



Phins 9 Compact

Technical Description

Revision History

Edition	Date	Comments
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Phins 9 Compact Documentation

The following documents give all the information you need in order to understand and to use your product.

- > **Phins 9 Compact Technical Description** (*ref.: MU-P9CTD-AN-001*)
 - Phins 9 Compact and Exail technology presentation
 - Technical specifications
 - Certification and qualification, life cycle
 - Mechanical, electrical and communication interface description
- > **Phins 9 Compact Installation & Setup Guide** (*ref.: MU-P9CISG-AN-001*)
 - Conventions
 - Physical and electrical installation
 - Connecting to the Web-Based Graphical User Interface
 - Setup the Phins 9 Compact
 - Contacting Exail support
- > **Phins 9 Compact Operation Guide** (*ref.: MU-P9COG-AN-001*)
 - Introduction to the Inertial Navigation System
 - Start-up Phases
 - Web-Based Graphical User Interface description
 - Configuring the navigation parameters & managing the external information
 - Viewing the system information
 - Recording data
- > **Phins 9 Compact Interface Library** (*ref.: MU-P9CIIL-AN-001*)
 - NMEA frames
 - Digital input and output protocols
 - Pulses interfaces specification
 - Control commands
- > **Application Note - INS+DVL Calibration** (*ref.: MU-DVLINS-AN-001*)
 - Configuring the calibration
 - Calibrating the DVL+INS
- > **Application Note - Installation and Configuration of AHRS and INS for Seabed Mapping Measurements** (*ref.: MU-HEAVAPN-AN-001*)
 - Using heave compensation on seabed mapping
 - Effect of vehicle transient movements

Abbreviations and Acronyms

ACC	Accelerometer
FOG	Fiber Optic Gyroscope
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (operated by the United States Department of Defense)
GUI	Graphical User Interface
HRP	Heading, Roll, Pitch
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IP	Internet Protocol
LVA	Lever Arms
PPS	Pulse Per Second
SD	Standard Deviation
UTC	International acronym for Coordinated Universal Time (CUT)
UTM	Universal Transverse Mercator
ZUPT	Zero velocity UPdaTe

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1 Phins 9 Compact Description

1.1 Exail Technology

Exail Phins 9 Compact design is based on fiber-optic gyros (FOG) and quartz accelerometers.

Exail's fiber-optic gyros are the result of more than 40 years of research and development, and they address the most demanding applications with performance from 0.1 deg/h to 0.001 deg/h. All main components are designed and manufactured by Exail. This vertical integration is a key to achieve the high performances, higher quality standards and obsolescence management.

Exail technology is an interferometric closed loop FOG. It is a high end design made to reach the highest spectrum of gyroscope performances. It has demonstrated superior reliability and navigation performance over many years and thousands of units. Exail navigation systems have been chosen as the primary and secondary gyrocompass and INSs by the world's leading navies.

FOG Definition

FOG is a solid state / strap-down optical gyroscope technology based on the Sagnac effect (one of the physical effects used to create gyroscopes). A FOG is a 2-wave ring interferometer made of a multi-turn fiber coil (see Figure 1). It includes no moving parts or anything that will wear out or require any maintenance.

The Sagnac effect

The Sagnac Effect is a physical phenomenon of relativistic type. Understanding it requires a good grasp of Special Relativity. However, it is possible to provide a simplified (although representative) physical interpretation of the effect with Newtonian physics.

Let us consider a Multi-Integrated Optical Circuit (MIOC) and a coil of optical fiber (Figure 1). The light entering in the MIOC is separated in two equivalent pulses of light which propagate in opposite direction in the fiber coil.

At rest, the two pulses of light travel at the same velocity (speed of light) along the same path in opposite directions in the coil. As their optical path is equivalent, they return "in phase" at the end of the coil and no signal is measured.

When the FOG is rotating, we can consider that the exit point of light has moved during the travel of light. Thus, the pulse propagating in the opposite direction of the FOG rotation will be late, and a "phase shift" between the two pulses is measured.

FOG Description

Dedicated signal processing allows conversion of the information on optical phase, (carrying information on rotation), into a digital signal useable by a computer.

The difference of transit time is proportional to the product of the rotation rate and the area A enclosed by the coil (calculated as the diameter of the coil multiplied by the number of times the fiber is wound around the coil).

As such the FOG performance improves as FOG diameter increases and the total optical path length increases. For example, increasing the fiber length results in a longer optical path length that will translate into a larger time shift between waves for a given rotation speed. The fiber optic gyroscope (FOG) is a flexible technology that can meet diverse requirement. It has no moving parts which reduce maintenance and recalibration operations. It provides a very wide dynamic range and can tolerate extremely demanding mechanical environments without compromise to its performances.

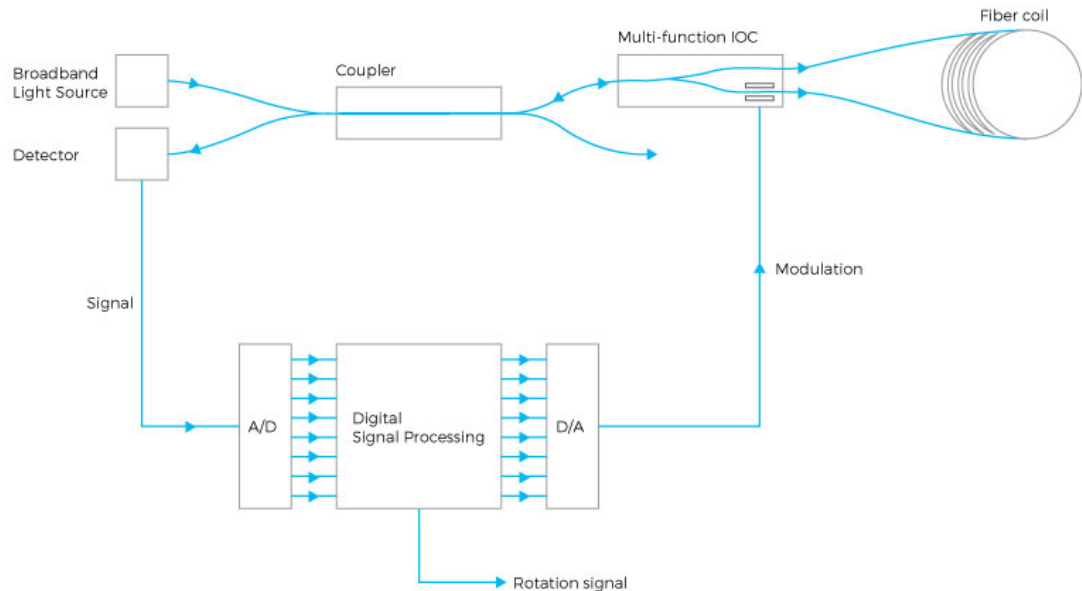


Figure 1 - Optical gyroscope technology

1.2 Phins 9 Compact Design

Phins 9 Compact is an Inertial Navigation System (INS) for OEM integration. It delivers heading and attitude information as well as position and speed, to other systems and displays. It can receive data from other sensors to improve its accuracy.

