GMN
BEARING USA

MRO Support Toolkit

Maintenance | Repair | Operations

Introduction

At GMN Bearing USA, we're here to help you get the information you need fast, no matter where you are in your knowledge journey or your MRO project.

This MRO Support Toolkit is designed to provide you information about proper bearing MRO—from greasing to installation to break-in and more. To help with all aspects of maintenance, repair and operational functions, this guide serves as a practical, all-in-one reference tool.

And if you have any questions, just call us! GMN Bearing USA's in-house engineers and technical specialists are happy to answer your inquiries and better learn how we can support your needs. You can reach us at 800-323-5725, **www.gmnbt.com**.

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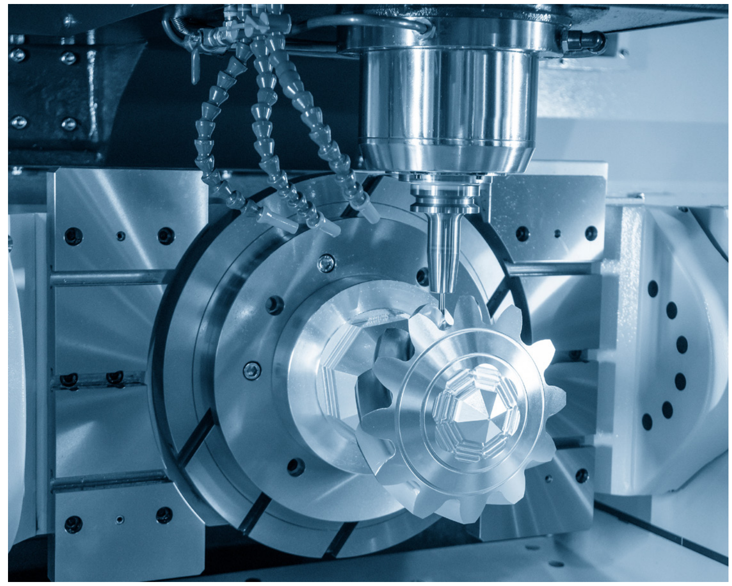
Bearing Arrangement: 101

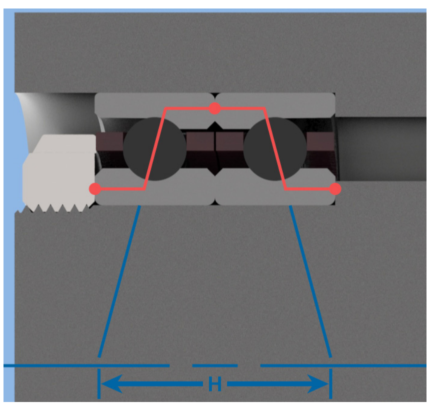
Terms & Differences

Angular contact bearings are different from radial bearings in multiple ways, but one key difference is in the bearing orientation. **Angular contact bearings are designed to only allow load in one direction.**

That means if a bearing is installed backwards it will fail. It also means that there is almost never a single angular contact bearing in an application. It's common for there to be two close together but there can be as many as four on one end of the spindle. It's also common to have two to four bearings on one side of a spindle and another pair floating on the other side.



COMMON ARRANGEMENTS

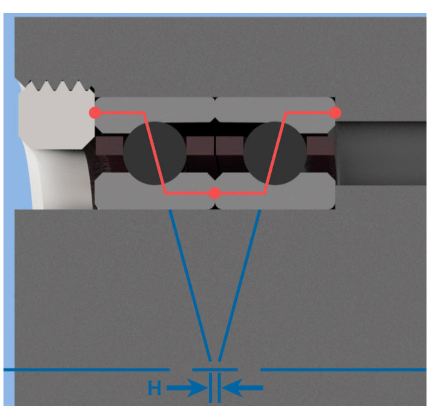


BACK-TO-BACK (ALSO KNOWN AS DB OR O)

The back-to-back arrangement is one of the most common and is characterized by locking elements on both sides of the inner race pair. Typically, there is a shaft shoulder on one side and a lock nut on the other side. In this arrangement, the load side (thicker side) of the outer race of each bearing is facing inwards. That also means the writing is facing inwards.

This arrangement causes the bearing contact angles to go away from each other as they move toward the centerline, giving it a wider base to resist tilting moments.

This arrangement can also handle axial loads in both directions.



FACE-TO-FACE (ALSO KNOWN AS DF OR X)

In the face-to-face arrangement, the bearing orientation is flipped. That means that the clamping components are now on the housing. Typically, there is a housing shoulder on one side and a nut or bolt plate on the other side. The outer race load faces (thicker sides) are also facing outward. In this arrangement, the writing will also be facing outward.

This arrangement causes the contact angles to come together as they go towards the centerline, giving a narrower base which can help with misalignment.

This arrangement can also handle axial loads in both directions.

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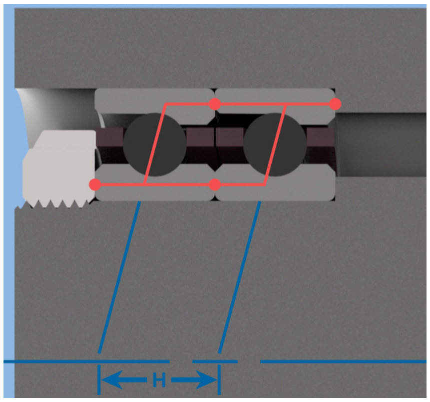


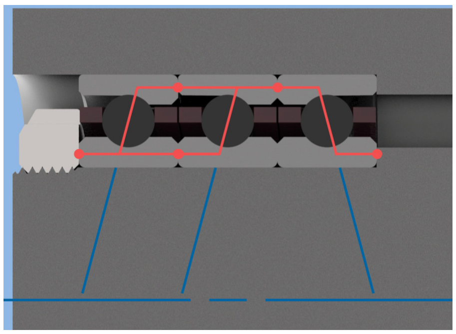
TANDEM (ALSO KNOW AS DT)

The tandem arrangement has the bearings facing the same direction. The load face (thicker side) of the first bearing outer race is contacting the non-load face (thinner side) of the next bearing's outer race. It can be harder to tell in an assembly which orientation is correct, but it depends on how the axial load is applied to the system. Typically, *it's pushing*, which would mean that the writing and load side are facing toward the back of the spindle.

This arrangement can only handle axial load in one direction and is used in heaver axial load conditions because each bearing will take half the application axial load.

For this orientation to operate correctly, there typically needs to be a third angular contact bearing facing the opposite direction somewhere else in the system.

