Honeywell

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HG4930 INERTIAL MEASUREMENT UNIT (IMU)

Performance and Environmental Information

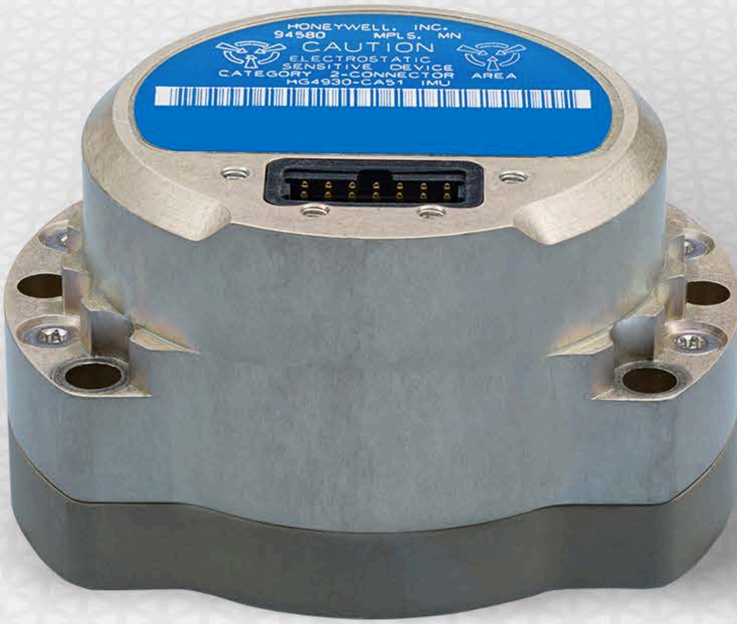
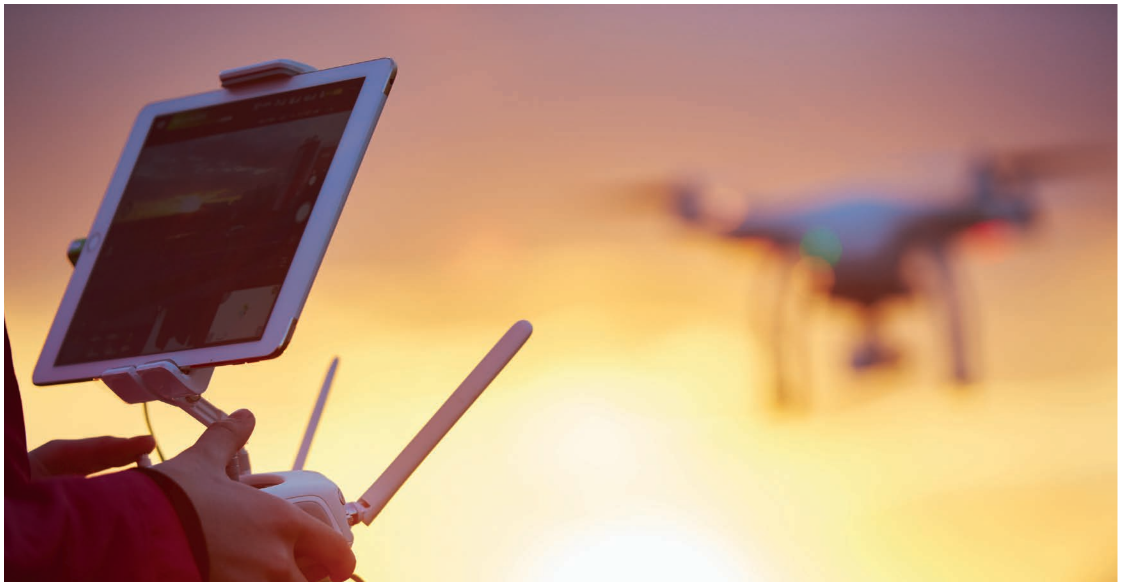


Table of Contents

Table of Tables

Table of Figures

Honeywell Industrial Inertial Measurement Units



Honeywell produces No License Required (NLR) Inertial Measurement Units (IMU) for industrial applications including agricultural vehicles, robotics, survey, mapping, and stabilized systems. These IMUs are designed for industrial application and can be used on air, land, and sea. Honeywell began producing gyros in the 1940's for the Honeywell C-1 autopilot and specifically began producing MEMS gyros and accelerometers in the early 2000's. Honeywell's IMUs utilize proprietary Honeywell technology and leverage existing production and engineering infrastructure. Honeywell has deep and long lasting relations with many commercial customers and is carrying that philosophy and product pedigree into our NLR IMU line. Honeywell's forward looking product strategies ensure that our NLR IMUs fit your current and future needs.

