Inertial Labs
a VIAVI Solutions company

GPS-Aided Inertial Navigation Systems

INS-FI

Datasheet

STANDARD MIL-STD 810G

CERTIFIED ISO 9001:2015 COMPANY

MADE IN THE USA

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.

The fully integrated INS-FI contains an Inertial Measurement Unit (IMU) combining Fiber Optic Gyroscopes and MEMS Accelerometers, along with 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 to MIL-STD-810 standard
- MIL-STD-461 standard based EMC, EMI, and ERD protection
- 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

SPECIFICATIONS

	Parameter	Units						
Inputs & Outputs	Input signals		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					
	Output signals		**IMU** data: Accelerations, Angular rates, Magnetic field; **AHRS** data: Heading, Pitch & Roll **MRU** data: Heave, Surge, Sway **INS** data: Positions, Velocity, Delta Theta and Delta Velocity, GNSS data, Time **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					
	Update rate	Hz	1 … 200 (INS & AHRS data); up to 1000 (IMU data)					
	Start-up time	sec	<1					
	Positions, Velocity, and Timestamps							
Navigation	Horizontal position accuracy (SP)	m	1.2					
	Horizontal position accuracy (SBAS) [1]	m	0.6					
	Horizontal position accuracy (DGPS)	m	0.4					
	Horizontal position accuracy (PPP TerraStar-C PRO) [2]	m	0.025					
	Horizontal position accuracy (RTK)	m	0.01					
	Vertical position accuracy (RTK)	m	0.02					
	Velocity accuracy (OEM7720, Mosaic H), RMS	m/sec	0.03					
	Velocity accuracy (uBlox F9P), RMS	m/sec	0.05					
	Horizontal Position accuracy (free inertial, land vehicles)	% DT	0.1					
	Horizontal Position accuracy (free inertial, aerial)	NMPH	3					
	Heading							
Orientation	Range	deg	0 to 360					
	Angular Resolution	deg	0.01					
	Static & Dynamic Accuracy [4] (Dual antenna, 1 meter baseline)	deg	0.15					
	Static & Dynamic Accuracy [4] (Dual antenna, 2 meters baseline)	deg	0.08					
	Dynamic Accuracy [4] (Single antenna)	deg	0.15					
	Post processing accuracy [3]	deg	0.01					
	Free inertial	deg	0.5					
	With External Stand-Alone Magnetic Compass (after calibration)	deg	1					
	Pitch and Roll							
	Range	deg	±90, ±180					
	Angular Resolution	deg	0.01					
	Static Accuracy	deg	0.01					
	Dynamic Accuracy	deg	0.01					
	Post processing accuracy [3]	deg	0.005					
	Gyroscopes							
IMU	Technology	-	Closed-loop FOG					
	Measurement range	deg/sec	±490					
	Bandwidth (-3dB)	Hz	200					
	Data update rate	Hz	1000					
	Bias repeatability (over temperature range)	deg/hr	0.5					
