SeaKing 700 Series

Integrated Oceanographic Sensor Suite

0367-SOM-00001, Issue: 06

Tritech

Outstanding Performance in Underwater Technology

A Moog Inc. Company

Table of Contents

Help & Support

First please read this manual thoroughly (particularly the Troubleshooting section, if present). If a warranty is applicable, further details can be found in the Warranty Statement, 0080-STF-00139, available upon request.

Tritech International Ltd can be contacted as follows:

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Telephone	++44(0)1224 744 111
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Email	support@tritech.co.uk
Website	www.tritech.co.uk

Prior to contacting *Tritech International Ltd* please ensure that the following is available:

1. The Serial Numbers of the product and any *Tritech International Ltd* equipment connected directly or indirectly to it.
2. Software or firmware revision numbers.
3. A clear fault description.
4. Details of any remedial action implemented.

Contamination

If the product has been used in a contaminated or hazardous environment you *must* de-contaminate the product and report any hazards *prior* to returning the unit for repair. *Under no circumstances should a product be returned that is contaminated with radioactive material.*

The name of the organisation which purchased the system is held on record at *Tritech International Ltd* and details of new software or hardware packages will be announced at regular intervals. This manual may not detail every aspect of operation and for the latest revision of the manual please refer to www.tritech.co.uk

Tritech International Ltd can only undertake to provide software support of systems loaded with the software in accordance with the instructions given in this manual. It is the customer's responsibility to ensure the compatibility of any other package they choose to use.

Warning Symbols

Throughout this manual the following symbols may be used where applicable to denote any particular hazards or areas which should be given special attention:

Note

This symbol highlights anything which would be of particular interest to the reader or provides extra information outside of the current topic.

Important

When this is shown there is potential to cause harm to the device due to static discharge. The components should not be handled without appropriate protection to prevent such a discharge occurring.

Caution

This highlights areas where extra care is needed to ensure that certain delicate components are not damaged.

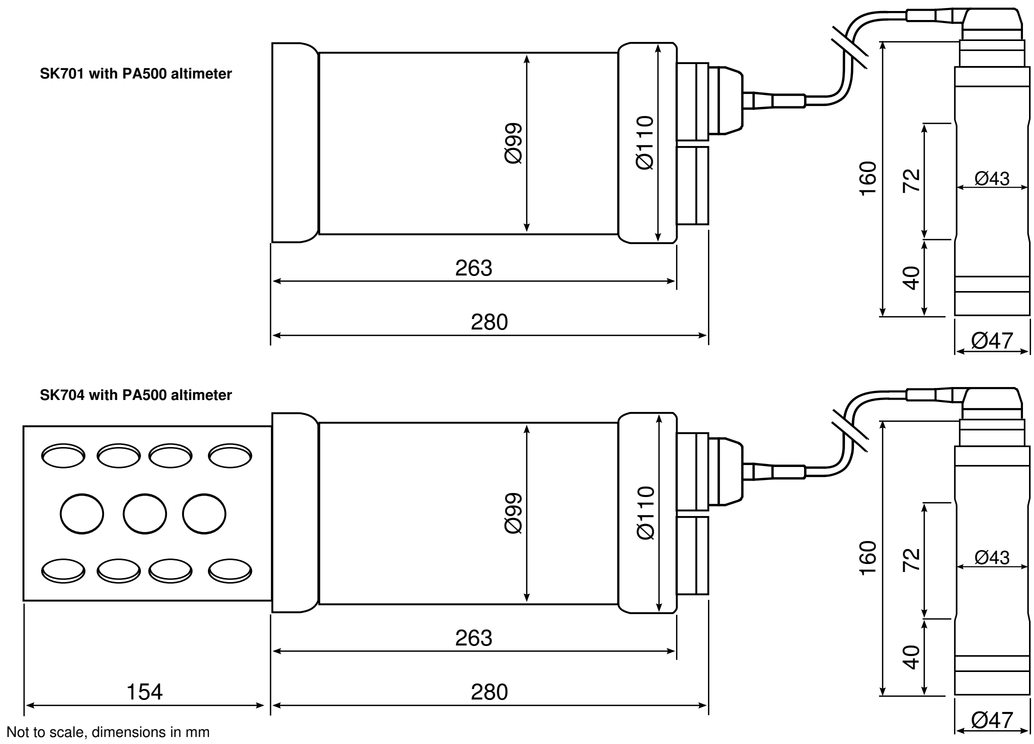
Warning

DANGER OF INJURY TO SELF OR OTHERS

Where this symbol is present there is a serious risk of injury or loss of life. Care should be taken to follow the instructions correctly and also conduct a separate Risk Assessment prior to commencing work.

