fastCTD Profiler
Operating Manual

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1. Introduction

An evolution of the fastCTD, the fastCTD Profiler has been designed to deliver the highest quality CTD casts at fast drop rates as well as conventional casts. A conductivity cell designed for optimum flow-through, a fast response thermistor temperature sensor and a 0.01% pressure sensor synchronously sampling at up to 32Hz deliver the highest quality profiles in a lightweight and robust package.

Add in an integral fluorometer based on Valeport's new Hyperion range, an optional Bluetooth communications module and the fastCTD Profiler offers a unique and versatile solution.

2. Sensors

The fastCTD Profiler is available with a number of options:

Fast Response, high accuracy thermistor temperature sensor - T1
Robust, high accuracy thermistor temperature sensor - T2

High specification, 0.01% of full scale, pressure sensor with a number of pressure ranges to best suit your operational requirements and maintain the highest possible accuracy.

Optional Fluorometer sensor, integrated into the main housing of the profiler.

The option for a SubConn connector for wired comms or Bluetooth connectivity options.

The Fast Profiler is available with either Titanium or Acetal housing material.

2.1. Conductivity

Range:	0 - 80 mS/cm
Resolution:	0.001mS/cm
Accuracy:	±0.01mS/cm
Response Time:	30 milliseconds

2.2. Temperature (T1) - Fast Response Thermistor

Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C
Response Time:	50 milliseconds

2.3. Temperature (T2) - Robust Thermistor

Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C
Response Time:	150 milliseconds

2.4. Pressure

Range:	10, 50 Bar (Acetal housed systems)
	10, 50, 100, 200 Bar (Titanium Bluetooth equipped unit)
	10, 50, 100, 300 or 600 Bar (Titanium housed systems only)
Resolution:	0.001% range
Accuracy:	±0.01% range
Response Time:	1 milliseconds

2.5. Optical Sensors

Hyperion Fluorometer are configured and correlated with a specific fluorophore. This is identified by the letter after the 5-digit serial number:

2.5.1. Chlorophyll a

Performance	
Excitation:	470 nm
Detection:	696 nm
Dynamic Range:	0-800 µg/l 2 gain settings: 0-40 and 0-800 software controlled
Instrument Detection limit:	0.025 µg/l*
Actual Detection limit:	0.025 µg /l**
Linearity:	0.99 R^2
Response Time:	0.03 to 2 sec
Output Rate:	0.5 Hz to 32 Hz (free running) software controlled

* 3x SD in RO water
** calibrated against Chlorophyll a in acetone solution

2.5.2. Fluorescein

Performance	
Excitation:	470 nm
Detection:	545 nm
Dynamic Range:	0-500 ppb 2 gain settings: 0-25 and 0-500 software controlled
Instrument Detection limit:	<0.01 ppb*
Actual Detection limit:	0.03 ppb**
Linearity:	0.99 R^2
Response Time:	0.03 to 2 sec
Output Rate:	0.5 Hz to 32 Hz (free running) software controlled

* 3x SD in RO water
** Calibrated against Fluorescein solution

2.5.3. Rhodamine

	Performance
Excitation:	520 nm
Detection:	650 nm
Dynamic Range:	0-1000 ppb 2 gain settings, 0-50, 0-1000 software controlled
Instrument Detection limit:	<0.01 ppb*
Actual Detection limit:	0.06 ppb**
Linearity:	0.99 R^2
Response Time:	0.03 to 2 s
Output Rate:	0.5 Hz to 32 Hz (free running) software controlled

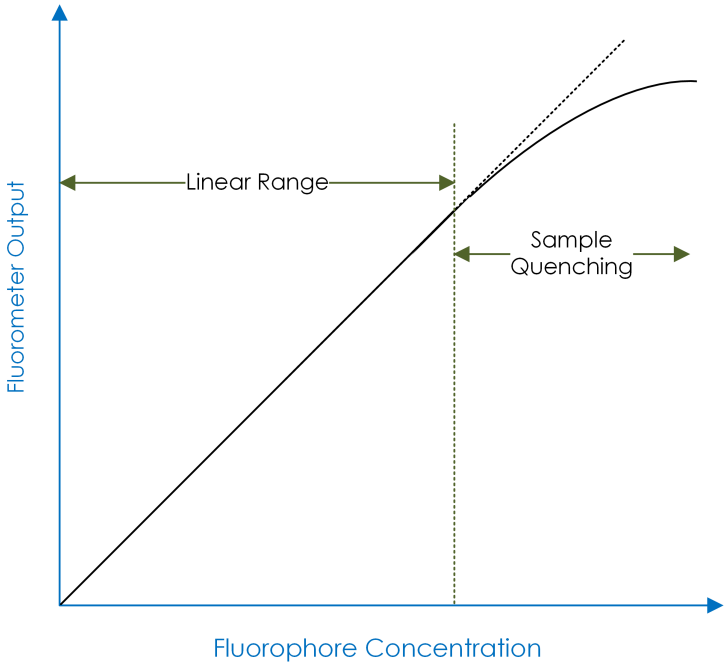
* 3x SD in RO water
** Calibrated against Rhodamine solution

