ISRO Inertial Systems Unit

Thiruvananthapuram

Navigation Systems

"THE DREAM OF YESTERDAY
IS THE HOPE OF TODAY
AND THE REALITY OF TOMORROW"

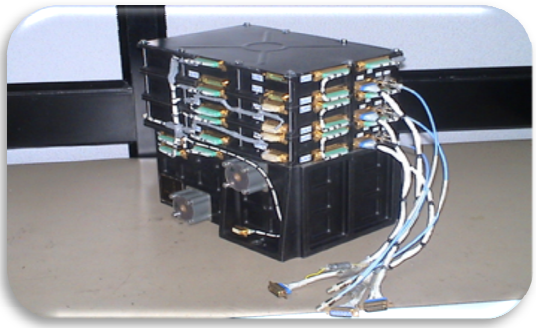
IRAP-200/ IRAP-300

High Reliability High Accuracy Inertial Referencing and Accelerometer Package for Interplanetary Missions

Designed for interplanetary missions where high accuracy and stability are required, IRAP-200/ IRAP-300 is a self-contained strap-down redundant rate and acceleration sensing unit.

Based on IISU's expertise in inertial sensors, mechanical design, electronics and system integration, IRAP-200/IRAP-300 incorporates IISU designed high accuracy Dynamically Tuned Gyroscopes (DTGs) and high accuracy Ceramic Servo Accelerometers (CSAs).World-class sensors powered by high-performance processor, FPGA and electronics ensures the availability of highly precise incremental angle and incremental velocity information for the most demanding missions.

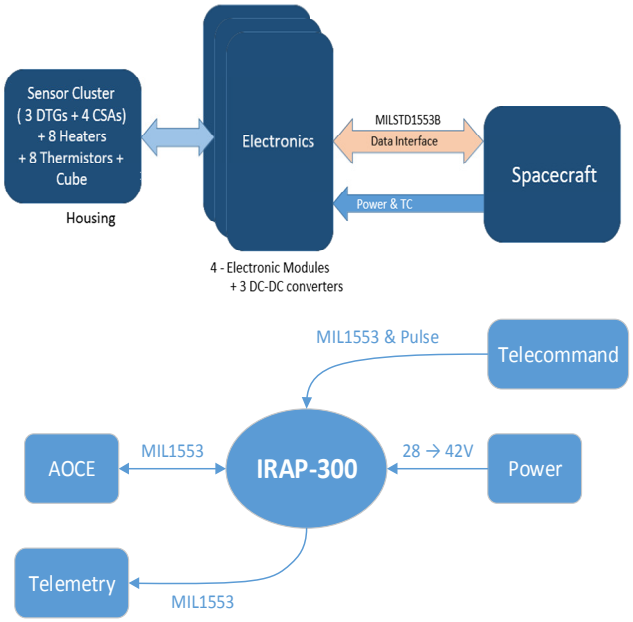
IRAP-200/IRAP-300 isan Inertial Measurement Unit (IMU) which is designed to meet the demands of space missions aiming sub-meter imaging capability, precise attitude control and critical mission manoeuvres for Interplanetary and Scientific missions. The design is flight proven in ISRO's spacecrafts, notably the Chandrayaan-1,2 and Mangalyaan missions.



Features

- 3 DTGs along Roll, Pitch and Yaw of spacecraft in orthogonal configuration to measure spacecraft rotation along its principal axes
- 4 CSAs mounted in octahedral tetrad to measure incremental velocity imparted to the spacecraft during various orbital manoeuvres
- Sensors mounted on space-qualified vibration-isolated cluster with optical cube for alignment
- Modular electronics with independent DC-DC converters and optimum power
- Sensor cluster temperature controller
- Precise delta Velocity measurement to enable on-board termination of LAM firing after achieving targeted delta V
- Fine rate information available, which provides spacecraft rate information during payload operation
- Standard MIL-STD-1553B interface with AOCE
- Radiation hardened electronics up to 100Krad and temperature range of -40°C to +125°C

System Configuration



IRAP-200/ IRAP-300

High Reliability High Accuracy Inertial Referencing and Accelerometer Package for Interplanetary Missions

Performance Indices

Specifications	IRAP-200	IRAP-300
Max Rate Input	± 10deg/sec	± 20deg/sec
Linear Range	± 3deg/sec	± 20deg/sec
Max Acceleration Input	± 20g	± 20g
Normal Acceleration Input	± 1.2g	± 1.2g
Bandwidth	9Hz +/- 1Hz	Variable
Misalignment	1800 arc sec (max)	1800 arc sec (max)
Stability	36 arc sec (max)	36 arc sec (max)
Short-term rate stability	0.05 deg/hr (1σ)	0.008 deg/hr (1σ)
Short-term acceleration stability	50 µg	50 µg
Scale Factor Asymmetry, Stability, Linearity	<200 ppm(1σ)	< 200 ppm(1σ)
Noise Equivalent Angle	1 arc sec	0.1 arc sec
Power Supply	28-42V	28-42V/ 70V
Power	65.6 Watts (Launch phase) 46.6 Watts (Operational phase)	82 Watts (Launch phase) 54.25 Watts (Operational phase)
Mechanical Package Size	355 x 233 x 293 mm	349 x 235 x 264 mm
Weight	14 kg	14 kg

IRU-400/ IRU-900

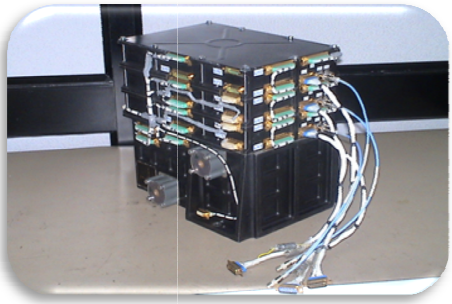
High Reliability High Accuracy Inertial Reference Unit for Spacecraft

Designed for all spacecraft missions where high accuracy and stability are required, IRU-400/ IRU-900 is a self-contained strap-down redundant attitude sensing unit.

