Model 606+ Multi-Parameter Logger with CTD

Section 1 - Mechanical Operation

CHAPTER	DESCRIPTION	PAGE

1 INTRODUCTION

This section of the manual describes the specification, construction, wiring diagrams and basic maintenance procedures of the Valeport Model 606+ Multi-Parameter CTD, including the optional additional sensors and water sampling system.

The Model 606+ system consists of the following components:

- Titanium housed instrument with bulkhead mounted sensors
- Stainless steel deployment cage
- 3m Y lead (interface to PC)
- Switching Plug
- Basic maintenance tools and spare o-rings
- DataLog 400 Software
- Operating Manual
- Transit case

In addition, the following components may be supplied as optional extras:

- Additional remote sensors with interface cables
- Water bottle sampling system
- RS485 communications adaptor
- RS422 communications adaptor
- FSK modem communications adaptor (includes pcb in instrument)
- Various lengths & types of signal cable are also available

Please refer to Section 2 of this manual for details of software operation.

2 SPECIFICATIONS

2.1 SENSOR SPECIFICATIONS

The unit is fitted with the following standard sensors:

Conductivity	Type:	Pressure balanced inductive coils
	Range:	0.1 to 60 mS/cm
	Accuracy:	± 0.01mS/cm
	Resolution:	0.003mS/cm
Pressure	Type:	Strain Gauge
	Range:	600Bar absolute (approx 6000m water depth)
	Accuracy:	± 0.1% Full scale
	Resolution:	0.005% Full scale
Temperature	Type:	Fast response PRT
	Range:	-5 to +35°C
	Accuracy:	± 0.005°C
	Resolution:	0.002°C

The instrument is also fitted with the following additional sensors:

Turbidity	Type:	Seapoint
	Range:	0 to 2000 FTU (max)
	Accuracy:	± <2% to 750 FTU
	Resolution:	0.005% FS
Fluorometer	Type:	Seapoint
	Range:	0 to 150µg/l (max)
	Accuracy:	± <0.03µg/l
	Resolution:	0.005% FS
DO	Type:	Idronaut
	Range:	0 to 200%sat (max) or 0 – 20ppm
	Accuracy:	± 1%sat or ±0.1ppm
	Resolution:	0.005% sat
PH	Type:	Valeport/Russell Pressure Balanced Electrode
	Range:	2 to 12pH
	Accuracy:	± 0.01pH
	Resolution:	0.001pH
Redox (ORP)	Type:	Valeport/Russell Pressure Balanced Electrode
	Range:	-1000 to +1000mV
	Accuracy:	± 0.5mV
	Resolution:	0.033mV

Note that all these sensors give an analogue output signal (either volts or amps) as standard – the accurate measurement of this signal is the function of the primary sensor calibration, which is given in the calibration section of this manual. This primary calibration has a high level of long-term stability, and should not need to be rechecked any more often than the conductivity, temperature or pressure sensors – typically every one or two years depending on the customer's own requirements.

However, this primary data output may be subjected to a secondary, or "User" calibration within the instrument, so that the output is converted into engineering units, for example mg/l. Details of how to perform these User calibrations are given in a separate manual.

2.2 MECHANICAL SPECIFICATIONS

2.2.1 INSTRUMENT

Materials

Housing:	Titanium
Exceptions:	Conductivity Cell, DO Sensor, Turbidity Sensor and pH Sensor use Acetal. Temperature Sensor uses Stainless Steel (316 grade). Redox and pH use glass electrodes.
Cage:	Stainless steel (316 grade) with polypropylene clamping brackets
Dimensions:	Instrument - 88mm Ø, 665mm long (including connector) Cage – 750mm long x 140mm x 120mm
Weight (in cage):	15kg (air), 8.5kg (water)
Depth Rating:	5000m (unless smaller pressure sensor fitted)

Connectors

Instrument:	10 pin female Subconn bulkhead type with lock ring, data and power
Comms Cable:	Valeport 3m Y lead. 10 pin male Subconn line type to instrument, 2 x 4mm banana plugs to external power, 9 pin female D type to PC.
Switching Plug:	10 pin male Subconn line type, with lock ring. Note that the switch cap contains wiring links to activate the instrument – it is not a dummy plug.

2.2.2 WATER SAMPLING SYSTEM

Motor System

Housing:	Pressure balanced perspex and stainless steel. Device filled with Fluorinert FC-77 to provide pressure balancing
Motor:	Brushed DC motor
Power:	10vDC input, drawing 25mA when running
Positioning:	Rotor position detected by optical switches

Rosette Frame

Materials:	316 grade stainless steel.
Dimensions:	assembled size is 92cm diameter x 1.7m high
Fittings:	Provision for 12 x 2.5litre water bottles, 1 x Valeport Model 606+ CTD, 1 x WS Envirotech EcoLab system.
Weight:	48kg (excluding instruments and bottles)

Sample Bottles

Materials:	PVC
Volume:	2.5litre
Weight:	2kg

2.3 PERFORMANCE SPECIFICATIONS

Memory:	8Mbyte solid state memory (upgradeable in 8 Mbyte steps to 32 Mbyte).
Internal Power:	8 x 1.5V alkaline D cells. The unit will accept 8 x 3.6V Lithium D cells with no alterations required. Do not mix battery types.
External Power:	Between 8 and 30V DC.
Current Drain:	Depends on sensors fitted. CTD only uses 50mA at 12V when running, and 0.25mA when in sleep mode.
Sampling Rate:	1, 2, 4 or 8Hz (synchronised).
Data Output:	RS232, RS485 or RS422, depending on pin selection. Baud rate is user selectable from 2400 to 115200.

2.4 SAMPLE LIFETIME CALCULATIONS

2.4.1 BASED ON MEMORY

Lifetime based on memory is simple to calculate. Conductivity, Temperature, Pressure, Turbidity, DO and pH values use 2 bytes of memory per sample. Therefore total memory used per record is (6 x 2) = 12 bytes. Note that in Trip mode, each record is also assigned a date/time stamp, which uses a further 7 bytes.

The 8 Mbyte memory actually contains 8,388,608 bytes. Allowing a small amount of memory usage for header files, the memory will store over 430,000 records in Trip sampling mode, and over 1 million records in all other modes.

The length of time that this will last for obviously depends on sampling scenario. Here are three examples:

Continuous data sampling, 8Hz:

Memory used per second is 8 x 12 bytes = 96 bytes.

Total memory fitted is 8,388,608 bytes.

Number of seconds before memory full is 8,388,608 / 96 = (approx) 87,381 seconds.

This is equivalent to 24 hours.

This period can be doubled by sampling at 4Hz.

Burst sampling, 4Hz, sampling for 1 minute every 10 minutes, recording all data points:

Memory used per burst is 12 bytes x 4Hz x 60 seconds = 2880 bytes.

The memory will therefore be full after 8,388,608 / 2880 bytes = 2912 bursts. At a 10 minute cycle time, this is 29120 minutes, which is equivalent to 20 days.

Trip sampling, 5000m cast, measuring every 1 metre:

In this example, the instrument will take 1 reading every metre of both descent and ascent. This means 5000 data points descending, and a further 5000 ascending. Each record consists of 12 bytes of data and 7 bytes of time stamp. Each record therefore uses 19 bytes. A single cast will take 10,000 such records, and will therefore use 190,000 bytes.

The 8Mbyte memory will therefore hold approximately 44 casts of data.

2.4.2 BASED ON BATTERIES

The Model 606+ will function with a voltage supply of between 9 and 30VDC. The voltage output of the 8 x D cell battery pack will vary according to the type of cell fitted. The most likely cells to be used will be standard alkaline type (1.5V each) or Lithium cells (3.6V each), giving a 12V nominal output for alkaline cells, or 28.8V nominal for Lithium cells. The following calculations are based on the same sampling scenarios as the memory calculations, using figures for a 12V alkaline battery pack. Each example also gives a figure for a Lithium battery pack, calculated from a basic ratio of alkaline to Lithium performance.

In all examples, it is taken that an 8 D cell alkaline battery pack will have a nominal capacity of 14Ah, and will be 75% efficient (total available charge, 10.5Ah), and that an 8 D cell Lithium pack will have a nominal capacity of 17.5Ah, and will be 95% efficient (total available charge, 16.6Ah).

Continuous data sampling, 8Hz:

At 12V, the instrument will draw approximately 60mA when sampling, with DO, pH and turbidity sensors fitted.

Total charge available is 10500mAh.

Number of hours available is therefore 10500mAh / 60mA = 175 hours.

This is equivalent to just over 7 days.

For Lithium cells, a similar calculation gives over 27 days.

Note that the instrument is effectively operating continuously when in Trip sampling mode, so similar calculations will apply.

Burst sampling, 4Hz, sampling for 1 minute every 10 minutes:

At 12V, instrument draws 60mA when sampling, plus 60mA for 5 seconds at the start of each burst. It draws 0.25mA when in sleep mode between bursts.

In this scenario then, the instrument will draw 60mA for 65 seconds, and then 0.25ms for 535 seconds. On average, it will draw:

$$\frac{(60 * 65) + (0.25 * 535)}{(65 + 535)} = 6.72\text{mA}$$

Total charge available is 10500mAh.

Number of hours available is therefore 10500mAh / 6.72mA = 1562 hours.

This is equivalent to approx 65 days.

For Lithium cells, a similar calculation gives approx 156 days.