The HG4930 IMU is a device which measures angular rates and linear acceleration. It provides compensated incremental angle and velocity data for inertial navigation as well as angular rates and linear accelerations for control. The data is reported through a digital serial interface bus and is available in a variety of serial formats. The unit contains MEMS gyroscopes and accelerometers as well as the electronics and software necessary to deliver precision inertial information. The input axes form a right handed frame aligned with the IMU mounting frame.

Contact Us

For more information, email imu.sales@honeywell.com or contact us on our website aerospace.honeywell.com/HG4930

Accelerometer Performance

The HG4930 is designed to achieve full performance by 5 seconds for the environmental conditions listed in Table 8.

Table 1. Accelerometer Performance

PARAMETER	AA51	BA51	CA51	CA51 TYPICAL @ 25°C	UNITS
Operating Range	-20 to +20				g
Scale Factor Repeatability	1000	800	600	200	ppm, 1σ
Scale Factor Linearity Error	200	150	100	50	ppm/g, 1σ
Bias Repeatability	10	10	5	1.7	mg, 1σ
Bias (In Run Stability)	0.5	0.5	0.3	0.02	mg, 1σ

Table 2. Accelerometer Navigation Data Specific Performance

PARAMETER	AA51	BA51	CA51	CA51 TYPICAL @ 25°C	UNITS
Vibration Rectification Error	25	15	5	2	mg shift maximum
Output Noise (standard deviation)	0.003	0.003	0.003	0.0003	m/sec, maximum
Velocity Random Walk	0.12	0.09	0.09	0.03	m/sec/√hr, maximum

Table 3. Accelerometer Control Data Specific Performance

PARAMETER	ALL HG4930	UNITS
Output Noise (standard deviation)	25 (< 10 Typical)	mg, maximum
Room Temperature Bandwidth (See Appendix A)	≥70	Hz

Angular Rate Performance

The HG4930 is designed to achieve full performance by 5 seconds for the environmental conditions listed in Table 8.

Table 4. Angular Rate Performance

PARAMETER	AA51	BA51	CA51	CA51 TYPICAL @ 25°C	UNITS
Operating Range	-200 to +200				°/s
Scale Factor Repeatability	1000	800	600	100	ppm, 1σ
X Scale Factor Static g Sensitivity	50	50	50	< 25	ppm/g 1σ
Y/Z Scale Factor Static g Sensitivity	50	50	50	< 5	ppm/g 1σ
Scale Factor Linearity	250	200	100	50	ppm, 1σ, FS
Bias Repeatability	60	40	20	5	°/hr, 1σ
Bias (In Run Stability)(<1 hour)	1.5	1.5	1.0	0.6	°/hr, 1σ
Bias Static g Sensitivity	2	2	1	0.5	°/hr/g, 1σ
Magnetic Field Sensitivity	1	1	1	1	°/hr/Gauss maximum

Table 5. Angular Rate Navigation Specific Performance

PARAMETER	AA51	BA51	CA51	CA51 TYPICAL @ 25°C	UNITS
Vibration Rectification Error (VRE)	40	20	10	5	°/hr shift maximum
Output Noise (standard deviation)	30	30	30	< 4	µrad, maximum
Angular Random Walk	0.175	0.125	0.09	.05	deg/√hr, maximum

Table 6. Angular Rate Control Data Specific Peformance

PARAMETER	ALL HG4930	UNITS
Output Noise (standard deviation)	8 (< 1 Typical)	mrad/sec, maximum
Room Temperature Bandwidth (See Appendix A)	≥70	Hz

