LORD DATASHEET

3DM[®]-CX5-45

GNSS-Aided Inertial Navigation System (GNSS/INS)

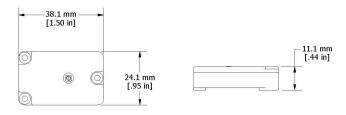


3DM-CX5-45- miniature, high-performance, industrial-grade allin-one navigation solution with integrated multi-constellation GNSS, high noise immunity, and exceptional performance

The **LORD Sensing** family of high-performance, industrialgrade 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 highperformance, 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, vaw, 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°/sec/\/Hz and VRE of 0.001°/s/g²RMS
- Accelerometer noise as low as 25 ug/\sqrt{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 backwardscompatible 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

Integrated sensors Triaxial accelerometer, triaxial gyroscope, triaxial magnetometer, pressure alimeter, temperature sensors, and GNSS receiver Inertial Measurement Unit (IMU) outputs: acceleration, angular rate, magnetic field, ambient pressure, Delta-theta, Delta-velocity Computed outputs Extended Kalman Filter (EKF): 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. Outputs Complementary Filter (CF): attitude estimates (in Euler angles, quaternion, orientation matrix), stabilized, north and up vectors, GNSS correlation timestamp Global Positioning System outputs (GPS): Clobal Navigation Satellite System outputs (GNSS): LLH position, ECEF position and velocity, NED velocity, UTC time, GNSS time, SV. GNSS protocol access mode available. Non-linearity ±0.02 % 15 ±0.02% fs ±0.3% fs Resolution 0.01 mg <0.003% sc ±75, ±150, ±40 g (optional) ±2.5 Gauss Non-linearity ±0.02 % fs ±0.02% fs ±0.03% fs Resolution <0.03% ±0.05% ±0.1% Non-linearity ±0.05% fs ±0.05% ±0.1% Nordicarity ±0.95% fs ±0.05% ±0.1%		Gene	ral		
angular rate, magnetic field, ambient pressure, Delta-theta, Delta-velocity Computed outputs Extended Kalman Filter (EKF): filter status, GNSS timestamp,LLH position, NED velocity, attitude estimates (in Euler angles, quaternion, orientation matrix), linear and compensated acceleration, bias compensate	-	magnetometer, press			
Data outputs Extended Kalman Filter (EKF): filter status, GNSS timestamp, LLH position, NED velocity, attitude estimates (in 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 up vectors, GNSS correlation timestamp Global Positioning System outputs (GNSS): LLH position, Satellite System outputs (GNSS): ±0.3% fis Measurement range 18 g (standard) ±2 g, ±4 g, ±20 g, ±40 g (optional) ±300"/sec ±2.5 Gauss Non-linearity ±0.02 % fis ±0.03% fis Resolution <0.1 mg		angular rate, magneti			
Satellite System outputs (GNSS): LLH position, ECEF position and velocity, NED velocity, UTC time, GNSS time, SV.GNSS protocol access mode available. Inertial Measurement Unit (IMU) Sensor Outputs Magnetometer Accelerometer Gyroscope Magnetometer #8 g (standard) ±2 g, ±4 g, ±20 g, ±40 g (optional) ±300°/sec (standard) ±75, ±150, ±900 (optional) ±2.5 Gauss Non-linearity ±0.02 % fs ±0.02% fs ±0.02% fs ±0.3% fs Resolution <0.1 mg	Data outputs	Extended Kalman Filt timestamp, LLH posit Euler angles, quatern compensated accele pressure altitude, gyr factors and uncertain more. Complementary Filte angles, quaternion, o	ion, NED velocity, attitue ion,orientation matrix), li ration, bias compensate oscope and accelerome ties, gravity and magnet r (CF): attitude estimate rientation matrix) stabiliz	de estimates (in near and d angular rate, ter bias, scale ic models, and es (in Euler	