Phins 9 Compact is a state-of-the-art inertial navigation systems, designed specifically for AUV requirements - low weight and small shape - Phins 9 Compact improves the efficiency of all operations where accurate position, heading and attitude are key benefits.

Phins 9 Compact embeds in a compact design an Inertial Navigation System (INS) from Exail based on the most compact high-performance Inertial Measurement Unit (Exail UmiX IMU) . Phins 9 Compact can be integrated into all types of surface or underwater vehicles to a depth of 6,000 m to guarantee accurate and trustworthy navigation for your specific subsea navigation requirements. This combined system is tailored for highly specialized tasks, such as seabed mapping or long duration missions.



Figure 2 - Phins 9 Compact

Due to the very high precision of its IMU, Phins 9 Compact is subject to export regulations.

The Phins 9 Compact greatly simplifies the work of subsea operators in the field. The system can be easily integrated into a variety of subsea vehicles, including ROVs, AUVs and tow fishes, thanks to its unique compact design and plug-and-play feature.

The Phins 9 Compact is an ideal choice for AUV manufacturers and e-ROV operators seeking to save watts without compromising on data processing power. It operates on low power consumption and is highly resistant to high pressure and harsh environments. It can be deployed down to 6,000 meters.

Phins 9 Compact is ready for immediate deployment and will help subsea operators saving significant time and money enabling fast in-motion self-alignment and not requiring in-the-field calibration.

Phins 9 Compact and DVL

One of the most valuable external sensors for INS is a Doppler Velocity Log (DVL) that is providing consistent and reliable speed information (in bottom tracking mode). Such 3D speeds input allows a direct correction and improvement of the Phins 9 Compact speeds computation data, moreover it improves entire navigation performances thanks to the Kalman Filter able to compensate in real time and instantaneously all internal sensors bias.

Phins 9 Compact and USBL Configuration

USBL (Ultra Short Base Line) positioning system is commonly used for quick and efficient tracking tool for subsea vehicle tracking (ROV, AUV, towed body, etc...). Although USBL technology allows good performance it is subject to several native limitations in terms of robustness (tracking range limit, noisy environment, poor acoustic propagation conditions) and position refresh rate.

Phins 9 Compact ideally complements USBL thanks to its capacity to provide a stable position between each acoustic interrogation. It will maintain reliable position output during short acoustic data outages, and smooths out USBL positioning noise by at least a factor 3.

In addition to a better and stable high recurrence position Phins 9 Compact provides full attitude of the subsea vehicle (heading, pitch and roll data).

Combination of USBL + INS (or better USBL + INS + DVL) makes GNSS-like subsea positioning a reality.

Phins 9 Compact naturally interfaces with Exail acoustic positioning systems (GAPS, RAMSES) but also includes communication protocols compatible with most industry standard subsea positioning systems.

Being a fully strap down system based on gyroscopes without any moving parts, Phins 9 Compact requires no scheduled maintenance to provide the best performance during the full length of its lifetime. Its modern design integrating state of the art technologies (Ethernet, Web-Based Graphical User Interface, high baud rate ...) allows easy installation and interfacing to most standard external sensors and vehicle control systems.

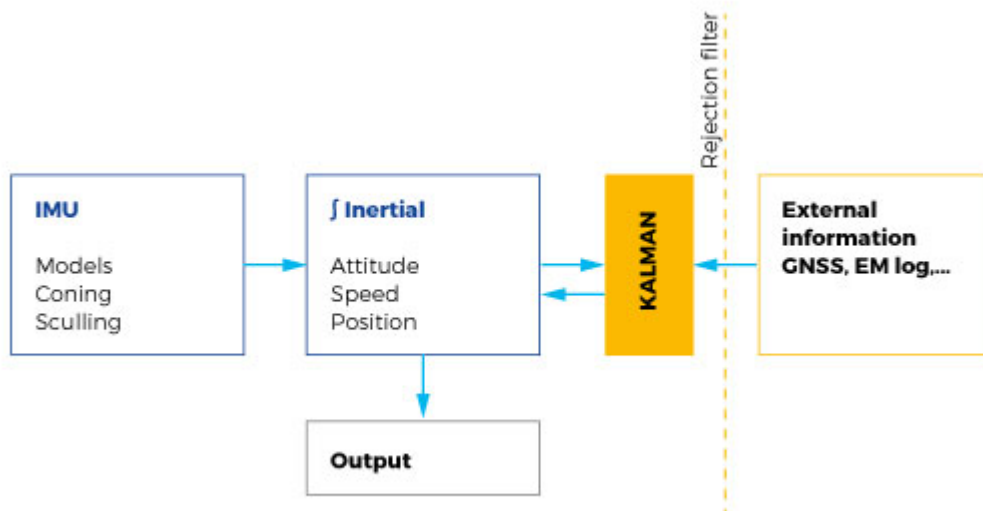
To deliver the best during operations, Phins 9 Compact is designed to:

- > Align at sea
- > Optimize the integration of most industry standard USBL/LBL/GNSS data positioning systems
- > Smooth data from USBL/LBL/GNSS
- > Reject USBL/LBL/GNSS outlier
- > Provide high output rate position and speed data
- > Maintain position, over short periods, during USBL/LBL/GNSS outages
- > Navigate using only DVL information at low update rate

- > Log raw data for post processing with DELPHINS software to quality check or improve navigation data.

Phins 9 Compact is a strap-down all in one INS that contains:

- > An IMU with 3 Fiber Optic Gyroscopes (FOGs) and 3 quartz accelerometers
- > A rejection filter
- > A Kalman filter
- > A Built In Test (BIT)
- > A real-time Digital Signal Processor (DSP) supporting the navigation software
- > An interface board that manages input and output protocol conversion
- > An embedded Web-Based Graphical User Interface (GUI)



Phins 9 Compact navigation algorithm is based on a very advanced Kalman filter that enables the unit to constantly auto calibrate, using any external information that can be provided.

Connection is available both through serial and Ethernet connections.

Phins 9 Compact can be connected to any GNSS receiver (GPS, Glonass, Galileo or other) or any other external sensor (a second Doppler Velocity Log, Depth sensor, USBL, LBL) providing position, speed and time or to work in a INS-DVL mode.

