GMN
BEARING USA

Bearing Engineering Support Toolkit

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Toolkit Overview

This toolkit was created by mechanical engineers on the customer support frontlines at GMN Bearing USA.

BEARING SUPPORT FOR ENGINEERS FROM ENGINEERS

Bearings play a critical role in the operation of an application, so it's no surprise that some of our most frequent engineering support conversations are centered around precision bearings.

We understand that learning about bearing nuances and calculations 'on-the-go' can get overwhelming, **which is why we've created this toolkit — to showcase our unique abilities and support we offer engineers.**

Our company was built on providing free engineering assistance and service. Being able to use our advanced knowledge to help others excites us.

THE GOAL OF THIS TOOLKIT

The Bearing Engineering Support Toolkit is **not** a definitive list of all our engineering capabilities. This toolkit shows a small sample of the type of bearing support we commonly provide.

This packet is not intended to be a 'plug-and-play' guide, but instead give you a general understanding of our engineering effectiveness and how we can support your bearing needs.

Our hope is the next time you need bearing help and support, you will remember us "the bearing engineers" at GMN Bearing USA and save yourself hours of time trying to figure it out yourself.

If you have questions, you can reach us at 800-232-5725. Or you can complete our **contact form**, and we'll get back to you right away.

We help engineers increase productivity and efficiency by:

1. Performing bearing calculations
2. Analyzing bearing performance to prevent or detect failures
3. Finding the right, best performing precision bearing for the specific application

GMN QUICK STATS

- GMN was established in 1908
- All GMN products are manufactured in Nuremberg, Germany
- GMN Bearing USA is the only authorized GMN partner in the USA
- We specialize in challenging projects in the field of high-precision and high-speed applications

Shaft & Housing Tolerance Calculators

DECREASE THE RISK OF FAILURES & MALFUNCTIONS

Reduce your chances of a premature bearing failure or machine malfunction by using our quick-and-easy proprietary tolerancing calculators:

- **Automatic Tolerance Calculator:** Ensures your shaft and housing is (or will be) machined within the recommended tolerances.
- **Thermal Range Calculator:** Calculates the thermal expansion of shaft and housing material caused by operating temperatures to find the right shaft and housing tolerances for the application.

Use our automatic calculators to shave hours off your design process by eliminating the cumbersome task of manual calculations.

IMPORTANCE OF TOLERANCING

Machined parts and components all have tolerance standards when manufactured. This standard produces a consistent, uniform product.

Bearings have a tolerance on the inner diameter (ID) and the outer diameter (OD), and machined shaft and housings also have tolerance standards. All these tolerances adjust with the temperature.

During operation, temperatures rise causing the bearings, shaft and housing to expand. Being prepared for these changes, when machining a shaft and housing, will ensure that you are choosing the correct bearing and fit for your application. Using our automatic thermal range calculator eliminates the need for manual calculation.

Typical shaft and housing tolerance ranges are around 10µm but establishing the correct tolerances for the shaft and housing is important for achieving optimal performance in your application.

RESULTANT FITS

Finding the right shaft OD to match the ID of the bearing and the correct housing ID to match the OD of the bearing, produces the **resultant fit**.

In rotating shaft applications, we recommend achieving a **press fit** between the shaft and the ID of the bearing and a **slip fit** between the housing and the OD of the bearing, when the application is running.

Using our thermal range calculator, you can manipulate the shaft and housing tolerances to automatically find the best tolerances for the resultant fit.

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WHY TOLERANCING & RESULTANT FITS ARE IMPORTANT

On applications where the shaft is rotating, using a press fit will prevent inner ring rotation, relative to the shaft, that could result in micro-fretting and premature bearing failure.

For high-speed applications, centrifugal force could cause the inner ring to expand and lift off the shaft. This may result in drastic machine malfunctions and a decrease in the life of the bearing. Increasing the press fit would help counteract this scenario.

SLIP FIT

We recommend using a slip fit on the housing so bearings can move axially for spring preloads or to absorb thermal growth.

However, if the slip fit is too large then micro-fretting between the bearing OD and the housing could occur. In extreme cases the bearing orbiting a geometric center could also result.

Web-Based Tolerance Analysis Calculators

Use our free web-based automatic tolerance calculators to get the tolerance analysis you need for a machined shaft and housing.

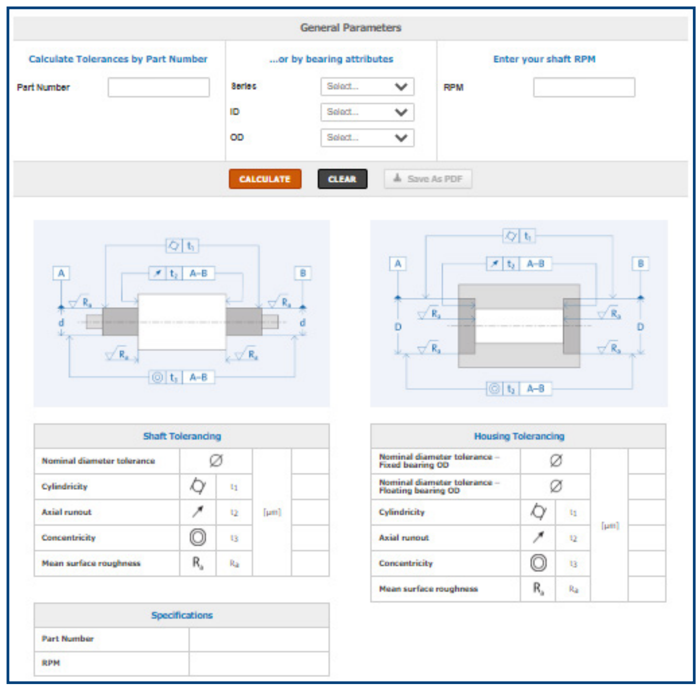
START CALCULATING IMMEDIATELY

Here is the information you'll need for each tolerance calculator:

One: Automatic Tolerance Calculator

Data to enter:

