SCHAEFFLER

High-Speed Deep Groove Ball Bearings for Electric Drive Systems

Schaeffler e-bearing Family

Technical Product Information

Foreword

The electrification of the drive system in the automotive sector places the highest demands on the components used. In particular, ball bearings in electric drive systems must work reliably under extreme operating conditions while meeting a wide range of technical requirements.

Requirements for ball bearings in electric drive systems

- **Efficiency**: In electric drive systems, reducing mechanical losses is crucial for both range and energy consumption. Ball bearings must therefore be designed with minimal friction and optimised lubrication in order to maximise the overall efficiency of the electric drive system.
- **Power density**: The trend towards compact and high-performance electric drive systems calls for bearing solutions which offer a high load carrying capacity in a limited installation space. Innovative materials and optimised geometries are needed to meet the increasing demands on power density.
- **High speeds**: Electric motors in electric drive systems often operate at very high speeds, particularly in direct drives or integrated gearbox concepts. As a result, ball bearings must be designed to provide stable running conditions and low heat generation at these speeds. A specially engineered cage design, combined with materials selected for the specific application, plays a key role in resisting extreme centrifugal forces and minimising deformation.
- **NVH (Noise, Vibration, Harshness)**: Noise and vibration behaviour are key quality characteristics in vehicles. Ball bearings play a key role in reducing structure-borne noise and minimising resonances to ensure a comfortable driving experience.
- **Electrical robustness**: The proximity to power electronics and the high voltages present in electric drive systems increase the risk of current passage through the bearing positions. At the relevant bearing positions, the ball bearings must therefore be designed to be electrically insulating or conductive, to prevent damage from electrical discharges and ensure a long service life.

High-speed deep groove ball bearings (HSBB) from Schaeffler have been developed precisely for these requirements. They combine high speed capability with optimised NVH characteristics to create a compact and efficient bearing solution for the e-mobility of tomorrow.

With its high-speed ball bearings, Schaeffler offers a standardised and cost-optimised portfolio in standard dimensions and for different speed requirement levels. For more advanced requirements, additional design variants are available by agreement within the Schaeffler e-bearing Family. These include versions that provide additional electrical protection functions. These protection functions can, for example, prevent current passage through the bearing caused by the power electronics or enable the targeted discharge of currents via discharge elements.

