

HG1120 INERTIAL MEASUREMENT UNIT (IMU)

Performance and Environmental Information



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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 HG1120 IMU is a device which measures angular rates, linear accelerations, and magnetic fields, in a body mounted strap down configuration. 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 HG1120 is designed to achieve full performance by 0.2 seconds for the environmental conditions listed in Table 10.

Table 1. Accelerometer Performance

PARAMETER	AA50	BA50	CA50	CA51 TYPICAL @ 25°C	UNITS
Operating Range	-16 to +16				g
Scale Factor Repeatability	3000	2000	1500	1000	ppm, 1σ
Scale Factor Linearity @ FS For Accelerations < 2g, Linearity Error Negligible	1% FS	1% FS	1% FS	< 1% FS	ppm/g, 1σ
Bias Repeatability	24	16	8	5	mg, 1σ
Bias (In Run Stability)(<1 hour)	0.2	0.15	0.1	0.06	mg, 1σ
Magnetic Field Sensitivity	Insensitive to Magnetic Fields				

Table 2. Accelerometer Navigation Data Specific Performance

PARAMETER	AA50	BA50	CA50	CA51 TYPICAL @ 25°C	UNITS
Output Noise (standard deviation) @300 Hz Data Rate	0.0003	0.0003	0.0003	7.62 E-5	m/sec, maximum
Velocity Random Walk	0.15	0.09	0.06	0.04	m/sec/√hr, maximum

Table 3. Accelerometer Control Data Specific Performance

PARAMETER	PERFORMANCE	UNITS
Output Noise (standard deviation) @ 1800 Hz Data Rate, No Filtering	8 (< 2.5 Typical) @ 1800 Hz, No Filtering	mg, maximum
1800 Hz/300 HZ Frequency Response	See Table 4	

Table 4. HG1120 Typical Frequency Response Parameters

HG1120 FREQUENCY RESPONSE TYPICAL	GYRO		ACCEL	
	-90°	-3dB	-90°	-3dB
50 Hz	51 Hz	94 Hz	53 Hz	80 Hz
90 Hz	92 Hz	211 Hz	91 Hz	176 Hz
No Filtering	97Hz	298 Hz	160 Hz	288 Hz



Angular Rate Performance

The HG1120 is designed to achieve full performance by 0.2 seconds for the environmental conditions listed in Table 10.

Table 5. Angular Rate Performance

PARAMETER	AA50	BA50	CA50	CA51 TYPICAL @ 25°C	UNITS
Operating Rate Range	-500 to +500				°/s
Scale Factor Repeatability	5000	5000	5000	2500	ppm, 1 σ
X,Z Scale Factor Static g Sensitivity	150	150	150	100	ppm/g 1 σ
Y Scale Factor Static g Sensitivity	350	350	350	200	ppm/g 1 σ
Scale Factor Linearity @ Full Rate Range For Rates < 100°/s, Linearity Error Negligible	1%	1%	1%	< 0.5% < 400°/s	NA
Bias Repeatability	1080	720	500	360	°/hr, 1 σ
Bias (In Run Stability)(<1 hour)	120	65	40	20	°/hr/g, 1 σ
Bias Static g Sensitivity	30	30	30	< 15	°/hr shift maximum
Magnetic Field Sensitivity	Insensitive to Magnetic Fields				

Table 6. Angular Rate Navigation Specific Performance

PARAMETER	AA50	BA50	CA50	CA51 TYPICAL @ 25°C	UNITS
Output Noise (standard deviation) @ 300 Hz Data Rate	1	1	1	< 0.75	mrاد, 1 σ
Angular Random Walk	1.3	0.7	0.4	0.25	°/√hr, maximum

Table 7. Angular Rate Control Performance

PARAMETER	PERFORMANCE	UNITS
Output Noise (standard deviation) @ 1800 Hz Data Rate, No Filtering	0.153 (< 0.1 Typical)	°/s, 1 σ
1800 Hz/300 HZ Frequency Response	See Table 4	

Magnetometer Performance

Table 8. Magnetometer Performance

PARAMETER	PERFORMANCE	UNITS
Operating Range	+/- 12	Gauss
Zero-Gauss Bias	+/-0.5	Gauss, 1 σ
Magnetic RMS Noise	4.1	mGauss
Non-linearity	+/-1.0	%, (typical)
Sensor Bandwidth	40	Hz
Alignment	3.0	Degree, 1 σ