- Your GMN part number or the ID and OD dimensions
- The RPM of your shaft



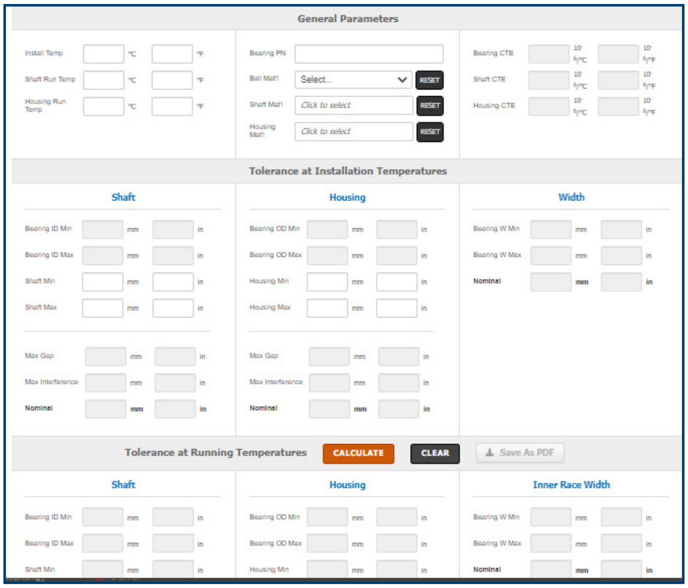
TWO: THERMAL RANGE CALCULATOR

Here is the information you'll need for each tolerance calculator:

One: Automatic Tolerance Calculator

Data to enter:

- Installation Temperature
- Shaft Run Temperature
- Housing Run Temperature
- Bearing Part Number
- Bearing Ball Material (Select either 52100 Bearing Steel or Silicon Nitride)
- Shaft Material*
- Housing Material*
- Bearing CTE (Coefficient of Thermal Expansion)**
- Shaft CTE (Coefficient of Thermal Expansion)**
- Housing CTE (Coefficient of Thermal Expansion)**
- Bearing ID Min and Max (mm or in)***
- Bearing OD Min and Max (mm or in)***



- Initial Shaft Min and Max (mm or in)
- Initial Housing Min and Max (mm or in)

**Standard selection options are provided in the dropdown*
***Tool will auto-populate these values when standard materials are selected for ball, shaft and housing material.*
****Tool will auto-populate these values using ISO 492 (ABEC 7 / P4) standard tolerances.*

THERMAL RANGE CALCULATIONS: WHAT DO THEY MEAN?

Once you hit "calculate" you'll immediately see the resultant fits for the shaft and housing. You can play with these values to achieve the desired resultant fits that you need for your application.

It's recommended to use a shaft and housing material that has a thermal expansion coefficient as close as possible to the bearing. This will help minimize the changes in the resultant fits from the application's running conditions.

GMN PRECISION BEARING PRODUCTS

Our P4+ precision class of bearings allow for tighter resultant fits for those doing final grinding / lapping just before assembly. We provide the exact bearing inner diameter (ID), outer diameter (OD) and width (W) value deviation from nominal for each specific bearing which will also give you a tighter resultant fit.

Other tolerance recommendations such as shaft and housing concentricity, surface roughness and runout are located on pages 70-72 of the GMN Bearing catalog. Get the catalog at: **http://bit.ly/GMN-catalog**

On the next page we included a sample tolerance analysis performed by one of our engineers. If you'd like a custom bearing performance analysis or tolerance analysis give us a call today at 800.323.5725 for more information.

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Sample Tolerance Analysis

FOR HIGH PRECISION BEARING

Company: ABC Sample Company Name
Contact: Joe Sample Smith
Application: Sample Application

Date: 7/1/20
GMN Engineer: Brice Land
Proposed Tolerance

General Parameters					
Bearing PN:	S6005 CTA P4+ UL		Shaft Mat'l:	8620 Steel (0-100°C)	
Bearing Mat'l:	52100 Bearing Steel		Housing Mat'l:	4140 Steel (0-100°C)	
Install Temp:	21 °C	70 °F	Bearing CTE:	11.9 10^{-6}/°C	6.61 10^{-6}/°F
Shaft Run Temp:	40 °C	104 °F	Shaft CTE:	12.2 10^{-6}/°C	6.78 10^{-6}/°F
Hous. Run Temp:	30 °C	86 °F	Housing CTE:	12.2 10^{-6}/°C	6.78 10^{-6}/°F

Shaft & Housing Tolerance at Installation Temperatures					
Shaft			Housing		
Bearing ID Min:	24.995 mm	0.9841 in	Bearing OD Min:	46.994 mm	1.8502 in
Bearing ID Max:	25.000 mm	0.9843 in	Bearing OD Max:	47.000 mm	1.8504 in
Shaft Min:	25.001 mm	0.9843 in	Housing Min:	47.001 mm	1.8504 in
Shaft Max:	25.011 mm	0.9847 in	Housing Max:	47.011 mm	1.8508 in
Max Gap:	-0.001 mm	0.0000 in	Max Gap:	0.017 mm	0.0007 in
Max Interference:	-0.016 mm	-0.0006 in	Max Interference:	0.001 mm	0.0000 in
Nominal:	**-0.008 mm**	**-0.0003 in**	**Nominal:**	**0.009 mm**	**0.0004 in**

Shaft & Housing Tolerance at Running Temperatures					
Shaft			Housing		
Bearing ID Min:	25.001 mm	0.9843 in	Bearing OD Min:	46.999 mm	1.8504 in
Bearing ID Max:	25.006 mm	0.9845 in	Bearing OD Max:	47.005 mm	1.8506 in
Shaft Min:	25.007 mm	0.9845 in	Housing Min:	47.006 mm	1.8506 in
Shaft Max:	25.017 mm	0.9849 in	Housing Max:	47.016 mm	1.8510 in
Max Gap:	-0.001 mm	0.0000 in	Max Gap:	0.017 mm	0.0007 in
Max Interference:	-0.016 mm	-0.0006 in	Max Interference:	0.001 mm	0.0000 in
Nominal:	**-0.009 mm**	**-0.0003 in**	**Nominal:**	**0.009 mm**	**0.0004 in**

Notes

1. The ID of the Bearing should never float on the shaft. A line fit is an ideal minimum.
2. The OD of the Bearing should have a slight gap during install. This gap will ensure space for heat expansion.
3. The generic suggested nominal install tolerances are a 3 micron press fit on the ID and a 4 micron gap on the OD. This is an "ideal" world and can be expensive/difficult to machine. These values should also be adjusted for bearing size, speed, temperature, and other possible application specifics.
4. A positive resultant number above implies a GAP where a negative number implies INTERFERENCE.

