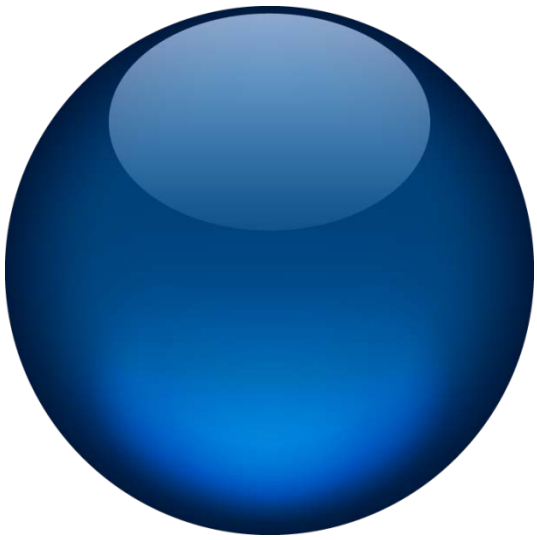

HYDRINS

Product Specification

iXblue
DEEP INSIGHT. SHARPER SENSES.

Document Revision History

Edition	Date	Comments
A	02/2016	Creation

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1 INTRODUCTION

This document contains the HYDRINS product specifications.

It provides information on the HYDRINS performance, environmental and dynamic conditions of use.

The HYDRINS is an **Inertial Navigation System (INS)**. 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.

System Design

The HYDRINS is a state-of-the-art naval inertial navigation systems (INS), designed to meet the demands of the navy for high performance INS.

The HYDRINS enables stealth autonomous navigation for surface or subsea applications, providing very accurate heading, roll, pitch, speed and position. These products also uniquely address the navigation needs of advanced naval surface vessels, operating in severe GNSS-denied environments.

The HYDRINS is based on iXBlue fiber-optic gyroscope (FOG) technology, which has demonstrated superior reliability and navigation performance over many years and thousands of units. iXBlue navigation systems have been chosen as the primary and secondary gyrocompas and INSs by the world's leading navies.

Figure 1: HYDRINS

Due to the very high precision of its IMU, HYDRINS is subject to **export regulations.** See *General Information* document *(Ref.: MU-INS&AHRS-AN-007)* and *INS Interface Library (Ref.: MU-INSIII-AN-001*) for details.

HYDRINS contains a navigation algorithm based on a very advanced Kalman filter.

This structure enables HYDRINS to be connected to GNSS (GPS, Glonass, Galileo or other) or to work in a pure inertial mode (see document *Inertial Products: Principle & Conventions (Ref.: MU-INS&AHRS-AN-003)* for an overview of HYDRINS technology).

iXBlue's fiber-optic gyros are the result of more than 30 years of research and development, and they address the most demanding applications with performance from 0.1 deg/h to 0.001 deg/h.

Because of iXBlue's full in house mastery of all key FOG components (optical fiber, coil winding, modulator and source) along with advanced modeling of potential environmental sensitivity, iXBlue fiber-gyros are immune to temperature changes and magnetic perturbations and also resilient to extreme shocks and vibration.

iXBlue has delivered more than 10,000 high performance gyroscopes.

iXBlue FOG solutions have been selected by more than 30 navies, for a full range of vessels from attack craft to aircraft carrier or nuclear submarines.

Being a fully strap down system based on gyroscopes without any moving parts, HYDRINS 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 MMI, high baud rate, …) allows easy installation and interfacing to any ship's navigation and/or weapon system.

