



# FOG IMU-BASED GPS-AIDED INERTIAL NAVIGATION SYSTEM



## INS-FI



The **Inertial Labs GPS-Aided Inertial Navigation System INS-FI** is the newest Inertial Navigation System (INS) developed by Inertial Labs using Tactical-grade Fiber Optic Gyroscope technology. The INS-FI is the result of over 20 years of experience in developing and supplying INS solutions to land, marine and aerial platforms around the world.

This system, the INS-FI, is an IP67 rated version of an all-new generation of super ruggedized and EMC/EMI shielded INSs. The fully integrated INS-FI contains an Inertial Measurement Unit (IMU) combining Fiber Optic Gyroscopes and MEMS Accelerometers, along with an all constellations (GPS, GLONASS, GALILEO, QZSS, BEIDOU and NAVIC) and multiple bands GNSS receiver. It determines horizontal and vertical positions, 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.



Due to its high-performing FOG IMU, the **INS-FI** can measure GNSS-free Heading (True North) with less than 0.5 deg error, Horizontal & Vertical Positions with approximately 0.1% error of Distance Traveled for land applications, and 5 nautical miles per hour drift for aerospace (Unmanned Aerial Vehicles) applications without GNSS signal.

**INS-FI** is fully compatible with the Inertial Labs developed VINS (Visual Inertial Navigation Systems) and SAMC (Stand-Alone Magnetic Compass).

The **INS-FI** contains Inertial Labs' latest version of the 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 (ECCN 7A994)
- 3-in-1 strapdown system: IMU + AHRS + INS
- Fiber Optic Gyroscopes (FOG) & MEMS accelerometers Inertial Measurement Unit (IMU)
- NovAtel OEM7, u-blox ZED-F9P, or Septentrio mosaic-H High Precision GNSS receiver
- Embedded Anti-Jamming and Spoofing mitigation features
- L1/L2/L5 GPS, GLONASS, GALILEO, BEIDOU, QZSS, IRNSS
- SP, SBAS, DGPS, RTK and PPP for real time operation
- Sensor fusion algorithms with advanced extended Kalman Filter
- State-of-the-art algorithms for Land, Aerospace and Maritime applications
- Full temperature calibration of all sensing elements according MIL-STD-810 standard
- MIL-STD-461 standard based 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
- Internal/External Air Data Computer (ADC) and External Stand-Alone Magnetic Compass (SAMC)
- Full integration with ArduPilot platform

<b>GENERAL</b>	<b>OPTIONAL INPUT SIGNALS</b>	
	<ul style="list-style-type: none"> <li>External Magnetometer, Embedded/External Air Data Computer (ADC), Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading aiding data</li> </ul>	
	<b>OUTPUT DATA</b>	
	<ul style="list-style-type: none"> <li>IMU data: Accelerations, Angular rates, Magnetic field;</li> <li>AHRS data: Heading, Pitch &amp; Roll</li> <li>MRU data: Heave, Surge, Sway</li> <li>INS data: Positions, Velocity, Delta Theta and Delta Velocity, GNSS data, Time</li> <li>External 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</li> </ul>	
	<b>ELECTRICAL AND MECHANICAL</b>	
	Update rate	1 ... 200 Hz (INS & AHRS data); up to 1000 Hz (IMU data)
	Start-up time	<1 sec
	Interface	RS-232 / RS-422 / CAN / Ethernet
	Input power protection	Standard
	Input power	9 to 36 V DC (27 ± 10 for MIL-STD-1275 protection)
	Output data	Binary, NMEA 0183 ASCII characters
	1 PPS level	3.3 V DC TTL / 5 V DC TTL / differential
	EMC/EMI	MIL-STD-461F
	Type of Sealing	IP67
	MTBF	100,000 hours
	Dimensions	D88.9 x H127.5 mm
	Weight	950 grams
	<b>ENVIRONMENT</b>	
	Operational Temperature	-40 to +75C
	Storage Temperature	-50 to +85C
Humidity	Up to 95%	
Sand, Dust, Water, Shock, Vibration	MIL-STD-810G	
Altitude	up to 15,000 m (50,000 ft)	
Acoustic noise	185 dB max	



<b>INERTIAL MEASUREMENT UNIT (IMU)</b>	<b>GYROSCOPES</b>		
	Technology		Closed-loop FOG
	Measurement range	deg/sec	±490
	Bandwidth (-3dB)	Hz	200
	Data update rate	Hz	400 (1000 is optional)
	Bias in-run stability (Allan Variance)	deg/hr	0.025
	Bias repeatability (over temperature range)	deg/hr	0.5
	SF accuracy (over temperature range)	ppm	100
	Noise. Angular Random Walk (ARW)	deg/Vhr	0.025 (typical)
	Non-linearity	ppm	50
	<b>ACCELEROMETERS</b>		
	Technology		MEMS
	Measurement range	g	±8      ±40
	Bandwidth (-3dB)	Hz	260      260
	Data update rate	Hz	400 (1000 is optional)      400 (1000 is optional)
	Bias in-run stability (RMS, Allan Variance)	mg	0.005      0.02
	Bias repeatability (over temperature range)	mg	0.5      1.2
	SF accuracy (over temperature range)	ppm	150      500
	Noise. Velocity Random Walk (VRW)	m/sec/Vhr	0.015 (typical)      0.045 (typical)
	Non-linearity	ppm	150      150