1. Bathy Specification

Dimensions Diagram



Physical Specification

Weight in air	3.5kg (4.2kg with CT probe)
Weight in water	1.5kg (2.1kg with CT probe)
Materials	Anodised aluminium alloy (6Al4V titanium alloy or stainless steel optional)

Note

The weight shown is for the Aluminium body tube model only.

Electrical and Communication

Power consumption	20 to 72VDC at 8W AUX port voltage set at 24VDC
Communications	ARCNET, RS232, RS485 (AUX only)

Caution

Bathy units that do not have a V6 COMS PCB fitted should not be supplied with more than 28VDC. Both the Bathy and Altimeter can be damaged if this limit is exceed.
Please contact *Tritech International Ltd* if you need more help and advice.

Altimeter

Make	Tritech International
Type	PA500
Weight in air	1.15kg
Weight in water	0.8kg
Frequency	500kHz
Beamwidth	6° conical
Range	0.3 to 50m (0.1 to 10m optional)
Resolution	1mm
Material	Stainless steel

Depth Sensor

Make	Paroscientific Digiquartz
Repeatability	0.01% FSD
Hysteresis	0.015% FSD
Drift	0.015% FSD

Temperature Sensor (SK704 units only)

Make	Teledyne RDI (Falmouth Scientific)
Type	Platinum resistance
Range	-5 to 35°C
Accuracy	±0.05°C
Drift	±0.005°C per month

Conductivity Sensor (SK704 units only)

Make	Teledyne RDI (Falmouth Scientific)
Range	0 to 6.5 $S \cdot m^{-1}$
Accuracy	±2.0$mS \cdot m^{-1}$
Drift	±0.5$mS \cdot m^{-1}$ per month

2. Introduction

2.1. Overview

The SeaKing 700 Series of bathymetric and oceanographic sensors are supplied in the following configurations:

SEAKING701	Precision Depth Sensor and Altimeter
SEAKING704	Precision Depth Sensor with Conductivity and Temperature Sensor and Altimeter

The SeaKing 700 range of sensors are designed to be integrated along with other sonar or profiling heads from the *Tritech International Ltd* SeaKing or Gemini ranges to form a fully integrated oceanographic system controlled from a Surface Control Unit (SCU).

Alternatively the device can be operated as a stand-alone unit and connected to a computer system through the SeaHub interface box, or using the Gemini Hub and an Ethernet link into an existing infrastructure.

The SeaKing 700 sensors (except the altimeter) are mounted on the end-cap of a tube assembly (which is hard-anodised aluminium as standard but other materials are also available). The electronics are contained within the body tube in dry air at one atmosphere pressure. The end-caps are retained by a threaded plastic ring and when the conductivity sensor is fitted it is protected by a nylon cage assembly fitted to the sensor end-cap.

The standard configuration uses *Tritech International Ltd* 6-pin water blocks for the main and auxiliary connections. The auxiliary port is used for connecting to and powering the altimeter sensor (which is housed within a separate body-tube).

2.2. Software Version

The instructions within this manual apply to the following software version:

- Seanet Pro - 2.23 build 539 onwards

Screenshots and images within the software may differ slightly from the ones used within this manual. The latest version of software can be downloaded from www.tritech.co.uk.

3. Installation

3.1. Mechanical Installation

The SeaKing 700 units are supplied with connectors and a length of polyurethane jacketed cable (1 metre). Depending on the specification of the system, the cable will either need to be terminated to a suitable connector or may be supplied already terminated.

The standard *Tritech International Ltd* connector may be disconnected from the unit by unscrewing the four securing Allen screws and removing the connector from the water block fitted to the end-cap, do not remove the water block (for devices fitted with non-Tritech connectors this procedure will vary). While the cable is removed the exposed connectors should be fitted with appropriate blanking caps to prevent the ingress of dirt or moisture.

The SeaKing 700 units are rugged but they should be handled with care, particularly the connector and sensor ends, it is strongly recommended that the unit be positioned so as to protect it from impact damage.