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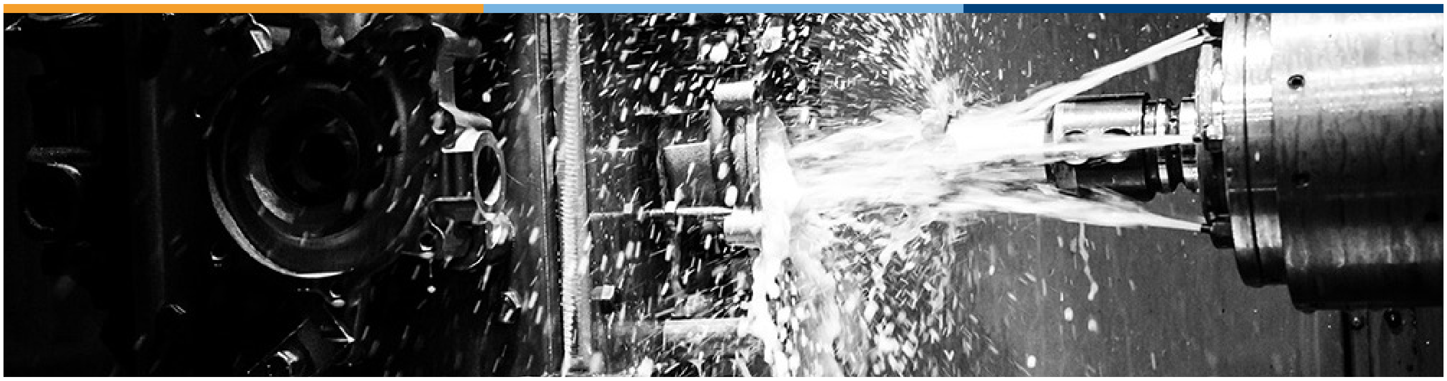
System-Wide Bearing Performance Analysis



One of the most common questions we receive from engineers is "How well will these bearings work in our application?"

Before we can accurately answer, we need to know your key performance indicator (KPI), the metric most important to your application's success.

Here are some common responses:

- Lifespan: How long will the bearings last?
- Speed: How fast can the application rotate?
- Loads: How high can the loads be?
- Rigidity: How rigid can the bearing system become?

Next, we'll run a system-wide bearing performance analysis to determine how well the GMN precision bearings will operate in your application.

BEARING PERFORMANCE

Successful bearing performance is a balancing act.

For example, one of the things we analyze is spin-to-roll ratio. This metric is important to ensure there is enough force to promote good ball action.

If the loads are too light, the balls could skid and generate excessive heat. This is identified in the analysis report if the spin-to-roll ratio exceeds 25%.

Excessive loads and RPMs create large contact pressure between the balls and the races, known as Hertzian contact stress. High Hertzian contact stress can cause fatigue failure and limits the life of the bearing.

These are just a few calculation examples that we perform when we do a bearing performance analysis. All in all, we calculate over 70 different variable metrics in our analysis.

A sample bearing performance analysis is on the next page, along with a glossary list of all the variables in the analysis.

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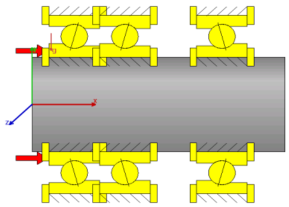
Sample Performance Calculations

View the full size pdf of these calculations



Inputs				
ID Calc.	Shaft Speed (RPM)	Shaft Temp. (°C)	Hous. Temp. (°C)	Shaft F_{1X} (N)
1	15,000	35	25	200
2	15,000	35	25	400
3	15,000	35	25	600
4	15,000	35	25	800
5	15,000	35	25	1,000

Bearing 1: S6005 CTA P4+ UM Lubrication: Lubcon Turmogrease Highspeed L252																									
ID Calc.	F_X (N)	F_Y (N)	St. α (°)	St. α Eff. (°)	OR Dyn. α Max. (°)	OR Dyn. α Min. (°)	IR Dyn. α Max. (°)	IR Dyn. α Min. (°)	OR St. Fit (µm)	OR Dyn. Fit (µm)	IR St. Fit (µm)	IR Dyn. Fit (µm)	L_{10} (h)	L_{nm} (h)	K_{BRV} Max. (%)	P_{OR} Dyn. (N/mm^2)	P_{IR} Dyn. (N/mm^2)	K_PH_{OR} Max. (N/mm^2)	K_PH_{IR} Max. (N/mm^2)	C_{Ax} (N/µm)	$C_{Rad Y}$ (N/µm)	$C_{Rad Z}$ (N/µm)	S_X (µm)	S_Y (µm)	S_Z (µm)
1	277	-1	15.00	11.54	14.21	14.21	16.68	16.67	-4	-3	4	4	46,836	2,341,810	11.73	0.000	5.109	1059.7	1144.4	25.01	168.93	168.93	-4.09	0.00	0.00
2	341	0	15.00	11.69	14.88	14.88	17.02	17.02	-4	-2	4	4	27,090	1,354,480	11.50	0.000	5.276	1120.8	1217.4	28.49	180.74	180.74	-1.71	0.00	0.00
3	410	0	15.00	11.83	15.49	15.49	17.39	17.38	-4	-2	4	5	16,736	836,815	11.38	0.000	5.451	1178.2	1285.2	31.87	191.05	191.06	0.57	0.00	0.00
4	483	0	15.00	11.99	16.06	16.06	17.76	17.76	-4	-2	4	5	10,920	545,980	11.33	0.000	5.630	1232.0	1348.2	35.32	200.22	200.22	2.76	0.00	0.00
5	561	0	15.00	12.14	16.58	16.58	18.13	18.13	-4	-2	4	5	7,455	372,762	11.32	0.000	5.812	1282.7	1407.0	38.76	208.48	208.48	4.85	0.00	0.00

