Inertial Labs Single and Dual Antenna GPS-Aided Inertial Navigation Systems INS

Inertial Labs

Address: 39959 Catoctin Ridge Street, Paeonian Springs, VA 20129 U.S.A.

Tel: +1 (703) 880-4222, Website: www.inertiallabs.com

www.inertiallabs.com
The Inertial Labs Single and Dual Antenna GPS-Aided Inertial Navigation System – INS is a new generation of fully-integrated, combined GPS, GLONASS, GALILEO, QZSS, BEIDOU and L-Band navigation and high-performance strapdown system, that determines position, velocity and absolute orientation (Heading, Pitch and Roll) for any device on which it is mounted. Horizontal and Vertical Position, Velocity 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 (up to 0.05 % DT)
- Tactical-grade IMU + Fluxgate compass + Aiding data
- Support: ROS, LabVIEW, Waypoint Inertial Explorer, QINSy
- 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 or 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, 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

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### GENERAL

**Output signals**
- Positions, Heading, Dual antenna Heading (DAH), Pitch, Roll, Velocity, Accelerations, Angular rates, Barometer, PPS
- Direct AT_TINS message with Position, Heading, Pitch & Roll to COBHAM AVIATOR UAV 200

**Input signals**
- 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)
- All: External Stand Alone Magnetic Compass (SAMC/AHRS)

**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

**Compatible with**
- Pixhawk Autopilot; Embleton Autopilot; COBHAM AVIATOR UAV 200

**Internal Data Logger (storage) - optional**
- Up to 200 (INS data); Up to 2000 (IMU data)
- Up to 2000 (INS) & 2000 (IMU)

**Start-up time**
- sec
- <1
- <1

### Navigation

**Positions, Velocity and Timestamps**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical position accuracy (GPS L1)</td>
<td>meters, RMS</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal position accuracy (GPS L1/L2)</td>
<td>meters, RMS</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal position accuracy (SBAS)</td>
<td>meters, RMS</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic accuracy (GNSS)</td>
<td>degrees RMS</td>
<td>0.1</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post processing accuracy</td>
<td>degrees RMS</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position accuracy</td>
<td>%, °T</td>
<td>0.2% DT (w/o odometer input)</td>
<td>0.05% DT (w/o odometer input)</td>
<td>0.5% DT (w/o odometer input)</td>
<td>0.1% DT (w/o odometer input)</td>
</tr>
<tr>
<td>Velocity accuracy, RMS</td>
<td>meters/sec</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPS timestamps accuracy</td>
<td>nanoseconds</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Heading**

<table>
<thead>
<tr>
<th>Range (deg)</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal position accuracy</td>
<td>0 to 360</td>
<td>0 to 360</td>
<td>0 to 360</td>
<td>0 to 360</td>
</tr>
<tr>
<td>Vertical position accuracy</td>
<td>0.15 (1 meter baseline)</td>
<td>0.15 (1 meter baseline)</td>
<td>0.2 (2 meters baseline)</td>
<td>0.2 (2 meters baseline)</td>
</tr>
<tr>
<td>Dynamic accuracy</td>
<td>degrees RMS</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post processing accuracy</td>
<td>degrees RMS</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Velocity accuracy, RMS</td>
<td>meters/sec</td>
<td>&lt;0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time accuracy (clock drift)</td>
<td>nanoseconds</td>
<td>&lt;0.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Orientation

**Number of GNSS Antennas**
- Single
- Single
- Single
- Dual
- Dual

**GNSS**

<table>
<thead>
<tr>
<th>Supported navigation signals</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS L1/C/A, L1C, L2C, L2P, L5; GLONASS L1 C/A, L2 C/A, L2P, L3, Beidou B1, B2; Galileo E1, E5AB/EOC, E5a, E5b, NavIC (RINSS) L5S; SBAS L1, L5 QZSS L1 C/A, L1C, L2C, L5; Band up to 2 channels; DGPS; RTK</td>
<td>GPS L1/GLO L1/L2/BDS B1/B2, GAL E1/E5, QZSS L1/L2, DGPS, RTK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Channel configuration (4)**
- 555 Channels
- 432 Channels