2.5.4. Linear Observation Range

The linear range is the concentration range for which the fluorometer signal is directly proportional to the concentration of the fluorophore. The linear range starts at the minimum detection limit (MDL) and extends to the upper limit of the instrument (dependent on fluorophore properties, optical filters, LED power, sample volume and optical path length).

The Hyperion has a calibrated linear response for 2 gain settings (e.g. the ranges 0-40 µg/l (G5) and 0-800 µg/l (G1) for chlorophyll a). At higher concentrations, unlike analogue devices which generally flatline at full-scale deflection (e.g. FSD 5V) the Hyperion will continue to output a signal which increases with concentration (i.e. meaningful data), though which is no longer guaranteed to be linear.

At very high fluorophore concentrations, signal quenching can occur, whereby the instrument output does not increase linearly with fluorophore concentration (roll-off) and may decrease at even higher levels.



To perform a quick linearity check, dilute the sample 1:1 with RO water. If the reading decreases by 50%, the sample is in the linear range. If the reading decreases by less than 50% or even increases, the sample is above the linear range.

2.5.4.1. Quenching

Quenching refers to the reduction in fluorescence of a fluorophore. Several processes can result in quenching:

1. Chloride is known to quench quinine sulphate and Fluorescein. It is, therefore, advisable to prepare any fluorophore solutions with RO* or DI** water.

2. Temperature quenching - as the temperature of the sample increases, the fluorescence decreases, that is, fluorescence is sensitive to temperature. In order to improve accuracy, measure the sample at different temperatures and derive corrections for changes in temperature.

3. Photo-bleaching (or fading) is the (permanent) degradation of a fluorophore molecule by light resulting in lower signal levels. Photo-bleaching is dependent on exposure (intensity of light and duration) and wavelength (UV is more damaging than longer wavelengths). Use of more robust fluorophores is recommended to avoid photo-bleaching.

* Reverse Osmosis
** De-Ionised

3. Data Acquisition

The fastCTD uses the concept of distributed processing, where each sensor has its own microprocessor controlling sampling and calibration of readings. Each of these processors is then controlled by a central processor, which issues global commands and handles all the data. This means that all data is sampled at precisely the same instant, giving superior quality profile data.

The fastCTD features a selection of pre-programmed sampling regimes, covering many standard applications. Data may be sampled at up to 32Hz for all sensors, making it suitable for rapid profiling or for continuous measurement at a fixed point

3.1. Sampling Modes

Three specific sampling modes are available:

Continuous:

Regular and synchronous data collection from all sensors up to 32Hz

Profile:

Data is logged as the instrument descends (or rises), by a user defined pressure difference, through the water column.

Rapid:

Once the instrument is set to run mode no data is logged until a programmed trigger depth is reached (e.g. 2 metres below the surface). Completely programmable, the device can be set to record down cast data only, for example, when the probe stops descending and rises by a defined amount logging is stopped.

4. Physical Characteristics

Materials:

Acetal or Titanium housing (as specified)
Polyurethane and ceramic sensor components
Stainless steel (316) deployment cage

Depth Rating:

500m (Acetal)
6000m (Titanium)
NB: Maximum deployment depth may be limited by transducer range

Instrument Size:

Main Housing 48mmØ
Sensor Body 54mmØ
Length 370mm (including connector, 496mm with Bluetooth Pack)

Deployment Cage:

110mmØ x 550mm long

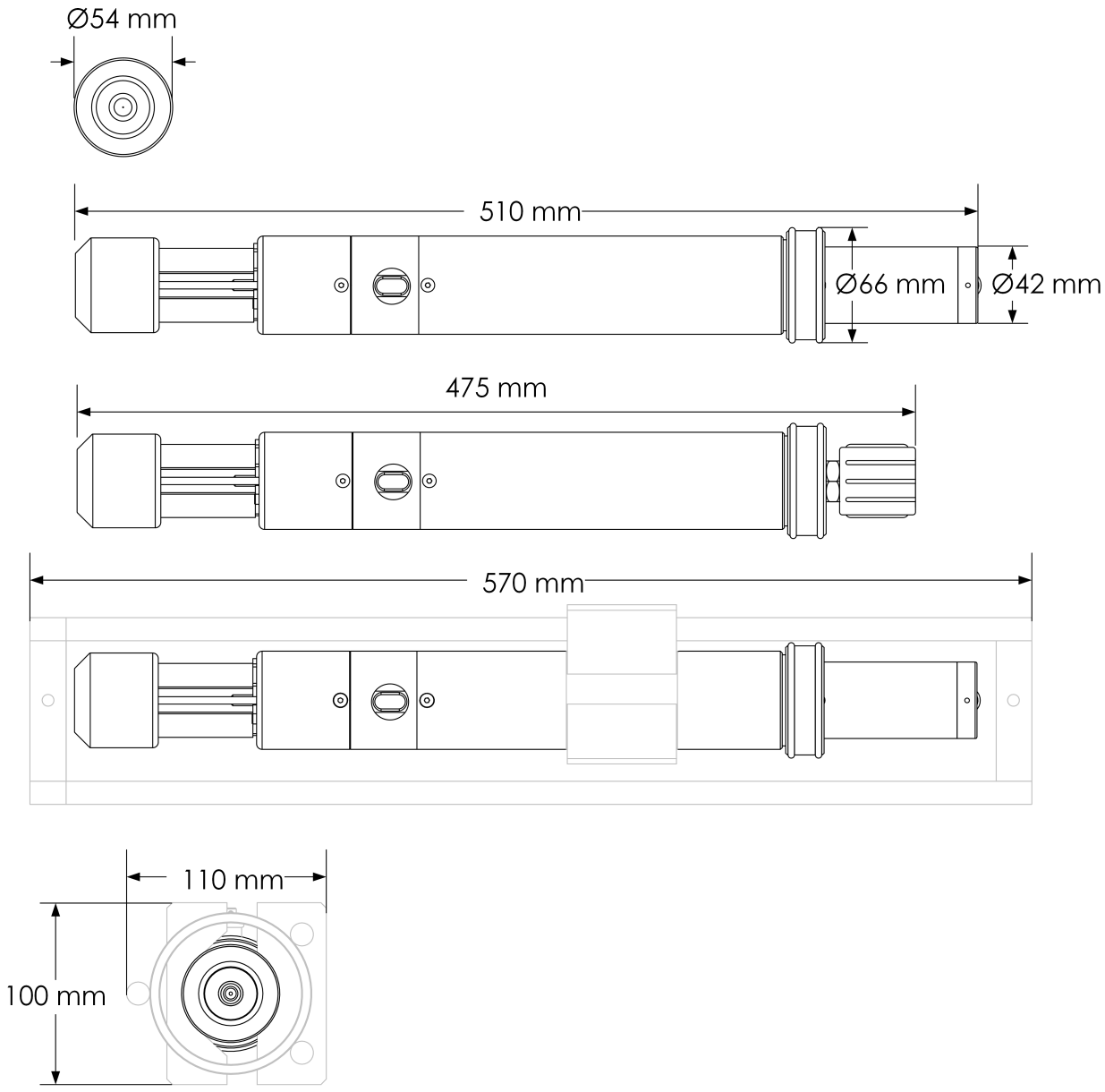
Weight:

1kg (Acetal)
1.8kg (Titanium)

Shipping:

51 x 42 x 27cm
10kg

4.1. Dimensions



5. Communications

The instrument is designed to operate autonomously, with setup and data extraction performed over Bluetooth connection with a PC before and after deployment. Multiple profiles can be taken by switching the instrument on/off with the magnetic switch key. Bluetooth auto-pairing and discovery make connecting to the instrument simple and robust..

The instrument can also be supplied with a traditional SubConn connector with a choice of communication protocols fitted as standard and selected by pin choice on the output connector:

RS232:	Up to 200m cable, direct to serial port
RS485:	Up to 1000m cable
Baud Rate:	4800 - 460800
Protocol:	8 data bits 1 stop bit No parity No flow control

5.1. Data Telegrams

Real Time Data is output as columns of comma separated ASCII data

Data output is:

"Ticks"	Units="1/800s"	Counter from start of file, measured in 1/800th's of a second. To convert to milliseconds, multiply by 800
"Pressure"	Units="dBar"	Depth or Pressure depending on operating units set in instrument
"Temperature"	Units="°C"	Temperature
"Conductivity"	Units="mS/cm"	Conductivity
"Fluorometer"	Units="ug/l"	Optional depending on whether and which Fluorometer is fitted.