OTHER ARRANGEMENTS



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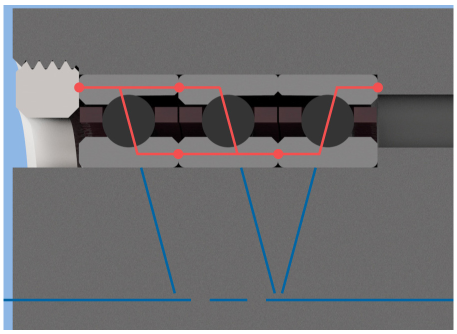

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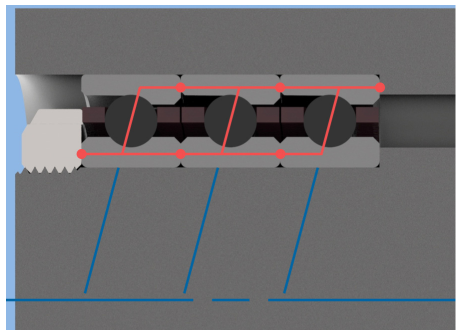

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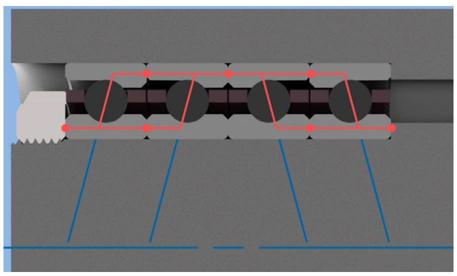

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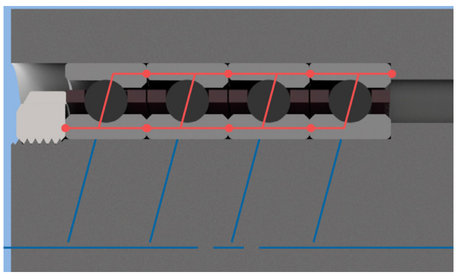

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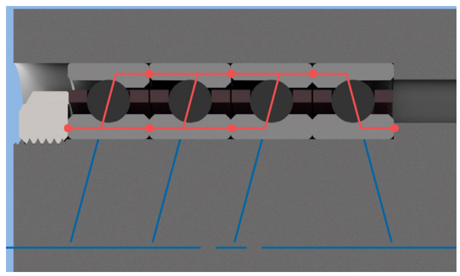

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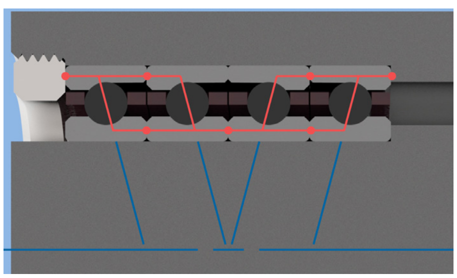

QFC

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How to Orient GMN Bearings

Angular contact bearings are different from standard radial deep groove ball bearings in that they are *not bidirectional*. Deep groove ball bearings have raceways that go all around the balls on both the inner and outer race. This means an axial load can be transferred through the bearing in both directions.

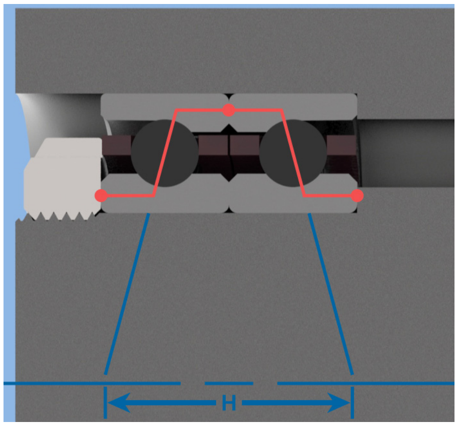
Angular contact bearings have one raceway that doesn't go all the way around the bearing, which means the axial load can only be transferred in one direction. If the load goes the other direction, the bearing will fail.

> **!** This makes the proper orientation critical when repairing units that use angular contact bearings. It is very common to see radically decreased bearing life, excessive vibrations, poor runouts, or excessive heat and the root cause analysis confirms that that at least one or a pair of bearings were installed backwards.

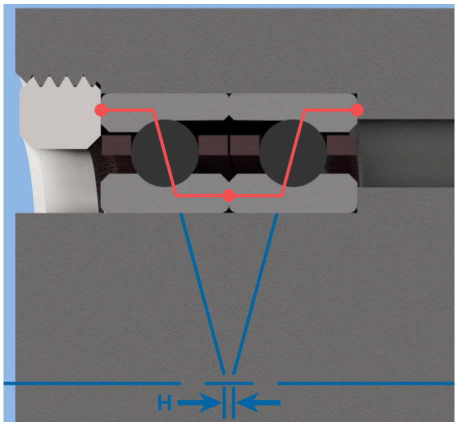
Many manufacturers rely on arrows on the bearing OD to indicate the arrangement. When the arrows make a diamond (<>), that means it's a back-to-back arrangement. When they make an "X" (><) that indicates a face-to-face arrangement. When the arrows are facing the same direction (<<) that indicates a tandem arrangement.

THE GMN DIFFERENCE

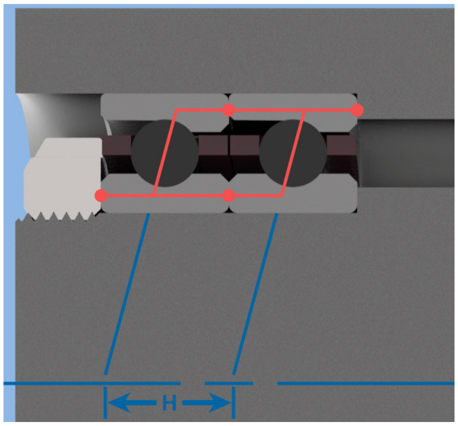
GMN does not use arrows on the bearing ODs. Instead, GMN relies on the writing on the bearing outer ring to indicate which side is the load side. (Most bearing manufacturers follow the same convention.)



For the back-to-back arrangement, also known as O or DB, the bearing writing faces each other.



For the face-to-face arrangement, also known as X or DF, the bearing writing faces out on both sides of the bearing pair.



For the tandem arrangement, also known as DT, the bearing writing on one bearing goes against the side without writing on the other.

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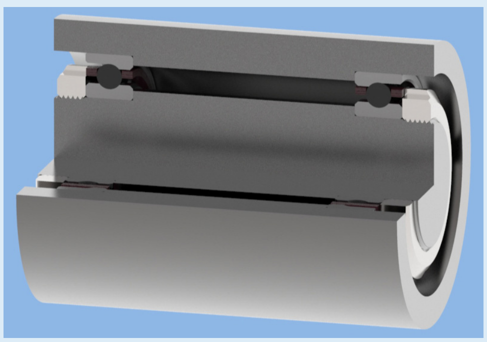
Spring vs. Rigid Preload

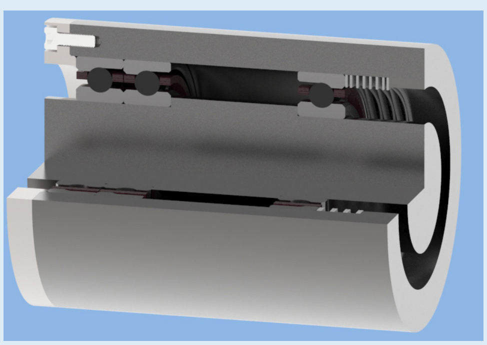
Angular contact bearings rely on preloading to perform correctly but establishing the preload can be done in different ways.

The two most common methods are:

- **Rigid**, and
- **Spring preload**



For **rigid preload**, the bearing set is locked together with the bearings either directly against each other or with match ground spacers between them. It's not uncommon to have a set of bearings in the front of the system and another set in the back with the front set locked together on the shaft and housing and the back set only locked on the shaft. The back set is allowed to "float" in the housing axially to allow for thermal growth of the shaft. By locking the bearing sets together, the offset between the inner and outer races of the bearings is removed and the bearings are preloaded.



In **spring preload** assemblies, there is typically a wave washer, or spring pack acting directly against one of the bearings that is not receiving the application loads. This spring will push on that bearing, which will cause all the bearings in the system to be preloaded. It's not uncommon to have this wave spring or coil pack in the back of the application assembly.

