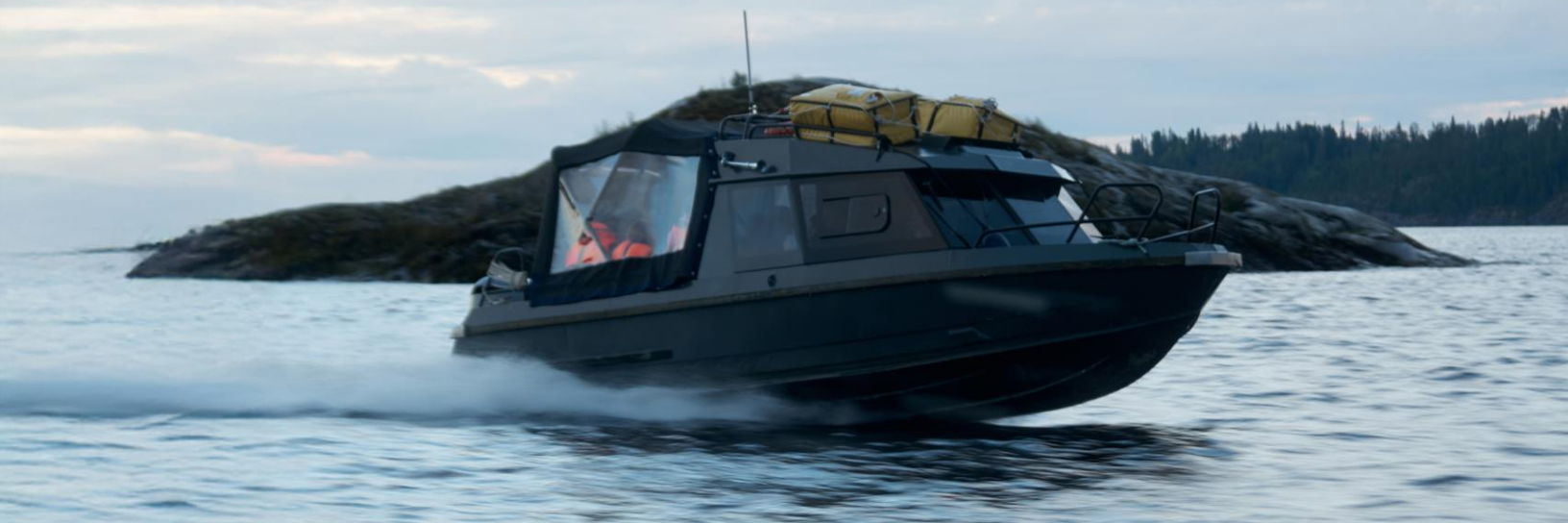
Inertial Labs
a VIAVI Solutions company

GPS-Aided Inertial Navigation Systems

INS-DM-FI

INS-BM-FI



STANDARD MIL-STD 810G

CERTIFIED ISO 9001:2015 COMPANY

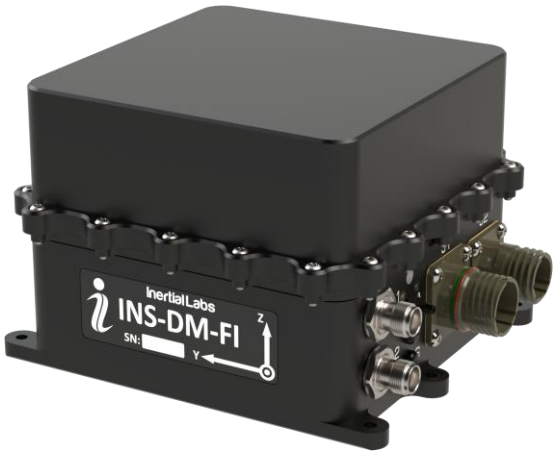
MADE IN THE USA

Datasheet

The **Inertial Labs GPS-Aided Inertial Navigation System (INS-DM-FI, INS-BM-FI)** is the newest Inertial Navigation System (INS) developed by Inertial Labs using Tactical-grade Fiber Optic Gyroscopes technology. The INS-DM-FI/INS-BM-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 is an IP67 rated version of an all-new generation of super ruggedized, shielded from the EMC/EMI, fully integrated, combined INS + AHRS + MRU + FOG IMU-based Attitude & Heading Reference System (AHRS) + optional embedded Air Data Computer (ADC) high-performance strapdown system. It determines position, velocity, vertical and horizontal displacements, 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 **INS-DM-FI/INS-BM-FI** contains Inertial Labs latest version of the on-board sensor fusion filter, state of the art navigation and guidance algorithms, and calibration software.



