

KM3NeT Italia Project ("Phase III")

Calibration System: Instrumentation

V 1.0 – 21/01/2013 Author G: Riccobene

Input from the KM3NeT Steering Committee (17/01/2013):

- 1) Oceanographic monitoring instrumentation must be installed on KM3NeT-IT for both detector calibration aims and cross fertilization with Earth and Sea science.
 - 2) Standard oceanographic sensors will be displaced in several towers on-board tower base and dedicated instrumented floors:
lower (floor 1), middle (floor 7), upper (floor 14)
This allows sufficient vertical sampling of the water column for calibration and oceanographic purposes.
 - 3) Standard oceanographic sensors comprise: CTDs, DCS (Doppler Current Sensors), Sound Velocimeters, pressure gauges.
All sensors must be compliant with weight limits, communication standards (RS232) and maximum power limits and standard set by electronics and mechanics design.
Oxygen sensors should be installed on CTDs.
The use of the C-star transmissometers is considered not necessary due to too low resolution of the instrument. The light propagation properties will be recovered from data acquired by nano-beacons.
 - 4) The Porfido system will be installed on-board one or two dedicated tower(s) under the condition that reliable and enough precise pressure, temperature and/or salinity gauges will be integrated in the system.
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KM3NeT Italia layout parameters

8 towers
16 floors (14 instrumented) and active tower base
20 m inter-distance among floors
100 m distance among towers

“Standard” Oceanographic probes

Costs and integration strategy:

Standard probes will be purchased by manufacturers/re-sellers

All instruments must be compliant with the following specs

Data interface protocol: RS232, 96k Baud.

Connector: 4 wires (Rx, TX, Power 12VDC, GND)

All instruments will be placed only on floors:1,7,14, and tower base

Costs (approx):

Qt. 3 * CTD Microcat SBE-37 SIP-IDO w pump and O2 sensor = 38 k€

Qt. 1 * Paroscientific 8BT4000-I =18 k€

Qt. 3 * Aanderaa Zpulse-4520DW DCS = 18 k€

Qt. 1 * Aanderaa Optode 4831 = 5 k€

Qt. 2* Valeport minSVS = 8 k€

Total= 87 k€

Tower 1

Floors equipped with standard oceanographic probes

Floor 1: CTDs Microcat SBE-37 SIP-IDO w pump and O2 sensor (appendix 1)

Floor 7: CTDs Microcat SBE-37 SIP-IDO w pump and O2 sensor (appendix 1)

Floor 14 : CTDs Microcat SBE-37 SIP-IDO w pump and O2 sensor (appendix 1)

Base: Absolute pressure gauge -Paroscientific 8BT4000-I (appendix 2)

Aims:

- Measure Temperature, Pressure and Conductivity (Salinity) along the instrumented water column.
- Provide (indirect) sound velocity measurement for Acoustic Positioning system.
- Provide independent measurements of floors' heights along the tower.
- Provide absolute pressure measurements to recover absolute depth, and pressure variations due to tidal and wave effect.
- Provide real-time and long-term series of data to oceanographers and geophysicists.

Paroscientific 8BT4000-I Facts

(see appendix 1 and

<http://www.paroscientific.com/pdf/Series8000.pdf>)

Case: titanium 4000 m

Dimension (max): 275 mm (h) x 40 mm (r)

Weight in air: 1.3 kg

Connector: RMG4FS

Power: 16-32 mAmps at 6 - 16 VDC

Communication: RS232 configurable

SBE-37 SIP-IDO Facts

(see appendix 1 and

http://www.seabird.com/products/spec_sheets/37sipidodata.htm)

Case: Titanium, 7000 m

Dimension (max): 478 mm (h) x 66.3 mm x 87.6 mm

Weight in air: 3.8 kg; in water: 2.3 kg

Connector: Impulse XSG 4BCL HP SS

Power: Max 0.5 Amps at 9 - 24 VDC
Communication: RS232

Tower 2

Floors equipped with standard oceanographic probes

Floor 1: Aanderaa Zpulse 4520-DW DCS (appendix 3)
Floor 7: Aanderaa Zpulse 4520-DW DCS (appendix 3)
Floor 14 : Aanderaa Zpulse 4520-DW DCS (appendix 3)

Aanderaa Zpulse-4520DW DCS Facts

(see appendix 2 and

<http://www.aadi.no/Aanderaa/Document%20Library/1/Data%20Sheets/ZPulse%20Doppler%20Current%20Sensor.pdf>)

Case: Durotong, epoxy coated Titanium

Dimension (max): 108 mm (h) x 120 mm (r)

Weight in air: 1.8 kg

Connector: 10-pin Strain-proof Plug. Aanderaa Standard. Requires interface

Power: XX Amps at 7 - 14 VDC

Communication: RS232 9600 Baud, 8 data bit, No parity, 2stop bits

Aims:

- Measure current intensity and direction along the instrumented water column.
- Measure and test dependence on currents of the tower mechanics
- Correlate bioluminescence events to underwater current
- Provide real-time and long-term series of oceanographic data to oceanographers

Tower 3 (to be confirmed)

Floors equipped with standard oceanographic probes

Floor 1: Sound Velocimeter miniSVS Valeport (appendix 5)
Floor 7: Oxygen Sensor Aandera Optode 4831-DW(appendix 4)
Floor 14 : Sound Velocimeter miniSVS Valeport (appendix 5)

Aims:

- Provide independent measurement of sound velocity (different technique wrt CTD)
- Provide independent measurement of Dissolved Oxygen (different technique wrt CTD)

Aanderaa Optode 4831 Facts

(see appendix 4 and

<http://www.aadi.no/Aanderaa/Document%20Library/1/Data%20Sheets/Oxygen%20Optode%204831%204831F.pdf>)

Case: Epoxy coated Titanium, PA

Dimension (max): 115 mm (h) x 36 mm (r)

Weight in air: 0.22 kg

Connector: 8 pin Subconn MCBH8M

Power: 0.02 to 0.1 Amps at 5 - 14 VDC

Communication: RS232 9600 Baud, 8 data bit, No parity, 2stop bits

Valeport minSVS Facts

(see appendix 5 and

http://www.valeport.co.uk/Portals/0/Docs/Datasheets/Valeport_miniSVS_v2a.pdf)

Case: Titanium

Dimension (max): 100 mm (h) x 36 mm (r)

Weight in air: 1 kg

Connector: 6 pin Subconn MCBH6F

Power: 20 to 30 mAmps at 8 - 30 VDC

Communication: Configurable Baud, 8 data bit, No parity, 2 stop bits

Porfido system probes

Tower 8

Porfido RFID will be installed on-board one OM in each floor.

