InertialLabs
a VIAVI Solutions company

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MADE IN USA

VISION-AIDED INERTIAL NAVIGATION SYSTEM

VINS

MULTIROTOR UAV

FIXED WING UAV

VTOL UAV

VISUAL ODOMETRY

RF AIDED NAVIGATION

INERTIAL NAVIGATION

GNSS NAVIGATION

NAVIGATION IN GPS-DENIED

VISUAL NAVIGATION USING MAPPING

The **Inertial Labs Vision Aided Inertial Navigation System (VINS)** is the latest version of Inertial Navigation System, developed by Inertial Labs. **VINS** is the result of over 20 years of our experience in development of Inertial Navigation Systems solutions and Machine Vision Algorithms to be used in GPS-denied, Jamming and Spoofing Environments.

VINS is a MIL-STD-810 and MIL-STD-461 compliant, 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 Fixed-wing, VTOL and Multirotor Unmanned Aerial Vehicles. Horizontal and Vertical Position, Velocity and Orientation are determined with high accuracy for both motionless and dynamic applications, in GPS-enabled and GPS-denied environments.

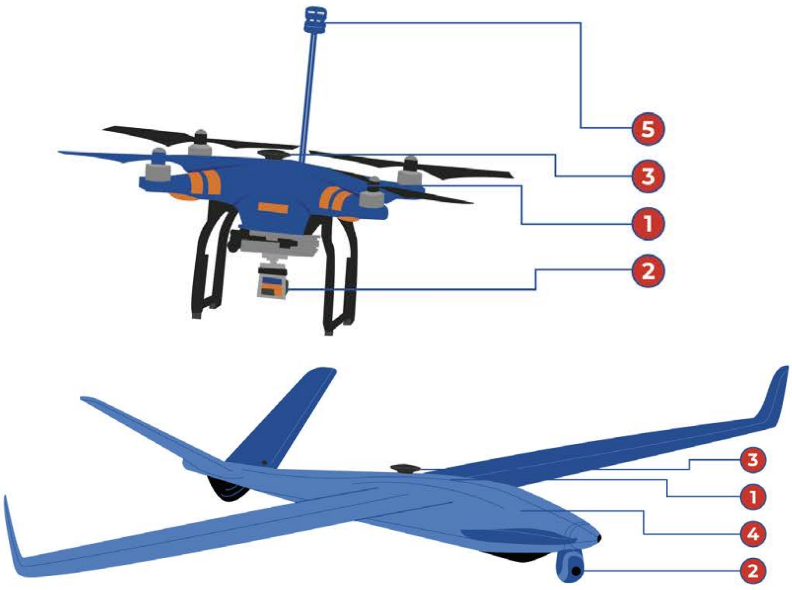
VINS is very compact and one of the most sophisticated Navigation Solutions on the market which allows Unmanned Aerial Vehicles to accomplish very long-term missions in GNSS-challenging environments.

The **VINS** design utilizes:

- Processing Module
- Sensor Module
- GNSS or CRPA antenna
- Air Data Computer (ADC) for fixed-wing UAV
- Digital Windspeed Sensor for multirotor UAV

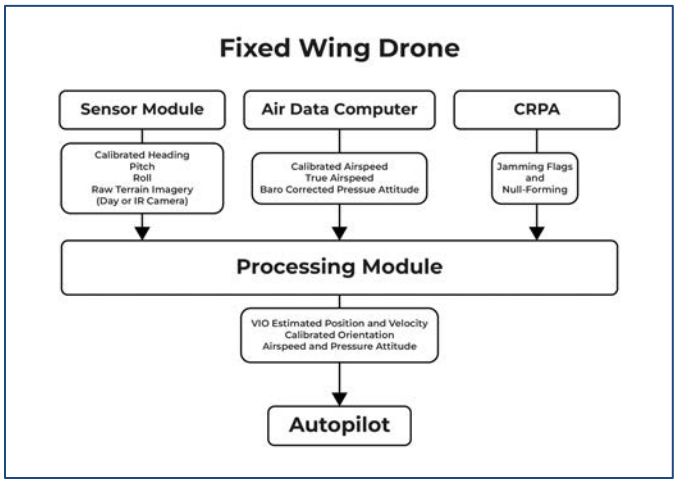
Optionally **VINS** can be equipped with:

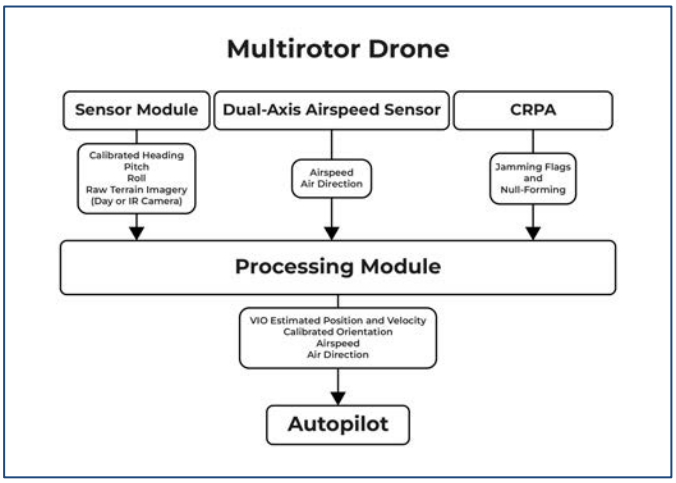
- Radio and data link as a source of RF aiding data to improve performance of **VINS** in GPS-denied environment.
- LEO GNSS receiver (Iridium)
- M-code / SAASM GNSS Receiver



PRIMARY COMPONENTS		
#	Device Name	Device Image
1	**VINS Processing Module** - Sensor Fusion Filter - Machine Vision Algorithm - Multi-constellation and multi-band GNSS Module	
2	**VINS Sensor Module** - Day or IR Camera - Attitude and Heading Reference System (AHRS)	
3	**GNSS Antenna** (GPS/GLO/GAL/BDS/QZSS L1/L2/L5)	
4	**Air Data Computer (ADC)**	
5	**Digital Windspeed Sensor (DWS)**	
OPTIONAL COMPONENTS		
	Anti Jamming Controlled Reception Pattern Antenna (CRPA)	
	RF Ranging Software Defined Radio (SDR)	
	M-Code / SAASM GNSS Receiver	
	ALTNAV Receiver	

VINS Functional diagrams for use on Fixed-wing and Multirotor UAVs:





VINS main components:

SENSOR MODULE

FLIR Boson+ IR Camera

- Fusion of a high precision optical camera and miniature Attitude & Heading Reference System (miniAHRS).
- ±2000 deg/sec MEMS Gyroscope.
- ±40 g MEMS Accelerometer.
- Fluxgate Magnetometer.
- Heading, Pitch & Roll.
- Up to 640 x 512 IR camera images, Boson+ Driver, interface over USB2.0.
- Camera strobe pulses (3VTTL, configurable polarity).
- Camera intrinsic calibration and alignment to the miniAHRS, accessible in camera's NVMe.

PROCESSING MODULE

- Embedded Dual GNSS antenna, Multi-constellation and Multi-band GNSS receiver (Novatel OEM7720)
- GPS L1/L2/L5; GLO; GAL; BDS; NAVIC
- SP, SBAS, DGPS, PPP, RTK
- Jamming and spoofing mitigation
- Multiple serial ports and Ethernet
- Embedded barometric Altimeter
- IP-67 sealing rating
- MIL-STD-810 and MIL-STD-461 compliance

AIR DATA COMPUTER
(for fixed wing/VTOL UAV)

- Static Pressure Over Total Pressure
- Dynamic Pressure (calibrated)
- Static Pressure (calibrated)
- Baro-Corrected Pressure
- Calibrated Airspeed
- IP-67 sealing rating
- Aiding Data Input
- True Airspeed
- Mach-Number
- Air Density

DIGITAL WINDSPEED SENSOR
(for multi-rotor UAV)

- IP-67 sealing rating
- Wind speed
  - Range: 0 to 75 m/sec
  - Resolution: 0.1 m/sec
  - Accuracy: ±0.3 m/sec
- Wind direction
  - Range: 0 to 360 deg
  - Resolution: 1 deg
  - Accuracy: 4 deg
- Pressure
  - Range: 260 – 1260 hPa
  - Resolution: 0.0001hPa
  - Accuracy: ±0.5%
- Altitude: 0 to 4000 meters

GNSS ANTENNA

- GPS L1/L2/L5, QZSS-L1/L2, QZSS-L6, GLONASS G1/G2, Galileo-E1/E6, BeiDou-B1/B3
- L-band
- Rugged IP67 rating with SMA/TNC mount
- Small form factor
- Ground Plane Independent
- Low power consumption
- Low phase center variation over azimuth and elevation and among different samples
- Ultra-lightweight

VINS main specifications

Parameter	GNSS-Enabled	GNSS-Denied
Horizontal Position (Visual Odometry)	1 meter	<1% DT [1]
Horizontal Position (Map Matching)	1 meter	<35 meters (RMS)
Vertical Position	<2 meters	<5 meters
Velocity	0.03 m/sec	<0.9 m/sec
Heading	0.1 deg	1 deg
Pitch & Roll	0.03 deg	0.1 deg