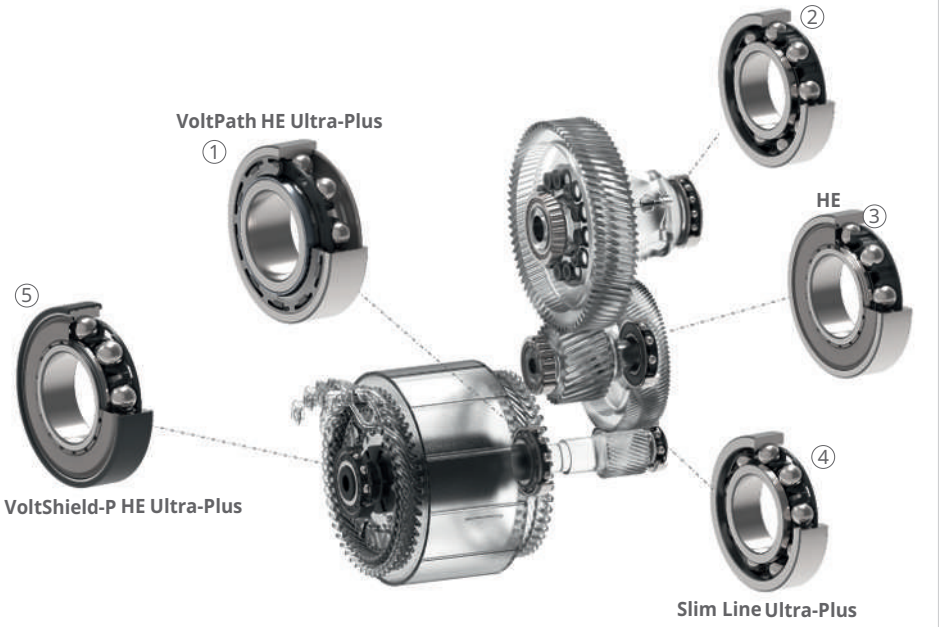
Contents

1 Schaeffler e-bearing Family

Weight reduction and continuous efficiency improvement in electric drive systems are essential for meeting high CO_2 reduction targets and material efficiency requirements. With the increasing use of 800 V systems and fast-switching inverters based on SiC or GaN technologies, the importance of additional electrical protection functions continues to grow.

The Schaeffler e-bearing Family offers solutions for reliable and efficient e-mobility systems in the form of bearing concepts with optimised installation space and weight characteristics. Integrated electrical protection functions prevent harmful effects caused by parasitic currents.

1 Solutions for electric drive systems



1	Integrated discharge solution combined with centrifugal disc and high-speed cage	2	Standard high-speed deep groove ball bearing
3	Centrifugal disc reduces friction (churning losses) and contamination inside the bearing.	4	Bearing design with optimised installation space and weight characteristics, with high-speed cage
5	Outer ring with plastic overmoulding combined with centrifugal disc and high-speed cage		

In addition to conventional high-speed deep groove ball bearings, the e-bearing Family includes additional features. These features can be combined as required to create an optimal bearing solution for the specific application.

1 Suitable bearing design for every requirement

Requirements	Design variants						
	Speed factor $n \cdot d_M$ up to $1{,}8 \cdot 10^6$	**Speed factor $n \cdot d_M$ up to $2{,}4 \cdot 10^6$**	**Optimised friction characteristics for oil lubrication**	**Optimised installation space and weight characteristics**	**Current-insulated, ceramic balls**	**Current-insulated, overmoulded outer ring**	**Electrically conductive**
Speed factor $n \cdot d_M$ up to $1{,}8 \cdot 10^6$	Ultra	–	HE Ultra	Slim Line	VoltShield-C Ultra [1)]	VoltShield-P Ultra [1)]	VoltPath Ultra [1)]
Speed factor $n \cdot d_M$ up to $2{,}4 \cdot 10^6$	–	Ultra-Plus	HE Ultra-Plus	Slim Line Ultra-Plus	VoltShield-C Ultra-Plus [1)]	VoltShield-P Ultra-Plus [1)]	VoltPath Ultra-Plus [1)]
Optimised friction characteristics for oil lubrication	HE Ultra	HE Ultra-Plus	HE	–	VoltShield-C HE	VoltShield-P HE	VoltPath HE
Optimised installation space and weight characteristics	Slim Line	Slim Line Ultra-Plus	–	Slim Line	VoltShield-C Slim Line	VoltShield-P Slim Line	–
Current-insulated, ceramic balls	VoltShield-C Ultra [1)]	VoltShield-C Ultra-Plus [1)]	VoltShield-C HE	VoltShield-C Slim Line	VoltShield-C	–	–
Current-insulated, overmoulded outer ring	VoltShield-P Ultra [1)]	VoltShield-P Ultra-Plus [1)]	VoltShield-P HE	VoltShield-P Slim Line	–	VoltShield-P	–
Electrically conductive	VoltPath Ultra [1)]	VoltPath Ultra-Plus [1)]	VoltPath HE	–	–	–	VoltPath

[1)] Variants are also available in an optimised friction design for oil lubrication HE. Further design variants are available upon consultation with Schaeffler Application Engineering.

