The Inertial Labs GPS-Aided Inertial Navigation System (INS-DM) is the latest version of Inertial Navigation System, developed by Inertial Labs. The INS-DM is the result of over 20 years of our experience in developing and supplying INS solutions to land, marine and aerial platforms around the world.

This system, the INS-DM, is an IP68 rated version of an all-new generation of super ruggedized, shielded from the EMC/EMI, fully-integrated, combined Inertial Navigation System (INS) + Attitude & Heading Reference System (AHRS) + Air Data Computer (ADC) 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-DM can support multiple types of MEMS Inertial Measurement Units (IMU) developed by Inertial Labs. Additionally, the INS-DM supports other IMU’s, like the Honeywell HG4930. The INS-DM also utilizes different multi constellation (GPS, GLONASS, GALILEO, QZSS and BEIDOU) GNSS receivers like Novatel OEM7 series or the uBlox F9 series.

The design of the INS-DM also includes an optional Air Data Computer (ADC), supported by two barometers, and the ability to support an external Stand-Alone Magnetic Compass (SAMC). The INS-DM contains Inertial Labs new on-board sensor fusion filter, state of the art navigation and guidance algorithms, and calibration software.

KEY FEATURES, BENEFITS & FUNCTIONALITY

- Commercially exportable GPS-Aided Inertial Navigation System
- 3-in-1 strapdown system: INS + AHRS + ADC (Air Data Computer)
- Embedded Honeywell or Inertial Labs MEMS Inertial Measurement Unit (IMU)
- Novatel OEM7 or uBlox ZED-F9P F9 High Precision GNSS receiver
- GPS, GLONASS, GALILEO, BEIDOU, QZSS, RTK supported signals
- Total and Static Pressure Sensors for calculating Indicated Airspeed
- SP, SBAS, DGPS, RTK and PPP for real time operation
- GNSS measurements and IMU raw data for post processing
- Advanced, extendable, embedded Kalman Filter based sensor fusion algorithms
- State-of-the-art algorithms for different dynamic motions of Helicopters, and UAV
- Full temperature calibration of all sensing elements
- EMC, EMI and ERD protection
- Environmentally sealed (IP67)
- Aiding data: Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading
### General

#### Optional Input Signals
- External Magnetometer, Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading aiding data

#### Output Signals
- IMU data: Accelerations, Angular rates;
- AHRS data: Heading, Pitch & Roll
- INS data: Positions, Velocity, Delta Theta and Delta Velocity, GNSS data, Time
- Air Data Computer data: Static Pressure (calibrated), Dynamic Pressure (calibrated), Baro-Corrected Pressure Altitude, Pressure Altitude, Calibrated Airspeed, True Airspeed, Mach-Number, Static Pressure Over Total Pressure, True Angle of Attack, Rate of Climb

#### Electrical & Mechanical
- Update rate: 1 ... 200 Hz (user settable)
- Start-up time: <1 sec
- Interface: RS-232 / RS-422 / CAN / Ethernet
- Input power: 9 to 36 V DC (27 ± 10 for MIL-1275 protection)
- Output data: Binary, NMEA 0183 ASCII characters
- 1 PPS level: 3.3 V DC TTL / 5 V DC TTL / differential via RS-422
- EMC/EMI: MIL-STD-461F
- Input Power Protection: MIL-1275 (optional)
- Type of Sealing: IP-68
- MTBF: 100000 hours
- Dimensions: 160.4 x 141.2 x 61.1 mm
- Weight: 1345 grams (depends on configuration)

#### Environment
- Operational Temperature: -40 to +80°C
- Storage Temperature: -50 to +85°C
- Humidity: Up to 95%
- Altitude: up to 15,000 m (50,000 ft)
- Acoustic noise: 185 dB max

