GEO•FOG 3D INS

Fiber Optic Gyro (FOG)-based Inertial Navigation System

Key Features

- Core processor: KVH 1750 IMU
- 6 DoF IMU consisting of integrated FOGs and accelerometers
- Triple frequency Trimble® GNSS receiver
- Cutting-edge sensor fusion algorithm delivering accurate, reliable data for navigation, orientation, and control
- North-seeking gyrocompass
- Attitude and Heading Reference System (AHRS)

Applications

- Navigation and control
- Unmanned systems
- Autonomous systems
- Manned systems
- AHRS
- Positioning and imaging
- Georeferencing
- Land surveying
- Robotics
- Underground navigation
- Stabilization and orientation

Rugged, Highly Accurate INS and AHRS with Embedded GNSS

The GEO•FOG™ 3D INS uses sensor fusion to deliver reliable, high-accuracy navigation and control to a wide variety of unmanned, autonomous, and manned aerial, ground, marine, and subsurface marine applications and platforms. The KVH GEO•FOG 3D Inertial Navigation System (INS) is built upon the company's landmark high-performance Fiber Optic Gyro (FOG)-based 1750 Inertial Measurement Unit (IMU). The advanced unit contains three KVH DSP-1750 gyros – the world's smallest high-performance FOG – integrated with three very low noise MEMS accelerometers. The GEO•FOG 3D INS is an integration of the 1750 IMU with a pressure sensor, a 3-axis magnetometer, and a dual antenna RTK GNSS receiver.

High Accuracy, Intelligent Inertial Performance

Designed for demanding navigation and control applications, the GEO•FOG 3D INS has performance monitoring and instability protections to ensure stable and reliable data. Utilizing an innovative sensor fusion algorithm, its high performance filter is more intelligent than the typical Kalman filter used in many inertial solutions. The GEO•FOG 3D is capable of extracting significantly more information from the 1750 IMU core processor by using a cutting-edge artificial intelligence algorithm.

Designed for Mission Critical Control Applications

The rugged KVH GEO•FOG 3D INS is designed and tested to ensure that the hardware is both secure and reliable. It is protected from reverse polarity, overvoltage, surges, static and short circuits on all external surfaces. The embedded GNSS includes Receiver Autonomous Integrity Monitoring (RAIM) to assess the integrity of satellite signals. The system also contains a backup MEMS IMU providing seamless inertial data collection for redundancy and backup purposes.

Embedded RTK GNSS Receiver

The KVH GEO•FOG 3D contains a triple frequency GNSS receiver providing 8 mm positioning accuracy. It supports all of the current and future satellite navigation systems including GPS, GLONASS, GALILEO, and BeiDou. It also offers data rates up to 1000 Hz, and data can be output over a high-speed RS-422 interface or RS-232 interface.

Integrated North-seeking Gyrocompass

In addition to providing GNSS positioning backed with highly accurate inertial data, the GEO•FOG 3D features a north-seeking algorithm. This provides accurate heading as fast as 10 seconds after power-on from a hot start, and 10 minutes from a cold start. The north-seeking algorithm runs continuously while the INS is operating, and is unaffected by velocity or angular motion. This means the GEO•FOG 3D provides high accuracy heading in environments in which magnetometers and GPS-heading cannot be used.

GEO•FOG 3D INS

IMU Specifications

Gyro Technology	FOG
Input Rate (max)	±490°/sec
Bias Instability *(25°C)*	≤0.1°/hr, 1σ (max), ≤0.05°/hr, 1σ (typical)
Bias vs. Temperature *(≤1°C/min)*	≤1°/hr, 1σ (max), ≤0.7°, 1σ (typical)
Bias Offset *(25°C)*	±2°/hr
Scale Factor Non-linearity *(max rate, 25°C)*	≤50 ppm, 1σ
Scale Factor vs. Temperature *(≤1°C/min)*	≤200 ppm, 1σ
Angle Random Walk *(25°C)*	≤0.012°/√hr (≤0.7°/hr/√Hz)
Bandwidth *(-3 dB)*	≥440 Hz
Initialization Time *(valid data)*	≤1.5 secs
Data Interface	Asynchronous or Synchronous RS-422
Baud Rate	Selectable 9.6 Kbps to 921.6 Kbps
Data Rate	User Selectable 1 to 1000 Hz

