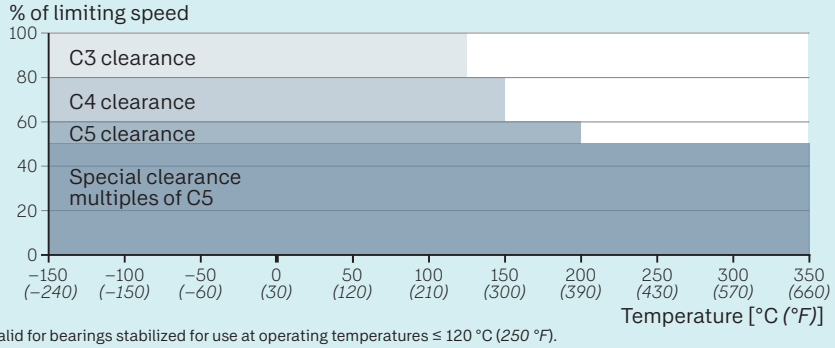
[1] Consult www.skf.com/bearings for additional information

Speed limits

The limiting speed for the different variants of SKF DryLube bearings can be calculated using the formulas listed in **table 1**, **page 8**. **Diagram 4** provides estimated values. If the bearing clearance is greater than C3, the limiting speed should be reduced according to **diagrams 1** to **3**.

Diagram 1

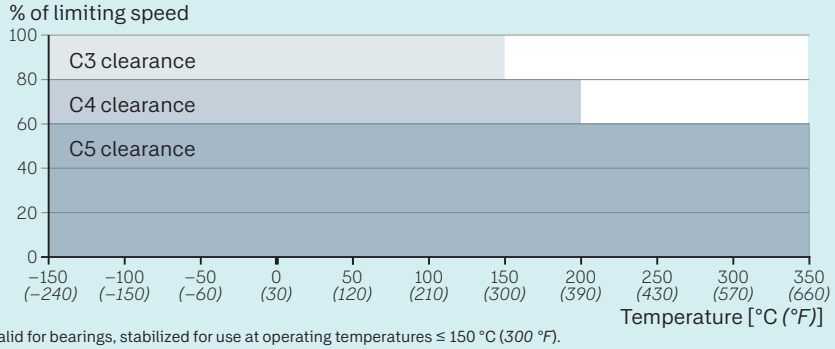
Selection guidelines for initial clearance of SKF DryLube deep groove ball bearings



Valid for bearings stabilized for use at operating temperatures ≤ 120 °C (*250 °F*).

Diagram 2

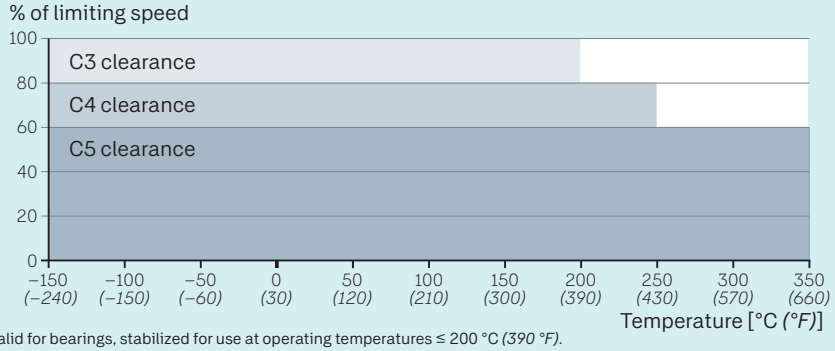
Selection guidelines for initial clearance of SKF DryLube cylindrical roller bearings



Valid for bearings, stabilized for use at operating temperatures ≤ 150 °C (*300 °F*).

Diagram 3

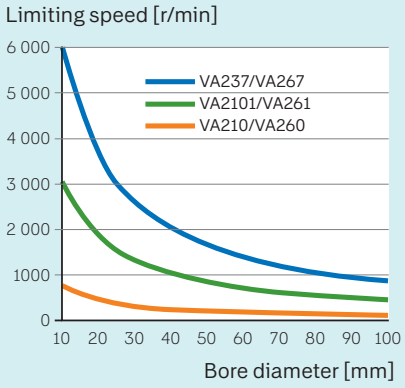
Selection guidelines for initial clearance of SKF DryLube spherical roller bearings



Valid for bearings, stabilized for use at operating temperatures ≤ 200 °C (*390 °F*).

Diagram 4

Guidelines for limiting speed of SKF DryLube radial ball bearings



For thrust bearings, 25% of the limiting speed is permissible.

For radial roller bearings, 50% of the limiting speed is permissible.

⚠ WARNING

Safety precautions for bearings with PFPE based oil additives. PFPE oil is very stable and harmless under normal operating conditions up to +250 °C *(480 °F)*. However, if exposed to extreme temperatures such as those above 300 °C *(570 °F)*, PFPE oils give off hazardous fumes. These fumes can be harmful to the eyes and to the lungs, if inhaled.

The following safety precautions should be observed:

- Follow the safety precautions in the appropriate material safety data sheet (MSDS).
- If there is a risk of human exposure and the bearing operating temperature is above 300 °C, appropriate ventilation is required.

If the fumes have been inhaled, consult a doctor immediately.

Extreme temperature bearings

Deep groove ball bearings and Y-bearings with a graphite cage or graphite paste

Extreme temperature bearings are designed to reduce machine operating costs, extend maintenance intervals and provide a high degree of operational reliability even in extremely high temperature applications. The SKF assortment of extreme temperature bearings includes:

- deep groove ball bearings (→ **fig. 1, page 13**)
- Y-bearings (insert bearings) (→ **fig. 2, page 13**)
- Y-bearing units (→ www.skf.com/bearings)

Extreme temperature bearings listed in this catalogue constitute the basic SKF assortment. On request, SKF can supply other extreme temperature bearings to meet the needs of a particular application. For information about these engineered products, contact the SKF application engineering service.