Note that the above examples are intended as guides only. Valeport accepts no responsibility for variation in actual performance. Note that performance of individual battery cells is not always consistent.

3 INSTALLATION

The Model 606+ system is supplied in an ABS transit case, together with any communications adaptors ordered. Any additional lengths of signal cable are packed separately. The water sampler system is packed in a wooden crate together with the sampling bottles.

3.1 COMMUNICATIONS WITH PC

The Model 606+ can be set up and interrogated using the DataLog 400 software supplied. Please refer to Section 2 of this manual for details of how to use the software.

To connect the instrument directly to a PC for RS232 communications, use the 3m Y lead supplied. This lead is fitted with a 10 pin Subconn type connector, which should be plugged directly into the connector on the top of the housing (or to a length of signal cable). The lead also features 2 x 4mm banana plugs for application of external power if required and a 9 way D type connector which should plug directly into a spare comm port on the back of the PC. Note that a 9 - 25 way adaptor may be required, depending on PC configuration.

If non-RS232 communications are to be used, via the optional RS485, RS422 or FSK methods, then the appropriate adaptor should be used. Each adaptor is supplied with a switched 3m Y lead (different to the standard RS232 Y lead), which should be connected as follows:

Comms Method	Adaptor Part no.	Connections
RS485	0400029	Connect 15 pin D type and 4mm plugs from Y lead into adaptor. Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor housing.
RS422	0400030	Connect 15 pin D type and 4mm plugs from Y lead into adaptor. Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor housing.
FSK	0400005	Connect 4mm plugs from Y lead into adaptor, leaving D types unconnected (FSK uses power and signal on just two wires). Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor

3.2 DEPLOYING THE MODEL 606+ ON ITS OWN

All parts of the standard system (with the exception of the top part of the 3m Y lead) are designed for immersion. All communications adaptors (RS485, RS422, FSK) are splash proof, but should be sited in a dry place, as close to the PC as possible.

The Model 606+ is supplied with a stainless steel protective cage, but care should still be taken not to damage the instrument. For profiling work, the recommended deployment method is to suspend the instrument using the stainless steel wire strop. For fixed deployments, the user may wish to remove the steel cage, and use the grooves in the titanium instrument housing as clamping points.

3.2.1 REAL TIME OPERATION

For real time data output, connect the signal cable to the 10 pin Subconn connector on the instrument. All Valeport signal cables include a suspension point for strain relief, and a similar arrangement is recommended for other cable types. Connect the top end of the cable to a PC using the appropriate method as described above.

3.2.2 SELF RECORDING OPERATION

For self recording only deployments, the instrument is switched on by insertion of the Subconn style switch plug. This plug must be inserted for the unit to operate.

3.2.3 RECOVERY

On recovery, data can be extracted to PC via the 3m Y lead. This is covered in Section 2.

To prolong the lifetime of the instrument the following procedures should be carried out once the instrument has been recovered:

- Remove any significant growth from the instrument, taking care not to damage any of the sensor faces. A high pressure water jet or stiff (not metal) brush is recommended.
- Remove any significant growth from the pressure sensor port. Take care not to introduce any sharp objects onto the sensor face – this may result in sensor damage.
- Check instrument for signs of damage.
- Rinse the instrument in fresh water
- Dry the instrument if possible, paying particular attention to the sensors and connector.
- Repack the instrument in the transit cases provided.

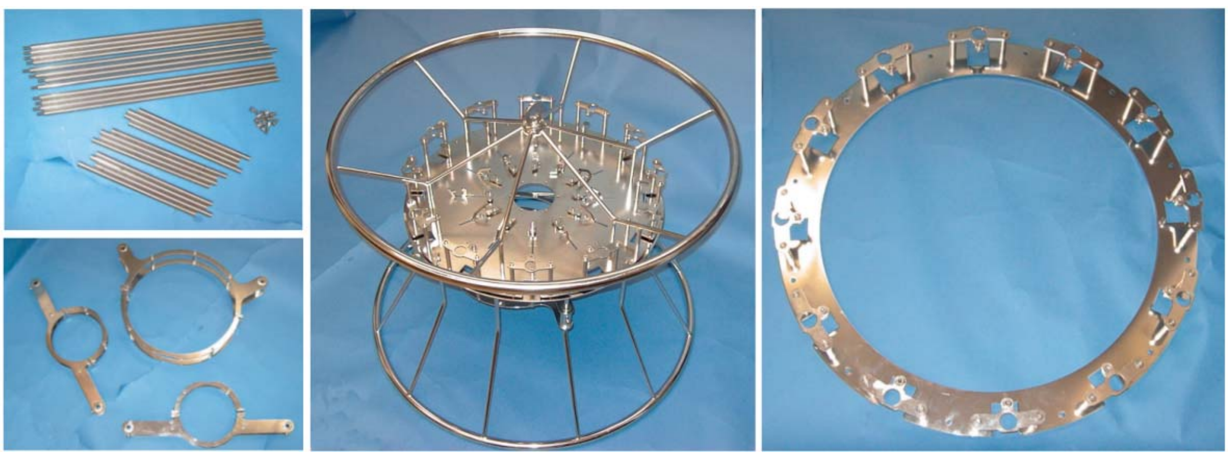
3.3 DEPLOYMENT OF THE WATER SAMPLER SYSTEM

3.3.1 ASSEMBLY

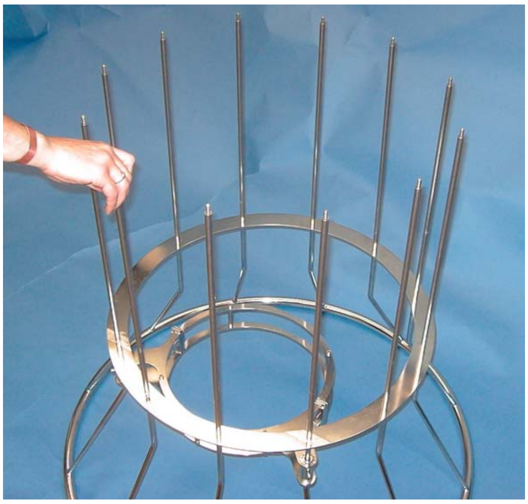
The water sampler system is supplied in kit form, and must be assembled prior to use. The procedure should take no more than 30 minutes. All required tools are provided.

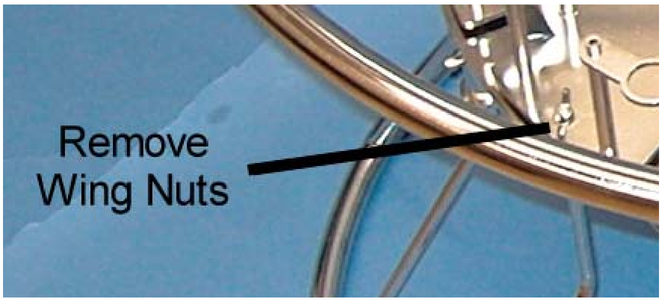
Unpack the frame from the packing case, and remove all the packaging materials. The following components should be present, as illustrated:

12 x 40cm stainless steel rods
12 x 20cm stainless steel rods
12 x M5 stainless steel screws
1 x stainless steel bottle mounting ring
1 x combined top & bottom frame
2 x 150mm diameter clamping rings for Model 606+
2 x 310mm diameter clamping rings for EcoLab (1 packed separate, 1 fixed to bottom frame)
1 x motor assembly (not illustrated)



Begin by separating the top and bottom frames, by undoing the wing nuts holding them together:



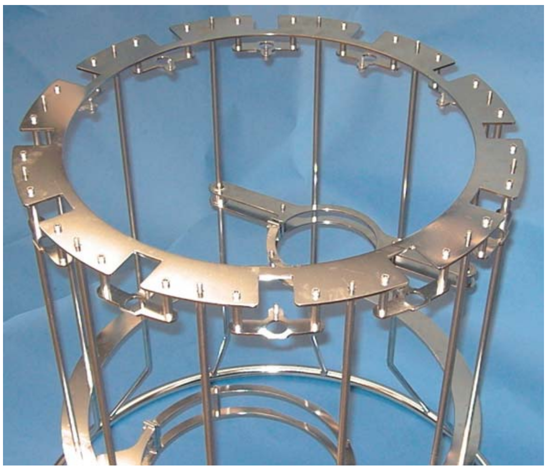


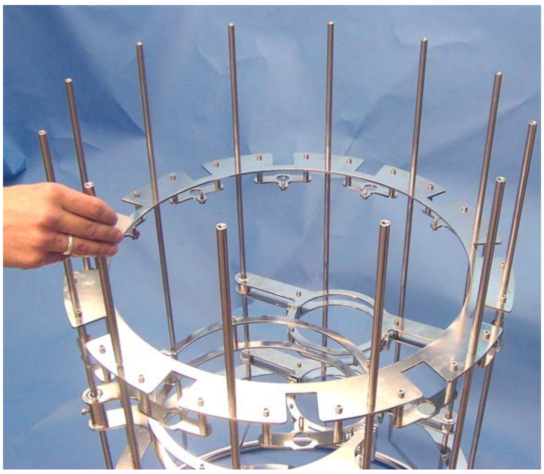
Screw the 12 x 40cm stainless steel rods onto the bottom frame, tightening as much as possible.