Still in R&D Phase. Functionality, reliability and performances must be demonstrated by the LNF group.

Temperature sensors are the main probes to be integrated.

Conductivity probes require longer R&D to evaluate stable response as a function of time in deep sea environment.

Aims:

- a) Measure temperature with high precision, high data rate and high spatial sampling.
- b) Provide real-time and long-term series of data to oceanographers.
- c) Comparison with NIOZ “standard” system.

Costs and integration strategy:

Porfido production is in charge to the LNF group.

Strategy to be decided:

- a) purchase of raw material and integration at LNF
- b) purchase of integrated system

Critical path: submarine wiring system. To be decided with tower cabling coordinator

Electrical and data communication interface between the nanobeacon and the FEM is the same as Phase II.

OM integration group (Sez. Catania) will provide all support for integration and tests

Porfido-Temperature Facts

To be completed by LNF Group and KM3Net-IT Electronics and OM Coordinators

Optical Calibration: LED nanobeacons

Towers 1-8

Nanobeacons will be installed onboard all 8 towers.

To be decided:

In each OM or in 2 or 3 OM per floor ???

Nanobeacons will be installed inside the OMs to produce upward-oriented flashes of light, illuminating OMs in upper floors (estimated distance max 100 m).

Aims:

- Perform time calibration of the tower
- Measure light transmission (spectral) properties along the instrumented water column, with a redundant measurement at the most interesting lambda (440 nm) for light propagation

Costs and integration strategy:

Nanobeacons production is in charge to the IFIC Valencia group

Electrical and data communication interface between the nanobeacon and the FEM is under development with the Electronics group.

OM integration group (Sez. Catania) will provide all support for integration and tests

Nano-beacons Facts

To be completed by IFIC Group and KM3Net-IT Electronics and OM Coordinators

Dimensions

Power consumption

Communication

Geometrical layout and LED wavelengths (assuming only 2 OMs per floor):

(Proposal, to be confirmed after discussion with IFIC)

Towers 1,2,3

floors 1,..,14	OM0 → LED (440 nm)
floors 1,5,9,13,14	OM4 → LED (420 nm)
floors 2,4,7,10,12	OM4 → LED (460 nm)
floors 3,6,8,11	OM4 → LED (480 nm)

Towers 4,5,6

floors 1,..,14	OM0 → LED (440 nm)
floors 1,5,9,13,14	OM4 → LED (400 nm)
floors 2,4,7,10,12	OM4 → LED (500 nm)
floors 3,6,8,11	OM4 → LED (650 nm)

Towers 7,8

floors 1,..,14	OM0 → LED (440 nm)
floors 1,5,9,13,14	OM4 → LED (420 nm)
floors 2,4,7,10,12	OM4 → LED (550 nm)
floors 3,6,8,11	OM4 → LED (480 nm)

Optical Calibration: Laser beacon

Towers 7,8

Laser beacons could be installed on-board 1 or 2 towers.

They will be hosted in the tower base.

No more details are available, since the system is under R&D phase at the IFIC Valencia.

Aims:

- a) Perform and check time calibration among towers
- b) Measure optical properties close the sea bottom at 532 nm.

Costs and integration strategy:

Production should be in charge to the IFIC Valencia group

Electrical and data communication interface between the Laser Beacon and Tower base has to be defined.

Laser-beacons Facts

To be completed by IFIC Group and KM3Net-IT Electronics and Mechanics
Coordinators

Dimensions

Power consumption

Communication

Position Calibration: Compasses, Gyro and accelerometer boards

Towers 1 to 8, all floors

AHRS (Altitude, Heading Reference system) boards will be installed onboard all 8 towers in all FCMs.

Aims:

- a) Perform measurements of absolute orientation of the FCM vessel
- b) Provide information on the acceleration (during opening and during operation) of the floors

Costs and integration strategy:

AHRS boards will be designed by INFN-LNS

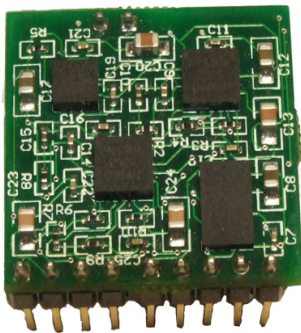
Electrical and data communication interface between the board and FCM will be obtained through RS-232 communication.

AHRS board Facts

Dimensions: 25 x 25 x 4 (h) mm³

Power consumption : 30 mA @3.3 VDC

Communication: RS-232 (available I²C and CanBus)



Acoustic Positioning System

Towers 1 to 8

All floors or every 2 floors (to be decided)

Each tower will be equipped with an array of hydrophones for positioning and bio-acoustic signal detection. Two hydrophones per floor will be installed, at each floor end. Auto-calibrating Long Baseline (LBL) transceivers will be installed on the tower base. The beacons should be compliant with USBL (Ultra Short Baseline) Systems for absolute positioning and ROV guidance during deployment operations.

Aims:

- a) Perform measurements of relative and absolute positions of the floors
- b) Detect and track acoustic sources in the sea
- c) Perform preliminary studies on neutrino acoustic detection

Costs and integration strategy:

Hydrophones and transceiver will be produced by external companies, under the specifications of INFN.

1) Hydrophones must come with:

preamplifier, ADC and DIT onboard ("Digital Hydrophones"-DH), moulded in the cable connecting the hydrophone to the FCM.
Communication with the FCM will be in AES-3/EBU standard, 192kHz (or more)/24 bit.
5VDC power and master clock will be provided by the FCM.