### IMU Options

#### GYROSCOPES
- **KERNEL-100**
  - Measurement range: ±2000 deg/sec
  - Bias in-run stability, RMS: 2 deg/hr
  - Bias residual error, RMS: 72 deg/hr
  - SF error: 1000 ppm
  - Noise (ARW): 0.38 deg/√hr
- **IMU-P Tactical**
  - Measurement range: ±2000 deg/sec
  - Bias in-run stability, RMS: 1 deg/hr
  - Bias residual error, RMS: 30 deg/hr
  - SF error: 1000 ppm
  - Noise (ARW): 0.2 deg/√hr
- **IMU-NAV-100**
  - Measurement range: ±2000 deg/sec
  - Bias in-run stability, RMS: 0.5 deg/hr
  - Bias residual error, RMS: 15 deg/hr
  - SF error: 1000 ppm
  - Noise (ARW): 0.1 deg/√hr
- **HG4930 CA51**
  - Measurement range: ±400 deg/sec
  - Bias in-run stability, RMS: 0.25 deg/hr
  - Bias residual error, RMS: 7 deg/hr
  - SF error: 100 ppm
  - Noise (ARW): 0.04 deg/√hr

#### ACCELEROMETERS
- **KERNEL-100**
  - Measurement range: ±8g (±15g & ±40g)
  - Bias in-run stability, RMS: 0.01 mg
  - Bias residual error, RMS: 0.7 mg
  - SF error: 500 ppm
  - Noise (VRW): 0.02 m/s/√hr
- **IMU-P Tactical**
  - Measurement range: ±8g (±15g & ±40g)
  - Bias in-run stability, RMS: 0.005 mg
  - Bias residual error, RMS: 0.5 mg
  - SF error: 150 ppm
  - Noise (VRW): 0.015 m/s/√hr
- **IMU-NAV-100**
  - Measurement range: ±8g (±15g & ±40g)
  - Bias in-run stability, RMS: 0.003 mg
  - Bias residual error, RMS: 0.4 mg
  - SF error: 150 ppm
  - Noise (VRW): 0.008 m/s/√hr
- **HG4930 CA51**
  - Measurement range: ±20g
  - Bias in-run stability, RMS: 0.025 mg
  - Bias residual error, RMS: 1.7 mg
  - SF error: 600 ppm
  - Noise (VRW): 0.03 m/s/√hr
## GNSS Receiver Options

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Novatel OEM7720</th>
<th>uBlox ZED-F9P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of GNSS Antennas</strong></td>
<td>Dual</td>
<td>Dual</td>
</tr>
<tr>
<td><strong>GNSS constellations</strong></td>
<td>GPS L1 C/A, L1C, L2C, L2P, L5; GLONASS L1 C/A, L2 C/A, L2P, L3, L5; BeiDou B1I, B1C, B2I, B2a, B3I; Galileo E1, E5 AltBOC, E5a, E5b, E6; NavIC (IRNSS) L5; QZSS L1 C/A, L1C, L2C, L5, L6; L-Band</td>
<td>GPS L1/C/A L2C, GLONASS L1OF L2OF, Galileo E1B/C E5b, BeiDou B1I B2I, QZSS L1C/A L2C</td>
</tr>
<tr>
<td><strong>GNSS corrections</strong></td>
<td>WAAS; EGNOS; MSAS; GAGAN; SBAS L1, L5; DGPS; RTK; PPP Terrastar</td>
<td>WAAS; EGNOS; MSAS; GAGAN; SBAS L1C/A; DGPS; RTK</td>
</tr>
<tr>
<td><strong>Channel configuration</strong></td>
<td>555 Channels</td>
<td>184 Channels</td>
</tr>
<tr>
<td><strong>GNSS data rate</strong></td>
<td>5 Hz / 20 Hz / 100 Hz</td>
<td>10, 20 Hz (1)</td>
</tr>
<tr>
<td><strong>RTK corrections</strong></td>
<td>RTCM 2, RTCM 3</td>
<td>RTCM 3</td>
</tr>
<tr>
<td><strong>Velocity accuracy, RMS</strong></td>
<td>0.03 m/sec</td>
<td>0.05 m/sec</td>
</tr>
<tr>
<td><strong>Initialization time</strong></td>
<td>&lt;39 (cold start), &lt;20 (hot start)</td>
<td>&lt;30 (cold start), &lt;10 (hot start)</td>
</tr>
<tr>
<td><strong>Time accuracy (clock drift)</strong></td>
<td>20 nano sec</td>
<td>30 nano sec</td>
</tr>
</tbody>
</table>

(1) If tracking GPS Only.

