CFN-15N Product Description
(Nautilus 5000 series)

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Summary

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1 General

1.1 Scope of the document

This document provides a technical description of the CFN-15N unit (Nautilus 5000 series), a FOG-based Inertial Navigation Systems (INS) for maritime applications, identified with the basic part number PCFN0015N. It will be generally referred to as "Inertial Navigation Unit" or "INS".

This document describes the general characteristics of the system organized as follows:

- background information necessary for understanding the functionalities, protocols and algorithms implemented
- high-level block diagram indicating functionality and operating modes
- performance and operating frequency features
- identification of the interfaces of the processing module to the other subsystems
- description of the failure detection and safety monitoring by means of the built-in testing capabilities and specific hardware integrity monitors
- mechanical and physical interface descriptions
- environmental conditions and specific electrical qualification

1.2 References

[1] MIL-STD-461F – "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment"

[2] RTCA/DO-160E – "Environmental Conditions and Test Procedures for Airborne Equipment"

[3] MIL-STD-810F - "Environmental Engineering Considerations and Laboratory Tests"

[4] IEC 60945 – "Maritime Navigation and Radio Communication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results".

[5] IEC 61162-1 – "Maritime Navigation and Radio Communication Equipment and Systems - Digital Interfaces"

[6] MIL-STD-167-1A – "Mechanical Vibrations of Shipboard Equipment".

[7] PRJ-ICD-CFN0015N-01 – "CFN-15N Interface Control Document"

1.3 Definitions and Acronyms

ADC	Analog-to-Digital Converter
AHRS	Attitude and Heading Reference System
ASE	Amplified Spontaneous Emission
BIT	Built-In Test
CBIT	Continuous Built-In Test
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DAC	Digital-to-Analog Converter
DAL	Design Assurance Level
DOF	Degrees Of Freedom
DPU	Data Processing Unit
EMI	Electro Magnetic Interference
FOG	Fiber Optic Gyroscope
FPGA	Field Programmable Gate Array
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronic Engineers
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
I/O	Input/Output
KF	Kalman Filter
LRU	Line Replaceable Unit
LSB	Least Significant Bit/Byte
MSB	Most Significant Bit/Byte
NA	Not Applicable
NED	North-East-Down
NM	Nautical Mile
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
PBIT	Power-up Built-In Test
PPS	Pulse-per-Second
PS	Processor System
PVT	Position Velocity Time
RAM	Random Access Memory
RMS	Root Mean Square
ROM	Read-Only Memory
RFU	Reserved for Future Use
SBAS	Satellite Based Augmentation System
SOC	System-On-Chip
UTC	Universal Time Coordinated
VDC	Voltage Direct Current
WGS	World Geodetic System

2 System Description

The Inertial Navigation Unit is an Inertial Navigation System (INS) that can integrate input data from external speed log and internal GPS to generate the navigation solution. The INS provides high accuracy heading, pitch, roll, heave, rate-of-turn data, linear velocities in navigation frame (NED), accelerations in body frame, both INS-based and GPS-based position, speed log and ancillary navigation data.

These data are delivered via digital interfaces to advanced digital instruments for usage by the vessel system.

A dedicated external Control Display Unit (CDU) system (not included in this product) might be connected to provide information to the user and to communicate special information to the INS unit such as reference position or configuration parameters for the communication ports.

The Inertial Navigation Unit contains an inertial measurement unit (IMU) that provides the terna of the angular rates and acceleration of the systems. The INS also contains a data processing unit that elaborates the inertial measurements to implement both an Inertial Navigation solution and an Attitude & Heading Reference measurement. The INS can combine by means of Kalman filtering the internal inertial measurements with navigation data coming from the GPS Receiver Unit to provide a hybrid navigation solution, which represents the optimal estimation of the navigation solution. In addition, data measured by an external Doppler velocity log (not included in this product) can be used as a further source of aiding. However, the INS is not bound to external aiding sensors, as it can also compute the navigation solution in a completely autonomous condition, i.e. pure-inertial navigation.

2.1 System Components

The Inertial Navigation Systems is built around three main subsystems that communicate through dedicated electrical interfaces. In detail:

- Sensor-Block subsystem: it is based on an inertial measurement unit (IMU) and contains three orthogonally mounted FOG-based angular rate sensors, three orthogonally mounted accelerometers, optical modules and temperature sensors. The inertial sensors are mounted in strap-down configuration with sensibility axes aligned to the object body reference system.
- Electronic-Unit subsystem: it contains a CPU-FAM3 board (based on SoC component) that elaborates the inertial measurements by means of the navigation software, then combines them with GPS data coming from the internal GPS receiver or from external Doppler speed-logger to implement the navigation solution. Besides, this board interfaces with the sensor-block subsystem for managing the inertial data.
  This subsystem also contains the power supply board and the ASE board that manage the FOG light source generation.
- GPS subsystem: the INS contains an embedded GNSS receiver board that receives and utilizes the signals coming from Global Positioning System (GPS) satellite constellation.
  The primary function of the GPS receiver is to compute the position, velocities and precise time solution (PVT solution).

The embedded GPS communicates with the electronic-unit subsystem through a bi-directional UART serial communication link and provides the time mark synchronization to GPS UTC time through a digital signal (PPS).

The following block diagram shows the basic connection between the Inertial Navigation Unit and the external devices.

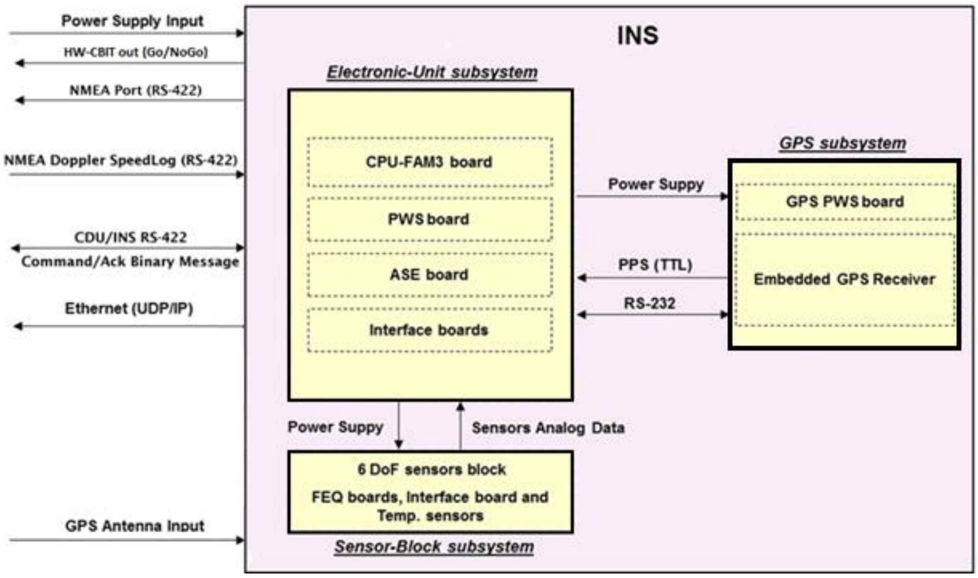

Figure 1 – CFN-15N Subsystems and Interconnections

2.2 System Data Output

The INS provides inertial data, GPS data and log speed, diagnostics information and status of the current operative mode. A brief list of the system data output is provided hereinafter:

- the three Euler angles: Roll, Pitch and True Heading
- the rate-of-turn and angular rates in body frame
- the three velocities in NED frame computed by the INS
- the three linear accelerations in body frame
- the heave
- the UTC and date of year synchronized to GPS
- the local position (latitude, longitude) computed by the INS
- the local position (latitude, longitude) as provided by the GPS
- the velocity as provided by the GPS
- the velocity as provided by the speed log
- the GNSS internal receiver status (diagnostic and operative modes) if available
- the BIT diagnostics: system health, status and operative modes

2.3 IMU Block Diagram

The block diagram of the IMU sensors block based on gyroscope's FOG technology and solid state accelerometers is depicted in the following figure.

