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SubCtech
Ocean Monitoring

D2.3

Integrated ICD - Interface Control Document for partners' vehicles, platforms and infrastructure

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Deliverable Title	Integrated ICD- Interface Control Document for partners' vehicles, platforms and infrastructure
Work Package Title	Technical Requirements
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Description	The present document compiles all relevant information for 1) technical requirements and specifications for sensors and samplers developed in this project. 2) Standard sensor and system specifications including sensor electronics, mechanics, material selection, biofouling, communication systems, protocols, data management, analytics. 3) Sensor integration requirements: platform-independent, use of standards (e.g. communication protocols), low-power, cost-effectiveness (low man power demand).
Lead Beneficiary	SubCtech
Lead Authors	Jana Fahning (SCT), Konstantin Keller (SCT)
Contributors	A. King (NIVA), P. Jaccard (NIVA), S. Marty (NIVA), Damien Malardé (NKE), Manolis Ntoumas (HCMR), Armindo Torres (CEiiA), A. João, A. Costa (CEiiA), R. Machado (CEiiA), Elmar Berghöfer (DFKI), Oliver Ferdinand (DFKI), N. Haavisto (SYKE), J. Seppälä (SYKE), G. Lanfranchi (EL), P. Cristofolini (CSEM), P. Penna (CNR), M. Martinelli (CNR), A. Smerdon (Aquatec), M. Mazza (HESSO), D. Vrtačnik (UL-FE)
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V0.2	May 2021	K. Keller	first draft completed
V0.3	May 2021	J. Fahning	Partner's recommendations added
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Nature of the deliverable		
R	Report	x
DEC	Websites, patents, filing, etc.	
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NAUTILOS - New Approach to Underwater Technologies for Innovative, Low-cost Ocean observation is an H2020 project funded under the Future of Seas and Oceans Flagship Initiative, coordinated by the National Research Council of Italy (CNR, Consiglio Nazionale delle Ricerche). It brings together a group of 21 entities from 11 European countries with multidisciplinary expertise ranging from ocean instrumentation development and integration, ocean sensing and sampling instrumentation, data processing, modelling and control, operational oceanography and biology and ecosystems and biogeochemistry such, water and climate change science, technological marine applications and research infrastructures.

NAUTILOS will fill-in marine observation and modelling gaps for chemical, biological and deep ocean physics variables through the development of a new generation of cost-effective sensors and samplers, the integration of the aforementioned technologies within observing platforms and their deployment in large-scale demonstrations in European seas. The fundamental aim of the project will be to complement and expand current European observation tools and services, to obtain a collection of data at a much higher spatial resolution, temporal regularity and length than currently available at the European scale, and to further enable and democratise the monitoring of the marine environment to both traditional and non-traditional data users.

NAUTILOS is one of two projects included in the EU´s efforts to support of the European Strategy for Plastics in a Circular Economy by supporting the demonstration of new and innovative technologies to measure the Essential Ocean Variables (EOV).

More information on the project can be found at: http://www.nautilos-project.eu.

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EXECUTIVE SUMMARY

The deliverable defines an Interface Control Document (ICD) for selected platforms within the project. The objective is to define technical requirements for platform-independent sensor integration and communication interfaces. Together with 12 platform operators the ICD has been developed in order to cover the following main topics:

- Mechanical integration
- Electrical integration
- Communication and Data transmission

The common requirements provide guidance for the development of the sensors and samplers within NAUTILOS, in liaison with Deliverable D2.2, to ease the integration of the instruments by taking into account the different specifications of the various platforms within the NAUTILOS project, as well as the possibility of other future platforms beyond the NAUTILOS project.

List of Acronyms and Abbreviations

Abbreviation	Definition
AC	Alternating Current
AI	Artificial Intelligence
ASCII	American Standard Code for Information Interchange
ASV	Autonomous Surface Vehicle
AUV	Autonomous Underwater Vehicle
CAN	Controller Area Network
DAQ	Data Acquisition
DC	Direct Current
FOOS	Fishery and Oceanography Observing System
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
HW	Hardware
ICD	Interface Control Document
IP	Internet Protocol
LTE	Long Term Evolution
NMEA-0183	National Marine Electronics Association Interface Standard 0183
OBC	On-Board Computer
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
POM	Polyoxymethylene
RF	Radio Frequency
RS-232	Recommended Standard 232
RS-485	Recommended Standard 485
RUDICS	Router-based Unrestricted Digital Interworking Connectivity Solution
RxD	Receive line of Device
SQL	Structured Query Language
SW	Software
TCP	Transmission Control Protocol
TxD	Transmit line of Device
UAV	Unmanned Aerial Vehicle
UDP	User Datagram Protocol
USB	Universal Serial Bus
WLAN	Wireless Local Network

