LORD **DATASHEET**

3DM-GX4-45™

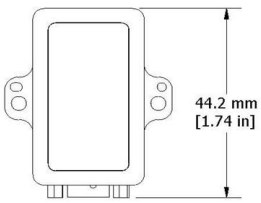
GPS-Aided Inertial Navigation System (GPS/INS)

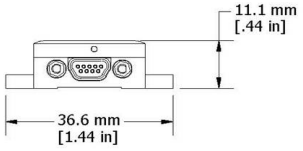
3DM-GX4-45™ - *miniature industrial-grade all-in-one navigation solution with integrated GPS and magnetometers, high noise immunity, and exceptional performance*

The **LORD MicroStrain®** family of **industrial** and **tactical 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, angular rate, and atmospheric pressure. Sensor measurements are processed through an on-board processor running a sophisticated estimation filter or fusion algorithm to produce high accuracy computed outputs with compensation options for magnetic and linear acceleration anomalies, sensor biases, auto-zero update, and noise offsets. The computed outputs vary between models and can include pitch, roll, yaw, a complete attitude, heading, and reference solution (AHRS) or a complete position, velocity and attitude solution (PVA), as well as integrated GNSS outputs. All sensors are 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.

The LORD MicroStrain® **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

- High performance integrated GPS receiver and MEMS sensor technology provide direct satellite and inertial measurements, and computed position, velocity, and attitude outputs in a small package
- Triaxial accelerometer, gyroscope, magnetometer, temperature sensors, and a pressure altimeter achieve the best combination of measurement qualities
- Dual on-board processors run a sophisticated Extended Kalman Filter (EKF) for excellent PVA estimates

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, magnetic, and gravitational field modeling allow for fine tuning to conditions in each application
- High-performance, low-drift gyros with noise density of 0.005°/sec/√Hz and VRE of 0.001°/s/g^2RMS
- Smallest and lightest industrial GPS/INSavailable

Ease of Use

- User-defined sensor-to-vehicle frame transformation
- Easy integration via comprehensive and fully backwards-compatible communication protocol
- Common protocol between 3DM-GX3, GX4, RQ1, GQ4, and GX5 inertial sensor families for easy migration

Cost Effective

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

Applications

- GPS-aided navigation system
- Unmanned vehicle navigation
- Platform stabilization, artificial horizon

3DM-GX4-45™ GPS-Aided Inertial Navigation System (GPS/INS)

Specifications

General			
Integrated sensors	Triaxial accelerometer, triaxial gyroscope, triaxial magnetometer, temperature sensors, pressure altimeter, and GPS receiver		
Data outputs	**Inertial Measurement Unit (IMU) outputs:** acceleration, angular rate, magnetic field , ambient pressure, deltaTheta, deltaVelocity **Computed outputs:** **Extended Kalman Filter (EKF):** filter status, GPS timestamp, LLH position, NED velocity, attitude estimates (in Euler angles, quaternion, orientation matrix), linear and compensated acceleration, bias compensated angular rate, pressure altitude, gyroscope and accelerometer bias, scale factors and uncertainties, gravity and magnetic models, and more. **Complementary Filter (CF):** attitude estimates (in Euler angles, quaternion, orientation matrix), stabilized north and gravity vectors, GPS correlation timestamp **Global Positioning System outputs (GPS):** LLH position, ECEF position and velocity, NED velocity, UTC time, GPS time, SV. GPS protocol access mode available.		
Inertial Measurement Unit (IMU) Sensor Outputs			
	Accelerometer	**Gyroscope**	**Magnetometer**
Measurement range	±5 *g* (standard) ±16*g* (option)	300°/sec (standard) ±75, ±150, ±900 °/sec (options)	±2.5 Gauss
Non-linearity	±0.03 % fs	±0.03 % fs	±0.4% fs
Resolution	<0.1 m*g*	<0.008°/sec	--
Bias instability	±0.04 m*g*	10°/hr	--
Initial bias error	±0.002 *g*	±0.05°/sec	±0.003 Gauss
Scale factor stability	±0.05 %	±0.05 %	±0.1 %
Noise density	100 µg/√Hz	0.005°/sec/√Hz	100 µGauss/√Hz
Alignment error	±0.05°	±0.05°	±0.05°
Adjustable bandwidth	225 Hz (max)	250 Hz (max)	-
Offset error over temperature	0.06% (typ)	0.05 % (typ)	--
Gain error over temperature	0.05% (typ)	0.05% (typ)	--
Scale factor non-linearity (@ 25° C)	0.02% (typ) 0.06% (max)	0.02% (typ) 0.06% (max)	±0.0015 Gauss
Vibration induced noise	--	0.072°/s RMS/*g* RMS	--
Vibration rectification error (VRE)	--	0.001°/s/g^2 RMS	--
IMU filtering	4 stage filtering: analog bandwidth filter to digital sigma-delta wide band anti-aliasing filter to (user adjustable) digital averaging filter sampled at 4 kHz and scaled into physical units; coning and sculling integrals computed at 1 kHz		
Sampling rate	4 kHz	4 kHz	50 Hz
IMU data output rate	1 Hz to 500 Hz		
Pressure Altimeter			
Range	-1800 m to 10,000 m		
Resolution	< 0.1 m		
Noise density	0.01 hPa RMS		
Sampling rate	25 Hz		