SKF extreme temperature bearings provide the following benefits:

- effective lubrication for extreme temperature applications
- lubricated for the life of the bearing
- minimal lubricant loss over the life of the bearing
- suitable for slow and extremely slow speeds
- improved worker safety and environmentally friendly compared to many oils and greases
- efficient lubricant even at the upper temperature limit of 350 °C (*660 °F*)

Extreme temperature deep groove ball bearings

SKF extreme temperature deep groove ball bearings correspond in design to standard deep groove ball bearings of the same size. They have no filling slots and can accommodate axial loads in addition to radial loads. The radial internal clearance is a multiple of C5 to maintain bearing operating clearance even when operating at maximum operating temperature. All surfaces of the bearing and shields are manganese phosphated to enhance adhesion of the dry lubricant to the metal and provide additional protection against corrosion.

SKF extreme temperature deep groove ball bearings are available in the variants listed in **table 1**. The bearings have a shield on both sides (designation suffix 2Z). The VA201 variant is also available as an open bearing (→ **fig. 1**). Shields prevent the ingress of solid contaminants into the bearing.

Exteme temperature Y-bearings

SKF extreme temperature Y-bearings (insert bearings) correspond in design to standard Y-bearings with grub screws in the YAR 2-2F series. The bearings have a shield and a flinger on both sides to prevent the ingress of solid contaminants into the bearing. The radial internal clearance is twice the C5 clearance of same-size deep groove ball bearings. All surfaces of the bearing and shields are manganese phosphated to enhance adhesion of the dry lubricant to the metal and provide additional protection against corrosion.

SKF extreme temperature Y-bearings are available in the VA201 and VA228 variants (→ **fig. 2**).

Fig. 1

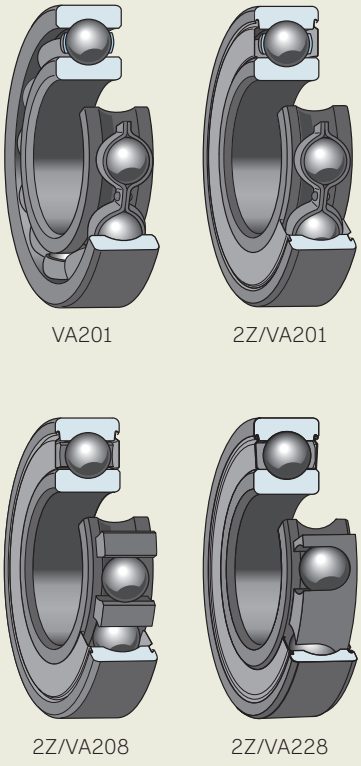


Table 1

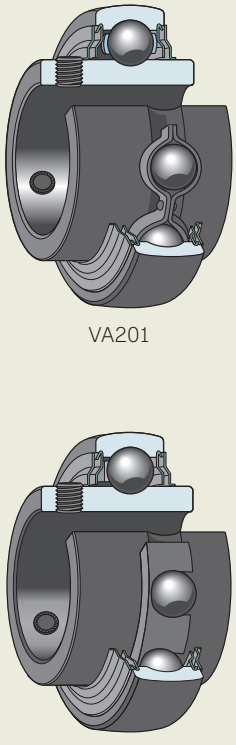
Extreme temperature variants for deep groove ball bearings and Y-bearings

Available types	**VA201** Y-bearings/deep groove ball bearings	**VA208** deep groove ball bearings	**VA228** Y-bearings/deep groove ball bearings
Characteristics	• Bearing with a riveted steel cage • Filled with a polyalkylene glycol/graphite mixture for lubrication	• Bearing with a segmented cage made of graphite • A shield on both sides of the bearing guides the cage segments. • Even at the upper temperature limits, the segmented graphite cage will not release harmful vapours. • Should not be used for applications where the direction of rotation changes frequently.	• Bearing with a coronet cage made of graphite • A shield on both sides of the bearing guides the cage. • Even at the upper temperature limits, the graphite cage will not release harmful vapours.
Operating temperature Minimum Maximum	 –30 °C *(–20 °F)*[1)] 250 °C *(480 °F)*	 –60 °C *(–75 °F)* 350 °C *(660 °F)*	 –60 °C *(–75 °F)* 350 °C *(660 °F)*
Limiting speed [r/min]	$\frac{9\,000}{d_m}$	$\frac{4\,500}{d_m}$	$\frac{9\,000}{d_m}$

d_m = bearing mean diameter [mm] = 0,5 (d + D)

[1)] VA201 bearings operating below 200 °C *(390 °F)* at speeds below 25% of limiting speed require a running-in procedure. These bearings should be heated to 200 °C *(390 °F)* for at least 48 hours.

Fig. 2



Maintenance

Extreme temperature bearings with a shield on both sides do not have a relubrication facility as they are lubricated for the life of the bearing.

Open VA201 design deep groove ball bearings should be inspected after some six months of operation. These can be relubricated with a polyalkylene glycol/graphite mixture. For additional information, contact the SKF application engineering service.

Bearing data

	Extreme temperature deep groove ball bearings	Extreme temperature Y-bearings
Dimension standards	Boundary dimensions: ISO 15:1998	Boundary dimensions: ISO 9628:2006
Tolerances	Normal Values: ISO 492:2002	Normal, except the bore and outside diameter Values: ISO 492:2002 Values for the bore and outside diameter (→ **table 5**, **page 17**)
	Due to the special surface treatment of the bearings, there may be slight deviations from the standard tolerances. These deviations do not have an influence on mounting or bearing operation.	
Internal clearance	Multiples of C5	Twice C5 of deep groove ball bearings in accordance with ISO 5753-1:2009
	Values (→ **table 6**, **page 17**) are valid for unmounted bearings under zero measuring load.	
Misalignment	≈ 20 to 30 minutes of arc	
	The above values apply only when the bearings rotate slowly. The permissible angular misalignment between the inner and outer ring depends on the size and internal design of the bearing, radial internal clearance in operation and the forces and moments acting on the bearing. As a result, only approximate values are listed here. Any misalignment will increase bearing noise and reduce bearing service life.	