The Inertial Labs **INS-DM-FI/INS-BM-FI** contains Inertial Measurement Units (IMU) utilizing Tactical-grade Fiber Optic Gyroscopes and MEMS accelerometers. The **INS-DM-FI/INS-BM-FI** also utilize embedded multi constellations (GPS, GLONASS, GALILEO, QZSS and BEIDOU) GNSS receivers like NovAtel OEM7 series, u-blox F9 or Septentrio mosaic-H series. The design of the **INS-DM-FI/INS-BM-FI** also include an optional embedded Air Data Computer (ADC), supported by two barometers, and the ability to support an external Stand-Alone Magnetic Compass (SAMC).

KEY FEATURES AND 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
- Advanced, extendable, embedded Kalman Filter based sensor fusion algorithms
- 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
- MIL-STD-1275 compliance
- Environmentally sealed (IP67)
- Aiding data: Wind sensor, Air Speed Sensor, Doppler shift from locator (for long-term GPS denied), External position and External Heading
- External Air Data Computer (ADC) and Stand-Alone Magnetic Compass (SAMC)

SPECIFICATIONS

	Parameter	Units							
Inputs & Outputs	Input signals	-	External Magnetometer, 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, MRU & AHRS data); up to 2000 (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 (without GNSS and Magnetometer)	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						
	Heave, Surge, Sway								
	Measurement range	m	±300						
	Resolution	m	0.01						
	Real time accuracy, RMS	m	5% / 0.05						
	Post Processing (delayed) accuracy, RMS	m	2% / 0.02						
	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	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, L2P(Y), L2C) GLONASS (L1C/A, L2C/A) Beidou (B1I, B2I, B3I) Galileo (E1, E5b) QZSS (L1C/A, L1C/B, L2C) NavIC (L5)	GPS (L1C/A, L1PY, L2C, L2P(Y), L5) GLONASS (L1CA, L2CA, L2P, L3 CDMA) Beidou (B1I, B1C, B2a, B2I, B2b, B3I) Galileo (E1, E5a, E5b, E5 AltBoc, E6) NavIC (L5)		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/s	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						

General	**Environment**		
	Operational and Storage Temperature	deg C	-40 to +71
	EMC/EMI	-	MIL-STD-461F
	Altitude	meters	Up to 15000
	Acoustic Noise	dB	185
	Environmental protection	-	IP67
	MTBF (GM @ +65degC)	hr	100000
	Electrical		
	Input Power Protection	-	MIL-STD-1275 (optional)
	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	160 x 149 x 96
	Weight [9]	gram	2100

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. [9] Depends on configuration.

Product Code Structure

Model	IMU	Gyro	Accel	Calibration	Connector	Encoder	Pressure Ports	Color	External Compass	Data Logger	GNSS receiver	Version	Interface
INS-DM	FI	G490	A8	TGA	C71	E	0P	B	SAMC	S64	O719	V9	12345
INS-BM			A40		C73		2P				O7720	VD9	123457
							2PEXT				SMX5		123458
							2PMAX				DMX5		
											DMH		
											ZF9P		
											ZF9P-L5		
											ZD9P		

Example:
INS-DM-FI-G490-A40-TGA-C71E-0P-B-SAMC-S64-ZD9P-VD9.12345
INS-BM-FI-G490-A40-TGA-C71E-0P-B-SAMC-S64-O719-V9.12345

Product code details:

- INS-DM: Dual Antenna GPS-Aided Inertial Navigation System
- INS-BM: Single Antenna GPS-Aided Inertial Navigation System
- FI: FOG IMU-FI-200T
- G490: Gyroscopes measurement range = ±490 deg/sec
- A8: Accelerometers measurement range ±8g
- A40: Accelerometers measurement range ±40g
- TGA: Calibration of IMU (Gyroscopes and Accelerometers) in operational temperature range
- C71: two connectors (22 – main; 13 – auxiliary), enclosure with asymmetrical alignment mounting holes
- C73: C71 with MIL-STD-1275 protection
- E: Encoder support
- 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)
- B: Black 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, NavIC L5, SBAS, L-band, RTK, AIM+ anti-jamming, anti-spoofing Advanced Interference Monitoring and Mitigation
- DMX5: Dual 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, NavIC L5, SBAS, L-band, RTK, Dual Antenna GNSS Heading, 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, NavIC L5, 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
- .12345: RS-232, RS-422, RS-485 (for stand-alone magnetic compass only), CAN, Ethernet
- .123457: RS-232, RS-422, RS-485 (for stand-alone magnetic compass only), CAN, Ethernet, ARINC-429
- .123458: RS-232, RS-422, RS-485 (for stand-alone magnetic compass only), CAN, Ethernet, RS-422 interface of COM4

INS-DM-FI Mechanical Interfaces Description