INTRODUCTION

The Horizon 2020 NAUTILOS project with its variety of sensors and samplers that will be developed (WP3/4) and the platforms they will be integrated on to demonstrate functionality in end-user specific environments (WP5-7), brings the necessity to develop common requirements for the integration of the sensors with platforms. The common requirements provide guidance for the development of the sensors and samplers within NAUTILOS, in liaison with Deliverable D2.2, to ease the integration of the instruments by taking into account the different specifications of the various platforms within the NAUTILOS project, as well as the possibility of other future platforms beyond the NAUTILOS project.

In order to enable a complete hardware and software integration task 2.3 provides an interface protocol that partners should use to adapt the mechanical, electrical, and communication architecture of their platforms. Task 2.3 is linked to task 2.1 that addresses the political and societal drivers and requirements of current and future ocean observing needs and task 2.2 that defines technical requirements for the sensors and samplers developed within the NAUTILOS project to ensure compatibility, modularity and durability. Within Task 2.3 technical requirements for platform-independent sensor integration and communication interfaces were defined in close collaboration with the involved partners (NIVA, NKE, HCMR, CEiiA, DFKI, SYKE, CSEM, CNR, Aquatec, HESSO, UL-FE) addressing the following activities:

- Reviewing and evaluating existing technologies for different platforms
- Identifying sensors that can optionally operate in a fully self-contained mode for rapid and simple deployment on multiple platforms
- Establishing a platform-independent sensor integration toolkit
- Establishing a platform-independent communication interface (telemetry)

Some of the topics will be specified in more depth within D2.2, due to the very close link between sensors and platforms, including materials, form factor and bio-fouling measures.

INTERFACE CONTROL DOCUMENT FOR NAUTILOS PLATFORMS

The NAUTILOS project involves eight ocean observing platforms with different versions of several of the platforms (e.g., the FerryBox platform has four different versions depending on the operator). These observing platforms include: FerryBoxes, Autonomous surface vehicles (ASVs), Fisheries research vessels, Autonomous Underwater Vehicles (AUVs), Argo profiling floats, Benthic landers, Fixed platforms, and Unmanned Aerial Vehicles (UAV's; drones). Due to this heterogeneity in platform type/version and the intent for NAUTILOS sensors and samplers to be operable on a variety of platforms (modularity, compatibility and scalability), the varying requirements for each platform type and version have been defined in the NAUTILOS Interface Control Document (ICD). Deliverable 2.2 outlines the recommendations for instrument development to ensure modularity, compatibility and possible scalability, whilst this Deliverable outlines recommendations from the point-of-view of the ocean observing platforms to ensure modularity, compatibility and future scalability. The basis for the ICD was platform-specific information provided by each of the NAUTILOS partners that operate platforms within the project. The provision of platform-specific information via the ICDs enables partners who are developing and adapting NAUTILOS instruments, as well as future activities and projects that develop new instrumentation, to efficiently and effectively integrate with the respective platforms. This information can be found in Appendix 1: Partners' ICDs.

1. Mechanical Requirements

For the physical link of sensors and platforms, existing technologies and sensors within the marine sector were evaluated. The cylindrical form factor is with no doubt the most common and widespread form factor. This is most likely due to the compromise between pressure resistance needed for sensors deployed at great depths and manufacturing possibilities that guarantee reliable sealing against water ingress (see Deliverable 2.2 for more details). Platforms such as buoys, landers and moorings already provide good solutions for physical integration of cylindrical sensors, most of them using clamps or brackets. Another aspect considered in both tasks 2.2 and 2.3 was the material and anti-biofouling measures, as this affects mostly the sensors directly and not the platforms they are installed on. This is covered within D2.2 that concentrates on the sensors developed within the NAUTILOS project. The mechanical requirements define how to install different types of sensors on the platforms included in the NAUTILOS project.

1.1. Mounting type:

The **cylindrical form factor** as described above is the most common for sensors throughout the marine industry. A good and reliable way of mounting is the use of **clamps and brackets** that can be attached with fasteners to the platforms.