The SeaKing 700 should be secured by clamping on the cylindrical body section such that the sensor head is in a good water flow and not shielded. Any metallic clamps should be electrically insulated from the body tube by means of rubber or plastic strips or mount brackets of at least 3mm thickness and extending at least 3mm beyond the clamp boundary. Non metallic clamps are preferable and if metallic clamps are used they should be painted or lacquered with at least three coatings.

Orientation

The SeaKing 700 head is designed to be orientated such that the connectors are at the top and the sensor cage is at the bottom (this orientation helps to keep sediment out of the sensor cage). If required it can be inverted so that the sensors are at the top but this will alter the depth readings which should be corrected for in software.

Caution

Avoid any clamping material that contains brass or bronze.

Take care not to block the depth sensor inlet hole when mounting the SEAKING 700 units. The SEAKING 704 units have a cage fitted to protect the conductivity sensor and therefore prevent the depth sensor inlet from being covered.

Note

It is advisable that the conductivity sensor head should have a free radius around the head of at least 10cm. Any objects that lie within this diameter must be electrically stable (either a fixed dielectric or conductor) and have a fixed position relative to the sensor. Locate the sensor head away from such items as motors, sense coils, cameras, etc., to ensure accurate readings.

3.2. Communication Configuration

The SeaKing 700 series may form part of an ARCNET multidrop network of sensors that are normally interfaced to a Surface Control Unit (SCU) through an internal DA-15 ARCNET interface (AIF) port or through the DA-15 AIF port on a SeaHub.

Normal communications with the sonar head is via a customised version of the ARCNET network system and requires a good quality balanced twisted pair cable. There is also the option to run a single head from an RS232 connection.

Note

The ARCNET system requires termination resistors to be fitted at each end of the umbilical. Please refer to Appendix A, *ARCNET Termination* for more details of the termination requirements.

Note

The SeaKing heads that are compatible with Seanet SCUv4, SCUv5 and SeaHub cannot be used with AIF cards found in earlier WINSON systems and must be used with the later SeaKing AIF (AIF V3/V4) cards. Older systems should be upgraded to the latest specification where possible, please contact *Tritech International Ltd* for more details of the upgrade options available.

3.3. Electrical Installation

The SeaKing 700 Series units are designed to work from a smoothed DC power supply. If a switched mode power supply is used it is imperative that a good quality filter (using both inductive and capacitive elements) is used for suppressing the switch mode spikes that may affect the AGC circuit within the altimeter.

If using a rectified transformer PSU, the output of the PSU must have a filter capacitor of not less than 470μF, for each unit being powered. If an unregulated PSU is used, the voltage value measured during power on/off and running conditions at the unit should be within the voltage range specified for the system. If powering the unit(s) down a long lead or umbilical, the maximum recommended resistance of the power line must not exceed 10Ω for one unit, 5Ω for two units and 3Ω for three units.

Caution

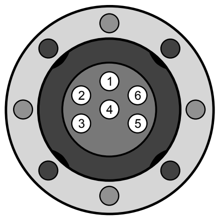
Never try to make a Bathy that doesn't have a COMV6 PCB fitted work down a long cable by increasing the PSU voltage above 28V DC.

3.4. Ground Fault Monitoring

The power supply within SeaKing subsea devices includes an electrically isolated DC-DC converter front-end, There is a small capacitive connection to the sonar chassis which should not noticeably affect any impressed current ground fault indicator (GFI) equipment.

3.5. Wiring Specification

Standard pin-out diagram



Tritech Waterblock

Pin	MAIN port	AUX port	Cable colour
1	ARCNET A RS232 TX	RS485 A	Yellow
2	ARCNET B RS232 RX	RS485 B	Blue
3	+ DC Power		Red
4	- DC Power		Black
5	RS232 Ground or Optional Altimeter Analogue Output		Green
6	Earth/cable shield		cable screen