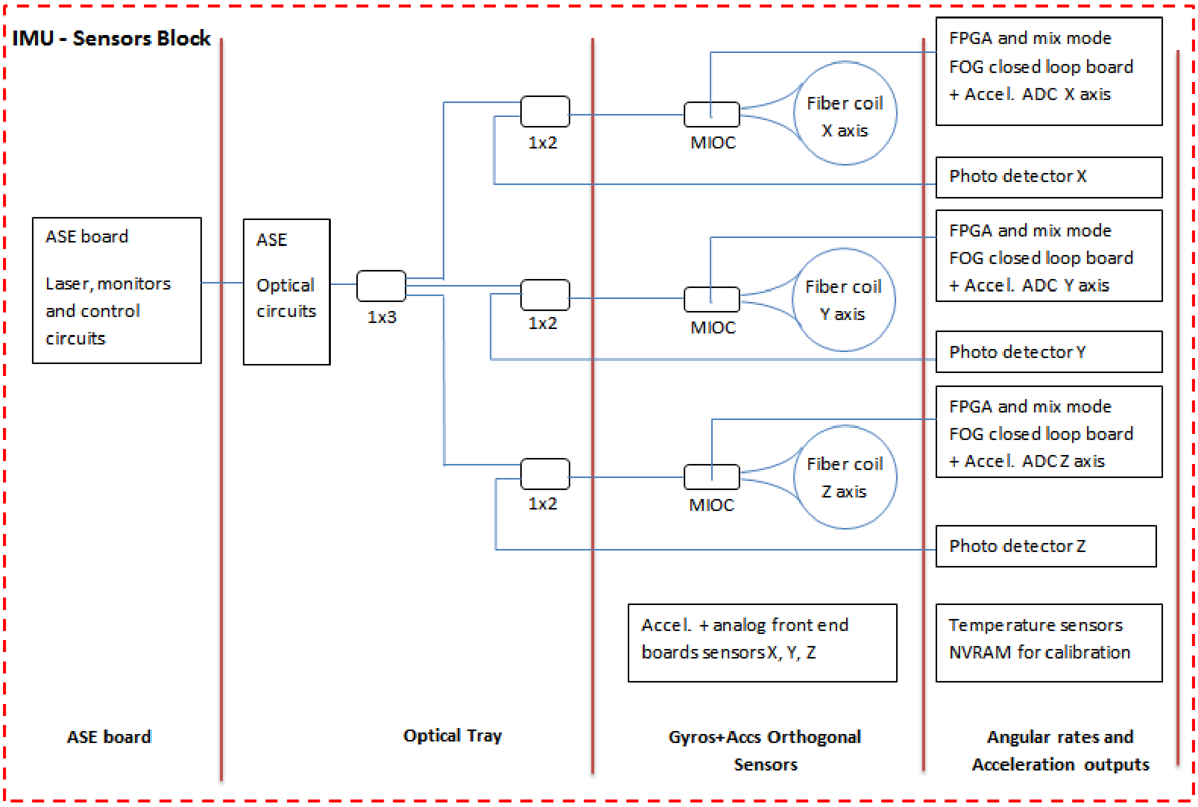

Figure 2 – IMU sensor block diagram

2.4 System Software Overview

The INS Data Processing Unit (DPU) is programmed to perform the following main functions:

- *Sensors Compensation*. It reads the raw inertial sensors data as provided by the IMU unit and performs compensation of the sensors' errors at the maximum internal elaboration frequency, applying specific mathematics equations and using of IEEE-764 compliant functions such as multiplication, addition and subtraction on 64-bit floating-point operands.
- *Sensors Fusion Algorithm*. It utilizes the gyroscope and accelerometer measurements to propagate the attitude and the velocity and position of the system. The GPS received data can be used as reference for the velocity and position computation and also to adjust the attitude and heading estimation in the blended INS/GPS solution. In the case of GPS outage, a Doppler velocity log can be used as an additional velocity reference and for computing the set and drift (respectively the direction of the current of the water and its speed)
- *Built-in Test checks*. This feature is intended to provide some basic safety monitoring capabilities. The feature involves both hardware and software implementations and several

checks performed also on data coming from both the IMU and GPS components. The operative modes of the systems will also depend on the output of the diagnostic process.

- *Communication Interface Management*. The system data output, both AHRS and INS data, are provided to the vessel digital equipment through communication busses. Packets of digital information coming from the GPS and external speed log RS-422 digital bus are received by the INS to be used inside the sensor fusion algorithm. Temporary loss of digital connections with mentioned systems are managed through system software state changes and by providing information about the missed data or the accuracy of the provided external data in the BIT status words. Commands and initial position datum can be provided to the INS through the "CDU" serial interface, according to an interface protocol based on fixed-length command input messages and acknowledgment replies.
- *Calibration parameters loader*. This is a reserved software mode ("Configuration" mode) that writes calibration data set into the system's dedicated NVM. The calibration data are intended to provide the correction parameters that compensate for the *lever arm* effect due to the different mounting position of the GPS antenna with respect of the IMU system and for installation misalignments (*system boresight angles*). This software module shall never be used during normal operations on board.
- *Service and configuration*. When the system is in "Configuration" mode, it can accept various maintenance commands to transfer information from/to an external system (e.g. the system can execute a firmware update, provide stored diagnostic history, etc.).
- *IMU inertial and diagnostic data collector*. The DPU interfaces an IMU FPGA over a dedicated high-speed communication channel: the IMU FPGA continuously sends (at the maximum processing frequency) the digitalized sensors measurements and the results of its internal diagnostic tests.

2.4.1 Software Navigation Functions

The INS DPU executes the navigation software algorithms based on Kalman filtering, which implements a sensors data fusion in order to compute the best estimation of the internal system data. The main objectives of the INS DPU sensors fusion algorithms are to compute the following inertial data:

- attitude and heading angles of the INS, with respect to the NED navigation frame;
- horizontal position vector, in the geodetic frame. The horizontal position vector is composed of the geodetic latitude and longitude of the system with respect to the ellipsoid-modeled Earth reference. The WGS-84 model will be used as reference ellipsoid. The system provides also the Heave data that is the vertical displacement around the zero mean value.
- velocity vector of the system, in local navigation frame which is the North-East-Down (NED) frame. The three components of the velocity vector will be the velocity in South-North direction, the West-East direction, the Up-Down direction.

The INS navigation is based on inertial principles. In the system, the acceleration measured by the accelerometers and the angular rate measured by the gyroscopes are integrated over time. Through the integration process, the linear velocity, position and attitude of the system can be obtained, once provided the knowledge of their initial values. In INS/GPS mode, the GPS aiding sensor provides stable measurement references, so that the measurement errors (deterministic and stochastic) of the accelerometers and gyroscopes can be decreased, limiting the drift in position, velocity and attitude solutions due to the integration process.