1.3 Phins 9 Compact Data Availability

Phins 9 Compact provides the subsea vehicle survey package and/or subsea vehicle control system with full navigation data:

- > Position (Latitude and Longitude)
- > Speed (North, East, Vertical Speed and ship speeds)
- > Depth and Altitude
- > Roll/Pitch and Heading
- > Polar Heading, Latitude, Longitude, Speed
- > Rate of turn and Accelerations (all three axis)
- > Heave, Surge, Sway
- > True course
- > Current speed and direction
- > Standard deviation of data
- > Built In Test Status data

The exhaustive list of output data is detailed in the Phins 9 Compact Interface Library.

Heave measurement/ Center of Gravity of the vehicle (COG)

Phins 9 Compact can output two distinct heave measurements:

- > Specific Heave which provides heave in real-time.
- > Smart HeaveTM which provides a measurement of heave with a fixed 100 s delay. In this case heave is compensated for error due to high pass filtering distortions and is more accurate.

To avoid the effect of transient subsea vehicle movement on the heave measurement, you can define the position of the center of gravity (COG) of the subsea vehicle. When this is done, Phins 9 Compact will compute heave at the COG and add the heave induced by lever arms from the COG to external monitoring points. For more details refer to Phins 9 Compact Installation & Setup Guide.

UTC/Time synchro

All data is accurately time stamped with respect to internal reference time, GNSS time or any autonomous external clock.

Phins 9 Compact internal clock can be synchronized with data coming from an external reference clock (i.e., GNSS clock or autonomous external clock). In this case, internal reference time is synchronized with the input coming from the selected interface with the appropriate protocol.

Phins 9 Compact clock can also be synchronized with NTP (network time protocol) servers. For more details on time synchronization setting, refer to Phins 9 Compact Installation & Setup Guide.

Availability of full quality check data

Phins 9 Compact provides a numeric quality checks indicator (RMS/CEP50/CEP95) for all main navigation data:

- > Speed standard deviation estimation (North, East and Vertical Speed)
- > Roll/Pitch and Heading standard deviation estimation

1.4 External Sensors

Phins 9 Compact uses external sensor data to improve its own estimates of position, speed, attitude and heading. The following external sensors can be connected to Phins 9 Compact:

- > GNSS
- > LBL
- > USBL
- > EM Log
- > DVL
- > CTD/SVP
- > Depth Sensor.

The system constantly and automatically uses the information from the external sensors when it is available and runs in full free inertial mode when no external information is available. As soon as external information is back, the system will use it. Phins 9 Compact also integrates a rejection filter that will prevent inconsistent data from being sent to the Kalman Filter.

Phins 9 Compact can be operated over serial or Ethernet through its embedded Web-Based Graphical User Interface or through a third-party system interface via a control command link.

For more details on:

- > Electrical connection of the external sensors: refer to section 4
- > The configuration of the external sensors: refer to the Phins 9 Compact Installation & Setup Guide.
- > The available input protocols for external sensors: refer to Phins 9 Compact Interface Library.

2 Technical Specification

2.1 Performance Prerequisites

The performances listed hereafter are achieved at sea under the following conditions (which complements the environmental conditions stated in section 1).

> **Subsea vehicle's motion does not exceed:**

	Amplitude	Period (sinusoidal)
Heading	$\pm 10^\circ$	10 s
Roll	$\pm 40^\circ$	9 s
Pitch	$\pm 15^\circ$	6 s

As some external sensors do not provide any quality indicator with the provided data, some hypothesis of performance have been made in the system for those sensors. This can be manually modified using the advanced filtering page, refer to Phins 9 Compact Installation & Setup Guide.

> **EM Log sensor**

Log speed accuracy: 0.5 m/s RMS (with respect to water)

Ocean current stability: 1 knot (One sigma) 3 hours correlation time

To ensure EM Log performance, it must be calibrated after installation.

Log sensor must only be used outside of harbors. During harbor maneuvers erroneous EM Log data could be sent to Phins 9 Compact, e.g., while working tug boats produce strong local currents over the EM Log sensor, and these erroneous inputs would adversely affect Phins 9 Compact performance.

> **Doppler Velocity Log (DVL) sensor:**

Performance using any other technology (i.e.: Correlation Velocity Log [CVL]) should be submitted to qualification testing to evaluate their impact on navigation performance.

For example CVL technology does not have the same performance as DVL. Navigation performance would be degraded.

EM Log can be used by selecting an extra DVL input and choosing the corresponding protocol (e.g. EM Log VBW)

2.2 Equipment Data Dynamic Range

Heading	0° to 360°
Roll	-180° to +180°
Pitch	-90° to +90°
Roll / Pitch / Heading Rate	± 750°/s
Geodetic Latitude	90° S to 90° N
Geodetic Longitude	180° E to 180° W
Altitude⁽¹⁾	Up to altitude saturation (refer to section 2.8)
Depth⁽¹⁾	Down to seabed
Speed	Up to speed saturation (refer to section 2.8)
Linear Acceleration	± 30 g

(1) Depth and altitude data are encoded a single “z” information. Depth being from surface to seabed, altitude being from surface to sky. Note: altitude from seabed is not handled by Phins 9 Compact.

2.3 External Sensors

	External Sensors
GNSS	2
DVL	2
EM Log	1
CDT/SVP	1
Depth Sensor	1
USBL	Up to 3 beacons
LBL (range meter) Sparse Array	Up to 10 simultaneous beacons
UTC	Up to 2
NTP	Up to 3 servers

2.4 Navigation Data

GPS or USBL or LBL & DVL	DVL (Bottom Track mode)	EM Log	No aiding
Position (Latitude and Longitude) accuracy			
2 to 3 times better than aiding sensor	0.1 % (CEP50) of distance traveled in a straight line 0.02 % (CEP50) of distance traveled on survey pattern	2 Nm/8 h (TRMS)	0.2 m after 1 min (CEP50) 0.6 m after 2 min (CEP50)
Speed (North and East) accuracy			
0.01 knot (RMS)		0.1 knot (RMS)	1 knot (RMS)
Heading accuracy			
0.04 deg secant latitude RMS	0.07° seclat (RMS)		
Attitude (Roll and Pitch) accuracy			
		0.01° (RMS)	

With or without aiding:

Dynamic stability⁽¹⁾

Heading rate accuracy	0,001°/s RMS
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Roll rate accuracy	0.001°/s RMS
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Pitch rate accuracy	0.001°/s RMS
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Heave Surge Sway

Heave ⁽²⁾	5 cm or 5% of movement full amplitude
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Smart Heave™ ⁽³⁾	2.5 cm or 2.5% of movement full amplitude
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Surge and Sway ⁽⁴⁾	5 cm or 5% of movement full amplitude
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⁽¹⁾ According to the dynamics stated in the prerequisites in section 1.