Note

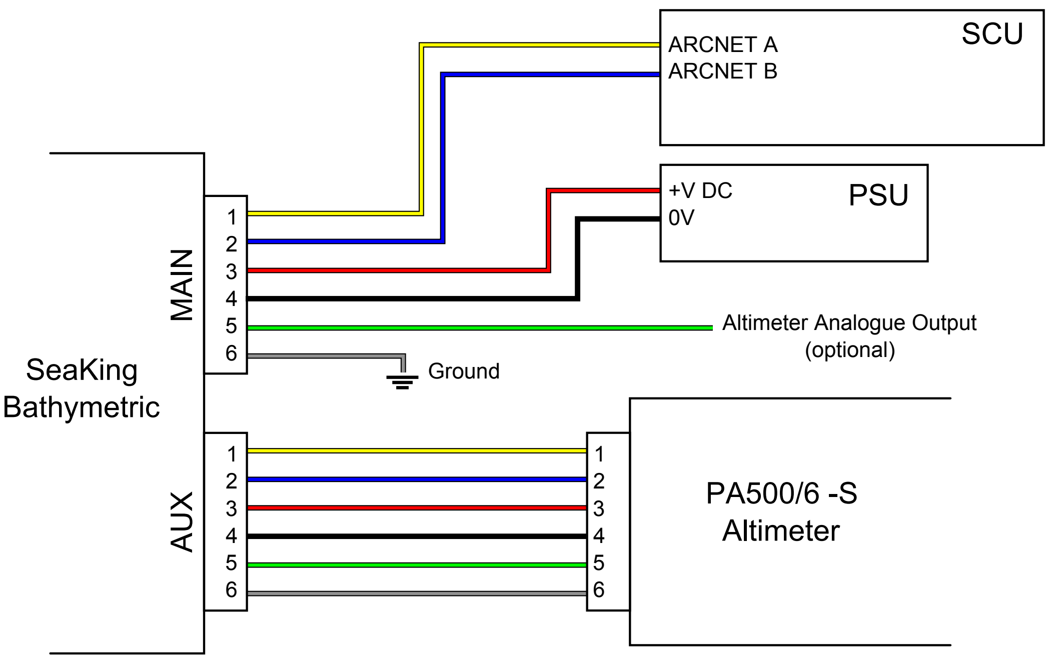
There are a variety of connector options available on the SeaKing 700 Series sensor unit and altimeter. For all other connector types please contact *Tritech International Ltd* to get the correct pin out specification.

Note

It is not possible to establish RS485 communications on the Main port, even with a V6 COM PCB fitted.

Connecting an Altimeter

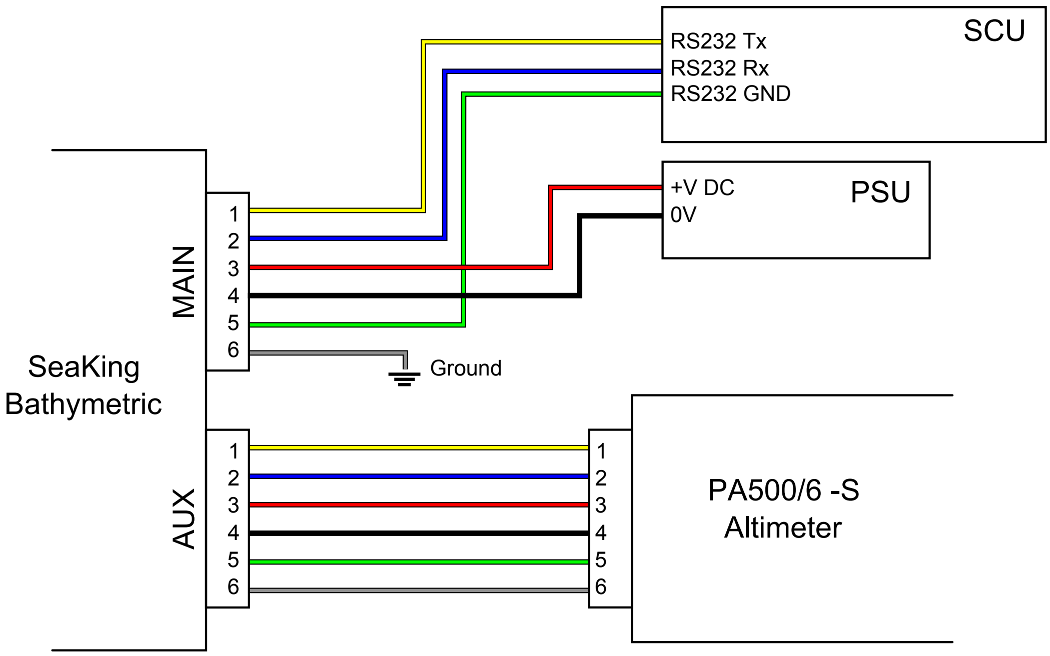
For SEAKING701 and SEAKING704 units that come with a PA500 altimeter and standard *Tritech International Ltd* 6-pin water block, the ARCNET wiring is as follows:



ARCNET

The ARCNET system requires termination resistors to be fitted at each end of the umbilical. Please refer to Appendix A, *ARCNET Termination* for more details of the termination requirements.