Hydrophones will be of 2 types:

- High sensitivity DH (-190 dB w/o preamplifier) will be installed on floors 1,7,14
- Low sensitivity DH (-200 dB w/o preamplifier) will be installed on all other floors and on tower base

HS-DH must have:

Large bandwidth (100 Hz - 70 kHz), omnidirectional beam pattern, flat sensitivity (+-3 dB) over the sensitive frequency band, dynamic range >90 dB, saturation level >180 dB re 1uPa @ 1m

LS-DH must have:

Large bandwidth (100 Hz - 70 kHz), quasi-omnidirectional beam pattern, flat sensitivity (+-3 dB) over the sensitive frequency band, dynamic range >70 dB, saturation level > 180 dB re 1uPa @ 1m

All hydrophones must come with:

- Pressure test certification (400 bar), calibration sheet (sensitivity vs frequency)
- Sensitivity vs. pressure (1,100,200,350 bar) calibration must be performed for the different production batches.
- Measured electronics latency at given clock frequency

Estimated costs:

HS-DH : $2000 \times 2 \times 3 \times 8 = 96 \text{ k€}$

LS-DH : $800 \times 2 \times 12 \times 8 = 153 \text{ k€}$ or $800 \times 2 \times 5 \times 8 = 64 \text{ k€}$

Critical path: define cabling and connector specs between mechanical, Electronics and Acoustics Coordinators

Hydrophone Facts (to be confirmed)

Dimensions: 250 mm (h) x 25 mm (r)
 Power consumption: <150 mA @ 5 VDC
 Communication: AES-EBU
 Material: Polyurethane jacket

2) Acoustic transmitters must come with:

Piezo-ceramic transducer excitation system

Interface board for:

programmable acoustic emission signal (fs, Amp, shape)
 FCM emission trigger signal reception

Communication with the FCM could be obtained via RS-232 link (programming)

LVDS link (trigger, mclk)

Power line must be decided

Transducer system must have:

Bandwidth (10 kHz - 50 kHz), flat (+/-3 dB) dB, max emission level 190 dB re 1uPa @ 1m

All transducers must come with:

- Pressure test certification (400 bar), calibration sheet (TVR vs frequency)
- Emission vs. pressure (1,100,350 bar) calibration.
- Measured electronics latency at given clock frequency

Critical path: define transducer LBL system between mechanical, Electronics, Sea Operation and Acoustics Coordinators

Estimated costs:

LBL Emitter (including electronics) : $4000 \times 8 = 32$ k€

Transducers Facts (to be defined)

Geometrical layout

Towers 1,...,8

floors 1, 7, 14	2 x HS-DH
floors 2..6, 8.. 14	2 x LS-DH
tower base	1 x LS-DH
tower base	1 x LBL transducer

Appendixes : data sheets

SBE 37-SIP-IDO MicroCAT C-T-DO (Pressure optional) Sensor Configuration Details

[Brochure/specifications](#) Manual ([RS-232](#)) Reference Sheet ([RS-232](#)) RS-485 Manual and Reference Sheet not yet available

Note: We do not publish prices on the website. Please contact us [seabird@seabird.com or (+1) 425-643-9866] for pricing.

Part #	Description	Notes
37SIP-IDO	MicroCAT C & T (pressure optional) Sensor with Integrated Dissolved Oxygen sensor (IDO), Serial Interface, & Internal Pump - Includes 7000 m titanium housing, 8 MB Flash memory, RS-232C interface, data/power cable 801385 (cable may be deleted for credit), AF24173 Anti-Foulant Devices, Seasoft software, & complete documentation.	There are numerous SBE 37 MicroCAT models (SM, SMP, SMP-IDO, SMP-ODO, SI, SIP, SIP-IDO, SIP-ODO, IM, IMP, IMP-IDO, & IMP-ODO -- click here for comparison of features). 37-SIP-IDO MicroCAT includes: Serial Interface (RS-232 standard, RS-485 optional) Memory internal, integral Pump Integrated Dissolved Oxygen sensor For photos of standard shipment, click here. Note that 37-SIP-IDO does not include internal batteries. See 37-SMP-IDO for comparable instrument with internal batteries.

SBE 37-SIP-IDO Pressure Sensor Range (Depth) Options

37SIP-1a	20 m strain gauge pressure sensor	Pressure sensor is installed in end cap, & is not field replaceable / swappable. While highest pressure rating gives you most flexibility in using 37-SIP-IDO, it is at expense of accuracy & resolution. It is advantageous to use lowest range pressure sensor compatible with your intended maximum operating depth, because accuracy & resolution are proportional to pressure sensor's full scale range. For example, comparing 2000 & 7000 m sensors -- 2000 m sensor: - initial accuracy = 2 m (= 0.1% * 2000 m), resolution = 0.04 m (= 0.002% * 2000 m) 7000 m sensor: - initial accuracy = 7 m (= 0.1% * 7000 m), resolution = 0.14 m (= 0.002% * 7000 m)
37SIP-1b	100 m strain gauge pressure sensor	
37SIP-1c	350 m strain gauge pressure sensor	
37SIP-1h	600 m strain gauge pressure sensor	
37SIP-1d	1000 m strain gauge pressure sensor	
37SIP-1e	2000 m strain gauge pressure sensor	
37SIP-1f	3500 m strain gauge pressure sensor	
37SIP-1g	7000 m strain gauge pressure sensor	

SBE 37-SIP-IDO *ShallowCAT* Option -- Plastic (PET-P) Housing with 250 meter depth rating

37SIP-2	250 m plastic housing instead of standard titanium housing (CREDIT)	
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37-SMP-IDO shown; plastic housing detail similar for 37-SIP-IDO

Substituting plastic housing for standard 7000 m titanium housing provides lower cost option for shallow deployments.

SBE 37-SIP-IDO Alternate Serial Interface Option

37SIP-3	RS-485 (half duplex ONLY) serial interface (replaces RS-232 interface)	Two-wire, RS-485 interface provides communication with individual 37-SIP-IDO or with all 37-SIP-IDOs attached to RS-485 interface. This allows for coordination of sampling among many instruments. However, note that half-duplex communication is one-direction at a time (i.e., you cannot send commands & receive data at same time). Note that RS-232 & RS-485 versions of 37-SIP-IDO have separate manuals; see manual links at top of page.
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SBE 37-SIP-IDO Mounting Bracket Options *(Specify mount clamp size to match O.D. of wire jacket)*

37SIP-4a	Plastic brackets to provide through-bolt mounting to a flat surface	See document 67218 .
37SIP-4b	Wire guide & mounting clamp for 1/4 in. diameter mooring wire	
37SIP-4c	Wire guide & mounting clamp for 5/16 in. diameter mooring wire	
37SIP-4d	Wire guide & mounting clamp for 3/8 in. diameter mooring wire	
37SIP-4e	Wire guide & mounting clamp for 1/2 in. diameter mooring wire	
37SIP-4f	Wire guide & mounting clamp for 6 mm diameter mooring wire	
37SIP-4g	Wire guide & mounting clamp for 8 mm diameter mooring wire	
37SIP-4h	Wire guide & mounting clamp for 10 mm diameter mooring wire	
37SIP-4i	Wire guide & mounting clamp for 12 mm diameter	

	mooring wire
37SIP-4j	Wire guide & mounting clamp for 16 mm (5/8 in.) diameter mooring wire