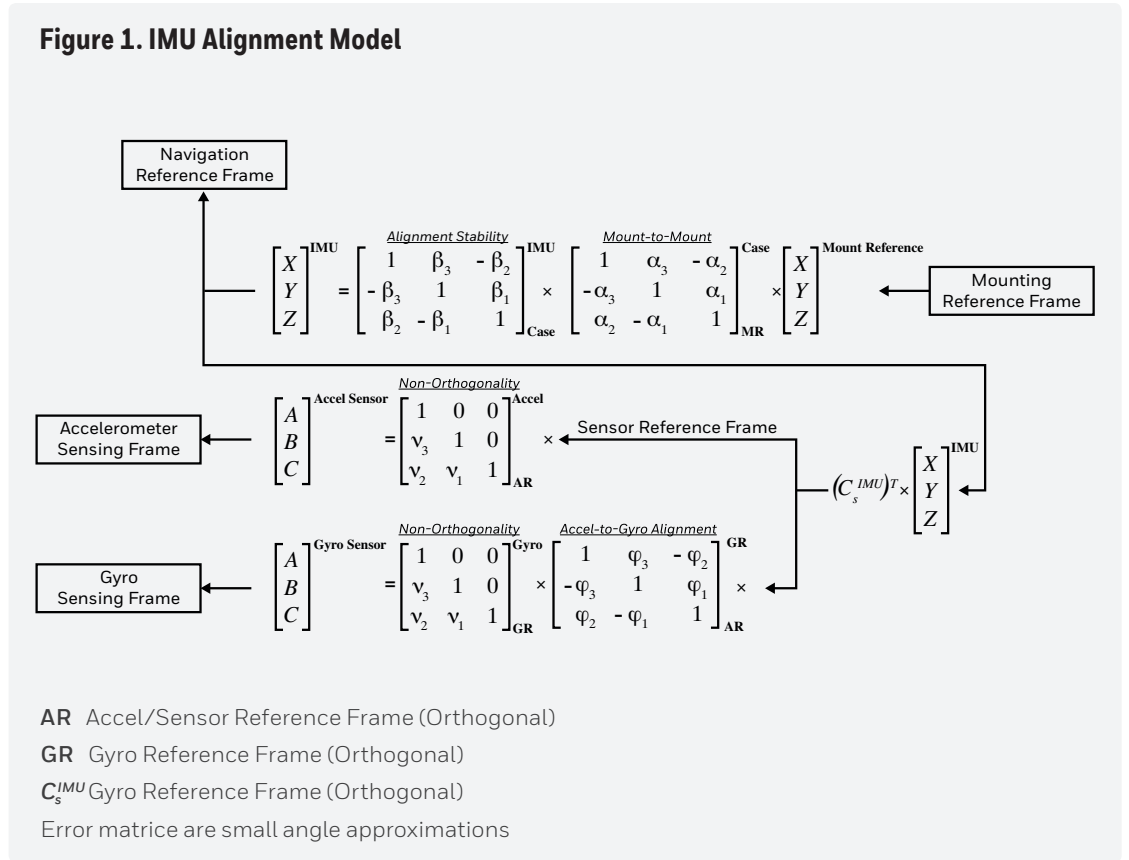
IMU Alignment Model

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

Table 9. Alignment and Orthogonality Performance

PARAMETER	ERROR REQUIREMENT	UNITS
Mount to Mount with Pins	3600	μrad max
Alignment Stability	1200 (< 250 Typical @ 25°C)	μrad 1σ
Accelerometer Non-orthogonality	1200 (< 250 Typical @ 25°C)	μrad 1σ
Accelerometer to Gyro Alignment	1200 (< 250 Typical @ 25°C)	μrad 1σ
Gyro Non-Orthogonality	1200 (< 250 Typical @ 25°C)	μrad 1σ

Figure 1. IMU Alignment Model



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 $^{\circ}/\text{hr}$ 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 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 ($< 100^{\circ}/\text{s}$), 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 $^{\circ}/\sqrt{\text{hr}}$.

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 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 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.

Accelerometer Velocity Random Walk (VRW)

VRW is the velocity error buildup with time due to white noise in acceleration expressed in $m/sec/\sqrt{hr}$.

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 is 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 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.



Environmental Conditions

The IMU operating and non-operating environmental conditions are shown below. The HG1120 is an extremely rugged device and the customer is advised to contact Honeywell if specific advice is needed on shock and vibration environments.

Table 10. Table of Environmental Conditions

ENVIRONMENT	OPERATING	NON-OPERATING	UNITS
Temperature	-40 to +85	-55 to +105	°C
Temperature Soak	±3 Operating ±0.8 Full Performance	-55 for 4 hours +105 for 4 hours	°C
Shock	250g, 1.7 ms half sine. Signal saturation could affect customer performance	NA	NA
Altitude	0 to 13,700 meters, -43 to +87°C	NA	NA
Magnetic Field	±10 Gauss	NA	Gauss

Reliability

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

Table 11. Reliability Calculations

DRONES	85°C	53,000 Hour MTBF
	71°C	59,000 Hour MTBF
ROTARY WING UAV'S/AIRCRAFT	55°C	79,000 Hour MTBF
TRACTORS, GROUND BASED TRANSPORT	55°C	170,000 Hour MTBF
	25°C	206,000 Hour MTBF
DRILLING, SURVEY STATIONS	55°C	378,000 Hour MTBF
	25°C	476,000 Hour MTBF
SATELLITE TRACKING STATIONS	25°C	1,037,000 Hour 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.

For more information

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