If there is no spring in the system, then the replacement bearings need to come with a preset preload. GMN typically does light, medium, or heavy preload. Many bearings designate what preload they have. In that case, it's encouraged to replace the old bearing with a GMN bearing of the same preload. If it's unclear what preload the original bearings had, then the safest bet is to try a light preload bearing.

For applications that use a spring preload, the spring supersedes the bearing preload value. Therefore, any GMN bearing preload can be used in the replacement bearings. It's just important to keep all the bearings of the same size with the same preload or the load sharing won't be equal. If there are only two bearings in the assembly with a spring preload, then it's also possible to use unground bearings, which don't have a factory preload designation.

Using the Proper Preload for Angular Contact Bearings

Precision angular contact bearings come with manufactured offsets to establish a preload when installed by having the offset removed and the balls pressed into the raceways. The level of offset determines if it is a **light**, **medium**, or **heavy preload**.

When replacing bearings, it's important to use the same preload as the bearings that are being replaced. However, this can be challenging because not all manufacturers (GMN included) mark the bearing preload on the bearing. If possible, it's helpful to keep the box that the bearings came in for future reference when doing a repair.

The majority of applications use light preload bearings. This is especially the case for applications with high speeds and or high loads. When in doubt on what preload to use, it's the safest bet to err on the side of light preload.

Medium and heavy preload bearings increase the rigidity of the system. However, if the system needs to be extra stiff to minimize shaft deflection from the application loads, it can be helpful to go higher on the preload. But keep in mind that there is typically a trade-off on part life, maximum speed, and allowable load the system can handle.

If a spring is being used to preload the bearings, then it doesn't matter what preload designation the bearings have. They just need to all be the same.

PRELOAD

	RIGIDITY	LOAD CAPACITY	SPEEDS	LIFE
LIGHT	+	+++	+++	+++
MEDIUM	++	++	++	++
HEAVY	+++	+	+	+

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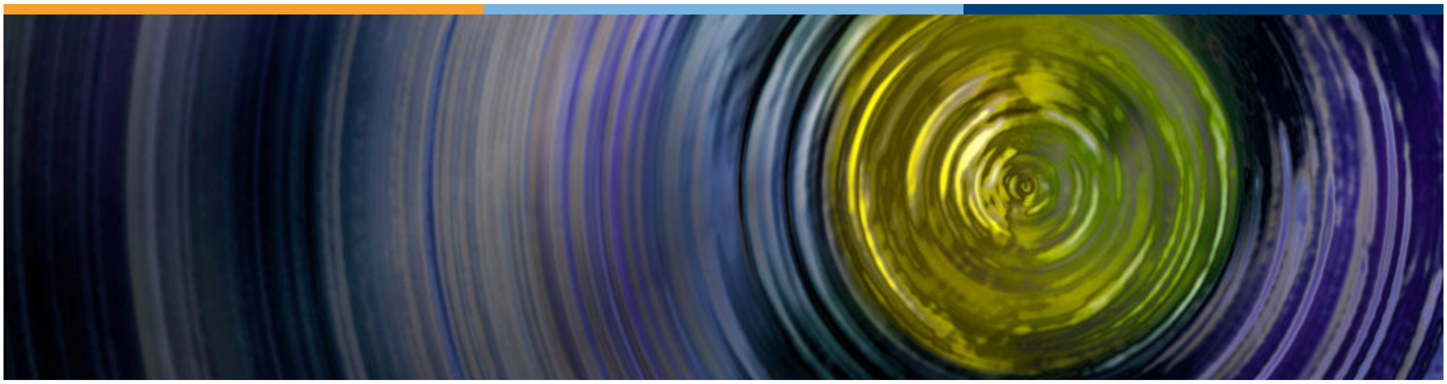
Spacer Grinding to Change Bearing Preload



In rigid preload applications, the precision angular contact bearings will have a specific factory preload. This factory preload is achieved by a precise offset between the inner and outer race—the larger the offset, the higher the preload. When the bearing is installed, the offset is removed as the inner and outer races become aligned. While custom preload values are available, the majority of GMN bearings have a standard **light**, **medium**, or **heavy** preload.

When doing repairs, it's important to match the preload of the new bearings with the original bearings that are being replaced. This is true even when switching to GMN brand for the new bearings. While GMN has an extensive stock of bearings with different preloads, there can be situations where the specific standard preload is not in stock.

However, if there is a set of spacers between the bearings, it is possible to modify the spacer lengths to achieve the desired preload.

Typically, spacers are *match ground*, meaning that the lengths of the inner and outer spacers are *exactly the same*.

- In a back-to-back arrangement, the inner spacer can be machined down a few microns to increase the preload. Alternatively, to decrease the preload, the outer ring spacer can be machined down.
- For a face-to-face arrangement, everything switches; the outer ring is machined down to increase the preload and the inner ring is machined down to decrease the preload.

This does not work with bearings that are in back-to-back or face-to-face arrangements directly against each other because there are no spacers to adjust. However, if there are tandem bearings against each other and spacers between bearing pairs that are facing opposite directions, it will still work. This applies only to the spacers that are between the two bearings that face different directions. If there are spacers between tandem pairs as well as spacers between the sets facing opposite directions, do not adjust the spacers between the tandem pairs.

The following charts provide how much height difference there needs to be between the inner and outer spacers to change the preload. This is the actual value for the spacers to adjust the bearing sets. These values only work for changing from a standard GMN preload to another standard GMN preload. It also only works for changing existing preload. So, it does not apply when using unground or custom preload bearings.

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GMN BEARING USA

Preload Change - S618xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 61800 C	8	5	25	5	50
S 61801 C	9	4	25	5	55
S 61802 C	10	5	30	5	60
S 61803 C	10	4	30	5	60
S 61804 C	19	6	55	6	110
S 61805 C	19	5	55	6	110
S 61806 C	20	5	60	5	120
S 61807 C	20	5	60	5	120
S 61808 C	21	5	60	5	120
S 61809 C	21	5	65	5	130
S 61810 C	30	6	90	6	180
S 61811 C	45	7	140	6	250
S 61812 C	45	7	140	8	300
S 61813 C	65	8	190	9	400
S 61814 C	65	7	190	8	400

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 61800 E	13	3	40	4	80
S 61801 E	15	3	45	4	90
S 61802 E	15	3	45	3	90
S 61803 E	16	3	50	3	100
S 61804 E	30	4	90	4	170
S 61805 E	30	4	90	4	170
S 61806 E	30	3	90	4	180
S 61807 E	30	3	90	4	190
S 61808 E	30	4	100	3	190
S 61809 E	35	3	100	3	200
S 61810 E	45	4	140	5	300
S 61811 E	70	5	210	5	400
S 61812 E	75	5	220	5	450
S 61813 E	100	5	300	6	600
S 61814 E	100	5	300	6	600