2 Example combinations of design variants

Requirements	Design variants						Designation
	Ultra	Ultra-Plus	HE	Slim Line	VoltShield	VoltPath	
Electrically conductive Optimised friction characteristics for oil lubrication Speed factor $n \cdot d_M$ up to $1{,}8 \cdot 10^6$	✓		✓			✓	VoltPath HE Ultra
Electrically conductive Optimised friction characteristics for oil lubrication Speed factor $n \cdot d_M$ up to $2{,}4 \cdot 10^6$		✓	✓			✓	VoltPath HE Ultra-Plus
Current-insulated Optimised friction characteristics for oil lubrication Speed factor $n \cdot d_M$ up to $1{,}8 \cdot 10^6$	✓		✓		✓		VoltShield-C HE Ultra
Current-insulated Optimised friction characteristics for oil lubrication Speed factor $n \cdot d_M$ up to $2{,}4 \cdot 10^6$		✓	✓		✓		VoltShield-C HE Ultra-Plus
Current-insulated Optimised installation space and weight characteristics Speed factor $n \cdot d_M$ up to $2{,}4 \cdot 10^6$		✓		✓	✓		VoltShield-P Slim Line Ultra-Plus

2 Bearing design

High-speed deep groove ball bearings from Schaeffler are optimised in the respective variants for the requirements of electric drive systems. The dimensions of single row high-speed deep groove ball bearings correspond to catalogue series 60, 62 and 63 in accordance with DIN 616 (ISO 15).

The following bearing designs are available:

- open bearings
- with non-contact sealing shields
- with high-speed cage reinforced with glass fibre: Ultra
- with high-speed cage reinforced with carbon fibre: Ultra-Plus
- narrow version: Slim Line
- with centrifugal discs: HE
- current insulation provided by outer ring with plastic overmoulding: VoltShield-P
- current insulation provided by ceramic balls: VoltShield-C
- electrically conductive via grounding element: VoltPath

2 Bearing design and suitability

1	Very high speeds enabled by fibre-reinforced high-speed cage	2	High power density due to narrow, asymmetric construction
3	High efficiency due to centrifugal discs	4	Current insulation provided by outer ring with plastic overmoulding
5	Current insulation provided by ceramic balls	6	Electrical conduction via grounding element

Further information

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https://www.schaeffler.de/std/1D3D

2.1 Open high-speed deep groove ball bearings

3 Open design

001A996C

The following bearing series are available:

- F-800000.01.60
- F-800000.01.62
- F-800000.01.63

2.2 High-speed deep groove ball bearings with non-contact sealing shield

4 Design with non-contact sealing shields

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The following bearing series are available:

- F-800000.60
- F-800000.62
- F-800000.63

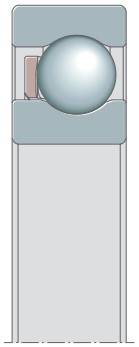
2.3 Narrow high-speed deep groove ball bearings Slim Line

Compactness and weight reduction in electric drive systems are becoming increasingly important in meeting future requirements for CO_2 emissions and driving range. The increased power density of the bearings helps fulfil these requirements. The Slim Line design from Schaeffler comprises open bearings with standard diameters that are reduced in width and weight.

The reduced installation space of the bearings enables material and weight savings in the electric drive system and lowers overall system costs. Bearings in the Slim Line design are equipped as standard with the space-optimised Ultra high-speed cage and are suitable for very high speeds.

The Slim Line design has an asymmetrical form in order to achieve the smallest possible bearing width.

5 Narrow asymmetric design Slim Line



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The Slim Line design offers the following advantages:

- up to 20 % reduction in bearing width
- up to 12 % reduction in weight
- reduced friction
- higher speeds

2.3.1 High-speed deep groove ball bearings Slim Line

High-speed deep groove ball bearings in the Slim Line design are equipped as standard with the Ultra high-speed cage reinforced with glass fibres.

6 Design Slim Line

001D0DE0

The following bearing series are available:

- F-800000.50.60
- F-800000.50.62
- F-800000.50.63

2.3.2 High-speed deep groove ball bearings Slim Line Ultra-Plus

High-speed deep groove ball bearings in the Slim Line Ultra-Plus design are equipped with the Ultra-Plus high-speed cage reinforced with carbon fibres and are suitable for the highest speeds.