To deliver the best during operations, HYDRINS is designed to:

- Align at quay and also at sea
- Auto-calibrate its internal sensors during navigation
- Integrate data from GNSS when available and reject inconsistent data

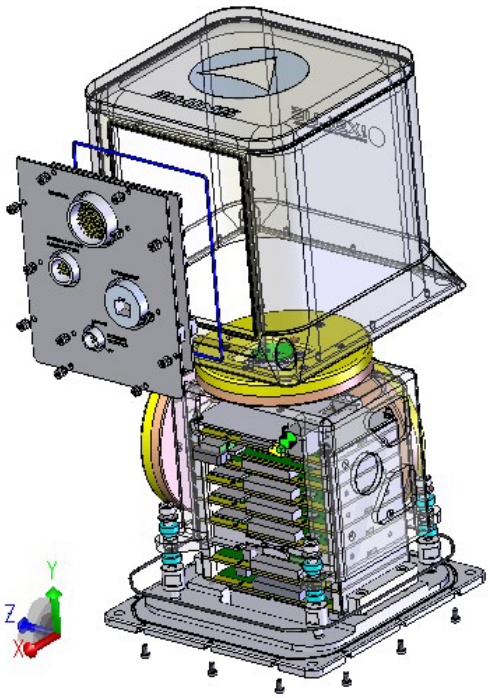

Figure 2: HYDRINS Inertial Navigation System (INS)

2 PRODUCT DOCUMENTATION

HYDRINS belongs to the iXBlue inertial products family. The following documents provide information that will be helpful in using your product in the best possible manner:

- The **HYDRINS Product Specifications** *(Ref.: MU–HYDRINS–AN–012)* provides information about:
  - Product performance and settling time
  - Qualification standards and classification
  - Life cycle maintenance

- **HYDRINS Interface Control Document** *(Ref.: MU–HYDRINS–AN–013)* provides information about:
  - General interface specifications
  - Mechanical specifications
  - Electrical interface specifications

- **Inertial Products – General Information** *(Ref.: MU-INS&AHRS-AN-007)* provides information about:
  - Export Regulations
  - Warranty
  - Customer Support and iXBlue contacts

- **Inertial Products – Principles & Conventions** *(Ref.: MU-INS&AHRS-AN-003)* provides information about:
  - Abbreviations
  - Terminology
  - Behavior and operational principles
  - Geometrical conventions

- **Inertial Products – Installation Form** *(Ref.: MU-INS&AHRS-AN-004)**:*** this document is a link between the installation process and the configuration process. It contains blank tables to be filled in.

- **Inertial Products – Network Set-up Guide** (*Ref.: MU-INS&AHRS-AN-005*) provides information about network configuration.

- **Inertial Products – Web-based interface user guide** (*Ref.: MU-INSIII-AN-021)* provides information about:
  - How to perform the software configuration of the product (which sensor is connected, to which port, …).
  - Operation: how to use the product.

- **INS – Interface Library** *(Ref.: MU-INSIII-AN-001)* provides information about all the input/output protocols that your product can use.

- **INS – Advanced Configuration** *(Ref.: MU-INSIII-AN-004)* provides all the configuration and monitoring commands which can be used during operation. These commands are sent directly through the repeater port.

- **Inertial Products – System Updater Tool User Guide** (*Ref.: MU-UPDTAPN-AN-001*) describes the procedure to update the HYDRINS firmware.

- **Inertial Products – IP Data Logger Tool User Guide** (*Ref.: MU-IPDATAPN-AN-001*) explains how to use the iXBlue data logger tool.

Depending of the use of your product, the following *Application Notes* can be useful for product installations:

- **Inertial Products – Application Note – Mechanical Integration of Inertial Systems** (*Ref.: MU-MECHAAPN-AN-001*).
- **Inertial Products – Application Note – Installation and Configuration of AHRS and INS for Seabed Mapping Measurements** *(Ref.: MU-HEAVAPN-AN-001).*

3 HYDRINS DATA

3.1 Data availability

HYDRINS provides the ship's navigation system and/or weapon 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 Interface Library manual document *(Ref.: MU-INSIII-AN-001)*.

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

HYDRINS can output two distinct heave measurements:

- Real Time Heave which provides heave in real time mode.
- Smart Heave™ which provides a measurement of heave with a fixed 100 s delay. In this case Heave is compensated for error due to latency and is more accurate.