37-SMP-IDO shown; clamp and guide detail identical for 37-SIP-IDO

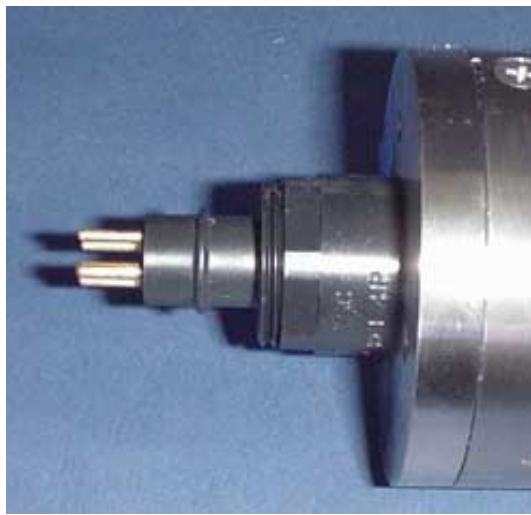
Cable fits loosely through wire guide, & is clamped only at mounting clamp. See document [67219](#).

Thread for clamping to mooring cable:

- 37SIP-1b (1/4 in. diameter): 1/4-28 UNF
- 37SIP-1c (5/16 in. diameter): 5/16-24 UNF
- 37SIP-1d (3/8 in. diameter): 3/8-24 UNF
- 37SIP-1e (1/2 in. diameter): 9/16-12 UNC
- 37SIP-1f (6 mm diameter): 1/4-20 UNF
- 37SIP-1g (8 mm diameter): 5/16-24 UNF
- 37SIP-1h (10 mm diameter): 7/16 -14 UNF
- 37SIP-1i (12 mm diameter): 1/2-13 UNF
- 37SIP-1j (16 mm, 5/8 in. diameter): 5/8-18 UNF

SBE 37-SIP-IDO Wet-Pluggable Connector Option

37SIP-5	Wet-pluggable (MCBH) I/O connector instead of Standard (XSG) connector (includes data/power cable)
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Standard Connector (Impulse XSG)



Wet-pluggable Connector (MCBH)

Wet-pluggable connectors may be mated in wet conditions. Their pins do not need to be dried before mating. By design, water on connector pins is forced out as connector is mated. However, they must not be mated or un-mated while submerged. Wet-pluggable connectors have a non-conducting guide pin to assist pin alignment & require less force to mate, making them easier to mate reliably under dark or cold conditions, compared to our standard (Impulse XSG/RMG) connectors. Like standard connectors, wet-pluggables need proper lubrication & require care during use to avoid trapping water in sockets.

37SIP-5 includes a data/power cable compatible with wet-pluggable data/power connector.

SBE 37-SIP-IDO Storm Shipping Case Option -- holds up to 3 SBE 37-SIP-IDOs

37SIP-6I Storm shipping case (iM2950) instead of standard wood crate -- holds up to 3 SBE 37-SIP-IDOs

[Storm shipping case](#) with *custom* foam inserts holds up to 3 IDO MicroCATs of any type -- IMP-IDO, SMP-IDO, SIP-IDO.

- Injection molded case with HPX resin plastic body, recessed wheels, automatic pressure equalization valve, hinged push-button latches, fold-down padded handle, & O-ring seal. Meets airline luggage regulations.
- Inner dimensions: 29 x 18 x 10.5 inches (74 x 46 x 27 cm).
- Outer dimensions: 31.3 x 20.4 x 12.2 inches (80 x 52 x 31 cm).



Price for 37SIP-6I reflects a credit for deletion of our standard wood crate.

SBE 37-SIP-IDO Spares & Accessories

801542 AF24173 Anti-Foulant Device (pair, bagged, labeled for shipping)

		Anti-foulant devices fit into anti-foulant device cups at conductivity cell intake and plumbing exhaust, under the conductivity cell guard. Anti-foulant devices included with standard shipment; these are spares. Useful life varies, depending on several factors. We recommend that customers consider more frequent replacement when high biological activity & strong current flow (greater dilution of anti-foulant concentration) are present. Moored instruments in high growth & strong dilution environments have been known to obtain a few months of quality data while drifters that operate in more photic, less turbid open ocean environments may achieve years of quality data. Experience may be strongest determining factor in specific deployment environments.	 AF24173 Anti-Foulant Device
801376	Data/Power interface cable, RMG-4FS to DB-9S & 9V battery snap , 2.4 m (DN 32604)	801376 -- Some users prefer battery snap connector instead of red/black twisted wire leads. Order 801376 in place of 801206 if desired.	
801263	Data/Power interface cable, Wet-Pluggable , MCIL-4FS to DB-9S & 9V battery snap , 2.4 m (DN 32490)	801263 -- Some users prefer battery snap connector instead of red/black twisted wire leads. If 37SIP-5 (wet-pluggable connector) specified, order 801263 in place of 801206 if desired.	
801385	Data/Power interface cable, RMG-4FS to DB-9S & red/black twisted wire leads , 2.4 m (DN 32277)	801385 -- Included with standard shipment; this is spare.	
801206	Data/Power interface cable, Wet-Pluggable , MCIL-4FS to DB-9S & red/black twisted wire leads , 2.4 m (DN 32366)	801206 -- Included with standard shipment if 37SIP-5 (wet-pluggable connector) specified; this is spare.	
801378	Data / Power interface cable, shielded , RMG-4FS to DB-9S & red/black twisted wire leads, 20 m (DN 32720)	801378 -- Longer (20 m), shielded cable.	
20200	USB to Serial Port Adapter, FTDI UC232R-10 (connects computers with USB ports to RS-232 instruments)	Many newer PCs & laptop computers have USB port(s) instead of RS-232 serial port(s). USB serial adapter plugs into USB port, & allows a serial device to be connected through adapter. Multi-port adapters are available from other companies; see Application Note 68.	
TBD	Storm shipping case (iM2950) -- holds up to 3 SBE 37-SIP-IDOs	Storm shipping case with <i>custom</i> foam inserts holds up to 3 IDO MicroCATs -- IMP-IDO, SMP-IDO, SIP-IDO. • Injection molded case with HPX resin plastic body, recessed wheels, automatic pressure equalization valve, hinged push-button latches, fold-down padded handle, & O-ring seal. Meets airline luggage regulations. • Inner dimensions: 29 x 18 x 10.5 inches (74 x 46 x 27 cm). • Outer dimensions: 31.3 x 20.4 x 12.2 inches (80 x 52 x 31 cm).	