2. Electrical Requirements

The electrical requirements hereafter define the electrical connection between sensors and platforms being used within the NAUTILOS project. This includes supply voltage and the pin assignment, as well as the connector type.

Even though sensors powered by internal batteries are available on the market, many sensors require an external power source. Most sensors used for marine studies use DC power, as this can be provided by platforms and batteries. Fixed platforms providing AC power can provide DC power using AC/DC converters that can modify from a large AC range to a defined DC output. Input voltage required by sensors can cover a large range (9-35 VDC) or being fixed to one standard (e.g., 5, 12, 24 VDC). For the sensors developed within NAUTILOS a variable range is recommended and recorded in D2.2. To provide reliable power in cases of voltage drops that can occur due to long cables and wire cross sections, we recommend a specific voltage supply to be used on the platforms within NAUTILOS. To provide this power to the sensors a physical cable connection is necessary. For this the industry standard within the marine scientific environment has been evaluated. Wet mateable connector types such as SubConn or Seacon are the common standard that provide a reliable connection even at great depths. The rubber molded connector withstands a large temperature range and is very resistant to corrosion. For safety reasons the current carrying connector type should always be the female part.

To allow easy integration of sensors into the existing platforms the connector type and pin layout is defined.

2.1. Supply Voltage

24 V DC

24V DC is one of the standard voltages for sensors and systems in general, and it is the most widely available voltage on all platforms. It provides a good balance between availability, minimization of losses and wire cross-section.

2.2. Connector type

SubConn Micro Circular series

The SubConn Micro Circular is the most common connector type within the marine industry. They are reliable, globally trusted connectors that meet industry requirements.

2.3. Pin Assignment

1: Power Ground
2: Voltage-IN (24VDC)
3: Data Ground
4: RxD (RS-232)
5: TxD (RS-232)

The pin assignments of major sensor manufacturers such as Sea-Bird Scientific, Turner, TriOS, NKE, Aquatec have been analysed. Consequently, the pin assignment for NAUTILOS has been developed. The main point is the separation of power and data ground. In the past, many sensors were designed and developed with a common ground for power and data. Experience has shown that a common ground can cause malfunction of the communication; therefore, two separate grounds are preferable.

3. Communication Requirements

For the communication between sensors and platforms, a standard has been defined. This is needed for data transmission, especially for sensors that do not provide internal logging, as well as sensor configuration and setup. In D2.2, different communication and format protocols have been assessed to come up with the best solution for all sensors and samplers developed within NAUTILOS. The general recommendation made in D2.2 for instruments – RS232 communication interface and ASCII communication protocol – is also recommended for platforms.

3.1. Communication Interface

RS232

RS-232 is a common standard for serial communication transmission of data and available on all platforms within NAUTILOS. For short distances between sensor or sampler and platform and the point-to-point communication, RS-232 is fully sufficient.

3.2. Communication Protocol

NMEA-0183 (ASCII)

NMEA-0183 defines the communication protocol between two instruments. This standard is used worldwide in marine applications and well documented and maintained. The simple ASCII protocol makes it possible to be used with the majority of instruments.

3.3. Special high-level communication

Ethernet

For external processing and AI-based event triggering, high-level communication is necessary. However, this is only applicable for stationary platforms and FerryBoxes. The communication has to be bidirectional to receive data and information from the platform but also to send commands for event-based triggering.

Telemetry

Telemetry system via Satellite/LTE to transmit data to the platform operator may result very useful for remote sensing applications, even though not applicable to all platforms. Such technology is reasonable for long term deployment platforms, which will receive data and transmit information on system status and behaviour.

Appendix 1: Partners' ICDs

Interface Control Document - *SYKE Alg@line Ferrybox*

Author: Noora Haavisto, Jukka Seppälä *(Finnish Environment Institute, SYKE)*

Operating system (Hard- & Software)

DQ card NI PCI-6221, M SERIES DAQ Multifunctional I/O Board for PC
DQ card NI PCIE-6321, X SERIES DAQ Multifunctional I/O Board for PC
Comport card PCI Express RS232 Comport card for example: Sunix Golden I/O 4466A 8 port (Deltaco SX-142)

Any standalone system may be used, but not necessarily connected to the main datalogger and data stream. Then data may be retrieved by visiting the ship (possible on average once per week)
Software allows logging single values at user selected intervals (e.g. 30 sec). Sensors with more complex output need to be connected with their own software.