## Air Data Computer

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Using Honeywell 025MD sensor</th>
<th>Using Honeywell 600MD sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static Pressure (calibrated)</strong></td>
<td>300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: ±0.1% FSS</td>
<td>300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: ±0.1% FSS</td>
</tr>
<tr>
<td><strong>Dynamic Pressure (calibrated)</strong></td>
<td>0.15 to 25 hPa / 10 to 124 KCAS, Accuracy: ±0.25% FSS</td>
<td>0.15 to 600 hPa / 10 to 600 KCAS, Accuracy: ±0.25% FSS</td>
</tr>
<tr>
<td><strong>Baro-Corrected Pressure Altitude</strong></td>
<td>-500 to 9000 meters; Accuracy: 1</td>
<td>-500 to 9000 meters; Accuracy: 1</td>
</tr>
<tr>
<td><strong>Pressure Altitude</strong></td>
<td>-500 to 9000 meters; Accuracy: 1</td>
<td>-500 to 9000 meters; Accuracy: 1</td>
</tr>
<tr>
<td><strong>Calibrated Airspeed</strong></td>
<td>5 to 64 meters/sec; Accuracy: 0.5</td>
<td>5 to 310 meters/sec; Accuracy: 0.5</td>
</tr>
<tr>
<td><strong>True Airspeed</strong></td>
<td>5 to 64 meters/sec; Accuracy: 0.5</td>
<td>5 to 310 meters/sec; Accuracy: 0.5</td>
</tr>
<tr>
<td><strong>Mach-Number</strong></td>
<td>0.01 to 0.2 M, Accuracy: 0.001 M</td>
<td>0.01 to 0.99 M, Accuracy: 0.002 M</td>
</tr>
<tr>
<td><strong>Static Pressure Over Total Pressure</strong></td>
<td>0.97 to 1, Resolution 0.000001</td>
<td>0.63 to 1, Resolution 0.000001</td>
</tr>
<tr>
<td><strong>True Angle of Attack</strong></td>
<td>-50 to 50 deg; Accuracy ±0.25</td>
<td>-50 to 50 deg, Accuracy ±0.25</td>
</tr>
<tr>
<td><strong>Rate of Climb</strong></td>
<td>±515 meters/sec; Accuracy 0.05</td>
<td>±515 meters/sec; Accuracy 0.05</td>
</tr>
<tr>
<td><strong>Air Density</strong></td>
<td>0.3 to 1.6 kg/m³; Accuracy 0.002</td>
<td>0.3 to 1.6 kg/m³; Accuracy 0.002</td>
</tr>
<tr>
<td><strong>Outside Air Temperature (OAT)</strong></td>
<td>-40 to +85 deg C; Resolution 0.01</td>
<td>-40 to +85 deg C; Resolution 0.01</td>
</tr>
<tr>
<td><strong>Wind Speed</strong></td>
<td>±200 meters/sec; Accuracy: 0.1</td>
<td>±200 meters/sec; Accuracy: 0.1</td>
</tr>
</tbody>
</table>