IRU-400/IRU-900 is an Inertial Reference Unit (IRU) which is designed to meet the demands of space missions aiming sub-meter imaging capability and precise attitude control. Based on IISU's expertise in inertial sensors, mechanical design, electronics and system integration, IRU-400/IRU-900 incorporates IISU designed high accuracy Dynamically Tuned Gyroscopes (DTGs). World-class sensor powered by high-performance processor, FPGA and electronics ensures the availability of highly precise incremental angle information for the most demanding missions. The design is flight proven in all ISRO'sspacecrafts, notably the IRS, GEOSAT and IRNSS missions, being used in all phases of operation starting from launch and injection to orbit acquisition and station keeping.

Features

- 3 DTGs along Roll, Pitch and Yaw of spacecraft in orthogonal configuration to measure spacecraft rotation along its principal axes
- Sensors mounted on space-qualified vibration-isolated cluster with optical cube for alignment
- Modular electronics with independent DC-DC converters and optimum power
- Sensor cluster temperature controller
- Fine rate information available, which provides spacecraft rate information during payload operation
- Standard MIL-STD-1553B interface with AOCE
- Radiation hardened electronics up to 100Krad and temperature range of -40°C to +125°C



Specifications	IRU-400	IRU-900
Max Rate Input	± 20deg/sec	± 20deg/sec
Linear Range	± 3deg/sec	± 20deg/sec
Bandwidth	9Hz +/- 1Hz	Variable
Misalignment	1800 arc sec (max)	1800 arc sec (max)
Stability	36 arc sec (max)	36 arc sec (max)
Short-term stability	0.05 deg/hr (1σ)	0.008 deg/hr (1σ)
Noise Equivalent Angle	1 arc sec	0.1 arc sec
Power Supply	40V/ 70V	40V/ 70V
Power	20 Watts/ channel	22 Watts/ channel
Mechanical Package Size	420 x 277 x 227 mm	420 x 277 x 227 mm
Weight	16 kg	11 kg

mIRU-100/µIRU-100/memsIRU-100

Inertial Reference Unit for Small Spacecraft

Designed for small satellite missions where an optimum is placed on performance, cost, size and power, different variants of self-contained strap-down redundant attitude sensing units are available.

Based on IISU's expertise in inertial sensors, mechanical design, electronics and system integration, mIRU-100/µIRU-100 incorporates IISU designed high accuracy miniature Dynamically Tuned Gyroscopes (mDTGs). memsIRU-100 is based on proven MEMS gyroscopes. World-class sensors powered by high-performance ASIC, FPGA and electronics ensures the availability of precise incremental angle information with the best in-class power and size indices.

The design is flight proven in all ISRO's mini and micro spacecrafts, notably the HYSIS and Microsat missions, being used in all phases of operation starting from launch, injection to orbit acquisition and station keeping.

Features

- Inertial Reference Unit (IRU) which is designed to meet the market demands of low size, power and cost requirements for small satellite industry
- mDTGs and MEMS Gyros in orthogonal configuration
- Sensors mounted on space-qualified vibration-isolated cluster with optical cube for alignment
- Modular electronics with independent DC-DC converters and optimum power
- Standard SPI interface with AOCE (memsIRU-100), Custom Serial Interface (mIRU-100/µIRU-100)

Specifications	mIRU-100	µIRU-100	memsIRU-100
Max Rate Input	± 10deg/sec	± 10deg/sec	± 60deg/sec
Linear Range	± 3deg/sec	± 3deg/sec	± 60deg/sec
Bandwidth	5Hz	5Hz	10Hz
Misalignment	3600 arc sec (max)	3600 arc sec (max)	3600 arc sec (max)
Stability	36 arc sec (max)	36 arc sec (max)	180 arc sec (max)
Short-term stability	0.05 deg/hr (1σ)	0.05 deg/hr (1σ)	<5 deg/hr (1σ)
Noise Equivalent Angle	0.5 arc sec	0.5 arc sec	<10 arc sec
Power Supply	40V	40V	16V
Power	16 Watts/ channel	16 Watts/ channel	1 Watt
Package Size	277 x 269 x 223 mm	330 x 236 x 112 mm	110 x 95 x 30 mm
Weight	8.5 kg	6 kg	0.25 kg

miniAINS

Miniature Advanced Inertial Navigation System

Autonomous Navigation System for high injection accuracy application

miniAINS is Inertial Navigation System for Launch Vehicles based on proven ISRO Laser Gyro and Quartz Accelerometer technology.It offers self-azimuth and level alignment capability with high dynamic range and high accuracy.