For SEAKING701 and SEAKING704 units that come with a PA500 altimeter and standard *Tritech International Ltd* 6-pin water block, the RS232 wiring is as follows:



RS232 Ground

If the SeaKing 700 series is communicating using RS232 protocols then pin 5 on the `MAIN` port must be used as the RS232 Ground (providing a 3-wire RS232 connection). Note that when using RS232 communications, the attached Altimeter cannot output an analogue signal.

Altimeter Analogue Output

The optional analogue output from the PA500 altimeter is, as standard, disabled. If the SeaKing 700 series unit is communicating using RS232 protocols the analogue output must be disabled in order for proper functionality to be maintained.

3.6. Software Installation

The Seanet Pro Windows software will be provided either pre-installed on the Seanet SCU on an installation CD-ROM (if using a SeaHub).

For the CD-ROM version, if setup does not auto-run on disc insertion, run the `SETUP.EXE` file from the disc to start the installation.

Note

The latest version of the software is also available from www.tritech.co.uk

4. Calibration

The SeaKing 700 Series Bathymetric devices are shipped in a fully calibrated state and should not require any further calibration prior to use.

The calibration interval is normally one year but may be brought forward if the unit has suffered mechanical shock or exceeded the specified pressure rating by more than 10%. If recalibration of existing units is desired, please contact *Tritech International Ltd* for details of calibration and service options available.

5. Operation

5.1. System Check

The SeaKing 700 series heads should be checked for serviceability on the bench prior to undertaking any testing underwater. Before applying power to the unit ensure that it is in physically good condition with no damage to the sensors or housing.

The unit should be wired up and installed in exactly the same manner as it is intended to be used (i.e. on an ROV/AUV) and connected to the surface computer. Power should then be applied

Note

The device will dissipate a small amount of heat but this will not cause any overheating problems if left running continuously in air or water.

5.2. Pre-Dive Setup

Before deploying the sensors, start Seanet Pro and ensure that the system has been configured as follows:

1. Enter or check the `Latitude`
2. Enter or check `Density` ("Mean Relative Density", default: 1.029g cm^{-3})
3. Enter or check `V.O.S.` ("Velocity of Sound", default: 1475.0m s^{-1})
4. Enter `Barometer` ("Barometric Pressure", default: 1000mbar)
5. Set all offsets (see Section 5.3, “Offsets”)

Options 1 to 4 are found in the `Environment` setup page (select `Settings` menu and then `Environment`). Option 5 is found by right-clicking on the main Bathymetric display and selecting `Offsets`. For more details of the operation of Seanet Pro refer to Section 5.6, “Seanet Pro”.

Note

For the above options to be available it may be necessary to open the Bathymetric screen by selecting `Single Bathy` (or similar) from the `Applications` menu.