**RTK corrections**
- RTCM 2, RTCM 3
- RTCM 2, RTCM 3

**GNSS Positions data rate**
- 5 Hz
- 20, 50
- 20

**Velocity accuracy, RMS**
- 5 Hz
- 20
- 20

**Time accuracy (clock drift)**
- <0.03
- <0.03
- <0.03

### Gyrosopes

<table>
<thead>
<tr>
<th>Type</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>deg/sec</td>
<td>±650 / ±950</td>
<td>±650 / ±950</td>
<td>±650 / ±950</td>
</tr>
<tr>
<td>Bias in-run stability</td>
<td>degrees/hr</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Bias error over temperature range</td>
<td>degrees/hr</td>
<td>&gt;30</td>
<td>&lt;30</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Angular Random Walk</td>
<td>deg/√hr</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
</tbody>
</table>

### Accelerometers

<table>
<thead>
<tr>
<th>Type</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>g</td>
<td>±8 g / ±15 g / ±40 g</td>
<td>±8 g / ±15 g / ±40 g</td>
<td>±8 g / ±15 g / ±40 g</td>
</tr>
<tr>
<td>Bias in-run stability</td>
<td>mg</td>
<td>0.005 (±8 g) / 0.03 (±15 g)</td>
<td>0.005 (±8 g) / 0.03 (±15 g)</td>
<td>0.005 (±8 g) / 0.03 (±15 g)</td>
</tr>
<tr>
<td>Bias error over temperature range</td>
<td>mg</td>
<td>0.5 (±8 g) / 1.2 (±15 g)</td>
<td>0.5 (±8 g) / 1.2 (±15 g)</td>
<td>0.5 (±8 g) / 1.2 (±15 g)</td>
</tr>
<tr>
<td>Bias one-year repeatability</td>
<td>mg</td>
<td>1.0 (±8 g) / 1.5 (±15 g)</td>
<td>1.0 (±8 g) / 1.5 (±15 g)</td>
<td>1.0 (±8 g) / 1.5 (±15 g)</td>
</tr>
<tr>
<td>Velocity Random Walk</td>
<td>m/s/√hr</td>
<td>0.015 (±8 g) / 0.045 (±15 g) / 0.045 (±40 g)</td>
<td>0.015 (±8 g) / 0.045 (±15 g) / 0.045 (±40 g)</td>
<td>0.015 (±8 g) / 0.045 (±15 g) / 0.045 (±40 g)</td>
</tr>
</tbody>
</table>

### Magnetometers

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>Gauss</th>
<th>INS-B</th>
<th>INS-P</th>
<th>INS-O</th>
<th>INS-DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias in-run stability, RMS</td>
<td>nT</td>
<td>Optional</td>
<td>0.2</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Noise density, PSD</td>
<td>nT/√Hz</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Pressure

### Environment

| Operating temperature | deg C | -40 to +75 | -40 to +70 |       |
| Storage temperature | deg C | -50 to +85 | -50 to +85 |       |
| Max operating hours |       | 100,000 | 100,000 |       |

### Shock and Vibration
- MIL-STD-810G
- MIL-STD-461F
- MIL-STD-461G

### Electrical

| Supply voltage | V DC | 9 to 36 | 9 to 36 | 9 to 36 |       |
| Power consumption | Watts | 2.5 | 3.5 | 5 | 9 |

### Physical

| Size | mm | 120 x 50 x 53 | 120 x 50 x 53 | 120 x 50 x 53 | 120 x 50 x 53 |

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1. GPS only
2. Requires a subscription to a Territorial data service (TDDS)
3. IMS incremental error growth from steady state accuracy
4. Post-processing results using third party software
5. Calibrated in-house operational temperature range, in homogeneous magnetic environment, for altitude up to ±65 deg; (6) coverage to +60 to 70 satellites; (7) 50 Hz during tracking up to 20 satellites, 20 Hz post update position update for Basic model of INS; (8) dynamic accuracy may depend on type of motion; (9) time accuracy does not include biases due to RF or antenna delay.