Recorded Data is stored as ASCII text files. It consists of a variable number of colon delimited header lines depending on the configuration of the instrument, followed by comma separated ASCII column data as per the real time output.

5.1.1. Recorded File Format

Now: 21/01/2016 15:15:11
Battery Level: 1.4V
serial_number: 45716.000000
site_info: Valeport Test Site
version: 0660713A0 Jan 13 2015 12:15
cal_date: 00/00/2000
address_485: 1
pcb_serial_number: 0
operational sequence: 13;14;3;1;2
trigger_interval: 0.031250
averaging time constant: 1.000000
trigger_count: 32
temperature_sensor_type: 21
temperature_adc_res_cal: -1.941120e+13;8.349707e+06;1.632860e+02;-9.741146e-06
temperature_cal_steinhart: 6.388685e-04;2.268763e-04;0.000000e+00;7.224784e-08
temperature_cal_secondary: 0.000000e+00;“.483648e-43;“.483648e-43
pressure_ser_no: 1
pressure_trip_step: 10.000000
pressure_trip_start: 9.000000
pressure_trip_stop: 2.000000
pressure_tare: 10.114415
pressure_tare_mode:
user_output_stats_ID: -1,-1
fluoro_gain: 4
fluoro_sync_measure_duration: 1.000000
fluoro_high_lightlevel: 235
fluoro_cal_coefficients: 1.000000e+00;0.000000e+00;0.000000e+00
columns:time,pressure,temperature,conductivity,fluorometery,
units:1/800sec,dbar,deg C,mS/cm,ug/l,
1729,00.001,23.245,-0.003,305.925
2500,00.002,23.247,-0.003,171.626
3300,00.001,23.246,-0.003,190.889
4100,00.002,23.248,-0.004,203.170
4900,00.002,23.249,-0.004,117.875
5700,00.002,23.249,-0.004,227.219
6500,00.001,23.251,-0.004,208.928
7300,00.002,23.256,-0.003,246.401
8100,00.002,23.261,-0.003,282.974

5.2. Command Codes

The fastCTD is designed to be used with Valeport's DataLog X2 software. However, the instrument will respond to a series of text commands that are detailed here. Note that this list is not comprehensive, but will allow the standard functions of the instrument to be accessed. For more detailed information, please contact Valeport Ltd.

Notes

- All commands must be confirmed using "Carriage Return" or "Enter" on the keyboard, with the exception of the "Stop" command (#).
- All commands are echoed back by the instrument as they are typed

Stop Command

The instrument can be stopped at any time by sending the '#' character. The instrument returns a '>', and waits for a further command.

Run Commands

R1	Collects rapid profile at 1 Hz
R2	Collects rapid profile at 2 Hz
R4	Collects rapid profile at 4 Hz
R8	Collects rapid profile at 8 Hz
R16	Collects rapid profile at 16 Hz
R32	Collects rapid profile at 32 Hz

M1	Performs continuous measurement at 1Hz
M2	Performs continuous measurement at 2Hz
M4	Performs continuous measurement at 4Hz
M8	Performs continuous measurement at 8Hz
M16	Performs continuous measurement at 16 Hz
M32	Performs continuous measurement at 32 Hz

Command	Notes
Pn.nn	Performs profile at a depth increment of n.nn, as set by the operator, in the current profiling units (see command #018). e.g.: P0.25 takes a reading every 0.25 dBar, metres or feet as appropriate
Rapid Profile Settings	
#812;NN.N	Start Depth (Logging on)
#813	Report Start Depth
#814;NN.N	Stop Step (Logging off when depth decreases by amount. Should signify bottom of profile.)
#815	Report Stop Step
Bluetooth Power Saving Mode	
#820;0	Bluetooth Power Saving mode off
#820;1	Bluetooth Power Saving mode on
#824;NN.N	Bluetooth off Depth
#825	Report Bluetooth Off Depth
#822;NN.N	Bluetooth on Depth
#823	Report Bluetooth On Depth
Fluorometer Power Saving	
#434;0	Fluorometer Power Saving mode off
#434;1	Fluorometer Power Saving mode on
#436;NN.N	Fluorometer off depth
Pressure Units	
#018;0	Pressure is output in dBar
#018;1	Pressure is output in metres, calculated using simplified UNESCO formula
#018;2	Pressure is output in feet, calculated using simplified UNESCO formula
Pressure Tare	
#009;	Takes a single reading of the pressure sensor and uses the measured value as a Tare (note the ';' in the command)
#009;nn	Sets the Pressure Tare to 'nn', a user specified value (entered in the chosen units as set with command #018) e.g: #009;10.3 sets Pressure Tare to 10.3 dBar metres or feet.
#010	Instrument responds with current Tare value

