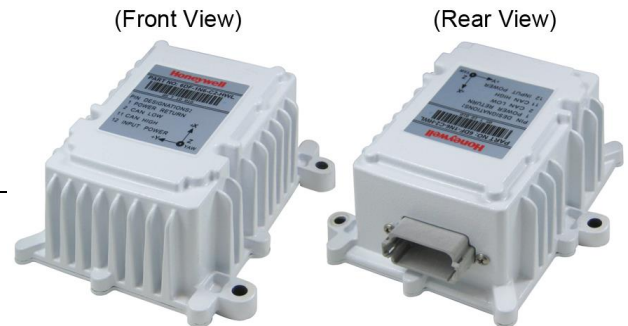


6DF Series

6 Degrees of Freedom Inertial Measurement Unit, 6-D Motion Variant



DESCRIPTION

The Honeywell 6-D Motion Variant 6DF (six degrees of freedom) Inertial Measurement Unit (IMU) sensors are designed to provide motion, position, and navigational sensing from a durable single device over six degrees of freedom. This is achieved by using MEMS (microelectromechanical system) technology to sense translational movement in three perpendicular axes (surge, heave, sway) and rotational movement about three perpendicular axes (roll, pitch, yaw). Because the movement and rotation along the three axes are independent of each other, such motion is said to have “six degrees of freedom” (see Figure 1 on page 3).

The 6DF Series IMU measures the motion of the equipment onto which it is attached and delivers the data to the equipment’s control module using industry-standard CAN SAEJ1939 communications protocol, allowing the operator to focus on other equipment functions, enabling more precise control than can be achieved by using only the human eye, thus increasing safety, stability and productivity.

VALUE TO CUSTOMER (★=competitive differentiator)

- ★ **Designed to Six Sigma standards:** Six Sigma standards provide the highest level of product quality, performance, and consistency. Six Sigma provides confidence that the IMU will perform to specification. Some competitive products may be produced to much lower Sigma tolerances, which may result in some products not performing to the specification in some conditions
- ★ **Industry-leading durability:**
 - Aluminum housing protects device from damage due to stones, dust, dirt, pressure washing, and humidity, allowing for use in harsh and outdoor environments
 - Corrosion-resistance minimizes susceptibility to deterioration often experienced in saltwater environments
 - Compatible with chemicals such as diesel fuel, hydraulic oil, gas/ethylene glycol, brake fluids, urea, liquid lime, NPK fertilizer, ammonia hydroxide, and alkaline degreasers
 - IP67 and IP69k ratings provide resistance to weather
 - Wide operating temperature range withstands most thermal extremes, preventing package breakage
 - EMI (electromagnetic interference) and EMC (electromagnetic compatibility) rating protects device from environmental radio frequencies

The 6DF Series is available in two versions, one with a 2 g accelerometer and the other with a 6 g accelerometer, as shown in the order guide on the back page.

6DF-1N2-C2-HWL: This version is slightly more accurate than the 6DF-1N6-C2-HWL, but less tolerant of vibration. It is designed for “cleaner” environments, where the higher accuracy can be realized due to the reduced environmental interference with respect to the signals.

6DF-1N6-C2-HWL: This version is much more tolerant of vibration and rugged environments than the 6DF-1N2-C2-HWL. This allows for optimum performance in harsh environments, with a small reduction in accuracy.

The 6DF Series may potentially be used in numerous Transportation, Industrial, and Aerospace/Military applications with harsh environments.

