

# MicroStrain Product Datasheet

## 3DM-CX5-GNSS/INS

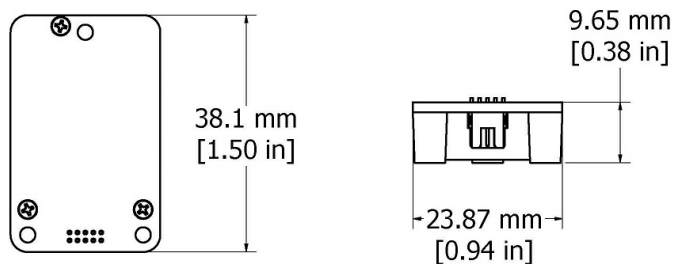
### GNSS Aided Inertial Navigation System



The MicroStrain Sensing 3DM-CX5 family of high-performance, industrial-grade, board-level inertial sensors provide a wide range of triaxial inertial measurements, computed attitude, and navigation solutions.

The 3DM-CX5-GNSS/INS 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. Micro-Electro-Mechanical Systems (MEMS) technology provides a highly accurate, small, light-weight device.

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

- 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 low noise density and vibration rectification error
- Accelerometer noise as low as 20  $\mu\text{g}/\sqrt{\text{Hz}}$

##### EASE OF USE

- Sensor Connect enables simple device configuration, live data monitoring and recording
- Optional hardware development kit available
- The MSCL API allows easy integration with C++, Python, .NET, C#, Visual Basic, LabVIEW and MATLAB environments
- MIP open byte level communication protocol
- Automatic magnetometer calibration and anomaly rejection eliminates the need for field calibration
- Automatically compensates for vehicle noise and vibration

##### COST EFFECTIVE

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

#### APPLICATIONS

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



ENGINEERING YOUR SUCCESS.

# GNSS Aided Inertial Navigation System

## Specifications

General				Computed Outputs	
<b>Integrated sensors</b>	Triaxial accelerometer, triaxial gyroscope, triaxial magnetometer, pressure altimeter, temperature sensors, and GNSS receiver			<b>Position accuracy</b>	±2 m RMS horizontal, ± 5 m RMS vertical (typ)
<b>Data outputs</b>	<b>Inertial Measurement Unit (IMU) outputs:</b> acceleration, angular rate, magnetic field, ambient pressure, Delta-theta, Delta-velocity <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 <b>Global Positioning System outputs (GPS)</b> <b>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.			<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° RMS 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: up to 500 Hz CF outputs: up to 500 Hz	
Inertial Measurement Unit (IMU) Sensor Outputs				Global Navigation Satellite System (GNSS) Outputs	
	<b>Accelerometer</b>	<b>Gyroscope</b>	<b>Magnetometer</b>	<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>Measurement range</b>	±8 g (standard) ±2 g, ±4 g, ±20 g, ±40 g (optional)	300°/sec (standard) ±75, ±150, ±900 (optional)	±8 Gauss	<b>GNSS data output rate</b>	1 Hz to 4 Hz
<b>Non-linearity</b>	±0.02% fs	±0.02% fs	±0.3% fs	<b>Time-to-first-fix</b>	Cold start: 27 second, reacquisition: 1 second hot start: <1 second
<b>Resolution</b>	0.02 mg (+/- 8 g)	<0.003°/sec (300 dps)	--	<b>Sensitivity</b>	Tracking: -164 dBm, cold start: -147 dBm hot start: - 156 dBm
<b>Bias instability</b>	±0.04 mg	8°/hr	--	<b>Velocity accuracy</b>	0.1 m/sec
<b>Initial bias error</b>	±0.002 g	±0.04°/sec	±0.003 Gauss	<b>Heading accuracy</b>	0.5°
<b>Scale factor stability</b>	±0.03%	±0.05%	±0.1%	<b>Horizontal position accuracy</b>	GNSS: 2.5 m CEP SBAS: 2.0 m CEP
<b>Noise density</b>	20 µg/√Hz (2 g)	0.005°/sec/√Hz (300°/sec)	400 µGauss/√Hz	<b>Time pulse signal accuracy</b>	30 nsec RMS < 60 nsec 99%
<b>Alignment error</b>	±0.05°	±0.08°	±0.05°	<b>Acceleration limit</b>	≤ 4 g
<b>Adjustable bandwidth</b>	225 Hz	250 Hz	--	<b>Altitude limit</b>	50,000 meters
<b>Offset error over temperature</b>	0.06% (typ)	0.04% (typ)	--	<b>Velocity limit</b>	500 m /sec (972 knots)
<b>Gain error over temperature</b>	0.03% (typ)	0.03% (typ)	--	Operating Parameters	
<b>Vibration induced noise (VRE) Vibration rectification error</b>	--	0.072°/s RMS/g RMS	--	<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>IMU filtering</b>	Digital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.			<b>Power source</b>	+ 3.2 to 5.2 V dc
<b>Sampling rate</b>	1 kHz	4 kHz	100 Hz	<b>Power consumption</b>	500 mW (typ)
<b>IMU data output rate</b>	1 Hz to 500 Hz (standard mode) 1 Hz to 1000 Hz (sensor direct mode)			<b>Operating temperature</b>	-40°C to +85°C
Pressure Altimeter				<b>Mechanical shock limit</b>	500g/1ms absolute maximum survivability.*
<b>Range</b>	-1400 m to 10,000 m (1260-260 hPa)			<b>MTBF</b>	400,094 hours (Telcordia method, GM/35C)
<b>Resolution</b>	0.01 hPa RMS			Physical Specifications	
<b>Relative Accuracy</b>	± 0.1 hPa over the range 800-1000 hPa @ T= 25°C			<b>Dimensions</b>	38 mm x 24 mm x 9.7 mm
<b>Sampling rate</b>	25 Hz			<b>Weight</b>	8 grams
				<b>Enclosure material</b>	Aluminum
				<b>Regulatory compliance</b>	CE, REACH, ROHS
				Integration	
				<b>Connectors</b>	Data/power: Samtec FTSH Series GNSS antenna: MMCX type Connectivity kit: Micro-D9
				<b>Software</b>	SensorConnect and MIP Monitor software included; Windows XP/Vista/7/8/10 compatible
				<b>Data Communications Protocol (DCP)</b>	Protocol compatibility across GX3, GX4, RQ1, GQ4, GX5 CX5 and CV5 product families
				<b>Software development kit (SDK)</b>	MicroStrain Communication Library (MSCL) open source license includes full documentation and sample code.

\* Note: Repeated exposure to > 2x full scale can result in permanent damage.



Parker Hannifin Corporation  
**MicroStrain Sensing**  
 459 Hurricane Lane  
 Williston, VT 05495 · USA

phone: +1.802.862.6629  
 email: sensing\_sales@LORD.com  
 sensing\_support@LORD.com  
 www.microstrain.com  
 www.parker.com