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Design of a demonstrator of junction box with user port for external users

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Abstract

This document reports on technical implementation of a demonstrator Junction box (JB) aimed at connection of general purpose instrumentation to the KM3NeT subsea network for power and data transmission.

I. COPYRIGHT NOTICE

II. DELIVERY SLIP

	Name	Partner/WP	Date
From	P. Piattelli, G. Riccobene	INFN	15/02/2021
Author(s)			
Reviewed by	R. van der Meer	NWO-I	20/02/2021
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III. DOCUMENT LOG

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1	15/02/2021	draft	INFN
2			
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IV. APPLICATON AREA

This document is a formal deliverable for the GA of the project, applicable to all members of the KM3NeT INFRADEV project, beneficiaries and third parties, as well as its collaborating projects.

V. PROJECT SUMMARY

KM3NeT is a large Research Infrastructure that will consist of a network of deep-sea neutrino telescopes in the Mediterranean Sea with user ports for Earth and Sea sciences. Following the appearance of KM3NeT 2.0 on the ESFRI roadmap 2016 and in line with the recommendations of the Assessment Expert Group in 2013, the KM3NeT-INFRADEV project addresses the Coordination and Support Actions (CSA) to prepare a legal entity and appropriate services for KM3NeT, thereby providing a sustainable solution for the operation of the research infrastructure during ten (or more) years. The KM3NeT-INFRADEV is funded by the European Commission's Horizon 2020 framework and its objectives comprise, amongst others, the preparation of services to provide access of users external to the astroparticle physics community to the RI (work package 8).

VI. EXECUTIVE SUMMARY

This document reports on technical implementation of a demonstrator Junction box (JB) aimed at connection of general purpose instrumentation to the KM3NeT subsea network for power and data transmission.

Both for ARCA and ORCA the JB design implements safe and easy interface to auxiliary instrumentation.

User ports allow connection of instruments directly onboard the JB or through a dedicated RS422 link. The latter is designed to connect mooring lines or seafloor instruments far from the KM3NeT detector footprint. As a pilot application the collaboration has designed and integrated Instrumentation Units (IUs) equipped with oceanographic probes, such as Current Metres, Sound Velocimeters, CTD (Conductivity, temperature, Depth probes) and Pressure gauges.

Two designs have been carried out, taking into account different architecture of power and data transmission systems adopted in ARCA and ORCA.

Table of Contents

1. Introduction

KM3NeT, the large Research Infrastructure (RI) that will host the latest generation of deep-sea neutrino detectors in the Mediterranean Sea, will open a new window on our Universe, but also advance the research into the properties of neutrinos. KM3NeT will be a distributed infrastructure with deep-sea instrumentation east of the Sicilian Coast (Italy), south of Toulon (France) and off the South-West coast of Peloponnese (Greece). The main science objectives, a description of the technology and a summary of the costs are presented in the KM3NeT 2.0 Letter of Intent [1].

The present document describes the KM3NeT User Port for Earth and Sea science.

The mechanical design and functional characteristics of the junction box are described together with specific ports/interfaces for instrumentation.
The junction box foresees connection of 3 local instruments:

1. a hydrophone (AES3-format and power)
2. an external instrument (12VDC power) with RS232 connection. This is presently adapted to an acoustic beacon.
3. an external instrument (5VD power) with double RS232 connection. This is presently adapted to a laser beacon.

In addition an RS422 port (12 VDC power), suitable to connect a mooring line equipped with oceanographic instrumentation has been designed and implemented. The latter is also discussed in the present document as practical implementation of user port for oceanographic measurements.

Due to architectural differences and different deployment depths, separate mechanical design solutions have been adopted for ARCA and ORCA User Ports. Electrical and data transmission interfaces are the same, exploiting KM3NeT standards.

[1] *Letter of Intent for KM3NeT 2.0.* **Adrián-Martínez, S., et al.** 2016, Journal of Physics G: Nuclear and Particle Physics, Vol. 43 (8), p. 084001. arXiv:1601.07459 [astro-ph.IM]. DOI: 10.1088/0954-3899/43/8/084001

2. The junction box

The KM3NeT junction box for user ports consists of 5 main components:

1) a mechanical structure suitable for long term deployment in deep-seawater environment;
2) a pressure-resistant vessel hosting data transmission and control and power electronics;
3) an electro-optical interface to the KM3NeT power and data network;
4) electrical interfaces to local instruments;
5) an electrical interface to remote (retrievable) instruments.

The design of the junction box is optimised to allow 20 years operation in a harsh marine environment: average salinity 39 PSU, temperature 13.5°, at 3500 m water depth (ARCA) and 2500 m water depth (ORCA). Adequate construction materials, special coating/painting and corrosion protection have been used, in compliance with subsea standards used in the subsea oil-and-gas industry:

- UNI EN ISO 12628-6 (Subsea System design and operation)
- Metallic frame design (NOROSOK N-004, M-101, M-120)
- Cathodic protection (DNV RP B401, NF EN 13174, NF EN 12473)
- Welding (UNI EN ISO 15614-1:2017
- coating (NOROSOK M-501)

Both mechanics and electronics have been designed and validated against mechanical shocks and vibration that the structure faces during transportation and deployment, following KM3NeT qualification rules and procedures.

The mechanical structure is optimised to allow easy transportation from construction site to ship and fast and safe deployment through ship heavy lift line. Figure 1 shows the Junction box of ORCA and ARCA.

For both architectures the JB will be placed at the rim of the detector footprint and connected: in ORCA, to a Detection Unit (in daisy chain); in ARCA, to a star centre JB. To minimise sea operations and improve reliability, the interlink cables for the ESS JB to detector are winded in the mechanical frame. The clear difference of mechanical designs are necessary to accommodate different interlink lengths (few tens meters for ORCA, hundreds of meteors for ARCA).

The ORCA JB structure has onboard an additional electrical interlink cable (few tens meters) towards a remote station, e.g. the inductive mooring line described in the following sections. The interlink is a purely electrical link terminated with a ROV mate connector Teledyne ODI Rolling Seal connector with the following characteristics:

- 2 power conductors (12 VDDC, GND)
- 2 twisted pairs for RS 422 link (RX_P, RX_N, TX_P, TX_N)

Due to larger distances the latter interlink cannot be accommodated in the ARCA JB and must be deployed separately. A ROV operable connector (Teledyne ODI Nautilus NRH 7 pins) is installed for this purpose. A metallic shield has been added in the ARCA solution.