	SF accuracy (over temperature range)	ppm	100					
	Noise. Angular Random Walk (ARW)[8]	deg/√hr	0.025					
	Non-linearity	ppm	50					
	Accelerometers							
	Technology	-	MEMS					
	Measurement range	g	±8			±40		
	Bandwidth (-3dB)	Hz	260					
	Data update rate	Hz	1000					
	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)[8]	m/sec/√hr	0.015			0.045		
	Non-linearity	ppm	150					
	Receiver		**NovAtel OEM7720**	**NovAtel OEM719**	**Septentrio mosaic-H**	**Septentrio mosaic-X5**	**u-blox ZED-F9P**	**u-blox ZED-F9P L5**
GNSS	Number of GNSS Antennas	-	Dual	Single	Dual	Single	Dual / Single	Single
	GNSS Constellations	-	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, 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		GPS L1C/A, L2C; GLONASS L1OF, L2OF; Galileo E1B/C, E5b; BeiDou B1I, B2I; QZSS L1C/A, L2C	GPS L1C/A, L5; GLONASS L1OF; Galileo E1B/C, E5a; BeiDou B1I, B2a; QZSS L1C/A L1S L5; NavIC L5
	GNSS Corrections	-	WAAS; EGNOS; MSAS; GAGAN; SBAS L1, L5; DGPS; RTK; PPP Terrastar		WAAS; EGNOS; MSAS; GAGAN; SBAS; DGPS; RTK		WAAS; EGNOS; MSAS; GAGAN; SBAS L1C/A; DGPS; RTK	
	Channel Configuration [5]	channels	555		448		184	
	GNSS Data Rate [6]	Hz	5 / 20 / 100		100 (max)		10, 20	
	RTK Corrections	-	RTCM 2, RTCM 3				RTCM 3	
	Velocity Accuracy	m/sec	0.03				0.05	
	Initialization Time	s	<39 (cold start), <20 (hot start)		<45 (cold start); <20 (hot start)		<30 (cold start), <10 (hot start)	
	Time Accuracy (clock drift) [7]	nano sec	20				30	
	Air Data Computer		**2P**		**2PEXT**		**2PMAX**	
Air Data Computer	Pressure Sensor Range	mbar	±25		±600		±4000	
	Static Pressure Range	hPa, % FS	300 to 1100					
	Static Pressure Accuracy	% FSS	±0.1					
	Dynamic Pressure Range	hPa	0.15 to 25		0.15 to 600		0.15 to 4000	
	Dynamic Pressure Accuracy	% FSS	±0.25					
	Pressure Altitude Range	m	-500 to 9000					
	Pressure Altitude Accuracy	m	1					
	Airspeed Range	m/sec	5 to 64		5 to 310		5 to 800	
	Airspeed Accuracy	m/sec	0.5					
	Mach Number Range	M	0.01 to 0.2		0.01 to 0.99		0.01 to 2.5	
	Mach Number Accuracy	M	0.001		0.002			
	Static Pressure Over Total Pressure Range	-	0.97 to 1		0.63 to 1		0.20 to 1	
	Static Pressure Over Total Pressure Resolution	ppm	1					
	Air Density Range	kg/m3	0.3 to 1.6					
	Air Density Accuracy	kg/m3	0.002					
	Outside Air Temperature (OAT) Range	deg C	-40 to +85					
	Outside Air Temperature (OAT) Resolution	deg C	0.01					
	Environment							
	Operational and Storage Temperature	deg C	-40 to +65					
	EMC/EMI	-	MIL-STD-461F					
	Altitude	meters	Up to 15000					
	Acoustic noise	dB	185					
	MTBF (GM @ +65degC)	hr	100000					