7 Design Slim Line Ultra-Plus

001D0DE0

The following bearing series are available:

- F-800000.60.60
- F-800000.60.62
- F-800000.60.63

3 Advantages

3.1 High speed

High-speed deep groove ball bearings in the standard design are suitable for speeds up to a speed factor $n \cdot d_M$ of 1300000 $min^{-1} \cdot mm$.

For higher speed requirements, bearings in the Ultra design are available by agreement up to a speed factor $n \cdot d_M$ of 1800000 $min^{-1} \cdot mm$, and bearings in the Ultra-Plus design for a speed factor $n \cdot d_M$ of up to 2400000 $min^{-1} \cdot mm$.

3.2 Minimal noise generation

The high quality of the balls, optimised surface finish, and reduced roundness and waviness deviations of the raceways, together with the stable cage geometry, help reduce noise generation.

3.3 Low friction

Raceway osculations designed specifically for high speeds, along with the high surface quality of the raceways, reduce friction within the bearing.

In oil-lubricated applications, the High Efficiency (HE) design with centrifugal discs can regulate oil flow and thereby minimise churning losses within the bearing.

3.4 Good sealing effect

The design with non-contact sealing shields on both sides provides particularly good protection against grease egress and the ingress of dust. In applications operating in an oil bath, centrifugal discs protect the bearing against contamination.

3.5 Higher cost-effectiveness

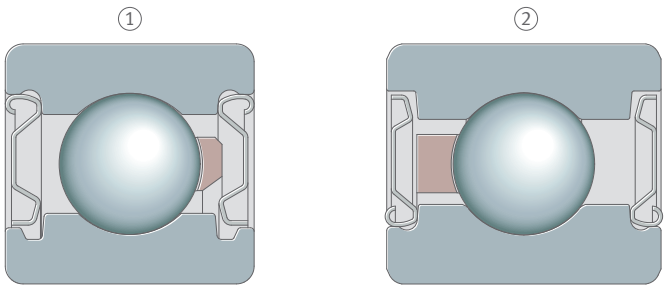
Due to the lower friction, energy costs for operation are reduced. The reduced grease loss, improved protection against contamination and lower strain on the lubricant extend the grease operating life and thus the rating life of the bearing.

4 Sealing

For speeds up to a speed factor $n \cdot d_M$ of 1300000 $min^{-1} \cdot mm$, bearings are available which are sealed on both sides with non-contact sealing shields. These bearings featuring seals on both sides are pre-filled at the factory with a high-quality, high-performance grease.

The innovative shield design ensures reliable protection against lubricant leakage, as well as against the ingress of dust and other contaminants. This design plays a key role in extending bearing life and increasing operational reliability, particularly under demanding operating conditions.

8 Sealing



1	Sealed on both sides with sealing shields	2	Centrifugal disc

For applications in which the bearings operate in an oil bath, bearings in the HE design variant with centrifugal discs are available by agreement. The centrifugal disc reduces oil churning losses. Ideally, the centrifugal disc should be positioned on the side facing the oil. This arrangement reduces bearing friction and helps keep oil temperatures low. In addition, the centrifugal disc protects the bearing against contamination.

5 Speeds

1 Characteristic speed

$n \cdot d_M$

d_M	mm	Mean bearing diameter (d+D)/2
n	min^{-1}	Operating speed or equivalent speed

3 Example

Bearing		F-800000.60.6208
d	mm	40
D	mm	80
d_M	mm	(40 + 80) / 2 = 60
n	min^{-1}	40000
$n \cdot d_M$	$min^{-1} \cdot mm$	2400000

The bearings listed in the product tables are designed, depending on the design variant, up to a speed factor $n \cdot d_M$ of 2400000 $min^{-1} \cdot mm$. The specific speed factor $n \cdot d_M$ takes into account the limiting speed n_G of the bearing multiplied by the pitch circle d_M. The limiting speed defines the speed range within which the respective bearing design can be used.