SKF extreme temperature Y-bearings showing SY-, FY- and FYT Y-bearing units.
Dimensions and assortment of Y-bearing units
→ ***www.skf.com/bearings***

Principles of bearing selection and applications

Design of bearing arrangements

SKF DryLube bearings and extreme temperature bearings can be mounted with a loose or an interference fit on the shaft and in the housing. However, either the inner or outer ring should be mounted with an interference fit, to locate the shaft and provide satisfactory support (→ **table 1**).

Mounting

Mounting with mechanical force might crack the dry lubricant. Therefore, SKF DryLube bearings and the extreme temperature bearings should always be hot mounted
to reduce the mounting force.

For additional information, refer to skf.com/mount.

Y-bearing arrangement

Axial displacement

Y-bearing units do not accommodate axial displacement of the shaft and are therefore not normally suitable for non-locating bearing (free unit) arrangements. The distance between bearing positions should therefore be short or the units should be supported by resilient sheet metal support surfaces or walls to prevent them from being subjected to excessive stresses as a result of thermal elongation of the shaft.

In applications where there are low speeds, light loads, the distance between the bearing positions is too long or the operating temperatures too high and one bearing position has to accommodate thermal elongation of the shaft, the following arrangement is recommended.

The shaft on the non-locating side should be provided with one or two grooves 120° apart, to engage one of the following:

- grub screws with a finger, e.g. in accordance with ISO 4028:2003, but with a fine thread according to **table 2**, secured by a nut and spring washer or star lock washer (→ **fig. 1**)
- flat head screws in accordance with ISO 1580:1994, but with a fine thread according to **table 2**, locked with a spring or star lock washer

The fingers and grooves accommodate changes in shaft length and prevent relative rotational movements between the shaft and bearing bore. To help provide trouble-free operation, the ends of the grub screws should be ground and the sliding surfaces in the shaft grooves coated with a lubricant paste.

Shaft tolerances

For moderate loads (0,035 C < P ≤ 0,05 C), the shaft seats for Y-bearings should be machined to an h7 tolerance. For light loads and low speeds, an h8 shaft tolerance is sufficient.

Mounting

To mount or dismount Y-bearing units, the following tools are required:

- a hexagonal key (hex wrench) to tighten or loosen grub (set) screws (→ **table 2**)
- a spanner or hexagonal key to tighten or loosen the fasteners

For additional mounting information, refer to skf.com/mount.

Table 1

Fits for SKF Dry lubricated bearings on solid steel shafts or in cast iron and steel housings

Load condition	Tolerance class
Rotating inner ring load	
Shaft diameter	k5[1)]
Housing bore	F7
Stationary inner ring load	
Shaft diameter	g6
Housing bore	J7

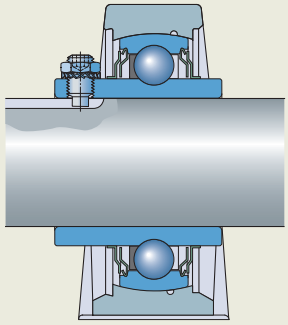
[1)] For d > 100 mm, contact the SKF application engineering service.

Table 2

Grub screw hexagonal socket dimensions and tightening torques

Bearing bore over	Bearing bore incl.	Threaded holes	Hexagonal key size	Tightening torque
mm/in				Nm
For metric shafts				
	35	M 6 × 0,75	3	4
35	**45**	M 8 × 1	4	6,5
45	**65**	M 10 × 1	5	16,5
65	**75**	M 10 × 1	6	28,5
For inch shafts				
	1 3/16	5/16 - 24 UNF	1/8	4
1 3/16	**1 3/4**	5/16 - 24 UNF	5/32	6,5
1 3/4	**2 7/16**	3/8 - 24 UNF	3/16	16,5
2 7/16	**2 15/16**	7/16 - 20 UNF	7/32	28,5

Fig. 1



Selection of bearing size

The requisite bearing size for rotating bearings can be determined based on the basic dynamic load rating C. The corresponding standard bearing should have a C value ≥ the requisite value.
However, the basic static load rating C_0 is used when the bearings are to:

- rotate at very slow speeds (n < 10 r/min)
- perform very slow oscillating movements
- be stationary under load for extended periods
- generally used for extreme temperature bearings (suffixes VA201, VA208 and VA228)

The corresponding standard bearing should have a C_0 value ≥ the requisite value. C and C_0 values for deep groove ball bearings and Y-bearings are available on **pages 22** to **24**. For other bearing types consult www.skf.com/bearings.

Calculating the requisite basic dynamic load rating	**Calculating the requisite basic static load rating**	**Symbols**
$C_{req} = S_{req}\, P/f_T$	$C_{0\,req} = 2\, P_0/f_T$	C_{req} = requisite basic dynamic load rating [kN] $C_{0\,req}$ = requisite basic static load rating [kN] F_a = axial load [kN] F_r = radial load [kN] f_T = temperature factor (→ **table 3**) P = equivalent dynamic bearing load [kN] P_0 = equivalent static bearing load [kN] S_{req} = guideline value for dynamic load safety factor (→ **table 4**)
For calculating P, refer to the product chapter of the relevant standard bearing. $P = F_r$ when $P < F_r$	For calculating P_0, refer to the product chapter of the relevant standard bearing. $P_0 = F_r$ when $P_0 < F_r$	
For deep groove ball bearings, F_a should not exceed 0,15 C_0		

Dry lubricated bearings to be kept dry

Since dry lubricated bearings are supplied without preservative oils and are to be used without grease or oil lubrication the anti-corrosion properties of the bearings is limited. Therefore the bearings should be used in a dry environment or with proper sealing arrangement to keep the bearings dry.