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# INS Options

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>TYPE of IMU:</td>
<td>IMU: KERNEL-100</td>
<td>IMU: IMU-P Tactical</td>
<td>IMU: IMU-NAV-100</td>
<td>IMU: HG4930 CA51</td>
</tr>
<tr>
<td>NAVIGATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal position accuracy (SP)</td>
<td>1.2 m</td>
<td>1.2 m</td>
<td>1.2 m</td>
<td>1.2 m</td>
</tr>
<tr>
<td>Horizontal position accuracy (SBAS)&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>0.6 m</td>
<td>0.6 m</td>
<td>0.6 m</td>
<td>0.6 m</td>
</tr>
<tr>
<td>Horizontal position accuracy (DGPS)</td>
<td>0.4 m</td>
<td>0.4 m</td>
<td>0.4 m</td>
<td>0.4 m</td>
</tr>
<tr>
<td>Horizontal position accuracy (TerraStar-C PRO)&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>0.025 m</td>
<td>0.025 m</td>
<td>0.025 m</td>
<td>0.025 m</td>
</tr>
<tr>
<td>Horizontal position accuracy (PPK)&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>0.005 m</td>
<td>0.005 m</td>
<td>0.005 m</td>
<td>0.005 m</td>
</tr>
<tr>
<td>Horizontal position accuracy (RTK)</td>
<td>0.01 m</td>
<td>0.01 m</td>
<td>0.01 m</td>
<td>0.01 m</td>
</tr>
<tr>
<td>Vertical position accuracy (RTK)</td>
<td>0.02 m</td>
<td>0.02 m</td>
<td>0.02 m</td>
<td>0.02 m</td>
</tr>
<tr>
<td>Velocity accuracy (OEM7720), RMS</td>
<td>0.03 m/sec</td>
<td>0.03 m/sec</td>
<td>0.03 m/sec</td>
<td>0.03 m/sec</td>
</tr>
<tr>
<td>Velocity accuracy (uBlox F9P), RMS</td>
<td>0.05 m/sec</td>
<td>0.05 m/sec</td>
<td>0.05 m/sec</td>
<td>0.05 m/sec</td>
</tr>
<tr>
<td>Horizontal Position accuracy (free inertial, land vehicles)</td>
<td>&lt;10 NMPH</td>
<td>&lt;7 NMPH</td>
<td>&lt;5 NMPH</td>
<td>&lt;3 NMPH</td>
</tr>
<tr>
<td>Horizontal Position accuracy (free inertial, aerial)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HEADING</td>
<td></td>
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</tr>
<tr>
<td>Range</td>
<td>0 to 360 deg</td>
<td>0 to 360 deg</td>
<td>0 to 360 deg</td>
<td>0 to 360 deg</td>
</tr>
<tr>
<td>Angular Resolution</td>
<td>0.01 deg</td>
<td>0.01 deg</td>
<td>0.01 deg</td>
<td>0.01 deg</td>
</tr>
<tr>
<td>Static &amp; Dynamic Accuracy&lt;sup&gt;(4)&lt;/sup&gt; (Dual antenna, 1 meter baseline)</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
</tr>
<tr>
<td>Static &amp; Dynamic Accuracy&lt;sup&gt;(4)&lt;/sup&gt; (Dual antenna, 2 meters baseline)</td>
<td>0.08 deg</td>
<td>0.08 deg</td>
<td>0.08 deg</td>
<td>0.08 deg</td>
</tr>
<tr>
<td>Dynamic Accuracy&lt;sup&gt;(4)&lt;/sup&gt; (Single antenna)</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
<td>0.15 deg</td>
</tr>
<tr>
<td>Post processing accuracy&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>0.05 deg</td>
<td>0.03 deg</td>
<td>0.015 deg</td>
<td>0.01 deg</td>
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<tr>
<td>Post processing accuracy</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>PITCH &amp; ROLL</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Range</td>
<td>±90, ±180</td>
<td>±90, ±180</td>
<td>±90, ±180</td>
<td>±90, ±180</td>
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<tr>
<td>Angular Resolution</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
<td>Static Accuracy</td>
<td>0.08</td>
<td>0.05</td>
<td>0.03</td>
<td>0.02</td>
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<tr>
<td>Dynamic Accuracy (with GNSS correction)</td>
<td>0.05</td>
<td>0.03</td>
<td>0.02</td>
<td>0.01</td>
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<tr>
<td>Post processing accuracy&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>0.05 deg</td>
<td>0.006 deg</td>
<td>0.003 deg</td>
<td>0.002 deg</td>
</tr>
</tbody>
</table>

**Notes:**

<sup>(1)</sup> GPS only;
<sup>(2)</sup> For Novatel OEM7720 GNSS receiver only. Requires a subscription to a TerraStar data service.
<sup>(3)</sup> RMS, incremental error growth from steady state accuracy. Post-processing results using third party software;
<sup>(4)</sup> Dynamic accuracy may depend on type of motion.
**INS-DM Product Code Structure**