⁽²⁾ Whichever is higher for wave periods up to 25 s.

⁽³⁾ Whichever is higher for wave periods up to 30 s.

⁽⁴⁾ Whichever is higher for wave periods up to 15 s.

2.5 Input / Output

Baud rate	600 bauds to 921 kbauds
Data output rate	0.1 Hz to 200 Hz
Data input rate	Up to 5 Hz (1 Hz recommended)
Time stamping accuracy	< 100 µs
Embedded Datalogger	8 GBytes

(1) 200 Hz update rate for attitude data (Heading, roll, pitch, surge, sway).

Update rate for position is performed at 100 Hz.

	Serial (All)	Ethernet 1	Ethernet 2	Ethernet 3	Ethernet 4	Ethernet 5
Jitter	< 200 µs	< 400 µs		< 800 µs		
Fixed Latency	2.35 ms	2.95 ms	3.45 ms	3.95 ms	4.45 ms	4.95 ms
	Input	Output	Configuration & Repeater			
Serial RS232 or RS422	6	5		1		
Ethernet⁽²⁾	7	5		1		
Max (Serial & Ethernet)	7	5		1		
Pulse Port	2	2		-		

Ethernet⁽²⁾	UDP (Unicast, multicast and broadcast)/ TCP client / TCP server (10 / 100 Mbits)
Pulse port	5 V (TTL level)
Input / output formats	Industry standards: NMEA 0183, ASCII, BINARY

(2) All inputs and outputs are available on the Ethernet link. Output can be duplicated both on serial and Ethernet port.

2.6 IMU Performances

	FOG	ACC
Noise	0.01 °/√Hz	15 µg/√Hz @ 1Hz
Bias instability	0.01 °/h 1σ	10 µg
Scale Factor	50 ppm 1σ	40 ppm 1σ
Bandwidth	5 kHz	500 Hz
Input Range	± 490 °/s	± 30 g
IMU baudrate	4 MHz max	
IMU datarate	10 kHz max	
IMU Latency	300 µs @ 10 kHz	

2.7 Power Supply

Power supply / consumption	24 V _{DC} (20 to 32 V) / < 12 W ⁽¹⁾
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⁽¹⁾ Typical value @ 24 V and ambient temperature.

2.8 Export Limitations

	Limitations
Rotation rate resolution	3.6°/h
Acceleration resolution	1 mg
Heading, Roll, Pitch resolution	0.001°
Speed saturation	150 km/h / 80 knots
Altitude saturation	4,000 m
Acceleration saturation	30 g
Rotation rate saturation	750°/s

2.9 Settling Time

Important

To achieve the highest performance, during the alignment procedure, it is recommended that the systems generating stationary magnetic fields be put into operation before starting the Phins 9 Compact and left running as long as it is operational. High magnetic fields can temporarily disturb the Phins 9 Compact. The Kalman filter used in the Phins 9 Compact constantly estimates the bias of the sensors produced by this magnetic field. If this interference is stationary, the unit can compensate for the presence of this field.

Power Up

Power up is automatic, as soon as power is applied to the system.

Restart or Power Down

Equipment can be restarted either through the embedded Web-Based Graphical User Interface, in the maintenance menu or by sending a re-start command.

To power down the equipment, you need to disconnect it from its power source.

Initialization:

The system must be initialized before it will provide fully accurate information. This initialization is performed using external sensor data, during several phases.

Alignment Phases

> Coarse Alignment

The data are computed by the Phins 9 Compact but are not yet valid.

Coarse alignment will finish when heading standard deviation gets lower than 1° seclat.

> Heave initialization

During the heave filter initialization phase, the heave, surge and sway outputs have not reached full accuracy. Once the heave filter completes its initialization, it will accurately measure any variations of Phins 9 Compact positions in the three directions (heave, surge and sway).

> Fine Alignment

After the coarse alignment phase, Phins 9 Compact is ready for navigation. The performance of the system has not been reached, but all the data are valid.

Fine alignment phase completes when heading standard deviation gets below 0.1° seclat.

> Optimal alignment

Optimal alignment means that the system is reaching the specified heading performance.

When optimal alignment is completed, the system is ready and gives all the data with full performance.

> System ready

The legacy System ready flag is raised when heading standard deviation gets below 0.04° seclat. The system is ready to operate with full performance.

For more information about the alignment phases, refer to Phins 9 Compact Operation Guide.

2.10 Qualifications

Electromagnetic compatibility

CEM NF EN 60945 2003

Immersion

NF X10812 Juin 2013 Class B

Magnetic Field

Operating	1 Gauss
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2.11 Life Cycle

2.11.1 PACKAGING, HANDLING, STORAGE, TRANSPORTATION REQUIREMENTS

During storage and transportation, Phins 9 Compact should be kept locked in its transportation case, it shall have its protective caps installed on its connectors.

2.11.2 AUTO-CALIBRATION

At each start up, and continuously while aided, Phins 9 Compact is calibrating its internal gyrometer and accelerometer sensors using aiding sensors information and its advanced Kalman Filter. Therefore, there is no need to recalibrate the system periodically.

2.11.3 BUILT-IN-TEST

Phins 9 Compact includes a Continuous Built-In Test (CBIT) that covers internal sensor status verification, system status and algorithm status. The Interface Library document details the complete list of parameters that are monitored. Refer to Phins 9 Compact Interface Library for further detail.

2.11.4 RELIABILITY & MAINTAINABILITY

Due to the technology used in its design, Phins 9 Compact is a fully strap-down / solid-state piece of equipment. It does not use any gas filled cavity that could leak nor any moving mechanical part that would wear out. Consequently, Phins 9 Compact requires no scheduled maintenance.

Phins 9 Compact does not have any life limited parts and as such, it has no predicted life limitation.

The entire Phins 9 Compact is a Line Replacement Unit (LRU).

MTBF

- > 100,000 hours (System observed)
- > 500,000 hours (FOG + Accelerometers)

End-of-life product management

When the product reaches the end of its life, it must be returned to Exail where it will be sent to a treatment facility meeting the requirements of the directive on Waste Electrical and Electronic Equipment (WEEE).

3 Mechanical Description

3.1 Presentation And Overall Dimensions

Dimensions (Ø x H)	96 x 138 mm
Weight in air	1.2 kg
Construction	Aluminium
Mounting (Ø in mm)	Top: 3 bore holes M4 Bottom: 6 blind holes M4
Connector	69 pins micro D standard

3.2 Mechanical Alignment

The Phins 9 Compact is designed with a ruler which allows the mechanical alignment through five holes for alignment of Phins 9 Compact axis X1 with a reference direction.