6DF Series

- Reduces replacement and downtime due to broken parts, temperature incompatibilities, EMC and EMI, and exposure to chemicals
 - ★ **Industry-leading accuracy:** Provides highly accurate 6-dimensional rotation and acceleration outputs due to the IMU's industry-leading durable packaging, industry-leading stability, temperature compensation, software filtering and design, and automotive-grade Six Sigma testing requirements
 - ★ **Eases integration:**
 - SAEJ1939 CAN 29 bit identifier communication output—the standard for the transportation segment—allows more data to be transmitted than an RS-485 output
 - IP67 and IP69k ratings minimize the customer having to design a weather resistant packaging around the IMU, allowing for a wide range of use in the application
 - Wide voltage range (7 V to 32 V) minimizes the need for a voltage converter
 - Deutsch connector, common in transportation applications, simplifies the customer's supply chain and reduces design complexity
 - Chemical compatibility minimizes the OEM having to expose the device to the substances
 - **6-dimensional motion sensing:** Senses 3-D motion in the forward/backward, up/down, and left/right accelerations combined with rotation about three perpendicular axes (pitch, yaw, roll):
 - Provides key equipment operating data for automated steering and control
 - Frees the operator to focus on equipment functions
 - Enables precise control which otherwise cannot be achieved with the human eye alone
 - Increases accuracy
 - Increases safety
 - Increases stability
 - Increases operator productivity
 - ★ **Industry-leading voltage input flexibility (7 V to 32 V):**
 - Allows customers with multiple product lines the ability to purchase only one catalog listing instead of multiple listings
 - Allows the IMU to accommodate voltage fluctuation within the vehicle/device
 - Provides reverse polarity protection in case the end customer accidentally reverses the red and black battery voltage wires
 - ★ **Industry-leading application expertise:** Honeywell application engineers are available to provide assistance to customers to help troubleshoot unforeseen communication protocol data, helping to optimize the customers' system performance; additionally, Honeywell application engineers are available to answer design questions during the development, launch, and production of the customer's product
 - ★ **Industry-leading customization:** For transportation applications with high volumes over 500 units per year, Honeywell will consider offering customers a choice of any CAN protocol, acceleration range up to ± 6 g, rotation rates up to ± 75 °/s, inclination angles up to $\pm 50^\circ$ and a sensor update rate from 1 Hz to 100 Hz:
 - Allows customers to customize the IMU so that it readily fits into existing vehicle protocol architecture
 - Allows customers the ability to make custom protocol inclusions into the IMU quickly and easily
 - Allows fast customer development turnaround with expert engineering support
 - No customization for aerospace and military ITAR-applicable applications
 - ★ **Automotive-grade qualified:** Certified to operate in automotive-grade environments due to:
 - Temperature compensated to operate from -40 °C to 85 °C [-40 °F to 185 °F]
 - Meets EMC and EMI requirements
 - Meets ESD (electrostatic discharge) requirements
 - Chemical compatibility (e.g., diesel, hydraulic oil, gas/ethylene glycol, brake fluid, urea, liquid lime, NPK fertilizer, ammonia hydroxide, and alkaline degreaser)
 - ★ **Industry-leading temperature performance:** A temperature sensor is placed within each rotation rate sensor within the IMU:
 - Provides a temperature value to the processing module where the data samples are filtered and compensated
 - Allows the customer's system to perform over a wide temperature range
 - **Long-term stability:** Even after long-term use and thermal extremes, these sensors offer customers enhanced long-term stability:
 - Minimizes system calibration needs
 - Maximizes system performance
 - Helps support system uptime by eliminating the need to service or replace the sensor during its application life
 - **No calibration needed:** Large batches of the IMU are calibrated to a flat surface, providing calibration consistency between units and eliminating the customer's need to calibrate the IMU
- ## FEATURES AND BENEFITS
- **Industry-standard SAEJ1939 CAN:** Provides easy-to-integrate, cost-effective, high-integrity serial data communications bus for real-time control applications, allowing enhanced error detection
 - **Test to mechanical shock, thermal shock, and random vibration:** Provides the customer with durability in tough environments

6DF Series 6 Degrees of Freedom Inertial Measurement Unit, 6-D Motion Variant

POTENTIAL APPLICATIONS

| Motion Type | KEY INDUSTRY | | |
|-----------------------------------|--|---|---|
| | Transportation (tractors, harvesters, loaders, graders, bulldozers) | Industrial (mining conveyors, robotics, shaker tables) | Aerospace/Military (non ITAR) (ground vehicles UAVs, unmanned aerial vehicles) |
| Stability | X | X | X |
| Rollover Prevention/ Detection | X | X | X |
| Grading/Harvesting | X | - | - |

NOTICE

- Honeywell will provide the customer with the following outputs, all of which are not compensated for stochastic bias; only compensated for deterministic bias in a lab environment:
 - Roll and pitch angles under static and dynamic conditions.
 - Accelerometer measurements.
 - Rate gyro measurements.
- The effects of field installation are ultimately the responsibility of the customer. Honeywell shall provide a diagram and installation setup for its laboratory installation upon which the specifications shall be completed and valid.