Bearing 2: S6005C TA P4+ UM Lubrication: Lubcon Turmogrease Highspeed L252																									
ID Calc.	F_X (N)	F_Y (N)	St. α (°)	St. α Eff. (°)	OR Dyn. α Max. (°)	OR Dyn. α Min. (°)	IR Dyn. α Max. (°)	IR Dyn. α Min. (°)	OR St. Fit (µm)	OR Dyn. Fit (µm)	IR St. Fit (µm)	IR Dyn. Fit (µm)	L_{10} (h)	L_{nm} (h)	K_{BRV} Max. (%)	P_{OR} Dyn. (N/mm^2)	P_{IR} Dyn. (N/mm^2)	K_PH_{OR} Max. (N/mm^2)	K_PH_{IR} Max. (N/mm^2)	C_{Ax} (N/µm)	$C_{Rad Y}$ (N/µm)	$C_{Rad Z}$ (N/µm)	S_X (µm)	S_Y (µm)	S_Z (µm)
1	313	-1	15.00	11.62	14.60	14.60	16.87	16.87	-4	-3	4	4	33,827	1,691,370	11.59	0.000	5.205	1095.6	1187.4	27.02	175.96	175.96	-2.70	0.00	0.00
2	381	-1	15.00	11.77	15.25	15.25	17.24	17.24	-4	-2	4	4	20,182	1,009,090	11.42	0.000	5.380	1155.6	1258.5	30.57	187.05	187.05	-0.34	0.00	0.00
3	454	-1	15.00	11.93	15.84	15.84	17.62	17.61	-4	-2	4	5	12,790	639,491	11.34	0.000	5.561	1211.9	1324.7	33.99	196.82	196.82	1.93	0.00	0.00
4	532	-1	15.00	12.08	16.40	16.40	17.99	17.99	-4	-2	4	5	8,522	426,115	11.32	0.000	5.746	1264.8	1386.3	37.51	205.58	205.58	4.10	0.00	0.00
5	614	-1	15.00	12.24	16.91	16.91	18.37	18.37	-4	-2	4	5	5,922	296,101	11.34	0.000	5.933	1314.5	1443.8	41.02	213.49	213.49	6.17	0.00	0.00

Bearing 3: S6005C TA P4+ UM Lubrication: Lubcon Turmogrease Highspeed L252																									
ID Calc.	F_X (N)	F_Y (N)	St. α (°)	St. α Eff. (°)	OR Dyn. α Max. (°)	OR Dyn. α Min. (°)	IR Dyn. α Max. (°)	IR Dyn. α Min. (°)	OR St. Fit (µm)	OR Dyn. Fit (µm)	IR St. Fit (µm)	IR Dyn. Fit (µm)	L_{10} (h)	L_{nm} (h)	K_{BRV} Max. (%)	P_{OR} Dyn. (N/mm^2)	P_{IR} Dyn. (N/mm^2)	K_PH_{OR} Max. (N/mm^2)	K_PH_{IR} Max. (N/mm^2)	C_{Ax} (N/µm)	$C_{Rad Y}$ (N/µm)	$C_{Rad Z}$ (N/µm)	S_X (µm)	S_Y (µm)	S_Z (µm)
1	-391	-1	15.00	11.79	15.33	15.33	17.29	17.29	-4	-2	4	5	18,924	946,198	11.41	0.000	5.404	1163.5	1267.9	31.04	188.42	188.42	0.03	-0.01	0.00
2	-322	-1	15.00	11.64	14.69	14.69	16.92	16.92	-4	-3	4	4	31,426	1,571,300	11.56	0.000	5.228	1104.2	1197.6	27.50	177.55	177.55	2.38	-0.01	0.00
3	-264	-1	15.00	11.51	14.05	14.05	16.61	16.60	-4	-3	4	4	53,403	2,670,160	11.80	0.000	5.073	1046.1	1127.9	24.24	166.06	166.06	4.63	-0.01	0.00
4	-215	-1	15.00	11.39	13.40	13.39	16.35	16.34	-4	-3	4	4	92,956	4,647,790	12.16	0.000	4.936	989.6	1059.1	21.24	153.76	153.76	6.79	-0.01	0.00
5	-174	-1	15.00	11.28	12.73	12.72	16.15	16.14	-4	-3	4	4	165,734	8,286,680	12.65	0.000	4.818	934.9	991.2	18.46	140.37	140.37	8.86	-0.01	0.00

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Glossary Terms & Definitions

View the full size pdf of these definitions

SYMBOL	NAME	UNIT	DESCRIPTION
INPUTS			
ID Calc.	Calculation Number	Whole Num.	Added for ease of conversation about results.
Shaft Speed	Speed	RPM	Rotational speed of the bearing, usually the Inner Race.
Shaft Temp.	Shaft and Inner Race Temperature	°C	Application shaft temperature at the bearing inner race. Typically around 10°C hotter than the housing temperature.
Hous. Temp.	Housing and Outer Race Temperature	°C	Application housing temperature at the bearing outer race. Typically around 10°C cooler than the shaft temperature
Shaft $F1_X$	Axial Force	N	Application axial force. Positive is acting to the right.
Shaft $F1_Y$	Radial Force	N	If present, application radial force in the Y direction. Positive is acting upwards.
Shaft $F1_Z$	Radial Force	N	If present, application radial force in the Z direction. Positive is acting out of the page.
Hous. 2 $F1_X$	Spring Preload Force	N	If present, Housing 2 typically represents a spring. A positive force is the spring force acting on the outer race to the right.
BEARING RESULTS			
ID Calc.	Calculation Number	Whole Num.	Added for ease of conversation about results.
F_X	Axial Force	N	Resultant axial force acting on the bearing.
F_Y	Radial Force	N	Resultant radial force in the Y direction acting on the bearing.
F_Z	Radial Force	N	If present, resultant radial force in the Z direction acting on the bearing.
St. α	Static Contact Angle	°	Manufactured contact angle before installation.
St. α Eff.	Effective Static Contact Angle	°	Resultant contact angle factoring in shaft and housing fits, temperatures, and centrifugal forces on the rings from RPM.
OR Dyn. α Max.	Outer Ring Maximum Dynamic Contact Angle	°	Dynamic contact angle factoring in application loads, RPMs, and thermal effects. High speeds will cause the outer ring contact angle to decrease and the inner ring contact angle to increase. The contact angle will also change as the ball goes around the raceway due to non-uniform load distribution from radial loads.
OR Dyn. α Min.	Outer Ring Minimum Dynamic Contact Angle	°	
IR Dyn. α Max.	Inner Ring Maximum Dynamic Contact Angle	°	
IR Dyn. α Min.	Inner Ring Minimum Dynamic Contact Angle	°	
OR St. Fit	Outer Ring Static Housing Fit	µm	Fit between the bearing inner and outer ring to the shaft and housing. The static fit does not factor in application conditions. The dynamic fit reflects the changes due to RPMs and thermal expansion. A positive value indicates a press fit. A negative value indicates a slip fit.
OR Dyn. Fit	Outer Ring Dynamic Housing Fit	µm	
IR St. Fit	Inner Ring Static Shaft Fit	µm	
IR Dyn. Fit	Inner Ring Dynamic Shaft Fit	µm	
L_{10}	L_{10} Life	h	90% reliability estimated bearing life in hours. This is the Bearing Industry standard life comparison value.
L_{nm}	Modified L_{10} Life	h	Adjusts the L10 life to factor in reliability and effects of lubrication and contamination.
K_{BRV} Max.	Spin to Roll Ratio	%	Ball spin is skidding along a raceway while ball roll is correct movement on a raceway. Correct ball action should have a spin to roll ratio of under 25%
P_{OR} Dyn.	Outer Race Dynamic Surface Pressure to Housing	N/mm² (MPa)	A "zero" values indicate that there is no contact pressure between the bearing ring and the shaft or housing during application conditions. High RPMs can cause the inner ring to lift off the shaft.
P_{IR} Dyn.	Inner Race Dynamic Surface Pressure to Shaft	N/mm² (MPa)	
K_pH_{OR} Max.	Outer Race Maximum Ball to Raceway Contact Pressure	N/mm² (MPa)	The contact pressure of the balls to the inner or outer race, called Hertzian pressure. GMN recommends that a bearing with steel balls and steel raceways should not exceed 1500 N/mm². Also, GMN recommends that a bearing with silicon nitride ceramic balls and steel raceways should not exceed 1800 N/mm².
K_pH_{IR} Max.	Inner Race Maximum Ball to Raceway Contact Pressure	N/mm² (MPa)	
C_{ax}	Axial Rigidity	N/µm	Rigidity or stiffness is the force required to move the bearing one micron. Rigidity numbers are not linear, the second micron will take more force to move than the first micron stated in the calculation.
$C_{Rad\,Y}$	Radial Rigidity	N/µm	
$C_{Rad\,Z}$	Radial Rigidity	N/µm	
S_X	Axial Displacement	µm	Movement of the inner ring relative to the outer ring in the axial and radial directions.
S_Y	Radial Displacement	µm	
S_Z	Radial Displacement	µm	