AccelerometerGyroscopeMagnetometerMeasurement range $\pm 8 g$ (standard) $\pm 2 g, \pm 4 g, \pm 20 g,$ $\pm 40 g$ (optional) $\pm 300^\circ$ /sec (standard) $\pm 75, \pm 150,$ ± 900 (optional) ± 2.5 GaussNon-linearity $\pm 0.02 \%$ fs $\pm 0.02\%$ fs $\pm 0.3\%$ fsResolution $<0.1 mg$ $<0.003^\circ$ /secBias instability $\pm 0.04 mg$ $8^\circ/hr$ Initial bias error $\pm 0.002 g$ $\pm 0.04^\circ/sec$ ± 0.003 GaussScale factor stability 0.03% $\pm 0.05\%$ $\pm 0.1\%$ Noise density $25 \mu g/\sqrt{Hz} (2 g)$ $0.005^\circ/sec/\sqrt{Hz}$ ($300^\circ/sec)$ 100 $\mu Gauss/\sqrt{Hz}$ Alignment error $\pm 0.05^\circ$ $\pm 0.08^\circ$ $\pm 0.05^\circ$ Bandwidth $225 Hz$ $250 Hz$ -Offset error over temperature 0.06% (typ) 0.04% (typ)Gain error over temperature 0.03% (typ) $0.072^\circ/s RMS/g$ RMSVibration rectification error (VRE)Digital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.Sampling rate $1 Hz$ to 500 Hz (standard mode), $1 Hz$ to 1000 Hz (stensor direct mode)-IMU data output rate $1 Hz$ to 500 Hz (standard mode), $1 Hz$ to 1000 Hz (stensor direct mode)-Resolution $< 0.1 m$ $0.01 hPa RMS$		Satellite System outputs (GNSS): LLH position, ECEF position and velocity, NED velocity, UTC time, GNSS time,			
Measurement range $\pm 8 g (standard)$ $\pm 2 g , \pm 4 g , \pm 20 g ,$ $\pm 40 g (optional)$ $\pm 300^\circ/sec (standard)$ $\pm 75, \pm 150,$ $\pm 900 (optional)$ $\pm 2.5 \text{ Gauss}$ Non-linearity $\pm 0.02 \% \text{ fs}$ $\pm 0.02\% \text{ fs}$ $\pm 0.3\% \text{ fs}$ Resolution $<0.1 \text{ mg}$ $<0.003^\circ/\text{sec}$ Bias instability $\pm 0.02 \text{ mg}$ $8^\circ/\text{hr}$ Initial bias error $\pm 0.002 g$ $\pm 0.04^\circ/\text{sec}$ $\pm 0.003 \text{ Gauss}$ Scale factor stability 0.03% $\pm 0.05\%$ $\pm 0.1\%$ Noise density $25 \mu g / \sqrt{\text{Hz}} (2 g)$ $0.005^\circ/\text{sec} / \sqrt{\text{Hz}}$ $(300^\circ/\text{sec})$ $100 \mu \text{Gauss} / \sqrt{\text{Hz}}$ Alignment error $\pm 0.05^\circ$ $\pm 0.08^\circ$ $\pm 0.05^\circ$ Bandwidth 225Hz 250Hz -Offset error over temperature $0.06\% (\text{typ})$ $0.04\% (\text{typ})$ Qibration induced noise $0.072^\circ/\text{s RMS}/g \text{RMS}$ Vibration rectification error (VRE)Digital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.Sampling rate 1kHz 4kHz 50Hz IMU data output rate 1Hz 4kHz 50Hz IMU data output rate 1Hz 4kmetrer 50Hz INU data output rate 1Hz 0.01Hp RMS 1Hz Noise density 0.01Hp RMS 0.01Hp RMS	Ine	rtial Measurement Unit	(IMU) Sensor Outputs		
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Resolution<0.1 mg	Non-linearity	±0.02 % fs	,	±0.3% fs	
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Bandwidth225 Hz250 Hz-Offset error over temperature0.06% (typ)0.04% (typ)Gain error over temperature0.03% (typ)0.03% (typ)Vibration induced noise0.072°/s RMS/g RMSVibration rectification error (VRE)Digital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.Sampling rate1 kHz4 kHz50 HzIMU filtering rateDigital sigma-delta wide band anti-aliasing filter to digital averaging filter (user adjustable) scaled into physical units.Sampling rate1 kHz4 kHz50 HzIMU data output rate1 Hz to 500 Hz (standard mode), 1 Hz to 1000 Hz (sensor direct mode)Pressure AltimeterRange1800 m to 10,000 mResolution<0.1 m	Noise density	25 μg/√Hz (2 <i>g</i>)			
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Noise density 0.01 hPa RMS	Range	-1800 m to 10,000 m			
······································	Resolution	< 0.1 m			
Compliane mto 25 Lin		0.01 hPa RMS			
Sampling rate 25 HZ	Sampling rate	25 Hz			