[Product configuration options listing for all products](#)

Additional cables, mount kits, and spares may be found at: [Cables](#), [Mount kits for Sea-Bird sensors](#), [Mount kits for Third Party sensors](#), [Spare parts](#)

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Submersible Depth Sensors

Series 8000



Digiquartz® Depth Sensors provide the ultimate precision in water level measurements. Typical application **accuracy of 0.01%** is achieved even under difficult environmental conditions. Desirable characteristics include excellent long-term stability, **1×10^{-8} resolution**, low power consumption, and high reliability.

The remarkable performance of these depth sensors is achieved through the use of a precision quartz crystal resonator whose frequency of oscillation varies with pressure-induced stress. A quartz crystal temperature signal is provided to thermally compensate the calculated pressure and achieve high accuracy over a broad range of temperatures. The depth sensors include waterproof housings with integral shock protection.

High accuracy, resolution, and stability make Digiquartz® Depth Sensors ideal for applications such as Tsunami detection, wave and tide gauges, platform leveling, underwater pipe laying, and as depth sensors in ROVs and AUVs.

All Depth Sensor ranges are available with either frequency outputs or integral intelligent electronics with bi-directional digital communications.

RANGES

Absolute

0-10 m H₂O to 0-7000 m H₂O

0-30 psia to 0-10,000 psia

Gauge

0-10 m H₂O to 0-140 m H₂O

0-15 psig to 0-200 psig

FEATURES

0.01% Accuracy

1×10^{-8} Resolution

Unique Anti-Fouling Port

Low Power Consumption

High Stability and Reliability

Fully Calibrated and Characterized

ISO 9001 Quality System – NIST Traceable

Frequency Outputs or Dual RS-232 and RS-485 Interfaces

APPLICATION AREAS

Hydrology

Oceanography

Tsunami Detection

Wave and Tide Gauges

Offshore Platform Leveling

Dam and Reservoir Level Sensing

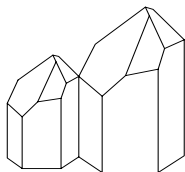
Underwater Pipe Laying and Surveying

Remotely Operated and Autonomous Underwater Vehicles

Dual RS-232 and RS-485 interfaces allow complete remote configuration and control of all operating parameters, including resolution, sample rate, and 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.

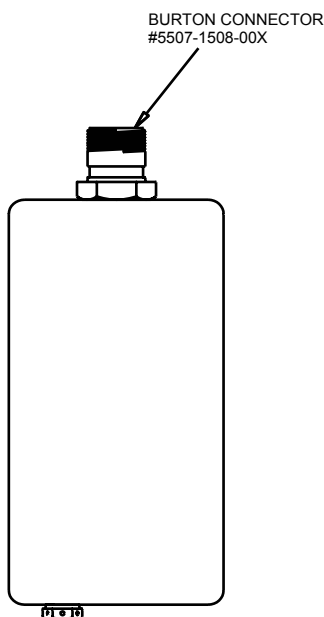
New and enhanced features include support for both serial loop and multi-drop networking, selectable baud rates up to 115,200 baud, synchronization of measurements with time-based integration, 2 or 4 wire RS-485 transmission distances greater than 1 kilometer, improved high-speed continuous pressure measurements, a power management "sleep" mode, data formatting features, and unit identification commands.

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

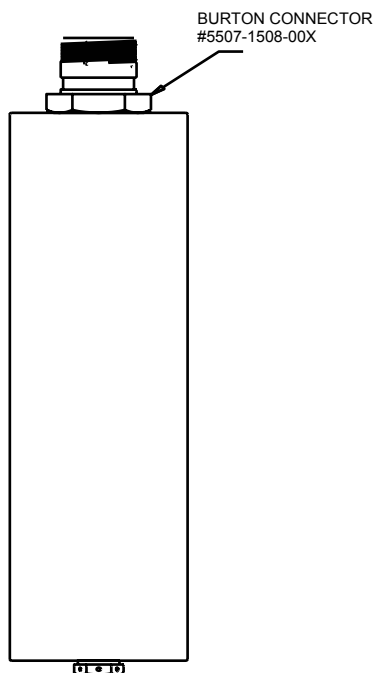


Paroscientific, Inc.
Digiquartz® Pressure Instrumentation





Series 8CDP (0 to 700 meters)



Series 8CB (0 to 7,000 meters)

PERFORMANCE CHARACTERISTICS

Pressure Performance	Accuracy typically better than 0.01% Full Scale (See SCD)
Calibrated Temperature Range:	-2C to +40C
Hysteresis:	8CB $\leq \pm 0.01\%$ Full Scale 8CDP $\leq \pm 0.005\%$ Full Scale
Repeatability:	8CB $\leq \pm 0.01\%$ Full Scale 8CDP $\leq \pm 0.005\%$ Full Scale
Over Pressure:	1.2 times Full Scale
Thermal Sensitivity:	<0.0008% Full Scale / deg C

ELECTRICAL CHARACTERISTICS

Input Voltage:	+6 (Min) to +16 VDC
Current Consumption:	16.5 mA Quiescent, 32 mA max @ +6 VDC
Output Signal:	RS-232 meets EIA/TIA specs RS-485 meets EIA/TIA specs

ENVIRONMENTAL CHARACTERISTICS

Weight:	8CB Dry: 2.94 lbs (1.33 Kg) Max 8CDP Dry: 3.48 lbs (1.58 Kg) Max 8CDP 700m Dry: 5.0 lbs (2.26 Kg) Max
Housing Materials/Wetted:	8CB - Stainless Steel 8CDP-PVC Type 1 or Acetal, White

OTHER ACCESSORIES AVAILABLE

- Model 715 Remote LCD Display
- Cables with Mating Connectors
- Power Module Kit

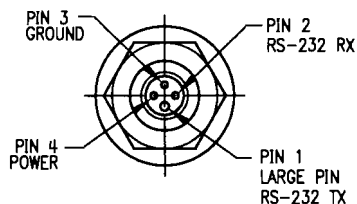
Connector Pin-Out	
PIN	SIGNAL
1	RS-232 to Computer
2	RS-232 from Computer
3	Power/Signal Ground
4	Power
5	RS-485 RX+
6	RS-485 RX-
7	RS-485 TX+
8	RS-485 TX-

SPECIFICATION CONTROL DRAWING

CAUTION

DELICATE INSTRUMENT.
HANDLE WITH CARE. DO NOT TRANSMIT
SHOCK OR EXCESSIVE VIBRATION TO
PRESSURE PORT OR DEPTH SENSOR BODY.
PERMANENT DAMAGE MAY RESULT.