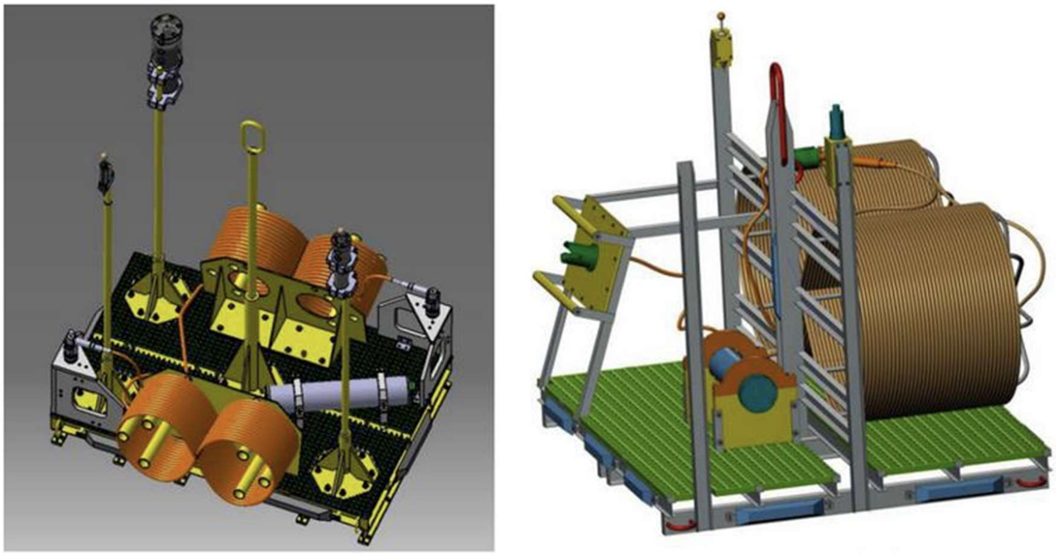

Figure 1: Left- Design of the ORCA JB. Right- Design of the ARCA JB.

A so called base module is located in a safe position inside the mechanical structure. The module consists of a pressure resistant vessel, in Grade V Titanium, hosting power and data communication electronics. In order to standardise solutions the base module of the ESS JB is almost identical to a standard KM3NeT DU base module.

The base module (figure 2) hosts:

- a base power supply board (BPS) customised, wrt to standard BPS_DU, to sustain additional power of multipurpose and RS422 ports
- a central logic board (CLB) identical to standard DU, but with dedicated firmware to drive and retrieve data from user port instruments
- an FMC mezzanine board, piggy backed on the CLB to interface external instruments

Specifically for the ORCA architecture, the base module also hosts optical Erbium-doped fibre amplifiers and an AC/DC power converter needed to interface the port to a KM3NeT DU in daisy chain.

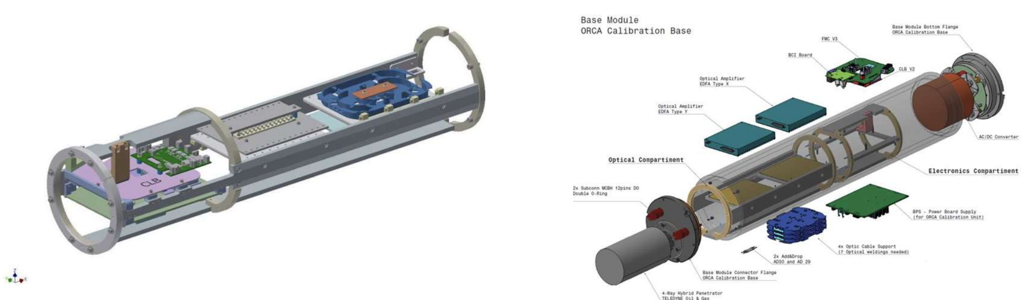

Figure 2: Left- Interior of the ARCA user port base module. Right- The ORCA base module.

3. Instruments interfaces

The KM3NeT user port offers a plethora of connections to external sensors for the sake of the ESS community. The main interface between external instruments and the KM3NeT architecture is the so-called FMC mezzanine board. The scheme of the FMC board is shown in Figure 3.

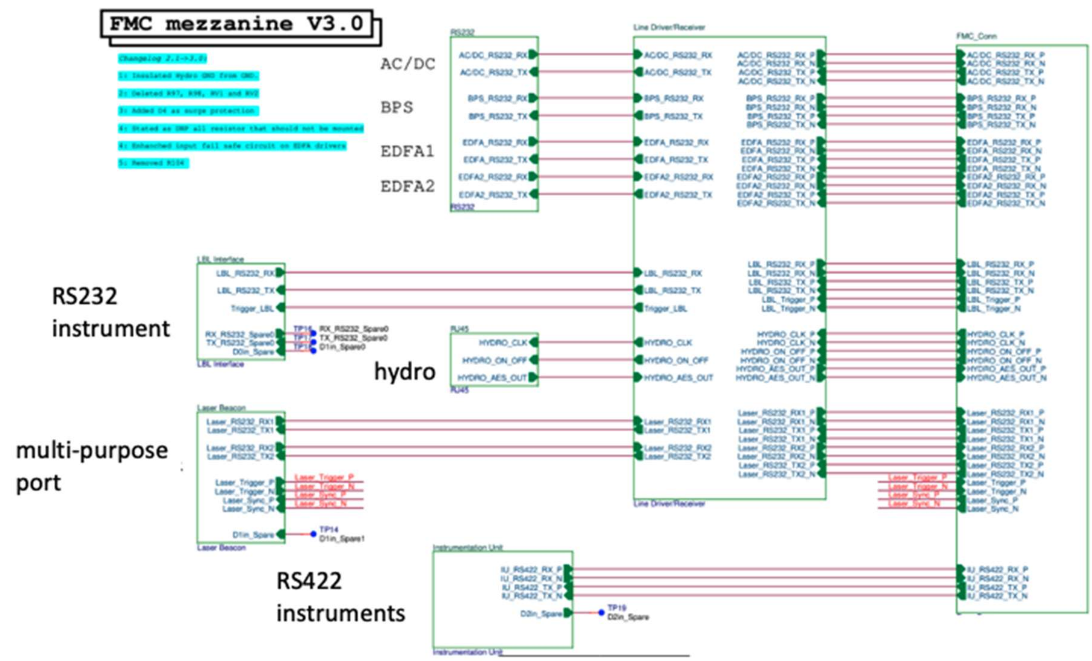

Figure 3: FMC Mezzanine board scheme

The FMC board allows control and data retrieval from specific KM3NeT equipment (the BPS_CU and -only for ORCA- EDFAs and AC/DC), plus four dedicated interfaces described in the following sections.