VINS Minimum Altitude Operating Range (AGL, m): 100m
VINS Maximum Altitude Operating Range (AGL, m): Variable [2]

VINS general specifications

Main Component	Weight	Size
Sensor Module (Boson+ -> IR Camera)	330 grams	83 x 100 x 80 mm
Processing Module	420 grams	80 x 45 x 134 mm
Air Data Computer	130 grams	73 x 55 x 29 mm
Digital Windspeed Sensor	252 grams	D56 x H71 mm
GNSS antenna	20 grams	D34 x H51 mm

VINS electrical specifications:

- Input power: 9 to 36 V DC
- Power consumption (Day Camera Sensor Module): 11 W
- Power consumption (IR Camera Sensor Module): 10 W
- Interface: RS-232, RS-422, Ethernet

VINS Environmental Specifications (MIL-STD-810G):

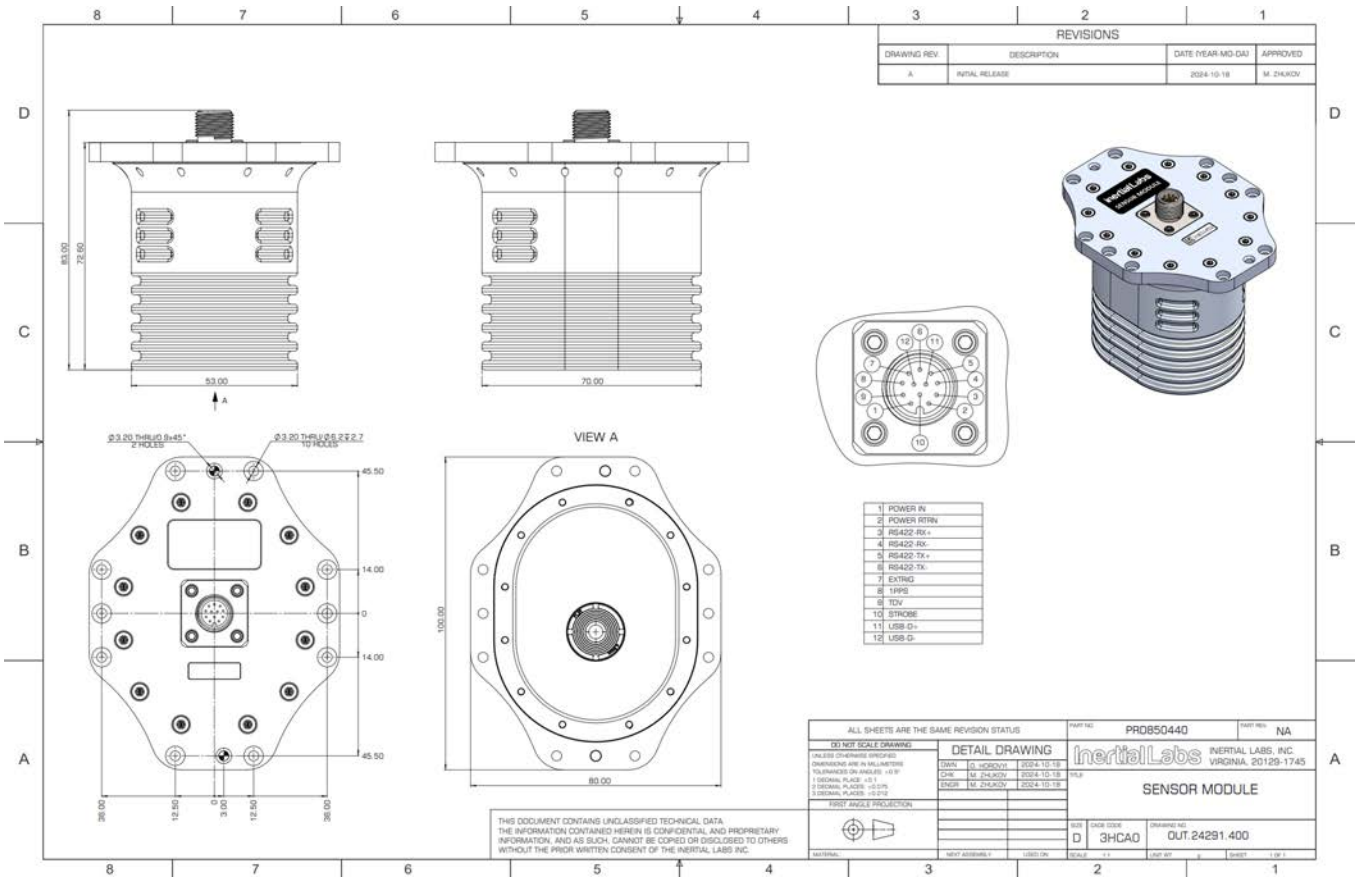
Temperature Range (Operational) MIL-STD-810G Method 501.5 & 502.5 Procedure II	-40°C to 85°C
Vibration (Operational) MIL-STD-810G Method 514.6 Procedure I (Jet Profile)	20-2000 Hz, 4g RMS
Functional Shock (Operational) MIL-STD-810G Method 516.6 Procedure I	20g, 11ms (Terminal Peak Sawtooth)
Transportation Altitude MIL-STD-810G Method 500.5. Procedure I	15,000m (1.75 psia), 1 hour