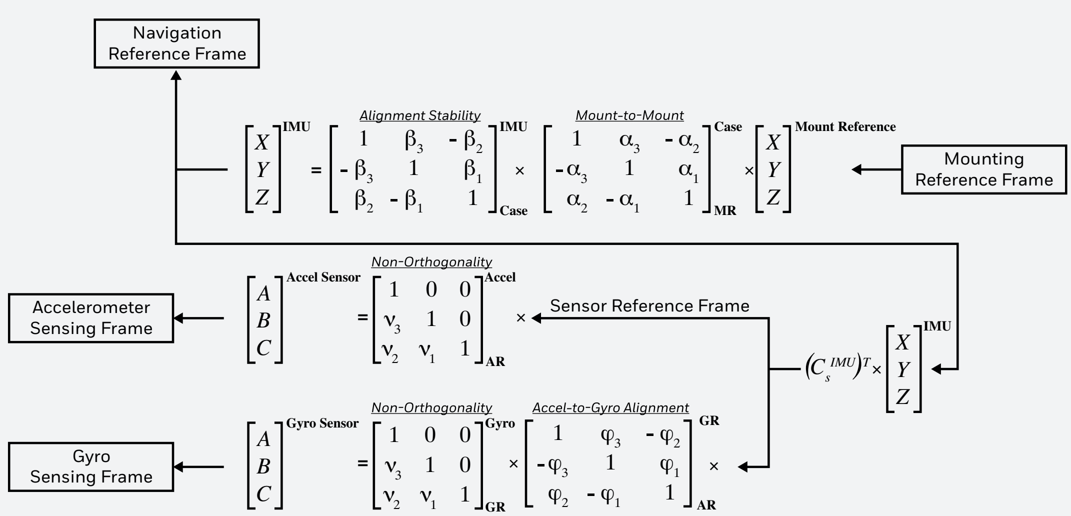
IMU Alignment Model

The mathematical IMU alignment consists of Mount-to-Mount, Alignment Stability, Accelerometer-to-Gyro Alignment, and Non-Orthogonality error components, as shown in the table and figure below.

Table 7. Alignment and Orthogonality Performance

PARAMETER	ERROR REQUIREMENT	UNITS
Mount to Mount with Pins	3500	µrad max
Alignment Stability	750 (< 375 Typical @ 25°C)	µrad 1σ
Accelerometer Non-orthogonality	750 (< 375 Typical@ 25°C)	µrad 1σ
Accelerometer to Gyro Alignment	750 (<375 Typical@ 25°C)	µrad 1σ
Gyro Non-Orthogonality	750 (< 375 Typical@ 25°C)	µrad 1σ

Figure 1. IMU Alignment Model



AR Accel/Sensor Reference Frame (Orthogonal)

GR Gyro Reference Frame (Orthogonal)

C_s^{IMU} Gyro Reference Frame (Orthogonal)

Error Matrices are small angle approximations

Gyro Definitions

Gyro Bias In Run Stability

In-run gyro bias stability is a measure of random variation in bias as computed over a specified sample time and averaging time interval. This non-stationary (evolutionary) process is characterized by 1/f power spectral density. It is typically expressed in °/hr and measured using the Allan Variance method.

Gyro Bias Repeatability

Gyro bias repeatability is defined as the residual output bias error after calibration and internal compensation, including the effects of turn-off and turn-on, time, and temperature variations. This measure represents the statistical expected value for output bias error at any given time and thermal condition.

Gyro Vibration Rectification Error (VRE)

Gyro vibration rectification error is a measure of the apparent shift in gyro steady state bias error as a function of a change in the applied vibration level. This effect may be nonlinear with vibration level, and may also depend on the spectrum.

Gyro Output Scale Factor (SF)

The ratio of a change in output to a change in the input intended to be measured. Scale factor is generally evaluated as the slope of the straight line that can be fitted by the method of least squares to input-output data.

Gyro Scale Factor Repeatability

Gyro SF repeatability is defined as the residual output SF error, after calibration and internal compensation, including the effects of turn-off and turn-on, time, and temperature variations. The repeatability error is expressed in ppm of the output angular rate. For low rates (< 100 °/s), gyro SF repeatability is considered inclusive of the linearity error and static g sensitivity.

Gyro Scale Factor Linearity

Gyro SF linearity is a measure of the one sigma deviation of the output from the least squares linear fit of the input-output data expressed in ppm of the output.

Gyro Angle Random Walk (ARW)

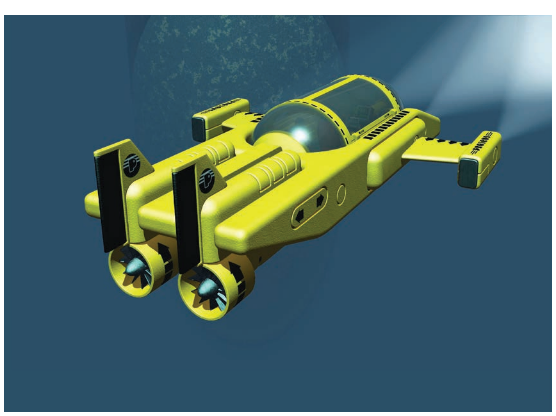
ARW is the angular error buildup with time due to white noise in angular rate expressed in °/√hr.