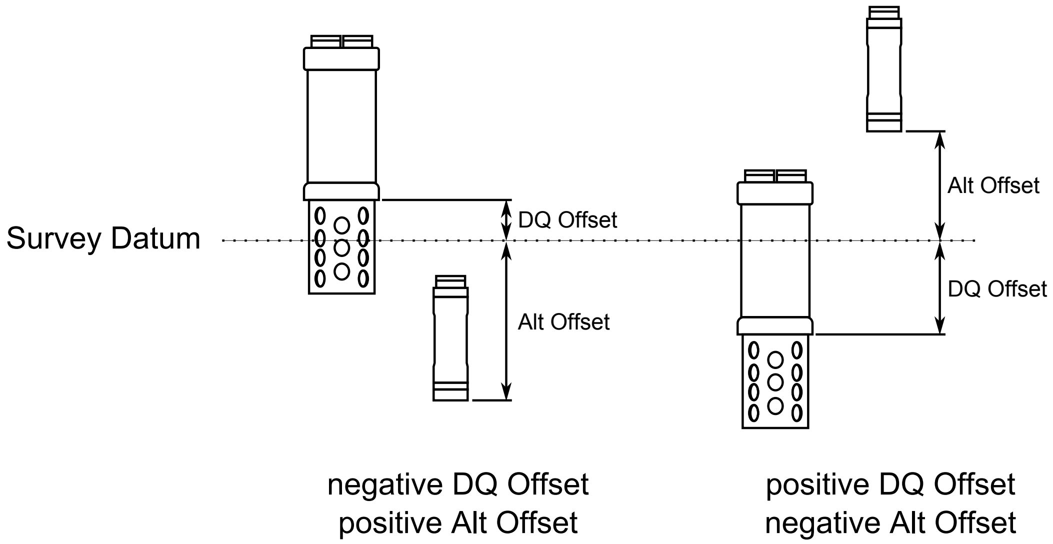
5.3. Offsets

Note

Prior to setting the `DQ Offset` the `DQ Zero` should be set, refer to Section 5.5, “Optimising the SeaKing 700” for more information.

The sensor head vertical offset (`DQ Offset`) and altimeter vertical offset (`Alt Offset`) will be required if a datum reference point is to be used on the vehicle above or below the SeaKing 700 series sensor head and/or the altimeter.

If the survey datum is *above* the pressure port then apply a *positive* DQ Offset. If the datum is *below* the altimeter transducer then apply a *negative* Alt Offset



Note

If the SeaKing 700 series is to be used in an inverted orientation (i.e., with the sensor cage at the top) then an additional offset will need to be applied to compensate for the effect of inversion on the pressure sensor.

5.4. Repeatability

The SeaKing 700 series devices are available with a number of depth ratings. The pressure sensor accuracy is stated as a percentage of the maximum operating depth (%FSD). Selection of the most appropriate depth rated unit will provide the most accurate results, for instance, in under 700m of water a 4000m rated unit will have a repeatability figure of 0.01% of 4000, whereas a 700m rated unit will have a repeatability of 0.01% of 700.

5.5. Optimising the SeaKing 700

5.5.1. Factors Affecting Measurements

Water Density

A bathymetric sensor measures seawater pressure. In order to calculate depth it must know the density throughout the water column from the surface to the operating depth.

This value changes with the temperature and salinity of the water and will vary as the unit is moved down through the water column and also will vary over time.

Atmospheric Pressure

The pressure measured includes the atmospheric pressure imposed on the surface of the water. A bathymetric system must know this pressure and subtract it from the total pressure measured (1mbar change is equal to 1cm in the depth measurement). For sudden changes of barometric pressure, for instance when a weather front moves across, there may be a significant lag (up to 1 hour) in the transmittal of the effect to the pressure measurements.

The height of barometric measurement above sea level may need to be accounted for if this is significant (10m air height is equivalent to 1cm difference in depth reading).

Note

Tritech International Ltd can supply a barometric sensor as an option. These are accurate to 1mbar. If the option is not used then the barometric pressure must be entered manually.

Tidal Movement

Tidal movement does not directly affect the depth measurement from the surface, but is needed to establish the datum for a survey.

The surveyor will need to correct the depth measurements to mean seawater levels.

Local Gravity

Gravity varies with position on the Earth's surface.

To a good approximation it varies as a function of latitude and can be calculated using known geodetic formulae.

Instrument Accuracy and Stability

The different sensors housed within the SeaKing 700 series units are provided by different manufacturers and have different levels of accuracy. All the sensors are fully calibrated when the unit is shipped and should fall within the following parameters:

Pressure
: Specified as having a repeatability of 0.01% and hysteresis of 0.01% of full range These figures represent one standard deviation and are cumulative such that the statistical variability of the calibrated pressure sensor will result in a depth value uncertainty of 0.015%.

Density
: (only applicable to SeaKing 704 units) The conductivity and temperature sensor are used to calculate density local to the instrument using standard oceanographic equations. The values calculated are valid only at the time of descent and if water conditions change (e.g. varying temperature or salinity) the value becomes historic and may induce errors. If desired the calculated value can be overwritten with a manually entered value. Generally for calculated values it is expected that density variations could double the uncertainty of a depth measurement to 0.03% of full scale.

Calibration

The calibration interval is normally 1 year but intermediate calibration may be required if the SeaKing 700 series head has suffered a severe impact or been subject to pressure in excess of 10% of the specified maximum rating.