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Preload Change - (HY)S619xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 619/5 C	6	5	18	5	36
S 619/6 C	7	5	20	5	40
S 619/7 C	8	5	23	5	46
S 619/8 C	12	6	30	6	70
S 619/9 C	12	7	35	5	75
S 61900 C	12	7	40	5	75
S 61901 C	15	6	40	6	85
S 61902 C	22	8	43	8	140
S 61903 C	25	8	70	8	150
S 61904 C	35	9	75	8	220
S 61905 C	40	9	110	9	240
S 61906 C	40	8	120	8	240
S 61907 C	55	9	165	9	330
S 61908 C	75	11	230	11	460
S 61909 C	80	9	230	10	460
S 61910 C	80	9	230	10	460
S 61911 C	90	11	280	11	560
S 61912 C	100	11	300	11	600
S 61913 C	100	10	300	10	600
S 61914 C	130	11	370	11	740
S 61915 C	150	12	450	12	900
S 61916 C	180	13	540	13	1090
S 61917 C	200	14	610	14	1220
S 61918 C	210	14	620	14	1240
S 61919 C	210	14	630	14	1250
S 61920 C	260	16	790	16	1570
S 61921 C	270	16	800	16	1610
S 61922 C	270	16	820	16	1640
S 61924 C	340	18	1030	18	2060

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 61900 E	22	5	70	5	140
S 61901 E	25	4	75	5	150
S 61902 E	35	5	110	6	220
S 61903 E	40	5	120	6	240
S 61904 E	55	6	170	6	340
S 61905 E	60	5	180	6	360
S 61906 E	60	6	190	6	380
S 61907 E	90	6	260	7	520
S 61908 E	120	7	360	7	720
S 61909 E	120	7	360	7	720
S 61910 E	120	7	370	7	740
S 61911 E	150	7	440	8	880
S 61912 E	150	7	460	8	920
S 61913 E	160	7	470	8	940
S 61914 E	200	8	590	8	1180
S 61915 E	230	8	700	9	1400
S 61916 E	280	9	850	10	1710
S 61917 E	320	10	960	10	1910
S 61918 E	330	9	980	10	1960
S 61919 E	330	9	990	10	1990
S 61920 E	410	11	1240	12	2470
S 61921 E	420	11	1260	12	2520
S 61922 E	420	10	1270	11	2550
S 61924 E	540	12	1620	13	3240

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Preload Change - (HY)S619xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY S 619/5 C	6	5	18	5	36
HY S 619/6 C	7	5	20	5	40
HY S 619/7 C	8	4	23	5	46
HY S 619/8 C	12	5	35	6	70
HY S 619/9 C	12	6	40	5	75
HY S 61900 C	12	6	40	5	75
HY S 61901 C	15	5	43	5	85
HY S 61902 C	22	7	70	7	140
HY S 61903 C	25	7	75	7	150
HY S 61904 C	35	8	110	8	220
HY S 61905 C	40	8	120	8	240
HY S 61906 C	40	7	120	7	240
HY S 61907 C	55	8	165	8	330
HY S 61908 C	75	10	230	10	460
HY S 61909 C	80	9	230	9	460
HY S 61910 C	80	9	230	9	460
HY S 61911 C	90	10	280	10	560
HY S 61912 C	100	10	300	10	600
HY S 61913 C	100	9	300	10	600
HY S 61914 C	130	10	370	10	740
HY S 61915 C	150	11	450	11	900
HY S 61916 C	180	12	540	12	1090
HY S 61917 C	200	13	610	13	1220
HY S 61918 C	210	12	620	13	1240
HY S 61919 C	210	13	630	13	1250
HY S 61920 C	260	15	790	15	1570
HY S 61921 C	270	14	800	15	1610
HY S 61922 C	270	14	820	15	1640
HY S 61924 C	340	16	1030	16	2060

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY S 61900 E	22	4	70	4	140
HY S 61901 E	25	4	75	4	150
HY S 61902 E	35	5	110	5	220
HY S 61903 E	40	5	120	5	240
HY S 61904 E	55	5	170	6	340
HY S 61905 E	60	5	180	5	360
HY S 61906 E	60	5	190	5	380
HY S 61907 E	90	5	260	6	520
HY S 61908 E	120	7	360	7	720
HY S 61909 E	120	6	360	6	720
HY S 61910 E	120	6	370	6	740
HY S 61911 E	150	6	440	7	880
HY S 61912 E	150	6	460	7	920
HY S 61913 E	160	6	470	7	940
HY S 61914 E	200	7	590	8	1180
HY S 61915 E	230	7	700	8	1400
HY S 61916 E	280	8	850	9	1710
HY S 61917 E	320	9	960	9	1910
HY S 61918 E	330	9	980	9	1960
HY S 61919 E	330	8	990	9	1990
HY S 61920 E	410	10	1240	10	2470
HY S 61921 E	420	10	1260	10	2520
HY S 61922 E	420	10	1270	10	2550
HY S 61924 E	540	11	1620	12	3240

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Preload Change - (HY)S60xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 605 C	7	5	20	5	40
S 606 C	8	5	25	4	45
S 607 C	12	7	40	7	80
S 608 C	17	8	50	9	100
S 609 C	20	8	60	8	120
S 6000 C	25	9	80	9	160
S 6001 C	30	9	90	9	180
S 6002 C	32	9	100	9	200
S 6003 C	35	9	105	9	210
S 6004 C	60	11	180	11	360
S 6005 C	70	10	200	10	400
S 6006 C	85	11	250	12	500
S 6007 C	100	12	300	12	600
S 6008 C	110	12	360	12	660
S 6009 C	130	13	400	13	800
S 6010 C	140	13	420	13	840
S 61011 C	160	14	490	14	980
S 6012 C	170	14	515	14	1030
S 6013 C	175	13	525	14	1050
S 6014 C	240	16	700	17	1400
S 6015 C	250	18	760	18	1510
S 6016 C	310	19	920	19	1830
S 6017 C	310	19	940	19	1880
S 6018 C	380	21	1140	21	2280
S 6019 C	390	21	1180	21	2350
S 6020 C	400	20	1190	21	2390
S 6021 C	440	21	1310	22	2630
S 6022 C	500	24	1510	24	3030
S 6024 C	530	23	1590	23	3180

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 6000 E	45	6	130	7	260
S 6001 E	50	6	140	6	280
S 6002 E	55	6	160	7	320
S 6003 E	60	6	170	7	340
S 6004 E	100	8	300	8	600
S 6005 E	110	7	320	8	640
S 6006 E	130	8	400	9	800
S 6007 E	170	9	500	9	1000
S 6008 E	180	8	530	10	1100
S 6009 E	210	9	650	10	1300
S 6010 E	220	9	670	9	1330
S 6011 E	260	10	770	10	1540
S 6012 E	270	9	810	10	1620
S 6013 E	275	9	825	10	1650
S 6014 E	400	12	1200	13	2400
S 6015 E	400	12	1200	13	2400
S 6016 E	490	14	1480	14	2960
S 6017 E	510	13	1520	14	3030
S 6018 E	600	15	1800	16	3590
S 6019 E	610	15	1830	16	3670
S 6020 E	630	15	1890	16	3770
S 6021 E	690	15	2060	16	4130
S 6022 E	800	16	2400	17	4790
S 6024 E	830	16	2500	17	4990