Gyro Frequency Response

The gyro frequency response is defined as the total IMU transfer function, from linear acceleration input to digital acceleration data being made available to the customer. This includes the isolator, the actual sensor, the IMU processing delay, and any incorporated filters.

Gyro Operating Rate Range

Gyro operating rate range is the maximum angular rate input in both directions at which the IMU rate output performance parameters apply.



Accelerometer Definitions

Accelerometer Bias In Run Stability

In-run accelerometer bias stability is a measure of random variation in bias as computed over a specified sample time and averaging time interval. This non-stationary (evolutionary) process is characterized by 1/f power spectral density. It is typically expressed in mg and measured using the Allan Variance method.

Accelerometer Bias Repeatability

Accelerometer bias repeatability should be defined as the residual output bias error after calibration and internal compensation, including the effects of turn-off and turn-on, time, and temperature variations. This measure represents the statistical expected value for output bias error at any given time and thermal condition.

Accelerometer Vibration Rectification Error (VRE)

Accelerometer vibration rectification error is a measure of the apparent shift in accelerometer bias as a function of a change in the applied vibration level. This effect may be nonlinear with vibration level, and may also depend on the spectrum

Accelerometer Scale Factor (SF)

The ratio of a change in output to a change in the input intended to be measured. Scale factor is generally evaluated as the slope of the straight line that can be fitted by the method of least squares to input-output data.

Accelerometer Scale Factor Repeatability

SF repeatability is defined as the residual output SF error after calibration and internal compensation, including the effects of turn-off and turn-on, time, and temperature variations. The repeatability error is expressed in ppm of the output acceleration. For under 1 g, accelerometer scale factor repeatability sis inclusive of the linearity error.

Accelerometer Scale Factor Linearity Error

Accelerometer SF linearity error is a measure of the one-sigma deviation of the output from the least squares linear fit of the input-output data expressed in ppm of the output. The linearity error under 1 g is typically negligible.

Accelerometer Velocity Random Walk (VRW)

VRW is the velocity error buildup with time due to white noise in acceleration expressed in m/sec/√hr.

Accelerometer Frequency Response

The accelerometer frequency response is defined as the total IMU transfer function, from linear acceleration input to digital acceleration data being made available to the customer. This includes the isolator, the actual sensor, the IMU processing delay, and any incorporated filters.

Accelerometer Operating Rate Range

Accelerometer operating rate range is the maximum linear acceleration input in both directions at which the IMU acceleration output performance parameters apply.

Environmental Specifications

The minimum IMU operating and non-operating environmental specifications are shown in Table 8 - Table of Environmental Conditions. The HG4930 is an extremely rugged device and the customer is advised to contact Honeywell if specific advice is needed on shock and vibration environments

Table 8. Environmental Conditions

ENVIRONMENT	OPERATING	NON-OPERATING	UNITS
Temperature	-54 to +85 -40 to +71 (Full Performance)	-54 to +95	°C
Temperature Shock	±3 Operating ±0.8 Full Performance	±15	°C/minute
Random Vibration	0.003 g^2/Hz, 10Hz to 2KHz 2.5 g's RMS	0.012 g^2/Hz, 10Hz to 2KHz	NA
Shock	10 g, 3ms half-sine pulse	50 g, 3ms half-sine pulse	NA
Static Acceleration	The HG4930 is designed to withstand > 50 g's of static acceleration in all directions.		
Altitude	0 to 30,000, Mean Sea Level	NA	Meters
Magnetic Field	±10	NA	Gauss

Reliability

The Mean Time Between Failure (MTBF) calculations incorporate Honeywell proprietary methodologies that tailor industry standards.

Table 9. Reliability Calculations

TRACTORS, GROUND BASED TRANSPORT	25°C	102,000 Hour MTBF
DRONES	71°C	59,000 Hours MTBF

Export Guidance

All technology that leaves the United States is subject to export regulations. This manual contains technology that has an Export Commodity Classification of ECCN 7E994 with associated country chart control code of AT1. This technology generally will not require a license to be exported or re-exported. However, if you plan to export this item to an embargoed or sanctioned country, to a party of concern, or in support of a prohibited end-use, you may be required to obtain a license.