Lower the instrument clamping brackets onto the rods. The larger EcoLab bracket should be positioned vertically above the bracket that is already in place. The smaller Model 606+ brackets should be positioned directly opposite the EcoLab brackets, vertically above each other.

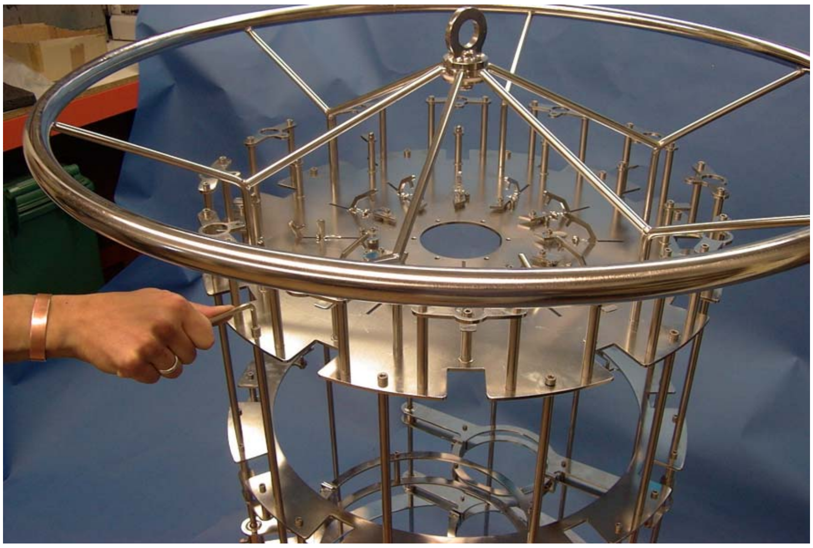
Also note that the Model 606+ is supplied with a fluorometer; the clamping brackets for this should be fitted to one of the rods at this time.

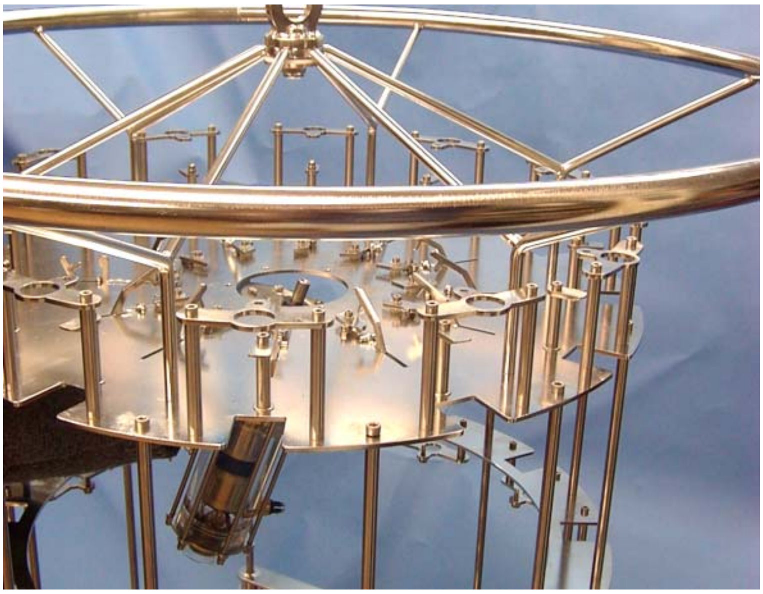
Next, place the bottle mounting ring on the rods, taking care to position it the right way up. The thread on the top of the rods should fit through the holes in the ring. Then, screw the 20cm rods in place as shown, tightening as much as possible.





Now, position the top frame on the rods, and secure in place with the M5 screws, using a 4mm Allen key.





The motor system is pressure balanced, and contains a liquid called Fluorinert. It is important that the motor housing contains little or no air bubbles, as this will affect the pressure balancing capabilities of the housing. If there are air bubbles visible in the housing, the Fluorinert must be replenished, using the procedure described in Section 4.3 of this manual.

Position the motor underneath the top frame, so that the mounting holes align. The rotor arm may need to be removed to allow this. Secure in place with the screws provided.

If the rotor arm is loose, it must be secured in the correct position. To do this it is necessary to communicate with the instrument using the software. This procedure is therefore described in the software manual.

Assembly of the frame is now complete.

3.3.2 FITTING INSTRUMENTS TO FRAME

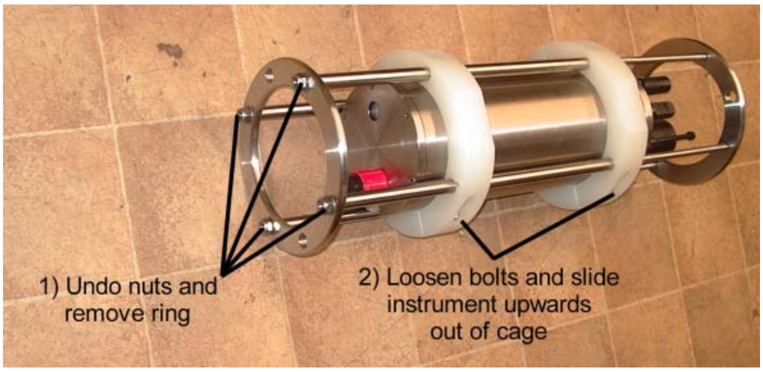
It is easiest to fit the Model 606+ by laying the frame on its side. Use the locking screws to tighten the lower clamping bracket onto the frame, and loosen the upper clamping bracket.

Each clamping bracket is made of two half-clamps. These should be separated by undoing the screws as shown:

The Model 606+ is shipped in a separate frame, which may be used for deploying the instrument on its own if required.

The instrument must be removed from this frame to allow it to fit into the water sampler frame.

Remove the instrument from its frame as shown in the picture.



Gently place the Model 606+ into the clamping brackets on the water sampler frame, with the sensors towards the bottom of the frame. Slide the upper bracket so that the clamps fit into the grooves in the instrument housing. Fix the upper bracket tightly to the frame. Now replace the other half of the clamps, and screw into place.

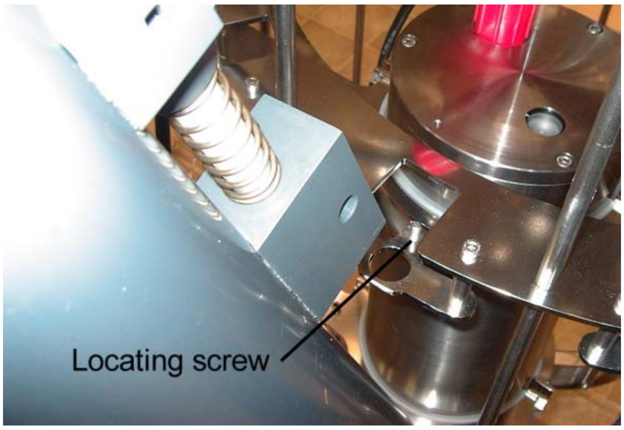
Repeat this procedure to fit the EcoLab system into the large clamps.

Using the lead supplied, connect the instrument to the motor unit. The lead may be held to the frame by means of cable ties.

3.3.3 LOADING THE WATER BOTTLES

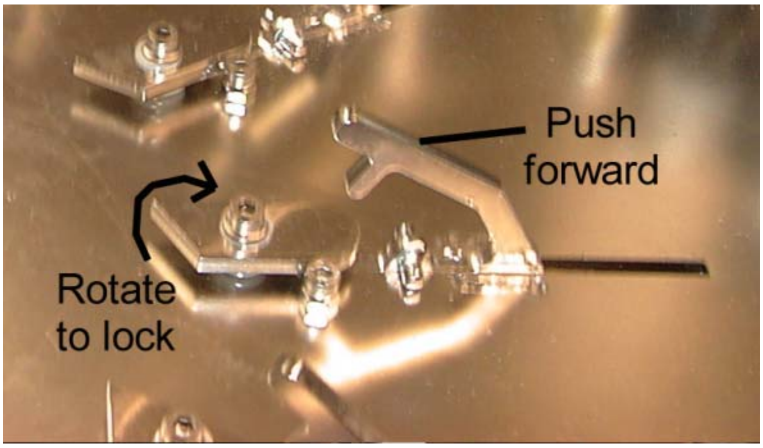
The motor and frame are designed to work with 12 x 2.5 litre water bottles. The bottles should be fixed to the frame as follows.

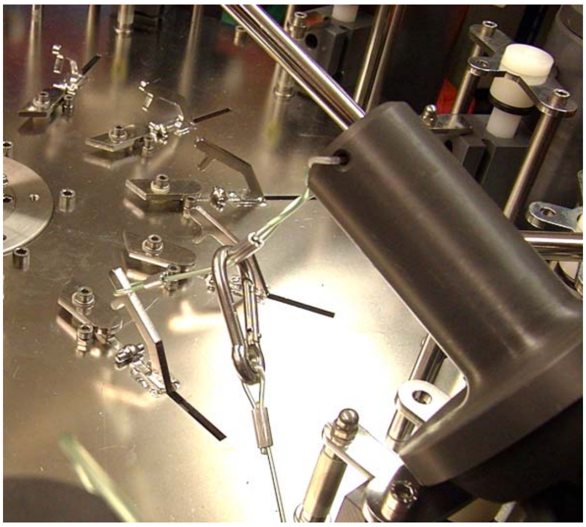
Locate the hole in the mounting block of the bottle onto the screw of the bottle mounting ring, as shown, and then depress the white plunger. This allows the top of the bottle to slide into place in the top part of the frame. The white plunger is spring loaded, and should release into the hole in the frame, locking it in place.