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Preload Change - (HY)S60xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY S 605 C	7	4	20	5	40
HY S 606 C	8	5	25	4	45
HY S 607 C	12	6	40	6	80
HY S 608 C	17	7	50	8	100
HY S 609 C	20	7	60	7	120
HY S 6000 C	25	8	80	8	160
HY S 6001 C	30	9	90	9	180
HY S 6002 C	32	9	100	9	200
HY S 6003 C	35	8	105	8	210
HY S 6004 C	60	10	180	10	360
HY S 6005 C	70	10	200	10	400
HY S 6006 C	85	11	250	11	500
HY S 6007 C	100	11	300	11	600
HY S 6008 C	110	12	360	10	660
HY S 6009 C	130	12	400	12	800
HY S 6010 C	140	12	420	12	840
HY S 6011 C	160	13	490	13	980
HY S 6012 C	170	12	515	13	1030
HY S 6013 C	175	12	525	12	1050
HY S 6014 C	240	15	700	15	1400
HY S 6015 C	250	16	760	16	1510
HY S 6016 C	310	17	920	18	1830
HY S 6017 C	310	17	940	17	1880
HY S 6018 C	380	19	1140	19	2280
HY S 6019 C	390	19	1180	19	2350
HY S 6020 C	400	18	1190	19	2390
HY S 6021 C	440	19	1310	20	2630
HY S 6022 C	500	21	1510	21	3030
HY S 6024 C	530	21	1590	21	3180

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY S 6000 E	45	5	130	6	260
HY S 6001 E	50	5	140	6	280
HY S 6002 E	55	5	160	6	320
HY S 6003 E	60	5	170	6	340
HY S 6004 E	100	8	300	8	600
HY S 6005 E	110	6	320	7	640
HY S 6006 E	130	7	400	8	800
HY S 6007 E	170	8	500	9	1000
HY S 6008 E	180	7	530	9	1100
HY S 6009 E	210	9	650	9	1300
HY S 6010 E	220	8	670	9	1330
HY S 6011 E	260	9	770	9	1540
HY S 6012 E	270	8	810	9	1620
HY S 6013 E	275	8	825	9	1650
HY S 6014 E	400	11	1200	11	2400
HY S 6015 E	400	11	1200	12	2400
HY S 6016 E	490	12	1480	13	2960
HY S 6017 E	510	12	1520	13	3030
HY S 6018 E	600	13	1800	14	3590
HY S 6019 E	610	13	1830	14	3670
HY S 6020 E	630	14	1890	15	3770
HY S 6021 E	690	13	2060	14	4130
HY S 6022 E	800	14	2400	15	4790
HY S 6024 E	830	14	2500	15	4990

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Preload Change - (HY)S62xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
S 625 C	10	7	30	7	60
S 626 C	15	7	40	8	80
S 627 C	20	7	50	9	100
S 629 C	30	8	80	9	160
S 6200 C	40	10	120	10	230
S 6201 C	42	11	130	11	250
S 6202 C	45	10	130	12	270
S 6203 C	60	11	170	12	350
S 6204 C	85	13	260	12	500
S 6205 C	100	14	300	14	600
S 6206 C	130	15	380	15	760
S 6207 C	180	17	530	16	1000
S 6208 C	185	19	560	18	1100
S 6209 C	230	22	700	21	1400
S 6210 C	240	22	720	22	1440
S 6211 C	300	22	900	21	1800
S 6212 C	350	22	1000	24	2100
S 6213 C	370	23	1110	23	2220
S 6200 E	60	7	180	8	360
S 6201 E	70	7	200	8	400
S 6202 E	75	7	220	8	440
S 6203 E	90	9	280	9	560
S 6204 E	140	9	410	10	820
S 6205 E	150	9	450	10	900
S 6206 E	200	11	600	12	1200
S 6207 E	280	12	840	13	1700
S 6208 E	300	13	900	14	1800
S 6209 E	370	14	1100	15	2200
S 6210 E	380	14	1140	14	2280
S 6211 E	470	15	1400	16	2800
S 6212 E	560	17	1700	18	3400
S 6213 E	590	16	1760	17	3520

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY S 625 C	10	6	30	6	60
HY S 626 C	15	7	40	7	80
HY S 627 C	20	7	50	8	100
HY S 629 C	30	7	80	8	160
HY S 6200 C	40	9	120	9	230
HY S 6201 C	42	10	130	9	250
HY S 6202 C	45	9	130	10	270
HY S 6203 C	60	10	170	11	350
HY S 6204 C	85	12	260	11	500
HY S 6205 C	100	13	300	13	600
HY S 6206 C	130	14	380	14	760
HY S 6207 C	180	16	530	14	1000
HY S 6208 C	185	18	560	17	1100
HY S 6209 C	230	20	700	20	1400
HY S 6210 C	240	20	720	20	1440
HY S 6211 C	300	20	900	20	1800
HY S 6212 C	350	20	1000	22	2100
HY S 6213 C	370	21	1110	21	2220
HY S 6200 E	60	6	180	7	360
HY S 6201 E	70	7	200	7	400
HY S 6202 E	75	7	220	7	440
HY S 6203 E	9	8	280	8	560
HY S 6204 E	140	8	410	9	820
HY S 6205 E	150	8	450	9	900
HY S 6206 E	200	10	600	10	1200
HY S 6207 E	280	11	840	12	1700
HY S 6208 E	300	12	900	13	1800
HY S 6209 E	370	14	1100	14	2200
HY S 6210 E	380	12	1140	13	2280
HY S 6211 E	470	13	1400	14	2800
HY S 6212 E	560	15	1700	16	3400
HY S 6213 E	590	14	1760	16	3520

Preload Change - (HY)SM60xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
SM 605 C	5	5	14	5	28
SM 606 C	6	5	18	4	32
SM 607 C	10	6	30	7	60
SM 608 C	13	8	40	8	80
SM 609 C	16	8	50	9	100
SM 6000 C	18	9	60	8	110
SM 6001 C	22	9	65	9	130
SM 6002 C	22	9	75	9	150
SM 6003 C	25	9	80	9	160
SM 6004 C	40	11	120	11	240
SM 6005 C	50	10	140	10	280
SM 6006 C	60	11	180	12	360
SM 6007 C	70	12	21	13	420
SM 6008 C	80	13	230	14	460
SM 6009 C	90	13	275	14	550
SM 6010 C	100	13	290	14	580
SM 6011 C	115	14	330	15	700
SM 6012 C	125	14	375	14	750
SM 6013 C	130	13	380	14	760
SM 6014 C	180	15	500	17	1000

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY SM 605 C	5	4	14	5	28
HY SM 606 C	6	5	18	4	32
HY SM 607 C	10	6	30	6	60
HY SM 608 C	13	7	40	8	80
HY SM 609 C	16	8	50	8	100
HY SM 6000 C	18	9	60	7	110
HY SM 6001 C	22	8	65	8	130
HY SM 6002 C	22	8	75	8	150
HY SM 6003 C	25	8	80	8	160
HY SM 6004 C	40	10	120	10	240
HY SM 6005 C	50	10	140	11	280
HY SM 6006 C	60	10	180	11	360
HY SM 6007 C	70	11	210	12	420
HY SM 6008 C	80	11	230	12	460
HY SM 6009 C	90	12	275	12	550
HY SM 6010 C	100	12	290	12	580
HY SM 6011 C	115	13	330	13	700
HY SM 6012 C	125	12	375	13	750
HY SM 6013 C	130	12	380	13	760
HY SM 6014 C	180	14	500	15	1000