To avoid the effect of transient vehicle/vessel movement on the heave measurement, you can define the position of the center of gravity (COG) of the vehicle/vessel. When this is done, HYDRINS will compute heave at the COG and add the heave induced by lever arms from the COG to external monitoring points. For more details see:

- *Inertial Products – Application Note - Installation and Configuration of AHRS and INS for Seabed Mapping Measurements (Ref.: MU-HEAVAPN-AN-001)*
- *Inertial Products – Web-based interface user guide (Ref.: MU-INSIII-AN-021)*

UTC/Time synchro

All data are accurately time stamped with respect to internal reference time (and can be synchronized to GPS time or any autonomous external clock, see below "Performance" section for accuracy details).

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

For more details on time synchronization setting see *Inertial Products – Web-based interface user guide (Ref.: MU-INSIII-AN-021).*

Availability of full quality check data

HYDRINS provides a numeric quality checks indicator (RMS/CEP50/CEP95) for position data and a RMS quality check indicator for other navigation data:

- Position standard deviation estimation Latitude and Longitude
- Speed standard deviation estimation (North, East and Vertical Speed)
- Altitude or Depth standard deviation estimation
- Roll/Pitch and Heading standard deviation estimation

3.2 External sensors

HYDRINS uses external sensor data to improve its own estimates of position, speed, attitude and heading.
GNSS external sensor can be connected to HYDRINS

HYDRINS can simultaneously use all the sensors described above and its Kalman Filter will manage them without any manual intervention.

HYDRINS specific Kalman Filter is designed to allow automatic rejection of erroneous information provided by external sensors (position, speed, and depth sensors).

HYDRINS offers an ergonomic toggle to activate/deactivate external sensors as desired by the user. For more information, refer to *Principle & Conventions* document (*Ref.: MU-INS&AHRS-AN-003*).

HYDRINS also allows the user to provide a manual input position either at the start or during the navigation sequence.

For more details on:

- Electrical connection of the external sensors: refer to *HYDRINS Interface Control Document (Ref.: MU–HYDRINS–AN–013)*
- The configuration of the external sensors: refer to the *Inertial Products* – Web-based interface user guide (*Ref.: MU-INSIII-AN-021*).
- The available input protocols for external sensors: refer to *INS Interface Library (Ref.: MU-INSIII-AN-001)*.

4 SPECIFICATIONS

4.1 Performance prerequisites

The performances listed hereafter are achieved at sea under the following conditions (which complements the environmental conditions stated in section 6).

	Amplitude	Period (sinusoidal)
Heading	± 10°	10s
Roll	± 40°	9s
Pitch	± 15°	6s

4.2 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 (depth)(1)	up to 4000 m
Speed	Up to 80 knots
Linear Acceleration	±15 g

(1) No limitation for negative altitude (depth)

4.3 Navigation Data

GNSS	No aiding
Position (Latitude and Longitude) accuracy	
2 to 3 times better than aiding sensor	3m after 2min (CEP50) 20m after 5 min (CEP50) 0.6 NM/h (CEP50)
Speed (North and East) accuracy	
0.1 knot (RMS)	0,6 knot (RMS)
Heading accuracy	
0.01° seclat (RMS) 0.2 mrad (RMS) 0.6 arc min seclat (RMS)	0.05° seclat (RMS) 1 mrad (RMS) 3 arc min seclat (RMS)
Attitude (Roll and Pitch or Vertical Reference) accuracy	
0.01° (2RMS) 0.2 mrad (2RMS) 0.6 arc min (2RMS)	0.01° (RMS) 0.2 mrad (RMS) 0.6 arc min (RMS)

For all products, with or without aiding

Dynamic stability(2)	
Heading rate accuracy	0,001°/s RMS
Roll rate accuracy	0.003°/s RMS
Pitch rate accuracy	0.003°/s RMS
Heave Surge Sway	
Heave(3)	5 cm or 5% of movement full amplitude
Smart Heave™(4)	2.5 cm or 2.5% of movement full amplitude
Surge and Sway(5)	5 cm or 5% of movement full amplitude