Configuration: 6 sensors in skewed triad-hexad	
Fault tolerance	
Sensors	Two sensor failure
Electronics	One processing electronics
Range	
Gyro Channel	±100°/s
Accelerometer Channel	±20g
Sensor Technology/Spec	
ISRO Ring Laser Gyros	0.03deg/hr (1σ)
Ceramic Servo Accelerometers	20μg (1σ)

Mechanical/Electrical Specifications	
Power	105W
Mass	26 kg
Dimension	400x365x330±2mm
Output Interface	Cross-strapped P & R MIL STD 1553 4nos
Supply Voltage	24-45V
Vibration	$14.1g_{rms}$

High Injection Point Accuracy		
	SSPO	**GTO**
Apogee (km)	**10**	**125**
Perigee (km)	**10**	**2**
Inclination (deg)	**0.1**	**0.08**

Salient features

- ✓ ADSP21060 processor based design.
- ✓ Hot redundancy for processing electronics.
- ✓ Single footprint system.
- ✓ Power-in-digital-out.
- ✓ Temp compensation scheme used.

HERITAGE

Flight tested in PSLVC36 during December 2016 in piggyback mode

- ✓ **Flown in GSLVMkIII for GSAT 29 & Chandrayaan2 Mission.**
- ✓ **Successfully completed Integration Navigation Test for RLVLEX Mission.**

LASER Gyro based Inertial Reference & Accelerometer Package –LIRAP
Flown in India's Chandrayaan-2/Lander Mission

LIRAP Sensing Module

LIRAP Electronics Module

LIRAP is Inertial Navigation System based on proven ISRO Laser Gyro and Quartz Accelerometer technology in a fault tolerant configuration.

- Provides Delta-Theta and Delta-V at 8ms.
- Sensors and Electronics in separatemodules.
- 4 sensors in skewed tetrahedral configuration in open cluster.
- Tolerates one sensor failure.
- Temp. control& compensation schemes available.
- Computer electronicsbased onRad-Hard, fault tolerant LEON3processor.
- Dual redundant 1553b interface andIndigenous DCDC.
- Provision for onboard bias estimation and compensation available.

Parameter	Spec
Angle Channel	
Rate capability, deg/sec	± 30
Scale Factor (arcs/pulse)	0.77
Scale Factor stability (ppm)	10
Bias stability (day to day) (°/hr)	0. 15
Bias Stability(in run) (°/hr)	0.005
Acceleration channel	
Fine Range (g)	± 1.2
Velocity Resolution, m/s/pulse	0.00012
Scale Factor stability(ppm)	75
Bias stability(day to day)(µg)	175
Bias Stability (in run) (µg)	7

Stability spec are 1σ

Prime application Chandryaan2/Vikram Lander

- As an inertial navigation system till touchdown.
- Accelerometer based precise engine cut-off for de-boosts.

Other Highlights of the mission:

- The CSA measurements also applied in:
  - Characterizing the propulsion system performance of 5-engines during de-boost.
  - Fine tuning of Orbit Determination.
  - Resultant thrust axis misalignmentestimation.

Power Supply (V)	24 - 45
Power Consumption (W)	90
Mass (kg)	14
Dimensions (Envelope) LSM: Φ338 x 253mm, LEM: 254 x142 x104.5mm	

Chandrayaan2 Mission (Achieved Performance)

- ✓ Navigation Accuracy at 5km (altitude) <210m
- ✓ Accelerometer channel stability <2µg (spec 7µg)
- ✓ Gyro Channel stability <0.001deg/hr (spec 0.005 deg/hr)

MINS-6S

MEMS INS NavIC SYSTEM with Redundancy

Designed for Small Satellite Launch Vehicles, MINS-6S delivers high-grade navigation performance and accuracy with attitude update using NavIC data

A Low C-SWaP and NavIC aided Redundant inertial navigation system with in-house developed MEMS gyros, high accuracy Ceramic Servo Accelerometers, built-in NavIC receiver (with GPS, NavIC, and Hybrid solutions) DC-DC converters & sensor data processing electronics. It also houses navigation processor for navigation algorithms using a powerful multimode Kalman filter. In addition, magnetometer aiding is also incorporated for supporting multi-orbit missions.

Highly modular, MINS-6S has the advantages of a Size Weight & Power; optimized integrated navigation system in a single box. Easy to maintain and highly reliable, MINS-6S ensures the navigation availability for the most demanding missions.