Arm the bottles using the following procedure:

Push forward the release lever, and secure in place with the moving plate.





Carefully lift the top cap of the water bottle, and hook the loop of nylon cord over the end of the release lever.

Then, carefully disengage the bottom cap of the water bottle, and use the spring shackle to secure the nylon cord to the top nylon cord as shown. Ensure that the shackle goes over the whole cord, and not through it.

Repeat for each bottle.

Finally, to prepare the bottle for deployment, ensure that the tap on the side of the bottle is pulled out as far as the stop will allow, and that the release screw on the top of the bottle is tightly secured.

3.3.4 RELEASING THE WATER SAMPLE

To release the water sample after the deployment, place a small hose over the tap, leading to the desired container. Push the tap into the bottle as far as the stop will allow, causing a small amount of water to be ejected. Release the remainder of the sample by slowly release the screw on the top of the bottle. This allows the water to drain out of the tap under atmospheric pressure.

4 MAINTENANCE

The Model 606+ Multi-Parameter Logger with CTD is completely solid state, and therefore requires very little maintenance. Other than performing calibration routines on the sensors (detailed in a separate document), the user will need to keep the instrument relatively clean, and to change the batteries. This Chapter also covers details of the o-rings that are fitted to the instrument, and which should be checked regularly for damage and replaced if necessary.

4.1 CHANGING BATTERIES

The Model 606+ Multi-Parameter Logger with CTD accepts 8 x D cells, of either 1.5V alkaline or 3.6V Lithium type. These cells are arranged in series, so the output voltage is 12V (alkaline) or 28.8V (Lithium). Some example scenarios for lifetime of these batteries are given in Chapter 2.4.2.

The batteries are located in a holder in the top of the instrument, and should be accessed by removing the connector bulkhead.

1. Remove the instrument from the protective cage by loosening the M10 nuts on the polypropylene clamps. Gently lever these clamps apart, using a screwdriver if necessary.

2. Slide the instrument out of the cage, in either direction.

3. Remove the 3 M5 x 20 socket cap screws in the connector bulkhead, using the Allen key provided. Note that these screws are titanium, and should be replaced with titanium screws if lost. Other materials will suffer galvanic corrosion and may be destroyed.

4. Without twisting or putting undue stress on the Subconn connector slide the bulkhead and attached battery pack out of the main housing. A slot between the tube and the bulkhead allows levering with a screwdriver if necessary. Take care not to scratch the bore of the tube.

5. A lead connects the battery pack to the electronics inside the tube. This may be disconnected at the battery pack if required, for ease.

6. Replace the batteries.

7. Check the condition of the bore seal o-rings, and apply a light coating of silicon grease. Ensure that they sit in the groove correctly, and are free from damage.

8. Reattach the connector to the electronics if necessary, and gently slide the battery pack back into the tube, ensuring that the fixing holes are correctly aligned. Again, take care not to scratch the bore.

9. Replace the 3 x M5 titanium screws, using a small amount of copper grease (supplied). Do not force the screws, just tighten firmly.

10. Finally, slide the instrument back into the protective cage. Note that the clamping brackets are offset, and that the sensor end of the instrument should lie at the long end of the cage.

4.2 O-RING SIZES

The Model 606+ Multi-Parameter Logger with CTD is kept watertight by using o-ring seals. Double o-ring seals are used at each end of the titanium housing, although the customer should have no reason to open any seal other than that at the battery end. To help preserve the watertight nature of the equipment, please observe the following guidelines:

- Ensure that all o-rings are free from cuts, abrasions or perishing.
- Ensure that all-o-rings are free from dirt, grit, sand, hair and other foreign objects.
- Whenever an o-ring seal is opened (e.g. when changing batteries), ensure that a light coating of silicon grease is applied to the o-ring before the seal is closed.
- Ensure that all o-ring protected seals are tightened.

A set of spare o-rings is included with the equipment. If an o-ring needs replacing, be sure to use the correct size. If obtaining further spare o-rings from an alternative source, be sure to obtain the correct material (signified by the last 4 digits of the o-ring code number).

O-ring size: 200-158-4470

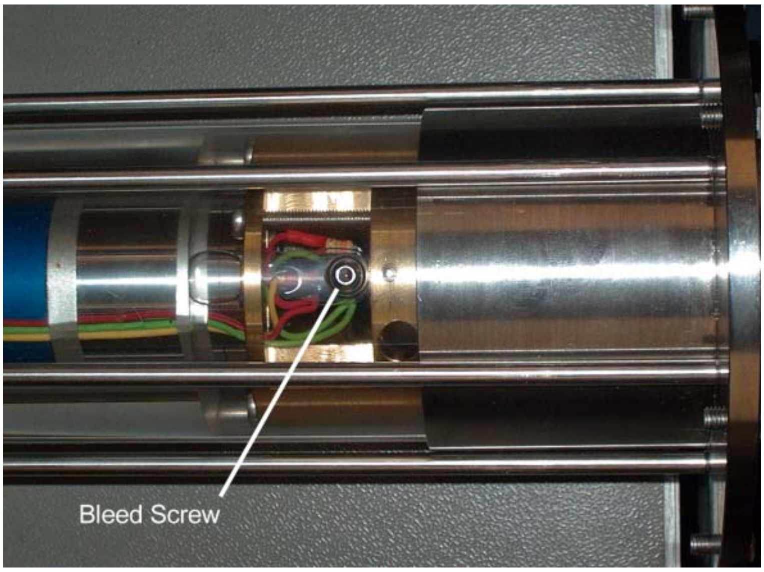
4.3 REPLENISHING PRESSURE BALANCE FLUID IN MOTOR HOUSING

The Motor housing for the water is pressure balanced using a liquid called Fluorinert FC-77. This is a very inert, non-toxic fluid. It is very important that there are no significant air bubbles in this fluid, since this will affect the pressure balancing of the housing, and may result in damage.

If there are air bubbles present, lay the housing horizontal, and position it such that the air bubbles are directly beneath the bleed screw shown.

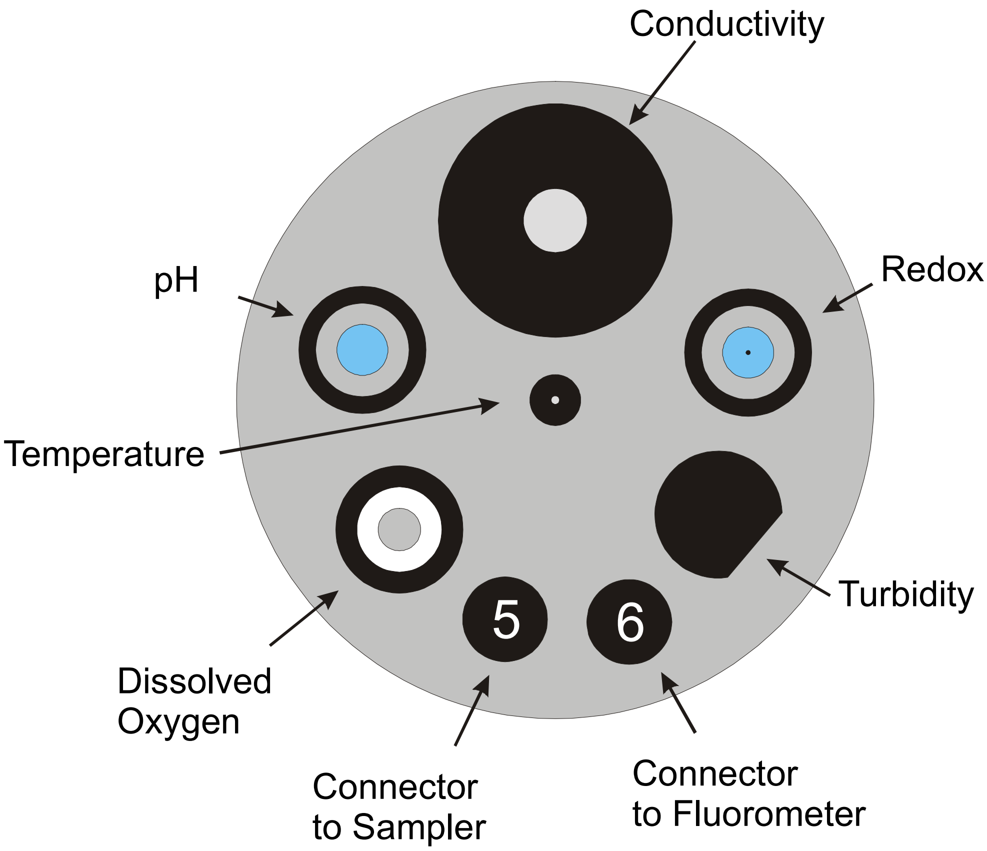
Remove the bleed screw, and using the syringe supplied, fill the housing with Fluorinert (approx 200ml are supplied for this purpose).

When the housing is full, refit the bleed screw and tighten.



5 SENSOR INFORMATION

The view onto the end of a fully specified Model 606+ is as below. Note that not all sensors may be fitted to a specific unit.



Notes:

The Temperature sensor is protected by a plastic guard. This guard may be unscrewed for cleaning or calibration purposes, but should be replaced prior to deployment.