Voltage supply

220 V, other voltages possible by using a transformer

Electrical connection

Customised for each sensor as needed

Mechanical mounting

Mounted on the floor (large units), or attached to a stainless-steel wall rack. Needs to be attached to water flow, thus flow through cap, or separate sampling/purging line needs to be constructed.

Communication interface

Serial port RS232
Analog (0-5 V) (not preferred)

Communication protocol

Serial communication

Telemetry/ Data transmission

For data submission only, through ship's server

Operating depth

Instrumentation above surface, water inlet at 5m

Deployment time

Minimum 4 days, no practical upper limit

Maintenance interval

4 days minimum possible, 1-2 weeks practical

Total power capacity

Ships power supply, no practical limit

Total payload and maximum payload per instrument

No practical limit

Maximum number of integratable instruments

No practical limit

Maximum instrument size

Approx. 1000 x1000x1000 mm

Maximum data storage capacity

No practical limit

Interface Control Document - HCMR OceanPack System (Ferrybox)

Author: Jana Fahning (SubCtech)

Operating system (Hard- & Software)

Hardware: ARM Controller, Windows software OceanView

Software: SubCtech's NetDI software (based on programming language C)

Voltage supply

5, 12, 24 VDC
230 VAC

Electrical connection

Subconn micro circular connectors (2-12 contacts)
Several other connection types

Mechanical mounting

Brackets/ clams (30-240mm diameter) for sensors with flow through cells
Within water reservoir (Debubbler) with POM brackets

Communication interface

Serial (RS-232, RS-485)
Analog (0-10V, 4-20mA)
Ethernet

Communication protocol

NMEA-0183 (ASCII)
Modbus

Telemetry/ Data transmission

Data output through serial (RS-232, RS-485) or Ethernet (TCP/IP)
Wireless data transmission through satellite (e.g. IRIDIUM) or mobile communcation (e.g. 3G/4G)

Operating depth

Surface (Flow-through System)

Deployment time

Unlimited

Maintenance interval

4 weeks

Total power capacity

Unlimited

Total payload and maximum payload per instrument

Maximum payload: Unlimited
Maximum payload per instrument: 90kg

Maximum number of integratable instruments

30

Maximum instrument size

240 x 1200 mm (diameter x length)

Maximum data storage capacity

32GB

Interface Control Document - *NIVA Ferrybox*

Author: Pierre Jaccard, Sabine Marty, Andrew Luke King *(Norwegian Institute for Water Research, NIVA)*

Operating system (Hard- & Software)

Windows 10 industrial computer or RT Linux like board
Labview, Node-Red or Python graphical interfaces

Voltage supply

220 VAC, 24VDC or 12VDC

Electrical connection

Sensor specific or circular industrial connectors M12.

Mechanical mounting

Mounted on vertical frames that are built and welded on the ship
Mounted on a vertical and movable frame module that is finally welded or screwed on deck
Mounted in portable peli-like cases

Communication interface

Cabled internet
Wifi
4G router

Communication protocol

Internet TCP/UDP

Telemetry/ Data transmission

Internet, ASCII format

Operating depth

Instrumentation above surface, water inlet at ~5m

Deployment time

Unlimited or as long as possible

Maintenance interval

Monthly

<u>Total power capacity</u>

Limited by ship capacity. Should remain reasonable

<u>Total payload and maximum payload per instrument</u>

Limited by space on board and ship’s crew acceptance threshold

<u>Maximum number of integratable instruments</u>

Limited by space on board and ship’s crew acceptance threshold

<u>Maximum instrument size</u>

Limited by access space

<u>Maximum data storage capacity</u>

Not a real issue, but limited by available storage space onboard the computer.

Interface Control Document – HCMR Ferrybox

Author: Manolis Ntoumas (HCMR)

Operating system (Hard- & Software)

Hardware: Windows PC,

Software: Labview, windows

Voltage supply

12-24 VDC
230 VAC (PC)

Electrical connection

Several connections types

Mechanical mounting

To be defined

Communication interface

Serial (RS-232)
Analog (0-10V, 4-20mA)
Usb
Ethernet

Communication protocol

ASCII

Telemetry/ Data transmission

Data output via RS-232 to FerryBox PC

Operating depth

Onboard FerryBox

Deployment time

2 years

Maintenance interval

2 weeks

Total power capacity

500W

Total payload and maximum payload per instrument

Does not apply

Maximum number of integratable instruments

Does not apply

Maximum instrument size

500 x 500 x 1000 mm (L x W X H)

Maximum data storage capacity

20 gigabytes

Interface Control Document - UAS 30

Author: Renato Machado (CEiiA)

