# MicroStrain Sensing Product Datasheet

## 3DM-GX5-VRU

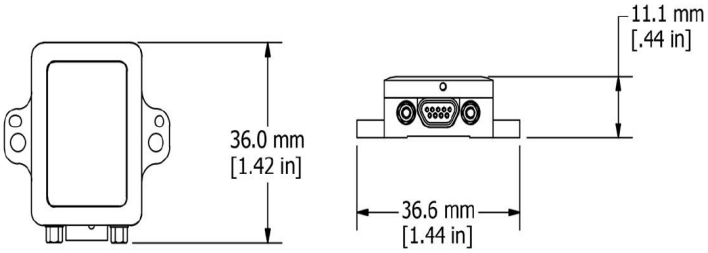
### Vertical Reference Unit


The MicroStrain Sensing 3DM-GX5 family of high-performance, industrial-grade inertial sensors provides a wide range of triaxial inertial measurements, computed attitude, and navigation solutions.

In all models, the Inertial Measurement Unit (IMU) includes direct measurement of acceleration and angular rate, and is fully temperature-compensated and calibrated over the operating temperature. The use of Micro-Electro-Mechanical System (MEMS) technology allows for highly accurate, small, lightweight devices.

SensorConnect software is a user friendly program for device configuration. MIP Monitor (MicroStrain Internet Protocol) can also be used. Both packages provide for device configuration, live data monitoring, and recording. Alternatively, the MIP Data Communications Protocol is available for development of custom interfaces and easy OEM integration.

The sensor operates independent of computer platform, operating system, or coding language.




### PRODUCT HIGHLIGHTS

- Triaxial accelerometer, gyroscope, magnetometer, temperature sensors achieve the optimal combination of measurement qualities
- Dual on-board processors run a new Auto-Adaptive Extended Kalman Filter (EKF) for outstanding dynamic attitude estimates
- Smallest, lightest, highest performance VR in its class

### FEATURES AND BENEFITS

#### BEST IN CLASS PERFORMANCE

- Fully calibrated, temperature-compensated, and mathematically-aligned to an orthogonal coordinate system for highly accurate outputs
- Bias tracking, error estimation, threshold flags, and adaptive noise modeling allow for fine tuning to conditions in each application
- High-performance, low-drift gyros with low noise density and Vibrational Rectification Error
- Accelerometer noise as low as 20 ug/$\sqrt{Hz}$

#### EASE OF USE

- SensorConnect enables simple device configuration, live data monitoring, and recording
- The MSCL API allows easy integration with C++, Python, .NET, C#, Visual Basic, LabVIEW and MATLAB environments.Robust, forward compatible MIP packet protocol
- MIP open byte level communication protocol
- User-defined sensor-to-vehicle frame transformation

#### COST EFFECTIVE

- Out-of-the box solution reduces development time
- Volume discounts

### APPLICATIONS

- Unmanned vehicle navigation
- Robotics
- Platform stabilization, artificial horizon
- Health and usage monitoring of vehicles

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# Vertical Reference Unit (VRU)