Table 3

Operating temperature factor f_T

		f_T
°C	*°F*	–
150	*300*	1
200	*390*	0,9
250	*480*	0,75
300	*570*	0,6
350	*660*	0,45

Table 4

Extreme temperature variants for deep groove ball bearings and Y-bearings

Application	S_{req}
Machines used for short periods or intermittently: cooling beds, guide rollers	3
Machines used for short periods or intermittently where high operational reliability is required: cranes in metals applications	5
Machines in use 8 hours per day and fully utilized: conveyor belts, hardening and annealing ovens	10
Machines in use 24 hours per day: conveyor systems, equipment in continuous casting mills	12

Example 1

A kiln truck is equipped with four wheels fitted on stub axles (→ **fig. 2**). Each wheel has two identical bearings. The bearings are to operate intermittently at 2 r/min under a constant radial load F_r = 15 kN per bearing. Flange load is neglected in this example. The kiln truck passes through an oven with a maximum operating temperature T = 300 °C *(570 °F)*. What would be a suitable SKF extreme temperature bearing for this application?

The slow speed (2 r/min) implies that the bearing static load capacity should be used to select the bearing. The requisite basic static load rating C_0 is

$$C_{O\,req} = 2\,\frac{P_O}{f_T}$$

- From **table 3**, for T = 300 °C *(570 °F)*, f_T = 0,6
- Since the load is purely radial, $P_0 = F_r$ = 15 kN

$$C_{O\,req} = 2\,\frac{15}{0,6} = 50\ kN$$

Thus, a bearing having a static load rating C_0 of at least 50 kN is required. For example, bearing **6216-2Z/VA208** (→ **product table**, **page 23**) is suitable (C_0 = 55 kN).

Example 2

A guide roll is equipped with two deep groove ball bearings. The guide rolls operate 24 h/day at 1 500 r/min under a radial load F_r = 2 kN per bearing. The operating temperature T = 150 °C *(300 °F)*. What would be a suitable SKF DryLube bearing?

The requisite basic dynamic load rating is

$$C_{req} = S_{req}\,\frac{P}{f_T}$$

- From **table 4**, for 24 h/day operation, the dynamic load safety factor S_{req} = 12
- From **table 3**, for T = 150 °C *(300 °F)*, f_T = 1
- Since the load is purely radial, P = F_r = 2 kN

$$C_{req} = 12\,\frac{2}{1} = 24\ kN$$

Thus, a bearing having a dynamic load rating C of at least 24 kN is required. For example, bearing **6207** is suitable (C = 27 kN).

Requisite initial clearance needs to be verified.

- From **diagram 1**, **page 10**, for T = 150 °C *(300 °F)*, C4 clearance is required.

The speed capability of the bearing needs to be verified.

- The appropriate variant of SKF DryLube bearing is selected based on the bearing speed, using the rotational speed and bearing mean diameter.
- From the product table for bearing **6207**, d_m = 0,5 (d + D) = 0,5 (35 + 72) = 53,5 mm.
- From **diagram 1**, **page 10**, limiting speed should be reduced to 80% for C4 clearance bearings.

$$n_{dm\ limiting} = \frac{n d_m}{\text{reduction factor}} = \frac{1\,500 \times 53,5}{0,8}$$

= 100 312 mm/min

where

$n_{dm\ limiting}$ = limiting speed factor, mm/min (→ **table 1**, **page 8**)

Therefore, **VA237** variant should be selected ($n_{dm\ limiting}$ = 120 000 mm/min).

Consequently, bearing **6207-2Z/C4VA237** is suitable.

Fig. 2

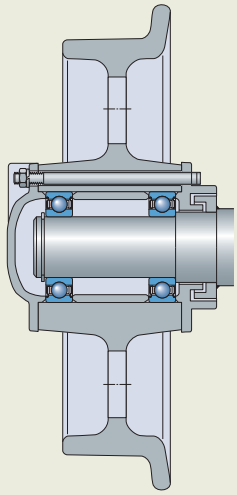


Table 5

Tolerances of dry lubricated Y-bearings

Nominal diameter d , D over	incl.	Bore diameter[1] Deviation high	low	Outside diameter Deviation high	low
mm		µm			
18	**30**	+18	0	–	–
30	**50**	+21	0	0	–10
50	**80**	+24	0	0	–10
80	**120**	+28	0	0	–15

[1] Values in accordance with ISO 9628:2006

Table 6

Radial internal clearance of dry lubricated bearings

Bore diameter d over	incl.	Radial internal clearance Deep groove ball bearings min	max	Y-bearings min	max
mm		µm			
	10	40	136	–	–
10	**18**	50	160	–	–
18	**24**	56	172	56	96
24	**30**	60	192	60	106
30	**40**	80	236	80	128
40	**50**	90	272	90	146
50	**65**	110	340	110	180
65	**80**	130	400	–	–
80	**120**	150	460	–	–

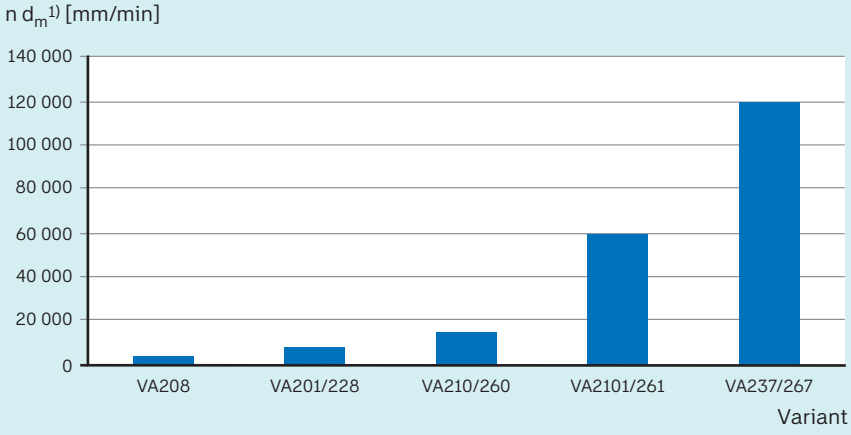
Selection guidelines for SKF DryLube bearings and extreme temperature bearings