Power to external instruments is provided by the BPS, whose functional scheme is reported in figure 4.

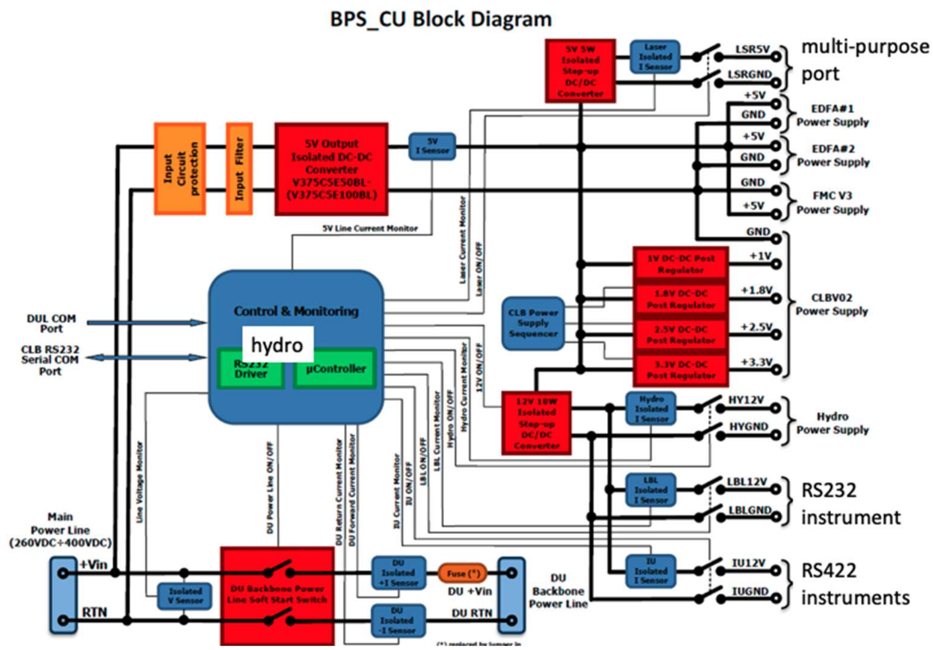

Figure 4: BPS block diagram

RS232 instrument interface

This port is designed to interface an instrument communicating via standard RS232 line (baud 9600, 8 bit, 1 stop bit, no parity). Power supply is 12VDC, with typical current of 250 mA and maximum inrush current of 500 mA for 500 ms.

Both power supply and RS232 lines are electrically isolated with switches and opto-insulators to protect the JB electronics in case of shorts in the instrument. In addition, a differential trigger line (RS485 levels) is available. The trigger time is extremely precise, being issued through the KM3NeT embedded White Rabbit time protocol.

Through KM3NeT detector control and data acquisition interfaces, controls and data retrieval to/from instruments are managed from shore. Trigger emission is, as well, controlled from shore.

The actual implementation used in KM3NeT foresees the installation of an acoustic emitter (acoustic beacon) in this port, used in the KM3NeT Positioning system.

The Instrument physical interface is obtained with a high-reliability deep-sea connector described in the following (hydrophone) section.

A pole in the mechanical structure is designed to host this instrument. Weight and dimensions should not exceed respectively 5 kg and 100 mm diameter, 600 mm length. Different values can be accommodated with a design change.

Hydrophone interface

The user port foresees the installation of a large bandwidth hydrophone as default option. Thanks to the enormous potential of acoustics in a deep-sea environment, installation of an acoustic sensor is considered highly desirable from the ESS community.

The interface is designed in compliance with hydrophones used by KM3NeT, the double-gain DG0330 manufactured by Colmar s.r.l. (http://www.colmaritalia.it). The low/gain feature is useful to avoid saturation of the hydrophone from close sources. As a very important feature, the clock frequency to the hydrophone electronics is provided by the CLB at 25 MHz, so the sampling frequency of the device is 195.3 kHz allowing full synchronisation with KM3NeT distributor network of sensors via the White Rabbit synchronisation gear. This makes a single hydrophone part of a distributed array of sensors synchronised with GPS time dispatched from shore. Hydrophone data are continuously streamed to shore for analysis

The connection of the hydrophone requires 4 conductors in 2 twisted pairs to stream differential clock and AES audio data. Power to hydrophone is provided via a phantom-like power line. The power supply is 12 VDC and power consumption is less than 100 mA @12 V. The hydrophone is designed to accept power supply in a wider range from +9VDC to +18 VDC.

The physical connection of hydrophone and RS232 interface to the base module is obtained through a high-reliability deep-sea connector GISMA Series 10, size-3, 12 pins, key “W” that also serves the RS232 instrument, through a so-called “Y cable”. The pin-out of the connection is reported in tables 1 and 2 for the full flange connector and hydrophone separately:

pin	Signal
1	Hydro Clock +
2	Hydro Clock -
3	Hydro AES +
4	Shield
5	Hydro AES -
6	Instrument Power GND
7	Instrument Trigger -
8	Instrument RS232 TX
9	Instrument RS232 RX
10	Instrument Trigger +
11	Instrument 12 VDC
12	Shield

Table 1: Base Module flange connector pinout

pin	Signal
1	Shield
2	Hydro Clock +
3	Hydro Clock -
4	Hydro AES +
5	Hydro AES -
6	Not Connected
7 (ARCA)	Not Connected

Table 2: hydrophone connector pinout. For ARCA the hydrophone is terminated with a GISMA series 10, size 2, 7 pins key “Y” connector. For ORCA a MB-IL-6 is used.

All electrical interfaces are insulated via line transformers to stop current drain and avoid propagation of damage in case of short circuits in the hydrophone. A pole in the mechanical structure is designed to host the hydrophone. Weight and dimensions should not exceed respectively 2 kg and 55 mm diameter, 300 mm length. Different values can be accommodated with a design change.