The software sensors fusion filter executes three main algorithms, which are depending on the power-on time, sensors availability and sensor accuracy:

- The ***leveling*** and ***gyro-compass*** filter (*GC*) is based on inertial principles. It uses the acceleration and angular rate measurements, together with the system position (latitude), to estimate the initial attitude and heading angles. The *leveling* and *gyro-compass* filter process can be typically divided in three main phases: *leveling phase,* where initial attitude angles are estimated; *coarse alignment phase,* where an initial raw heading angle is evaluated together with a refinement of the attitude data; *fine alignment phase,* where accurate heading and attitude angle are provided. In order to complete the gyro-compass process, the latitude datum must be available. The alignment phase is tuned depending on the two main condition of the vessel: alignment in mooring condition and alignment during sea navigation (see § 2.4.2).
- The ***Inertial Navigation*** filter (***INS***) does not use the GPS information to compute the roll, pitch and heading angles and velocity and position. The angular rate measurements are integrated over time to obtain roll, pitch and heading angles, corrected by an estimation of the stochastic component of the sensor angular rate biases. The accelerometer measurements are also (double) integrated over time in order to obtain the system velocity and, hence, the system position. In pure INS mode, the INS must be provided with initial position information thought its serial interface.
- The ***Inertial Navigation GPS-aided*** filter (***INS/GPS***) uses the GPS available sensor to compute position, velocities, attitude and heading of the system, using the estimation of the stochastic component of the gyroscope and the accelerometer sensors biases. In addition to GPS, longitudinal and transversal velocity received from the speed log are used to further improve the navigation output data.
  The angular rate measurements are integrated over time to obtain the roll, pitch and heading angles. The accelerometer measurements are also (double) integrated over time in order to obtain the system velocity and the system position. The GPS position and velocity measurements provide an absolute stable reference for the system velocity and position. The GPS data, accelerometers data, angular rate measurements are fused in the INS/GPS filter. The GPS data are considered accurate by the INS system on the basis the integrity information and Figure of Merit of the measurements (FOM) provided by the GPS receiver. In case of GPS outage during the navigation phase, the inertial internal velocity and position data are obtained through the integration process of the accelerometers and gyroscopes data. Because of the uncertainty of the inertial measurements, due to noise, bias and scale factor errors, the internal position information degrades with time.

The system can receive through its serial interface the command to exclude/include the GPS aiding in the navigation functions: the INS or INS/GPS navigation solutions can be externally selected.

2.4.2 Operative Modes Description

The INS essentially behaves as a Finite State Machine (FSM) with the following macroscopic "states" (or "operative modes") according to the navigation phase and system health:

1. **Initialize** state. After the power-on, if valid supply line is provided and no power supply failures are detected, the system transits to this state. During this phase the system is not ready to provide output data over the communication interfaces, the DPU hardware watchdog is activated and many tests for the integrity of system hardware components are performed (PBITs: RAM, ROM, PWR, EEPROM, IMU, ASE, etc.).
   Then the system transits to "Stand_By" state. The initialization phase takes typically less than 15 seconds.

2. **Stand_By** state. The system provides the available data output over the communication buses. In the Stand_By state the system waits the initial position in order to transit to the Alignment phase. The initial position can be obtained by both GPS data and external entered data via the communication buses.

3. **Alignment in Mooring condition** state. In the "Alignment in Mooring condition" state, the initial system values of the attitude and heading angles are estimated. This kind of Alignment is entered when a mooring condition state is received from communication buses. During the Alignment in mooring condition, the software computes the initial data by means both accelerometer and gyroscope sensor data. The system completes the Alignment in mooring condition in 15 minutes and after it transits to the "INS Navigation" state.

4. **Alignment in Sea condition** state. In the "Alignment in See condition" state, the initial system values of the attitude and heading angles are estimated. This kind of Alignment is entered when a Sea condition state is received from communication buses. During the Alignment in sea condition, the software computes the initial data by means both accelerometer and gyroscope sensor data, aiding the alignment functionality by both GPS and Speed Log data. The system complete the Alignment in sea condition in 30 minutes and after it transits to the "INS Navigation" state.

5. **INS Navigation** state. In the "INS Navigation" state, the system provides a complete navigation solution regarding to the attitude, heading, position, velocity, body angular rates and body linear accelerations.

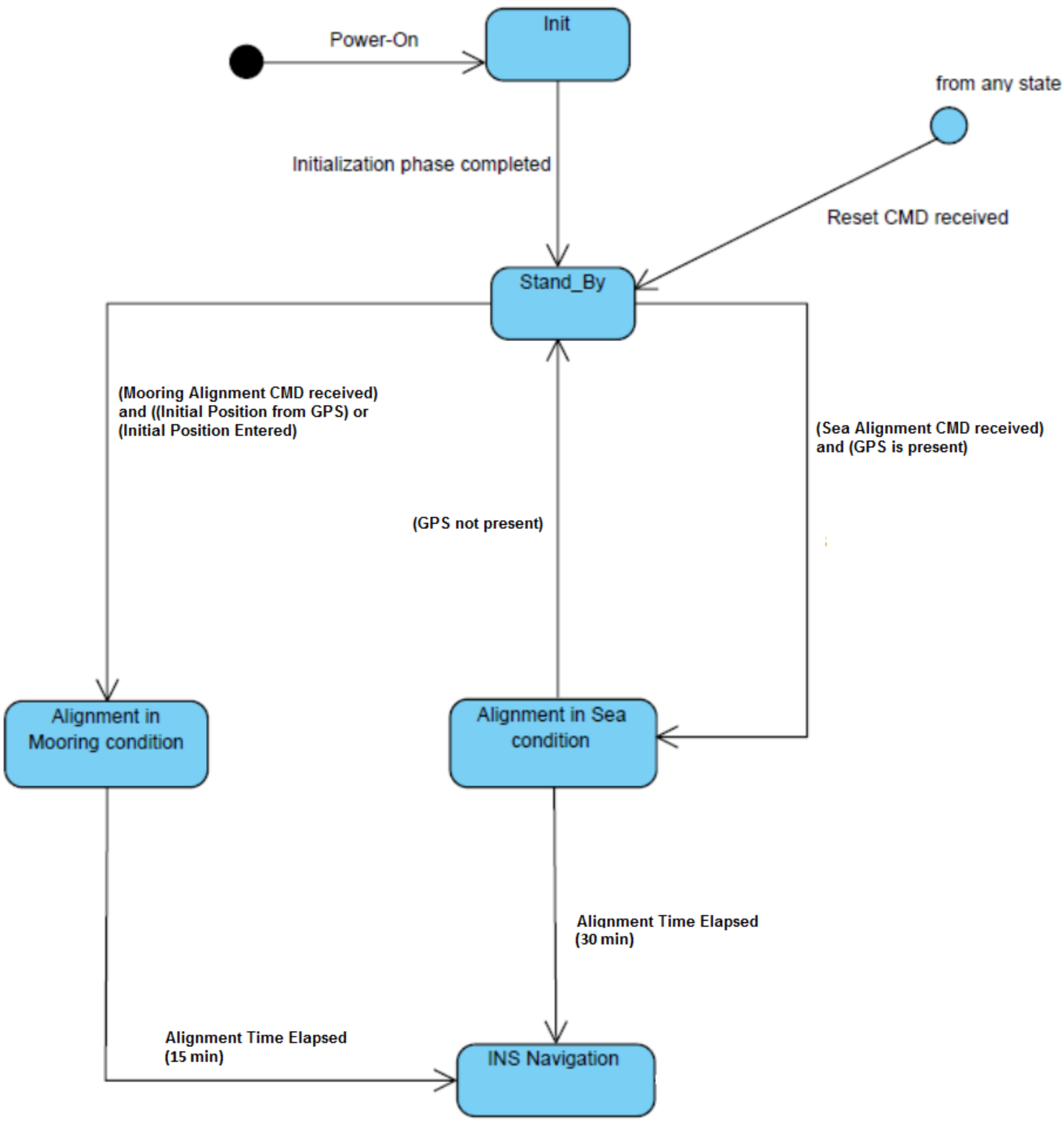

Figure 3 – Operating modes: state transition diagram

2.5 Failure Detection and Safety Monitoring

The health and the integrity of the INS system is monitored on a continuous basis and at power-up: these built-in tests prevent the system from providing misleading information in case of failure or, even, can prevent the system boot-up (e.g. in case of a corrupted software code area ROM or NVM failure).

