# GPS-Aided
# Inertial Navigation System
# INS-U

- INS, AHRS and ADC (Air Data Computer) output data
- Multi frequency and Multi constellations GNSS Receiver
- GPS, GLONASS, GALILEO, QZSS and BEIDOU GNSS
- Designed for fixed-wing and multi-rotor Aerial Platforms
- Two Barometers for Indicated Airspeed
- Position accuracy = 1 cm (RTK)
- Heading accuracy = 0.3 deg (RTK, Dynamic)
- Pitch & Roll accuracy = 0.08 deg (RTK, Dynamic)
- Gyro-compensated, embedded Fluxgate magnetic compass
- Optional external Stand-Alone Magnetic Compass
- Small Size, light weight, low power
- Affordable price

The **Inertial Labs GPS-Aided Inertial Navigation System (INS-U)** is an IP67 rated version of the new generation, 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-U** utilizes advanced single antenna multi constellation (GPS, GLONASS, GALILEO, QZSS and BEIDOU GNSS) receiver; two Honeywell TruStability® Board Mount Pressure Sensors; a miniature gyro-compensated Fluxgate compass; 3-axes each of calibrated in full operational temperature range Advanced MEMS Accelerometers and Gyroscopes to provide accurate Position, Velocity, Heading, Pitch and Roll of the device under measure.

**INS-U** contains Inertial Labs new on-board sensor fusion filter, state of the art navigation and guidance algorithms and calibration software.
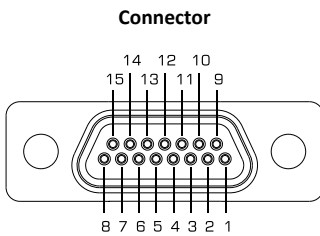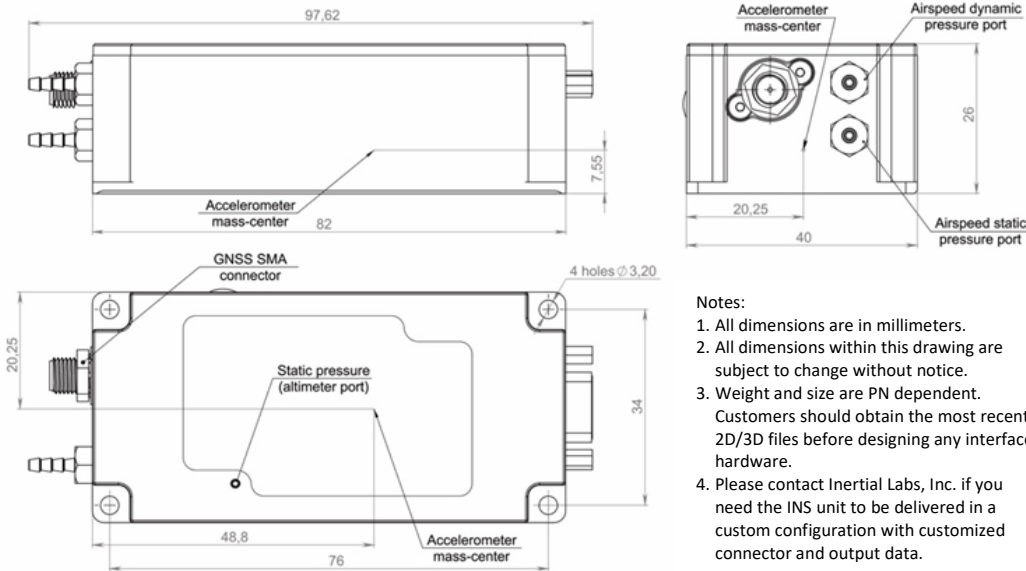
## KEY FEATURES, BENEFITS & FUNCTIONALITY

- Commercially exportable GPS-Aided Inertial Navigation System
- 3-in-1 strapdown system: INS + AHRS + ADC (Air Data Computer)
- Embedded in-flight calibration
- Designed for UAV application algorithm
- UBlox ZED-F9P F9 High Precision GNSS Module
- Small size, lightweight & low power: 82 x 40.0 x 26.0 mm, <200-grams, <1 watt
- GPS, GLONASS, GALILEO, BEIDOU, QZSS, RTK supported signals
- Total and Static Pressure Sensors for calculating Indicated Airspeed
- Embedded Gyro-compensated Mini-Fluxgate magnetometers (compass)
- 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
- Environmentally sealed (IP67)
- Aiding data: Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading

