

## 3DM<sup>®</sup>-CX5-45

### GNSS-Aided Inertial Navigation System (GNSS/INS)

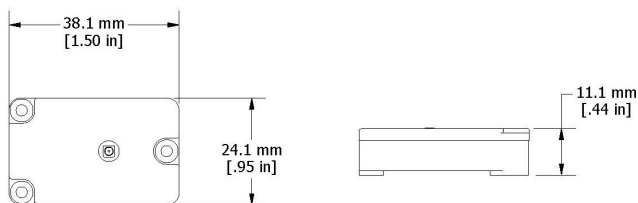


3DM-CX5-45- miniature, high-performance, industrial-grade all-in-one navigation solution with integrated multi-constellation GNSS, high noise immunity, and exceptional performance

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

The **3DM-CX5-45** all-in-one navigation solution features a high-performance, integrated multi-constellation GNSS receiver utilizing the GPS, GLONASS, BeiDou, and Galileo satellite constellations. Sensor measurements are fully calibrated, temperature-compensated, and mathematically-aligned to an orthogonal coordinate system for highly accurate outputs. The auto-adaptive estimation filter algorithm produces highly accurate computed outputs under dynamic conditions. Compensation options include automatic compensation for magnetic anomalies, gyro and accelerometer noise, and noise effects. The computed outputs include pitch, roll, yaw, heading, position, velocity, and GNSS outputs- making it a complete GNSS/INS (GNSS Aided Inertial Navigation System) solution. The use of Micro-Electro-Mechanical System (MEMS) technology provides a highly accurate, small, light-weight device.

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

- High-performance integrated multi-constellation GNSS receiver and advanced MEMS sensor technology provide direct inertial measurements, outputs in a small package
- Triaxial accelerometer, gyroscope, magnetometer, temperature sensors, and a pressure altimeter achieve the optimal combination of measurement qualities
- Dual on-board processors run a new Auto-Adaptive Extended Kalman Filter (EKF) for outstanding dynamic position, velocity, and attitude estimates

### Features and Benefits

#### **Best in Class Performance**

- Fully calibrated, temperature-compensated, and mathematically-aligned to an orthogonal coordinate system for highly accurate outputs
- High-performance, low-drift gyros with noise density of  $0.005^\circ/\text{sec}/\sqrt{\text{Hz}}$  and VRE of  $0.001^\circ/\text{s}/g^2\text{RMS}$
- Accelerometer noise as low as  $25 \mu g/\sqrt{\text{Hz}}$

#### **Ease of Use**

- Automatic magnetometer calibration and anomaly rejection eliminates the need for field calibration
- Automatically compensates for vehicle noise and vibration
- Easy integration via comprehensive and fully backwards-compatible communication protocol

#### **Cost Effective**

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

### Applications

- GNSS-aided navigation system
- Platform stabilization, artificial horizon
- Satellite dish, radar, and antenna pointing

## Specifications

General			
<b>Integrated sensors</b>	Triaxial accelerometer, triaxial gyroscope, triaxial magnetometer, pressure altimeter, temperature sensors, and GNSS receiver		
<b>Data outputs</b>	<p><b>Inertial Measurement Unit (IMU) outputs:</b> acceleration, angular rate, magnetic field, ambient pressure, Delta-theta, Delta-velocity</p> <p><b>Computed outputs</b>  <b>Extended Kalman Filter (EKF):</b> filter status, GNSS 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.  <b>Complementary Filter (CF):</b> attitude estimates (in Euler angles, quaternion, orientation matrix) stabilized, north and up vectors, GNSS correlation timestamp</p> <p><b>Global Positioning System outputs (GPS): Global Navigation Satellite System outputs (GNSS):</b> LLH position, ECEF position and velocity, NED velocity, UTC time, GNSS time, SV. GNSS protocol access mode available.</p>		
Inertial Measurement Unit (IMU) Sensor Outputs			
	Accelerometer	Gyroscope	Magnetometer
<b>Measurement range</b>	±8 g (standard) ±2 g, ±4 g, ±20 g, ±40 g (optional)	±300°/sec (standard) ±75, ±150, ±900 (optional)	±2.5 Gauss
<b>Non-linearity</b>	±0.02 % fs	±0.02% fs	±0.3% fs
<b>Resolution</b>	<0.1 mg	<0.003°/sec	--
<b>Bias instability</b>	±0.04 mg	8°/hr	--
<b>Initial bias error</b>	±0.002 g	±0.04°/sec	±0.003 Gauss
<b>Scale factor stability</b>	0.03%	±0.05%	±0.1%
<b>Noise density</b>	25 µg/√Hz (2 g)	0.005°/sec/√Hz (300°/sec)	100 µGauss/√Hz
<b>Alignment error</b>	±0.05°	±0.08°	±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/g <sup>2</sup> RMS	--
<b>IMU filtering</b>	Digital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.		
<b>Sampling rate</b>	1 kHz	4 kHz	50 Hz
<b>IMU data output rate</b>	1 Hz to 500 Hz (standard mode), 1 Hz to 1000 Hz (sensor direct mode)		
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>Position accuracy</b>	±2 m RMS horizontal, ±5 m RMS vertical (typ)
<b>Velocity accuracy</b>	±0.1 m/s RMS (typ)
<b>Attitude accuracy</b>	EKF outputs: ±0.25° RMS roll and pitch, ±0.8° RMS heading (typ) CF outputs: ±0.5° roll, pitch, and heading (static, typ), ±2.0° roll, 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 500 Hz
Global Navigation Satellite System (GNSS) Outputs	
<b>Receiver type</b>	72-channel GPS/QZSS L1 C/A, GLONASS L10F, BeiDou B1, SBAS L1 C/A: WAAS, EGNOS, MSAS Galileo E1B/C
<b>GNSS data output rate</b>	1 Hz to 4 Hz
<b>Time-to-first-fix</b>	Cold start: 27 second, reacquisition: 1 second, hot start: <1 second
<b>Sensitivity</b>	Tracking: -164 dBm, cold start: -147 dBm, hot start: -156 dBm
<b>Velocity accuracy</b>	0.1 m/sec
<b>Heading accuracy</b>	0.5°
<b>Horizontal position accuracy</b>	GNSS: 2.5 m CEP SBAS: 2.0 m CEP
<b>Time pulse signal accuracy</b>	30 nsec RMS < 60 nsec 99%
<b>Acceleration limit</b>	≤ 4 g
<b>Altitude limit</b>	50,000 meters
<b>Velocity limit</b>	500 m/sec (972 knots)
Operating Parameters	
<b>Communication</b>	USB 2.0 (full speed) TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200)
<b>Power source</b>	+ 3.2 to 5.2 V dc
<b>Power consumption</b>	700 mW (typ), 800 mW (max) 500 mW (typ)
<b>Operating temperature</b>	-40 °C to +85 °C
<b>Mechanical shock limit</b>	500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability)
<b>MTBF</b>	(TBD)
Physical Specifications	
<b>Dimensions</b>	38.1 mm x 24.1 mm x 11.1 mm
<b>Weight</b>	13 grams
<b>Enclosure material</b>	Aluminum
<b>Regulatory compliance</b>	ROHS, CE
Integration	
<b>Connectors</b>	Data/power output: micro-DB9 Samtec FTSH Series (FTSH-105-01-F-D-K) GNSS antenna: MMCX type
<b>Software</b>	MIP Monitor, MIP Hard and Soft Iron Calibration, 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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