Slim Line

Bearings with the Ultra high-speed cage can operate at speeds up to a speed factor $n \cdot d_M$ of 1800000 $min^{-1} \cdot mm$.

Bearings with the Ultra-Plus high-speed cage can operate at speeds up to a speed factor $n \cdot d_M$ of 2400000 $min^{-1} \cdot mm$.

6 Temperature range

The temperature range applies to open bearings, greased bearings with sealing shields and bearings in the Slim Line design.

The bearings are suitable for operation within a temperature range of −40 °C to +150 °C.

7 Cages

The single row high-speed deep groove ball bearings are fitted with a single-piece polyamide snap cage as standard.

High-speed deep groove ball bearings in the Slim Line design are equipped as standard with the Ultra high-speed cage reinforced with glass fibres.

High-speed deep groove ball bearings in the Slim Line Ultra-Plus design are equipped with the Ultra-Plus high-speed cage reinforced with carbon fibres and are suitable for the highest speeds.

8 Internal clearance

The radial internal clearance of the bearings corresponds to internal clearance group C4 (Group 4) in accordance with DIN 620-4 (ISO 5753-1). Bearings with a different internal clearance are available by agreement.

4 Radial internal clearance

d		**C4 (Group 4)**	
mm		**µm**	
>	**≤**	**min.**	**max.**
30	40	28	46
40	50	30	51
50	65	38	61

9 Dimensions, tolerances

The main dimensions of the single row high-speed deep groove ball bearings correspond to DIN 625-1 (ISO 15).

Tolerances

The dimensional and running tolerances of the bearings correspond as a minimum to tolerance class 6 in accordance with ISO 492:2023.

10 Minimum load

In order that no slippage occurs between the contact partners, the deep groove ball bearings must be constantly subjected to a sufficiently high load. Based on experience, this calls for a minimum radial load in the order of $P > C_{0r}/100$. In most cases, however, the radial load is already higher than the requisite minimum load due to the weight of the supported parts and the external forces.

If the minimum radial load is lower than stated, please consult Schaeffler.

11 Design of the bearing arrangement

The maximum undercut radius r_a, the diameter of the housing shoulder D_a and the abutment diameter of the shaft shoulder d_a are stated in the product tables ➤18|12.2.

The guide values in accordance with ISO 286-1 for the diameter tolerance are IT5 for the shaft seat and IT6 for the housing seat.

Further information

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https://www.schaeffler.de/std/1D3D

12 Product tables

Other bearing sizes are also available by agreement.

12.1 Explanations

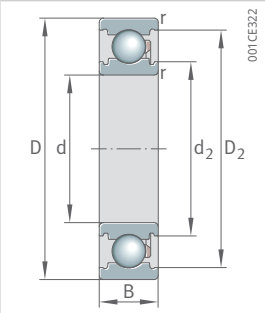
B	mm	Width
C_{0r}	N	Basic static load rating, radial
C_r	N	Basic dynamic load rating, radial
C_{ur}	N	Fatigue limit load, radial
d	mm	Bearing bore diameter
D	mm	Bearing outside diameter
d_2	mm	Calibre diameter of inner ring
D_2	mm	Calibre diameter of outer ring
d_a	mm	Abutment diameter of shaft shoulder
D_a	mm	Abutment diameter of housing shoulder
m	kg	Mass
n_G	min^{-1}	Limiting speed
r	mm	Chamfer dimension
r_a	mm	Undercut radius