Multi-purpose interface

The user port allows connection of a multi-purpose instrument with 2x RS232 ports, LVDS data interface and a differential trigger line. Power supply at 5VDC and 1 A max is available to power the instrument. The two RS232 lines are defined as below

Transmission speed	= 19200 bits/s
Data length	= 8 bits
Stop bit	= 1
Parity	= none
Flow Control	= none

Commands and data retrieval to/from both ports can be issued from shore, as well as enabling of trigger through a specific trigger line (RS485 levels) piloted through the CLB and synchronised by the White Rabbit gear..

At present the LVDS data line is addressed directly to the CLB to allow connection of a light detector providing, similarly to KM3NeT photo-sensors, amplitude and time information via time-over-threshold signal sampling. LVDS data readout is performed on-shore using standard KM3NeT data acquisition tools.

A pole in the mechanical structure is designed to host an external instrument with max weight of 8 kg and physical dimensions of 150 mm diameter and 600 mm length.

The electrical interface of this device is obtained via a GISMA Series 10, size 3, 12 pins, Key “X” in ARCA and MC-BH-12-F connector in ORCA. Proper subsea cable interlinks should be used to connect the instrument to the base module flange. The pin-out of the base module connector is:

pin	Signal
1	Trigger +
2	Trigger -
3	GND ISO
4	LVDS -
5	LVDS +
6	Instrument RS232 TX 1
7	Instrument RS232 RX 1
8	Instrument RS232 TX 2
9	Instrument RS232 RX 2
10	Instrument 5VDC
11	Instrument GND power and RS232
12	Instrument shield

Table 2: multipurpose instrument connector pinout.

RS422 interface

An additional interface is designed in the user port to allow connection of an RS422 bus to control instruments that need to be deployed far from the Junction Box. This port is physically available through an interlink terminated with a flying ROV connector in ORCA or via an ROV mateable bulkhead Teledyne ODI NRH 7pins connector installed in the User port JB in ARCA.

Power line is designed for an operating voltage of 12 V and max current of 1 A. The connector pin-out is reported in Table 4.

pin	Signal
1	Instrument RS422 RX_B
2	Instrument RS422 RX_A
3	Instrument RS422 TX_Z
4	Instrument RS422 TX_Y
5	Instrument RS422 and power GND
6	Instrument 12 VDC
7	Shield

Table 4: RS422 interface pinout.

KM3NeT has foreseen as possible application, the connection of an inductive mooring line to this connector described in the following section.

4. Instrumented Mooring Line

Deep ocean monitoring is a challenge for the scientific community, given the multi-scale processes and their multi-disciplinary nature. Interdisciplinary time series are important for understanding and predicting ocean variability as well as geological, geodetic, and seismological processes. Such time series can be measured using moored multi-disciplinary observatories at high frequency for several years. An instrumented mooring line equipped with oceanographic probes for measurement of water salinity, currents, conductivity, temperature and sound velocity as a function of depth is a "condicio sine qua non" for water column studies.

KM3NeT pursued as a standardised and reliable solution the use of inductive lines, following the standardised solution proposed by seabird electronics (see e.g. the SBE webpage https://www.seabird.com/eBooks/IM-Explained-Sea-Bird-Scientific-2019).

An instrumented mooring line uses a single-conductor electro-mechanical cable to host measurement sensors along the water column. The control and data transmission is obtained via inductive coupling of instruments to the cable and seawater. In typical applications, instruments communication is directed to an inductive modem module placed on a surface buoy, that allows wireless communication to shore.

Thanks to the possibility of using the subsea cable network as carrier for power and data lines, KM3NeT has designed instrumented mooring lines hosting the inductive modem module in the base anchor connected to the user port Junction box, as sketched in figure 5.

The mechanical design adopted by KM3NeT for instrumentation units is oriented at safe deployment and retrieval of the instrumentation unit, placing the line at safe distance from the Detection Units (several hundreds meters in ARCA, few tens meters for ORCA). The Instrumented line is composed by:

- a retrievable frame that acts as anchor and holder for inductive modem electronics and seafloor inductive instruments
- the inductive lines populated with instruments
- a buoy to keep the line in vertical position

Mechanical bases for mooring lines are designed both for ARCA and ORCA (figure 6) following the standards used for the construction of the Junction Box.

Available technology allows for connection of up to 100 inductive instruments to a single mooring line. The only limitation for this application is reduced lifetime of inductive sensors due to use of batteries. Nevertheless, since oceanographic instruments typically need for recalibration after a few years of deployment the data acquisition can be pre-configured to operate till retrieval and substitution. Connection between base inductive module and JB allows for streaming of acquired data to shore where data can be recorded on the collaboration database and made available in the user portal or directly provided to ESS users.

In the following section a short list of instruments selected by KM3NeT for monitoring of water column properties is reported. Datasheets can be found in annexes.