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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 &amp; Enclosure</th>
<th>Encoder support</th>
<th>Color</th>
<th>Data Logger</th>
<th>GNSS receiver</th>
<th>Version</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>INS-B</td>
<td>G450</td>
<td>A8</td>
<td>TGA</td>
<td>C1 (obsolete)</td>
<td>E (option)</td>
<td>B (default)</td>
<td>S64 (default)</td>
<td>O615 - obsolete</td>
<td>V0</td>
<td>1</td>
</tr>
<tr>
<td>INS-P</td>
<td>G050</td>
<td>A15</td>
<td>TMGA</td>
<td>C3 (default)</td>
<td></td>
<td>D</td>
<td>S8 (option)</td>
<td>O617D - obsolete</td>
<td>V1</td>
<td>2</td>
</tr>
<tr>
<td>INS-D</td>
<td>G2000</td>
<td>A40</td>
<td></td>
<td>C31</td>
<td></td>
<td>G</td>
<td></td>
<td>O718D (China only)</td>
<td>V2</td>
<td>3</td>
</tr>
<tr>
<td>INS-DL</td>
<td></td>
<td></td>
<td></td>
<td>C32</td>
<td></td>
<td>W</td>
<td></td>
<td></td>
<td>V7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V8</td>
<td>145</td>
</tr>
</tbody>
</table>

Example: INS-B-G450-A8-TGA-C3EB-S64-O719-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 = ±450 deg/sec
- G950: Gyroscopes measurement range = ±950 deg/sec
- G2000: Gyroscopes measurement range = ±2000 deg/sec
- 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) - OBSOLETE
- C3: 24 pins connector (RS-232, RS-422, CAN, Ethernet interfaces)
- C31: 24 pins connector (RS-232, 2 x RS-422, CAN interfaces)
- C32: 24 pins connector (RS-232, RS-422, CAN, Ethernet interfaces) with modified PPS (preserve PPS configurable polarity): Active high – 5v (1'). Active low – 0v (0')
- C5: 24 pins connector, flanges and alignment pins
- C7: two 19 pins connectors
- C71: two 19 pins connectors, MIL-STD1275 protection
- B: Basic Color (default)
- G: Green
- W: White
- S8: 8GB embedded Data Logger (optional)
- S64: 64GB embedded Data Logger (optional)
- D: Desert Color (Desert tan, color code 33446 (tan 686A) per FED STD-595, Change Notice 1.)
- E: encoder support
- 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)
- V4: GPS L1/L2, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- VR43: GPS L1/L2, GLONASS L1/L2, SBAS, DGPS, 20 Hz positions, 20 Hz measurements (INS-B and INS-P only)
- VR5: GPS L1/L2, GLONASS L1/L2, SBAS, DGPS, RTK, 20 Hz positions, 20 Hz measurements (INS-B and INS-P only)
- V8: 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)
- VD43: GPS L1/L2, GLONASS L1/L2, Dual antenna Heading, SBAS, DGPS, 20 Hz positions (INS-D only)
- VD9: 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)
- VX1: RS-232 interface
- VX2: RS-422 interface
- VX3: RS-485 interface (temporary is not available)
- VX4: CAN interface
- VX5: Ethernet interface
- VX11: two RS-232 interfaces
- VX22: two RS-422 interfaces
- VX145: RS-232, CAN and Ethernet interfaces (with optional encoder support)
- VX245: RS-422, CAN and Ethernet interfaces (w/o Encoder support)
Optional: INS-D / INS-DL with alignment pins

Default: INS-D / INS-DL mechanical interface drawing

Default: INS-B / INS-P mechanical interface drawing

Optional: INS-B / INS-P with alignment pins

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