## INS-U Specifications

| | Parameter | Units | INS-U |
|---|---|---|---|
| **Inputs & Outputs** | 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; <br>• **AHRS** data: Magnetic Field, Heading, Pitch & Roll <br>• **INS data**: Positions, Velocity, Delta Theta and Delta Velocity, GNSS data, Time <br>• **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 |
| | Update rate | Hz | 1 … 200 (user settable) |
| | Start-up time | sec | <1 |
| **Navigation** | **Positions, Velocity, and Timestamps** | **Units** | **INS-U** |
| | Horizontal position accuracy (SP), CEP | meters | 1.5 CEP |
| | Horizontal position accuracy (RTK), CEP [1] | meters | 0.01 + 1 ppm CEP |
| | Vertical position accuracy (RTK) [1], CEP | meters | 0.01 + 1 ppm CEP |
| | Velocity accuracy, CEP | meters/sec | 0.05 |
| **Orientation** | **Heading** | **Units** | **INS-U** |
| | Range | deg | 0 to 360 |
| | Angular Resolution | deg | 0.01 |
| | Static Accuracy [2] | deg RMS, 1σ | 0.6 |
| | Dynamic accuracy (GNSS) [3] | deg RMS, 1σ | 0.3 |
| | **Pitch and Roll** | **Units** | **INS-U** |
| | Range: Pitch, Roll | deg | ±90, ±180 |
| | Angular Resolution | deg | 0.01 |
| | Static Accuracy in Temperature Range | deg, 1σ | 0.08 |
| | Dynamic Accuracy [3] | deg RMS, 1σ | 0.05 |
| **GNSS** | **GNSS receiver** | **Units** | **INS-U** |
| | Type | | Single GNSS Antenna |
| | Supported GNSS signals & corrections | | GPS L1C/A L2C, GLO L1OF L2OF, GAL E1B/C E5b, BDS B1I B2I, QZSS L1C/A L2C SBAS L1C/A: WAAS, EGNOS, MSAS, GAGAN |
| | Channel configuration | | 184 Channels – F9 Engine |
| | Raw GNSS data rate | Hz | 10, 20 [6] |
| | Accuracy of Time Pulse Signal | Ns | 30 (RMS), 60 (99%) |
| | Frequency of Time Pulse Signal | Hz | 0.25 – 10,000 (configurable) |
| | GNSS Convergence time [4] | Sec | < 10 (GPS+GLO/GAL/BDS); < 30 (GPS) |
| | Acquisition time [5] | Sec | <30 (cold start), <2 (warm start), <1 (hot start) |
| **Air Data Computer** | **Air Data Computer** | **Units** | **INS-U** |
| | Static Pressure (calibrated) | hPa, % FS | 300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: ±0.1% FSS |
| | Dynamic Pressure (calibrated) | hPa, % FS | 0.15 to 25 hPa / 10 to 124 KCAS (600 KCAS is optional), Accuracy: ±0.25% FSS |
| | Baro-Corrected Pressure Altitude | meters | -500 to 9000 meters; Accuracy: 1 |
| | Pressure Altitude | meters | -500 to 9000 meters; Accuracy: 1 |
| | Calibrated Airspeed | meters/sec | 5 to 64 meters/sec (310 meters/sec is optional); Accuracy: 0.5 |
| | True Airspeed | meters/sec | 5 to 64 meters/sec (310 meters/sec is optional); Accuracy: 0.5 |
| | Mach-Number | M | 0.01 to 0.2 M, Accuracy: 0.001 M |
| | Static Pressure Over Total Pressure | | 0.97 to 1, Resolution 0.000001 |
| | True Angle of Attack | deg | -50 to 50 deg; Accuracy ±0.25 |
| | Rate of Climb | meters/sec | ±515 meters/sec; Accuracy 0.05 |
| | Air Density | kg/m³ | 0.3 to 1.6 kg/m³; Accuracy 0.002 |
| | Outside Air Temperature (OAT) | deg C | -40 to +85 degC; Resolution 0.01 |
| | Wind Speed | meters/sec | ±200 meters/sec; Accuracy: 0.1 |
| **IMU** | **Gyroscopes** | **Units** | **INS-U** |
| | Measurement range | deg/sec | ±2000 |
| | Bias in-run stability (RMS, Allan Variance) | deg/hr, 1σ | 2 |
| | Angular Random Walk (ARW) | deg/√hr, 1σ | 0.38 |
| | **Accelerometers** | **Units** | **INS-U** |
| | Measurement range | g | ±8, ±15, ±40 |
| | Bias in-run stability (RMS, Allan Variance) | mg, 1σ | 0.01, 0.03, 0.05 |
| | Velocity Random Walk (VRW) | m/sec/√hr, 1σ | 0.02, 0.045, 0.06 |
| | **Magnetometers (embedded)** | | **INS-U** |
| | Measurement range | Gauss, 1σ | ±8.0 |
| | Bias in-run stability (Allan Variance) | μGauss, 1σ | 8 |
| | Power Spectral Density | μGauss/√Hz, 1σ | 15 |
| | SF Accuracy | %, 1σ | 0.05 |
| **General** | **Environment** | **Units** | **INS-U** |
| | Operating Altitude | meters | Up to 10000 meters / 32800 ft |
| | Humidity | % | <95 |
| | Operating temperature | deg C | -40 to +85 |
| | Storage temperature | deg C | -50 to +90 |
| | Type of Sealing | | IP-67 |
| | Sand, Dust, Water, Humidity, Shock, Vibration | | MIL-STD-810G |
| | MTBF (GM) | hours | 100,000 |
| | **Electrical** | **Units** | **INS-U** |
| | Supply voltage | V DC | 5-32 |
| | Power consumption | Watts | <2 |
| | Output Interface | - | RS-232 or RS-422 |
| | Output data format | - | Binary, NMEA 0183 ASCII characters |
| | 1 PPS Level | V DC | 5 |
| | **Physical** | **Units** | **INS-U** |
| | Nominal Size [7] | mm | 82.0 x 40 x 26 |
| | Weight [7] | gram | < 200 |