<b>INS-FI PERFORMANCE</b>	<b>NAVIGATION</b>	
	Horizontal position accuracy (SP)	1.2 m
	Horizontal position accuracy (SBAS) <sup>(1)</sup>	0.6 m
	Horizontal position accuracy (DGPS)	0.4 m
	Horizontal position accuracy (PPP TerraStar-C PRO) <sup>(2)</sup>	0.025 m
	Horizontal position accuracy (RTK)	0.01 m
	Vertical position accuracy (RTK)	0.02 m
	Velocity accuracy (OEM7720, Mosaic H), RMS	0.03 m/sec
	Velocity accuracy (uBlox F9P), RMS	0.05 m/sec
	Horizontal Position accuracy (free inertial, land vehicles)	0.1% DT
	Horizontal Position accuracy (free inertial, aerial)	<5 NMPH
	<b>HEADING</b>	
	Range	0 to 360 deg
	Angular Resolution	0.01 deg
	Static & Dynamic Accuracy <sup>(4)</sup> (Dual antenna, 1 meter baseline)	0.15 deg
	Static & Dynamic Accuracy <sup>(4)</sup> (Dual antenna, 2 meters baseline)	0.08 deg
	Dynamic Accuracy <sup>(4)</sup> (Single antenna)	0.15 deg
	Post processing accuracy <sup>(3)</sup>	0.01 deg
	Free inertial	0.5 deg
	With External Stand-Alone Magnetic Compass (after calibration)	1 deg
	<b>PITCH &amp; ROLL</b>	
	Range	±90, ±180 deg
	Angular Resolution	0.01 deg
	Static Accuracy	0.01 deg
Dynamic Accuracy	0.01 deg	
Post processing accuracy <sup>(3)</sup>	0.005 deg	

**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

<b>GNSS RECEIVER OPTIONS</b>				
	<b>Novatel OEM7720</b>	<b>u-blox ZED-F9P</b>	<b>Septentrio mosaic-H</b>	
	<b>Number of GNSS Antennas</b>	Dual	Dual	Dual
	<b>GNSS constellations</b>	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	GPS L1C/A L2C, GLONASS L1OF L2OF, Galileo E1B/C E5b, BeiDou B1I B2I, QZSS L1C/A L2C	GPS L1C/A, L1C, L1PY, L2C, L2P, L5; GLONASS L1CA, L2CA, L2P, L3 CDMA; Beidou B1I, B1C, B2a, B2I, B3; Galileo E1, E5a, E5b, E5 AltBoc, E6; QZSS L1C/A, L1C, L2C, L5, L6; Navic L5; L-band
	<b>GNSS corrections</b>	WAAS; EGNOS; MSAS; GAGAN; SBAS L1, L5; DGPS; RTK; PPP Terrastar	WAAS; EGNOS; MSAS; GAGAN; SBAS; DGPS; RTK	WAAS; EGNOS; MSAS; GAGAN; SBAS; DGPS; RTK
	<b>Channel configuration <sup>(1)</sup></b>	555 Channels	184 Channels	448 Channels
	<b>GNSS data rate <sup>(1)</sup></b>	5 Hz / 20 Hz / 100 Hz	10, 20 Hz <sup>(2)</sup>	100 Hz (max)
	<b>RTK corrections</b>	RTCM 2, RTCM 3	RTCM 3	RTCM 2, RTCM 3
	<b>Velocity accuracy, RMS</b>	0.03 m/sec	0.05 m/sec	0.03 m/sec
	<b>Initialization time</b>	<39 (cold start), <20 (hot start)	<30 (cold start), <10 (hot start)	<45 (cold start); <20 (hot start)
<b>Time accuracy (clock drift) <sup>(3)</sup></b>	20 nano sec	30 nano sec	20 nano sec	