12.2 High speed deep groove ball bearings

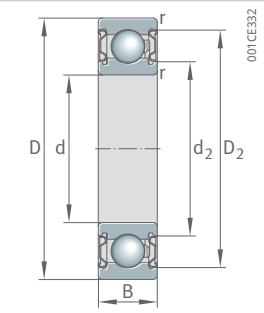
Single row

Open or sealed

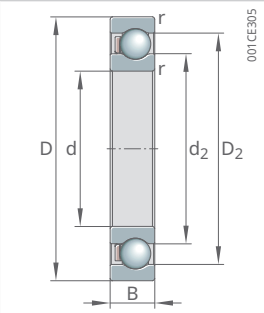
Standard or narrow design



Open
F-800000.01.6

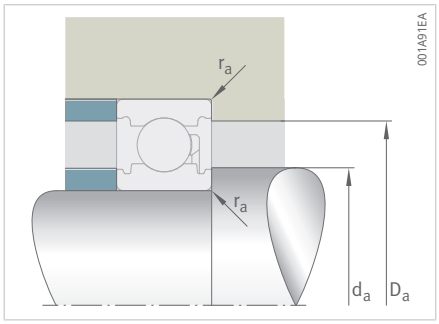


Sealed
F-800000.6

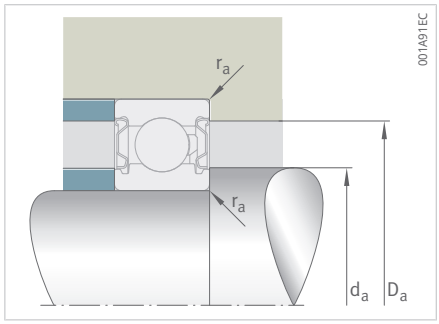


Slim Line
F-800000.50.6
Slim Line Ultra-Plus
F-800000.60.6

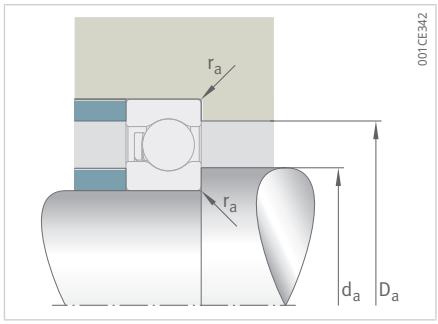
Designation	m	d	D	B	r min.	D_2	d_2
	kg	mm	mm	mm	mm	mm	mm
F-800000.6006	0,107	30	55	13	1	50,22	36,67
F-800000.01.6006	0,101	30	55	13	1	50,22	36,67
F-800000.50.6006	0,095	30	55	11	0,6	48	38,4
F-800000.60.6006	0,095	30	55	11	0,6	48	38,4
F-800000.6206	0,184	30	62	16	1	54,91	37,72
F-800000.01.6206	0,177	30	62	16	1	54,91	37,72
F-800000.50.6206	0,16	30	62	13,5	0,6	52,65	39,9
F-800000.60.6206	0,16	30	62	13,5	0,6	52,65	39,9
F-800000.6306	0,322	30	72	19	1,1	63,29	41,44
F-800000.01.6306	0,312	30	72	19	1,1	63,29	41,44
F-800000.50.6306	0,29	30	72	16,5	0,6	60,45	43,8
F-800000.60.6306	0,29	30	72	16,5	0,6	60,45	43,8
F-800000.6007	0,141	35	62	14	1	56,32	41,31
F-800000.01.6007	0,133	35	62	14	1	56,32	41,31
F-800000.50.6007	0,125	35	62	11,5	0,6	54,05	43,4
F-800000.60.6007	0,125	35	62	11,5	0,6	54,05	43,4
F-800000.6207	0,262	35	72	17	1,1	64,52	44,61
F-800000.01.6207	0,252	35	72	17	1,1	64,52	44,61
F-800000.50.6207	0,24	35	72	15	0,6	62,5	46,13
F-800000.60.6207	0,24	35	72	15	0,6	62,5	46,13
F-800000.6307	0,433	35	80	21	1,5	69,69	46,18
F-800000.01.6307	0,418	35	80	21	1,5	69,69	46,18
F-800000.50.6307	0,365	35	80	17,5	1,1	66,69	46,18
F-800000.60.6307	0,365	35	80	17,5	1,1	66,69	48,86
F-800000.6008	0,176	40	68	15	1	61,81	48,86
F-800000.01.6008	0,168	40	68	15	1	61,81	46,56
F-800000.50.6008	0,14	40	68	11,5	0,6	59,6	48,92
F-800000.60.6008	0,14	40	68	11,5	0,6	59,6	48,92
F-800000.6208	0,344	40	80	18	1,1	70,57	49,3
F-800000.01.6208	0,33	40	80	18	1,1	70,57	49,3
F-800000.50.6208	0,31	40	80	16	0,6	67,6	51,87
F-800000.60.6208	0,31	40	80	16	0,6	67,6	51,87
F-800000.6308	0,589	40	90	23	1,5	78,61	52,28
F-800000.01.6308	0,572	40	90	23	1,5	78,61	52,28
F-800000.50.6308	0,515	40	90	19,5	1,1	75,7	55,08
F-800000.60.6308	0,515	40	90	19,5	1,1	75,7	55,08
F-800000.6009	0,229	45	75	16	1	68,72	52,14
F-800000.01.6009	0,219	45	75	16	1	68,72	52,14
F-800000.50.6009	0,18	45	75	12,5	0,6	65,9	54,55
F-800000.60.6009	0,18	45	75	12,5	0,6	65,9	54,55