Figure 1. Six Degrees of Freedom General Definitions

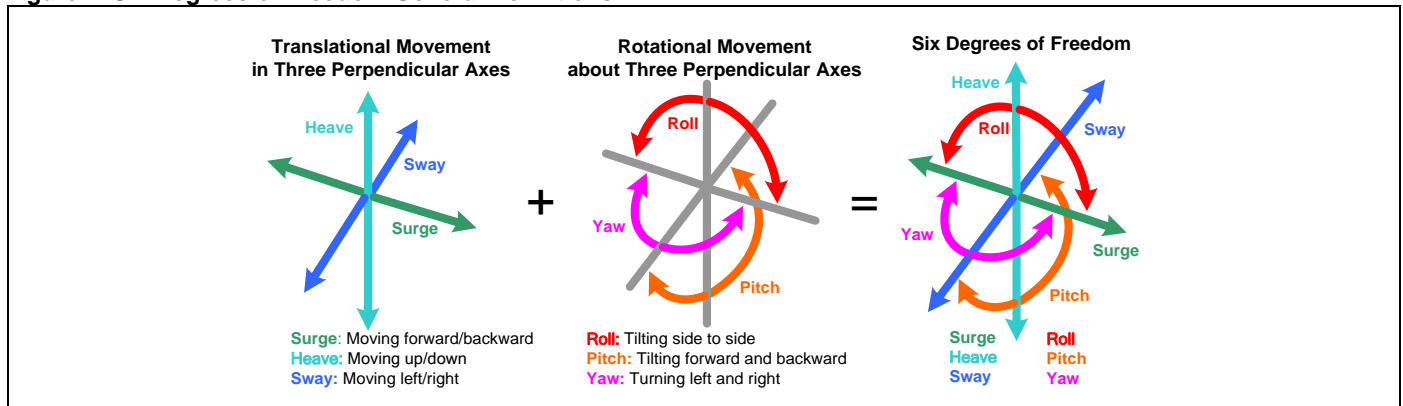
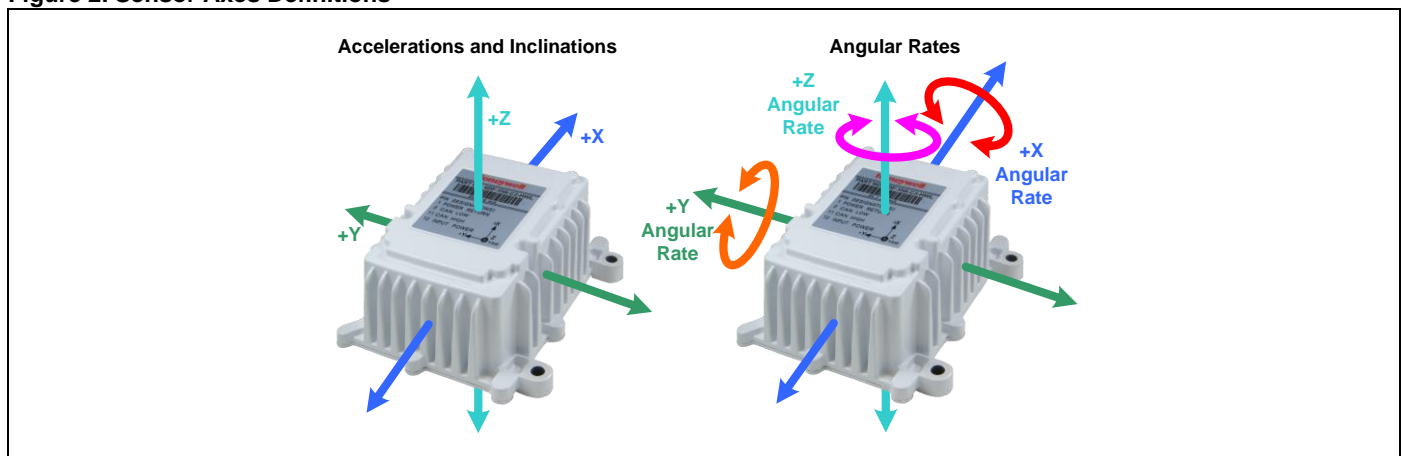