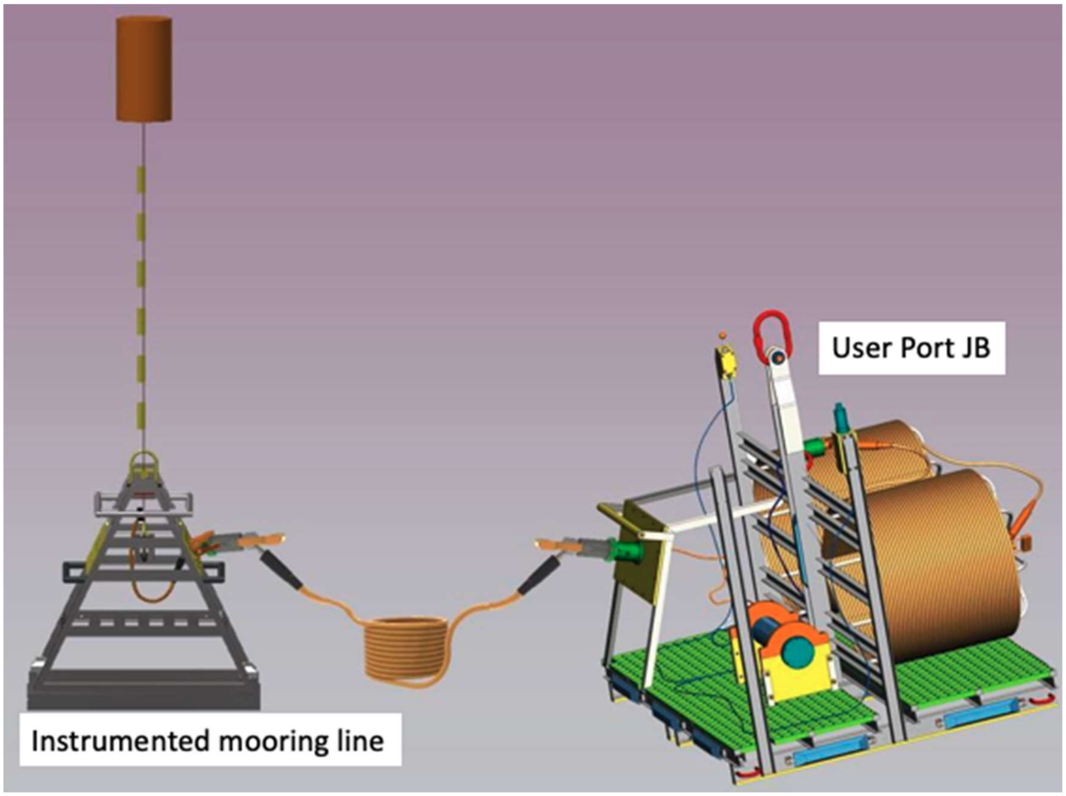

Figure 5: Sketch of connection of the ARCA instrumented mooring line to the user port JB.

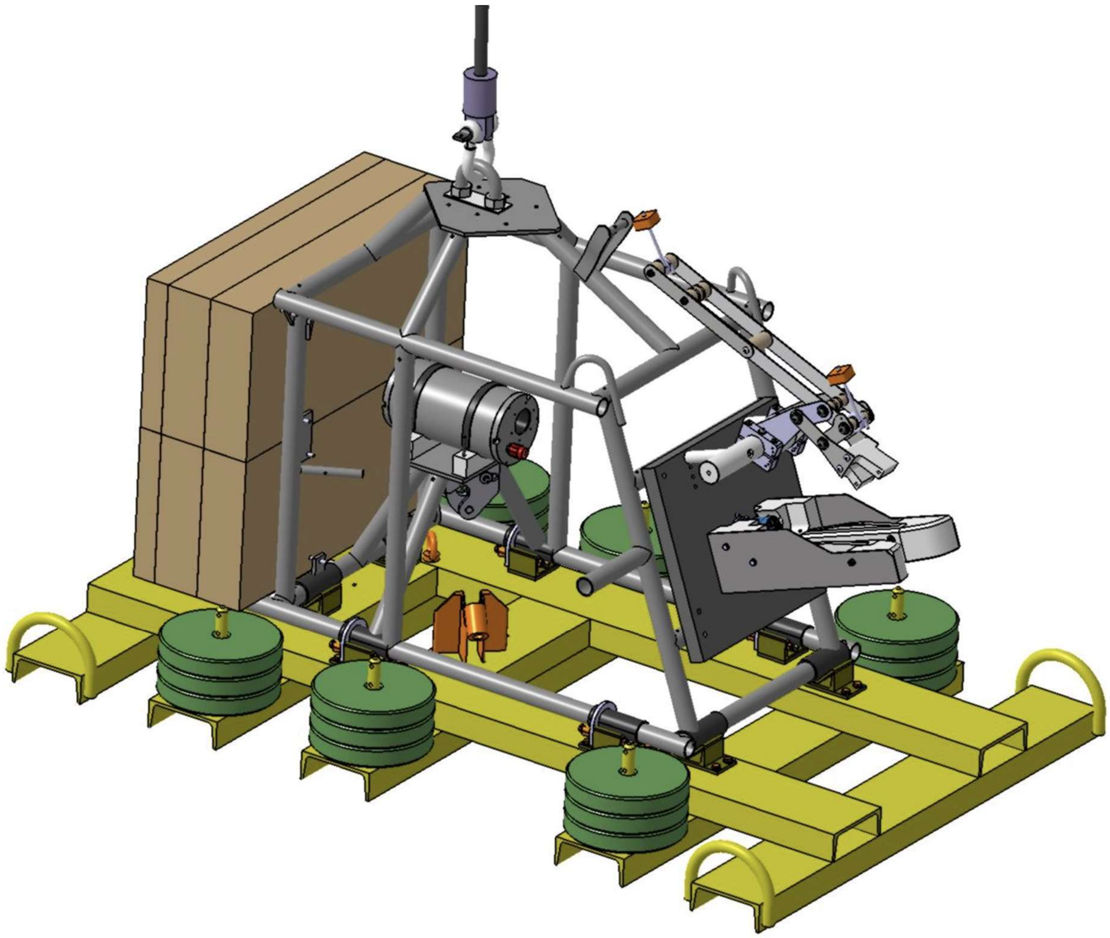

Figure 6: The anchor of the Instrumentation Mooring line for ORCA.

Seafloor instruments

An absolute pressure gauges to measure the height of the sea surface with cm accuracy. Digiquartz Intelligent Depth Sensors consist of a pressure transducer and a serial interface board in a rugged waterproof package. Commands are sent and measurement data are received via one RS-232 and one RS-485 serial port. Measurement data are provided directly in user-selectable engineering units with a typical total accuracy of 0.01% or better over a wide temperature range. Pressure measurements are fully temperature compensated using a precision quartz crystal.

Inductive instrumentation

The inductive CTD SBE 37 IMP-ODO with Titanium Housing, 600 dbar Pressure Sensor, Inductive Modem Telemetry and Dissolved Oxygen Sensor is another ideal instrument. This device is a high-accuracy conductivity and temperature recorder with integrated Inductive Modem (IM) interface, internal batteries, memory, integral Pump, and Optical Dissolved Oxygen. The CTD is designed for long-duration deployments on moorings. Data is recorded in memory and can be transmitted when polled through inductive modem telemetry. Measured data and derived variables (salinity, sound velocity, specific conductivity) are output in engineering terms.

The Valeport mini SVS Sound Velocity sensor has been developed to provide a cost effective tool for the collection of Sound Velocity measurement in seawater without compromising the quality of the data. Ideally suited to ROV, coastal, or small boat applications, the miniSVP will appeal to survey companies, military and academia alike, being simple to use and easy to handle. The miniSVP sensor is fitted with Valeport's digital time of flight sound velocity sensor, a PRT temperature sensor, and strain gauge pressure transducer.

