Inertial Labs Single and Dual Antenna GPS-Aided Inertial Navigation Systems INS
The Inertial Labs Single and Dual Antenna GPS-Aided Inertial Navigation System – INS is new generation of fully-integrated, combined GPS, GLONASS, GALILEO, QZSS, BEIDOU and L-Band navigation and high-performance strapdown system, that determines position, velocity, heave and absolute orientation (Heading, Pitch and Roll) for any device on which it is mounted. Horizontal and Vertical Position, Velocity, Heave and Orientation are determined with high accuracy for both motionless and dynamic applications.

The Inertial Labs INS utilizes advanced single and dual antenna GNSS receiver, barometer, 3-axes each of calibrated in full operational temperature range precision Fluxgate magnetometers, Accelerometers and Gyroscopes to provide accurate Position, Velocity, Heading, Pitch and Roll of the device under measure. INS contains Inertial Labs new on-board sensors fusion filter, state of the art navigation and guidance algorithms and calibration software.

**KEY FEATURES AND FUNCTIONALITY**

- Affordable price
- Excellent accuracy in GPS-Denied environments (Tactical-grade IMU + Fluxgate compass + Aiding data)
- GPS, GLONASS, GALILEO, BEIDOU, SBAS, DGPS, RTK supported signals
- Tactical-grade IMU (1 deg/hr gyroscopes and 5 micro g accelerometers Bias in-run stability)
- Fluxgate gyro-compensated compass to maintain free-inertial Heading (INS-P model)
- Single and Dual antenna GNSS receivers
- Compatibility with LiDARs (Velodyne, RIEGL, FARO) and optical cameras
- Odometer, Wheel sensor, Airspeed sensor, Wind sensor, Doppler shift from locator aiding data
- 1 cm + 1 ppm RTK Horizontal Position Accuracy
- 2.5 cm TerraStar-C PRO Horizontal Position Accuracy
- 0.05 deg GNSS Heading and <0.4 deg Free-inertial Heading accuracy (3 sigma)
- Advanced, extendable, embedded Kalman Filter based sensor fusion algorithms
- State-of-the-art algorithms for different dynamic motions of Vessels, Ships, Helicopters, UAV, UUV, UGV, AGV, ROV, Gimbals and Land Vehicles
- Implemented ZUPT, GNSS tracking angle features
- Full temperature calibration of all sensing elements
- Environmentally sealed (IP67), compact design, MIL-STD-810G/DO-160E

**Models & features**

**INS-B**
- Basic
- Ideal solution for remote sensing (UAV, LiDAR, Optical Camera, Point Clouds)

**INS-P**
- Professional
- High performance in long-term GPS-Denied environment

**INS-D**
- Dual Antenna
- High precision Heading Tactical-grade IMU SP/SBAS/DGPS/RTK

**INS-DL**
- Dual Antenna
- High precision Heading Industrial-grade IMU 1 cm RTK position
## General

- **Orientation**
  - Marine application: DVL (Doppler Velocity Log)
  - Land application: Odometer, Wheel sensor, Encoder, DMI
  - Aerial application: Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied)

## Navigation

- **Electrical**
  - **Accelerometers**
    - Bias in MEMS accelerometers, RMS: ±0.015 m/s² RMS
    - Bias error over temperature range (RMS): ±0.03 m/s² RMS
    - Angular resolution: 0.01°
    - Static accuracy in whole temperature range: ±0.05°
  - **Gyrosopes**
    - Bias in MEMS gyrosopes, RMS: ±0.01°/hr
    - Bias error over temperature range (RMS): ±0.03°/hr
    - Angular resolution: 0.01°
    - Static accuracy in whole temperature range: ±0.05°
  - **GNSS**
    - Supported navigation signals: GPS L1/L2/L5; GLONASS L1/L2; BDS B1/B2/B3; QZSS L1/L2/L5; GALILEO E1/E5; SBAS, Dgps, RTK
    - GPS L1/L2, GLONASS L1/L2, BDS, QZSS L1/L5, GALILEO E1/E5; SBAS, Dgps, RTK
    - GPS L1/L2, GLONASS L1/L2, BDS, QZSS L1/L5, GALILEO E1/E5; SBAS, Dgps, RTK
    - Bias in MEMS accelerometers, RMS: ±0.015 m/s² RMS
    - Bias error over temperature range (RMS): ±0.03 m/s² RMS
    - Dynamic Accuracy: ±0.03°/hr
  - **IMU**
    - Measurement range: ±8 g, ±15 g, ±40 g
    - Bias in MEMS accelerometers, RMS: ±0.005 m/s² RMS
    - Bias error over temperature range (RMS): ±0.05 m/s² RMS
    - Angular resolution: 0.01°
    - Static accuracy in whole temperature range: ±0.05°
  - **Magnetoemters**
    - Measurement range: 300 to ±1100 nT
    - Bias in MEMS accelerometers, RMS: ±0.002 nT RMS
  - **Pressure**
    - Measurement range: 0 to ±500 mbar
    - Bias in MEMS accelerometers, RMS: ±0.002 mbar RMS
  - **Temperature**
    - Operating temperature: -40 to +70°C
    - Storage temperature: -50 to +85°C
  - **Environment**
    - EMC/EMI
      - MIL-STD-461: Class B/Class C
      - MIL-STD-188: Class B/Class C
  - **Electrical**
    - **Supply voltage**
      - V DC: 9 to 36 V DC
    - **Power consumption**
      - Watts: 1.4
    - **Output Interface (options)**
      - RS-232, RS-422, Ethernet, CAN