The pH and Reference sensors are fitted with a protective rubber cap, which is used to prevent the sensors from drying out. A small amount of reference solution should be put into the cap before it is fitted for storage.

No maintenance is required on the standard Valeport sensors – Conductivity, Temperature and Pressure, other than making sure that they are cleaned after deployment. Details of standard operating principles and maintenance procedures for the remaining sensors are given on the following pages.

Secondary calibration procedures for these sensors are covered in the separate manual.

5.1 SEAPOINT TURBIDITY METER

Seapoint Turbidity Meter

User Manual

Bulkhead Version

5.1.1 DIMENSIONS

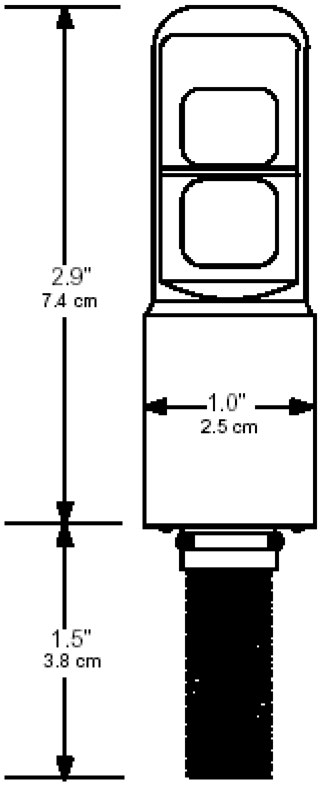


Figure 1. Outline Drawing

5.1.2 SPECIFICATIONS

Power Requirements:	7-20VDC, 3.5mA avg, 6mA pk	
Output:	0-5.0 VDC	
Output Time Constant:	0.1 sec	
RMS Noise:	< 1 mV	
Power-up Transient Period:	<1 sec	
Light Source Wavelength:	880 nm	
Scatterance Angles:	15 - 150 degrees	
Linearity:	< 2 % deviation 0-750 FTU	
Sensitivity/Range:	100x gain:	200 mV/FTU 25 FTU
	20x gain:	40 mV/FTU 125 FTU
	5x gain:	10 mV/FTU 500 FTU
	1x gain:	2 mV/FTU (< 750 FTU) *
Temperature Coefficient:	< 0.05 %/°C	
Operating Temperature:	0°C to 65°C	
Depth Capability:	6000 m (19,700 ft)	
Overall Length:	11.2 cm (4.4 in)	
Sensor Weight (dry):	95 g (3.3 oz)	
Body Diameter:	2.5 cm (1.0 in)	

* Response to turbidity levels greater than 750 FTU is nonlinear

5.1.3 INTRODUCTION

The Seapoint Turbidity Meter is a sensor that measures turbidity by detecting scattered light from suspended particles in water. Its small size, very low power consumption, high sensitivity, wide dynamic range, and 6000 meter depth capability allow this sensor to be used in most applications where turbidity or suspended particle concentrations are to be measured. The sensor is also insensitive to ambient light when under water and has a very low temperature coefficient.

The Seapoint Turbidity Meter senses scattered light from a small volume within 5 centimeters of the sensor windows. Confining the sensing volume allows the sensor to be calibrated in relatively small water containers without errors from surface and wall reflections. It also allows the sensor to be used in tight spaces such as crowded instrumentation packages, pipes, and shallow streams.

Two control lines allow the user to externally set the sensitivity of the Seapoint Turbidity Meter by choosing one of four gains. This provides an easy means to set the sensitivity to provide the range and resolution required for a particular application.
Sensitivities of 2, 10, 40 and 200 mV/FTU are possible.

Each sensor is factory adjusted for consistent response to Formazin Turbidity Standard measured in Formazin Turbidity Units (FTU). The user may also calibrate the sensor with particles of interest to measure their suspended concentrations.

The Seapoint Turbidity Meter is constructed of rugged, corrosion resistant materials and quality surface mount electronic components for durability and high reliability.

5.1.4 OPTICAL DESIGN

Figure 2 shows a cross-section of the Seapoint Turbidity Meter optics.

The light sources are side by side 880 nm Light Emitting Diodes.

The light detectors are side by side silicon photodiodes with visible light blocking filters. The light sources are extremely efficient and well matched to the peak sensitivity of the silicon photodiodes.

The opaque housing forms a light block which prevents light from the emitter from reaching the detector directly. Light from the LEDs shines through the clear epoxy emitter window into the sensing volume where it is scattered by particles.

It is possible for light scattered at angles between 15 and 150 degrees to pass through the detector window and reach the detector. The amount of scattered light that reaches the detector is proportional to the turbidity or particle concentration in the water over a very large range.

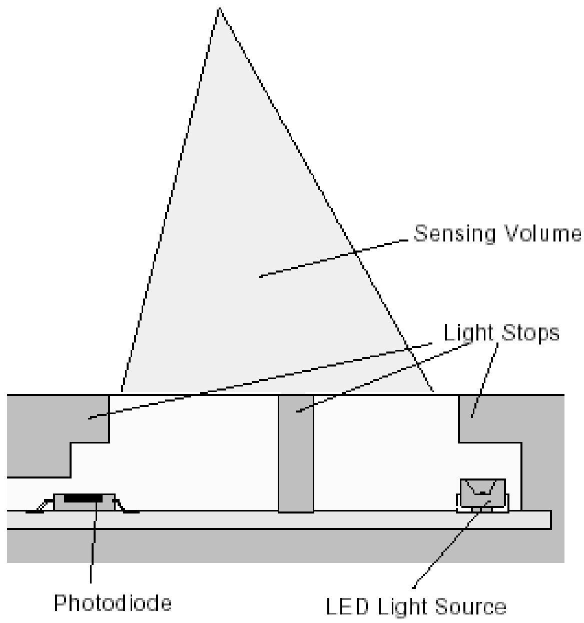


Figure 2. Diagram of Seapoint Turbidity Meter Optics

The optical design of the Seapoint Turbidity Meter is unique in its restriction of the angle of emission of the light sources and the angle of detection of the light detectors. This confines the sensing volume to within five centimeters of the sensor windows. The advantage to confining the sensing volume to a small space near the sensor is the great reduction of interference from reflections from large objects outside the sensing volume. This allows the sensor to be calibrated in a relatively small water container without interference from surface or wall reflections. It also allows the sensor to be used where limited volumes of water exist for sensing or in the midst of objects which would otherwise cause interfering reflections. Examples include instrumentation packages with limited space between instruments or limited space inside the frame, monitoring water inside pipes, and measuring water in shallow streams or near stream beds.

5.1.5 ELECTRONIC DESIGN

The Seapoint Turbidity Meter has an electronic design that achieves high sensitivity while consuming very little power. Surface mount components are used for high reliability and compact design. Low quiescent current components are used so that most of the power drawn by the sensor is used to drive the light source. Overall power requirements are 7-20 VDC, 3.5 mA average, 6 mA peak.

Optical feedback is incorporated in the light source drive circuitry. This offers several benefits including excellent temperature compensation for the optical components, ompensation for the aging of the optical components, and table output within a second after power up.

The light source is modulated and synchronous detection is used to extract the scatterance signal from the unwanted portion of the signal resulting from ambient light and electronic noise.

Achieving high sensitivity using low power was accomplished by paying careful attention to proper circuit board layout to prevent any stray coupling of signals synchronous with the modulation of the light source into the detection circuitry. The need for offset adjustment was thereby eliminated — the offset voltage for this sensor at any gain is within one millivolt of zero.

5.1.6 OPERATION

The Seapoint Turbidity Meter requires 7 to 20 VDC input and will draw an average of 3.5 mA current with a peak current draw of 6 mA. Output is 0 to 5.0 VDC with a 0.1 second time constant.

Warning: Applying voltages to the output pin or powering the sensor with a voltage greater than 20 V will result in damage to the sensor.

A mechanical drawing for the machined housing and Seapoint Turbidity Meter is shown in Figure 3.

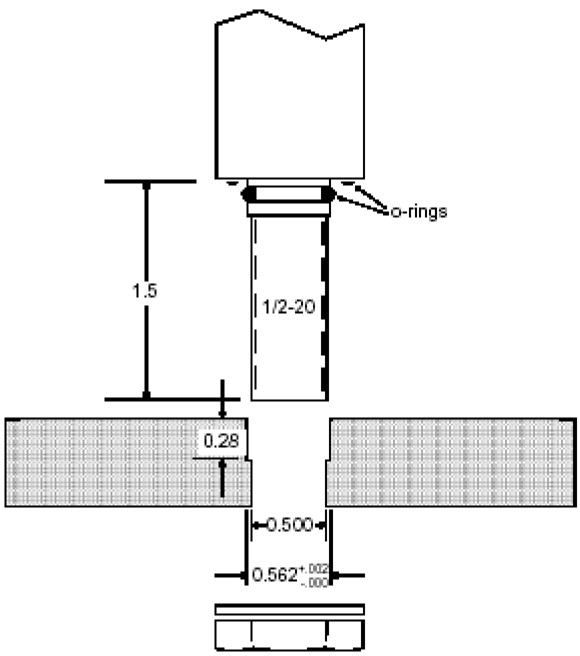


Figure 3. Drawing of Bulkhead Sensor and Customer Housing

The bulkhead (connector end of sensor) and the mating machined housing should be cleaned and lubricated with an o-ring lubricant.