The INS will perform a set of diagnostic tests: the results shall be collected by the INS DPU and signaled appropriately to the external system through the communication busses.

2.5.1 Watchdog

The INS uses hardware watchdogs, based on the internal microprocessor PLL circuitry timers.

The watchdog timers servicing is required to be executed only once for each processing loop. When the supervising system fails to retrigger the watchdog circuit within the time-out interval, the hardware will automatically be reset.

The software module that drives the watchdog reset circuitry is executed on the detection of an external signal transition driven by the FPGA's IMU coprocessor. This approach allows the mutual monitoring of the processor/coprocessor systems lock-up due to random fault.

2.5.2 Power-up BIT

The Built-in Tests at power-up checks:

- the ROM/RAM area code
- the NVM integrity by calculating the NVM CRC and comparing it with a CRC signature stored into predefined cells of the NVM area.
- the sensors health

2.5.3 Continuous Built-in Test

The Continuous Built-in Tests (CBIT) executed on a continuous basis (at each processing cycle) monitor:

- the FPGA co-processors status
- the integrity of the Analog-to-Digital Converters
- the over-range of the gyroscopes, accelerometers, temperatures sensors
- internal Finite State Machines (FSM) faults
- the power-supply section integrity
- the operating device temperatures: many digitalized temperatures shall be compared each other in order to provide an integrity check of the temperature sensors' and detected the over-temperature of the system.
- the accelerometers' health
- the function of the closed-control loop of the gyroscope will be continually monitored and signalled.
- Sensors-fusion algorithms integrity
- Sensors-fusion algorithms status: initialization, accuracy modes
- the auxiliary, diagnostic and status information provided by the GPS: hardware probable equipment malfunction or failure, satellite in view, fix mode type, estimated errors, etc.
- the watchdog status.

The results of the Built-in Test are signalled through the digital data packets sent over the communication bus.

3 System Performances Characteristics

Table 1 Inertial Navigation System Performances

MEASUREMENT RANGE	
True Heading range	0° ÷ 360°
Roll/Pitch range	± 90°
Heave range	± 655 m
Rate of Turn range	± 300 °/sec
Acceleration range	± 10 g
Latitude range	± 90°
Longitude range	± 180°
Velocity range	± 65 m/s
HEADING AND ATTITUDE (RMS)	
True Heading accuracy (static and dynamic conditions)	≤ 0.02° Sec Latitude
Roll & Pitch accuracy (static and dynamic conditions)	≤ 0.01°
Heave accuracy	≤ 2.5 cm or 2.5%, whichever is greater (0-20 sec period)
Rate of Turn accuracy	< 0.005°/s (0.3°/min)
North/East/Down velocity accuracy	≤ 0.5 m/s
INS Position accuracy (No aiding mode) (1)	≤ 4 NM/24h
INS Position accuracy (Log aided mode) (1) (2)	≤ 0.8 NM/24h
ALIGNMENT TIME	
Alignment settling time (static accuracy)	≤ 15 minutes (mooring conditions)
Alignment settling time (dynamic accuracy)	≤ 30 minutes (all sea conditions)
GPS NOMINAL ACCURACY (if embedded GPS available) (1σ)	
Time to First Fix (3)	<45 seconds (Cold Start) <30 seconds (Warm Start)
Horizontal Position (4)	0.5 m (SBAS available)
Vertical Position (4)	0.85 m (SBAS available)
Horizontal Velocity accuracy (5)	0.007 m/s
Vertical Velocity accuracy (5)	0.02 m/s

(1) The autonomous navigation (without GPS) reaches the best performances after a GPS-aided navigation phase of at least 2 hours (about 30 minutes of navigation for each of the four orthogonal directions) with valid aiding data received by the embedded GNSS receiver

(2) DVL aiding with accuracy ± 0.03 kts (speed range 0-10 kts) / 0.3% (speed >10 kts).

(3) Cold Start: No previous satellite (ephemerides/almanac) or position information. Warm Start: Ephemerides and last used position known

(4) Typical observed values in C/A mode. They may be affected by atmospheric conditions, signal multipath, and satellite geometry and GPS U.S. DoD service selectivity.

(5) 1 sigma level, when using Trimble Zephyr antennas.

The heading, pitch and roll angle accuracy of the INS measurements represent the accuracy of the navigation frame (North/East/Down) and does not include accuracy degradation due to installation effects such as boresighting errors.

The *system boresight angles* are the misalignment angles between the INS body axes and the vessel reference axes. Errors in alignment will contribute directly to errors in measured acceleration and rotation relative to vessel reference axes and, then, in measured velocity, attitude and heading angles.

At very first vessel installation time, the INS should receive over the standard serial interface:

- the *mounting orientation* (*fore, aft, port, starboard:* see [7])
- the *system boresight angles* that represent the relative orientation of the INS body axes to the vessel reference axes.
- The *lever-arm parameters* that are the distances between the GPS antenna and the INS center

The position datum could be provided to the Inertial Navigation Unit through the serial digital interfaces (automatically from a valid and accurate datum from GPS) or CDU unit.

4 System Interfaces

The INS is provided with asynchronous full-duplex buses (RS-422/RS-232) and Ethernet interface. The system data are provided to the vessel systems at high rate through an RS-422 port, transmitting the ARHS data and the INS data. A dedicated RS-422 interface is used as communication channel to a CDU which provides the user with a graphical interface. The speed log measurements must also be delivered to the Inertial Navigation Unit thru dedicated serial interface.

Table 2 Interface to Vessel Electronics

POWER SUPPLY	
Voltage	18-36 VDC (24VDC typical)
Power Consumption	< 20 W
INS OUTPUT NMEA INTERFACE	
Output Data link	RS-422
Protocol	NMEA0183: HDT, ROT, GGA, TSS1, VTG (selectable)
Digital Data Rate	100 Hz
Serial bit rate	921600
INS OUTPUT ETH INTERFACE	
Output Data link	Ethernet UDP
Protocol	Seatex Binary 11
Digital Data Rate	100 Hz
Ethernet Link Speed	Base 10/100MB (auto negotiation)
Doppler Velocity Log INPUT INTERFACE	
Input Data link	RS-422
Protocol	PD6 (optional NMEA0183)
Digital Data Rate	1 Hz
Serial bit rate	38400 bps
CDU and INS INPUT/OUTPUT INTERFACE	
Asynchronous Full-Duplex Serial	RS-422
Protocol	Binary Custom
Digital Data Rate for Input Commands	Asynchronous
Serial bit rate	115200
Digital Data Rate for INS/AHRS measurements	10 Hz
DISCRETE OUTPUT HW-CBIT	
Go/NoGo line	Digital (Open collector)
GPS Antenna	

RF Link	Active Antenna (5VDC typical, <1W)

Note: Other protocols and interfaces can be available upon customer requests.