Additional Notes:

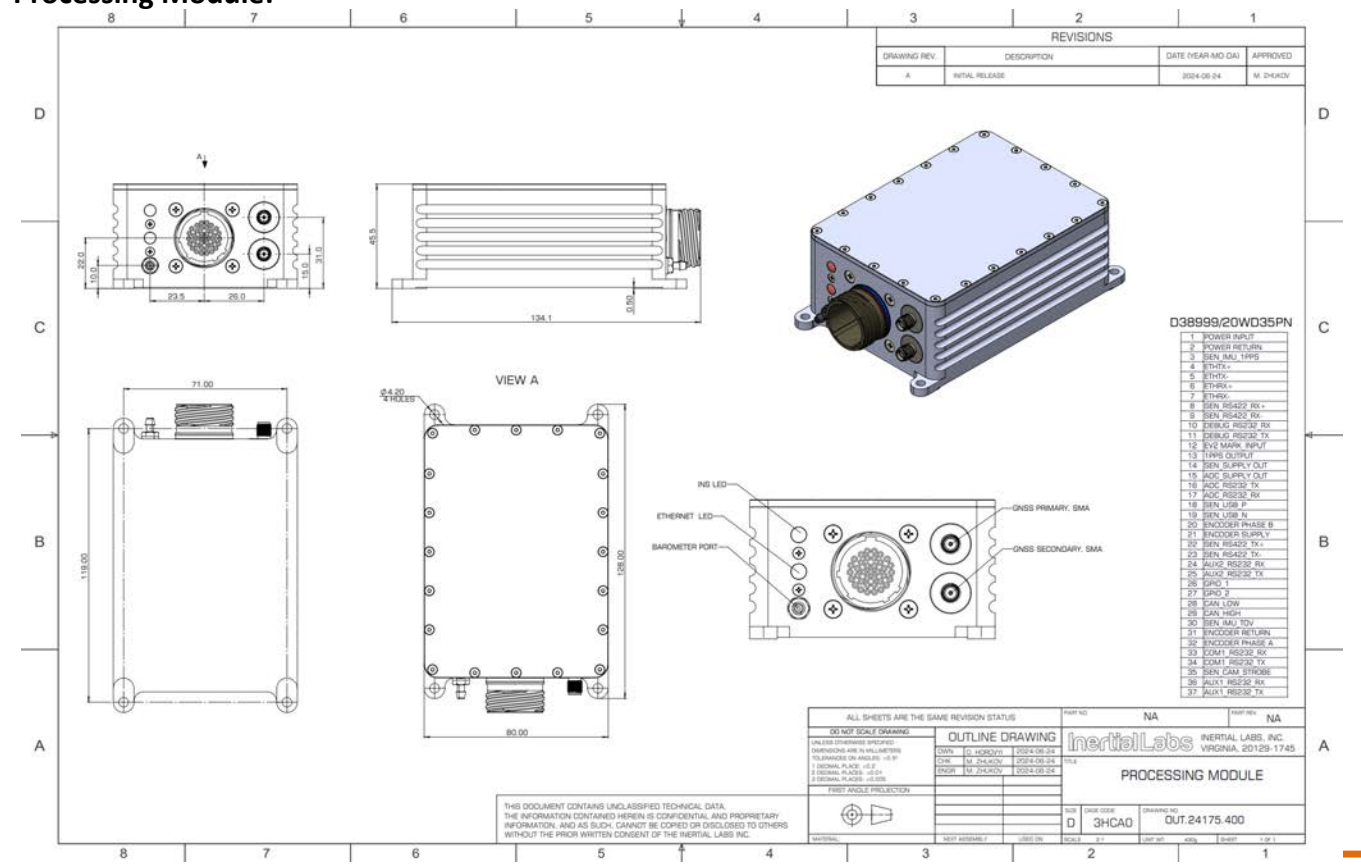
[1] The horizontal position estimation error can vary depending on multiple factors such as vehicle's operating AGL altitude, variation in ground elevation and vehicle motion path trajectory (i.e. straight-line motion will accumulate more position error than circular motion). Typical variation range in %DT error is from 0.5 – 1.