5.5.2. Datums & Zeroes

Usually a datum is established on the vehicle as a survey datum. This is generally not where the SeaKing 700 series head is actually mounted.

The Seanet Pro application allows for a position offset to be entered which corrects the displayed data for any physical offset between the survey datum and the location of the SeaKing 700 series head.

Ideally the SeaKing 700 depth output will read at or close to zero while the unit is on deck but variation are expected to occur. Zeroing a SeaKing 700 series is a complex process and it is difficult to achieve an accurate result, therefore resetting before each dive is *not* recommended.

5.5.3. Recommended Procedures

This section covers relative and absolute measurements. Taking a relative measurement is simpler and may be applicable to such tasks as:

- Pipeline out of straightness
- Template levelling
- Spool piece measurement

Absolute measurements only apply when an accurate reading for the full depth from the mean seawater level is needed.

Relative Measurements

For relative measurements there is no requirement to zero the unit on deck because any error at the surface will represent a constant offset (gravity effects are also negligible).

The important parameters are variations in atmospheric pressure, water column mean density and tidal corrections for the duration of the measurements. See Section 5.2, “Pre-Dive Setup”.

The SeaKing 700 units may be mounted in any orientation and with the correct atmospheric pressure entered an approximate zero offset can be entered such that the output depth reading is zero while on deck. It is recommended that no further alteration is made to the zero settings on deck for the duration of the job. See Section 5.3, “Offsets”.

Absolute Pressure

All of the factors affecting measurement detailed in Section 5.5.1, “Factors Affecting Measurements” will apply and any zero offset applied will also need to be known. Section 5.2, “Pre-Dive Setup” and Section 5.3, “Offsets”.

The pressure sensor fitted to the SeaKing 700 series heads is temperature compensated, however, it can take up to 2 hours for sensor to stabilise (if the external temperature is varying considerably this time will be longer). To get a reading the unit needs to be powered up and allowed to stabilise completely. If removing from the seawater to a deck that is a very different temperature (i.e. much hotter or colder than the sea temperature) then the readings can have a significant error.

There are two alternative approaches to setting the zero offset:

1. Ensure the unit is mounted either port up or port down and use the zero offset figure published on the build and calibration sheet for the instrument. This figure should not be

altered unless a full check is completed (i.e. follow step 2 below) even if errors are showing while on deck. The results at depth will be consistent and accurate.

2. Perform a thorough deck zero check as follows:

   - Keep the unit at a temperature close to seawater (i.e. use a bucket and ice/hot water as appropriate).
   - Power the unit for a minimum of 2 hours to allow stabilisation to occur.
   - Obtain correct values for atmospheric pressure and latitude and enter them into the system.
   - Set the position offset currently in the system to zero.
   - Remove the SeaKing 700 series head from the vehicle and lower to a known depth.
   - Adjust the zero offset so that the depth reading matches the known depth.

Note

If setting the zero offset using method 2 it will be necessary to do so with the SeaKing 700 head vertical with the sensor cage at the bottom (i.e. port down) and subsequently the unit should always be used in this orientation.

5.5.4. Suggested Pre-Dive checklist

The following is a suggest list of items to be checked during a Pre-Dive procedure when using Bathy units

- The communications protocol for the Bathy is known and the topside control unit has been setup appropriately
- All cabling has been correctly fitted with o-rings and is secure
- The head has been securely fastened to the ROV
- All offsets (Altimeter and Digiquartz) have been correctly measured and entered into Seanet Pro
- Latitude information has been correctly entered into Seanet Pro
- Barometric pressure has been correctly entered into Seanet Pro
- Third party outputs (to Survey packages) are setup in REMV4
- If requiring absolute measurements:
  - The correct Port Up or Port Down offset has been entered into the DQ Zero section of Seanet Pro
- The ROV is deployed and held at the surface so that the sensors can stabilise
- If requiring relative measurements:
  - A value is entered into DQ Zero that gives a reading of 0.000m on screen

This would conclude the minimum pre-dive checks required for the Bathy.