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Preload Change - (HY)KH619xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
KH 61900 C	7	4	21	4	45
KH 61901 C	7	4	22	4	45
KH 61902 C	10	4	30	4	60
KH 61903 C	11	4	35	4	65
KH 61904 C	20	6	60	6	120
KH 61905 C	22	6	65	6	130
KH 61906 C	23	5	70	6	140
KH 61907 C	25	5	80	5	150
KH 61908 C	35	6	100	7	210
KH 61909 C	35	6	110	6	220
KH 61910 C	40	5	110	6	230
KH 61911 C	50	7	150	7	300
KH 61912 C	50	7	160	7	310
KH 61913 C	55	6	160	7	320
KH 61914 C	65	7	200	7	390
KH 61900 E	11	3	35	3	70
KH 61901 E	12	3	35	3	70
KH 61902 E	16	3	50	4	100
KH 61903 E	17	3	50	3	100
KH 61904 E	30	4	90	5	180
KH 61905 E	35	4	100	5	200
KH 61906 E	35	4	110	4	220
KH 61907 E	40	4	120	4	240
KH 61908 E	55	4	160	5	330
KH 61909 E	60	4	170	5	350
KH 61910 E	60	4	180	5	360
KH 61911 E	80	5	240	5	480
KH 61912 E	80	5	240	5	490
KH 61913 E	80	5	250	5	500
KH 61914 E	100	5	310	6	620

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY KH 61900 C	7	3	21	4	45
HY KH 61901 C	7	3	22	4	45
HY KH 61902 C	10	4	30	4	60
HY KH 61903 C	11	4	35	4	65
HY KH 61904 C	20	5	60	6	120
HY KH 61905 C	22	5	65	5	130
HY KH 61906 C	23	5	70	5	140
HY KH 61907 C	25	5	80	4	150
HY KH 61908 C	35	5	100	6	210
HY KH 61909 C	35	5	110	6	220
HY KH 61910 C	40	5	110	6	230
HY KH 61911 C	50	6	150	6	300
HY KH 61912 C	50	6	160	6	310
HY KH 61913 C	55	5	160	6	320
HY KH 61914 C	65	6	200	7	390
HY KH 61900 E	11	3	35	3	70
HY KH 61901 E	12	3	35	3	70
HY KH 61902 E	16	3	50	3	100
HY KH 61903 E	17	3	50	3	100
HY KH 61904 E	30	4	90	4	180
HY KH 61905 E	35	4	100	4	200
HY KH 61906 E	35	4	110	4	220
HY KH 61907 E	40	3	120	4	240
HY KH 61908 E	55	4	160	5	330
HY KH 61909 E	60	4	170	5	350
HY KH 61910 E	60	4	180	4	360
HY KH 61911 E	80	4	240	5	480
HY KH 61912 E	80	4	240	5	490
HY KH 61913 E	80	4	250	5	500
HY KH 61914 E	100	5	310	5	620

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GMN BEARING USA

Preload Change - (HY)KH60xx

High Precision Ball Bearings

Preload change dimensions for bearing pairs. If a single bearing is to be adjusted, the below measurement must be divided by two.

	O-Arrangement	X-Arrangement
Width of inner spacer smaller than outer spacer	Increase of preload	Decrease of preload
Width of outer spacer smaller than inner spacer	Decrease of preload	Increase of preload

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
KH 6000 C	10	5	30	5	60
KH 6001 C	11	5	35	5	70
KH 6002 C	17	6	50	6	100
KH 6003 C	19	5	55	6	110
KH 6004 C	35	8	100	9	200
KH 6005 C	35	8	110	8	220
KH 6006 C	40	7	120	8	250
KH 6007 C	50	9	160	9	320
KH 6008 C	55	8	160	9	330
KH 6009 C	55	8	160	9	330
KH 6010 C	60	8	180	9	350
KH 6011 C	80	10	250	10	500
KH 6012 C	90	9	260	10	510
KH 6013 C	90	9	260	10	520
KH 6014 C	120	11	360	12	720
KH 6000 E	16	4	50	4	100
KH 6001 E	18	4	55	4	110
KH 6002 E	30	4	80	5	160
KH 6003 E	30	5	90	5	180
KH 6004 E	50	6	160	7	320
KH 6005 E	60	6	180	6	360
KH 6006 E	65	6	200	7	390
KH 6007 E	80	6	250	7	500
KH 6008 E	90	6	260	7	520
KH 6009 E	90	6	260	7	520
KH 6010 E	90	6	280	6	560
KH 6011 E	130	7	400	8	800
KH 6012 E	140	7	400	8	800
KH 6013 E	140	7	410	7	800
KH 6014 E	190	8	570	9	1150

	L [N]	Difference [micron]	M [N]	Difference [micron]	S [N]
HY KH 6000 C	10	5	30	5	60
HY KH 6001 C	11	5	35	5	70
HY KH 6002 C	17	5	50	6	100
HY KH 6003 C	19	6	55	4	110
HY KH 6004 C	35	7	100	8	200
HY KH 6005 C	35	7	110	7	220
HY KH 6006 C	40	7	120	8	250
HY KH 6007 C	50	8	160	8	320
HY KH 6008 C	55	7	160	8	330
HY KH 6009 C	55	7	160	8	330
HY KH 6010 C	60	8	180	8	350
HY KH 6011 C	80	9	250	9	500
HY KH 6012 C	90	8	260	9	510
HY KH 6013 C	90	8	260	9	520
HY KH 6014 C	120	10	360	11	720
HY KH 6000 E	16	4	50	4	100
HY KH 6001 E	18	4	55	4	110
HY KH 6002 E	30	4	80	4	160
HY KH 6003 E	30	4	90	4	180
HY KH 6004 E	50	6	160	6	320
HY KH 6005 E	60	5	180	6	360
HY KH 6006 E	65	6	200	6	390
HY KH 6007 E	80	6	250	6	500
HY KH 6008 E	90	5	260	6	520
HY KH 6009 E	90	5	260	6	520
HY KH 6010 E	90	5	280	6	560
HY KH 6011 E	130	7	400	7	800
HY KH 6012 E	140	6	400	7	800
HY KH 6013 E	140	6	410	7	800
HY KH 6014 E	190	7	570	8	1150

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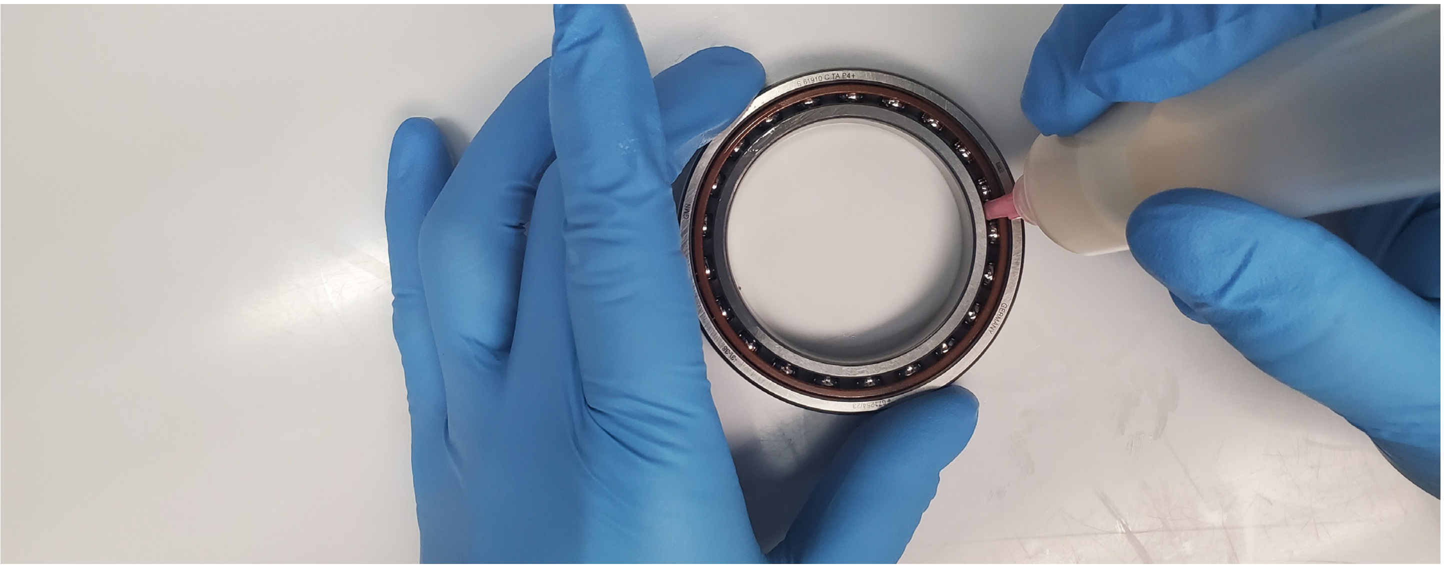
Greasing a Bearing: Things to Consider