## GNSS

- **Number of Antennas**
  - GPS: Single
  - Dual: Dual
  - GNSS Positioning: <50 (cold start), <30 (hot start)

## IMU

- **Orientation**
  - Pitch and Roll: ±90, ±180° ±90, ±180° ±90, ±180° ±90, ±180° ±90, ±180° ±90, ±180°
  - Heading: °/sec

## Gyroscopes

- **Type**
  - Tactical-grade
  - Industrial-grade

## Accelerometers

- **Type**
  - Tactical-grade
  - Industrial-grade

## Magnetometers

- **Type**
  - Tactical-grade
  - Industrial-grade

## Pressure

- **Type**
  - Tactical-grade
  - Industrial-grade

## Temperature

- **Type**
  - Tactical-grade
  - Industrial-grade

## Electrical

- **Supply voltage**
  - V DC: 9 to 36 V DC
- **Power consumption**
  - Watts: 1.4

## General

- **Output data format**
  - Binary, TSS-1, NMEA 0183 ASCII characters

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(1) GPS only; (2) Requires a subscription to a Terrestrial data service; (3) RIMS, incremental error growth from steady state accuracy; Post-processing results using third party software; (4) calibrated in vehicle operational temperature range, in homogeneous magnetic environment, for latitude up to ±65°; (5) tracks up to 60 L1/L2 satellites; (6) 50 Hz vehicle tracking up to 20 satellites; (7) 20 Hz position update rate for base model of INS; (8) dynamic accuracy may depend on type of motion; (9) time accuracy does not include biases due to RT or antenna delay.

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**Single and Dual Antenna GPS-Aided INS Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>INS-B (Basic)</th>
<th>INS-P (Professional)</th>
<th>INS-D (Dual Antenna)</th>
<th>INS-DL (Low-cost Dual Antenna)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signals</td>
<td>Positions, Heading, Dual antenna Heading (LIDAR), Pitch, Roll, Velocity, Accelerations, Angular rates, Barometric data, PPS</td>
<td>Marine application: DVL (Doppler Velocity Log)</td>
<td>Land application: Odometer, Wheel sensor, Encoder, DMI</td>
<td>Aerial application: Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied)</td>
</tr>
</tbody>
</table>

**Main features**

- Ideal solution for remote sensing (with LIDAR, Optical Camera)
- High performance in long-term GPS-Denied environment
- High precision Heading
- Tactical-grade (IMU)
- Affordable price
- High precision Heading
- 1 cm RTK position

**Update rate**

- Hz: 200 (INS data) 2000 (MU data)
- 200 (INS data) 2000 (MU data)
- 200 (INS data) 2000 (MU data)

**Start-up time**

- sec: <1
- <1
- <1

**Position, Velocity and Timestamps**

- Horizontal position accuracy (GPS L1): meters, RMS
  - 1.5
  - 1.5
  - 1.5
- Vertical position accuracy (GPS L1): meters, RMS
  - <1
  - <1
  - <1
- Horizontal position accuracy (GPS L1/L2): meters, RMS
  - 1.2
  - 1.2
  - 1.2
- Horizontal position accuracy (SBAS): meters, RMS
  - 0.6
  - 0.6
  - 0.6
- Horizontal position accuracy (DGPS): meters, RMS
  - 0.4
  - 0.4
  - 0.4
- Horizontal position accuracy (TerraStar-L): meters, RMS
  - 0.4
  - 0.4
  - 0.4
- Horizontal position accuracy (RTK): meters, RMS
  - 0.01 ± 1 ppm
  - 0.01 ± 1 ppm
  - 0.01 ± 1 ppm
- Horizontal position accuracy (GPS L1/L2): meters, RMS
  - 0.02
  - 0.02
  - 0.02
- Horizontal position accuracy (GPS L1/L2, SBAS): meters, RMS
  - 0.03
  - 0.03
  - 0.03
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.02
  - 0.02
  - 0.02
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.02
  - 0.02
  - 0.02
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.01
  - 0.01
  - 0.01
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.01
  - 0.01
  - 0.01
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.01
  - 0.01
  - 0.01
- Horizontal position accuracy (GPS L1/L2, SBAS, Dgps, RTK): meters, RMS
  - 0.01
  - 0.01
  - 0.01