Operating system (Hard- & Software)

UAS 30 Unmanned Aerial Vehicle

Voltage supply

5V DC, 12V DC and 24V DC

Electrical connection

XT 60 connectors

Mechanical mounting

Customised according to the payload

Communication interface

TBD

Communication protocol

TBD

Telemetry/ Data transmission

TBD

Operating depth

NA

Deployment time

20 Minutes

Maintenance interval

25 hours

Total power capacity

TBD

Total payload and maximum payload per instrument
5 kg

Maximum number of integratable instruments

NA

Maximum instrument size

40 x 20 x 14 cm (approximately)
If required we can develop a specific cover to accommodate larger payloads

Maximum data storage capacity

The data storage device has to be defined

Interface Control Document – CEIIA LANDER

Author: Alexander Costa (CEIIA)

Operating system (Hard- & Software)

In house developed OBC

Voltage supply

5, 12, 24 VDC

Electrical connection

Several Subconn Bulkhead connectors available for the project in dry containers.
(others may be considered upon request)

Mechanical mounting

The platform has a dedicated payload bay of: 1.5m x 1.5m x 0.25m
The platform has a dedicated communications bay of: 0.2m x 0.2m x 0.2m (x4)

Communication interface

Serial (RS-232, RS-485)
CAN
Ethernet

Communication protocol

To Be Defined (depends on Instrument)

Telemetry/ Data transmission

LANDER provides no real-time sensor data. This must be downloaded after the mission. Acoustic modem can be used, to transmit simple status messages to surface (previous used frequency is 18/34)

Operating depth

Maximum Depth: 3000m

Deployment time

6 months

Maintenance interval

To be defined (depends on operational conditions)

Total power capacity

4.5 kWh

Total payload and maximum payload per instrument

Maximum payload: 50kg wet weight

Maximum payload per instrument: depends on vehicle placement

Maximum number of integratable instruments

12 sensors can be connected to the processing unit (however it depends on their mass and size)

Maximum instrument size

The platform has a dedicated payload bay of: 1.5m x 1.5m x 0.25m
(The maximum instrument size will depend on the number and dimensions of instrument to install)

Maximum data storage capacity

250 GB

Interface Control Document – *EDGELAB AUV*

Author: *Gessica Lanfranchi (EDGELAB)*

Operating system (Hard- & Software)

ARM based controllers
LINUX based – Vital Unit process management software

Voltage supply

12, 24 VDC

Electrical connection

Subconn micro circular connectors (2-10 contacts)

Mechanical mounting

Circular clamps

Communication interface

Serial (RS-232)
Ethernet

Communication protocol

Serial communication
NMEA

Telemetry/ Data transmission

Wi-Fi
RF
Acoustic link

Operating depth

300 m

Deployment time

8h

Maintenance interval

2h

Total power capacity

1440 Wh

Total payload and maximum payload per instrument

3 kg

Maximum number of integratable instruments

2 modems and 2 sensors

Maximum instrument size

Ø 150 mm x 200 mm

Maximum data storage capacity

500 Gb

Interface Control Document - *CNR AdriFOOS*

Author: *Pierluigi Penna and Michela Martinelli (CNR-IRBIM)*

<u>Operating system (Hard- & Software)</u>

Hardware: FOOS logbook (industrial touch screen PC/windows) installed on commercial fishing vessel

Software: dedicated CNR-IRBIM software interfacing with NKE protocols; local SQL lite database

<u>Voltage supply</u>
12 VDC

<u>Electrical connection</u>

Serial DB9 connector with 12 VDC power supply

<u>Mechanical mounting</u>

NKE hub to be fixed on the vessel deck; NKE sensors to be fixed on outer doors

<u>Communication interface</u>

Serial port RS232 between NKE hub and FOOS logbook; then data are sent from the logbook to the AdriFOOS server on land via LTE4G

<u>Communication protocol</u>

ftp, Nmea

<u>Telemetry/ Data transmission</u>

Data transmitted from the NKE sensors to their hub on board should then be transferred to the FOOS logbook via serial link by FTP protocol (the data stored in the FOOS logbook will be periodically sent via LTE4G to AdriFOOS server on land)