All GMN bearings require lubrication for proper function. If there is no lubrication, the bearings will overheat, and failure will occur rapidly. There are several methods of bearing lubrication, but the two most common types are oil or grease (with grease being the most common).

With precision angular contact or radial bearings, adding grease is not as simple as filling the bearing with as much as possible. There is a lot that goes into proper grease application and filling. For this reason, we recommend that we grease the bearings in our clean room facility with our precise measuring equipment. We do not charge to grease bearings with standard greases.

5 FACTORS

1. GREASE TYPE
Precision angular contact and radial bearings are typically used in high-speed applications. But not all greases are capable of operating at the required bearing RPM. It's important to check the grease speed rating against the application RPMs. Grease speed ratings use the n.dm value instead of the RPM. The n.dm value is the speed multiplied by the pitch circle diameter of the bearing. That's the diameter to the center of the ball. If the grease n.dm rating is lower than the calculated n.dm rating for the application, the grease will not properly maintain lubrication and the bearing will overheat.

GMN standard greases are LUBCON® Turmogrease L 252, and Klüber ISOFLEX NBU 15.

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2. GREASE AMOUNT & DENSITY

The amount of grease applied to the bearing can also have a large impact on the function. If there is too little grease, there isn't enough to properly coat the balls and raceways, which will result in metal-to-metal contact and bearing failure.

However, if there is too much grease in a high-speed application, then the bearings will overheat because the balls are having to push too much grease out of the way. We recommend that bearings have 25% of their free space filled with grease.

GMN establishes the proper fill percentage by weighing the bearings dry, and then adding the equivalent grease weight for 25% fill. The tables on the following pages provide the weights for a class I grease density. Modifiers are also provided for different densities.

Bearing type	20%	25%	30%	35%	40%	100%
S 605	29	36	43	50	58	144
S 606	42	52	63	73	84	210
S 607	70	88	106	123	141	352
S 608	110	138	165	193	220	550
S 609	125	156	188	219	250	625
S 6000	172	215	258	301	344	859
S 6001	190	238	285	333	380	950
S 6002	263	329	395	461	526	1316
S 6003	353	441	529	617	706	1764
S 6004	624	781	937	1093	1249	3122
S 6005	695	869	1043	1217	1391	3477
S 6006	991	1239	1487	1735	1982	4956
S 6007	1410	1762	2115	2467	2820	7049
S 6008	1664	2080	2496	2913	3329	8321
S 6009	2158	2698	3237	3777	4316	10791
S 6010	2340	2925	3510	4096	4681	11702
S 6011	3101	3877	4652	5427	6203	15506
S 6012	3265	4081	4897	5713	6529	16323
S 6013	3517	4396	5275	6154	7033	17583
S 6014	5113	6391	7670	8948	10226	25565
S 6015	5422	6778	8133	9489	10844	27111
S 6016	7220	9024	10829	12634	14439	36098
S 6017	7571	9463	11356	13249	15141	37853
S 6018	9725	12156	14587	17018	19449	48623
S 6019	10167	12708	15250	17792	20333	50833
S 6020	10556	13195	15834	18473	21112	52781
S 6021	12942	16178	19413	22649	25884	64710
S 6022	15932	19915	23898	27881	31864	79660
S 6024	16928	21160	25392	29624	33856	84641

Bearing type	20%	25%	30%	35%	40%	100%
KH 6000	94	118	141	165	188	471
KH 6001	139	174	208	243	278	694
KH 6002	181	227	272	317	363	907
KH 6003	240	300	360	420	480	1201
KH 6004	470	587	704	822	939	2348
KH 6005	557	697	836	976	1115	2787
KH 6006	721	902	1082	1263	1443	3607
KH 6007	1026	1282	1539	1735	2052	5130
KH 6008	1254	1567	1880	2194	2507	6268
KH 6009	1615	2019	2422	2826	3230	8074
KH 6010	1704	2131	2557	2983	3409	8522
KH 6011	2441	3052	3662	4272	4883	12207
KH 6012	2607	3259	3911	4563	5215	13037
KH 6013	2775	3469	4163	4857	5551	13877
KH 6014	3985	4982	5978	6974	7971	19926

Bearing type	20%	25%	30%	35%	40%	100%
S 625	43	53	64	75	85	214
S 626	70	88	106	123	141	352
S 627	110	138	165	193	220	550
S 629	172	215	258	301	344	859
S 6200	243	303	364	424	485	1213
S 6201	316	395	475	554	633	1582
S 6202	447	558	670	781	893	2233
S 6203	591	739	887	1035	1182	2956
S 6204	946	1182	1419	1655	1891	4729
S 6205	1224	1530	1836	2142	2448	6121
S 6206	1683	2104	2525	2946	3367	8417
S 6207	2261	2826	3391	3956	4521	11303
S 6208	2975	3719	4462	5206	5950	14875
S 6209	3600	4500	5400	6300	7199	17999
S 6210	4275	5344	6413	7482	8550	21376
S 6211	5263	6579	7895	9210	10526	26316
S 6212	6615	8269	9923	11577	13230	33076
S 6213	7755	9693	11632	13571	15510	38774

Values in tables in milligrams (mg).
1 gram (g) = 0.035 oz

Correction factor for grease density class other than density class I (ς = 0.905 g/cm³)

Density class	Grease density [g/cm³]	Correction factor
0	0.820 - 0.879	0.94
I	0.880 - 0.930	1.00
II	0.931 - 0.990	1.06
III	0.991 - 1.090	1.15
IV	1.091 - 1.190	1.26
V	1.191 - 1.300	1.37
V/1	1.301 - 1.410	1.50
V/2	1.411 - 1.520	1.62
V/3	1.521 - 1.640	1.74
V/4	1.641 - 1.772	1.88
VI	1.831 - 1.970	2.08