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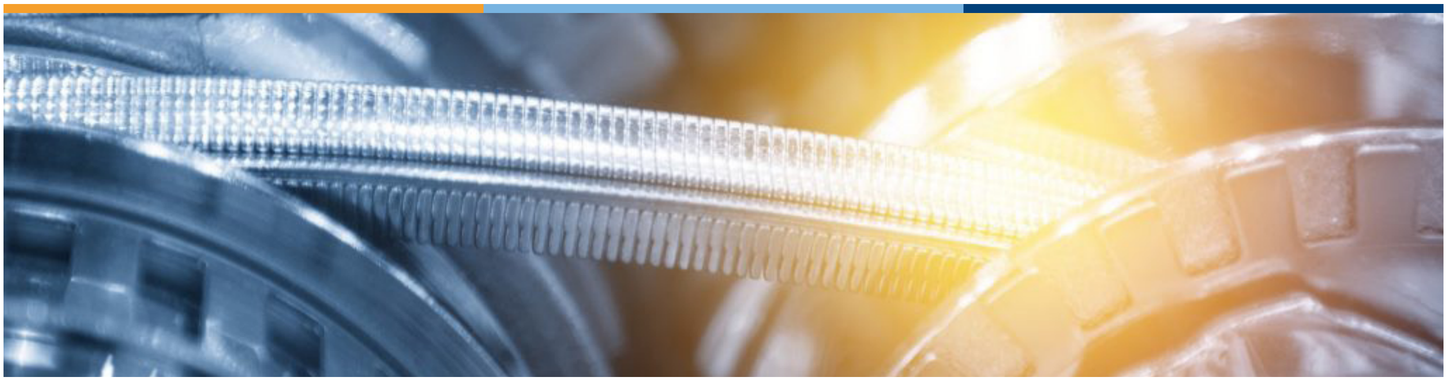
Support After Production: Bearing Issue Detector



Is your application not operating like it should?

Our frequency calculator is an automatic web-based tool that uses bearing kinematics to help you analyze the condition of your bearing system and detect issues.

A FREQUENCY ANALYSIS

Bearings are a combination of geometric shapes rotating relative to each other. Using mathematical models, we've calculated frequencies that would show up **if** there was damage to the bearing's inner race, outer race, balls or bearing cage.

Comparing frequency ranges from our calculator to your measured reading can pinpoint noise or vibration spikes that are outside the normal range.

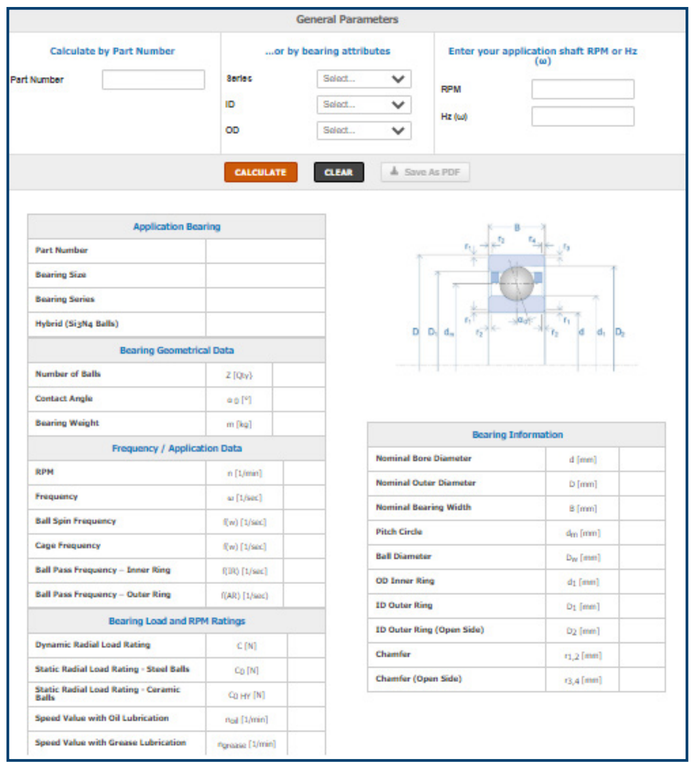
GET STARTED IN THREE EASY STEPS

Here are the steps for a quick-and-easy frequency analysis:

1. **Use our automatic frequency calculator.**
   Enter in your GMN bearing part number OR your non-GMN bearing dimensions (ID, OD, width), as well as the RPM of your shaft
2. Using a handheld instrument, like a decibel meter, measure the vibration levels coming from your application.
3. Compare the measured frequencies to our frequency calculator to detect bearing issues.