Mounting dimensions
Open design



Mounting dimensions
Sealed design



Mounting dimensions
Narrow design

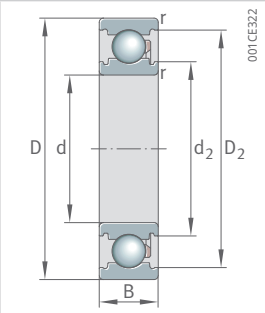
d_a min.	D_a max.	r_a max.	C_r	C_{0r}	C_{ur}	n_G
mm	mm	mm	N	N	N	min^{-1}
34,6	50,4	0,9	15500	9000	470	30000
34,6	50,4	0,9	15500	9000	470	30000
34,6	50,4	0,5	15500	9000	470	44500
34,6	50,4	0,5	15500	9000	470	59000
35,6	56,4	0,9	20100	11300	590	27000
35,6	56,4	0,9	20100	11300	590	27000
35,6	56,4	0,5	20100	11300	590	39500
35,6	56,4	0,5	20100	11300	590	52000
37	65	1	30000	22800	850	22800
37	65	1	30000	22800	850	22800
37	65	0,5	30000	22800	850	33500
37	65	0,5	30000	22800	850	44500
39,6	57,4	0,9	16200	10300	540	27000
39,6	57,4	0,9	16200	10300	540	27000
39,6	57,4	0,5	16200	10300	540	39000
39,6	57,4	0,5	16200	10300	540	52000
42	65	1	26500	15400	800	22700
42	65	1	26500	15400	800	22700
42	65	0,5	26500	15400	800	33000
42	65	0,5	26500	15400	800	44000
44	71	1,4	34500	19100	1000	20600
44	71	1,4	34500	19100	1000	20600
44	71	1	34500	19100	1000	30000
44	71	1	34500	19100	1000	40000
44,6	63,4	0,9	16900	11500	600	24400
44,6	63,4	0,9	16900	11500	600	24400
44,6	63,4	0,5	16900	11500	600	35500
44,6	63,4	0,5	16900	11500	600	47500
47	73	1	30000	17800	930	20600
47	73	1	30000	17800	930	20600
47	73	0,5	30000	17800	930	30000
47	73	0,5	30000	17800	930	40000
49	81	1,4	44500	25000	1310	17900
49	81	1,4	44500	25000	1310	17900
49	81	1	44500	25000	1310	26000
49	81	1	44500	25000	1310	35000
49,6	70,4	0,9	20100	14400	750	21900
49,6	70,4	0,9	20100	14400	750	21900
49,6	70,4	0,5	20100	14400	750	32000
49,6	70,4	0,5	20100	14400	750	42500