MODEL NO.	PART NO.	DEPTH RANGE	PRESSURE RANGE
8BT1400-I	1534-001-0	0 TO 1400 METERS	0 TO 2000 PSIA (13.79 MPa)
8BT2000-I	1535-001-0	0 TO 2000 METERS	0 TO 3000 PSIA (20.68 MPa)
8BT4000-I	1536-001-0	0 TO 4000 METERS	0 TO 6000 PSIA (41.40 MPa)
8BT7000-I	1537-001-0	0 TO 7000 METERS	0 TO 10,000 PSIA (68.95 MPa)



SEA-CON RMG-4BCL CONNECTOR
MATES WITH CABLE ASSY 6114-001

PRODUCT IDENTIFICATION

REFERENCE
ORIENTATION,
VERTICAL,
PORT DOWN

OIL HEAD REFERENCE POINT

ANTI-FOULING PRESSURE PORT
MATERIAL: ACETAL
SENSOR PORT ACCEPTS PARKER
A-LOK NUT (1BZ1-316) AND FERRULES
(1FF1-316, 1BF1-316) OR EQUIVALENT

PERFORMANCE:

REPEATABILITY $\leq \pm 0.01\%$ FULL SCALE
HYSTERESIS $\leq \pm 0.01\%$ FULL SCALE
SUPPLY VOLTAGE SENSITIVITY LESS THAN 0.001% FULL SCALE/V
(+6 TO +16 VDC)

CHARACTERISTICS:

NOMINAL TEMP SENSOR SENSITIVITY 45 PPM/°C
WEIGHT 42 OZ (1.19 KG)
SUPPLY VOLTAGE +6 VDC MIN TO +16 VDC MAX

OPERATING SUPPLY CURRENT:

	RESOLUTION MODE (SEE NOTE 6)		
	STANDARD (PARTS PER MILLION)	NANO (PARTS PER BILLION)	
		IIR	FIR
SLEEP MODE	7 mA	7 mA	7 mA
QUIESCENT	12 mA	43 mA	24 mA
MAXIMUM	16 mA	43 mA	27 mA

ENVIRONMENTAL:

OVERPRESSURE 1.2 X FULL SCALE WITH NO CHANGE IN CALIBRATION
CALIBRATED TEMPERATURE RANGE -2 °C TO +40 °C (28 °F TO 104 °F)
STORAGE TEMPERATURE RANGE -25 °C TO +65 °C (-13 °F TO 149 °F)
PRESSURE PORT IS OIL FILLED UNDER VACUUM WITH DOW CORNING FS-1265 FLUID. AT 25 °C,
SPECIFIC GRAVITY IS 1.25 AND VISCOSITY IS 300 CENTISTOKES.
CAUTION: DO NOT APPLY VACUUM OR GAS TO PRESSURE PORT. OIL COULD BE WITHDRAWN
ALLOWING PRESSURE MEDIUM TO COME INTO CONTACT WITH SENSING ELEMENTS.
OIL FILLED UNITS WILL GENERATE A PRESSURE HEAD THAT VARIES WITH ORIENTATION.

NOTES:

- HOUSING MATERIAL: 6AL-4V TITANIUM.
- CAUTION: IF RE-TORQUING ELECTRICAL CONNECTOR, DO NOT EXCEED 85 IN-LB (9.6 N-m).
- RS-232 COMMUNICATIONS PORT MEETS EIA/TIA-232 SPECIFICATIONS.
- ELECTRICAL ISOLATION: > 100 MEGOHMS AT 500 VDC; < 50 UA AT 500 VAC.
- THE FOLLOWING ARE CHARACTERISTICS OF FIRMWARE VERSION R3.00 OR LATER:
A. ALL COMMANDS MUST BE TERMINATED BY A CARRIAGE RETURN AND LINE FEED CHARACTER.
B. SERIAL PROTOCOL IS FIXED AT 8/N/1. PT PARAMETER IS READ ONLY, AND ALWAYS RETURNS "N".
C. MC AND CT DIAGNOSTIC COMMANDS ARE NOT SUPPORTED.
D. SN AND TC PARAMETERS ARE READ-ONLY.
- OPERATIONS MANUAL SUPPLIED WITH THE UNIT. SEE OPERATIONS MANUAL 8107-001 FOR
PROGRAM COMMAND INSTRUCTIONS AND CONFIGURATION SELECTION, AND FOR DEFINITIONS
OF STANDARD (PARTS PER MILLION) AND NANO (PARTS PER BILLION) IIR AND FIR FILTERS.
DEFAULT SETTING IS STANDARD RESOLUTION.
- TO TIGHTEN ACETAL PRESSURE PORT, TURN CLOCKWISE UNTIL HAND TIGHT OR FULLY SEATED.
AVOID OVERTIGHTENING.
- PRODUCT IS CE MARKED.

CURRENT APPROVALS				Paroscientific, Inc.		DESCRIPTION	
NAME	DATE	NAME	DATE	4500 140th Avenue NE, Redmond, WA 98052 Tel: 425.883.8700 Fax: 425.887.5447 Website: www.paroscientific.com		DIGIQUARTZ® 8BT INTELLIGENT DEPTH SENSOR, ELECTRICALLY ISOLATED, W/ RS-232	
CAD Raul Collado	8/27/12	MFG [Signature]	8/27/12			SIZE	CAGE
CHK [Signature]	8/27/12	QA [Signature]	8/27/12			A	54535
ENG T. Luxon	9/4/12	MKTG [Signature]	9/7/12			DOCUMENT NUMBER	REV
						7579-001	M
EO NO/EFFECTIVE DATE: 7867				ACAD FILENAME: 7579-001.dwg		SCALE	SHEET
						NONE	1 OF 1



a xylem brand



The ZPulse® Doppler Current Sensor (DCS) is a single-point current sensor primarily intended to be used with the AADI 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 output. 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

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.