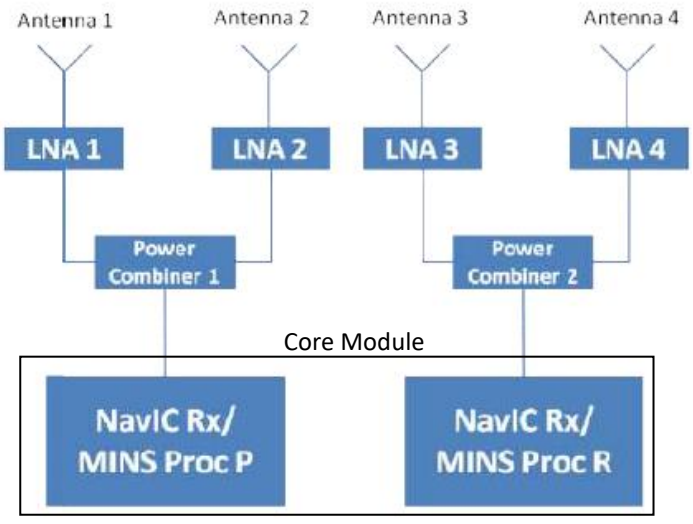
Application Areas

MINS-6S is well suited for navigation and guidance applications in Aerospace sector. The design is to be flight proven in ISRO's small satellite launch-vehicles. Its long-range capabilities make the system ideal for multi orbit launch vehicle missions and Airborne surveillance. MINS-6S can competitively replace navigation systems based on conventional gyros and improve system performance with respect to robustness, reliability, size, weight, power and cost. The high dynamic NavIC receiver with proven GNSS subsystems enables the MINS-6S a suitable choice for extended duration flights.

Key features

- Redundant Navigation system with fusion of MEMS INS + NavIC
- Reduced Cost, Size, Weight and Power
- Highly reliable MEMS gyros, accurate Ceramic Servo Accelerometers and NavIC Rx
- Temperature controlled cluster & software temperature compensation for sensor/electronics parameters
- 3 independent chains with capability of handling one chain failure
- NavIC receiver embedded Navigation processor (dual) in same module
- Novel NavIC ΔV based attitude & state vector aiding
- Single footprint, DC input – 1553B outputs
- No optical alignment
- MIL-STD-1553B: 2 Nos
- Single supply voltage: 24-45 V.
- Power: 65 W

System Configuration for Avionics Applications



The system comprises of four antennae mounted diametrically opposite to the launch vehicle upper stage for complete visibility of the GNSS satellites throughout the trajectory. The exact location of the antennae is decided based on the RF simulation studies done on GNSS constellation simulator for the particular trajectory of launcher. The antenna output is amplified by external low RF noise amplifier (LNA). Two LNA outputs each are combined using a power combiner and fed to the MINS-6S processor module. The core module comprises of IISU developed MEMS gyros & navigation grade ceramic accelerometers, Magnetometer and NavIC receiver embedded navigation processor. The system generates navigation outputs in required periodicity, which can be made available thru dual MIL-STD-1553 links.

Sensor Configuration

Sensor	Configuration
Accelerometers	6 units in skewed triad hexad configuration with 54.7356° half cone angle
Gyros	
3 axis magnetometers	2 units
NavIC Receiver	Channels: 12 GPS, 7 NavIC, 12 GALILEO, 2 GAGAN

Mechanical/Electrical Specification

Parameter	Specification
Footprint	Φ280 mm x 230 mm
Weight	6.7 kg (core system) 2.5 kg (RF elements)
Power	65 W
Supply voltage	24-45 V (34 V Nominal)
Operating temperature	5°C to +70°C

System Specification

Highlights	Specification (3σ)
Pointing accuracy	Pitch & Yaw: 0.1°, Roll: 0.5°
Position	100 m
Velocity	0.5 m/s
Rate capability	±50 °/s
Output rate	50 Hz
Acceleration Capability	±20 g (Const. acceleration)
NavIC TTFF	300 sec
NavIC TTSF	10 sec

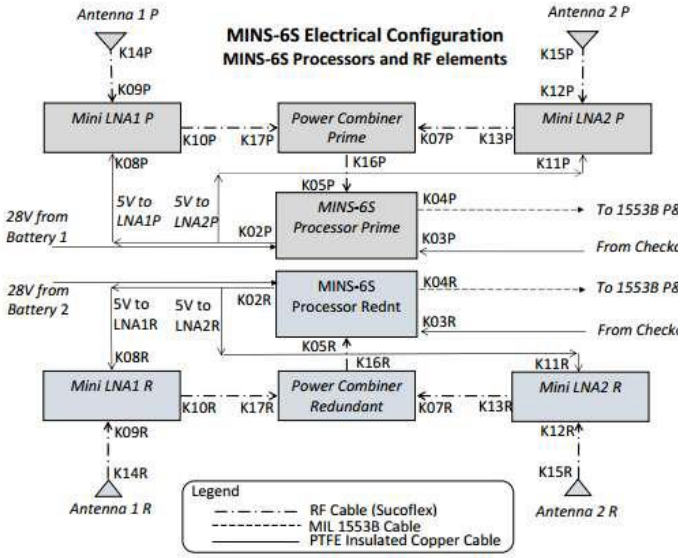
Sensor Specifications

Parameter	Value
Gyros	
Dynamic Range	±50 °/s
Scale Factor	200 mV/ °/sec
Bias Stability (short term)	<0.03 °/sec
Accelerometer	
Bias	175 µg
Scale Factor	150 ppm
Scale Factor Asymmetry	50 ppm
Maximum acceleration	±20g
NavIC Receiver	
Dynamics	
Velocity	15 km/s
Acceleration	20g
Jerk	20g/s
Altitude	No limit
Position	30m
Velocity	0.3m/s
Frequency of operation	L1, L5
System Misalignment	
Level error	35 arcs
Azimuth error	1800 arcs