Product group	Suffix	Phosphated rings, rolling elements and cage		Speed	High temp	Low temp	Low friction	Oscillation	Vibration
SKF DryLube bearings	VA210 VA260	– Yes	Graphite-based lubricant	++	+++	++	++++	+++	+
	VA2101 VA261	– Yes	Graphite-based lubricant and PFPE-oil additive	+++	+++	+	+++	+++	+
	VA237 VA267	– Yes	Graphite-based lubricant, PFPE-oil additive and nanoparticles	++++	+++	+	+++	+++	+
Extreme temperature bearings	VA201	Yes	Steel cage, lubricated with a polyalkylene glycol/graphite mixture	+	++	–	+	+	++
	VA208	Yes	Segmented cage made of graphite	0	++++	++	0	–	–
	VA228	Yes	Coronet cage made of graphite	+	++++	++	+	+	–

– Unsuitable
0 Moderate
+ Suitable
++ Recommended
+++ Highly suitable
++++ Excellent

Diagram 2

Limiting speed for SKF dry lubricated radial ball bearings



1) d_m = mean diameter = 0,5 (d + D) [mm]

Bearing designation system

				Group 1	Group 2	Group 3	/	Group 4					
								4.1	4.2	4.3	4.4	4.5	4.6

Designation example

22208 E/C4VA2101
W 6208-2Z/C4VA210
6210-2Z/VA260

Prefix

W	Stainless steel deep groove ball bearings
BS2	Spherical roller bearings with two rows of rollers non standard

Basic designation

Bore diameter

00	10 mm bore diameter
01	12 mm bore diameter
02	15 mm bore diameter
03	17 mm bore diameter
04	20 mm bore diameter
to	denotes bore diameter divided by 5
96	480 mm bore diameter

Suffixes

Group 1: Internal design

K	Tapered bore, taper 1:12

Group 2: External design (seals, snap ring groove etc.)

	Open bearing execution
2Z	Z shield on both sides of the bearing
2CS2	Contact seals of fluoro rubber (FKM) on both sides of the bearing
2CS5	Sheet steel reinforced contact seal of hydrogenated acrylonitrile-butadiene rubber (HNBR) on both sides of the bearing

Group 4.2: Clearance, preload

	Special clearance (multiples of C5) (applicable for deep groove ball bearings and Y-bearings only)
C3	Bearing internal clearance greater than normal (CN)
C4	Bearing internal clearance greater than C3
C5	Bearing internal clearance greater than C4

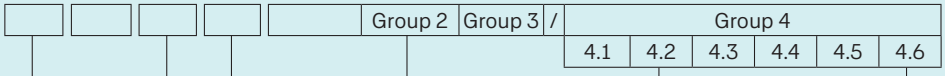
Group 4.4: Stabilization

	Standard stabilization for base bearing (→ *Bearing data*, **page 9**)
S0	Bearing rings dimensionally stabilized for use at operating temperatures up to +150°C *(+300°F)*
S1	Bearing rings dimensionally stabilized for use at operating temperatures up to +200°C *(+390°F)*
S2	Bearing rings dimensionally stabilized for use at operating temperatures up to +250°C *(+480°F)*
S3	Bearing rings dimensionally stabilized for use at operating temperatures up to +300°C *(+570°F)*

Group 4.6: Other variants

VA201	Extreme temperature bearings with a steel cage, lubricated with a polyalkylene glycol/graphite mixture
VA208	Extreme temperature bearings with segmented cage made of graphite
VA228	Extreme temperature bearings with coronet cage made of graphite
VA260	SKF DryLube bearings with graphite based lubricant + complete bearing phosphated
VA210	SKF DryLube bearings with graphite based lubricant
VA261	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + complete bearing phosphated
VA2101	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive
VA267	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles + complete bearing phosphated
VA237	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles

Y-bearings designation system



Designation example
YAR 208-2FW/VA260
YAR 210-2FW/C4VA2101
YAR 205-100-2FW/VA228

Bearing series

YAR 2 Inner ring extended on both sides, with grub screws

Bore diameter

Bearings for metric shafts
04 to **20** 20 mm bore diameter to 100 mm bore diameter

Bearings for inch shafts
–012 Three-digit combination that follows the designation of the basic metric bearing separated by a hyphen; the first digit is the number of whole inches and the second and third digits are the number of sixteenths of an inch, e.g. 204-012
$^{12}/_{16} = {}^{3}/_{4}$ of an inch = 19,050 mm bore diameter
–100 to **–208** 1 in = 25,400 mm bore diameter to $2\ ^{8}/_{16} = 2\ ^{1}/_{2}$ in = 63,500 mm bore diameter

Suffixes

Group 2: External design (seals)

2F Steel shield with an additional plain flinger on both sides of the bearing
W Bearing without lubrication hole

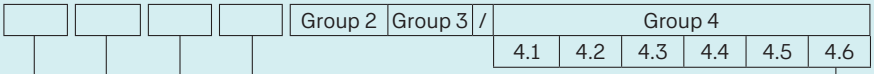
Group 4.2: Clearance

Special clearance (multiples of C5)
C4 Bearing internal clearance greater than C3