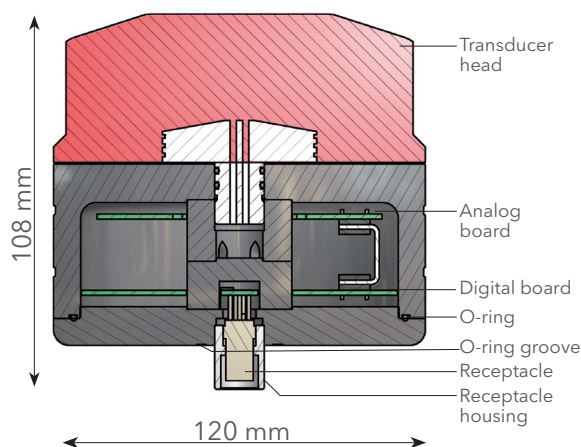
Features ZPulse® Doppler Current Sensor:

- 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 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.

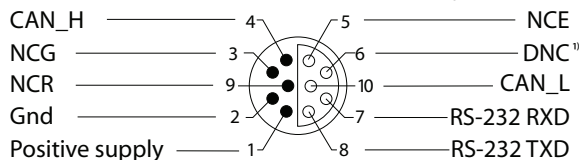
Another great advantage is the new ZPulse® technology which improves the statistical precision. Complex acoustic pulses comprising several distinct frequencies are combined into a single acoustic pulse. The ZPulse® based DCS separates the received signal into different frequency bands, one for each frequency 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.



PIN CONFIGURATION 4420/4520/4830/4930

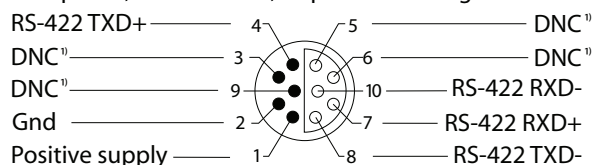
Receptacle, exterior view; pin = ● bushing = ○



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 - 300 cm/s
Resolution: 0.1 mm/s
Mean Accuracy: ±0.15 cm/s
Relative: ± 1% of reading
Statistic precision (std): 0.3cm/s (ZPulse[®] mode), 0.45 cm/s¹⁾

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 2.0 MHz
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: 15 meters
 RS-422: 1500 meters

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: 300 meters
 4520IW/4930IW: 2000 meters
 4520DW/4930IW: 6000 meters

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



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a xylem brand



Oxygen Optode 4831/4831F

is a compact fully integrated sensor for measuring the O_2 concentration.

Fast Response Foil (4831F, refer overleaf)

Advantages:

- Optical measurement principle
- Lifetime-based luminescence quenching principle
- Long time stability
- More than one year without recalibration
- Low maintenance needs
- Small size and weight
- Stand-alone sensor
- Output format: RS232, 0-5V
- Three depth ranges maximum 6000 meter

Since oxygen is involved in most of the biological and chemical processes in aquatic environments, it is one of the most important parameters to be measured. Oxygen can also be used as a tracer in oceanographic studies. For environmental reasons it is critical to monitor oxygen in areas where the supply of oxygen is limited compared to demand e.g.

- In shallow coastal areas with significant algae blooms
- In fjords or other areas with limited exchange of water
- Around fish farms
- Areas of interest for dumping of mine or dredging waste

The Aanderaa oxygen optodes are based on the ability of selected substances to act as dynamic fluorescence quenchers.

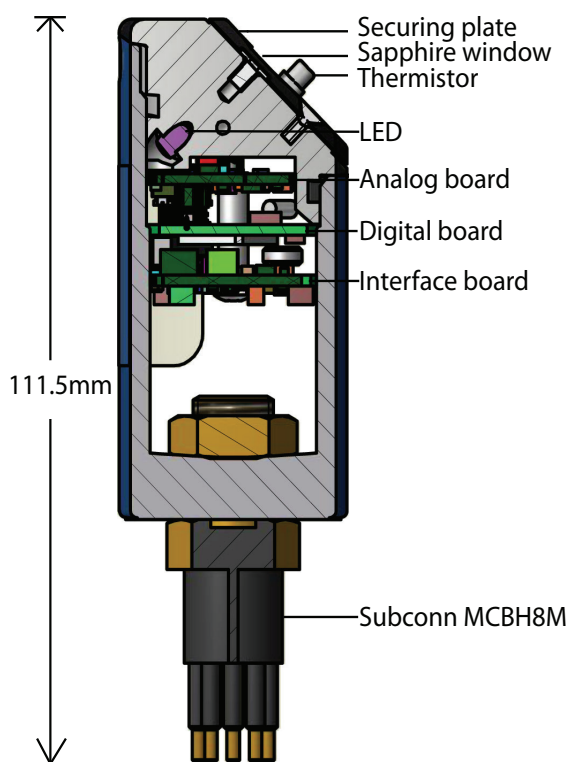
The fluorescent indicator is a special platinum porphyrin complex embedded in a gas permeable foil that is exposed to the surrounding water. For the standard version

4831 a black optical isolation coating protects the complex from sunlight and fluorescent particles in the water. This sensing foil is mounted on a sapphire window providing optical sampling from inside a watertight housing.

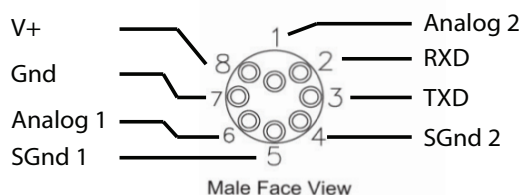
The lifetime-based luminescence quenching principle offers the following advantages over electro-chemical sensors:

- Not stirring sensitive (it consumes no oxygen)
- Less affected by fouling
- Measures absolute oxygen concentration without repeated calibrations
- Better long-term stability
- Less affected by pressure
- Pressure behaviour is predictable
- Faster response time

The oxygen optode outputs data in RS-232 and analog 0-5V. The sensor can present the O_2 concentration in μM , Air Saturation in % and Temperature in $^{\circ}C$.



PIN CONFIGURATION SUBCONN MCBH8



Foil Service Kit 4733/4794. PSt₃

Operating Principle

The sensing foil is excited by modulated blue light; the sensor measures the phase of the returned red light. For improved stability the optode also performs a reference phase reading by use of a red LED that do not produce fluorescence in the foil. The sensor has an incorporated temperature thermistor which enables linearization and temperature compensation of the phase measurements to provide the absolute O₂ concentration.