Deliverables

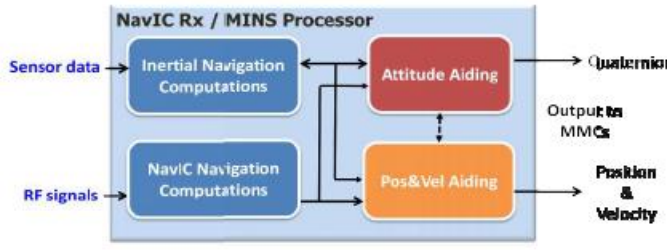
- MINS-6S core module: 1 unit
- Antenna: 4 units
- External low noise amplifiers: 4 units
- RF Power Combiners: 2 units
- RF cables: 4 units (Length is configurable up to 5m)

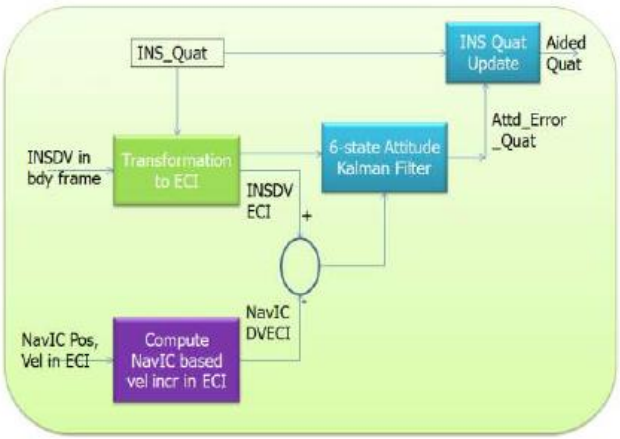
MINS-6S Electrical configuration



Software configuration

- Processing Inertial Sensor data and generating INS solution
- NavIC solution processing
- 9-state Kalman Filter for State Vector aiding
- 6-state Kalman Filter for Attitude aiding
- Feed-forward correction of INS attitude, position & velocity solution with INS error reset capability.





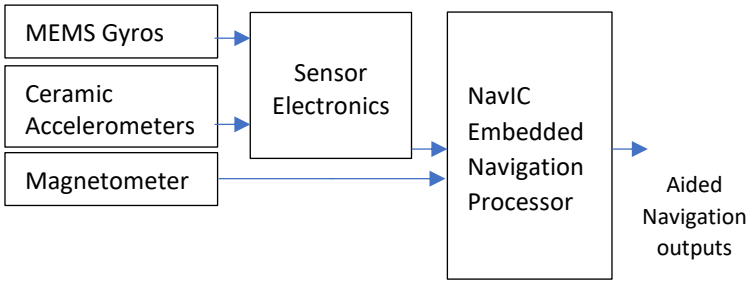
System Extendibility

MINS-6S is designed as an extendable navigation system which can be gluelessly connected with external navigation aids like Baro-altimeter/ Vision sensor/NavIC based telecommand module/LIDAR or any other sensors with RS422/RS485 interfaces. These features make the MINS6S truly a versatile system for a variety of applications

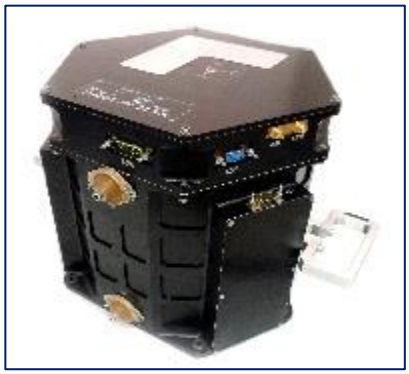
Additional Features

- Optional calibration coefficient/ Navigation initialization data loading capability by checkout computer thru MIL-STD-1553 link at launch pad
- Processor self-test and error reporting during flight
- Software development as per MISRA-C guidelines

System Configuration



System



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LINS-3S-20

High-Grade Inertial & Hybridized Navigation System

Designed for long duration & high dynamic missions, LINS-3S-20 delivers high-grade Inertial & Hybrid navigation performance, accuracy & flexibility.

Based on IISU's expertise in inertial sensors, GNSS technology, navigation algorithms, electronics design and system integration, LINS-3S-20 incorporates highly accurate indigenous ISRO Smart Laser Gyros (ISLG) with Ceramic Servo Accelerometers (CSA), inclinometer and magnetometer. It incorporates a 33-channel GAGAN-enabled GNSS receiver utilizing GPS, GALILEO and NavIC constellations. Using a powerful multimode Kalman filter, LINS-3S-20 optimizes the alignment and navigation capabilities. Inbuilt GNSS aiding enables the usage of the system for higher accuracy and extended duration missions. Highly versatile LINS-3S-20 combines all the advantages of Cost, Size, Weight and Power optimized Hybrid Inertial Navigation System in a single box. Easy to maintain and highly reliable, LINS-3S-20 ensures the navigation availability for even GNSS denied environments with the standalone navigation accuracy based on ISRO's flight-proven Ring LASER Gyros.