Connections for the bulkhead version are as follows:

Brown: Power Ground
Blue: Signal Output
Green: Signal Ground
Yellow: Power In
Orange: Gain Control A
Red: Gain Control B

The two independent gain control lines A and B are used to select one of four possible gain settings (see Table 1). These wires can be hardwired for the desired gain or interfaced with a microprocessor, using 5 volt logic, to allow gain to be controlled through software. Hardwiring the gain does not require an external voltage source. To hardwire a line to +5V, simply leave it open, which allows an internal pull-up to hold it at +5 VDC. To set a line to 0V, tie it to the power ground.

A	B	Gain	Sensitivity	Range
+5 V	+5 V	100X	200mV/FTU	25 FTU
+5 V	0 V	20X	40mV/FTU	125 FTU
0 V	+5 V	5X	10mV/FTU	500 FTU
0 V	0 V	1X	2 mV/FTU	n/a
			(<750 FTU)	

Table 1. Truth Table for Switching Gains

The sensor has a linearity in Formazin of ±2 % at the 100X, 20X, and 5X gain settings. The 1X gain setting is provided for extremely turbid water. The sensor response above 750 FTU is non-linear; however, the useful range can be extended by calibrating the sensor and fitting the response with a second order polynomial equation. This approach is limited by the increasingly flat response at turbidity levels approaching 4000 FTU. Figure 4 shows a typical sensor response.

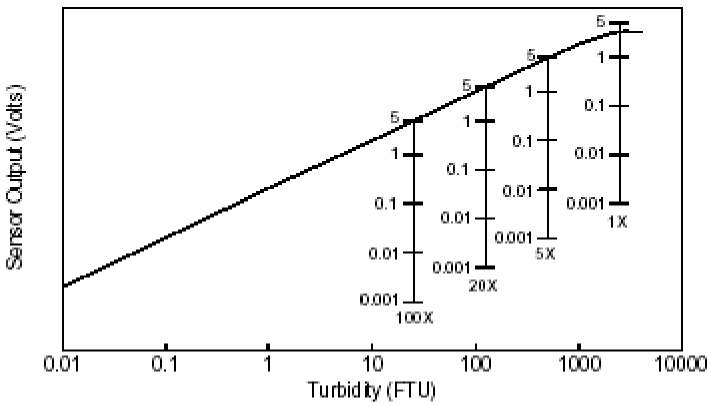


Figure 4. Sensor Response to Formazin Turbidity Standard

5.1.7 CALIBRATION

All sensors are adjusted to the nominal sensitivities specified so that for most purposes they are interchangeable. If greater accuracy is desired, it is recommended that the user perform calibrations on individual sensors.

The sensors can also be calibrated by the user to measure suspended particle concentrations. Like all optical instruments, this calibration must be performed using a sample from the measurement site. Calibrations with different particle types will
typically yield erroneous results.

Calibrations should be performed periodically at a frequency which depends on the condition of the windows. Although these sensors are electronically stable with time, scratching or fouling of the windows will result in reduced sensitivity. Visual inspection is a good test of whether the sensor needs recalibration: if the windows appear polished and clear when dry, the sensitivity probably has not changed significantly.

When calibrating in a small container, multiple scattering events may reflect off the container walls introducing a small error to the calibration. For this reason, the use of a black container is recommended.

Calibration should be performed under fluorescent lighting. Incandescent lights emit large amounts of energy at the operating wavelength which may interfere with measurements.

5.1.8 CARE

The Seapoint Turbidity Meter is a rugged instrument that should provide years of reliable performance with minimal care.

After using, rinse the sensors and clean the windows with water and mild detergent if necessary (avoid using organic solvents).

If windows become scratched, they may be polished using a cloth buffing wheel with polishing compound.

The connector should be cleaned and lubricated before the sensor is mounted with an o-ring lubricant.

The Seapoint Turbidity Meter contains no user serviceable electronics and must be returned to the factory if it does not operate properly.

5.1.9 LIMITED WARRANTY

Seapoint Sensors, Inc. warrants this Turbidity Meter to be free of defects of materials and workmanship under normal use and service for a period of 1 year from the date of shipment. This warranty extends
only to the original purchaser.

In the event the product fails to operate according to our published specifications during the warranty period, Seapoint Sensors, Inc. will repair or replace the instrument at our discretion. If it is determined that the failure was due to other than normal use or service, repairs will be billed and estimate will be submitted prior to repair work.

Shipping costs must be prepaid. Seapoint Sensors, Inc. accepts no responsibility for damage during return shipment.

5.2 SEAPOINT FLUOROMETER

Seapoint
Chlorophyll
Fluorometer

User Manual

Standard Version

5.2.1 DIMENSIONS

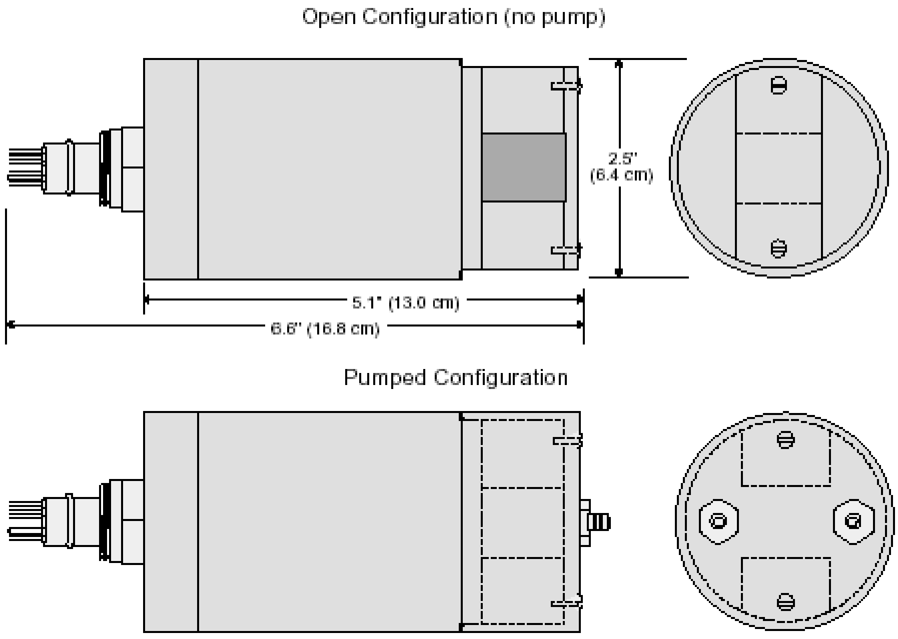


Figure 1. 1/2 Scale Drawing.

5.2.2 SPECIFICATIONS

Power Requirements:	8-20 VDC, 15mA avg, 27mA pk
Output:	0-5.0 VDC
Output Time Constant:	0.1 sec
Power-up Transient:	0.6 sec
RMS Noise (typ.):	30x gain: 3 mV
	10x gain: 1 mV
	3x gain: <1 mV
	1x gain: <1 mV
Excitation Wavelength:	470 nm peak, 30 nm FBHM
Emission Wavelength:	685 nm peak, 30 nm FBHM
Sensing Volume:	340 mm^3
Sensitivity/Range†:	30x gain: 1.0 V/(µg/l) 5 µg/l
	10x gain: 0.33 V/(µg/l) 15 µg/l
	3x gain: 0.1 V/(µg/l) 50 µg/l
	1x gain: 0.033V/(µg/l) 150µg/l
Min. Detectable Level:	0.02 µg/l
Temperature Coefficient:	< 0.2 %/°C
Operating Temperature:	0°C to 65°C
Depth Capability:	6000 m
Length:	16.8 cm
Body Diameter:	6.4 cm
Sensor Weight (dry):	850 g

† Specified sensitivities and ranges are nominal values. Instrument should be calibrated for quantitative measurements.

5.2.3 INTRODUCTION

The Seapoint Chlorophyll Fluorometer is a high-performance, low power instrument for *in situ* measurements of chlorophyll *a*. Its small size, very low power consumption, high sensitivity, wide dynamic range, 6000 meter depth capability, and open or pump-through sample volume options provide the power and flexibility to measure chlorophyll *a* in a wide variety of conditions. The instrument has good ambient light rejection and a low temperature coefficient.

The Seapoint Chlorophyll Fluorometer can be operated with or without a pump. The small sensing volume of approximately 340 mm^3 can be left open to the surrounding water, or, with the use of the supplied cap, can have water drawn through it using a pump.

Two control lines allow the user to externally set the sensitivity of the Seapoint Chlorophyll Fluorometer by choosing one of four gains. This provides an easy means to set the sensitivity to provide the range and resolution required for a particular application. Sensitivities of 0.033, 0.1, 0.33, and 1 V/(µg/l) are possible.

The Seapoint Chlorophyll Fluorometer is constructed of rugged, corrosion-free materials, surface mount electronics, and solid-state lamps and detector for excellent durability and high reliability.

The Seapoint Chlorophyll Fluorometer uses the same Impulse AG-206/306 connector as the Seapoint Turbidity Meter, and the two instruments are pin-compatible.

5.2.4 OPTICAL DESIGN

Figure 2 shows the Seapoint Chlorophyll Fluorometer optics.