Group 4.6: Other variants

VA201 Extreme temperature bearings with a sheet steel cage, lubricated with a polyalkylene glycol/graphite mixture
VA228 Extreme temperature bearings with coronet cage made of graphite
VA260 SKF DryLube bearings with graphite based lubricant + complete bearing phosphated
VA210 SKF DryLube bearings with graphite based lubricant
VA261 SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + complete bearing phosphated
VA2101 SKF DryLube bearings with graphite based lubricant + PFPE-oil additive
VA267 SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles + complete bearing phosphated
VA237 SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles

Y-bearing units designation system



Designation example
FY 40 TF/VA228
FY 60 TF/C4VA2101
FY 1.1/4 TF/VA228

Housing type

FY	Square flanged housing
FYT	Oval flanged housing
SY	Plummer block housing

Size

Bearing units for metric shafts: in millimetres uncoded

20	20 mm bore diameter
to	
100	100 mm bore diameter

Bearing units for inch shafts: in inches uncoded

3/4	3/4 inch bore diameter
to	
2 7/16	2 7/16 inch bore diameter

Suffixes

Identification of inserted Y-bearing

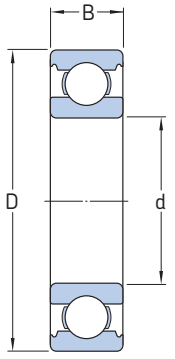
TF	Y-bearing with grub screw, YAR 2-2FW series

Group 4.6: Other variants

VA201	Extreme temperature bearings with a sheet steel cage, lubricated with a polyalkylene glycol/graphite mixture
VA228	Extreme temperature bearings with coronet cage made of graphite
VA260	SKF DryLube bearings with graphite based lubricant + complete bearing phosphated
VA210	SKF DryLube bearings with graphite based lubricant
VA261	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + complete bearing phosphated
VA2101	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive
VA267	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles + complete bearing phosphated
VA237	SKF DryLube bearings with graphite based lubricant + PFPE-oil additive + nanoparticles

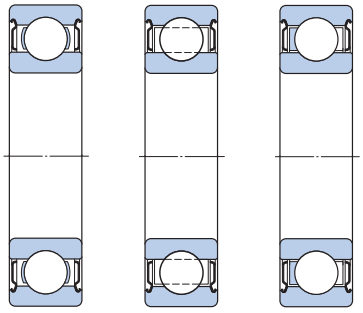
Deep groove ball bearings, SKF DryLube bearings and extreme temperature bearings

d **8 – 120** mm



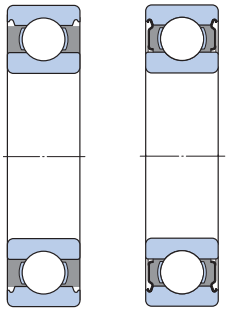
VA201

SKF extreme temperature bearings



2Z/VA201 2Z/VA208 2Z/VA228

SKF DryLube bearings



/VA... 2Z/VA...

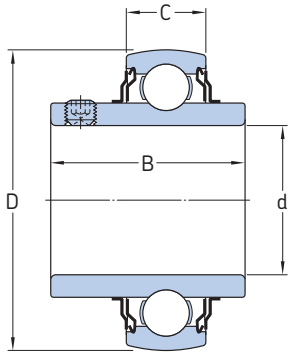
Principal dimensions			Basic load ratings		Designation	Limiting speed				
			dynamic	static	Base bearing	Extreme temperature bearings		SKF DryLube bearings[1]		
						VA208	VA201	VA210	VA2101	VA237
d	D	B	C	C_0			VA228	VA260	VA261	VA267
mm			kN			r/min				
8	22	7	3,45	1,37	**608**	300	600	1 000	4 000	8 000
	24	8	3,9	1,66	**628**	280	560	940	3 800	7 500
9	24	7	3,9	1,66	**609**	270	550	910	3 600	7 300
	26	8	4,75	1,96	**629**	260	510	860	3 400	6 900
10	26	8	4,75	1,96	**6000**	250	500	830	3 300	6 700
	30	9	5,4	2,36	**6200**	230	450	750	3 000	6 000
	35	11	8,52	3,4	**6300**	200	400	670	2 700	5 300
12	28	8	5,4	2,36	**6001**	230	450	750	3 000	6 000
	32	10	7,28	3,1	**6201**	200	410	680	2 700	5 500
	37	12	10,1	4,15	**6301**	180	370	610	2 400	4 900
15	32	9	5,85	2,85	**6002**	190	380	640	2 600	5 100
	35	11	8,06	3,75	**6202**	180	360	600	2 400	4 800
	42	13	11,9	5,4	**6302**	160	320	530	2 100	4 200
17	35	10	6,37	3,25	**6003**	170	350	580	2 300	4 600
	40	12	9,95	4,75	**6203**	160	320	530	2 100	4 200
	47	14	14,3	6,55	**6303**	140	280	470	1 900	3 800
20	42	12	9,95	5	**6004**	150	290	480	1 900	3 900
	47	14	13,5	6,55	**6204**	130	270	450	1 800	3 600
	52	15	16,8	7,8	**6304**	130	250	420	1 700	3 300
25	47	12	11,9	6,55	**6005**	130	250	420	1 700	3 300
	52	15	14,8	7,8	**6205**	120	230	390	1 600	3 100
	62	17	23,4	11,6	**6305**	100	210	340	1 400	2 800
30	55	13	13,8	8,3	**6006**	110	210	350	1 400	2 800
	62	16	20,3	11,2	**6206**	100	200	330	1 300	2 600
	72	19	29,6	16	**6306**	90	180	290	1 200	2 400
35	62	14	16,8	10,2	**6007**	90	190	310	1 200	2 500
	72	17	27	15,3	**6207**	80	170	280	1 100	2 200
	80	21	35,1	19	**6307**	80	160	260	1 000	2 100
40	68	15	17,8	11,6	**6008**	80	170	280	1 100	2 200
	80	18	32,5	19	**6208**	80	150	250	1 000	2 000
	90	23	42,3	24	**6308**	70	140	230	920	1 800
45	75	16	22,1	14,6	**6009**	80	150	250	1 000	2 000
	85	19	35,1	21,6	**6209**	70	140	230	920	1 800
	100	25	55,3	31,5	**6309**	60	120	210	830	1 700
50	80	16	22,9	16	**6010**	70	140	230	920	1 800
	90	20	37,1	23,2	**6210**	60	130	210	860	1 700
	110	27	65	38	**6310**	60	110	190	750	1 500