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Bearing type	20%	25%	30%	35%	40%	100%
S 605	29	36	43	50	58	144
S 606	42	52	63	73	84	210
S 607	70	88	106	123	141	352
S 608	110	138	165	193	220	550
S 609	125	156	188	219	250	625
S 6000	172	215	258	301	344	859
S 6001	190	238	285	333	380	950
S 6002	263	329	395	461	526	1316
S 6003	353	441	529	617	706	1764
S 6004	624	781	937	1093	1249	3122
S 6005	695	869	1043	1217	1391	3477
S 6006	991	1239	1487	1735	1982	4956
S 6007	1410	1762	2115	2467	2820	7049
S 6008	1664	2080	2496	2913	3329	8321
S 6009	2158	2698	3237	3777	4316	10791
S 6010	2340	2925	3510	4096	4681	11702
S 6011	3101	3877	4652	5427	6203	15506
S 6012	3265	4081	4897	5713	6529	16323
S 6013	3517	4396	5275	6154	7033	17583
S 6014	5113	6391	7670	8948	10226	25565
S 6015	5422	6778	8133	9489	10844	27111
S 6016	7220	9024	10829	12634	14439	36098
S 6017	7571	9463	11356	13249	15141	37853
S 6018	9725	12156	14587	17018	19449	48623
S 6019	10167	12708	15250	17792	20333	50833
S 6020	10556	13195	15834	18473	21112	52781
S 6021	12942	16178	19413	22649	25884	64710
S 6022	15932	19915	23898	27881	31864	79660
S 6024	16928	21160	25392	29624	33856	84641

Bearing type	20%	25%	30%	35%	40%	100%
S 625	43	53	64	75	85	214
S 626	70	88	106	123	141	352
S 627	110	138	165	193	220	550
S 629	172	215	258	301	344	859
S 6200	243	303	364	424	485	1213
S 6201	316	395	475	554	633	1582
S 6202	447	558	670	781	893	2233
S 6203	591	739	887	1035	1182	2956
S 6204	946	1182	1419	1655	1891	4729
S 6205	1224	1530	1836	2142	2448	6121
S 6206	1683	2104	2525	2946	3367	8417
S 6207	2261	2826	3391	3956	4521	11303
S 6208	2975	3719	4462	5206	5950	14875
S 6209	3600	4500	5400	6300	7199	17999
S 6210	4275	5344	6413	7482	8550	21376
S 6211	5263	6579	7895	9210	10526	26316
S 6212	6615	8269	9923	11577	13230	33076
S 6213	7755	9693	11632	13571	15510	38774

Values in tables in milligrams (mg).
1 gram (g) = 0.035 oz

Bearing type	20%	25%	30%	35%	40%	100%
KH 6000	94	118	141	165	188	471
KH 6001	139	174	208	243	278	694
KH 6002	181	227	272	317	363	907
KH 6003	240	300	360	420	480	1201
KH 6004	470	587	704	822	939	2348
KH 6005	557	697	836	976	1115	2787
KH 6006	721	902	1082	1263	1443	3607
KH 6007	1026	1282	1539	1735	2052	5130
KH 6008	1254	1567	1880	2194	2507	6268
KH 6009	1615	2019	2422	2826	3230	8074
KH 6010	1704	2131	2557	2983	3409	8522
KH 6011	2441	3052	3662	4272	4883	12207
KH 6012	2607	3259	3911	4563	5215	13037
KH 6013	2775	3469	4163	4857	5551	13877
KH 6014	3985	4982	5978	6974	7971	19926

Correction factor for grease density class other than density class I ($\varsigma = 0.905\ g/cm^3$)

Density class	Grease density [g/cm^3]	Correction factor
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V/4	1.641 - 1.772	1.88
VI	1.831 - 1.970	2.08

3. GREASE APPLICATION PROCESS

If the grease is not applied in an optimal manner, then it could also fail to properly lubricate the bearing. Grease should be applied on the inner race, inside the raceway between every ball. As the bearing rotates, the balls will carry the grease to the outer race and cage, lubricating all needed surfaces. We use a syringe with a plastic tip attached to a metering device that injects the precise amount of grease needed to get the proper fill percentage directly on the inner race.

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4. GREASE & BEARING CLEANLINESS

Absolute cleanliness must be maintained when greasing bearings as well. Even small contamination can be the difference between bearing success and rapid failure. Care must be taken to keep the bearing free from impurities when applying grease and installing the bearing. This includes using gloves to handle the bearings and not leaving them out uncovered. They should remain in their bags up until it is time for the grease to be applied and then have the bearings installed.

The environment of the facility needs to also be as clean and free from airborne contaminants as well. Additionally, the grease should be protected from pollution, including keeping the grease covered whenever not being used.

At our distribution headquarters, we use a clean room with a class 100 hood when lubricating parts to ensure the utmost cleanliness.

5. GREASE AGE

Grease has a shelf life. For most greases, it's three years. After that, the grease starts to break down and the oil separates from the thickener. Care needs to be taken to ensure that the grease has sufficient life remaining before applying it to the bearings.

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Bearing Break-in Procedure

When new bearings are installed, they need to be properly "broken in," whether they have grease or oil lubrication. Even though the precision manufacturing produces very smooth raceways, there is still microscopic surface roughness that gets smoothed out as the balls run over the raceways for the first time. This can generate heat that needs to be dissipated. Additionally, for greased bearings, it's important to ensure that the grease gets properly seated to adequately lubricate the bearings during the application usages.

The following precision bearing break-in procedure can be used as an example or starting point for a customized break-in procedure. Two important aspects are:

- Starting out at a much lower RPM than the application RPM
- Waiting for the temperature to homogenize before increasing the RPM

There are two overarching steps for the break-in procedure:

1. SHORT INTERVALS

The spindle should be brought up to speed in short intervals whereas the interval speed ranges from a portion to full nominal speed. The respective speed must be achieved within 20 seconds and should be held for approximately 1 minute. The complete cycle should be set up similar to:

1. 5 cycles of 1 minute each at 33% of max RPM
2. 5 cycles of 1 minute each at 66% of max RPM
3. 5 cycles of 1 minute each at 100% of max RPM

(**NOTE**: All cycles should have a 2-minute rest period between the short runs.)

2. CONTINUOUS RUNNING

For the continuous running cycle, the spindle should be operated at nominal or max nominal speed for about 30 minutes. No external loads should be applied to the spindle during this time.

1. 2 cycles of 30 minutes each at nominal or max nominal operating speed
2. 5 minutes rest period in between and after the cycles

IMPORTANT FACTORS FOR CONSIDERATION FOR BEARING BREAK-IN

TEMPERATURE

At any time during the run in, the procedure should be stopped if the spindle rises above 140 °F (~60 °C). The location of the temperature sensor must be considered. A temperature sensor on the housing of the spindle will read much cooler than what the bearings are actually running. Please consult product documentation for temperature limits or consult GMN Bearing USA for technical engineering support.

EXCESSIVE NOISE OR VIBRATION

At any time during the run in, the procedure should be stopped due to excessive noise or vibration. This characteristic is relative per a specific application but is a direct value for bearing performance. If your specific parameters are unclear, please consult GMN Bearing USA for technical engineering support.

GREASE FILL

The viscosity and volume of grease fill will influence the break-in procedure, specifically the time at each step. Ensure that spindle temperatures homogenize before moving to higher RPMs. This will be directly related to max temperatures during the break in.

Technical Expertise

GMN Bearing USA understands that our products are often the critical component to the success of our customers' applications. For this reason, we have Mechanical Engineers on site ready and eager to support in whatever capacity you need. It can be something as simple as a question about orientation or installation, or it can be as involved as designing a new application or running performance calculations.

For a more detailed explanation of GMN's engineering support capabilities, check out our Bearing Engineering Support Toolkit.

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