12.2 High speed deep groove ball bearings

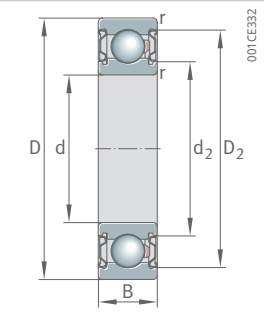
Single row

Open or sealed

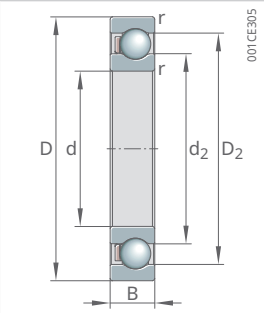
Standard or narrow design



Open
F-800000.01.6

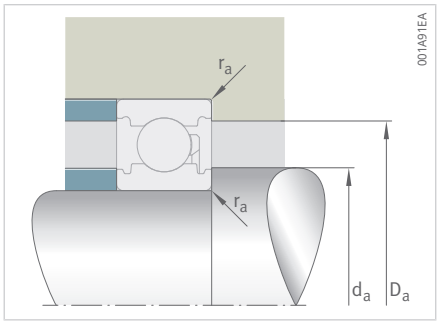


Sealed
F-800000.6

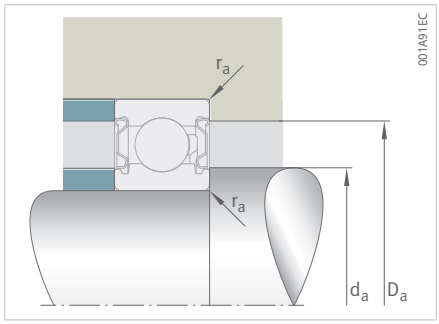


Slim Line
F-800000.50.6
Slim Line Ultra-Plus
F-800000.60.6

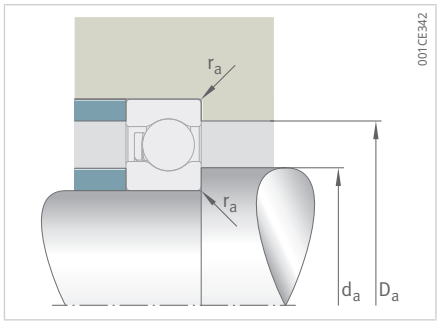
Designation	m	d	D	B	r min.	D_2	d_2
	kg	mm	mm	mm	mm	mm	mm
F-800000.01.6309	0,792	45	100	25	1,5	86,37	60,33
F-800000.50.6309	0,72	45	100	22	1	84,65	61,45
F-800000.60.6309	0,72	45	100	22	1	84,65	61,45
F-800000.6210	0,426	50	90	20	1,1	81,65	59,23
F-800000.01.6210	0,409	50	90	20	1,1	81,65	59,23
F-800000.50.6210	0,37	50	90	17	0,6	78,75	61,9
F-800000.60.6210	0,37	50	90	17	0,6	78,75	61,9
F-800000.50.6211	0,51	55	100	18,5	1	87,35	68,3
F-800000.60.6211	0,51	55	100	18,5	1	87,35	68,3



Mounting dimensions
Open design



Mounting dimensions
Sealed design



Mounting dimensions
Narrow design

d_a min.	D_a max.	r_a max.	C_r	C_{0r}	C_{ur}	n_G
mm	mm	mm	N	N	N	min^{-1}
54	91	1,4	55000	31500	1650	15900
54	91	0,9	55000	31500	1650	23100
54	91	0,9	55000	31500	1650	31000
57	83	1	36000	23200	1210	17700
57	83	1	36000	23200	1210	17700
57	83	0,5	36000	23200	1210	25500
57	83	0,5	36000	23200	1210	34500
64	91	0,9	44500	29000	1520	23000
64	91	0,9	44500	29000	1520	30500

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