[1] If clearance greater than C3, consult **diagram 1** to **3** on **page 10** for limiting speed reduction factors. Additional dimensions and CAD models of bearings are available for download from www.skf.com/bearings

Principal dimensions			Basic load ratings		Designations	Limiting speed				
			dynamic	static	Base bearings	Extreme temperature bearings		SKF DryLube bearings[1]		
						VA208	VA201	VA210	VA2101	VA237
d	D	B	C	C_0			VA228	VA260	VA261	VA267
mm			kN			r/min				
55	90	18	29,6	21,2	**6011**	60	120	210	830	1 700
	100	21	46,2	29	**6211**	60	120	190	770	1 500
	120	29	74,1	45	**6311**	50	100	170	690	1 400
60	95	18	30,7	23,2	**6012**	60	120	190	770	1 500
	110	22	55,3	36	**6212**	50	110	180	710	1 400
	130	31	85,2	52	**6312**	50	90	160	630	1 300
65	100	18	31,9	25	**6013**	50	110	180	730	1 500
	120	23	58,5	40,5	**6213**	50	100	160	650	1 300
	140	33	97,5	60	**6313**	40	90	150	590	1 200
70	110	20	39,7	31	**6014**	50	100	170	670	1 300
	125	24	63,7	45	**6214**	50	90	150	620	1 200
	150	35	111	68	**6314**	40	80	140	550	1 100
75	115	20	41,6	33,5	**6015**	50	90	160	630	1 300
	130	25	68,9	49	**6215**	40	90	150	590	1 200
	160	37	119	76,5	**6315**	40	80	130	510	1 000
80	125	22	49,4	40	**6016**	40	90	150	590	1 200
	140	26	72,8	55	**6216**	40	80	140	550	1 100
	170	39	130	86,5	**6316**	40	70	120	480	960
85	130	22	52	43	**6017**	40	80	140	560	1 100
	150	28	87,1	64	**6217**	40	80	130	510	1 000
	180	41	140	96,5	**6317**	30	70	110	450	910
90	140	24	60,5	50	**6018**	40	80	130	520	1 000
	160	30	101	73,5	**6218**	40	70	120	480	960
	190	43	151	108	**6318**	30	60	110	430	860
95	145	24	63,7	54	**6019**	40	80	130	500	1 000
	170	32	114	81,5	**6219**	30	70	110	450	910
	200	45	159	118	**6319**	30	60	100	410	810
100	150	24	63,7	54	**6020**	40	70	120	480	960
	180	34	127	93	**6220**	30	60	110	430	860
	215	47	174	140	**6320**	30	60	100	380	760
110	170	28	85,2	73,5	**6022**	30	60	110	430	860
	200	38	151	118	**6222**	30	60	100	390	770
	240	50	203	180	**6322**	30	50	90	340	690
120	180	28	88,4	80	**6024**	30	60	100	400	800
	215	40	146	118	**6224**	30	50	90	360	720
	260	55	208	186	**6324**	20	50	80	320	630

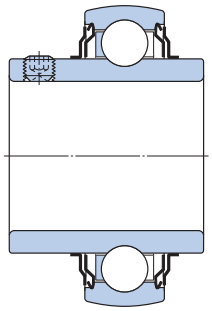
Y-bearings, SKF DryLube bearings and extreme temperature bearings, metric and inch shafts

d **20 – 75** mm
d **3/4 – 2 7/16** in



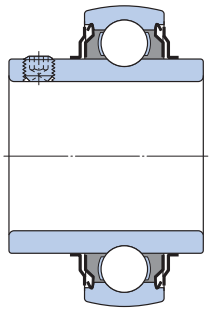
VA201

SKF extreme temperature bearings



VA228

SKF DryLube bearings



VA21...