You'll be able to pinpoint if the bearing problem is occurring at the inner race, outer race, balls, or cage. If no correlation is found, then the issue could be unrelated to the bearings.

We've provided an example of a frequency analysis on the next page.



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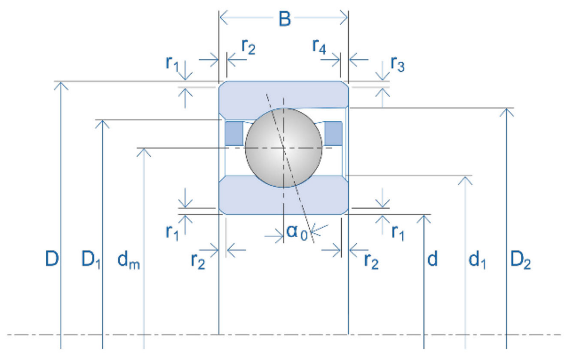
Sample Frequency Calculation

Application Bearing	
Part Number	S 6005 C TA
Bearing Size	6005
Bearing Series	S
Hybrid (Si_3N_4 Balls)	No

Bearing Geometrical Data		
Number of Balls	Z [Qty}	15.0
Contact Angle	α_o [°]	15.0
Bearing Weight	m [kg]	0.076

Frequency / Application Data		
RPM	n [1/min]	10,000
Frequency	ω [1/sec]	166.7
Ball Spin Frequency	f(w) [1/sec]	458.8
Cage Frequency	f(w) [1/sec]	69.1
Ball Pass Frequency – Inner Ring	f(IR) [1/sec]	1,463.3
Ball Pass Frequency – Outer Ring	f(AR) [1/sec)	1,037.2

Bearing Load and RPM Ratings		
Dynamic Radial Load Rating	C [N]	13,400
Static Radial Load Rating - Steel Balls	C [N]	9,200
Static Radial Load Rating - Ceramic Balls	C_{HY} [N]	6,500
Speed Value with Oil Lubrication	n_{oil} [1/min]	47,000
Speed Value with Grease Lubrication	n_{grease} [1/min]	35,000



Bearing Information		
Nominal Bore Diameter	d [mm]	25
Nominal Outer Diameter	D [mm]	47
Nominal Bearing Width	B [mm]	12
Pitch Circle	d_m [mm]	36.0
Ball Diameter	D_w [mm]	6.4
OD Inner Ring	d_1 [mm]	32.2
ID Outer Ring	D_1 [mm]	40.1
ID Outer Ring (Open Side)	D_2 [mm]	42.3
Chamfer	$r_{1,2}$ [mm]	0.6
Chamfer (Open Side)	$r_{3,4}$ [mm]	0.3

Precision Bearing Analysis Thoughts

Failure analysis, even at solely the frequency level, can be called an art form. Much experience can be brought into a thorough precision bearing system analysis. It is good to know that more often than not the frequencies do not perfectly align. This can happen for a multitude of reasons including the accuracy of various tools involved. For this reason, frequency spikes very close to those provided in the above tool may still be from the precision bearing(s). This is where analysis experience can be priceless.

Also, be aware of frequency spikes that are at RPM or at a harmonic of the RPM the unit is running at. This could be from an imbalance, out of roundness, out of concentric housing, tool noise, etc. There are times when a frequency analysis is quick and easy; be thankful for these times! In these instances and the much more difficult instances, be quick to contact GMN USA engineers for support. Precision bearing failure analysis can be much smoother and faster with years of experience on your side.

Note that precision bearing fault frequencies are derived from industry accepted calculations. If there are any questions on the methods used, please contact GMN USA engineers for support. Formulas are also outlined in the GMN Precision Bearing Catalog on page 92.

GMN Bearing USA Ltd. and its partners make no representations or warranties of any kind regarding the tool and information contained on this page. Any use or reliance upon this tool and information shall be at the sole risk of the user and GMN Bearing USA Ltd. shall have no liability whatsoever with respect to any decisions or actions made by the user based on results obtained from this tool and information.

DISCLAIMER: The data provided on this page is for general information purposes only. While the intention is to provide accurate information, the calculations performed by these tools/calculators are mathematical estimates only and errors may exist in the supplied information. There is NO WARRANTY OR GUARANTY, expressed or implied, regarding the accuracy of this information or its applicability to your engineering situation.

Please consult your own engineering consultant before making any technical decisions.

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Bearing Evaluation & Inspection Services

Our evaluation and inspection services are available to all existing and future customers, free of charge. Here is a short explanation on our bearing evaluation and inspection processes.

NEW APPLICATIONS

For prototypes, we'll have you run the application in short intervals, to simulate real-world operation, and then send us the bearings. Then, we inspect the bearings performance to make sure they operated as intended.

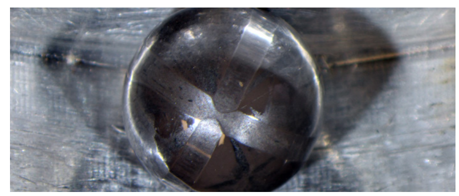
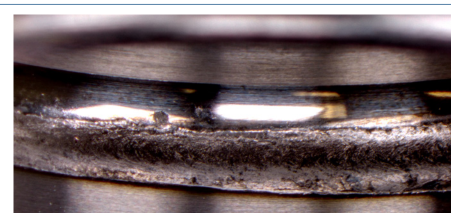
A bearing evaluation is a vital "best practice" for your design qualification process to ensure a successful application.

EXISTING APPLICATIONS

In the event of a machine failure, our inspection services are used as a diagnostic tool. We uncover what went wrong and our recommended steps to correct the problem.

COMMON BEARING ISSUES

In the table below are a few common bearing issues we've encountered in the decades of doing bearing inspections.