## Specifications

| General | | |
|---|---|---|
| **Integrated Sensors** | Triaxial accelerometer, triaxial gyroscope, pressure altimeter, and temperature sensors | |
| **Data Outputs** | **Inertial Measurement Unit (IMU) outputs:** acceleration, angular rate, ambient pressure, Delta-theta, Delta-velocity<br>**COMPUTED OUTPUTS**<br>**Extended Kalman Filter (EKF):** filter status, attitude estimates (in Euler angles, quaternion,orientation matrix), bias compensated angular rate, pressure altitude, gravity-free linear acceleration, attitude uncertainties, gyroscope and accelerometer bias, scale factors and uncertainties, gravity models, and more.<br>**Complementary Filter (CF):** attitude estimates (in Euler angles, quaternion, orientation matrix) stabilized, north and up vectors, GPS correlation timestamp | |
| **Inertial Measurement Unit (IMU) Sensor Outputs** | | |
| | **Accelerometer** | **Gyroscope** |
| **Measurement range** | ±8 g (standard)<br>±2 g, ±4 g, ±20 g, ±40 g (optional) | 300°/sec (standard)<br>±75, ±150, ±900 (optional) |
| **Non-linearity** | ±0.02 % fs | ±0.02% fs |
| **Resolution** | 0.02 mg (+/- 8 g) | <0.003°/sec (300 dps) |
| **Bias instability** | ±0.04 mg | 8°/hr |
| **Initial bias error** | ±0.002 g | ±0.04°/sec |
| **Scale factor stability** | 0.03% | ±0.05% |
| **Noise density** | 20 µg/√Hz (2 g) | 0.005°/sec/√Hz (300°/sec) |
| **Alignment error** | ±0.05° | ±0.05° |
| **Bandwidth** | 225 Hz | 250 Hz |
| **Offset error over temperature** | 0.06% (typ) | 0.04% (typ) |
| **Gain error over temperature** | 0.03% (typ) | 0.03% (typ) |
| **Vibration induced noise** | -- | 0.072°/s RMS/g RMS |
| **Vibration rectification error (VRE)** | -- | 0.001°/s/g² RMS |
| **IMU filtering** | Digital sigma-delta ADC sampled at 1kHz and 4kHz. 4kHz data averaged to 1kHz nominal sampling rate. Scaled into physical units at 1kHz. User adjustable IIR filter available for 1kHz data. Coning and sculling integrals computed at 1kHz. | |
| **Sampling rate** | 1 kHz | 4 kHz |
| **IMU data output rate** | 1 Hz to 1000 Hz | |
| **Pressure Altimeter** | | |
| **Altitude Range** | 1260-260 mB (hPa) (-500 to 10,000m) | |
| **Resolution** | 0.01 hPa RMS | |
| **Relative Accuracy** | ±0.1 mB, over the range 800-1000mB @ T=25°C | |
| **Sampling rate** | 25 Hz | |

| Computed Outputs | |
|---|---|
| **Attitude accuracy** | EKF outputs: ±0.25° RMS roll and pitch, (typ)<br>CF outputs: ±0.5° roll and pitch (static, typ) and ±2.0° roll and pitch (dynamic, typ) |
| **Attitude heading range** | 360° about all axes |
| **Attitude resolution** | < 0.01° |
| **Attitude repeatability** | 0.2° (typ) |
| **Calculation update rate** | 500 Hz |
| **Computed data output rate** | EKF outputs: 1 Hz to 500 Hz<br>CF outputs: 1 Hz to 1000 Hz |
| **Operating Parameters** | |
| **Communication** | USB 2.0 (full speed)<br>RS232 (9,600 bps to 921,600 bps, default 115,200) |
| **Power source** | +4 to + 36 V dc |
| **Power consumption** | 500 mW (typ) |
| **Operating temperature** | -40°C to +85°C |
| **Mechanical shock limit** | 500*g*/1ms absolute maximum survivability.* |
| **MTBF** | 557,280 hours (Telcordia method, GM/35C) |
| **Physical Specifications** | |
| **Dimensions** | 36.0 mm x 36.6 mm x 11.1 mm |
| **Weight** | 16.5 grams |
| **Enclosure material** | Aluminum |
| **Regulatory compliance** | CE, REACH, ROHS |
| **Integration** | |
| **Connectors** | Data/power: Micro-D9 |
| **Software** | SensorConnect and MIP Monitor software included; Windows XP/Vista/7/8/10 compatible |
| **Data Communications Protocol (DCP)** | Protocol compatibility across GX3, GX4, RQ1, GQ4, GX5 CX5 and CV5 product families |
| **Software development kit (SDK)** | MicroStrain Communication Library (MSCL) open source license includes full documentation and sample code.) |

*Prolonged exposure to >2x full scale range can result in permanent damage. See manual for details

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