Applications

- Long Duration, Multi-Orbit Launch Vehicles
- Aircraft Navigation Systems
- Underwater Navigation Systems
- Unmanned Aerial Vehicles
- Applications with GNSS outages
- Replacement of imported RLG systems
- Customizable for AHRS applications

*** System is expected to be in production by Aug 2021**

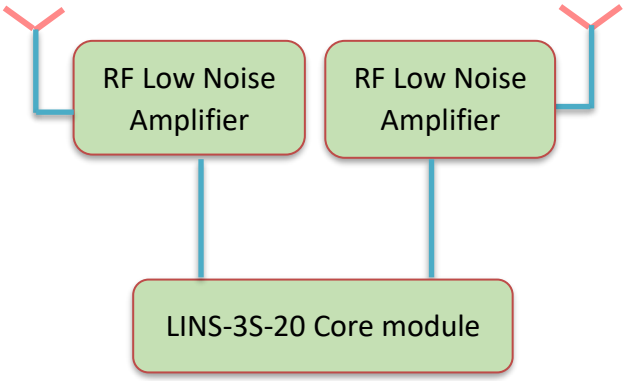
Salient Features

- Inertial & Hybrid Navigation modes
- Self-alignment accuracy of 180 arc-sec
- System warm up 20 mins including alignment
- Processing at 1ms rate for high dynamic applications
- Ultra-fast reacquisition of GNSS in 2 s
- High Dynamics GNSS Receiver up to 20 g
- MISRA-C compliant Firmware
- Supports user add-on application software (500kB, 50% time of 800MHz processor)

Interfaces

- DC Input : 24-45V
- RF input : SMA F (2 Nos)
- Power : 35W
- MIL-1553 : 2 Nos
- ARINC-429 : 2 Nos (optional)
- RS-422 : 3 Nos
- RS-485 : 3 Nos
- Connectors : Power-1, Signal-1, Sim-1

System Configuration



The system comprises of two antennae mounted appropriately for complete visibility of the GNSS satellites. The exact location of the antennae is decided based on the RF simulation studies done on GNSS constellation simulator at IISU.

Each antenna output is amplified by an external RF low noise amplifier (LNA). The LNA outputs are connected directly to the LINS-3S-20 core module. The core module comprises of ISLG and CSA based IMU, Magnetometer, Inclinometer, a multi-constellation GNSS receiver and indigenous 32-bit processor based single-board computer which carries out Navigation computations and aiding. The system generates navigation outputs in required periodicity, which can be made available through MIL-STD-1553/ARINC-429 & RS422 links.

Sensor Configuration

Sensor	Configuration
Accelerometer	3 nos. mounted in orthogonal triad
Gyro	
Magnetometer	
Inclinometer	2-axis
GNSS Receiver	Channels: 12 GPS, 7 NavIC, 2 GAGAN, GALILEO: 12

Mechanical/Electrical Specifications

Parameter	Specification
Dimensions	325 x 205 x 170 mm
Weight	8 kg (Core System) 1 kg (RF elements)
Power	35 W
Supply Voltage	24 V to 45 V DC

System Specifications

Parameter	Specification	
Navigation Mode	**Hybrid**	**Inertial**
Pointing accuracy	Roll, Pitch: 0.03° Heading: 0.05°	Roll, Pitch: 0.15° Heading: 0.5°
Position (CEP)	< 10 m	< 1.5 NM/hr
Velocity	0.1 m/s	2.5 m/s
Rate capability	±400 °/s	
Output data rate	100 Hz	
Acceleration	±20 g	
Level Error	10 arc sec	
Azimuth Error	180 arc sec	

Sensor Specifications

Parameter	Value
Gyros	
Range	±400 °/s
Bias stability	0.015°/hr
Non-linearity	10 ppm
Angular random walk	0.005°/√hr
Scale factor stability	10 ppm
Accelerometer	
Bias stability	50 µg
Scale factor stability	50 ppm
Scale factor non-linearity	±30 µg/ g^2
Scale factor asymmetry	100 ppm
Misalignment stability	10 arc sec
GNSS Receiver	
Dynamics	
Velocity	15 km/s
Acceleration	20 g
Jerk	20 g/s
Altitude	No limit
Position	30 m
Velocity	0.3 m/s
Frequency of operation	L1, L5
Time to First Fix	300 sec
Time to Subsequent Fix	10 sec

System Environmental Specifications

Parameter	Specification
Operating temperature	5°C to +70°C
Vibration	13.5 grms

LINS-3S-20

High-Grade Inertial & Hybridized Navigation System

System Features

- Built in self-test for all electronics
- Advanced Receiver Autonomous Integrity Monitoring for GNSS Receiver
- Built-in processor self-test and error indication in outputs
- Software code as per MISRA-C standard and software development in line with IEEE12207 standard

Navigation Initialization

- Three modes for navigation initialization, which can be selected based on command through external interface
  - Self-initialization using onboard sensors.
  - Re-use of the stored states at previous power-off.
  - Initialization of latitude, longitude & altitude through external system using interfaces provided.

System Extendibility

LINS-3S-20 is designed as an extendable navigation system which can be gluelessly connected with external navigation aids like Baro-altimeter/Vision Sensor/NavIC based telecommand module/LIDAR or any other sensors with RS422/RS485 interfaces. These features make the LINS-3S-20 truly a versatile system for a variety of applications.

Depending on the accuracy of the add-on navigation system, the navigation software is to be updated. The system specification can be improved using these add-on sensors. Requirements of add-on sensors, its interface details and communication protocols to be specified in advance and the software update to be obtained from IISU.

