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

INS

The **Inertial Labs Single and Dual Antenna GPS-Aided Inertial Navigation System – INS** is 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 (Tactical-grade IMU + Fluxgate compass + Aiding data)
- 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
- 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 of all sensing elements
- Environmentally sealed (IP67), compact design, MIL-STD-810G/DO-160E

Models & features

INS-B	INS-P	INS-D	INS-DL
Basic	Professional	Dual Antenna	Dual Antenna
Ideal solution for remote sensing (UAV, LiDAR, Optical Camera, Point Clouds)	High performance in long-term GPS-Denied environment	High precision Heading Tactical-grade IMU SP/SBAS/DGPS/RTK	High precision Heading Industrial-grade IMU 1 cm RTK position

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2

Single and Dual Antenna GPS-Aided INS Specifications

	Parameter	Units	INS-B	INS-P	INS-D	INS-DL
GENERAL	Output signals		• Positions, Heading, Dual antenna Heading (D/DL), Pitch, Roll, Velocity, Accelerations, Angular rates, Barometer, PPS • Direct AT_ITINS 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 High precision Heading 1 cm RTK position
	Data rate	Hz	Up to 200 (INS data); Up to 2000 (IMU data)			Up to 200 (INS) & 2000 (IMU)
	Internal Data Logger (storage) - optional		64 GB			64 GB
	Start-up time	sec	<1			<1
	Positions, Velocity and Timestamps	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
Navigation	Horizontal position accuracy (GPS L1)	meters, RMS	1.5			1.5
	Vertical position accuracy (GPS L1)	meters, RMS	<1			<2
	Horizontal position accuracy (GPS L1/L2)	meters, RMS	1.2			1.2
	Horizontal position accuracy (SBAS) [1]	meters, RMS	0.6			0.6
	Horizontal position accuracy (DGPS)	meters, RMS	0.4			0.4
	Horizontal position accuracy (TerraStar-L) [2]	meters, RMS	0.4			n/a
	Horizontal position accuracy (TerraStar-C PRO) [2]	meters, RMS	0.25			n/a
	Horizontal position accuracy (post processing) [3]	meters, RMS	0.005			0.005
	Horizontal position accuracy (RTK)	meters, RMS	0.01 + 1 ppm			0.01 + 1 ppm
	Vertical position accuracy (RTK)	meters, RMS	0.02			0.02
	Velocity accuracy, RMS	meters/sec	0.03			0.03
	PPS timestamps accuracy	nano sec	20			20
	Heading	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
Orientation	Range	deg	0 to 360	0 to 360	0 to 360	0 to 360
	Static Accuracy [4]	deg RMS	1	0.4	0.15 (1 meter base line)	0.2 (1 meter base line)
	Dynamic accuracy (GNSS) [7]	deg RMS	0.1	0.1	0.08 (2 meters baseline)	0.08 (2 meters baseline)
	Post processing accuracy [3]	deg RMS	0.03	0.03	0.03	0.03
	Pitch and Roll	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
	Range: Pitch, Roll	deg	±90, ±180			±90, ±180
	Angular Resolution	deg	0.01			0.01
	Static Accuracy in whole Temperature Range	deg RMS	0.05			0.05
	Dynamic Accuracy [7]	deg RMS	0.08			0.08
	Post processing accuracy [3]	deg RMS	0.006			0.006
	GNSS	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
GNSS	Number of Antennas		Single	Single	Dual	Dual
	Supported navigation signals		GPS L1/L2/L5; GLONASS L1/L2; BeiDou B1/B2/B3, QZSS L1/L2/L5; GALILEO E1/E5; SBAS; DGPS; RTK			GPS L1/L2, GLONASS L1/L2, BEIDOU B1/B2, GALILEO E1/E5, QZSS L1/L5, SBAS, DGPS, RTK
	Channel configuration [5]		555 Channels			435 Channels
	RTK corrections		RTCM 2.1/2.3/3.0/3.1			RTCM 2.3/3.0/3.2
	GNSS Positions data rate [6]	Hz	20, 50			20
	GNSS Measurements (raw) data rate	Hz	20			20
	Velocity accuracy, RMS	meters/sec	<0.03			<0.03
	Initialization time	Sec	<50 (cold start), <30 (hot start)			<50 (cold start), <30 (hot start)
	Time accuracy (clock drift) [8]	nano sec	20			20
	Gyroscopes	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
IMU	Type		Tactical-grade			Industrial-grade
	Measurement range	deg/sec	±450 / ±950			±450 / ±950
	Bias in-run stability (RMS, Allan Variance)	deg/hr	1			3
	Bias error over temperature range (RMS)	deg/hr	<30			<50
	Angular Random Walk	deg/√hr	<0.2			<0.3
	Accelerometers	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
	Type		Tactical-grade			Industrial-grade
	Measurement range	g	±8 g / ±15 g / ±40 g			±8 g | ±15 g | ±40 g
	Bias in-run stability (RMS, Allan Variance)	mg	0.005 (±8 g) / 0.02 (±15 g) / 0.03 (±40 g)			0.01 | 0.03 | 0.05
	Bias error over temperature range (RMS)	mg	0.5 (±8 g) / 0.7 (±15 g) / 1.2 (±40 g)			0.7 | 1.1 | 1.5
	Bias one-year repeatability	mg	1.0 (±8 g) / 1.3 (±15 g) / 1.5 (±40 g)			1.5 | 2.0 | 2.5
	Velocity Random Walk	m/s/√hr	0.015 (±8 g) / 0.035 (±15 g) / 0.045 (±40 g)			0.02 | 0.045 | 0.06
	Magnetometers	**Units**	**INS-B**	**INS-P (Fluxgate)**	**INS-D**	**INS-DL**
	Measurement range	Gauss		±1.6		
	Bias in-run stability, RMS	nT	Optional	0.2	Optional	Optional
	Noise density, PSD	nT√Hz		0.3		
	Pressure	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
	Measurement range	hPa	300 − 1100			300 − 1100
	Bias in-run stability (RMS, Allan Variance)	Pa	2			2
	Noise density	Pa/√Hz	0.8			0.8
	Environment	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
General	Operating temperature	deg C	-40 to +75			-40 to +70
	Storage temperature	deg C	-50 to +85			-50 to +85
	MTBF (G_M @ +65degC)	hours	100,000			100,000
	Shock and Vibration		MIL-STD-810G			MIL-STD-810G
	EMC/EMI		MIL-STD-461			MIL-STD-461
	Electrical	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
	Supply voltage	V DC	9 to 36	9 to 36	9 to 36	9 to 36
	Power consumption	Watts	1	1.4	2.6	2.6
	Output Interface (options)	-	RS-232, RS-422, Ethernet, CAN			
	Output data format		Binary, NMEA 0183 ASCII characters			
	Physical	**Units**	**INS-B**	**INS-P**	**INS-D**	**INS-DL**
	Size	mm	120 x 50 x 53	120 x 50 x 53	120 x 50 x 53	120 x 50 x 53
	Weight	gram	220	280	320	320