Command	Notes
Site information	
#037;info	Each data file may contain up to 58 characters of information about the deployment. Each file will use the same information until it is updated.
#038	Instrument responds with current site information
#016;lat	Sets the instrument deployment latitude in decimal degrees, for use in pressure / depth conversion algorithm
#017	Instrument responds with current latitude information
#022;long	Sets the instrument deployment latitude in decimal degrees
#023	Instrument responds with current longitude information
Instrument Information	
#032	Instrument responds with its software version number
#034	Instrument responds with its serial number
#138	Instrument responds with date of last calibration
Logger Control	
$DIR	Outputs file table (list of data files)
$CLR	Clears memory (use with caution!)
$OCLK	Reads Current Date & Time
$ICLK;DD;MM;CC;YY;HH;MM;SS	
	Sets Date & Time e.g.: $ICLK;03;02;20;08;14;30;00 sets clock to 14:30:00 on 3rd February 2008
$DEL;filename	Deletes specific file e.g.: $DEL;File1
$EXTT;filename	Performs simple text output data contained in specific file
$EXTZ;filename	Performs Zmodem extraction of data contained in specific file
$RN;filename;newfilename	
	Renames a file e.g.: $RN;File1;MyData
$FREE	Outputs amount of free memory
$VOLT	Reads internal and external voltage levels

6. Operation

6.1. Switch Cap Logger Pack Operation

If the fastCTD is supplied with a standard logger pack and connector, it will be also supplied with a SubConn Switch Cap. This is a dummy connector plug has pins 1 & 10 linked.

Inserting the switch cap into the instrument connector activates the instrument and it will begin logging data in the last configured mode. It will continue running until the switch cap is removed, or the battery is exhausted.

6.2. Bluetooth Logger Pack Operation

The Bluetooth miniLogger pack has been designed as a direct replacement for the standard SubConn miniLogger pack. The Bluetooth miniLogger is rated to 2000m and is secured using the same lock ring as used by the standard logger pack.

On first installation, it will require 2 minutes to initialise, during this period the magnetic switch-key should be removed.

After initialisation the switch-key can be used to turn the instrument on and off in the same manner as the SubConn switch-cap is used on the standard logger pack. Every time the switch is removed, the instrument will start a new file.

To ensure the reliability of the Bluetooth communications, the logger pack is supplied with a dedicated Bluetooth receiver. The logger and receiver are paired in the factory and will automatically connect whenever active and in range. The receiver is supplied with a stubby aerial, but can also be supplied with a weatherproof magnetic mount antenna for outside mounting

The receiver will install as a USB serial port adaptor and should install automatically on most windows PC's. If the receiver will not automatically install, drivers can be downloaded from:

Once installed, the device will scan for the paired logger, with the LED cycling from green to purple. When the logger pack is detected, the LED will go blue. If data is being transmitted then the LED will flash blue.

Once the device is connected, it can be communicated with as though connected with a cable. When using DataLog Express, the Bluetooth option should be checked.

For use with hyper terminal, the connection is 57600 baud, 8 N 1.
For use with DataLog Express, select the Bluetooth Comms option which fixes the baud rate to 57600 baud, 8 N 1.

6.3. Cabled Operation

If the fastCTD is supplied with a standard logger pack, it will be also supplied with a 3m Y lead.

Connecting the Y-lead to the instrument will switch the fastCTD on, where it can be configured via the DB9 connector attached to a PC serial port.

If the Y-lead is connected without supplying an external power source (9-30V DC), the instrument will remain on until the battery is exhausted.

7. Memory

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

8. Electrical

The following power modes are available in the fastCTD Profiler:

Internal:	1x D cell, 1.5v alkaline or 3.6v lithium
External:	9 - 28V DC
Power:	<250mW
Battery Life:	
at 32Hz, without an Optical Sensor	approx 55 hours continuous operation (alkaline cell with SubConn logger pack)
at 32Hz with an Optical Sensor	approx 9 hours continuous operation (alkaline cell with SubConn logger pack)
Connector:	SubConn MCBH10F (if fitted)

8.1. Changing Batteries

Changing batteries in the mini range of products is very simple process, which may be completed in under a minute. Note that all data is saved in non-volatile Flash memory, so data is secure during the battery change process.