The accuracy of this mechanical alignment is ± 0.01 degree. The adaptation plate should be designed with two pins $\phi 6$ g6 maximum height is 6 mm and with a flatness better than 0.05 mm on the fixing area.

For mechanical and installation recommendations, refer to Phins 9 Compact Installation & Setup Guide.

3.3 Reference Frame Center

All data is calculated at the Phins 9 Compact reference frame center 'P point'. This is the reference point from which all of the external sensor lever arms must be measured. This point is also the reference frame center for the intersection of the three-reference axis X1, X2 and X3. The Phins 9 Compact reference frame center is:

- > the sensing point of all product measurements
- > to be used as a reference point to the determination of Phins 9 Compact and external sensor lever arms.

The reference frame center is shown as the IMU measurement center point in figure next page, the measures are in mm.



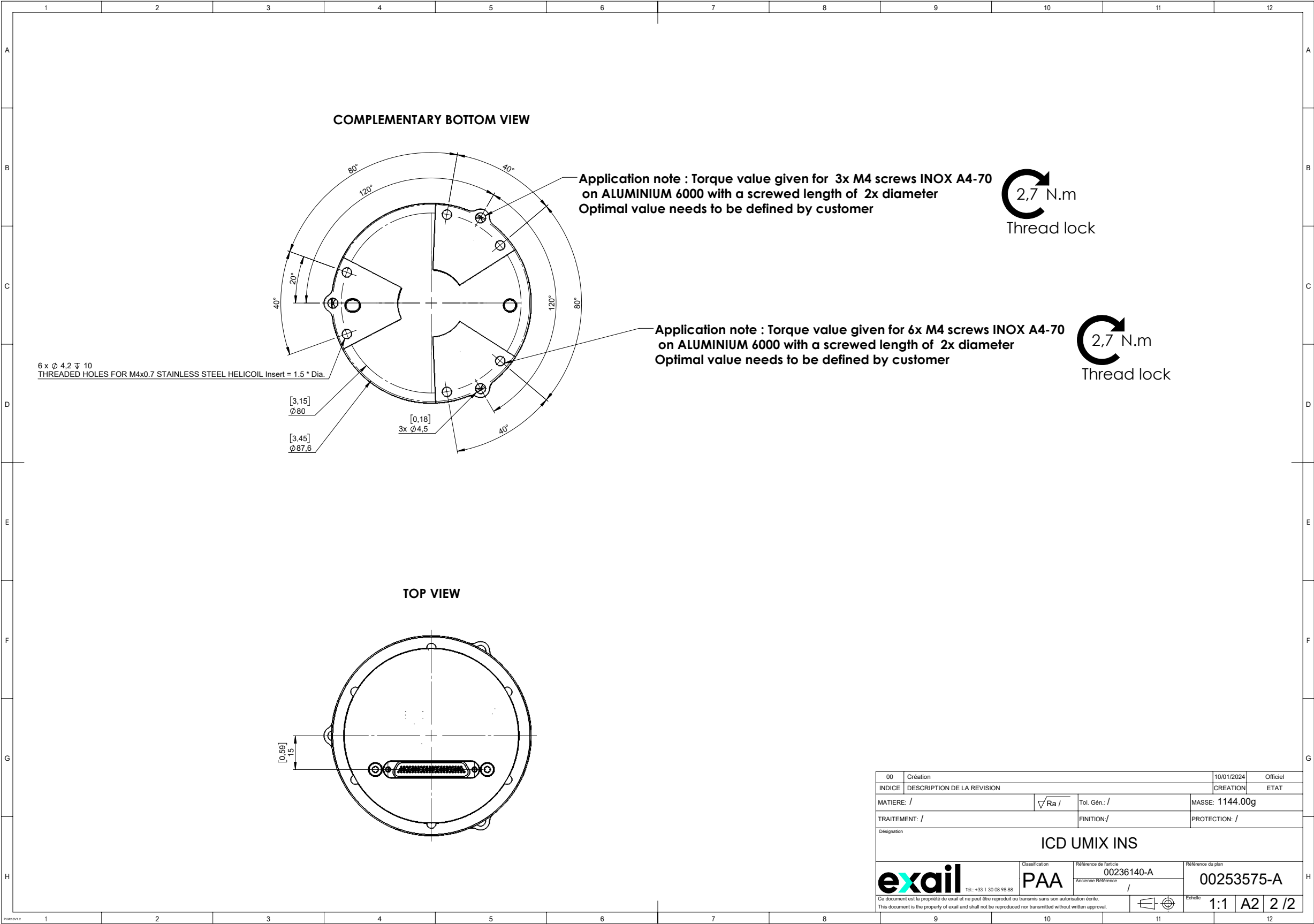


Figure 4 - Phins 9 Compact front and bottom view

4 Electrical Interface Description

4.1 Overview Of Phins 9 Compact Electrical Interface

One connector, a 69 pins micro D standard, is available on the front panel of Phins 9 Compact.

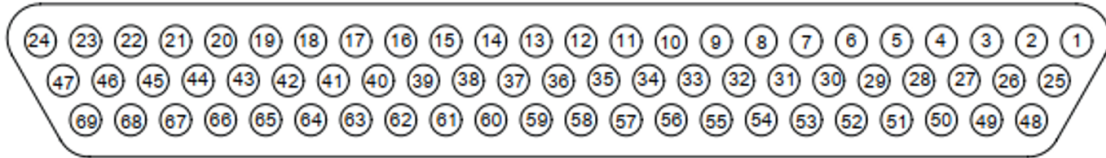


Figure 5 - Phins 9 Compact connector face

4.2 Main Connector

The Phins 9 Compact connector provides the following inputs and outputs:

- > 1 repeater serial port in RS232 or RS422 used to monitor system state and send configuration commands in serial mode.
- > 5 user-configurable serial input (RX). Pin assignment in RS232 or RS422 electrical levels is detailed in Table 1. Only one serial input in RS422.
- > 5 user-configurable serial output (TX). Pin assignment in RS232 or RS422 electrical levels is detailed in Table 1.
- > 1 Ethernet port
- > 1 TTL input pulse user-configurable, usually used to send PPS synchronization.
- > 1 TTL output pulse user-configurable.
- > System power supply (+24 VDC)



Power source shall be stable and filtered (use of UPS is recommended when possible).

RS232/RS422 ports have to be wired with twisted shielded pairs.
Refer to section 1 for wiring recommendations.