4.1 NMEA Input Sentences (RS-422)

The Inertial Navigation Unit can accept data from external Doppler velocity log units thru its dedicated asynchronous serial inputs. The system will accept and process either the following PD6 sentences:

- (BS) Bottom-Track Velocity Packet
- (WS) Water-Mass Velocity Packet
- (TS) Timing and Scaling Packet

or, optionally, the following NMEA0183 sentences:

- VBW
- VHW

Upon customer requests, other sentences or input sensor protocols can be accepted by the Inertial Navigation System.

4.2 NMEA Output Sentences (RS-422)

The INS will send a set of "GPS like" sentences, containing the attitude, heading and navigation position and velocity information. More details in the INS Interface Control Document

- §INGGA. These sentences basically provide latitude, longitude and UTC time calculated by the INS. The UTC time will be derived by the INS from the GPS time, if available.
- §INVTG. These sentences provide the horizontal vessel speed and the true course (true heading)
- §HEHDT. These sentences provide the north true heading angles
- §TSS1. These sentences basically provide the attitude and heave angles.
- §ROT. These sentences basically provide the vessel Rate-Of-Turn.

4.3 CDU Binary Input/Ouput (RS-422)

The CDU Binary messages are sent and received over an RS-422 serial interface with a proprietary protocol described into the ICD (see ref. [7] for details).
The output messages to the CDU provides INS/AHRS measurements besides system state and configuration information. They are sent at a fixed frequency of 10 Hz.
Upon customer request, the output data rate can be increased compatibly with the serial baud rate (currently fixed at 115200 bps) of the dedicated port.
The input messages from the CDU are asynchronous and are used as command/configuration interface to the INS.

4.4 Seatex Binary 11 Output (Ethernet UDP)

The Seatex Binary 11 messages (ref. [7] for details) are sent over an UDP protocol through the Ethernet port. This Ethernet port is a 10/100Mb port: at system start-up, it is required that Ethernet port shall be already cabled to the vessel system to permit the auto-negotiation speed process. If the Ethernet cable is not plugged in at power-up, the system will not send any data over the Ethernet link.

The Ethernet port shall be configured by the CDU interface.

5 Mechanical Characteristics

5.1 Physical Dimensions

The physical dimensions of the INS are summarized in the following table. More details are provided in the Interface Control Document (ref. [7]).

Table 3 INS Mechanical Characteristics

INS Mechanical characteristics	
Size (width, height, heave)	192x178x296 mm (including connectors)
Mass	< 12 kg

The INS system can be provided with an adapter plate (see §5.3) for installation mounting, whose mechanical characteristics are summarized hereafter:

Table 4 Adapter Plate Characteristics

Adaptor Plate Mechanical characteristics	
Size (width, height, heave)	196x14x274 mm
Mass	< 1 kg

5.2 Drawings

The INS drawings are provided in the Interface Control Document (ref. [7]). The main references are reported in the following figures.

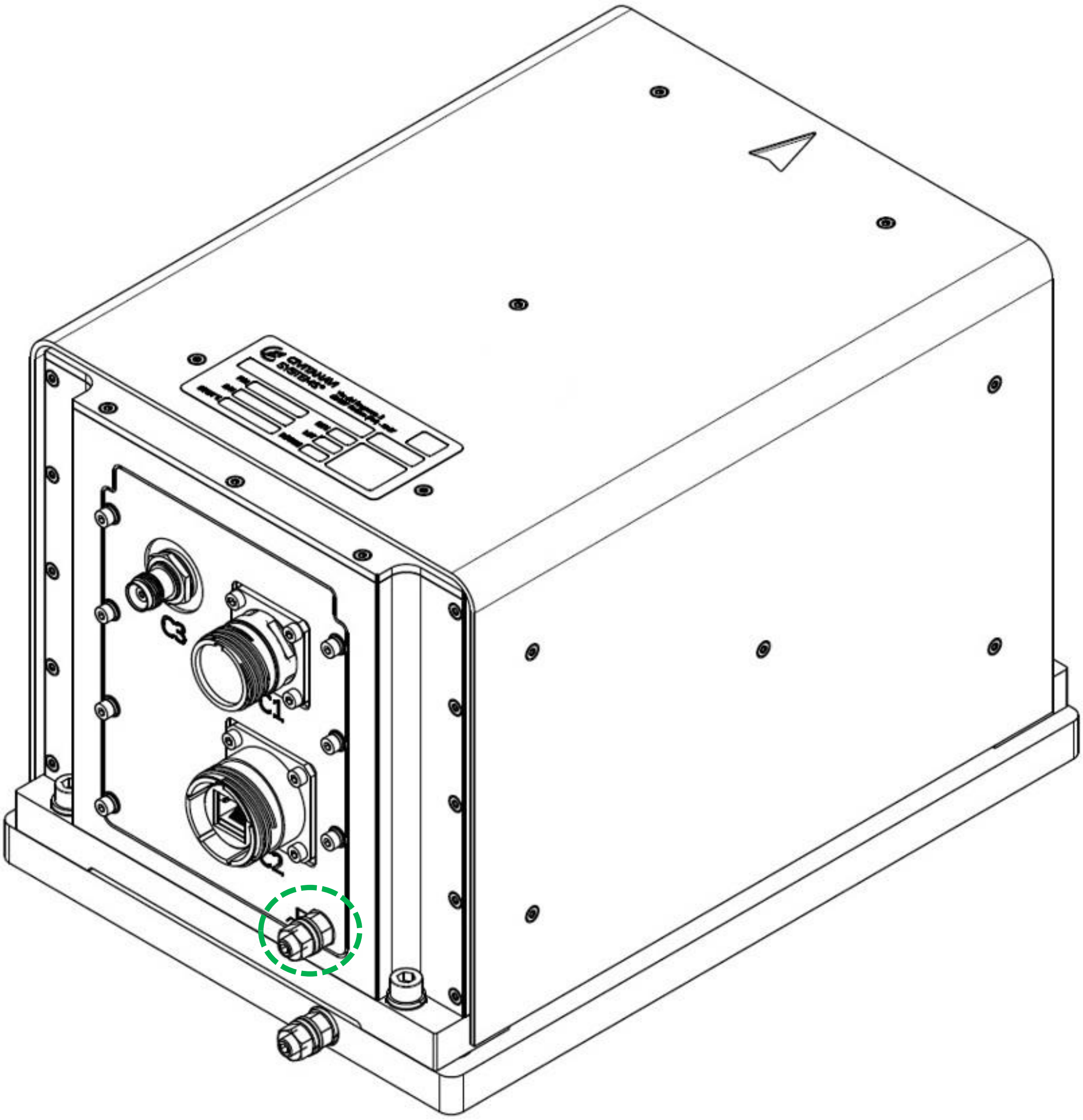

Figure 4 – Outline drawing: 3D schematic View

The case grounding is highlighted in the dotted green area of Figure 4.