Deliverables

- LINS-3S-20 core module: 1 unit
- Antenna: 2 units
- External Low Noise Amplifier: 2 units
- RF cables: 4 units (Length up to 5m)

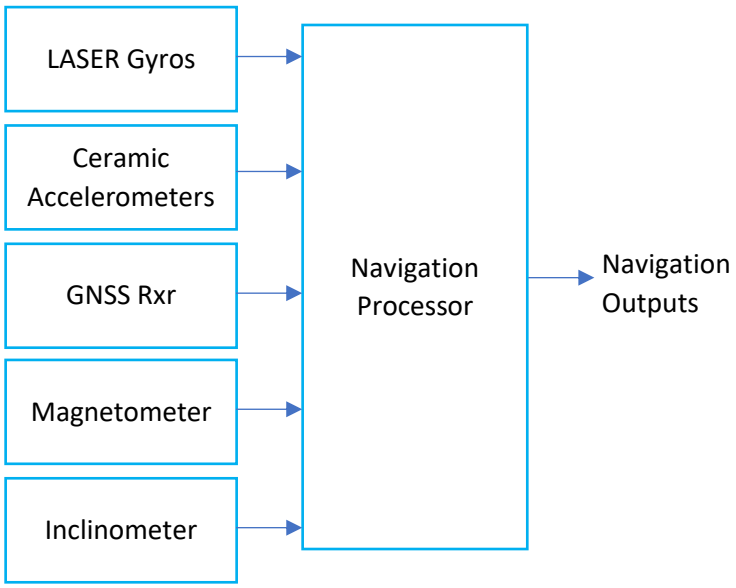
Additional Features

- Calibration coefficient data loading through MIL STD 1553 link

Redundancy

Two/Three units of same system can be used for redundancy

System Block Schematic



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HNS-20-IS

High Reliability High Accuracy Hybrid Navigation System

Designed for advanced launch vehicles, HNS-20-IS delivers high-grade navigation performance, accuracy and flexibility for short and long duration flights

Based on IISU's expertise in inertial sensors, GNSS technology, navigation algorithms, electronics and system integration, HNS-20-IS incorporates IISU designed MEMS gyros, high accuracy ceramic accelerometers and inclinometers. It uses IISU's GNSS expertise and have 33 channel GNSS receivers in built, with GPS, NavIC, GALILEO and GAGAN constellations. Using a powerful multimode Kalman filter, HNS-20-IS optimizes the alignment and navigation capabilities. Inbuilt GNSS aiding enables the system for extended duration missions. Highly modular, HNS-20-IS combines all the advantages of a Size Weight & Power optimized integrated navigation system in a single box. Easy to maintain and highly reliable, HNS-20-IS ensures the navigation availability for the most demanding missions.

Application Areas

HNS-20-IS is well suited for guidance and navigation applications in Aerospace sector. The design is flight proven in ISRO's launch-vehicles. Its long-range capabilities make the system ideal for multi orbit launch vehicle missions and Airborne surveillance. HNS-20-IS can competitively replace navigation systems based on conventional gyros and improve system performance with respect to robustness, reliability, size, weight, power and cost. The high dynamic GNSS receiver with proven GNSS subsystems enables the HNS-20-IS a suitable choice for extended duration flights

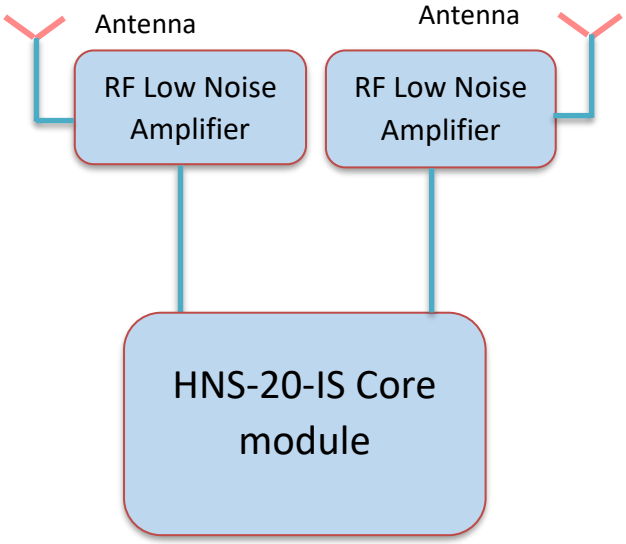
Features

- 500k Byte memory and 50% of 800MHz processor execution time is available for user designed application software. Control and guidance software can be integrated with HNS-20-IS and can use it as total mission management computer
- No external alignment requirement
- IISUs proprietary algorithm for attitude aiding using GNSS, which is proven in ISROs launch vehicles
- System warm up time of 15 minutes, including alignment
- 1pps output available from GNSS Receiver

Interfaces

- MIL STD 1553: 2 nos
- RS422: 3 nos
- RSS485: 3nos
- Single supply voltage: 24-45V, Typical value: 34V
- Power: 16W
- RF input: SMA-F (2 nos)
- Number of connectors: D type:1, RF:2

System Configuration for Avionics Applications



*The system is expected to be in production from Aug2021 onwards

HNS-20-IS

High Reliability High Accuracy Hybrid Navigation System

The system comprises of two antennae mounted diametrically opposite to the launch vehicle upper stage for complete visibility of the GNSS satellites throughout the trajectory. The exact location of the antennae is decided based on the RF simulation studies done on GNSS constellation simulator for the particular trajectory of launcher. The antenna output is amplified by external low RF noise amplifier (LNA). The LNA outputs are fed to the HNS-20-IS core module. The core module comprises of IISU developed MEMS gyros and navigation grade ceramic accelerometers, Magnetometer, inclinometer and GNSS receiver embedded navigation processor. The system generates navigation outputs in required periodicity, which can be made available thru RS422/ MIL 1553B links.