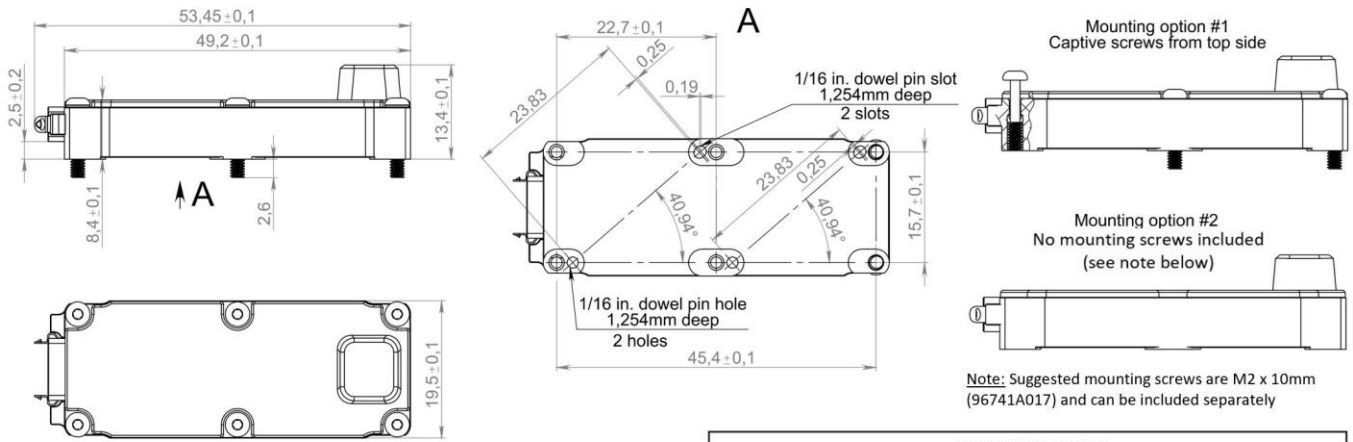
<sup>(1)</sup> tracks up to 60 L1/L2 satellites; <sup>(2)</sup> if tracking GPS Only; <sup>(3)</sup> time accuracy does not include biases due to RF or antenna delay

<b>AIR DATA COMPUTER</b>	 <b>Honeywell</b>	 <b>Honeywell</b>
<b>Specifications</b>	Using Honeywell 025MD sensor	Using Honeywell 600MD sensor
Static Pressure (calibrated)	300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: $\pm 0.1\%$ FSS	300 to 1100 hPa, from -2000 ft to 30000 ft, Accuracy: $\pm 0.1\%$ FSS
Dynamic Pressure (calibrated)	0.15 to 25 hPa / 10 to 124 KCAS, Accuracy: $\pm 0.25\%$ FSS	0.15 to 600 hPa / 10 to 600 KCAS, Accuracy: $\pm 0.25\%$ FSS
Baro-Corrected Pressure Altitude	-500 to 9000 meters; Accuracy: 1	-500 to 9000 meters; Accuracy: 1
Pressure Altitude	-500 to 9000 meters; Accuracy: 1	-500 to 9000 meters; Accuracy: 1
Calibrated Airspeed	5 to 64 meters/sec; Accuracy: 0.5	5 to 310 meters/sec; Accuracy: 0.5
True Airspeed	5 to 64 meters/sec; Accuracy: 0.5	5 to 310 meters/sec; Accuracy: 0.5
Mach-Number	0.01 to 0.2 M, Accuracy: 0.001 M	0.01 to 0.99 M, Accuracy: 0.002 M
Static Pressure Over Total Pressure	0.97 to 1, Resolution 0.000001	0.63 to 1, Resolution 0.000001
True Angle of Attack	-50 to 50 deg; Accuracy $\pm 0.25$	-50 to 50 deg, Accuracy $\pm 0.25$
Rate of Climb	$\pm 515$ meters/sec; Accuracy 0.05	$\pm 515$ meters/sec; Accuracy 0.05
Air Density	0.3 to 1.6 kg/m <sup>3</sup> ; Accuracy 0.002	0.3 to 1.6 kg/m <sup>3</sup> ; Accuracy 0.002
Outside Air Temperature (OAT)	-40 to +85 deg C; Resolution 0.01	-40 to +85 degC; Resolution 0.01
Wind Speed	$\pm 200$ meters/sec; Accuracy: 0.1	$\pm 200$ meters/sec; Accuracy: 0.1

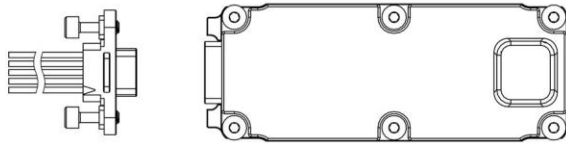
<b>EXTERNAL STAND-ALONE MAGNETIC COMPASS (SAMC)</b>	Output signals	Heading, Pitch, Roll; Quaternion; PPS Time; Accelerations; Angular rates; Magnetic field; Delta Theta & Delta Velocity	
	Update rate	Hz	1 ... 2000 (user settable)
	Start-up time	sec	< 1
	<b>HEADING</b>		
	Range	deg	0 to 360
	Angular Resolution	deg	0.01
	Static Accuracy in Temperature Range	deg, 1 $\sigma$	0.5
	Dynamic Accuracy	deg RMS, 1 $\sigma$	1.0
	<b>PITCH AND ROLL</b>		
	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	deg RMS, 1 $\sigma$	0.08



### Optional External Stand-Alone Magnetic Compass (SAMC)



Mating option #2 - screw-lock connector - G125-2241096F1



ADDITIONAL PARTS			
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	SSBA-M2-10-A2	M2 x 10mm Captive Screws	6
2	96741A017	M2 x 10mm	6
3	97325A101	Brass Dowel Pin, 1/16" Diameter, 1/4" Long	2
4	G125-FC11005F1-0150L	Screw-lock connector with cable	1