Computed Outputs	
Position accuracy	±2.5 m RMS horizontal, ± 5 m RMS vertical (typ)
Velocity accuracy	±0.1 m/s RMS (typ)
Attitude accuracy	EKF outputs: ±0.25° RMS roll & pitch, ±0.8° RMS heading (typ) CF outputs: ±0.5° roll, pitch, and heading (static, typ), ±2.0° roll, pitch, and heading (dynamic, typ)
Attitude heading range	360° about all axes
Attitude resolution	< 0.01°
Attitude repeatability	0.3° (typ)
Calculation update rate	500 Hz
Computed data output rate	EKF outputs: 1 Hz to 500 Hz CF outputs: 1 Hz to 1000 Hz
Global Positioning System (GPS) Outputs	
Receiver type	50-channel u-Blox 6 engine GPS, L1 frequency, C/A code SBAS: WAAS, EGNOS, MSAS
GPS data output rate	1 Hz to 4 Hz
Time-to-first-fix	Cold start: 27 second, aided start: 4 second, hot start: 1 second
Sensitivity	Tracking: -159 dBm, cold start: -147 dBm, hot start: -156 dBm
Velocity accuracy	0.1 m/sec
Heading accuracy	0.5°
Horizontal position accuracy	GPS: 2.5 m CEP SBAS: 2.0 m CEP
Time pulse signal accuracy	30 nsec RMS < 60 nsec 99%
Acceleration limit	≤ 4 *g*
Altitude limit	No limit
Velocity limit	500 m/sec (972 knots)
Operating Parameters	
Communication	USB 2.0 (full speed) RS232 (9,600 bps to 921,600 bps, default 115,200)
Power source	+ 3.2 to + 36 V dc
Power consumption	170 mA (typ), 200 mA (max) @ Vpri = 3.2 - 5.5 Vdc 750 mW (typ), 900 mW (max) @ Vaux = 5.2 - 36 Vdc
Operating temperature	-40 °C to +85 °C
Mechanical shock limit	500 *g* (calibration unaffected) 1000 *g* (bias may change), 5000 *g* (survivability)
MTBF	180,000 hours (Telcordia method I, GL/35C) 67,000 hours (Telcordia method I, GM/35C)
Physical Specifications	
Dimensions	44.2 mm x 24.0 mm x 36.6 mm
Weight	20 grams
Enclosure material	Aluminum
Regulatory compliance	ROHS, CE
Integration	
Connectors	Data/power output: micro-DB9 GPS antenna: MMCX type
Software	MIP™ Monitor, MIP™ Hard and Soft Iron Calibration, Windows XP/Vista/7/8 compatible
Compatibility	Protocol compatibility across 3DM-GX3, GX4, RQ1, GQ1, and GX5 product families
Software development kit (SDK)	MIP™ data communications protocol with sample code available (OS and platform independent)

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