Sensor Configuration

Sensor	Configuration
Accelerometers	3units each in orthogonal triad
Gyros	
Inclinometer	
3 axis magnetometers	1 unit
GNSS Receiver	Channels: 12 GPS, 7 NavIC, 12 GALILEO, 2 GAGAN

Mechanical/Electrical Specification

Parameter	Specification
Footprint	110x125x100mm^3
Weight	2.2kg
Power	10W
Supply voltage	24-45V, Typical value: 34V
Operating temperature	-40°C to +85°C

System Specification

Highlights	Specification (3σ)
Pointing accuracy	Pitch & Yaw:0.1°, roll: 0.5°
Position	30m
Velocity	0.3m/s
Rate capability	±60°/s
Output rate	50Hz
Acceleration Capability	±20g (Constant acceleration)
GNSS TTFF	300sec
GNSS TTSF	10sec

Sensor Specifications

Parameter	Value
Gyros	
Dynamic Range	±60 °/s
Scale Factor	30 mV/ °/sec
Bias Stability	<0.01 °/sec
Accelerometer	
Bias	175 µg
Scale Factor	250 ppm
Scale Factor Asymmetry	160 ppm
2nd order NL	50 µg/g^2
Maximum acceleration	±20 g
GNSS Receiver	
Dynamics	
Velocity	15 km/s
Acceleration	20 g
Jerk	20 g/s
Altitude	No limit
Position	30 m
Velocity	0.3 m/s
Frequency of operation	L1, L5
System Misalignment	
Level error	10 arc sec
Azimuth error	360 arc sec

Application Areas

a. Low cost application for small satellite launches vehicles
b. Heavy lift vehicles and long duration missions
c. AHRS for aerial vehicles
d. UAVs and land navigation
e. Satellite applications
f. Landing missions

Redundancy:

Two/Three units of same system can be used for redundancy

HNS-20-IS

High Reliability High Accuracy Hybrid Navigation System

Fault Tolerance

- Built in self-test for all electronics
- Advanced Receiver Autonomous Integrity Monitoring
- In built processor self-test and error indication in outputs
- Software code as per MISRA-C standard and software development in line with tailored version of IEEE12207 standard

Navigation Initialization

- Three modes for navigation initialization, which can be selected based on command through external interface
  - Total self-initialization using GNSS, magnetometers, inclinometers and inertial sensors
  - Re-use of the stored states at previous power-off
  - Initialization of latitude, longitude & altitude through external system using interfaces provided

System Extendibility

HNS-20-IS is designed as an extendable navigation system which can be gluelessly connected with external navigation aids like Baro-altimeter/Vision sensor/NavIC based telecommand module/LIDAR or any other sensors with RS422/RS485 interfaces. These features make the HNS-20-IS truly a versatile system for a variety of applications.

Depending on the accuracy of the add-on navigation system, the navigation software is to be updated. The system specification can be improved using these add-on sensors. Requirements of add-on sensors, its interface details and communication protocols to be specified in advance and the software update to be obtained from IISU.

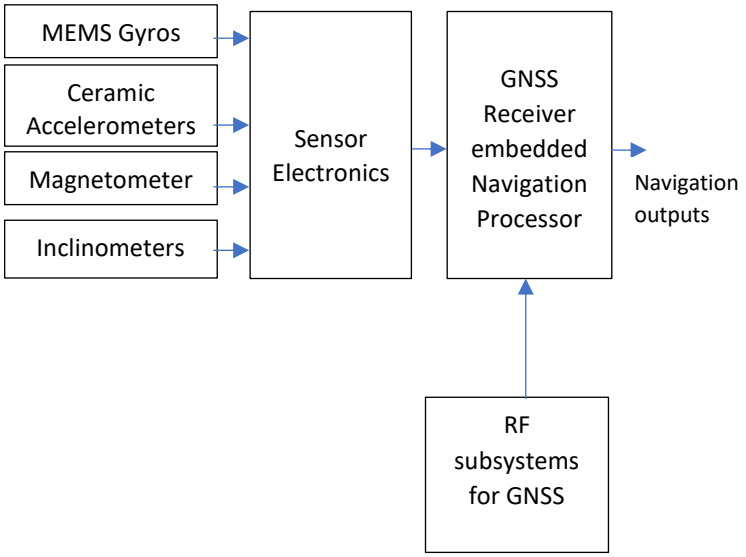
Additional Features

- Optional calibration coefficient/ Navigation initialization data loading capability by checkout computer through MIL STD 1553 link at launch pad
- Processor self-test and error reporting during flight

Deliverables

- HNS-20-IS core module: 1 unit
- Antenna: 2 units
- External low noise amplifiers: 2 units
- RF cables: 4 units (Length is configurable up to 5m)

System Configuration



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"THE DREAM OF YESTERDAY
IS THE HOPE OF TODAY
AND THE REALITY OF TOMORROW"