Oxygen:	O ₂ Concentration	Air Saturation
Measurement Range:	0 - 500 µM ¹⁾	0 - 150%
Resolution:	<1 µM	0.4 % ³⁾
Accuracy:	<8 µM or 5% ²⁾	<5 % ³⁾
	whichever is greater	
Response Time (63%):	4831F (with fast response foil) <8 sec	4831 (with standard foil) <25 sec
Temperature:		
Range:	-5 to +40°C (23 - 104°F)	
Resolution:	0.01°C (0.018°F)	
Accuracy:	±0.03°C (0.18°F) ⁴⁾	
Response Time (63%):	<2 sec	
Output format:	RS-232, 0-5V	
Output Parameters:		
RS-232:	O ₂ Concentration in µM, Air Saturation in %, Temperature in °C, Oxygen raw data and Temperature raw data	
Analog channel 1:	O ₂ Concentration in µM, or Air Saturation in %, Temperature in °C	
Analog channel 2:	Temperature in °C	
Sampling interval:	2s - 255 minutes	
Supply voltage:	5 to 14Vdc	
Current drain:		
Average:	0.16 +48 mA/S where S is sampling interval in seconds	
Maximum:	100 mA	
Quiescent:	0.16 mA	
Operating depth:	SW: 0-300 meters (0 - 984ft)	
	IW: 0 - 2000 meters (0 - 6,560ft)	
	DW: 0 - 6000 meter (0 - 19,690ft)	
Elec. connection:	8 pin Subconn MCBH8M	
Dimensions (WxDxH):	Ø36 x 111.5mm (Ø1.4"x 4.4")	
Weight:	217g (7.65oz)	
Materials:	Epoxy coated Titanium, PA	
Accessories:	Foil Service Kit 4733(standard)/4794(fast)	

- ⁽¹⁾ O₂ concentration in µM = µmol/l. To obtain mg/l, divide by 31.25
⁽²⁾ requires salinity compensation for salinity variations > 1mS/cm, and pressure compensation for pressure > 100meter
⁽³⁾ within calibrated range 0 - 120%
⁽⁴⁾ within calibrated range 0 - 36°C

Specifications subject to change without prior notice.

Sensing Foil Considerations

The standard sensing foil is protected by an optical isolation layer which makes the foil extra rugged and insensitive to direct sunlight. The fast response sensing foil is not equipped with this layer; ambient light intensity higher than 15000 lux may cause erroneous readings. To avoid potential bleaching the fast response foil should be protected from ambient light when storing the sensor. We recommend the standard foil in applications where fast response time is not needed.



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miniSVS



Our unique digital time of flight technology gives unmatched performance figures, with signal noise an order of magnitude better than any other sensor. The miniSVS is available in a selection of configurations and with optional pressure or temperature sensors. There are a variety of sizes to suit many applications.

miniSVS - still the most accurate sound velocity sensor in the world. Nothing else comes close.

Sound Velocity Measurement

Each sound velocity measurement is made using a single pulse of sound travelling over a known distance, so is independent of the inherent calculation errors present in all CTDs. Our unique digital signal processing technique virtually eliminates signal noise, and gives almost instantaneous response; the digital measurement is also entirely linear, giving predictable performance under all conditions.

Range:	1375 - 1900m/s	
Resolution:	0.001m/s	
Accuracy:	Dependent on sensor size	
100mm	Random noise (point to point)	±0.002m/s
	Max systematic calibration error	±0.013m/s
	Max systematic clock error	±0.002m/s
	Total max theoretical error	±0.017m/s
50mm	Total max theoretical error	±0.019m/s
25mm	Total max theoretical error	±0.020m/s

Acoustic Frequency: 2.5MHz

Sample Rate: Selectable, dependent on configuration

Rate	SV	SV+P	SV+T
Single Sample	•	•	•
1Hz	•	•	•
2Hz	•	•	•
4Hz	•	•	•
8Hz	•	•	•
16Hz	•	•	•
32Hz	•	•	•
60Hz	•	•	•

Optional Sensors

The miniSVS may be optionally supplied with either a pressure or temperature sensor (but not both). Data is sampled at the rates shown above

Sensor	Pressure	Temperature
Type	Strain Gauge	PRT
Range	5, 10, 50, 100 or 600 Bar	-5°C to +35°C
Resolution	0.001% range	0.001°C
Accuracy	±0.05% range	±0.01°C

Data Output

Unit has RS232 & RS485 output, selected by command code. RS232 data may be taken directly into a PC over cables up to 200m long, whereas RS485 is suitable for longer cables (up to 1000m) and allows for multiple addressed units on a single cable.

Baud Rate: 2400 - 115200 (NB. Low baud rates may limit data rate)
Protocol: 8 data bits, 1 stop bit, No parity, No flow control



Electrical

Voltage: 8 - 30VDC
Power: 0.25W (SV only), 0.35W (SV + Pressure)
Connector: Subconn MCBH6F (alternatives on request)

Data Format

Examples of data formats are:
<space>{sound_velocity}<cr><lf>
<space>{pressure}<space>{sound_velocity}<cr><lf>
<space>{temperature}<space>{sound_velocity}<cr><lf>

SV: Choose from mm/s (1510123), m/s to 3 decimal places (1510.123), or m/s to 2 decimal places (1510.12)

Pressure: If fitted, pressure is always output in dBar with 5 digits, with a decimal point, including leading zeroes if necessary. Position of the point is dependent on sensor range, e.g.

50dBar	47.123
100dBar	047.12
1000dBar	0047.1

Temperature: If fitted, temperature is output as a 5 digit number with 3 decimal places and leading zeroes, signed if negative, e.g.

21.456
02.298
-03.174

Physical

Please refer to drawing on reverse for detailed dimensions.

Depth Rating: 6000m (Titanium), 500m (acetal)
Weight: 1kg (housed type)
Housing & Bulkhead: Titanium or acetal, as selected
Transducer Window: Polycarbonate
Sensor Legs: Carbon Composite
Reflector Plate: Titanium.

Ordering

All systems supplied with operating manual and carry case. OEM units come with a test lead, housed units with a 0.5m pigtail.

Configuration	100mm	50mm	25mm
Titanium Housed	0652004	0652005	0652006
Acetal Housed	0652045	0652046	0652047
Bulkhead OEM	0652001	0652002	0652003
Remote OEM	0652007	0652008	0652009

0652010 Spare 50cm Pigtail
0652013 Pressure sensor option (specify range)
0652028 Temperature sensor option

Datasheet Reference: miniSVS version 2A, Feb 2011