Figure 2. Sensor Axes Definitions



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Table 1. General Specifications

| Characteristic | Minimum | Typical | Maximum | Unit |
|----------------------------------|---|---------|----------|---------|
| Supply voltage | 7 | - | 32 | V |
| Supply current (at 12 V) | - | - | 350 | mA |
| Reverse voltage | - | - | -18 | V |
| Startup time | - | 700 | 2000 | ms |
| Operating temperature | -40 [-40] | - | 85 [185] | °C [°F] |
| Storage temperature | -40 [-40] | - | 95 [203] | °C [°F] |
| Mechanical shock | - | - | 30 | g |
| Random vibration | 3,2 g RMS max. (10 Hz to 2000 Hz), 3 orthogonal plane at 32 hr/axis | | | |
| Thermal shock | -40 °C to 105 °C [-40 °F to 221 °F] soak time, 30 min; transfer time less than 10 s, 30 cycles | | | |
| Humidity | 95 %RH at 25 °C to 55 °C [77 °F to 131 °F] | | | |
| Salt spray | 5% salt solution, 96 hr at 35 °C [95 °F] | | | |
| Chemical compatibility | diesel fuel, hydraulic oil, ethylene glycol, motor oil, brake fluid, urea nitrogen, liquid lime, NPK fertilizer, ammonia hydroxide, alkaline degreaser | | | |
| Sealing | IP67, IP69K ¹ | | | |
| EMI/EMC: emission immunity | CISPR 25, ISO13766 ISO114252-2 (100 V/m at 200 MHz to 1 GHz, 50 V/m at 1 GHz to 2 GHz) ISO114252-5 (100 V/m at 10 kHz to 1 MHz) ISO114252-4 (100 mA at 1 MHz to 400 MHz) | | | |
| ESD | SAE J1113.13 (Nov 2004), 8 kV direct/15 kV air discharge | | | |
| Can bus standard | CAN-29 bits | | | |

Note 1: Paint peel during IPX9K testing is not considered as failure

Table 2. Installation Information

| Characteristic | Description |
|--------------------|---|
| Mating connector | Deutsch DT06-12S |
| Sealing plug | Deutsch 114017 (for unused connector terminations) |
| Weight | 675 g |
| Heading direction | +X |
| Mounting direction | +Z |
| Mounting bolt | M6X1 socket head cap stainless steel, length 20 mm min., torque 8 N m to 10 N m |

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Table 3. Sensor Specifications