Main connector pinout table:

Function	Pin Number	Name	I/O	Comments
POWER SUPPLY	2	24V_POWER_IN	I	24 V nominal. [9 – 36] V range.
	4	24V_POWER_IN	I	
	1	GND_POWER_IN	I	Power supply GND is not directly connected to system GND.
	3	GND_POWER_IN	I	
	67	MECHANICAL_GND	-	
ETHERNET	23	DA_P	IO	
	24	DA_N	IO	
	47	DB_P	IO	
	46	DB_N	IO	
	69	DC_P	IO	
	68	DC_N	IO	
	66	DD_P	IO	
	65	DD_N	IO	
SERIAL 1	42	SERIAL_1_RX+ / RS 232 Rx	I	Serial port 1 can be configured RS232/RS422. Repeater / configuration port.
	41	SERIAL_1_RX-	I	
	40	SERIAL_1_TX+	O	
	16	SERIAL_1_TX- / RS 232 Tx	O	
	17	GND	-	
PULSE IN 1	64	PULSE_IN_1	I	TTL level (+5 V).
	63	GND	-	
PULSE OUT 1	15	PULSE_OUT_1	O	TTL level (+5 V).
	39	GND	-	

Function	Pin Number	Name	I/O	Comments
SERIAL 2	62	SERIAL_2_RX+ / RS 232 Rx	I	Serial port 2 can be configured RS232/RS422. Port A.
	61	SERIAL_2_RX-	I	
	60	SERIAL_2_TX+	O	
	59	SERIAL_2_TX- / RS 232 Tx	O	
	58	GND	-	
PULSE IN 2	14	PULSE_IN_2	I	TTL level (+5 V).
	13	GND	-	
PULSE OUT 2	38	PULSE_OUT_2	O	TTL level (+5 V).
	37	GND	-	
SERIAL 3	10	SERIAL_3_RX+ / RS 232 Rx	I	Serial port 3 can be configured RS232/RS422. Port B.
	11	SERIAL_3_RX-	I	
	12	SERIAL_3_TX+	O	
	36	SERIAL_3_TX- / RS 232 Tx	O	
	35	GND	-	
PULSE IN 3	57	PULSE_IN_3	I	TTL level (+5 V).
	34	GND	-	
PULSE OUT 3	55	PULSE_OUT_3	O	TTL level (+5 V).
	56	GND	-	
SERIAL 4	33	SERIAL_4_RX+	I	Serial port 4 is RS232 only. Port C.
	31	SERIAL_4_TX+	O	
	9	GND	-	
PULSE IN 4	32	PULSE_IN_4	I	TTL level (+5 V).
	6	GND	-	
PULSE OUT 4	8	PULSE_OUT_4	O	TTL level (+5 V).
	7	GND	-	

Function	Pin Number	Name	I/O	Comments
SERIAL 5	54	SERIAL_5_RX+	I	Serial port 5 is RS232 only. Port D.
	53	SERIAL_5_TX+	O	
	52	GND	-	
SERIAL 6	29	SERIAL_6_RX+	I	Serial port 6 is RS232 only. Port E.
	30	SERIAL_6_TX+	O	
	28	GND	-	
DMI	51	DMI_A+	I	Differential odometer
	49	DMI_A-	I	
	48	DMI_B+	I	
	26	DMI_B-	I	
	50	GND	-	
	5	+5V_DMI	O	DMI power is limited to 1 W. Only one voltage output to be used at a time.
	25	+24V_DMI	O	
	27	GND	-	
CAN	44	CAN_L	IO	CAN BUS.
	45	CAN_H	IO	
	43	GND	-	
RESERVED	21	RESERVED	-	Do not connect.
	20	RESERVED	-	
	18	RESERVED	-	
	19	RESERVED	-	
RESERVED	22	RESERVED	-	Do not connect.

4.3 Recommended Wiring

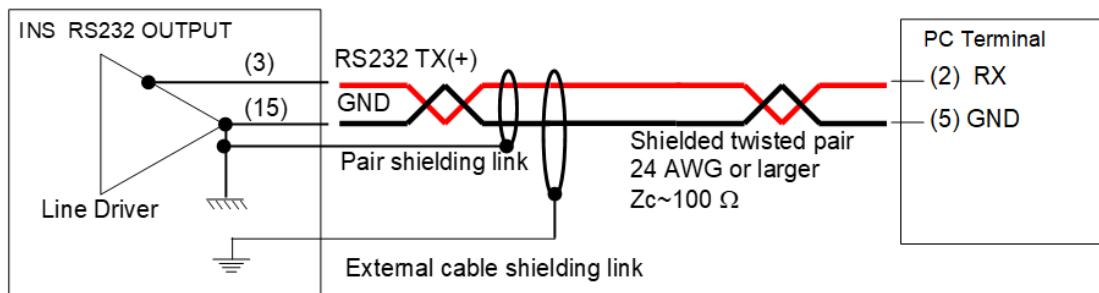
The recommended wiring with Shielded Twisted Pairs for RS232 (Output and Input), and Pulse (Output and Input) cables are described hereafter. According to the protocol, the maximum cable length must not exceed (see the following table):

Table 1 - Maximum cable length

	RS 232		RS422		Ethernet
Max data rate	20 kb/s	10 Mb/s	1 Mb/s	100 kb/s	-
Max cable length	15 m (~50 ft)	12 m (~40 ft)	120 m (~400 ft)	1,200 m (~4 000 ft)	100 m (~325 ft)

Important

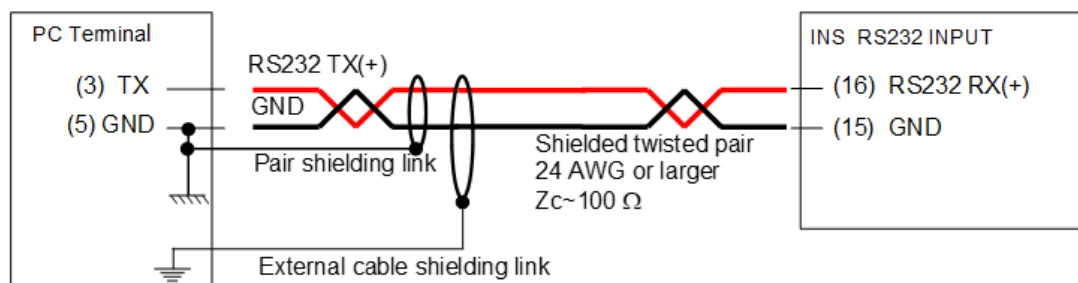
Shielded multi-twisted pairs must be used to avoid cross-talk problems between input and output, and this may give error or dysfunction. Shield link should be done at one end only to avoid ground loops unless shield is used as an electrical ground.



⏏ All pins marked GND are common electrical ground and can be used indifferently.

⏏ Mechanical GND connection is recommended through connector backshell on digital connector.