Appendix A:
Accelerometer Frequency Response

Figure 2. X Accelerometer Room Frequency

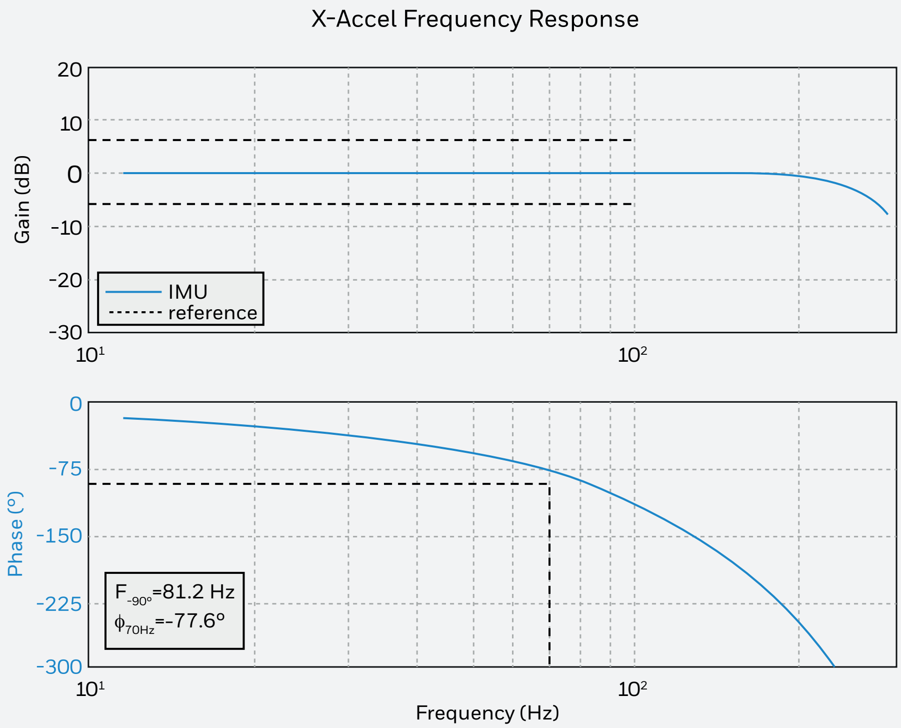
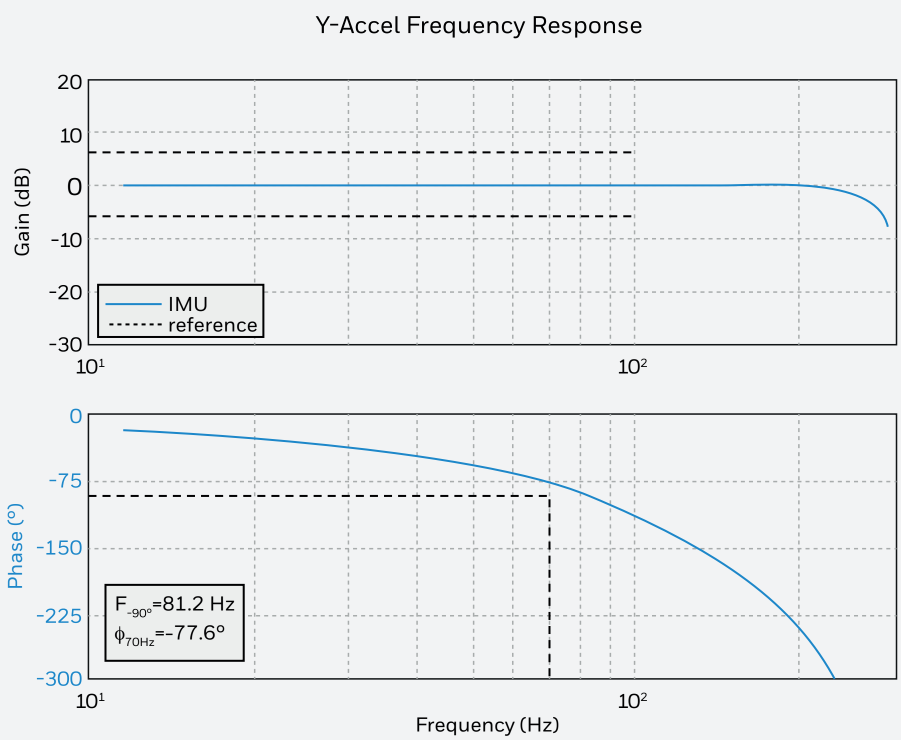