The ZPulse Doppler Current Sensor is a singlepoint current sensor primarily intended to be used with the Aanderaa SeaGuard platform to form a Recording Current Meter (RCM). It is designed for commercial as well as research use. The DCS sensors are based on the backscatter acoustic Doppler principle. The DCS has two orthogonal transducer axes with two transducers on each axis. This enables the DCS to measure in both directions on each axis which provides direction of currents.

The latter two instruments are not native inductive and can be interfaced to inductive cable though wired connection with the SBE 44 Underwater Inductive Modem. The SBE 44 is designed for long-duration deployments on moorings. It has a built-in inductive cable coupler (split toroid) and cable clamp, providing data communications without the need for electrical connections, and an easy and secure attachment to any point on a jacketed mooring wire. An underwater bulkhead connector on the end cap provides the serial data connection, a control line, and switched power out.

5. Conclusions

The design of an underwater user access port, in two different versions that take into account the different architecture of power and data transmission systems adopted in ARCA and ORCA, has been carried out.

These user ports allow connection of instruments directly onboard the JB or through a dedicated RS422 link. The latter is designed to connect mooring lines or seafloor instruments far from the KM3NeT detector footprint. As a pilot application the collaboration has designed and integrated Instrumentation Units (IUs) equipped with oceanographic probes, such as Current Metres, Sound Velocimeters, CTD (Conductivity, temperature, Depth probes) and Pressure gauges.

6. Annexes

Submersible Depth Sensors Series 8000

Digiquartz® Transducers are incorporated into submersible housings as depth sensors. All depth sensor ranges are available with either frequency outputs or integral intelligent electronics with bi-directional digital communications. Typical application accuracy is better than 0.01% with parts-per-billion resolution, low power consumption, and excellent long-term stability.

Intelligent Depth Sensors with dual RS-232 and RS-485 interfaces allow complete remote configuration and control of all operating parameters, including resolution, sample rate, choice of engineering units, integration time, and sampling requests. Commands include: Single sample and send, synchronized sample and hold, continuous sample and send, and special burst sampling modes. Other features include support for both serial loop and multi-drop networking, selectable baud rates up to 115,200 baud, high-speed continuous pressure measurements, a power management "sleep" mode, data formatting features, synchronization of measurements with time-based integration, unit identification commands, and 2 or 4 wire RS-485 transmission distances greater than 1 kilometer.

All Digiquartz® Transducers come with a limited five-year warranty with the first two years covered at 100%.

ABSOLUTE RANGES (Frequency or Serial Outputs Available)

0-10 mH_2O	(30 psia, 0.21 MPa)
0-20 mH_2O	(45 psia, 0.31 MPa)
0-60 mH_2O	(100 psia, 0.69 MPa)
0-130 mH_2O	(200 psia, 1.38 MPa)
0-200 mH_2O	(300 psia, 2.07 MPa)
0-270 mH_2O	(400 psia, 2.76 MPa)
0-700 mH_2O	(1000 psia, 6.89 MPa)
0-1400 mH_2O	(2000 psia, 13.8 MPa)
0-2000 mH_2O	(3000 psia, 20.7 MPa)
0-3000 mH_2O	(4400 psia, 30.3 MPa)
0-4000 mH_2O	(6000 psia, 41.4 MPa)
0-7000 mH_2O	(10,000 psia, 68.9 MPa)

GAUGE RANGES (Frequency or Serial Outputs Available)

0-10 mH_2O	(15 psig, 0.10 MPa)
0-15 mH_2O	(22 psig, 0.15 MPa)
0-20 mH_2O	(30 psig, 0.21 MPa)
0-70 mH_2O	(100 psig, 0.69 MPa)
0-100 mH_2O	(150 psig, 1.03 MPa)
0-140 mH_2O	(200 psig, 1.38 MPa)

FEATURES & PERFORMANCE*

- 0.01% Typical Accuracy
- Parts-per-billion Resolution**
- Low Power Consumption
- High Stability and Reliability
- NIST Traceable - CE Compliant
- Fully Calibrated and Characterized
- Frequency Outputs or Dual RS-232 and RS-485 Interfaces

*Products defined by specification control drawing
**With Digiquartz® Nano-resolution electronics

APPLICATION AREAS

- Geodesy
- Hydrology
- Oceanography
- Tsunami Detection
- Wave and Tide Gauges
- Offshore Platform Leveling
- Dam and Reservoir Level Sensing
- Underwater Pipe Laying and Surveying
- Remotely Operated and Autonomous Underwater Vehicles

Paroscientific, Inc.
Digiquartz® Pressure Instrumentation

SEA·BIRD SCIENTIFIC

SBE 37 IMP-ODO with Titanium Housing, 600 dbar Pressure Sensor, Inductive Modem Telemetry, 600 meter ODO Sensor

Product #:	**37IMP.34002S**
USD Price:	Contact Sea-Bird

Moored Conductivity, Temperature, Optical Dissolved Oxygen, and (optional) Pressure measurements, at user-programmable intervals. Inductive Modem (IM) interface, internal memory, and internal battery pack.

The SBE 37-IMP-ODO pumped MicroCAT is a high-accuracy conductivity and temperature (pressure optional) recorder with integrated Inductive Modem (IM) interface, internal batteries, memory, integral Pump, and Optical Dissolved Oxygen. The MicroCAT is designed for long-duration deployments on moorings.

Data is recorded in memory and can be transmitted when polled through inductive modem telemetry. Measured data and derived variables (salinity, sound velocity, specific conductivity) are output in engineering units.

Memory capacity exceeds 380,000 samples. Battery endurance varies, depending on sampling scheme and deployment temperature and pressure. Sampling every 15 minutes (10 °C, 500 dbar), the MicroCAT can be deployed for 8.5 months (24,000 samples).

Optimal Moored CTD
Moored Conductivity, Temperature, and Pressure (optional), at user-programmable 6-sec to 6-hour intervals.

Flexible Deployment Options
Internal memory and battery pack.

Inductive Modem Telemetry
Inductive Modem (IM) system provides reliable, low-cost, real-time data transmission for up to 100 IM-enabled instruments using plastic-coated wire rope (typically 3x19 galvanized steel) as both transmission line and mooring tension member. IM instruments clamp anywhere along the mooring, which is easily reconfigured by sliding and re-clamping instruments on the cable.