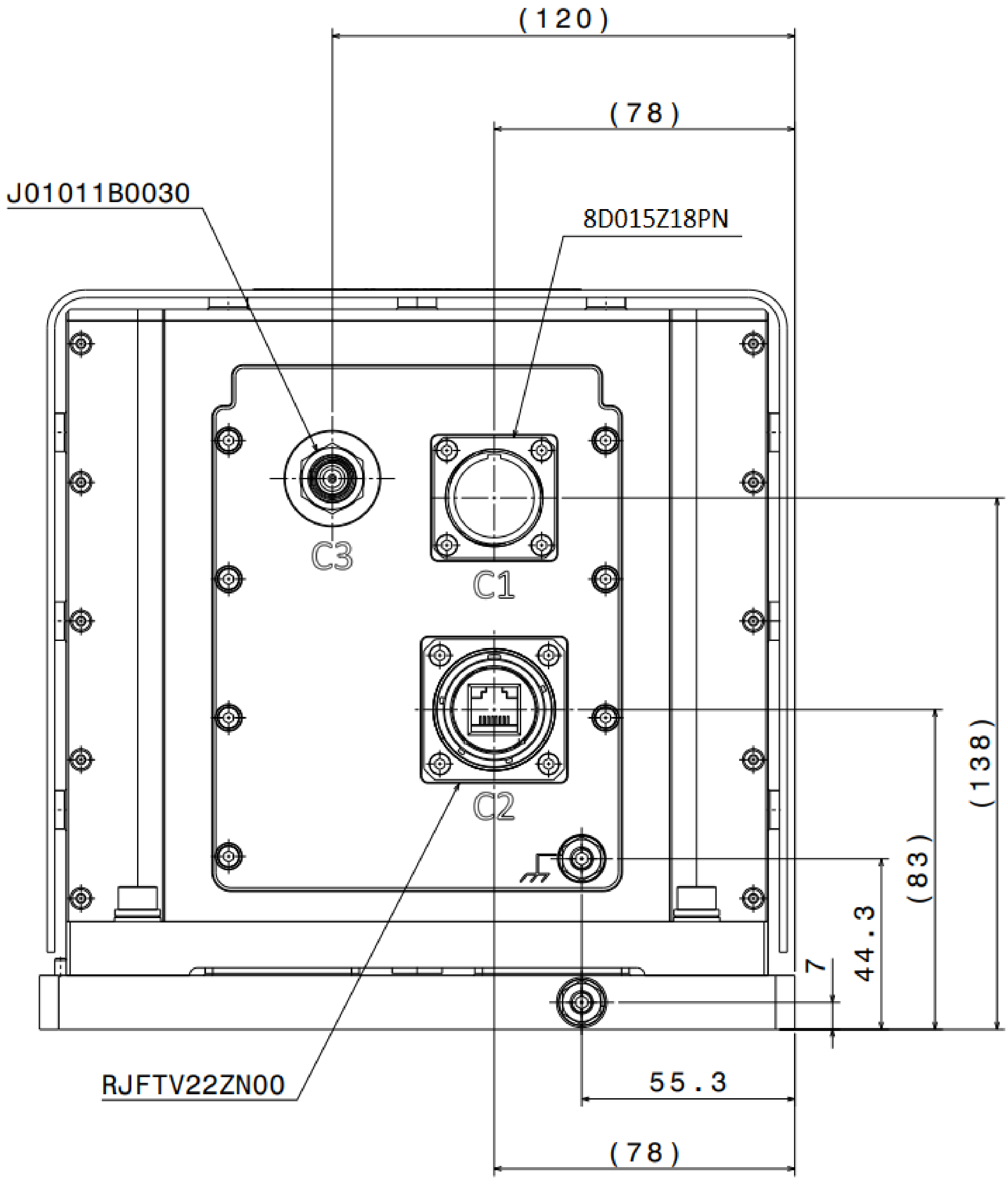

Figure 5 – Outline drawing: front view

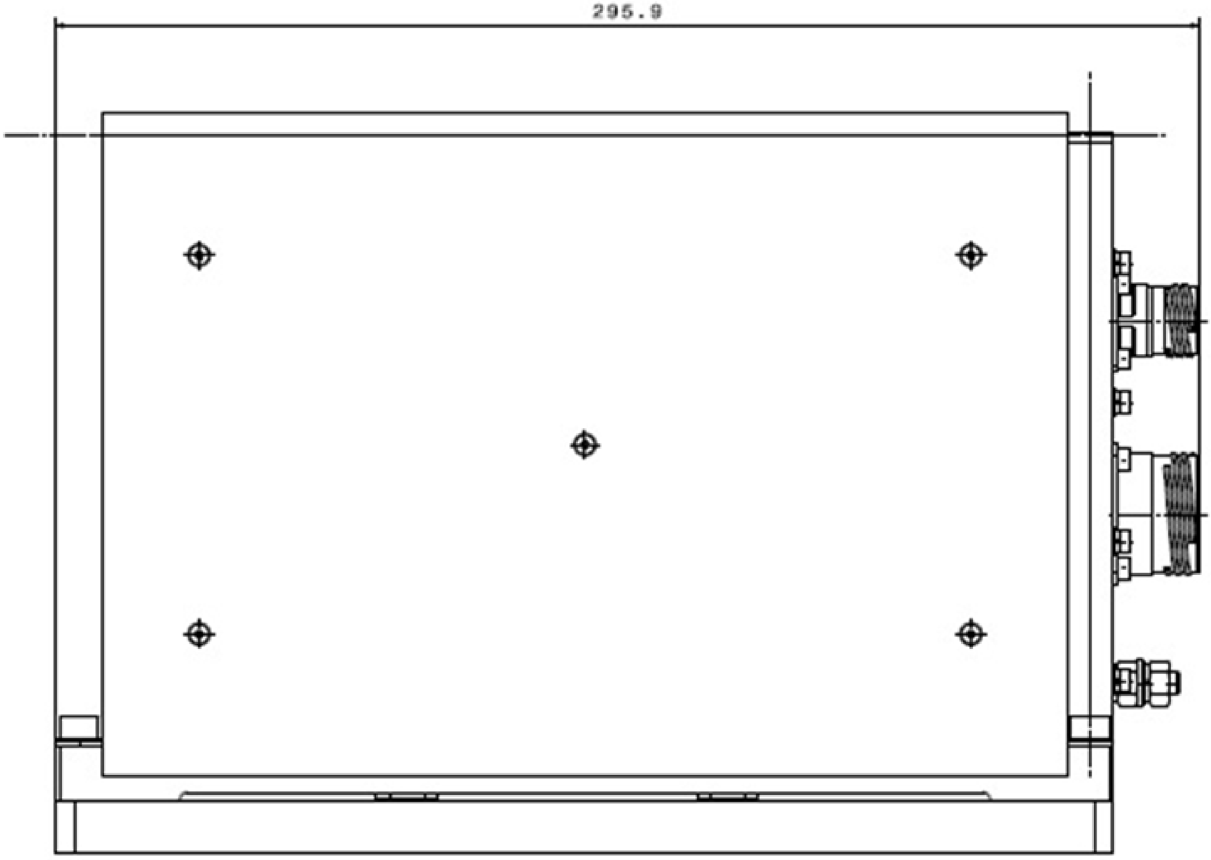

Figure 6 – Outline drawing: side view

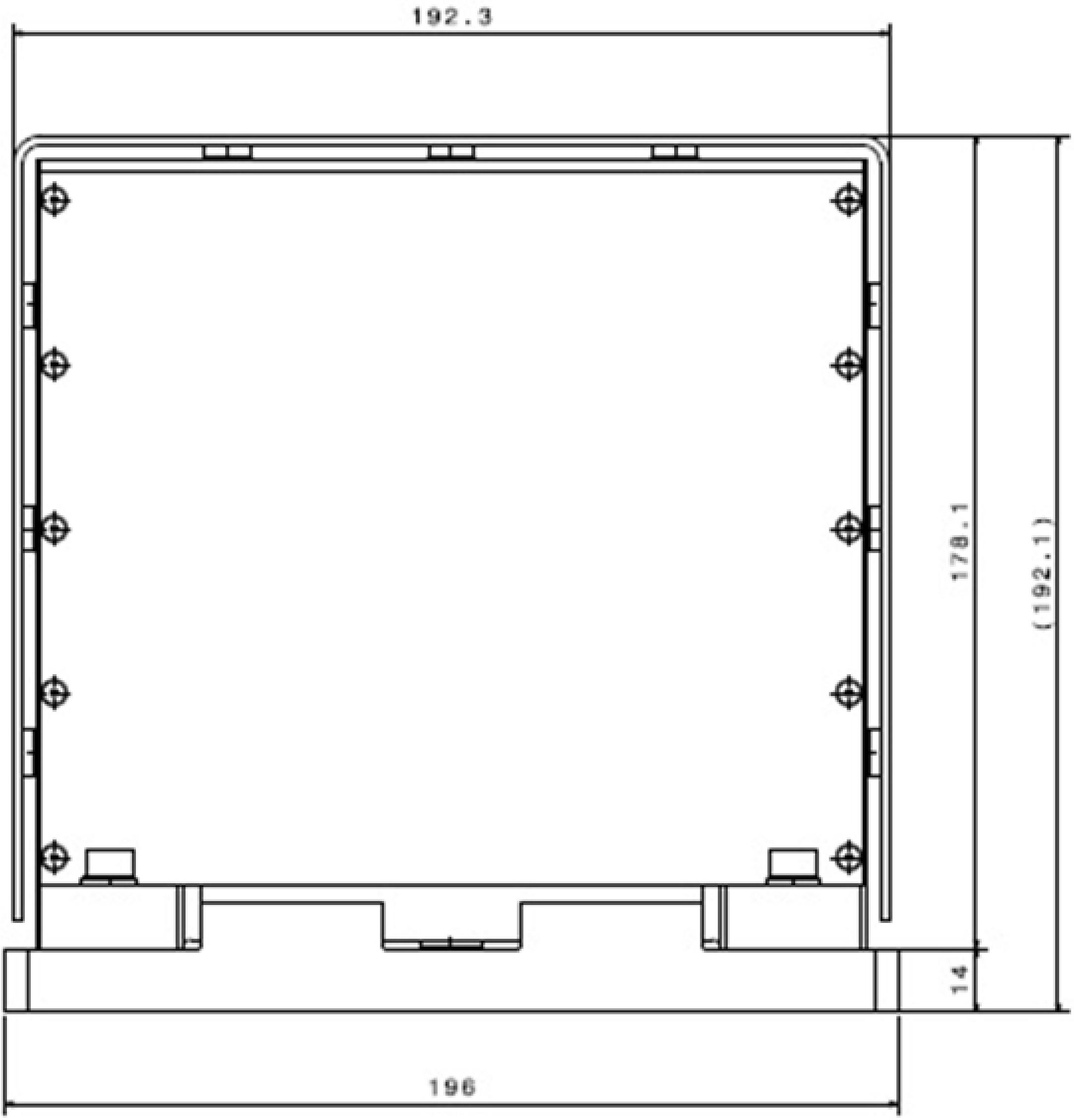

Figure 7 – Outline drawing: rear side view

5.3 Adaptor plate/Mounting Rack Reference

The adaptor plate (or Mounting rack) is a mechanical interface to be used for fixing the Inertial Navigation unit to the ship system. The Adaptor plate is used as the reference to guarantee the alignment of the INS navigator to the mounting rack and the repeatability of its mounting position.

In the following figure, the INS's Adapter Plate drawing is showed. More details in the Interface Control Document (ref. [7]).