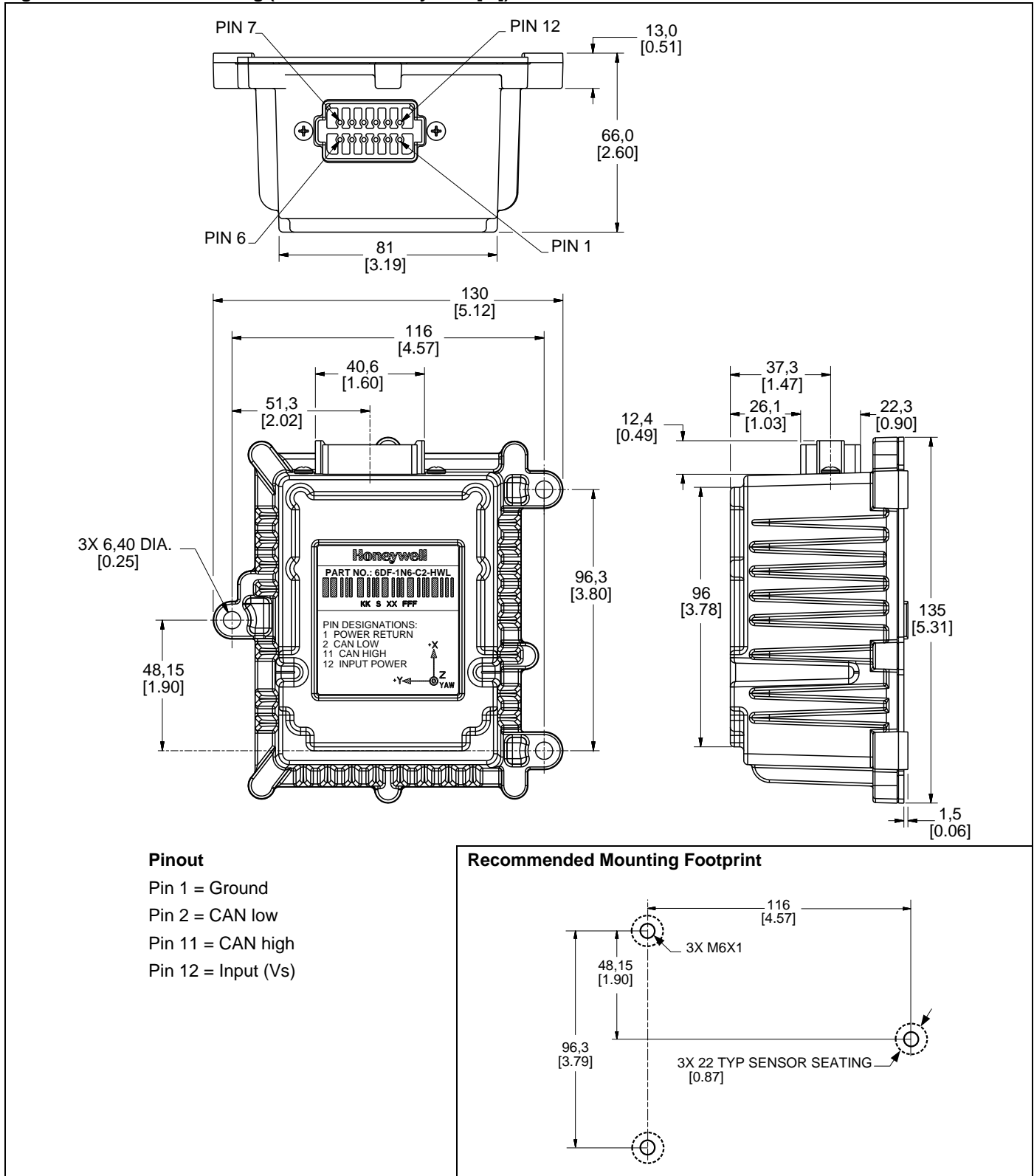
| 3-Axis Rotational Rate (X, Y, Z) | | | | | | | |
|---|-----------------------------------|---------|---------|----------------|---------|---------|------------------------|
| Characteristic | 6DF-1N2-C2-HWL and 6DF-1N6-C2-HWL | | | | | | Unit |
| | Minimum | Typical | | Maximum | | | |
| Range | -75 | - | | 75 | | | °/s |
| Resolution ¹ | - | 0.044 | | - | | | °/s |
| Linearity error | -1 | ±0.25 | | 1 | | | °/s |
| Noise | - | 0.25 | | 0.45 | | | °/s (RMS) |
| Sensitivity error | -4 | ±1.06 | | 4 | | | %FSS |
| Offset error ² | -2.5 | ±0.5 | | 2.5 | | | °/s |
| Frequency response | - | 22 | | - | | | Hz |
| G-Sensitivity ³ | -0.8 | ±0.5 | | +0.8 | | | °/s/g |
| Noise (pk-pk) ⁴ | -2 | ±1.5 | | 2 | | | °/s (pk-pk) |
| 2-Axis Inclination (X, Y) | | | | | | | |
| Characteristic | 6DF-1N2-C2-HWL and 6DF-1N6-C2-HWL | | | | | | Unit |
| | Minimum | Typical | | Maximum | | | |
| Range | -50 | - | | 50 | | | ° |
| Resolution ¹ | - | 0.025 | | - | | | ° |
| Linearity error | -0.2 | ±0.1 | | 0.2 | | | ° |
| Noise | - | 0.2 | | 0.45 | | | ° (RMS) |
| Sensitivity error | -2 | ±1 | | 2 | | | %FSS |
| Offset error ² | -2 | ±0.25 | | 2 | | | ° |
| Frequency response | - | 30 | | - | | | Hz |
| 3-Axis Acceleration (X, Y, Z) ^{5, 6} | | | | | | | |
| Characteristic | 6DF-1N2-C2-HWL | | | 6DF-1N6-C2-HWL | | | Unit |
| | Minimum | Typical | Maximum | Minimum | Typical | Maximum | |
| Range | -19.81 | - | 19.81 | -58.86 | - | 58.86 | m/s ² |
| Resolution ¹ | - | 0.022 | - | - | 0.03 | - | m/s ² |
| Linearity error | -0.392 | ±0.05 | 0.392 | -0.687 | ±0.05 | 0.687 | m/s ² |
| Noise | - | 0.2 | 0.45 | - | 0.2 | 0.45 | m/s ² (RMS) |
| Sensitivity error | -4 | ±0.5 | 4 | -3 | ±0.5 | 3 | %FSS |
| Offset error ² | -1 | ±0.245 | 1 | -1 | ±0.490 | 1 | m/s ² |
| Frequency response | - | 24 | - | - | 24 | - | Hz |

Notes:

- Resolution refers to sensor resolution and not CAN output resolution.
- Offset error is measured at relatively zero level or on a flat surface.
- G-Sensitivity is measured at 25 °C [77 °F].
- Pk-pk noise of rotational rate sensor is measured at 0 °/s at 25 °C [77 °F].
- Accelerometer specification is tested up to ±0.499 g (4.895 m/s²).
- Measuring specific force at 1 g = 9.8 m/s².