[1] Measured using 1 km baseline and patch antennas with good ground planes. Does not account for possible antenna phase center offset errors. ppm limited to baselines up to 20 km; [2] in homogeneous magnetic environment, for latitude up to ±65 deg; calibrated in whole operational temperature range; [3] With aiding GNSS data. 50% @ 30 m/s dynamic operation, accuracy may depend on type of motion; [4] depends on atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry. [5] Commanded start. All satellites at – 130 dBm; 1σ specifications are manufactured to a controlled 3σ standard; [6] If tracking GPS only. [7] Weight and size are PN dependent. Customers should obtain the most recent 2D/3D files before designing any interface hardware.

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## INS-U Mechanical & Electrical Interfaces Description (standard configuration)



**Notes:**
1. All dimensions are in millimeters.
2. All dimensions within this drawing are subject to change without notice.
3. Weight and size are PN dependent. Customers should obtain the most recent 2D/3D files before designing any interface hardware.
4. Please contact Inertial Labs, Inc. if you need the INS unit to be delivered in a custom configuration with customized connector and output data.

### Connector



### RS-232 & RS-485 interfaces

| PIN | FUNCTION | PIN | FUNCTION |
|-----|----------|-----|----------|
| 1 | POWER IN | 9 | POWER RTRN |
| 2 | POWER RTRN | 10 | 5VOUT |
| 3 | RS485-B | 11 | NC |
| 4 | POWER RTRN | 12 | NC |
| 5 | RS485-A | 13 | 1PPS OUT |
| 6 | RS232-TX2 | 14 | RS232-RX2 |
| 7 | RS232-RX1 | 15 | CHASSIS |
| 8 | RS232-TX1 | SHELL | CHASSIS |

### RS-422 & RS-485 interfaces

| FUNCTION | PIN | FUNCTION | PIN |
|----------|-----|----------|-----|
| POWER IN | 1 | POWER RETURN | 9 |
| POWER RETURN | 2 | 5V OUT | 10 |
| RS485-B | 3 | BOOT | 11 |
| POWER RETURN | 4 | NC | 12 |
| RS485-A | 5 | 1PPS OUT | 13 |
| RS422-TX- | 6 | RS422-TX+ | 14 |
| RS422-RX+ | 7 | POWER RETURN | 15 |
| RS422-RX- | 8 | CHASSIS | SHELL |

## INS-U Product Code Structure

| Model | Gyro | Accelerometers | Calibration | Connector | Pressure Ports | Color | Stand Alone Magnetic Compass | GNSS receiver | Version | Interface |
|-------|------|----------------|-------------|-----------|----------------|-------|------------------------------|---------------|---------|-----------|
| INS-U | G2000 | A8 | TMGA | C15 | 2P | B | SAMC | ZF9P | V9 | .13 |
| | | A15 | | C16 | 2PEXT | | | | V1 (OBSOLETE) | .23 |
| | | A40 | | | | | | | | |

Example: INS-U-G2000-A15-TMGA-C15-2P-B-ZF9P-V9.13

**Product code details:**
- INS-U: Enclosed IP67 Rated Version of the Single Antenna GPS-Aided Inertial Navigation System
- G2000: Gyroscopes measurement range = ±2000 deg/sec
- A8: Accelerometers measurement range ±8 g
- A15: Accelerometers measurement range ±15 g
- A40: Accelerometers measurement range ±40 g
- TMGA: Calibration of IMU (Gyroscopes, Accelerometers and Magnetometers) in operational temperature range
- C15: 15 pin micro-D-SUB plug MM-212-015-11 (by Airborn)
- C16: 15 pin micro-D-SUB plug MM-212-015-11 (by Airborn), special PIN dedicated to Firmware update
- 2P: Two Airspeed Pressure Ports Standard Range (Total/Static)
- 2PEXT: Two Airspeed Pressure Ports with Extended Range (Total/Static, Honeywell 600MD)
- B: Black Color (default)
- SAMC – Support external, Stand-Alone Magnetic Compass (optional)
- ZF9P: Single ZED-F9P, Dual-Frequency, Multi-Constellation, RTK Capable GNSS Receiver
- V9: GPS L1/L2, GLONASS L1/L2, BEIDOU B1/B2, GALILEO E1/E5, QZSS L1/L5, DGPS, RTK, GNSS measurements, GNSS positions (Single Antenna GNSS Receiver only)
- .13: RS-232/485 (RS-485 for stand-alone magnetic compass only)
- .23: RS-422/485 (RS-485 for stand-alone magnetic compass only) (such configuration does not support RTK GNSS correction)