(2) According to the dynamics stated in the prerequisites in section 4.1

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

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

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

4.4 Input/Output

Baud rate	600 bauds to 460 kbauds
Data output rate(6)	0.1 Hz to 200 Hz
Data input rate	Up to 5 Hz (1 Hz typical)
Time stamping accuracy	< 100 µs

	Serial (All)	Ethernet 1	Ethernet 2	Ethernet 3	Ethernet 4	Ethernet 5
Jitter(7)	< 200 µs	< 400 µs	< 800 µs			
Fixed Latency(7)	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	5	5	1
Ethernet(8)	7	5	1
Max (Serial & Ethernet)	7	5	1
Pulse port	4	2	

Ethernet(8)	UDP / TCP client / TCP server
Pulse port	5 V (TTL level)
Input/ output formats	industry standards: NMEA 0183, ASCII, BINARY
Alarm pulse	Open collector output to drive a relay

(6) 200 Hz update rate for attitude data (Heading, roll, pitch, surge, sway).
Update rate for position is performed at 100 Hz.
(7) All specifications valid for firmware version starting from FmWCINT v3.93
(8) All inputs and outputs are available on the Ethernet link. Output can be duplicated both on serial and Ethernet port.
HYDRINS supports the input of: GPS, Speed Log for ease of operation and full heading accuracy at high speed

4.5 External sensors

	External Sensors
GNSS	Up to 2
UTC	Up to 2

4.6 Power supply

Power supply / consumption	24 V_{DC} (20 to 32 V) / 18 W(9)
Maximal current cut duration	5 ms

(9) Typical value @ 24 V and ambient temperature
< 20 W over temperature and established voltage range

4.7 Mechanical

Dimensions (l x w x h)	< 180 mm x 180 mm x 162 mm
Weight	< 4.5 kg

4.8 Export limitations

HYDRINS is a dual use product and is thus submitted to export limitations on the provided data, and to export restrictions to some countries (*Ref.: MU-INS&AHRS-AN-007*).

	Limitations
Rotation rate resolution	3.6°/h
Acceleration resolution	1mg
Heading, Roll, Pitch resolution	0.001°
Speed saturation	80 knots
Altitude saturation	4,000 m
Acceleration saturation	15 g
Rotation rate saturation	750°/s
Post-processing data output	Available

5 SETTLING TIME

5.1 Power up

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

5.2 Restart or Power Down

Equipment can be restarted either through the Web MMI, in the maintenance menu or sending a start command. To power down the equipment, you need to disconnect it from its power source.

5.3 Initialization: Alignment Phase

The system must be initialized before it will provide fully accurate information.
This initialization is performed using external sensor data, during several phases.
IMO-level heading performance is available as soon as coarse alignment of the HYDRINS is completed.

5.3.1 COARSE ALIGNMENT

Coarse alignment phase is the first step of the alignment of the product.
Refer to Principle & Conventions (Ref.: MU-INS&AHRS-AN-003) for further detail on the coarse alignment phase.

5.3.2 COARSE ALIGNMENT AT QUAY

HYDRINS coarse alignment must be performed at quay with position information (GNSS or manual position with ZUPT “Manual Position”).

5.3.3 FINE ALIGNMENT

After the coarse alignment phase, HYDRINS is ready for navigation. The Kalman filter is activated to compute and estimate attitude, position and speed with optimal accuracy.
HYDRINS switches to the “fine alignment” phase to get full accuracy on attitude, position and speed by estimating the residual biases of accelerometers and gyroscopes.

Refer to *Principle & Conventions (Ref.: MU-INS&AHRS-AN-003)* for further details on the fine alignment phase.

	ZUPT or GPS (*)
Data availability	5 min
Roll/Pitch 0,01° RMS	5 min
Heading 0,1° seclat RMS 6 arc min seclat RMS	10 min(*)
Heading 0,05° seclat RMS 3 arc min seclat RMS	N/A
Heading 0,01° seclat RMS 0,6 arc min seclat RMS	N/A

(*) Alignment scenario: coarse alignment at quay during 5 minutes, then navigation with at least a heading change of at least 45°.