General	**Electrical**		
	Input power protection	-	Standard
	Supply voltage	V DC	9 to 36 (27±10 for MIL-STD-1275 protection)
	Output data format	-	Binary, NMEA 0183 ASCII characters
	1 PPS level	V DC TTL	3.3 / 5 / differential
	Physical		
	Size	mm	D88.9 x H129
	Weight	gram	950

Specifications subject to change without notice
(1) GPS only. (2) For Novatel OEM7720 GNSS receiver only. 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) Dynamic accuracy may depend on the type of motion. (5) Tracks up to 60 L1/L2 satellites. (6) If tracking GPS Only. (7) Time accuracy does not include biases due to RF or antenna delay. (8) Typical result value.

Product Code Structure

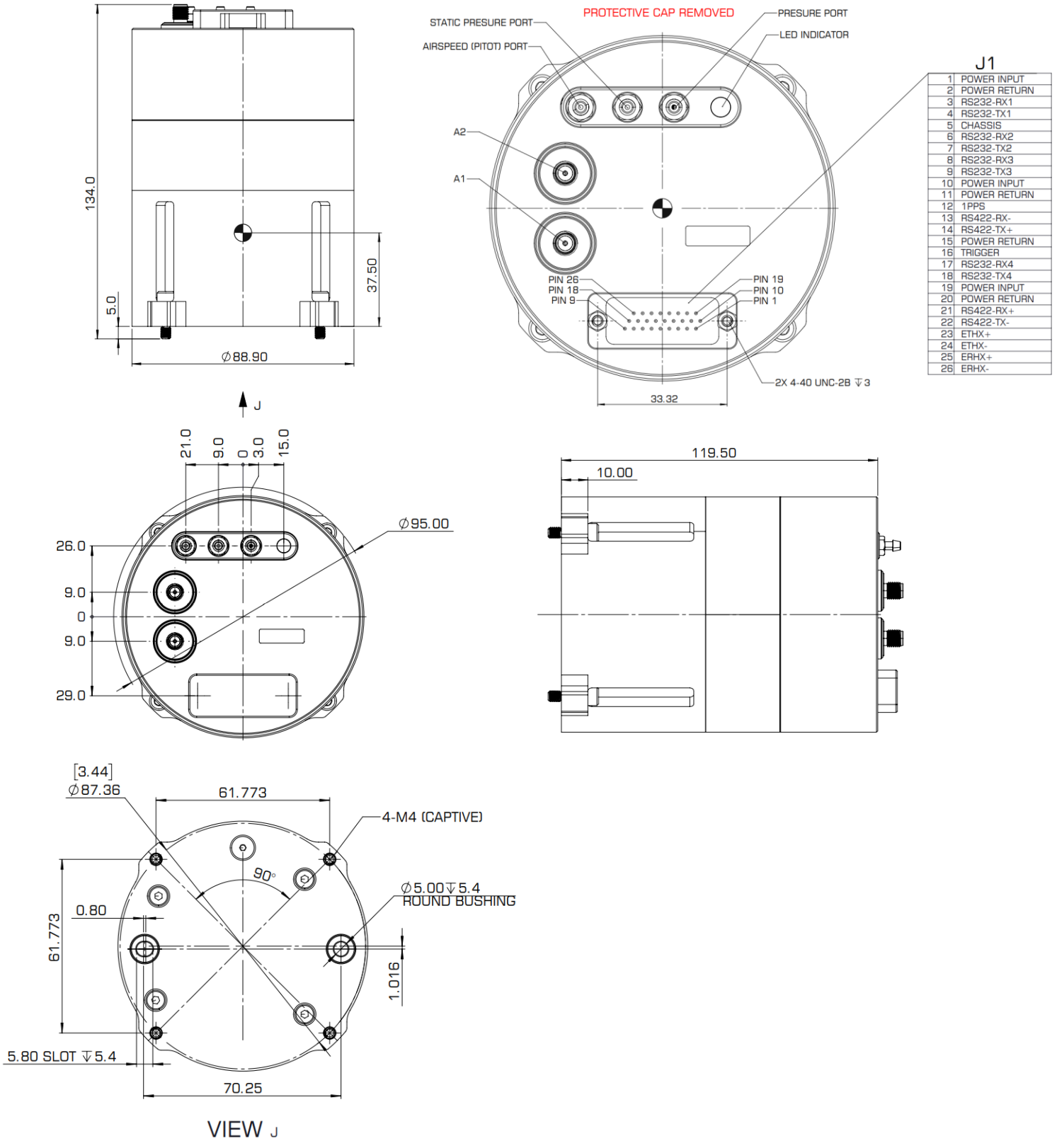
Model	Gyro	Accel	Calibration	Connector	Encoder	Pressure Ports	Color	External Compass	Data Logger	GNSS receiver	Version	Interface
INS-FI	G490	A8	TGA	C18	E	0P	S	SAMC	S64	O719	V9	124
		A40				2P				O7720	VD9	145
						2PEXT				DMH		1234
						2PMAX				SMX5		1245
										ZF9P		
										ZD9P		
										ZF9P-L5		

Example: INS-FI-G490-A40-TGA-C18-2P-S-SAMC-S64-ZD9P-VD9.12345

Product code details:

- INS-FI: Dual Antenna GPS-Aided Inertial Navigation System
- FI: FOG IMU-FI-200T
- G490: Gyroscopes measurement range = ±490 deg/sec
- A8: Accelerometers measurement range ±8 g
- A40: Accelerometers measurement range ±40 g
- TGA: Calibration of IMU (Gyroscopes and Accelerometers) in operational temperature range
- C18: 26-pin male, D-sub connector
- E: Encoder support (optional)
- 0P: Zero Airspeed Pressure Ports (Total/Static)
- 2P: Two Airspeed Pressure Ports with Standard Range (Total/Static, Honeywell 025MD)
- 2PEXT: Two Airspeed Pressure Ports with Extended Range (Total/Static, Honeywell 600MD)
- 2PMAX: Two Airspeed Pressure Ports with Extended Range (Total/Static, Honeywell 004BD)
- S: Silver Color of enclosure (default)
- SAMC: External Stand-Alone Magnetic Compass (optional)
- S64: 64GB embedded Data Logger (optional)
- O719: NovAtel OEM719: GPS+GLO+GAL+BDS+QZSS, L1/L2/L5/L6/E1/E5a/E5b/AltBOC/E6/B1/B2I/B2b/B2a/B3, NavIC L5, SBAS L1/L5, RTK+PPP+Single Point+DGPS PNT, 20 Hz Data Output Rate, Base Station Corrections + Measurements, GRIT Interference Mitigation and Spoofing Detection Includes GLIDE & RAIM
- O7720: NovAtel OEM7720: GPS+GAL+BDS+QZSS, L1/L2/L5/E1/E5a/E5b/AltBOC/B1/B2I/B2a/B2b, NavIC L5, SBAS L1/L5 Dual Antenna Activation, RTK+PPP+Single Point+DGPS PNT, ALIGN Heading, 20 Hz Data Output Rate, Base Station Corrections + Measurements, GRIT Interference Mitigation and Spoofing Detection Includes GLIDE & RAIM
- SMX5: Septentrio mosaic-X5: GPS+GLO+BDS+GAL+QZSS, L1C/A/L1PY/L2C/L2P(Y)/L5/L1CA/L2CA/L2P/L3 CDMA/B1I/B1C/B2a/B2I/B2b/B3I/E1/E5a/E5b/ E5 AltBoc/E6, SBAS, L-band, RTK, AIM+ anti-jamming, anti-spoofing Advanced Interference Monitoring and Mitigation
- DMH: Septentrio mosaic-H: GPS+GLO+BDS+GAL+QZSS, L1C/A/L2P(Y)/L2C/L1CA/L2CA/B1I/B2I/B3I/E1/E5b/L1C/A/L1C/B/L2C, SBAS, RTK, Dual Antenna GNSS Heading, AIM+ anti-jamming, anti-spoofing Advanced Interference Monitoring and Mitigation
- ZF9P: u-blox ZED-F9P-02B: GPS+GLO+GAL+BDS+QZSS, L1C/A/L2C/L1OF/L2OF/E1B/C/E5b/B1I/B2I/L1C/A/L1S/L2C/L5, SBAS, RTK, Active CW detection and removal, Onboard bandpass filter, Advanced anti-spoofing algorithms
- ZF9P-L5: u-blox ZED-F9P-15B: GPS+GLO+GAL+BDS+QZSS, L1C/A/L5/L1OF/E1B/C/E5a/B1I/B2a/L1C/A/L1S/L5/, NavIC L5, SBAS, RTK, Active CW detection and removal, Onboard bandpass filter, Advanced anti-spoofing algorithms
- ZD9P: Dual u-blox ZED-F9P-02B: GPS+GLO+GAL+BDS+QZSS, L1C/A/L2C/L1OF/L2OF/E1B/C/E5b/B1I/B2I/L1C/A/L1S/L2C/L5, SBAS, RTK, Dual Antenna GNSS Heading, Active CW detection and removal, Onboard bandpass filter, Advanced anti-spoofing algorithms
- V9: Single Antenna GNSS Receiver
- VD9: Dual Antenna GNSS Receiver
- .124: RS-232, RS-422 and CAN interface
- .145: RS-232, CAN and Ethernet interface (w/ Encoder support)
- .1234: RS-232, RS-422, RS-485 (to be used when connecting to a Stand-alone Magnetic Compass), and CAN interface
- .1245: RS-232, RS-422, CAN and Ethernet interface

INS-FI Mechanical Interfaces Description



J1	
1	POWER INPUT
2	POWER RETURN
3	RS232-RX1
4	RS232-TX1
5	CHASSIS
6	RS232-RX2
7	RS232-TX2
8	RS232-RX3
9	RS232-TX3
10	POWER INPUT
11	POWER RETURN
12	1PPS
13	RS422-RX-
14	RS422-TX+
15	POWER RETURN
16	TRIGGER
17	RS232-RX4
18	RS232-TX4
19	POWER INPUT
20	POWER RETURN
21	RS422-RX+
22	RS422-TX-
23	ETHX+
24	ETHX-
25	ERHX+
26	ERHX-