Integral Pump
Pump runs for 1 second for each sample, providing improved conductivity response and bio-fouling protection.

Optical Dissolved Oxygen Sensor
Integrated SBE 63 Optical Dissolved Oxygen Sensor. Adaptive Pump Control for high-accuracy oxygen data.

Specifications

Communication:	Inductive Modem Telemetry
Conductivity Accuracy:	± 0.0003 S/m (0.003 mS/cm)
Conductivity Measurement Range:	0 - 7 S/m (0 - 70 mS/cm)
Conductivity resolution:	0.00001 S/m (0.0001 mS/cm)
Conductivity Typical Stability:	0.0003 S/m (0.003 mS/cm) per month
Dissolved Oxygen Accuracy:	larger of ± 3 µmol/kg (equivalent to 0.07 ml/L or 0.1 mg/L) or ± 2%

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Dissolved Oxygen Range:	120% of surface saturation in all natural waters (fresh and salt)
Dissolved Oxygen Resolution:	0.2 µmol/kg
Dissolved Oxygen Typical Stability:	Sample-based drift < 1 µmol/kg/100,000 samples (20 °C)
Housing Material:	Titanium
Internal Batteries:	10.6 Amp-hour (nominal) battery pack (derated for calculations)
Pressure Initial Accuracy:	± 0.1% of full scale range
Pressure Resolution:	0.002% of full scale range
Pressure Sensor/Range:	600 dbar Pressure Sensor
PressureTypical Stability:	0.05% of full scale range per year
Pumps:	Yes
Sensor:	600 meter ODO Sensor
Temperature Accuracy:	± 0.002 °C (-5 to +35 °C); ± 0.01 (+35 to +45 °C)
Temperature Range:	-5 to +45 °C
Temperature Resolution:	0.0001 °C
Temperature Stability:	0.0002 °C per month

AANDERAA
a xylem brand

ZPulse® Doppler Current Sensor 4420/4520, 4420R/4520R 4830/4930, 4830R/4930R

A rugged, true vector-averaging sensor for measuring current speed and direction in the sea.

Features ZPulse Doppler Current Sensor:

- Unique ZPulse multi-frequency acoustic technology improves data quality, sampling speed and reduces power consumption
- Smart sensor for easy integration on the SeaGuard platform
- Built in solid state three axis tilt compensated compass
- Direct readout of engineering data
- Fast sampling rate
- Low power consumption
- Insensitive to fouling
- Low maintenance needs
- 4420/4520/4830/4930 model: AiCaP and RS-232 output
- 4420R/4520R/4830R/4830R model; RS-422 output
- 4830/4930/4830R/4930R including temperature

The ZPulse Doppler Current Sensor (DCS) is a single-point current sensor primarily intended to be used with the Aanderaa SeaGuard platform to form a Recording Current Meter (RCM). It is designed for commercial as well as research use. There are 8 versions; 4420/4420R, 4830/4830R has a depth rating of 300 meters, while the 4520/4520R/ 4930/4930R has a depth rating of 6000 meters. 4830/4830R/ 4939/4930R have a temperature sensor included.

4420/4520/4830/4930 has both AiCaP and RS-232 ouput. The SeaGuard platform and the smart sensor are interfaced by means of a reliable CANbus interface (AiCaP), using XML for plug and play capabilities. 4420R/4520R/ 4830R/4930R has only RS-422 output for use as stand-alone sensor with long cables. The sensor version must be specified when ordered as the versions are not interchangeable. The R-version can not be used in SeaGuard applications.

The DCS sensors are based on the backscatter acoustic Doppler principle. The DCS has two orthogonal transducer axes with two transducers on each axis. This enables the DCS to measure in both directions on each axis which is a great advantage. This makes it insensitive to disturbance from vortex speeds around the sensor itself and the mooring line when the forward ping feature is enabled. One transducer on each axis transmits short ultrasonic pulses simultaneously. The same transducers receive backscattered signals from particles in the water. This gives an orthogonal x and y speed component which is tilt compensated to find the correct horizontal speed components.

The North and East speed components are calculated based on the x and y speed components and the heading from the built-in solid state electronic compass. The sensor takes several of these two-component measurements and finally calculates the averaged north and east speed components and the vector averaged absolute speed and direction.

Another great advantage is the new ZPulse technology which improves the statistical precision. Complex acoustic pulses comprising several distinct frequencies are combined into a single acoustic pulse. The ZPulse based DCS separates the received signal into different frequency bands, one for each frequency in the transmitted signal. Further it analyses the frequency shift using a high speed Digital Signal Processor using an ARMA based parametric model processing algorithm to find the Doppler shift frequencies. This multi-frequency technique reduces the required number of pings needed in order to achieve an acceptable statistical error. The achieved measurement precision is proportional to the inverse of the square root of the number of ping measurements in a measurement interval. The ZPulse DCS uses two frequencies and this gives a reduction by a factor square root of two compared to a single frequency sensor. A single frequency sensor needs twice the number of ping to achieve the same precision as the Zpulse DCS.

The solid state sensor is well suited for monitoring low current speeds due to no moving parts. Because the sensor starts measuring in an area 0.4 to 1.0 meter from the instrument, the effect of marine fouling and local turbulence is minimized.

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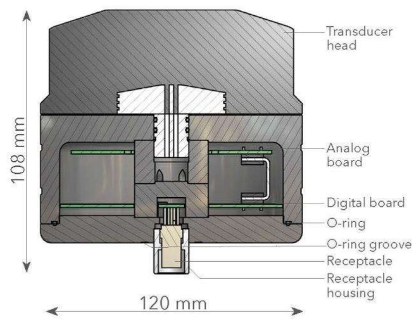
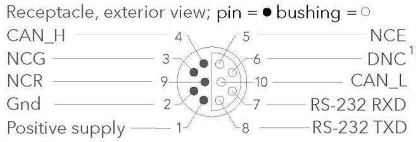


PIN CONFIGURATION

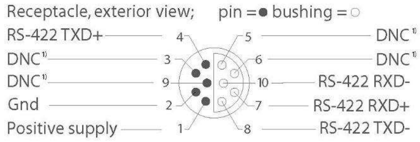
Receptacle, exterior view; pin = ● bushing = ○



DNC1) = Do Not Connect

PIN CONFIGURATION 4420R/4520R/4830R/4930R

Receptacle, exterior view; pin = ● bushing = ○



DNC1) = Do Not Connect

Specifications subject to change without prior notice.