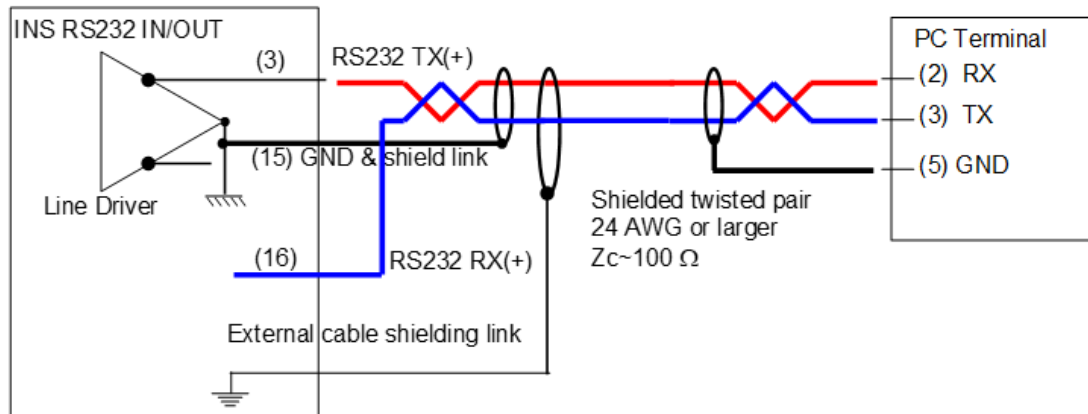
Figure 6 - Description of mono-directional RS232 Output wiring (Port A example)



⏏ All pins marked GND are common electrical ground and can be used indifferently.

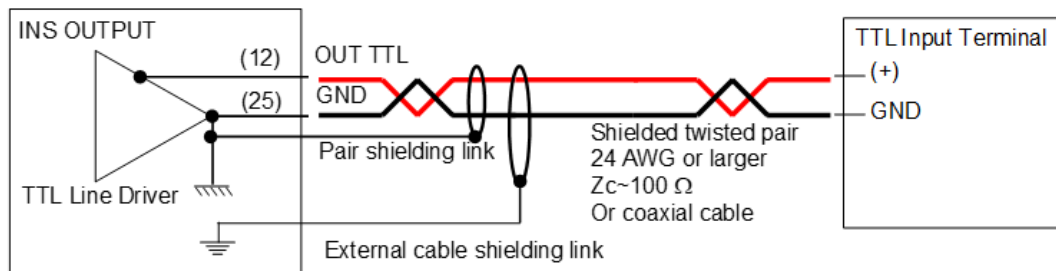
⏏ Mechanical GND connection is recommended through connector backshell on digital connector.

Figure 7 - Description of mono-directional RS232 Input wiring (Port A example)



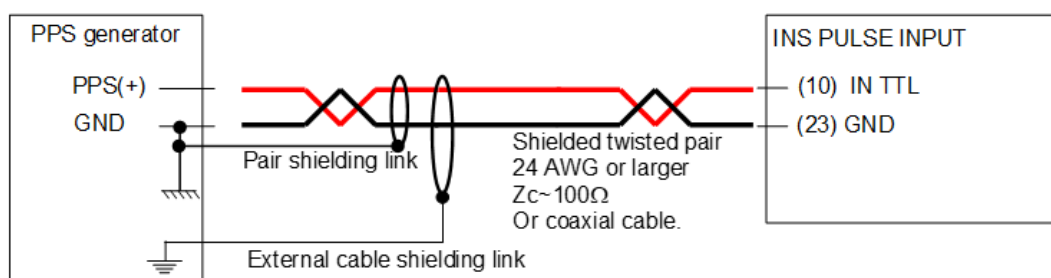
- ⏏ All pins marked GND are common electrical ground and can be used indifferently.
- ⏏ Mechanical GND connection is recommended through connector backshell on digital connector.

Figure 8 - Description of bi-directional RS232 Output wiring (Port A example)



- ⏏ All pins marked GND are common electrical ground and can be used indifferently.
- ⏏ Mechanical GND connection is recommended through connector backshell on digital connector.

Figure 9 - Description of the Pulse Output wiring with a Shielded Twisted Pair (Pulse A example)



- ⏏ All pins marked GND are common electrical ground and can be used indifferently.
- ⏏ Mechanical GND connection is recommended through connector backshell on digital connector.

Figure 10 - Description of the Pulse Input wiring with a Shielded Twisted Pair (Port A example)

4.4 RS232/RS422 Input And Output Characteristics

Each RS232 and RS422 input and output is based on a separate MAX3160 driver powered by its own DC/DC converter and isolated from each other and from the internal digital power by an ISO7220AD isolator.

The following table details input impedance of each port and voltage requirements for each port:

Table 2 - RS232/RS422 Input characteristics

	RS232	RS422
Input impedance	5 k Ω	48k Ω
Minimum input LOW threshold	0.8 V	N/A
Maximum input HIGH threshold	2.4 V	N/A
Minimum differential threshold	N/A	200 mV

The following table details output impedance of each port and maximal output current that can be delivered by each port driver.

Table 3 - RS232/RS422 Output characteristics

	RS232	RS422
Output impedance	100 Ω	40 Ω
Max. output drive current	110 mA	260 mA
Output voltage (no load)	± 11 V	10.4 V differential
Output voltage (loaded)	10.8 V (3 k Ω)	7.5 V differential (100 Ω)

4.5 Input Pulses Electrical Characteristics

Following table details input pulse characteristics:

Table 4 - Input Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Input pulse width	TW	1	-	μs
Low to High transition voltage	VLH	2	-	V
High to Low transition voltage	VHL	-	0.8	V
Input voltage	VIN	- 0.5	5.5	V
Input current	IIN	- 10	10	μA
Pulse internal latency	TL	-	10	μs

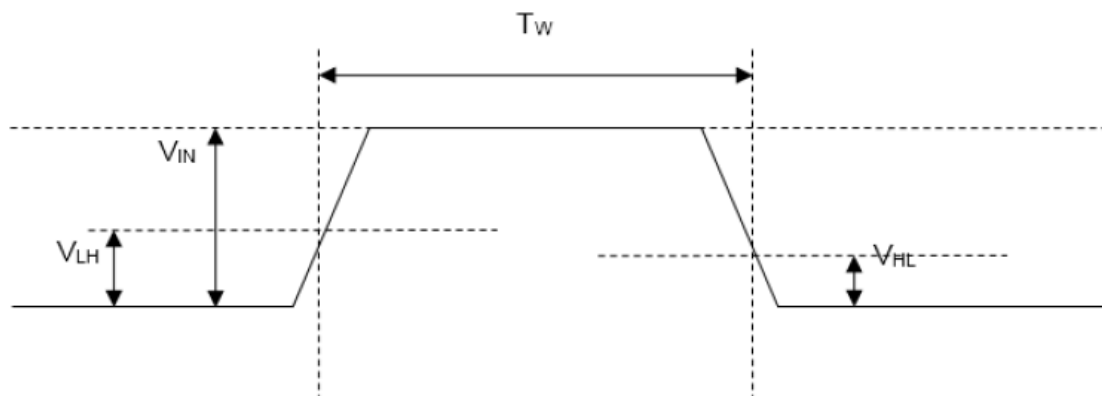


Figure 11 - Input Pulse Diagram

4.6 Output Pulses Electrical Characteristics

Following table details output pulse characteristics:

Table 5 - Output Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Output voltage at logic low	VL	0	0.4	V
Output voltage at logic high	VH	4.8	5	V
Output current	IOUT	-	4	mA

5 Communication Interface Description

5.1 Communication Link

Phins 9 Compact is able to receive and transmit data through 5 configurable asynchronous serial communication lines (digital I/O):

- > Baud rates, parity and number of stop bits can be configured independently for each of the 5 serial links
- > Electrical level (RS-232 or RS-422) can be configured independently for each of the 5 serial links

Phins 9 Compact is able to receive and transmit data through a 10/100 Mbits/s Ethernet link:

- > TCP/IP and UDP protocols are available
- > 7 input / 5 output virtual ports can be opened simultaneously

The output frequency can be selected as presented in the Interface Library document.

In default configuration, access to the Web-Based Graphical User Interface is only possible through the Ethernet connector.

On RSXX2 serial link, the Installation and Repeater output has to be configured in PPP mode to have access to the Web-Based Graphical User Interface (refer to Phins 9 Compact Installation & Setup Guide for more details).

For the Ethernet link, the following parameters are defined by default:

- > IP Address: 192.168.36.1xx, xx being the last two numbers of the Phins 9 Compact serial number
- > Connection through http web server (port 80)
- > Repeater flow available in TCP (port 8110)

By default, serial repeater link is configured as follows:

- > Protocol used: PHINS Standard, refer to Phins 9 Compact Interface Library for a description of PHINS Standard data frame output
- > Baudrate: 57.6 kBauds
- > Flow Control: Odd, 2 stop bits
- > Refresh rate: 5 Hz (200 ms)

5.2 Software Interfaces And Library

Input and output digital interfaces are user-configurable with a comprehensive set of protocols (or formats) to be selected from the digital interface library.

Digital protocols in binary format and NMEA compliant ASCII format are available for input and output data.

To get details on protocols, please refer to Phins 9 Compact Interface Library.

System configuration and operation can be performed either through the Web-Based Graphical User Interface (refer to Phins 9 Compact Installation & Setup Guide) or with text control command (refer to Phins 9 Compact Interface Library).

5.3 Web-Based Graphical User Interface

Phins 9 Compact is delivered with Exail established Web-Based Graphical User Interface. It runs either on a workstation or on a laptop and allows system configuration.

The embedded Web-Based Graphical User Interface has been optimized and qualified with computer running Windows 10 and Windows 11 operating systems.

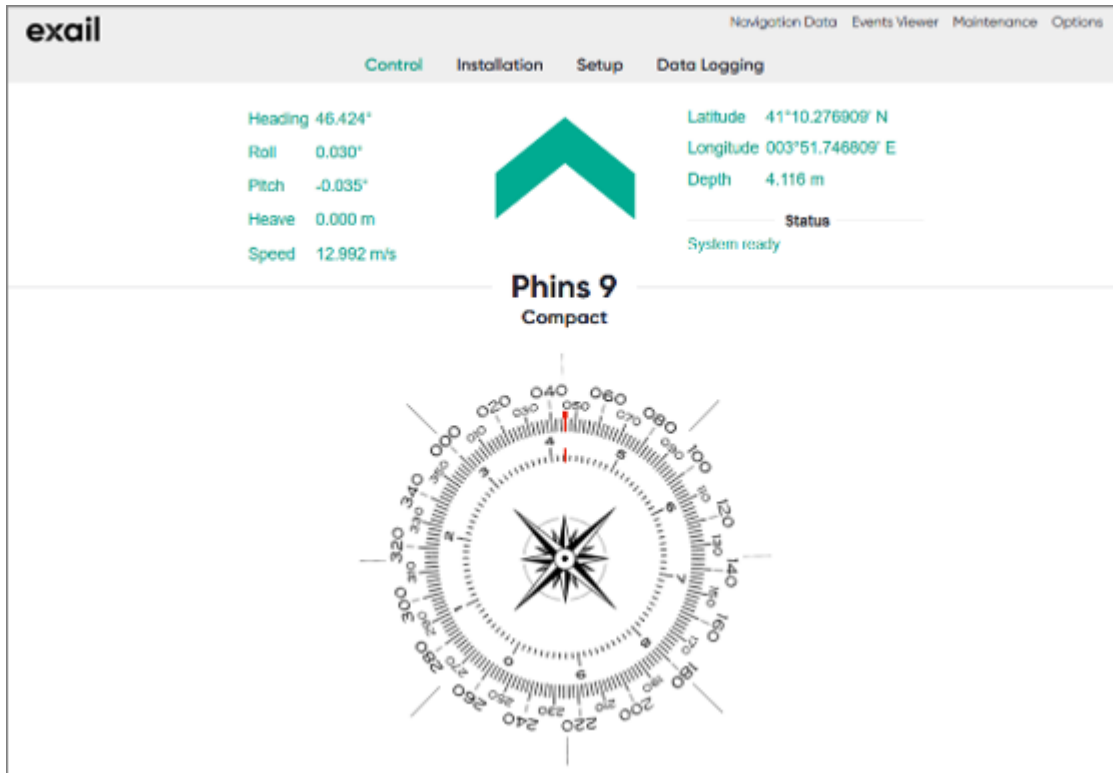


Figure 12 - Phins 9 Compact Web-based Graphical User Interface

5.4 Control Command

The control commands give access to the following features:

- > Installation
 - Misalignment configuration
 - Level arms configuration
 - Communication link configuration (physical parameter and software parameters)
 - External sensor configuration
- > Operation
 - Software reset
 - Manual position fix
 - Software activation / deactivation of external sensor
 - Data display (including all navigation and quality check data)
 - Data logging



Refer to Phins 9 Compact Interface Library to get details on the control commands.

Exail CONTACT - SUPPORT

For non-URGENT support:

- > by email: support@exail.com
- > using the form on the iXblue web site www.ixblue.com

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