BEARING ISSUE	DESCRIPTION	PHOTO
Insufficient Preload	Excessive skidding or lack of rotation can occur when there's bad ball action. The formation of lines (saturn rings) on the ball are an identifying factor.	
Contamination	Foreign particles can enter the bearing and get pressed into the raceway during operation. Over time this can create raceway craters with non-uniform edges.	
Cage Damage	Cage damage can occur for numerous reasons including insufficient preload, high acceleration, inadequate lubrication, excessive heat, and contamination	
Brinelling from Installation	This can occur when excessive force is transferred between the balls and raceways causing plastic deformation to the raceways. Evenly spaced axial grooves, from the nature of the force are an identifying factor.	
Brinelling from Radial Overload	This occurs when excessive radial loads cause plastic deformation to the raceway. Usually, the inner race has uniform wear along the entire raceway while the outer race has a more limited area that's effected area.	

These are just a few common examples that we've seen. If you are running into a bearing issue and need help inspecting or identifying the issue, we'd love to help. Give us a call at 800.323.5725.

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Bearing Data Sheets

Not all data sheets are created equal.

We frequently receive compliments on the technical aspects and information we provide on our robust data sheets.

Our data sheets provide important information on bearing:

- Dimensions
- Load ratings
- Rigidity
- Preload
- RPMs
- Recommendations for mating part shoulder dimensions
- and more

On the following page is a sample data sheet downloaded from our website, **www.gmnbt.com** for the product S 6005 C TA.

Please note: The values provided on our data sheets are considered "catalog" values, which means they're generic values that can be used by most applications.

If you have a special high-speed or heavy load application, we would love to run a custom performance analysis1 on your application. Give us a call today at 800.323.5725 or fill out our contact us form.

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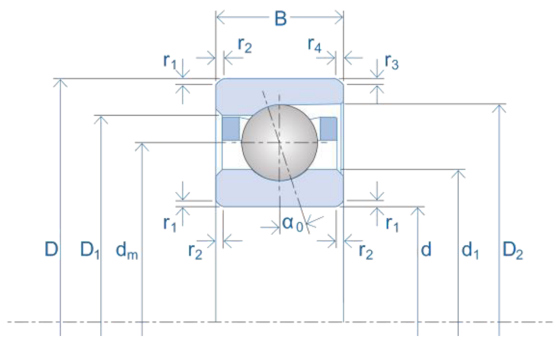
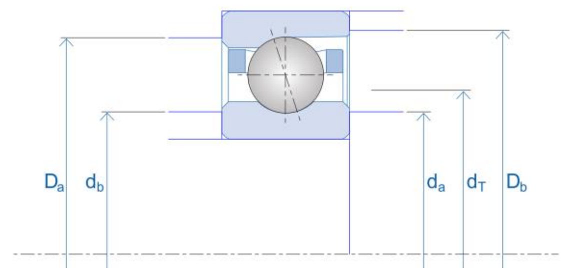
Sample GMN Data Sheet





Part Number	**S 6005 C TA**
Bearing Size	6005

Bearing Series	S
Hybrid (Si_3N_4 Balls)	No

Bearing Dimensions

Bore Diameter	d [mm]	25
Outer Diameter	D [mm]	47
Bearing Width	B [mm]	12
Pitch Circle	d_m [mm]	36.0
Ball Diameter	D_w [mm]	6.35
OD Inner Ring	d_1 [mm]	32.2
ID Outer Ring	D_1 [mm]	40.1
ID Outer Ring (Open Side)	D_2 [mm]	42.3
Chamfer	$r_{1,2}$ [mm]	0.6
Chamfer (Open Side)	$r_{3,4}$ [mm]	0.3

Bearing Load Ratings

Dynamic Radial Load Rating	C [N]	13,400
Static Radial Load Rating Steel Balls	C_0 [N]	9,200
Static Radial Load Rating Si_3N_4 balls	$C_{0\ HY}$ [N]	6,500

Bearing RPM Ratings

Speed Value with Oil Lubrication	n_{oil} [1/min]	47,000
Speed Value with Grease Lubrication	n_{grease} [1/min]	35,000

Geometrical Data

Number of Balls	Z [Qty.]	15
Contact Angle	α_0 [°]	15
Bearing Weight	m [kg]	0.076

Mating Part Dimensions

Abutment Diameter Inner Ring	d_a min. [mm]	30.0
Abutment Diameter Outer Ring	D_a max. [mm]	42.0
Chamfer Associated Component	r_a max. [mm]	0.6
Chamfer Associated Component (Open Side)	r_b max. [mm]	0.3

Bearing Preload Data

Light Pre-Load	Fv [N]	70
Light Axial Rigidity	C_{ax} [N/µm]	38
Medium Pre-Load	F_v [N]	200
Medium Axial Rigidity	C_{ax} [N/µm]	65
Heavy Pre-Load	F_v [N]	400
Heavy Axial Rigidity	C_{ax} [N/µm]	95
Minimum Spring Pre-Load	F_f [N]	345

Notes:

1. Position of the oiling Nozzle (d_T) for bearings with TA cage/ TXM cage upon request
2. The stated load and speed values are given for a spring preloaded single bearing with oil/air or oil mist lubrication. If specific applications differ, please consult correction factors and/or GMN USA engineers.

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Requested Project Information

We're excited about your project.

To best support you, please answer the questions below. If you don't have all the information, don't worry, we'll work with what you've got.

Bearing part number:

Bearing Arrangement:

Maximum RPMs:

Nominal RPMs:

Percentage of time at max vs. nominal RPMS:

Lubrication (grease/oil & what type):

Preload strategy (rigid or spring):

Preload force:

Axial loads:*

Radial loads:*

Shaft material:

Housing material:

Shaft tolerance:**

Housing tolerance:**

Shaft temperature:

Housing temperature:

Desired L10 life:***

Bonus: It's helpful if you could also send us a cross section of the application with dimensions locating the bearings relative to the load points.