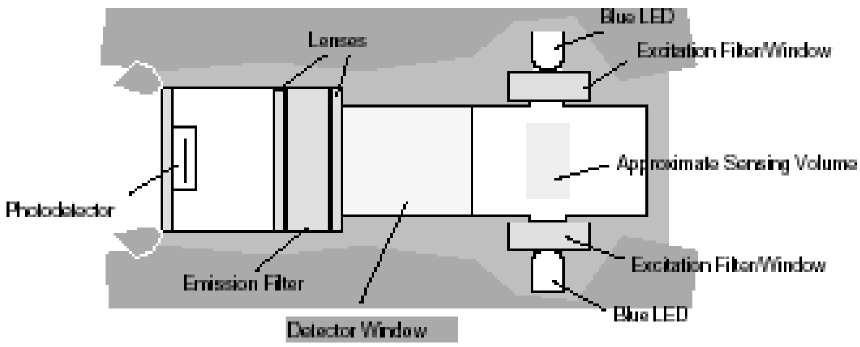


Figure 2. Seapoint Chlorophyll Fluorometer Optics

The blue LED lamps direct light through the blue excitation filter/windows illuminating the sensing volume. Chlorophyll *a* present in the sensing volume is excited with the blue light and fluoresces red light, a portion of which passes through the detector window. This fluorescent light is then collimated with a lens so that it passes through the emission filter nearly normal to the filter. A second lens then focuses the fluorescent light onto the detector.

The end plate of the instrument (or the cap in pumped operation) prevents ambient light from reaching the detector directly. The narrow bandwidth of the emission filter further reduces the amount of ambient light reaching the detector.

The sensing volume of the instrument is defined by the intersection of the lamp beams and the detector's cone of reception. This volume is nearly a cylinder of approximately 340 mm^3.

5.2.5 ELECTRONIC DESIGN

The Seapoint Chlorophyll Fluorometer has an electronic design that achieves high sensitivity while consuming very little power. Surface mount components are used for high reliability and compact design. Low quiescent current components are used, allowing all but about 3 milliamps of the total current drawn by the instrument to drive the lamps. Overall power requirements are 8-20 VDC, 15 mA average, 27 mA peak.

The instrument is very stable with temperature and time. The LED lamps and the detector have low temperature coefficients at their respective operating wavelengths. The overall temperature coefficient of the instrument is less than 0.2%/°C. Degradation of the lamps with operating time will result in about 10% reduction in sensitivity after 5000 hours of operation. Stable output of the instrument occurs at approximately 0.6 seconds after power up.

The light source is modulated at 700 Hz and synchronous detection is used to extract the fluorescent signal from the unwanted portion of the signal resulting from ambient light and electronic noise. Achieving high sensitivity using low power was accomplished by paying careful attention to proper circuit board layout to prevent any stray coupling of signals synchronous with the modulation of the light source into the detection circuitry. The offset voltage is proportional to the selected gain.

5.2.6 OPERATION

Electrical Connections

The Seapoint Chlorophyll Fluorometer requires 8 to 20 VDC input and will draw an average of 15 mA current with a peak current draw of 27 mA. Output is 0 to 5.0 VDC with a 0.1 second time constant.

Warning *Applying voltages to the output pin or powering the instrument with a voltage greater than 20 V will result in damage to the instrument.*

The Impulse AG-306 bulkhead (connector end of sensor) and the mating AG-206 connector (included with pigtail) should be cleaned and lubricated with 3M Silicone Spray, Dow Corning #111 Valve Lubricant or equivalent prior to connecting.

The pin numbering on the AG-306 is shown in Figure 3. Note that Pin 1 is larger than the other pins. The AG-206 connector has two raised bumps which align with Pin 1 to make connection with the AG-306 easy. The AG-206 pigtail is supplied with a locking sleeve which screws onto the AG-306 connector after the pigtail is plugged in.

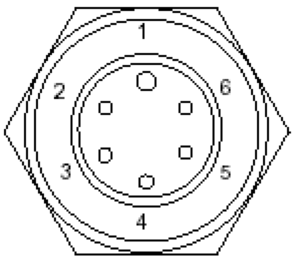


Figure 3. AG-306 Pin numbering.

Connections for the Impulse AG-206/306 are as follows:

Pin 1	white	Power Ground
Pin 2	black	Signal Output
Pin 3	blue	Signal Ground
Pin 4	orange	Power In
Pin 5	green	Gain Control A
Pin 6	red	Gain Control B

The two independent gain control lines A and B are used to select one of four possible gain settings (see Table 1). These wires can be hardwired for the desired gain or interfaced with a microprocessor, using 5 volt logic, to allow gain to be controlled through software. Hardwiring the gain does not require an external voltage source. To hardwire a line to +5V, simply leave it open, which allows an internal pull-up to hold it at +5 VDC. To set a line to 0V, tie it to the power ground.

A	B	Gain	Sensitivity	Range
+5 V	+5 V	30X	1 V/(µg/l)	5 µg/l
+5 V	0 V	10X	0.33 V/(µg/l)	15 µg/l
0 V	+5 V	3X	0.1 V/(µg/l)	50 µg/l
0 V	0 V	1X	0.033 V/(µg/l)	150 µg/l

Table 1. Truth Table for Switching Gains

The sensitivities and ranges given in Table 1 are nominal values for a typical instrument, and therefore the user should calibrate the instrument as described in the calibration section of this manual before making quantitative measurements.

5.2.6.1 CONSIDERATIONS FOR CHOOSING GAIN

Choosing an appropriate gain for a particular application will depend on a number of factors including expected chlorophyll concentrations, resolution of the data recorder's A/D converter, and whether smoothing will be applied to the data. The noise level of the instrument at 30X gain will be above the resolution of the A/D converters in most data loggers. The 150 µg/l range at 1X gain is much greater than what is necessary to cover chlorophyll *a* concentrations in most natural waters. Therefore, for most applications 3X or 10X gain will be most appropriate.

5.2.6.2 FILTERING THE OUTPUT FOR IMPROVED RESOLUTION

The Seapoint Chlorophyll Fluorometer has a low-pass filter with a 0.1 second time constant on its output (1.6 Hz cut-off frequency). In some applications, such as ocean profiling, this is useful in providing information which would be missed with a slower response. In other applications, such as with some moored applications, smoothing the data with a low-pass filter with a time constant greater than 0.1 second will be helpful in reducing the instrument noise thereby allowing lower chlorophyll *a* concentrations to be detected.

Analog filters can be constructed and placed between the instrument output and the A/D converter to smooth the output. Digital filtering can accomplish this as well, either before storing the data or during analysis of the data. Some data loggers have built-in averaging or smoothing functions which make this especially easy.

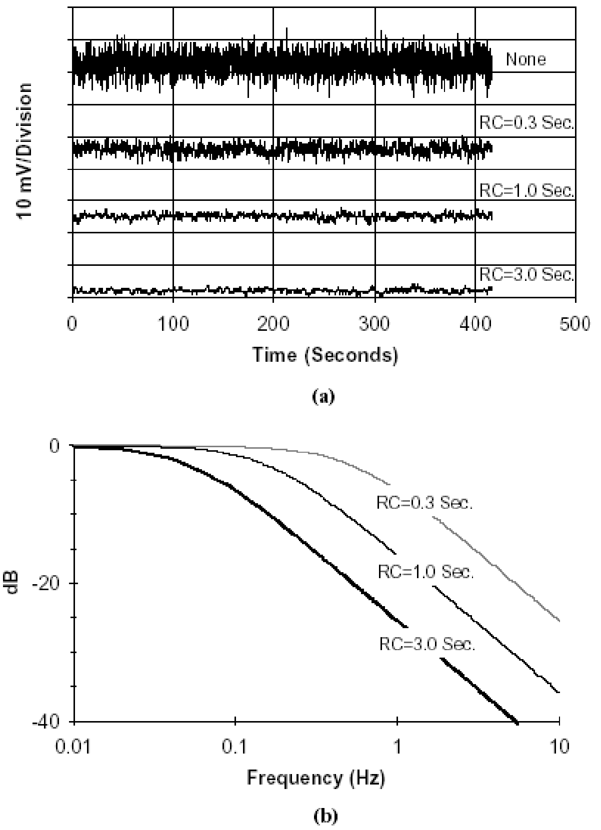


Figure 4. (a) Time series of fluorometer output at 30x gain with and without low-pass analog filtering.
(b) Frequency response of single pole RC filter.

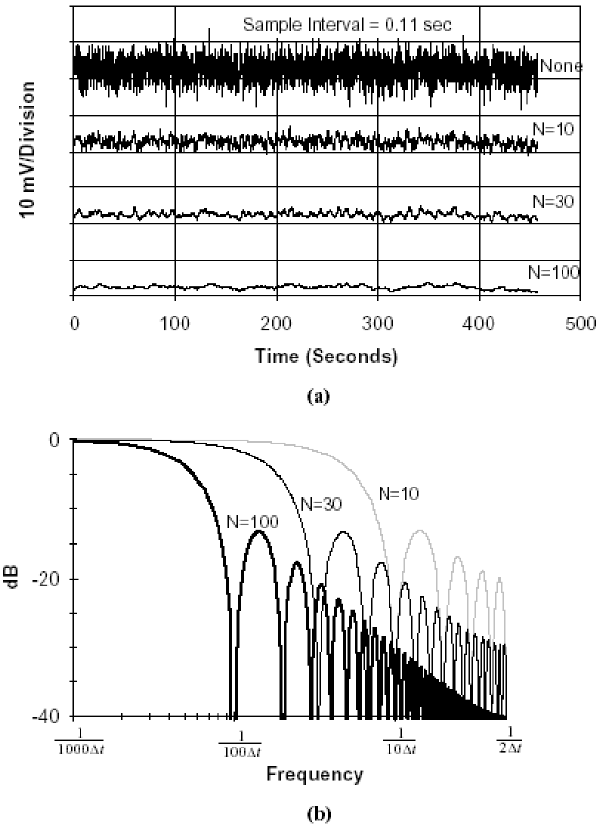


Figure 5. (a) Time series of fluorometer output at 30x gain with and without digital filtering.
(b) Frequency response of moving average digital filter.