Figure 3. Y/Z Accelerometer Frequency



Appendix B: Gyro Frequency Response

Figure 4. X Gyro Room Frequency

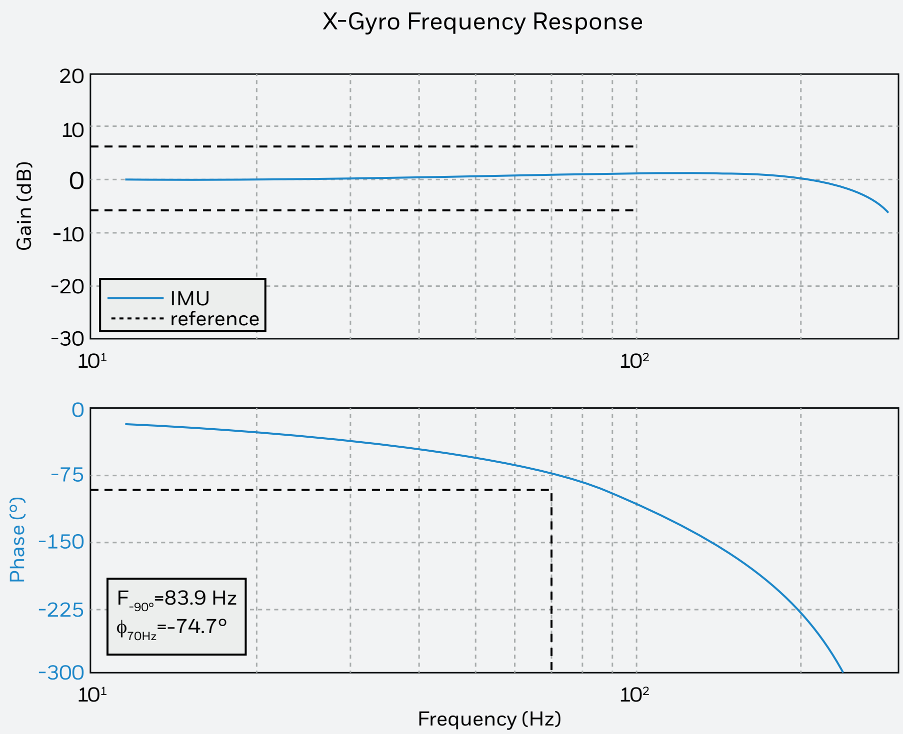
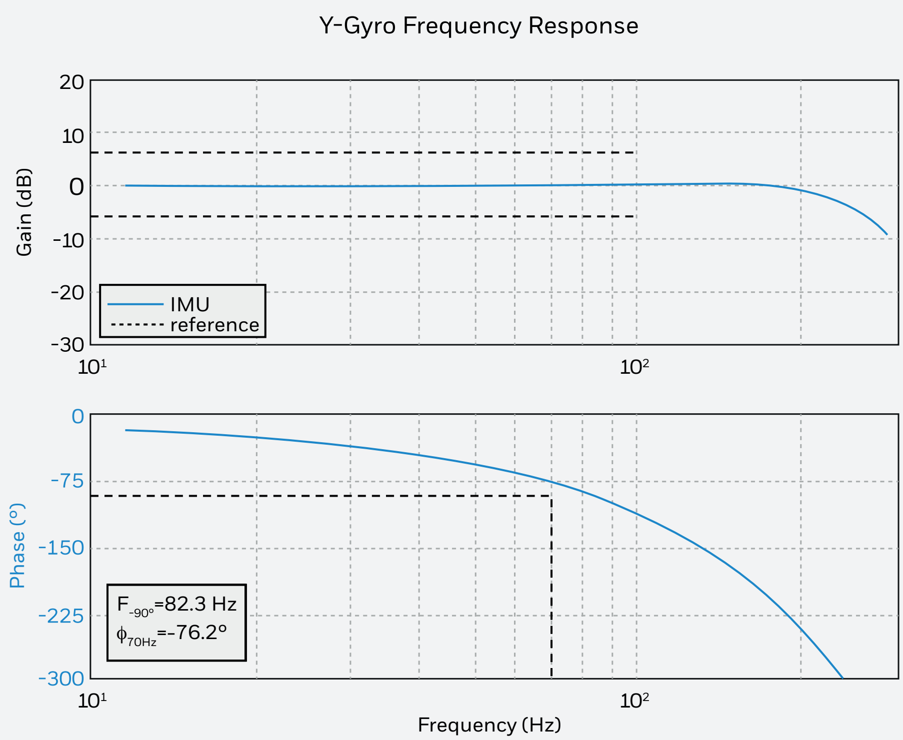


Figure 5. Y/Z Gyro Frequency Response



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