**Time accuracy (clock drift)**

- sec: 0.001
- 0.001
- 0.001

**Dynamic Accuracy**

- m/s RMS: 0.001
- 0.001
- 0.001

**Initialization time**

- Sec: <50 (cold start), <30 (hot start)
- <50 (cold start), <30 (hot start)
- <50 (cold start), <30 (hot start)

**Output data format**

- Binary, TSS-1, NMEA 0183 ASCII characters

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Inertial Labs GPS-Aided INS key sensors (IMU) performance

Inertial Labs GPS-Aided INS key applications
INS part numbers structure

<table>
<thead>
<tr>
<th>Model</th>
<th>Gyro</th>
<th>Accel</th>
<th>Calibration</th>
<th>Connector</th>
<th>GNSS receiver</th>
<th>Version</th>
<th>Interface</th>
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<tbody>
<tr>
<td>INS-B</td>
<td>G450</td>
<td>A8</td>
<td>TGA</td>
<td>C1</td>
<td>O615</td>
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<td>INS-P</td>
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<td>A15</td>
<td>TMGA</td>
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<td>INS-D</td>
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<td>V2</td>
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<td>P327</td>
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<td>VD4</td>
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<td>VD9</td>
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</tbody>
</table>

Example: INS-B-G450-A8-TGA-C1-O615-V0.1

- INS-B: Basic Model of GPS-Aided Inertial Navigation System
- INS-P: Professional Model of GPS-Aided Inertial Navigation System
- INS-D: Dual Antenna GPS-Aided Inertial Navigation System
- INS-DL: Dual Antenna GPS-Aided Inertial Navigation System
- G450: Gyroscopes measurement range = ±950 deg/sec
- G950: Gyroscopes measurement range = ±450 deg/sec
- A8: Accelerometers measurement range = ±8 g
- A15: Accelerometers measurement range = ±15 g
- A40: Accelerometers measurement range = ±40 g
- TGA: Gyroscopes and Accelerometers
- TMGA: Magnetometers, Gyroscopes and Accelerometers (INS-P and INS-D only)
- C1: 12 pins connector (RS-232)
- C3: 24 pins connector (RS-232, RS-422, CAN, Ethernet interfaces)
- O615: Novatel OEM615 single antenna GNSS receiver (INS-B and INS-P only)
- O617D: Novatel OEM617D dual antenna GNSS receiver (INS-D only)
- O718: Novatel OEM718D dual antenna GNSS receiver (INS-D only)
- O719: Novatel OEM719 single antenna GNSS receiver (INS-B and INS-P only)
- O7720: Novatel OEM7720 dual antenna GNSS receiver (INS-D only)
- P327: Hemisphere P327 single antenna GNSS receiver (INS-B and INS-P only)
- B482: Inertial Labs B482 dual antenna GNSS receiver (INS-DL only)
- V0: GPS L1, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- V1: GPS L1, SBAS, DGPS, 50 Hz positions (INS-B and INS-P only)
- V2: GPS L1, GLONASS, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- V3: GPS L1/L2, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- V4: GPS L1/L2, GLONASS L1/L2, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- VR43: GPS L1/L2, GLONASS L1/L2, SBAS, DGPS, RTK, 20 Hz positions, 20 Hz measurements (INS-B and INS-P only)
- V6: GPS L1/L2/L5, GLONASS L1/L2, BeiDou B1/B2/B3, GALILEO E1/E5; SBAS; DGPS; 20 Hz measurements; 20 Hz positions RTK (INS-B and INS-P only)
- VD4: GPS L1/L2, Dual antenna Heading, SBAS, DGPS, 20 Hz positions (INS-D only)
- VD42: GPS L1/L2, GLONASS L1/L2, Dual antenna Heading, SBAS, DGPS, RTK, 20 Hz measurements, 20 Hz positions (INS-D only)
- VR43: GPS L1/L2, GLONASS L1/L2, Dual antenna Heading, SBAS, DGPS, 20 Hz positions (INS-D only)
- VD5: GPS L1/L2, GLONASS L1/L2, BeiDou B1/B2, GALILEO E1/E5; QZSS L1/L5, DGPS, RTK, Dual antenna Heading, DGPS, RTK, 20 Hz measurements, 20 Hz positions (INS-DL only)
- VX.1: RS-232, CAN, Ethernet interface
- VX.2: RS-422, CAN, Ethernet interface

INS-D and INS-DL mechanical interface drawing

INS-B and INS-P mechanical interface drawing

Notes:
1. All dimensions are in millimeters.
2. All dimensions within this drawing are subject to change without notice. Customers should obtain final drawings before designing any interface hardware.

Interface connector type: Binder. Male receptacle, shielded, rear-mounting
GNSS antenna connector type: TNC - Female