[2] The maximum operating range varies based on observability of the ground, which is impacted by environmental factors such as cloud cover.

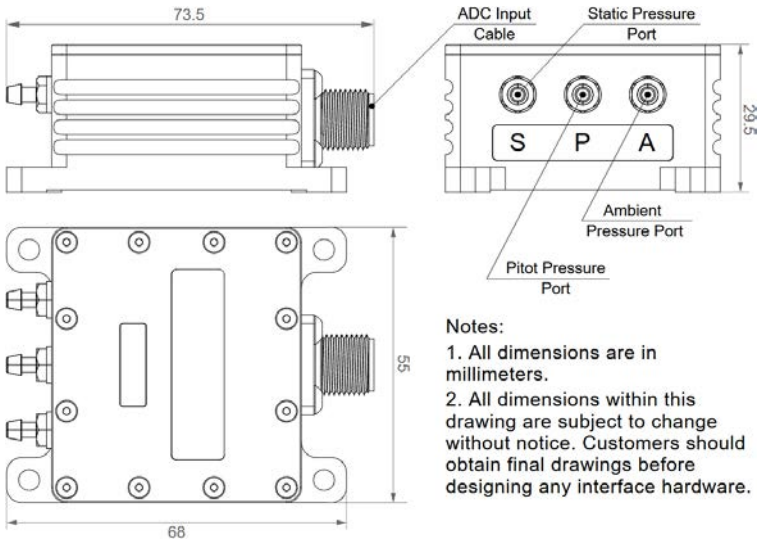
Sensor Module (IR Camera Option):



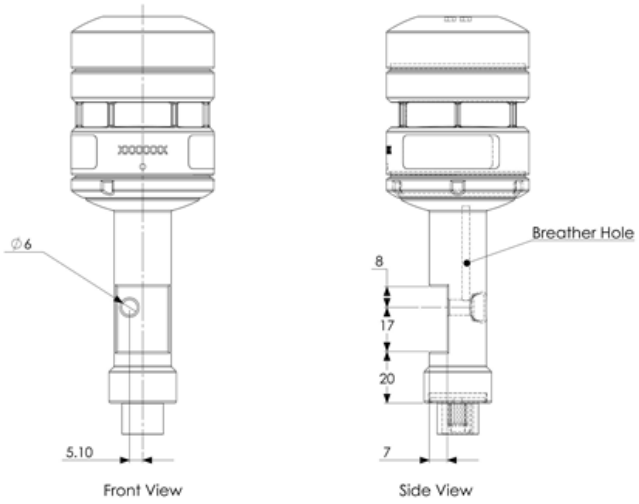
Processing Module:



Air Data Computer:



Digital Wind Speed Sensor:



VINS Product Code Structure:

Processing Module Product Code Structure:

Model	Connector & Enclosure	Color	GNSS Receiver	Version	Interface
VINS-PM	C28	S	Novatel OEM-O7720	VD9	.1245

Example: VINS-PM-C28-S-O7720-VD9.1245

- **VINS-PM:** Processing Module of Vision Aided Inertial Navigation System
- **C28:** Ruggedized Enclosure with one main 31Pin Connector
- **S:** Silver color
- **O7720:** NovAtel OEM7720 dual antenna GNSS receiver
- **VD9:** 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
- **.1245:** RS-232, RS-422, CAN and Ethernet interface.

Sensor Module Product Code Structure:

Model	Gyro	Accel	Calibration	Connector & Enclosure	Camera	Version	Interface
VINS-SM	G2000	A40	TMGA	C44	1R	V1	.29

Example: VINS-SM-OEM-G2000-A40-TMGA-C44-1R-V1.29

- **VINS-SM:** Sensor Module of Vision Aided Inertial Navigation System
- **G2000:** Gyroscopes measurement range = ±2000 deg/sec
- **A40:** Accelerometers measurement range ±40g
- **TMGA:** Magnetometers, Gyroscopes and Accelerometers
- **C44:** Ruggedized Enclosure with one main 12Pin Connector
- **1R:** One IR (Day/Night) Camera
- **V1:** Version 1
- **.29:** RS-422, USB data