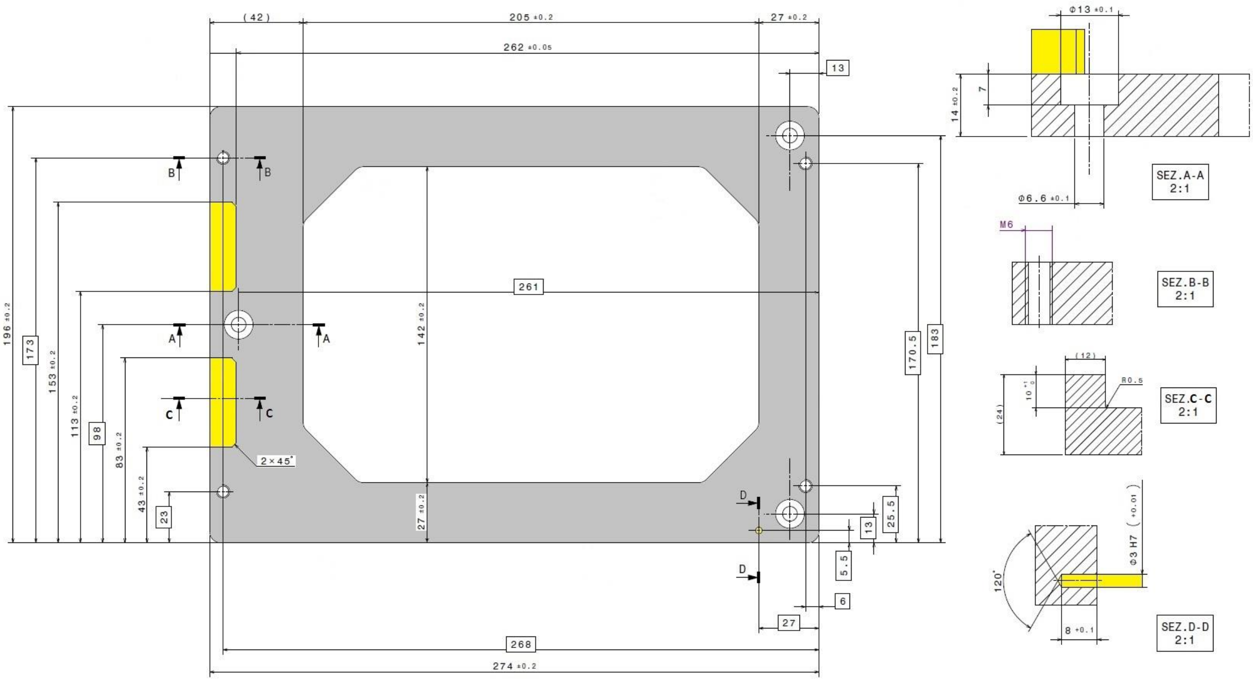

Figure 8 – Adaptor plate interface

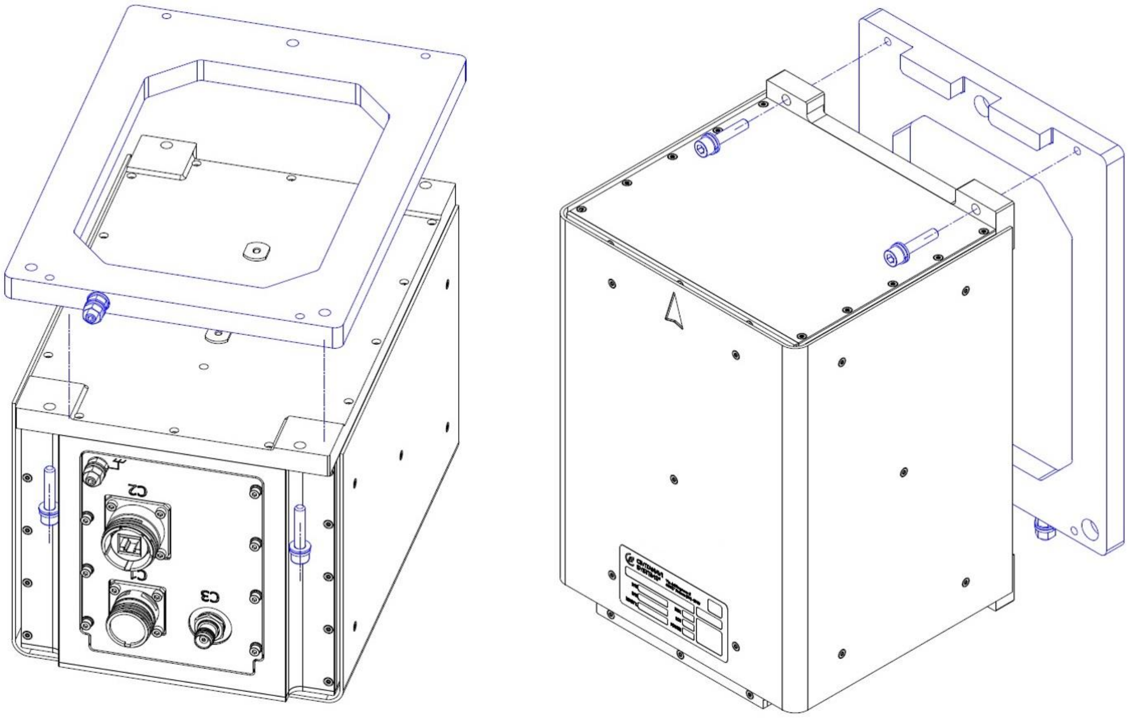

Figure 9 – Adaptor plate mounting details

5.4 GPS RF Antenna Interface

The INS GPS RF interface accepts and process GPS L1 C/A (1575.42 MHz) signal from a single GPS antenna subsystem. It is available if the embedded GPS is requested.

5.5 Connectors specification

5.5.1 C1 Connector

The C1 connector provides the system power interface and the data communication interface between the INS and the vessel via RS-422.

The CFN-15N C1 connector is a 18-pin circular, MIL-style connector type, Souriau 8D015Z18PN (Black Zinc RHOS compliant).

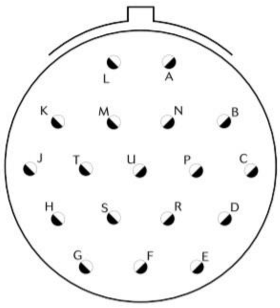

Figure 10 – Connector Souriau 8D015Z18PN

5.5.2 C2 Connector

The C2 connector provides the data communication interface between the INS and the vessel via Ethernet (UDP).

The C2 connector is an “Amphenol RJFTV22ZN00” (Black Zinc RHOS compliant).

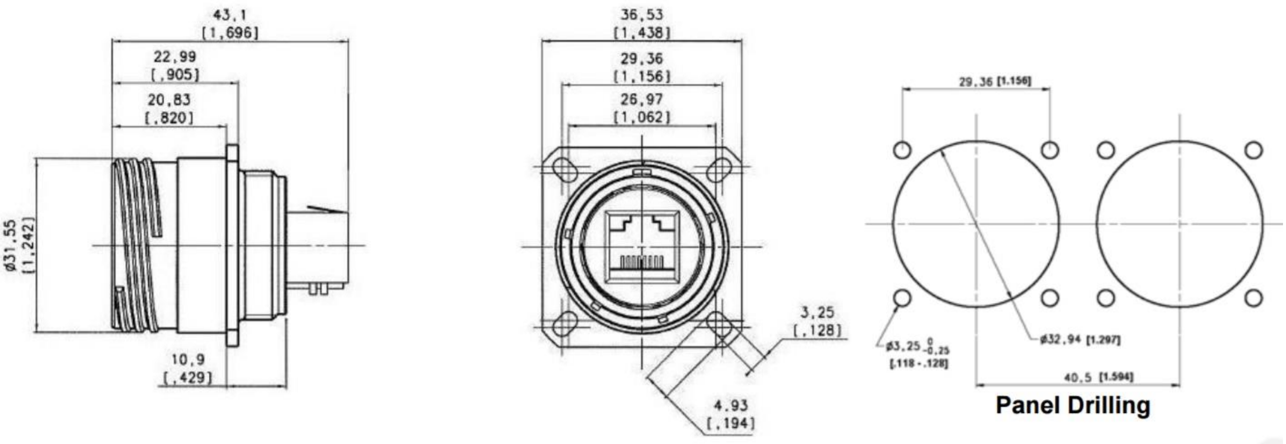

Figure 11 – Ethernet connector “Amphenol RJFTV22ZN00”

5.5.3 C3 Connector

The C3 connector is a GPS RF connector “Telegartner TNC RG178 J01011B0030”.

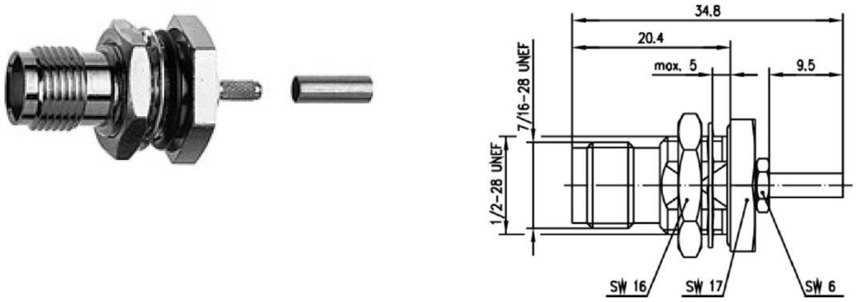

Figure 12 – RF connector “Telegartner TNC RG178 J01011B0030”

6 Environmental Characteristics

Minimum performances for the inertial systems of the CFN family are guaranteed under the environmental conditions described in the next table, according to the requirements specified in [1], [2], [3] and [6].

The following table summarizes the international standards used for the environmental test cases.

Table 5 CFN-15N Environmental Qualification summary

ENVIRONMENTAL	
Operating Temperature range	-32 to +50°C (MIL-STD-810F)
Storage Temperature range	-40 to +71°C (MIL-STD-810F)
Vibration	MIL-STD-810C, Procedure VIII
Shock	MIL-STD-810C, Method 516.2, Procedure I
Electromagnetic compatibility	MIL-STD-461E, Methods CE102, CS101, CS114, CS115, CS116, RE102, RE103
Water and Dust Resistance	IP66 (guideline CEI EN-60529)
Humidity	0 - 95% at 60°C (MIL-STD-810F)
Salt Fog	NaCl 5% @ 35°C, 96 h (48+48), MIL-STD-810F, Method 509.4
Fungus	MIL-HDBK-454, Guidelines 4, Tab. 4-1
Sand	MIL-STD-810F, Method 510.4, Procedure II.
Dust	MIL-STD-810F, Method 510.4, Procedure I.

7 System Compliance and Reliability

COMPLIANCE and RELIABILITY	
MTBF	> 45,000 hours
Material /component compliance	ROHS 2
US export controlled content	None
EU Dual Use classification	Yes