The system clock does require battery power in order to maintain the current date and time settings, but the instrument is fitted with a capacitor system to maintain a supply to the clock for a period of not less than 20 minutes after the removal of the battery. This should be more than sufficient to allow the battery to be changed. In the event that clock settings are lost during battery change, or after an extended period of storage with no battery fitted, then please use DataLog X2 or the # codes defined to reset the clock.

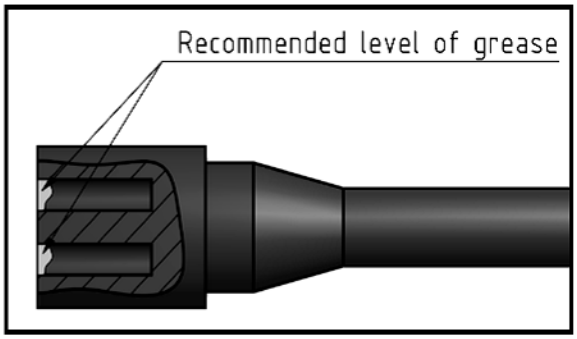
- Disconnect any external connections, including the switch plug, from the instrument's SubConn connector.
- Loosen the Acetal lock ring at the top of the instrument housing – this should be achievable by hand.
- Pull the logger pack from the top of the instrument.
- Replace the single C cell in the instrument; note that the cell should be inserted with the positive end upwards. Although it is possible to insert the battery incorrectly, it will not make contact.
- Check the o-ring on the logger pack for damage and debris. Clean it and smear lightly with silicon grease.
- Replace the logger pack, rotating slowly until the location pins align. Push the logger pack home.
- Replace the Acetal lock ring – hand tight is sufficient.

Note: for planned periods of extended storage, the battery should be removed from the instrument to prevent accidental leakage.

8.2. SubConn Care

The following handling procedures should be adopted when using SubConn connectors:

- The connector should not be exposed to long term heat or sunshine.
- If this occurs, and the connectors are very dry, soak in fresh water before use.
- Ensure the connectors are lubricated - the recommended lubricant is:
  Loctite 8021 in a spray can
  or
  Molykote 44 Medium - but use very sparingly.
- Any accumulation of sand or mud in the female contact should be removed with fresh water. Failure to do so could result in the splaying of the female contact and damage to the O-ring seals.
- When using bulkhead connectors ensure that there are no angular loads as this destroys the connector.



- Connectors must be greased with Molykote 44 Medium before every mating
- A layer of grease corresponding to minimum 1/10 of socket depth should be applied to the female connector
- The inner edge of all sockets should be completely covered, and a thin transparent layer of grease left visible on the face of the connector
- After greasing, fully mate the male and female connector in order to secure optimal distribution of grease on pins and in sockets
- To confirm that grease has been sufficiently applied, de-mate and check for grease on every male pin. Then re-mate the connector
- When disconnecting, pull straight, not at an angle

8.3. Wiring Information

Wiring colours are correct at the time the manual was printed.
However, it is advised that continuity checks are performed prior to all terminations.

Instrument Connector

SubConn MCBH10F	Function
1	Power Ground
2	Power +V
3	RS485 A
4	RS485 B
5	Mode Pin 2
6	Mode Pin 1
7	RS232 Tx (To PC)
8	RS232 Rx (From PC)
9	RS232 Ground
10	Internal Battery Enable Link to RS232 Ground

Mode Pins

Pins 5 and 6 on the output connector are designated as Mode Pins. By grounding a combination of these pins, the instrument can be automatically set to adjust its output protocol to suit different communications options. The pins should be grounded (closed) via a 1000W resistor.

Output Mode	Mode Pin 1	Mode Pin 2	Notes
RS232	open	open	Default baud rate 115200
RS485	open	closed	Fixed baud rate 38400, with transmission delays
Bluetooth	closed	closed	Fixed baud rate 57600, with transmission delays

Switch Plug

10 Way Male SubConn	Function
1	Link to Pin 10
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	NC
9	NC
10	Link to Pin 1

Break Out Cable

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

9. Software

The fastCTD Profiler is supplied with DataLog x2 Windows based PC software, for instrument setup, data extraction and display, please see separate manual.

DataLog x2 is licence free.