<table>
<thead>
<tr>
<th>Model</th>
<th>IMU type</th>
<th>Gyro</th>
<th>Acc</th>
<th>Calibration</th>
<th>Connector</th>
<th>Encoder support</th>
<th>Pressure Ports</th>
<th>Color</th>
<th>External Compass</th>
<th>Data Logger</th>
<th>GNSS receiver</th>
<th>Version</th>
<th>Interface</th>
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<tbody>
<tr>
<td>INS-DM</td>
<td>E1</td>
<td>G2000</td>
<td>A8</td>
<td>TGA</td>
<td>C71</td>
<td>E</td>
<td>0P</td>
<td>B</td>
<td>SAMC</td>
<td>S64</td>
<td>ZD9P</td>
<td>VD9</td>
<td>12345</td>
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<tr>
<td>M1</td>
<td>G950</td>
<td>A15</td>
<td>TMGA</td>
<td>C72</td>
<td>2P</td>
<td>G</td>
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<tr>
<td>A1</td>
<td>G450</td>
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<td>A40</td>
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<td>B1</td>
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</tbody>
</table>


- **INS-DM**: Dual Antenna GPS-Aided Inertial Navigation System
- **E1**: Inertial Labs KERNEL-100 IMU
- **M1**: Inertial Labs miniAHRS IMU
- **A1**: Inertial Labs IMU-P Tactical A
- **N11**: Inertial Labs IMU-NAV-100
- **B1**: Honeywell HG4930 CA51 IMU
- **G2000**: Gyroscopes measurement range ±2000 deg/sec
- **G950**: Gyroscopes measurement range ±950 deg/sec
- **G450**: Gyroscopes measurement range ±450 deg/sec
- **G400**: Gyroscopes measurement range ±400 deg/sec (using Honeywell HG4930 CA51 IMU)
- **A8**: Accelerometers measurement range ±8 g
- **A15**: Accelerometers measurement range ±15 g
- **A20**: Accelerometers measurement range ±20 g (using Honeywell HG4930 CA51 IMU)
- **A40**: Accelerometers measurement range ±40 g
- **TGA**: Calibration of IMU (Gyroscopes and Accelerometers) in operational temperature range
- **TMGA**: Calibration of IMU (Magnetometers, Gyroscopes and Accelerometers) in operational temperature range
- **C71**: two connectors (22 – main; 13 – auxiliary)
- **C72**: C71 with MIL-STD-1275 protection
- **E**: Encoder support
- **0P**: Zero Airspeed Pressure Ports (Total/Static)
- **2P**: Two Airspeed Pressure Ports Standard Range (Total/Static). Available options with pressure range from ±1.6 mbar to ±10 bar | ±160 Pa to ±1M Pa | ±0.5 in H₂O to ±150 psi; absolute range 1 bar to 8 bar | 15 psi to 150 psi
- **B**: Black Color of enclosure (default)
- **G**: Green Color of enclosure (optional)
- **D**: Desert Tan Color of enclosure (optional)
- **SAMC**: External Stand-Alone Magnetic Compass (optional)
- **S64**: 64GB embedded Data Logger (optional)
- **ZD9P**: dual uBlox ZED-F9P, Dual-Frequency, Multi-Constellation, RTK Capable GNSS Receiver
- **O7720**: Novatel OEM7720 GNSS receiver
- **VD9**: GPS L1/L2, GLONASS L1/L2, BEIDOU B1/B2, GALILEO E1/E5, QZSS L1/L5, DGPS, RTK, Dual antenna Heading, GNSS measurements, GNSS positions (Dual Antenna GNSS Receiver only)
- **VD9.12345**: RS-232, RS-422, RS-485 (for stand-alone magnetic compass only), CAN, Ethernet
- **VD9.1345**: RS-232, RS-485 (for stand-alone magnetic compass only), CAN, Ethernet – in case of PPS via RS-422
GPS-Aided INS-DM
Datasheet Revision 1.9

INS-DM mechanical and electrical interfaces description:

Notes:
1. All dimensions are in millimeters
2. All pinouts and dimensions are subject to change without notice. For verification of validity of mechanical drawing please contact Inertial Labs Support.