[1] GPS only; [2] Requires a subscription to a TerraStar data service [3] RMS, incremental error growth from steady state accuracy. Post-processing results using third party software; [4] calibrated in whole operational temperature range, in homogeneous magnetic environment, for latitude up to ±65 deg; [5] tracks up to 60 L1/L2 satellites; [6] 50 Hz while tracking up to 20 satellites. 20 Hz position update rate for Basic model of INS; [7] dynamic accuracy may depend on type of motion; [8] time accuracy does not include biases due to RF or antenna delay

Inertial Labs GPS-Aided INS key sensors (IMU) performance
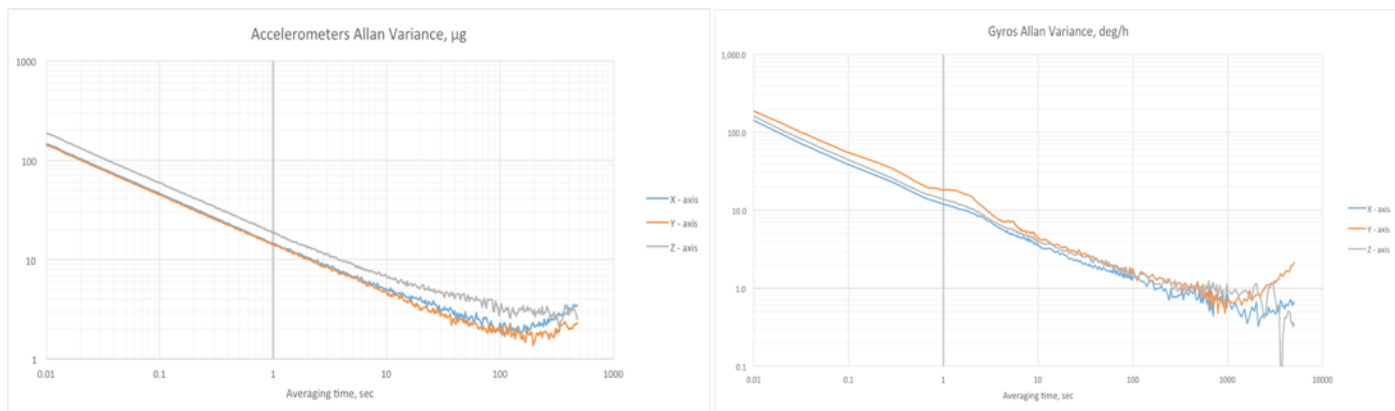