Current Speed:	(Vector averaged)
Range:	0–300cm/s
Resolution:	0.1mm/s
Mean Accuracy:	±0.15cm/s
Relative:	± 1% of reading
Statistic precision (std):	0.3cm/s (ZPulse mode), 0.45cm/s[1]
Current Direction:	
Range:	0–360° magnetic
Resolution:	0.01°
Accuracy:	±5° for 0-15° tilt ±7.5° for 15-35° tilt
Temperature (only 4830/4830R/4930/4930R):	
Range:	-5°C to +40°C
Resolution:	0.01°C
Accuracy:	0.1°C
Settling Time(63%):	30s
Tilt Circuitry:	
Range:	0-35°
Resolution:	0.01°
Accuracy:	±1.5°
Compass Circuitry:	
Resolution:	0.01°
Accuracy:	±3°
Acoustics:	
Frequency:	1.9 to 2.0MHz
Power:	25 Watts in 1ms pulses
Beam angle (main lobe):	2°
Interfaces:	
4420/4520/4830/4930:	AiCaP protocol, RS-232
4420R/4520R/4830R/4930R:	RS-422
RS-232/RS-422 Output:	9600 baud, 8 data bit, No parity, 1 stop bit, Xon/Xoff
Maximum cable length:	
RS-232:	15m
RS-422:	1500m
Installation distance:	
From surface:	0.75m
From bottom:	0.5m
Supply Voltage:	6–14 Vdc
Operating Temperature:	-5 to +50°C
Depth Capability:	
4420/4830:	300m
4520IW/4930IW:	3000m
4520DW/4930IW:	6000m
Electrical Connection:	10-pin plug
Material and Finish:	
4420/4420R:	Durotong, POM
4830/4830R:	Durotong, POM, epoxy coated titanium
4520/4930/4520R/4930R:	Durotong, epoxy coated titanium

[1] *Standard deviation based on 300 pings*

xylem
Let's Solve Water

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Aanderaa Data Instruments AS
Sanddalsringen 5b, P.O. Box 103 Midtun,
5843 Bergen, Norway
Tel +47 55 60 48 00
Fax +47 55 60 48 01

VALEPORT

miniSVP - Sound Velocity Profiler

The miniSVP has been developed to provide a cost effective tool for the collection of Sound Velocity Profiles without compromising the quality of the data. Ideally suited to ROV, coastal, or small boat applications, the miniSVP will appeal to survey companies, military and academia alike, being simple to use and easy to handle.

Sensors

The miniSVP is fitted with Valeport's digital time of flight sound velocity sensor, a PRT temperature sensor, and strain gauge pressure transducer.

Sound Velocity

Range:	1375 - 1900m/s
Resolution:	0.001m/s
Accuracy:	±0.02m/s

Temperature

Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C

Pressure

Range:	5, 10, 30, 50, 100, 300 or 600 Bar
Resolution:	0.001% range
Accuracy:	±0.05% range

Data Acquisition

The miniSVP features a selection of pre-programmed sampling regimes, covering many standard applications. Data may be sampled from 1 to 16Hz, making it suitable for rapid profiling or for continuous measurement at a fixed point.

Sampling Modes

Continuous:	Regular output from all sensors at 1, 2, 4, 8 or 16Hz.
Profile:	Logs data as the device falls (or rises) by a defined amount through the water column.

Communications

The instrument will operate autonomously, with setup and data extraction performed by direct communications with PC before and after deployment. It also operates in real time, with a choice of communication protocols fitted as standard and selected by pin choice on the output connector:

RS232:	Up to 200m cable, direct to serial port
RS485:	Up to 1000m cable
Baud Rate:	4800 - 460800
Protocol:	8 data bits, 1 stop bit, No parity, No flow control
Bluetooth:	Bluetooth logger and communication set available for cable free data recovery. Bluetooth module is limited to a depth rating of 500m

Memory

The miniSVP is fitted with a solid state non-volatile Flash memory, capable of storing over 10 million lines of data (equivalent to 10,000 profiles to 500m, at 1m profile resolution).

Electrical

Internal:	1 x C cell, 1.5V alkaline or 3.6V lithium
External:	9 - 28V DC
Power:	<250mW
Battery Life:	approx 30 hours operation (alkaline)
	approx 90 hours operation (lithium)
Connector:	SubConn MCBH10F

Physical

Materials:	Acetal or Titanium housing (as ordered) Polycarbonate & Composite sensor components Stainless steel (316) deployment cage
Depth Rating:	500m (Acetal) 6000m (Titanium)
Note:	Maximum deployment depth may be limited by pressure transducer range
Instrument Size:	Main Housing: 48mmØ
	Sensor Body: 54mmØ
	Length: 435mm (including connector)
Deployment Cage:	110mmØ x 450mm long
Weight:	0.8kg (Acetal)
	1.6kg (Titanium)
Shipping:	51 x 42 x 27cm
	10kg

Software

The system is supplied with DataLog Express Windows based PC software, for instrument setup, data extraction and display. DataLog Express is license free.

Ordering

0660001-XX	miniSVP Sound Velocity Profiler in Acetal Supplied with: • Deployment cage • Switch plug • 3m comms lead • DataLog x2 software • Manual and transit case
0660001BT-XX	miniSVP Sound Velocity Profiler in Acetal Supplied with: • Deployment cage • Switch plug • Bluetooth logger/communication set • DataLog x2 software • Manual and transit case
Note:	XX denotes pressure transducer range Select from 5, 10, 30 or 50bar
0660002-XX	miniSVP Sound Velocity Profiler in Titanium Supplied with: • Deployment cage • Switch plug • 3m comms lead • DataLog x2 software • Manual and transit case
Note:	XX denotes pressure transducer range. Select from 100, 300 or 600bar

Datasheet Reference: miniSVP - May 2016

Valeport Limited, St. Peter's Quay Totnes, Devon, TQ9 5EW UK
t. +44 (0)1803 869292 f. +44 (0)1803 869293 e. sales@valeport.co.uk w. www.valeport.co.uk