

## 3DM<sup>®</sup>-GX5-15 Vertical Reference Unit (VRU)



*3DM-GX5-15 – miniature, high-performance, industrial-grade inertial measurement unit (IMU) and vertical reference unit (VRU)*

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

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

The LORD Sensing MIP Monitor software can be used 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.

### 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 noise density of  $0.005^\circ/\text{sec}/\sqrt{\text{Hz}}$  and VRE of  $0.001^\circ/\text{s}/\text{g}^2\text{RMS}$
- Accelerometer noise as low as  $25 \mu\text{g}/\sqrt{\text{Hz}}$

#### EASE OF USE

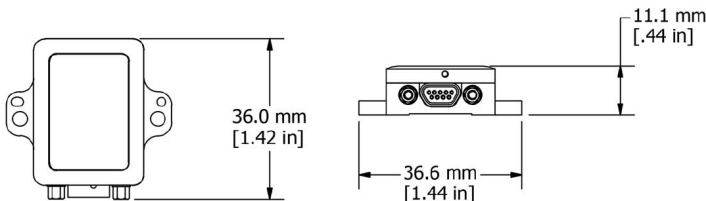
- User-defined sensor-to-vehicle frame transformation
- Easy integration via comprehensive and fully backwards-compatible communication protocol
- Robust, forward compatible MIP packet protocol

#### COST EFFECTIVE

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

#### APPLICATIONS

- Platform stabilization, artificial horizon
- Health and usage monitoring of vehicles



# 3DM®-GX5-15 Vertical Reference Unit (VRU)

## Specifications

General		
<b>Integrated Sensors</b>	Triaxial accelerometer, triaxial gyroscope, pressure altimeter, and temperature sensors	
<b>Data Outputs</b>	<b>Inertial Measurement Unit (IMU) outputs:</b> acceleration, angular rate, ambient pressure, Delta-theta, Delta-velocity <b>COMPUTED OUTPUTS</b> <b>Extended Kalman Filter (EKF):</b> 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. <b>Complementary Filter (CF):</b> attitude estimates (in Euler angles, quaternion, orientation matrix) stabilized, north and up vectors, GPS correlation timestamp	
Inertial Measurement Unit (IMU) Sensor Outputs		
	Accelerometer	Gyroscope
<b>Measurement range</b>	±8 g (standard) ±2 g, ±4 g, ±20 g, ±40 g (optional)	300°/sec (standard) ±75, ±150, ±900 (optional)
<b>Non-linearity</b>	±0.02 % fs	±0.02% fs
<b>Resolution</b>	0.02 mg (+/- 8 g)	<0.003°/sec (300 dps)
<b>Bias instability</b>	±0.04 mg	8°/hr
<b>Initial bias error</b>	±0.002 g	±0.04°/sec
<b>Scale factor stability</b>	0.03%	±0.05%
<b>Noise density</b>	25 µg/√Hz (2 g)	0.005°/sec/√Hz (300°/sec)
<b>Alignment error</b>	±0.05°	±0.05°
<b>Bandwidth</b>	225 Hz	250 Hz
<b>Offset error over temperature</b>	0.06% (typ)	0.04% (typ)
<b>Gain error over temperature</b>	0.03% (typ)	0.03% (typ)
<b>Vibration induced noise</b>	--	0.072°/s RMS/g RMS
<b>Vibration rectification error (VRE)</b>	--	0.001°/s/g² RMS
<b>IMU filtering</b>	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.	
<b>Sampling rate</b>	1 kHz	4 kHz
<b>IMU data output rate</b>	1 Hz to 1000 Hz	

Pressure Altimeter	
<b>Range</b>	-1800 m to 10,000 m
<b>Resolution</b>	< 0.1 m
<b>Noise density</b>	0.01 hPa RMS
<b>Sampling rate</b>	25 Hz
Computed Outputs	
<b>Attitude accuracy</b>	EKF outputs: ±0.25° RMS roll and pitch, (typ) CF outputs: ±0.5° roll and pitch (static, typ) and ±2.0° roll and pitch (dynamic, typ)
<b>Attitude heading range</b>	360° about all axes
<b>Attitude resolution</b>	< 0.01°
<b>Attitude repeatability</b>	0.2° (typ)
<b>Calculation update rate</b>	500 Hz
<b>Computed data output rate</b>	EKF outputs: 1 Hz to 500 Hz CF outputs: 1 Hz to 1000 Hz
Operating Parameters	
<b>Communication</b>	USB 2.0 (full speed) RS232 (9,600 bps to 921,600 bps, default 115,200)
<b>Power source</b>	+4 to +36 V dc
<b>Power consumption</b>	500 mW (typ)
<b>Operating temperature</b>	-40°C to +85°C
<b>Mechanical shock limit</b>	500g/1ms survivability
Physical Specifications	
<b>Dimensions</b>	36.0 mm x 36.6 mm x 11 mm
<b>Weight</b>	16.5 grams
<b>Enclosure material</b>	Aluminum
<b>Regulatory compliance</b>	ROHS, CE
Integration	
<b>Connectors</b>	Data/power output: micro-DB9
<b>Software</b>	MIP Monitor, Windows XP/Vista/7/8/10 compatible
<b>Compatibility</b>	Protocol compatibility across 3DM®-GX3, GX4, RQ1, GQ4, GX5 and CV5 product families
<b>Software development kit (SDK)</b>	MIP data communications protocol with sample code available (OS and platform independent)

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