** Please specify if it is at each bearing or for the overall application.*

*** If you want GMN to provide a recommended shaft and housing tolerance, please let us know how tight we can go.*

**** L10 life is bearing life in hours for a 90% success rate.*

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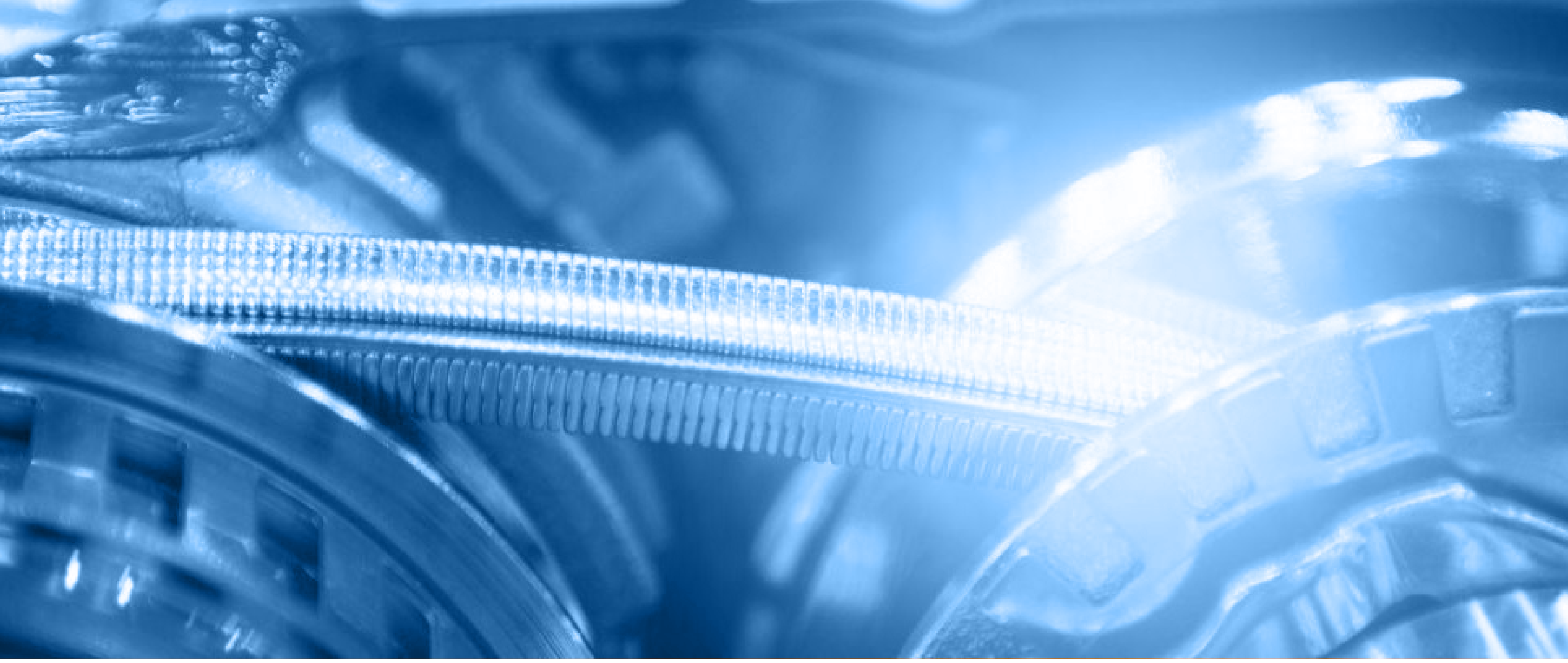

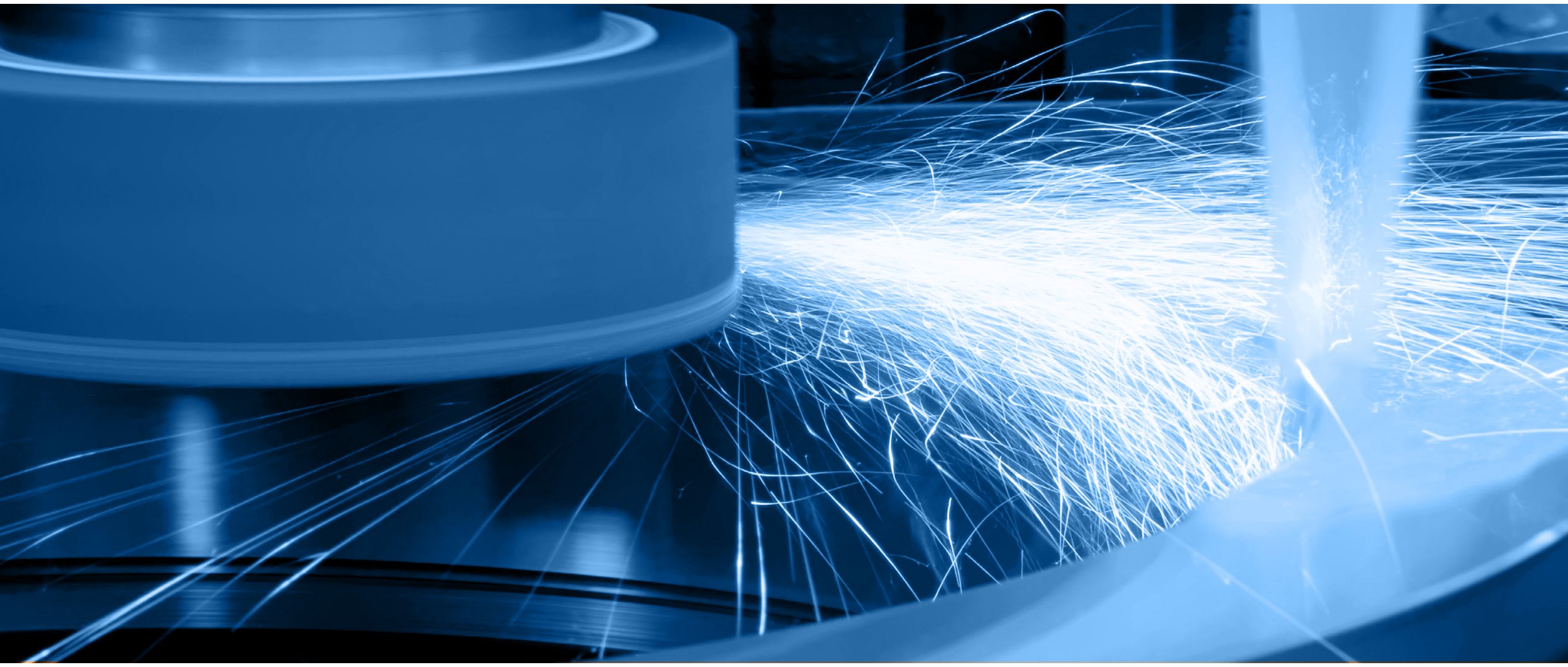

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