



# 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

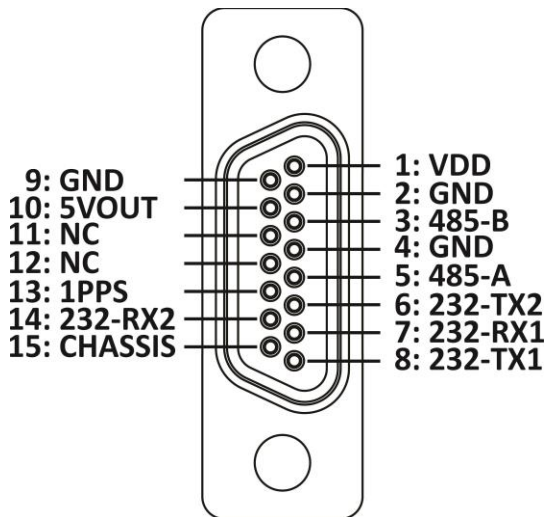
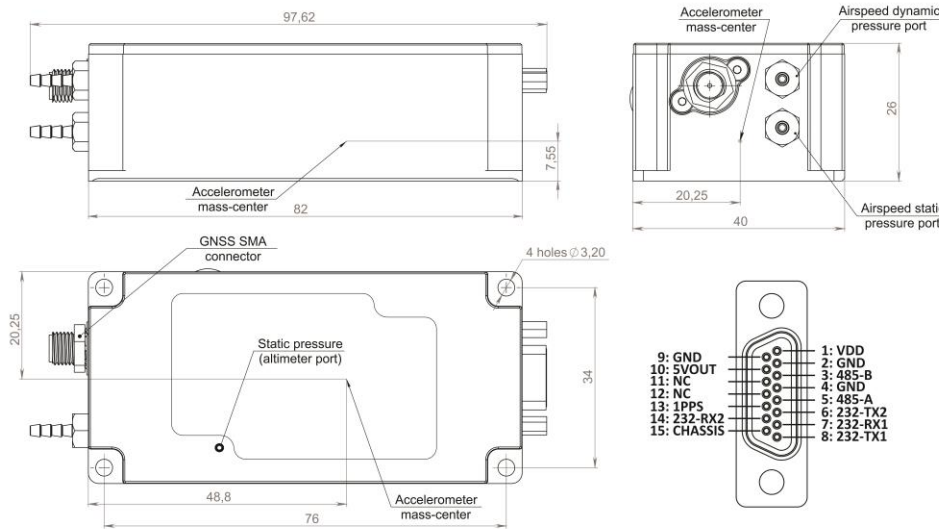
- Commercially exportable GPS-Aided Inertial Navigation System
- 3-in-1 strapdown system: INS + AHRS + ADC (Air Data Computer)
- Embedded in-flight calibration
- Designed for UAV application algorithm
- UBlock ZED-F9P F9 High Precision GNSS Module
- Small size, lightweight & low power: 82 x 40.0 x 26.0 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	
<b>Inputs &amp; Outputs</b>	Input signals		<ul style="list-style-type: none"> <li>External Magnetometer, Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading aiding data</li> </ul>	
	Output signals		<ul style="list-style-type: none"> <li><b>IMU</b> data: Accelerations, Angular rates;</li> <li><b>AHRS</b> data: Magnetic Field, Heading, Pitch &amp; Roll</li> <li><b>INS data</b>: Positions, Velocity, Delta Theta and Delta Velocity, GNSS data, Time</li> <li><b>Air Data Computer</b> 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</li> </ul>	
	Update rate	Hz	1 ... 200 (user settable)	
	Start-up time	sec	<1	
<b>Positions, Velocity, and Timestamps</b>				
<b>Navigation</b>	Horizontal position accuracy (SP), CEP	meters	1.5 CEP	
	Horizontal position accuracy (RTK), CEP <sup>(1)</sup>	meters	0.01 + 1 ppm CEP	
	Vertical position accuracy (RTK) <sup>(1)</sup> , CEP	meters	0.01 + 1 ppm CEP	
	Velocity accuracy, CEP	meters/sec	0.05	
<b>Heading</b>				
<b>Orientation</b>	Range	deg	0 to 360	
	Angular Resolution	deg	0.01	
	Static Accuracy <sup>(2)</sup>	deg RMS, 1 $\sigma$	0.6	
	Dynamic accuracy (GNSS) <sup>(3)</sup>	deg RMS, 1 $\sigma$	0.3	
	<b>Pitch and Roll</b>		Units	INS-U
	Range: Pitch, Roll	deg	$\pm 90$ , $\pm 180$	
	Angular Resolution	deg	0.01	
	Static Accuracy in Temperature Range	deg, 1 $\sigma$	0.05	
	Dynamic Accuracy <sup>(3)</sup>	deg RMS, 1 $\sigma$	0.08	
	<b>GNSS receiver</b>			
<b>GNSS</b>	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	20 (GPS+GLO+GAL+BDS or GPS+GLO+GAL) 25 (GPS only or GPS+GAL/GLO/BDS)	
	Accuracy of Time Pulse Signal	Ns	30 (RMS), 60 (99%)	
	Frequency of Time Pulse Signal	Hz	0.25 – 10,000 (configurable)	
	GNSS Convergence time <sup>(4)</sup>	Sec	< 10 (GPS+GLO/GAL/BDS); < 30 (GPS)	
	Acquisition time <sup>(5)</sup>	Sec	<30 (cold start), <2 (warm start), <1 (hot start)	
<b>Air Data Computer</b>				
<b>Air Data Computer</b>	Static Pressure (calibrated)	hPa, % FS	300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: $\pm 0.1\%$ FSS	
	Dynamic Pressure (calibrated)	hPa, % FS	0.15 to 25 hPa / 10 to 124 KCAS (600 KCAS is optional), Accuracy: $\pm 0.25\%$ 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 $\pm 0.25$	
	Rate of Climb	meters/sec	$\pm 515$ meters/sec; Accuracy 0.05	
	Air Density	kg/m <sup>3</sup>	0.3 to 1.6 kg/m <sup>3</sup> ; Accuracy 0.002	
	Outside Air Temperature (OAT)	deg C	-40 to +85 degC; Resolution 0.01	
	Wind Speed	meters/sec	$\pm 200$ meters/sec; Accuracy: 0.1	
	<b>Gyroscopes</b>			
<b>IMU</b>	Measurement range	deg/sec	$\pm 2000$	
	Bias in-run stability (RMS, Allan Variance)	deg/hr, 1 $\sigma$	2	
	Angular Random Walk (ARW)	deg/ $\sqrt{\text{hr}}$ , 1 $\sigma$	0.38	
	<b>Accelerometers</b>		Units	INS-U
	Measurement range	g	$\pm 8$ , $\pm 15$ , $\pm 40$	
	Bias in-run stability (RMS, Allan Variance)	mg, 1 $\sigma$	0.01, 0.03, 0.05	
	Velocity Random Walk (VRW)	m/sec/ $\sqrt{\text{hr}}$ , 1 $\sigma$	0.02, 0.045, 0.06	
	<b>Magnetometers (embedded)</b>		Units	INS-U
	Measurement range	Gauss, 1 $\sigma$	$\pm 8.0$	
	Bias in-run stability (Allan Variance)	$\mu\text{Gauss}$ , 1 $\sigma$	8	
Power Spectral Density	$\mu\text{Gauss}/\sqrt{\text{Hz}}$ , 1 $\sigma$	15		
SF Accuracy	%, 1 $\sigma$	0.05		
<b>Environment</b>				
<b>General</b>	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	
	<b>Electrical</b>		Units	INS-U
	Supply voltage	V DC	5-32	
	Power consumption	Watts	<1	
	Output Interface (options)	-	RS-232	
	Output data format	-	Binary, NMEA 0183 ASCII characters	
	1 PPS Level	V DC	5	
	<b>Physical</b>		Units	INS-U
Nominal Size	mm	82.0 x 40 x 26		
Weight	gram	< 200		