Figure 4(a) shows several time series of the instrument output at 30x gain. The top series shows the instrument output without any external filtering. The underlying series show the effects of applying low-pass analog filtering to the instrument output. Frequency responses of the filters used are shown in Figure 4(b).

Figure 5(a) shows more time series of the instrument output at 30x gain. The top series shows the instrument output sampled at 0.11 second intervals. The underlying series were generated by digitally filtering the series with moving averages, as described by:

$$y_n = \frac{1}{N}\sum_{k=0}^{N} x_{t-k}$$

Figure 5(b) shows the frequency responses of the moving mean filters.

5.2.6.3 AMBIENT LIGHT CONCERNS

The combined optical filtering and synchronous detection give the Seapoint Chlorophyll Fluorometer good ambient light rejection, and ambient light will not be a concern when the instrument is capped and operated with a pump. When operating with an open sample volume, ambient light will not contribute an offset to the output voltage of the instrument, but strong fluctuating light may cause a noisy signal. This can happen under fluorescent or incandescent lighting or in surface waters in bright sunlight.

Laboratory lighting usually will not increase instrument noise as long as the detector window faces down, away from the lights. If the noisy output persists, shade the instrument or perform tests or calibrations in a vessel with opaque walls.

If field measurements are to be made near the water surface with an open sample volume, it is a good idea to experiment with the instrument beforehand, and try to determine if the noise caused by the ambient light will be significant. Again, ambient light rejection will be best with the detector window facing down. If the noise is indeed a concern, consider constructing a baffle to shade the instrument.

5.2.6.4 MEASUREMENT CONFIGURATIONS

The Seapoint Chlorophyll Fluorometer may be configured for open or pumped measurements of chlorophyll *a* in water. Please note that the instrument is designed only for measurements in water. Never immerse the instrument in acetone solutions or pump acetone into the sensing volume, which will result in damage to the instrument body and windows.

The Seapoint Chlorophyll Fluorometer is supplied in the open sensing volume configuration. In this configuration, as the surrounding water flows past the instrument, it will also flow through the instrument's sensing volume.

The Seapoint Chlorophyll Fluorometer also comes with a cap which can be placed over the end of the instrument so that water may be drawn through the instrument with a pump.

To install the cap, take off the end plate by removing the two screws that hold it in place. Slip the large O-ring over the lamp towers so that it rests on the reduced diameter of the instrument body. Then slip the cap over the lamp towers so that it presses the O-ring in place. Secure the cap with the two screws which have small O-rings to prevent leaking. The cap has nipples for 3/8" tubing. These nipples can be replaced to accommodate other tubing sizes.

When using the instrument in pumped operation in the laboratory, care should be taken to assure that air bubbles are eliminated before making measurements. In this regard, drawing water through the sample volume generally is more effective that pushing it through with the pump.

5.2.7 CALIBRATION

The Seapoint Chlorophyll Fluorometer is adjusted at the factory for the nominal range and sensitivity at a given gain setting as
specified in this manual. However, for accurate quantitative measurements, user calibrations are required. The Seapoint Chlorophyll Fluorometer is very stable, with very little change in sensitivity over time. Nonetheless, frequent calibration of the instrument is recommended. Some decrease in sensitivity can be expected after extended use due to decreased output of the lamps (about a 10% decrease in output after 5000 hours of operation) and scratched window surfaces.

Measurement of chlorophyll *a* and calibration of chlorophyll fluorometers is somewhat inexact, and users not familiar with calibration techniques and the considerations associated with this subject are urged to consult with experts in this field or refer to texts and papers for detailed discussion of these matters1-4.

1. Parsons, T.R., Maita, Y. & Lalli, C.M. 1984. A Manual of Chemical and Biological Methods for Sea Water Analysis, Permagon, Oxford, 173 pp.

2. Smith, R.C., Baker, K.S., and Dustan, P. 1981. Fluorometric Techniques for the Measurement of Oceanic Chlorophyll in the Support of Remote Sensing, Scripps Institution of Oceanography Ref. 81-17, 14 pp.

3. Mills, D.K. & Tett, P.B. 1990. "Use of a recording Fluorometer for continuous measurement of phytoplankton concentration." Environment and Pollution Measurement Sensors and Systems, SPIE Proc., 1269, 106-115.

4. Yentsch, C.M. & Yentsch, C.S. 1984. "Emergence of optical Instrumentation for measuring biological properties." Oceanography and Marine Biology, an Annual Review, 22, 55-98.

6 WIRING INFORMATION

6.1 3M Y LEAD (RS232)

10 Way Male Subconn	3m Blue Polyurethane Cable	1m White Cable	4mm Banana Plugs	1m Grey Cable	9 Way D Type	Function
1	WHITE	BLUE	BLACK			Power Ground
2	PINK	BROWN	RED			Power +V
3	N/C					
4	N/C					
5	N/C					
6	N/C					
7	GREY			YELLOW	2	RS232 Tx (To PC)
8	BLUE			BLUE	3	RS232 Rx (From PC)
9	GREEN			GREEN	5 (link to 1,6,8,9)	RS232 Ground
	SCREEN			SCREEN	SHELL	
10	YELLOW					Internal Battery Enable Link to RS232 Ground

6.2 REMOTE FLUOROMETER FLYLEAD

END 1 :		END 2 :			FUNCTION
CONNECTOR	PIN	WIRE COLOUR	PIN	CONNECTOR	
6 WAY MALE SUBCONN	1	WHITE	1	IMPULSE AG306	PWR GND
MCIL6M	4	BLACK	2		SENSOR SIG (0-5v)
+ LOCKING SLEEVE	5	BLUE	3		SIG GND
	2	ORANGE	4		SENSOR PWR (10v)
	6	GREEN	5		GAIN CTRL A
	3	RED	6		GAIN CTRL B

6.3 WATER SAMPLER MOTOR FLYLEAD

END 1 :		END 2 :		FUNCTION
CONNECTOR	PIN	PIN	CONNECTOR	
5 WAY MALE SUBCONN	1	1	5 WAY FEMALE SUBCONN	Motor +10V
MCIL5M	2	2	MCIL5F	Motor 0V
+ LOCKING SLEEVE	3	3	+ LOCKING SLEEVE	+5V Sensor
	4	4		0V Sensor
	5	5		Sensor O/P

7 CALIBRATION INFORMATION

Inserted After This Page

8 EQUIPMENT CHECKLIST

Serial No.	Model No. ....
Customer:	Con Number: ....
....	Customer Ref: ....
....	Del. Note:..
....	Calibration Cert.: ....

ITEM	Quantity	Serial Number	Initials
Hardware			
Model 606+ Multiparameter CTD (6000) dBar	1		
Additional Sensors: Seapoint Turbidity Seapoint Fluorometer Idronaut Dissolved Oxygen Idronaut pH Idronaut Reference Idronaut Redox	1 1 1 1 1 1		
1.5V alkaline cells (fitted)	8		
Conductivity Test Loop	1		
Stainless steel deployment frame	1		
Suspension Strop	1		
3m Y Lead	1		
Switching Plug	1		
Titanium Grease and Syringe	1		
Tools and Accessories Kit	1		
System Transit Case	1		
Water Bottle Frame and Motor (12 bottle)	1		
Water Bottles (2.5litre)	12		
Software			
DataLog 400 CDROM	1		
Documentation			
Operating Manuals	1		
Calibration Certificates Enclosed	1		

SIGNED .... DATE ....

9 GUARANTEE CERTIFICATE

The following guarantee periods shall apply:

Pressure Transducers and semiconductors	*12 months from date of despatch*
All other system components	*36 months from date of despatch*

During the above periods, Valeport Limited warrants that (at their option), they will replace or repair any faulty items caused by bad workmanship or materials.

Any such claims must be submitted in writing during the above warranty periods.

Valeport Limited shall be under no liability for:

1) Any consequential loss or damage of any kind whatsoever.

2) For any defect or deficiency judged by Valeport Limited to be caused by wear and tear or of improper or unskilled handling of the goods or by any repair or attempted repair or dismantling by any one other than Valeport Limited or persons authorised to do so by Valeport Limited.

3) Batteries and other consumables supplied with the equipment, which are not covered by this guarantee.

Due to the specialised nature of the instrument it should, if possible, be returned to the factory for repair or servicing. The type and serial numbers of the instrument should always be quoted, together with full details of any fault or the service required.

Equipment returned to Valeport Limited for servicing must be adequately packed, preferably in the special box supplied and shipped with transportation charges prepaid. Return transport charges are also to the account of the customer.

Note: Any items supplied as part of a system which are not manufactured by Valeport Limited are covered by the individual manufacturer's guarantee of the equipment supplied.

MODEL NUMBER .... SERIAL NUMBER ....

DATE OF DESPATCH .... SIGNATURE...