

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

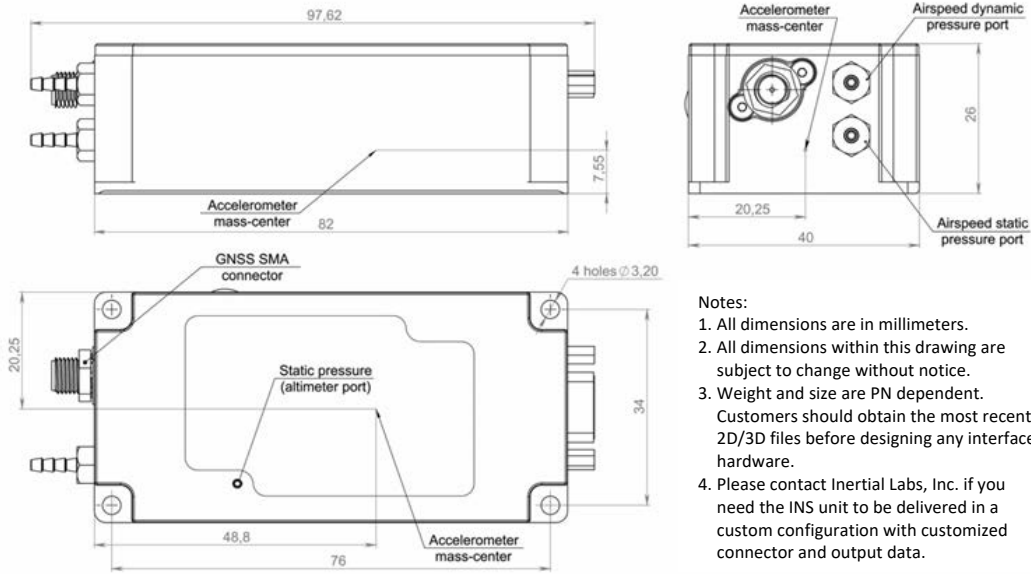
- Commercially exportable GPS-Aided Inertial Navigation System
- 3-in-1 strapdown system: INS + AHRS + ADC (Air Data Computer)
- Embedded in-flight calibration
- Designed for UAV application algorithm
- Ublox ZED-F9P F9 High Precision GNSS Module
- Small size, lightweight & low power: 82 x 40.0 x 26.0 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

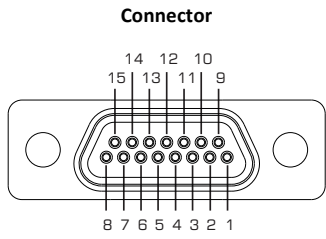
	Parameter	Units	INS-U
Inputs & Outputs	Input signals		<ul style="list-style-type: none"> External Magnetometer, Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading aiding data
	Output signals		<ul style="list-style-type: none"> IMU data: Accelerations, Angular rates; AHRS data: Magnetic Field, 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
	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, NAVIC L5
	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/m ³	0.3 to 1.6 kg/m ³ ; 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)	Units	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.

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.



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

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	V93	.23
		A40								V1 (OBSOLETE)	

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)
- V93: GPS L1C/A, L5 GLO L1OF GAL E1B/C, E5a BDS B1I, B2a QZSS L1C/A, L1S, L5; NavIC L5
- .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)