Accelerometer Specifications

Accelerometer Technology	MEMS
Input Limit *(max)*	±10 g
Bias Instability *(constant temp)*	<0.05 mg, 1σ
Scale Factor Temperature Sensitivity	250 ppm/°C, 1σ (max), ≤100 ppm/°C, 1σ (typical)
Velocity Random Walk *(25°C)*	≤0.12mg/√Hz (0.23 ft/sec/√hr)
Bandwidth *(-3 dB)*	≥200 Hz

Physical/Electrical/Environmental

Operating Voltage	9 to 36 V
Input Protection	-40 to 100 V
Power Consumption	550 mA @ 12 V (typical)
Hot Start Battery Capacity	>48 hours
Hot Start Battery Charge Time	30 minutes
Hot Start Battery Endurance	>10 years
Operating Temperature	-40°C to 75°C
Environmental Protection	IP67, MIL-STD-810G
MTBF	>36,000 hours
Shock Limit	25 g
Dimensions	90 x 90 x 88 mm
Weight	655 grams

Magnetometers

Range	8 G
Scale Factor Stability	<0.05%
Non-linearity	<0.05%
Noise Density	210 uG/√Hz
Bandwidth	110 Hz

Pressure

Range	10 to 120 Kpa
Noise Density	0.56 Pa/√Hz
Bias Instability	100 Pa/yr
Bandwidth	50 Hz

Connectors

GEO•FOG 3D features two general purpose input/output pins and two auxiliary RS-232/RS-422 ports that support an extensive number of peripherals, including odometer-based input for land vehicles, DVLs and USBLs for underwater navigation, NMEA input/output, and more.

Communications

Interface	RS-422 (RS-232 optional)
Protocol	AN Packet Protocol or NMEA
Peripheral Interface	2x GPIO and 2x Auxiliary, RS-232
GPIO Level	5 V or RS-232
GPIO Functions	1PPS Odometer Stationary Pitot Tube NMEA input/output NovAtel GNSS input Trimble GNSS input AN Packet Protocol input/output Packet Trigger input Teledyne DVL input Tritech USBL input

Navigation

Horizontal Position Accuracy	0.8 m
Vertical Position Accuracy	1.5 m
Horizontal Position Accuracy *(with SBAS)*	0.5 m
Vertical Position Accuracy *(with SBAS)*	0.8 m
Horizontal Position Accuracy *(with RTK)*	0.008 m
Vertical Position Accuracy *(with RTK)*	0.015 m
Velocity Accuracy	0.007 m/s
Roll & Pitch Accuracy	0.01°
Heading Accuracy	0.05°
Heave Accuracy	2% or 0.02 m (whichever is greater)
Orientation Range	Unlimited
Hot Start Time	2 s
Internal Filter Rate	1000 Hz
Output Data Rate	Up to 1000 Hz

GNSS

Model	Trimble BD930
Supported Navigation Systems	GPS L1, L2, L5 GLONASS L1, L2 GALILEO E1 BeiDou B1, B2
Supported SBAS Systems	WAAS, EGNOS, MSAS, GAGAN, QZSS
Update Rate	20 Hz
Hot Start First Fix	3 s
Cold Start First Fix	30 s
Horizontal Position Accuracy	1.2 m
Horizontal Position Accuracy *(with SBAS)*	0.5 m
Horizontal Position Accuracy *(with RTK)*	0.008 m
Velocity Accuracy	0.007 m/s
Timing Accuracy	20 ns
Acceleration Limit	11 g

Typical Accuracy in Ground Vehicle

Outage Duration	Position Accuracy (m)	Velocity Accuracy (m/s)	Roll & Pitch Accuracy (°)	Heading Accuracy (°)
0 s	0.008	0.007	0.01	0.05
10 s	0.05	0.009	0.01	0.05
30 s	0.15	0.012	0.01	0.051
1 m	0.6	0.014	0.01	0.052
5 m	2.9	0.025	0.01	0.062
10 m	5.8	0.048	0.01	0.075
30 m	17.4	0.05	0.01	0.125
60 m	34.8	0.05	0.01	0.2

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ISO 9001 QUALITY CERTIFIED SYSTEM

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