Computed Octority			
Computed Outputs			
Position accuracy	±2 m RMS horizontal, ±5 m RMS vertical (typ)		
Velocity accuracy	±0.1 m/s RMS (typ)		
	EKF outputs: ±0.25° RMS roll and pitch, ±0.8° RMS		
Attitude accuracy	heading (typ) CF outputs: ±0.5° roll, pitch, and heading (static, typ),		
	±2.0° roll, 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	EKF outputs: 1 Hz to 500 Hz		
rate	CF outputs: 1 Hz to 500 Hz		
Global Navigation Satellite System (GNSS) Outputs			
GIODUITTUT	72-channel GPS/QZSS L1 C/A, GLONASS L10F,		
Receiver type			
	Galileo E1B/C		
GNSS data output rate	1 Hz to 4 Hz		
Times to first first	Cold start: 27 second, reacquisition: 1 second, hot		
Time-to-first-fix	start: <1 second		
Consitivity	Tracking: -164 dBm, cold start: -147 dBm, hot start: -		
Sensitivity	156 dBm		
Velocity accuracy	0.1 m/sec		
Heading accuracy	0.5°		
Horizontal position	GNSS: 2.5 m CEP		
accuracy	SBAS: 2.0 m CEP		
Time pulse signal	30 nsec RMS		
accuracy	< 60 nsec 99%		
Acceleration limit	≤4 g		
Altitude limit	50,000 meters		
Velocity limit	500 m /sec (972 knots)		
	Operating Parameters		
	USB 2.0 (full speed)		
Communication	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default		
	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200)		
Communication Power source	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc		
	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max)		
Power source Power consumption	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ)		
Power source	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C		
Power source Power consumption	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected)		
Power source Power consumption Operating temperature Mechanical shock limit	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability)		
Power source Power consumption Operating temperature	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD)		
Power source Power consumption Operating temperature Mechanical shock limit MTBF	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance Connectors	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series (FTSH-105-01-F-D-K)GNSS antenna: MMCX type		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance Connectors Software	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series (FTSH-105-01-F-D-K)GNSS antenna: MMCX type MIP Monitor, MIP Hard and Soft Iron Calibration,		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance Connectors	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series (FTSH-105-01-F-D-K)GNSS antenna: MMCX type MIP Monitor, MIP Hard and Soft Iron Calibration, Windows XP/Vista/7/8/10 compatible		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance Connectors Software	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series (FTSH-105-01-F-D-K)GNSS antenna: MMCX type MIP Monitor, MIP Hard and Soft Iron Calibration, Windows XP/Vista/7/8/10 compatible Protocol compatibility across 3DM®-GX3, GX4, RQ1,		
Power source Power consumption Operating temperature Mechanical shock limit MTBF Dimensions Weight Enclosure material Regulatory compliance Connectors Software Compatibility	TTL serial (3.0 V dc, 9,600 bps to 921,600 bps, default 115,200) + 3.2 to 5.2 V dc 700 mW (typ), 800 mW (max) 500 mW (typ) -40 °C to +85 °C 500 g (calibration unaffected) 1000 g (bias may change), 5000 g (survivability) (TBD) Physical Specifications 38.1 mm x 24.1 mm x 11.1 mm 13 grams Aluminum ROHS, CE Integration Data/power output: micro-DB9Samtec FTSH Series (FTSH-105-01-F-D-K)GNSS antenna: MMCX type MIP Monitor, MIP Hard and Soft Iron Calibration, Windows XP/Vista/7/8/10 compatible Protocol compatibility across 3DM®-GX3, GX4, RQ1, GQ4, GX5 and CV5 product families		



LORD Corporation MicroStrain[®] Sensing Systems 459 Hurricane Lane , Suite 102 Williston, VT 05495 USA

ph: 802-862-6629 sensing_sales@LORD.com sensing_support@LORD.com