<u>Operating depth</u>

0 - 300m

<u>Deployment time</u>

1 year with deployment of 3-4 h for 3/4 times a day

<u>Maintenance interval</u>

When needed

Total power capacity

500mA

Total payload and maximum payload per instrument

Hub 1.5 kg + 2 sensors with protection 1.3 kg each

Maximum number of integratable instruments

2 sensors + 1 hub

Maximum instrument size

Size of the hub: 300 x 150 x 100 mm; size of the cylindrical protection of each sensor: 250 x 100 mm

Maximum data storage capacity

On board FOOS logbook physical storage capacity: 500 Giga (solid state hard disk), on land AdriFOOS server: theoretically unlimited

Interface Control Document – *CEiiA ASV (ORCA)*

Author: *André João (CEiiA)*

Operating system (Hard- & Software)

Main system is exclusive for vehicle control and safety functions, user payload should be isolated from it.
Payload system should be provided by user, according to payload requirements, both regarding HW and SW.

Voltage supply

Payload supply voltage 21-29 VDC
Payload max recommended power 630W (limited only by fuses)
Max total discharge rate = 130(A) x number of batteries installed

Electrical connection

Inside payload bay, whatever the user wants to connect to bare wires.
Outside, the user should provide the pass-through connectors of their choice.

Mechanical mounting

Dedicated retractable pole; Onboard Winch; Side bars. See presentation of last Nautilos consortium's meeting for pictures.

Communication interface

The payload system should be self-contained, so whatever the capture PC has available. Should be provided by user.

Communication protocol

Same as previous.

Telemetry/ Data transmission

Wi-Fi + LTE can be shared with payload system.

Operating depth

The platform operates on the surface.

Deployment time

The platform can be deployed either by crane or through a ramp using a customised trailer that also serves as a means of transportation when towed by a car. In both cases it takes around 10-20 minutes for deployment.

Maintenance interval

To be defined. Every time a campaign ends, a visual inspection is required. Every time a campaign is to happen, a visual inspection is performed beforehand and some parts can be replaced.

Total power capacity

TBD. (max: 4x2,7kwh) 4 batteries

Total payload and maximum payload per instrument

Maximum payload is 100kg. 9kg can be deployed by the onboard winch. The rest is to be installed either on a retractable pole (a single unit up until 8-9 kg), or on side bars for several small sensors up to around 1kg each. A payload box for control electronics is also available and that can have up to 20kg.

Maximum number of integratable instruments

Depends on the size. See below.

Maximum instrument size

500 x 500 x 200mm for equipment mounted on the retractable pole. 424 x 380 x 130mm mounted inside the control electronics payload box. 700 x 70x 70 deployed by the onboard winch.

Maximum data storage capacity

Payload system should be provided by the user, storage is a part of that system.

Interface Control Document - HCMR fixed platforms

Author: *Manolis Ntoumas (HCMR)*

Operating system (Hard- & Software)

Unix based software, several hardware modules

Voltage supply

12-24 V

Electrical connection

Subsonn connectors of different types

Mechanical mounting

Brackets and attachment points

Communication interface

Digital and analog

Communication protocol

Serial (rs 232 - rs 485), analog(0-5V), inductive underwater modem (serial)

Telemetry/ Data transmission

GPRS, satellite

Operating depth

0-1000 meters

Deployment time

6 months

Maintenance interval

6 months

Total power capacity

60 Watt

Total payload and maximum payload per instrument

0-20 sensors can be hosted in the buoys

Maximum number of integratable instruments

20

Maximum instrument size

Surface (limitations to weight/dimensions per case)
Underwater (no limitations)

Maximum data storage capacity

8 Gigabyte

Interface Control Document – ARGO Float (NKE)

Author: Damien Malardé (NKE)

Operating system (Hard- & Software)

Not documented

Voltage supply

10.8 VDC

Electrical connection

Subconn micro circular connectors (8 contacts)

Mechanical mounting

Not documented

Communication interface

Not documented

Communication protocol

ASCII protocols
Serial communication

Telemetry/ Data transmission

Satellite (Iridium RUDICS)

Operating depth

2000 m

Deployment time

Operating life 4.5 years at sea

Maintenance interval

No maintenance

Total power capacity

Not documented

Total payload and maximum payload per instrument

Float weight 40 kg (depending on configuration, according added payload, additional flotation and battery can be adapted

Maximum number of integratable instruments

Not documented

Maximum instrument size

Example: CRover – Length = 78.3 cm, Diameter =10.1 cm ; Size = ; Weight = 4531g; Volume = 4432 cm3 (Be careful: if too large, incompatibility with sensors already mounted)

Maximum data storage capacity

Not documented