Inertial Labs GPS-Aided INS key applications

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4
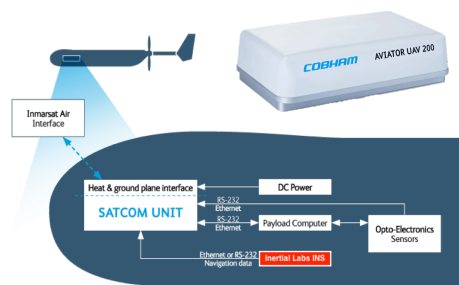
INS part numbers structure

| Model	Gyro	Accel	Calibration	Connector	Color	GNSS receiver	Version	Interface
INS-B	G450	A8	TGA	C1	D	O615	V0	1
INS-P	G950	A15	TMGA	C3	B	O617D	V1	2
INS-D		A40		C31		O718	V2	11
INS-DL				C32		O719	V3	22
						O7720	V4	
						P327	VR43	
						B482	VR5	
							V8	
							VD4	
							VD42	
							VD9	

<u>Example</u>: INS-B-G450-A8-TGA-C3D-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 measurment range = ±450 deg/sec
- G950: Gyroscopes measurment range = ±950 deg/sec
- A8: Accelerometers measurement range = ±8 g
- 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')
- D - Desert Color (Desert tan, color code 33446 (tan 686A) per FED-STD-595, Change Notice 1.)
- B – Black Color
- O615: Novatel OEM615 single antenna GNSS receiver (INS-B and INS-P only) - OBSOLETE
- O617D: Novatel OEM617D dual antenna GNSS receiver (INS-D only) - OBSOLETE
- O718: Novatel OEM718D dual antenna GNSS receiver (INS-D only)
- O719: Novatel OEM719 single antenna GNSS receiver (INS-B and INS-P only)
- O7720: Novatel OEM7720 dual antenna GNSS receiver (INS-D only)
- P327: Hemisphere P327 single antenna GNSS receiver (INS-B and INS-P only)
- B482: Inertial Labs B482 dual antenna GNSS receiver (INS-DL only)
- 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)
- V3: GPS L1/L2, SBAS, DGPS, 20 Hz positions (INS-B and INS-P only)
- V4: GPS L1/L2, GLONASS 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)
- VX.1: RS-232, CAN, Ethernet interface
- VX.2: RS-422, CAN, Ethernet interface
- VX.1: 2 x RS-232 interfaces
- VX.2: 2 x RS-422 interfaces

INS-D and INS-DL mechanical interface drawing
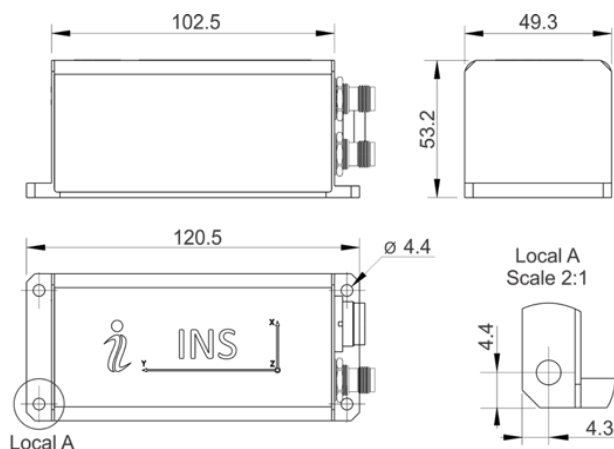
INS-B and INS-P mechanical interface drawing
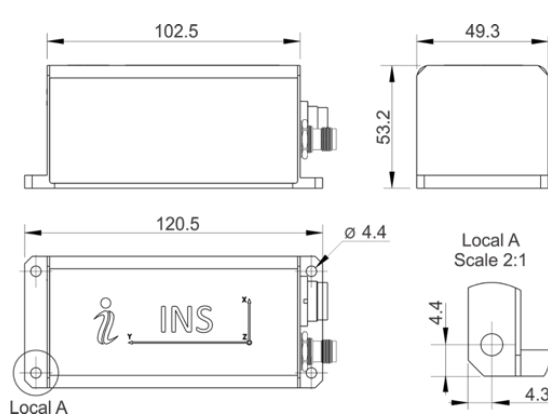
<u>Notes</u>:

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.

<u>Interface connector type</u>: Binder. Male receptacle, shielded, rear-mounting
<u>GNSS antenna connector type</u>: TNC - Female

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5