6 CERTIFICATION & QUALIFICATIONS

Except where specifically stated, HYDRINS meets or exceeds the environmental conditions specified hereafter.

6.1 Conformity to European and/or international legislations

This product applies to the applicable European directives.

Depending on the product:

- The product is certified Marine Equipment Directive (MED). It has a wheelmark marking. In this way, it complies with the IMO resolutions and standards referred to in the directive.

  The product is systematically delivered with its declaration of MED conformity. This product category is “protected from the weather” (according to IEC 60945 §4.4 and to IMO resolution A694/5).

or

- The product applies with the essential requirements of the relevant European health, safety and environmental protection legislations. It has a CE marking. In this way, it complies with the relevant harmonized standards in relation to its applications. The EC declaration of conformity is delivered upon customer request.

For the end-of-life product management, refer to section 7.4.

6.2 Qualifications

Temperature		
Operating	ISO 8728:2014(E), ISO1638:2014(E)	0 to +45°C
Transport and Storage	-40 °C to + 80 °C	
Waterproof & Humidity		
Waterproof and humidity	IP66 as per NF EN 60529 (Oct 1992) and Amendment A1 (June 2000)	
Salt spray	EN 60945:2002 Test method CEI60068-2-52	
Vibration		
Vibration in operating	ISO 8728:2014(E), ISO1638:2014(E)	5-40Hz 0.51g sinus max
Shock		
Shocks in operation	27g 15 ms damped shock – 1 shock per direction	
Magnetic Field		
Operating	1 Gauss	
Acoustic Emission		
Acoustic Emission	Complies with best A12 criteria demanded by the "Requirement 5" of MIL-STD-1474D-1997 standard (supersede the old MIL-STD-740-1(SH):1986 standard) with measurement carried out according to EN ISO 3755:2010 Compliant to EN 60945:2002 (A weighted sound at 1m < 60 dBA limit) Compliant to SEFC 17-50-05-A:2006 : sound power level to declare is 30dBA (supersedes old DCNS n°1571 E standard)	
Conducted Emission		
IEC 60945:2002 § 9.2 (protected equipment)		
Conducted Susceptibility		
IEC 60945:2002 § 10.3 (protected equipment)		
Radiated Susceptibility		
IEC 60945:2002 § 10.4 at 3m (protected equipment)		
Radiated Emission		
IEC 60945:2002 § 9.3 (protected equipment)		

Fast transient on power signal and control lines	
IEC 60945:2002 § 10.5 (protected equipment)	
Immunity to power supply failure	
IEC 60945:2002 § 10.8 (protected equipment)	
ESD	
IEC60945:2002 §10.9 (protected equipment)	10 air discharges at ±8kV, 10 contact discharge at ±6kV

7 LIFE CYCLE

7.1 Packaging, Handling, Storage, Transportation requirements

During storage and transportation, HYDRINS should be kept locked in its transportation case.

During storage and transportation, HYDRINS shall have its protective caps installed on its connectors. After installation, those caps from connectors in use, should be removed (cut the rope or unscrew it) to prevent the loose caps from knocking on the housing. These caps should be stored with the transportation case and mounted back on the connector plugs when the equipment is unmounted.

7.2 Auto-calibration

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

7.3 Built-in test

HYDRINS 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 *INS Interface Library (Ref.: MU-INSIII-AN-001)* for further detail.

7.4 Reliability & maintainability

Due to the technology used in its design, HYDRINS is a fully strapdown / solid-state equipment. It does not use any gas filled cavity that could leak nor any moving mechanical part that would wear out..

As a consequence, HYDRINS does not require any kind of preventive maintenance.

The HYDRINS does not have any life limited parts and as such, HYDRINS has no predicted life limitation.

The entire HYDRINS is the Line Replacement Unit (LRU).

MTBF		
Operational	Based on in-the-field repair statistics	100,000 Hours

End-of-life product management

When the product is at the end of its life, it must be returned to iXBlue where it will be oriented to a treatment facility appropriated to WEEE.