<sup>(1)</sup> 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; <sup>(2)</sup> in homogeneous magnetic environment, for latitude up to  $\pm 65$  deg; calibrated in whole operational temperature range; <sup>(3)</sup> With aiding GNSS data. 50% @ 30 m/s dynamic operation, accuracy may depend on type of motion; <sup>(4)</sup> depends on atmospheric conditions, baseline length, GNSS antenna, multipath conditions, satellite visibility and geometry. <sup>(5)</sup> Commanded start. All satellites at  $-130$  dBm; 1 $\sigma$  specifications are manufactured to a controlled 3 $\sigma$  standard.

## INS-U with embedded magnetometer mechanical & electrical interfaces description (default version)



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

### 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 A15 A40	TMGA	C15	2P	B	SAMC	ZF9P	V9 V1 (OBSOLETE)	.13

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

- INS-U: Enclosed IP67 Rated Version of the Single Antenna GPS-Aided Inertial Navigation System
- G2000: Gyroscopes measurement range =  $\pm 2000$  deg/sec
- A8: Accelerometers measurement range  $\pm 8$  g
- A15: Accelerometers measurement range  $\pm 15$  g
- A40: Accelerometers measurement range  $\pm 40$  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)
- 2P: Two Airspeed Pressure Ports (Total/Static)
- B: Black Color (default)
- SAMC – Support external, Stand-Alone Magnetic Compass (optional)
- ZF9P: uBlox 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, 20 Hz measurements, 20 Hz positions
- VX.13: RS-232/485 (RS-485 for stand-alone magnetic compass only)