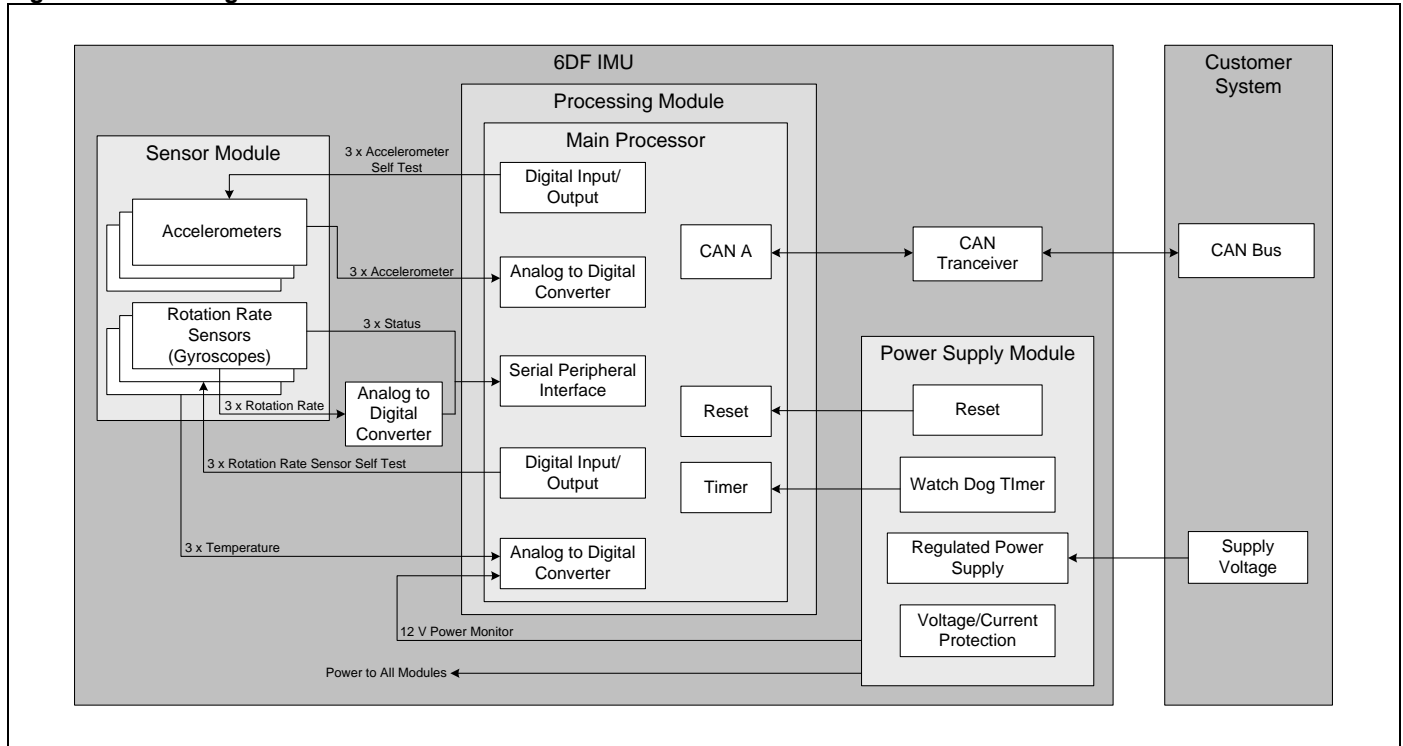
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Figure 3. Dimensional Drawing (For reference only: mm/[in])



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Figure 4. Block Diagram



Order Guide

| Catalog Listing | Description |
|-----------------|---|
| 6DF-1N2-C2-HWL | 6DF Series Inertial Measurement Unit, 6-D Motion Variant, 2 g accelerometer |
| 6DF-1N6-C2-HWL | 6DF Series Inertial Measurement Unit, 6-D Motion Variant, 6 g accelerometer |

WARNING

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items it finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this printing. However, we assume no responsibility for its use.

WARNING

MISUSE OF DOCUMENTATION

- The information presented in this product sheet is for reference only. Do not use this document as a product installation guide.
- Complete installation, operation, and maintenance information is provided in the instructions supplied with each product.

Failure to comply with these instructions could result in death or serious injury.

SALES AND SERVICE

Honeywell serves its customers through a worldwide network of sales offices, representatives and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact your local sales office or:

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