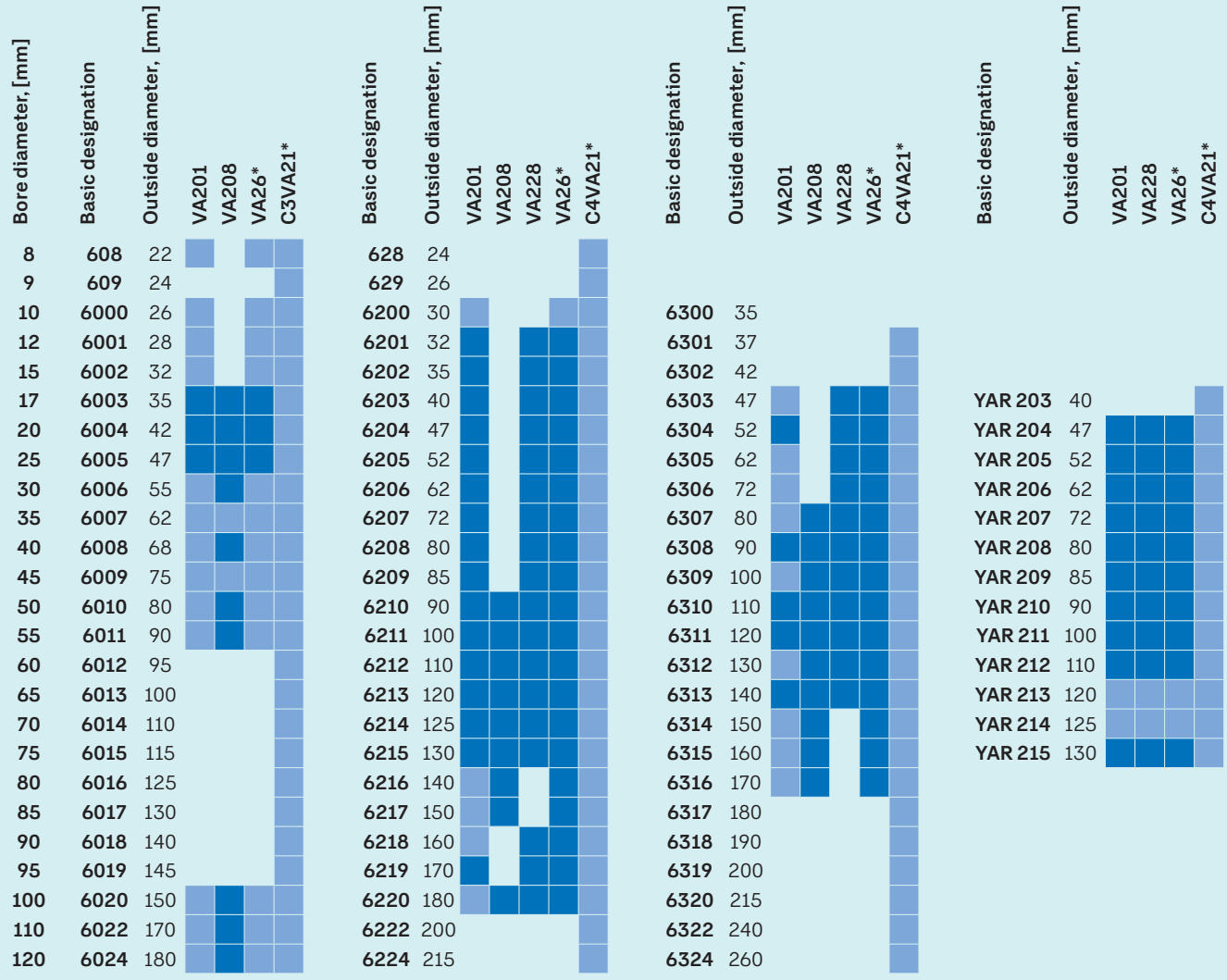
Principal dimensions			Basic load ratings		Designations	Limiting speed			
			dynamic	static	Base bearings	Extreme temperature bearings	SKF DryLube bearings[1]		
						VA201	VA210	VA2101	VA237
d	D	B	C	C_0		VA228	VA260	VA261	VA267
mm			kN			r/min			
20	47	31	13,5	6,55	**YAR 204-2FW**	270	450	1 800	3 600
25	52	34,1	14,8	7,8	**YAR 205-2FW**	230	390	1 600	3 100
30	62	38,1	20,3	11,2	**YAR 206-2FW**	200	330	1 300	2 600
35	72	42,9	27	15,3	**YAR 207-2FW**	170	280	1 100	2 200
40	80	49,2	32,5	19	**YAR 208-2FW**	150	250	1 000	2 000
45	85	49,2	35,1	21,6	**YAR 209-2FW**	140	230	920	1 800
50	90	51,6	37,1	23,2	**YAR 210-2FW**	130	210	860	1 700
55	100	55,6	46,2	29	**YAR 211-2FW**	120	190	770	1 500
60	110	65,1	55,3	36	**YAR 212-2FW**	110	180	710	1 400
75	130	73,1	68,9	49	**YAR 215-2FW**	90	150	590	1 200
in	mm		kN			r/min			
3/4	47	31	14	6,55	**YAR 204-012-2FW**	270	450	1 800	3 600
1	52	34,1	15	7,8	**YAR 205-100-2FW**	230	390	1 600	3 100
1 3/16	62	38,1	18	11,2	**YAR 206-103-2FW**	190	330	1 300	2 600
1 1/4	72	42,9	19	15,3	**YAR 207-104-2FW**	170	280	1 100	2 200
1 7/16	72	42,9	19	15,3	**YAR 207-107-2FW**	170	280	1 100	2 200
1 1/2	80	49,2	21	19	**YAR 208-108-2FW**	150	250	1 000	2 000
1 11/16	85	49,2	22	21,6	**YAR 209-111-2FW**	140	230	920	1 800
1 3/4	85	49,2	22	21,6	**YAR 209-112-2FW**	140	230	920	1 800
1 15/16	90	51,6	22	23,2	**YAR 210-115-2FW**	130	210	860	1 700
2	100	55,6	25	29	**YAR 211-200-2FW**	120	190	770	1 500
2 3/16	100	55,6	25	29	**YAR 211-203-2FW**	120	190	770	1 500
2 7/16	110	65,1	26	36	**YAR 212-207-2FW**	110	180	710	1 400

Virtually any SKF bearing is available as SKF DryLube bearings. For other series, sizes and designs, please contact SKF application engineering service or SKF Interactive Engineering Catalogue on www.skf.com/bearings

[1] If clearance greater than C3, consult **diagram 1** to **3** on **page 10** for limiting speed reduction factors. Additional dimensions and CAD models of bearings are available for download from www.skf.com/bearings

Matrix 1

Overview of product assortment of SKF deep groove ball bearings, Y-bearings, SKF DryLube bearings and extreme temperature bearings.



VA201	Extreme temperature bearings with a sheet steel cage, lubricated with a polyalkylene glycol/graphite mixture
VA208	Extreme temperature bearings with segmented cage made of graphite
VA228	Extreme temperature bearings with coronet cage made of graphite
VA26* VA260, VA261, VA267	SKF DryLube bearings with internal clearance multiples of C5
C3VA21*/C4VA21* VA210, VA2101, VA237	SKF DryLube bearings with internal clearance C3 or C4

For other dimension series, sizes and designs, please contact SKF application engineering service or www.skf.com/bearings

skf.com

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