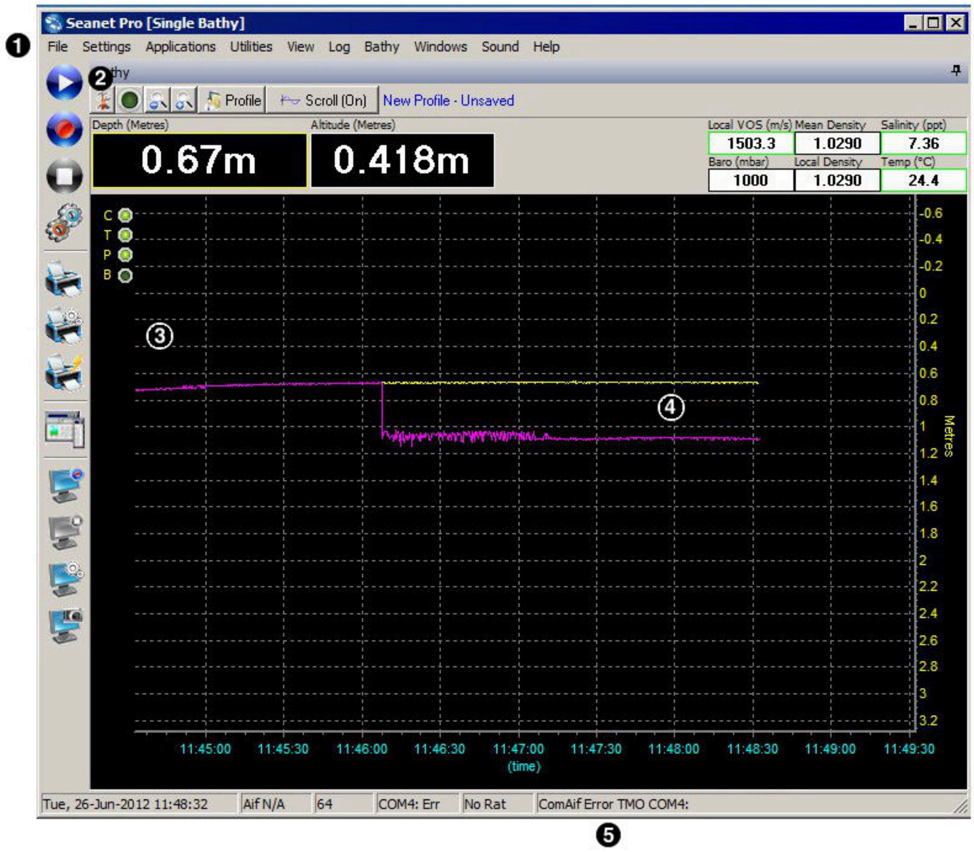
Note

All other pre-dive checks would need to be carried out as per your own company's guidelines and procedures.

5.6. Seanet Pro

5.6.1. Main Screen

The Seanet Pro application can be run from the `Programs` group in the Windows `Start` menu or from the desktop by double clicking on the shortcut icon.



1. Menu bar

2. Bathymetric settings bar

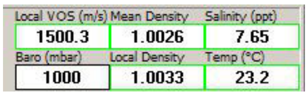
3. Sensor display area

4. Scroll plots (yellow is depth, magenta is depth + altitude)

5. Status bar

The SeaKing 700 series can be operated alongside other devices in a multi-window application. Depending on the space available in the multi-window display, the screen may only display the most important data if there is insufficient space to display them all. When the window size is reduced the first display boxes to be omitted are the `Salinity` and `Temperature` followed by the `Mean Density` and `Local Density` and finally the `Local VOS` and `Barometric`. The Bathy window can be expanded to fill the screen by pressing the `F2` button.

5.6.2. Display Boxes



These boxes show current data either taken directly from the sensors or derived through a series of calculations (see Appendix B, *Bathymetric Calculations* for details).

Mean Density

This box will either display the value set for `Manual Density` (default value of 1.029) or the `Auto Density` which is calculated using measurements taken from the conductivity and temperature sensors. If the conductivity and temperature sensors are not installed (i.e. a SeaKing 701 unit) then the `Manual Density` figure is always used. `Manual Density` might also be used even if the conductivity and temperature sensors are fitted if the following applies:

1. Either the measured conductivity or temperature is out of range
2. The conductivity or temperature readings are invalid or not present (which could indicate that there is a hardware fault)

The `Manual Density` figure should be checked and set while the unit is on deck. The default setting of 1.029 should only be used if a local average value is not known.

Local VOS

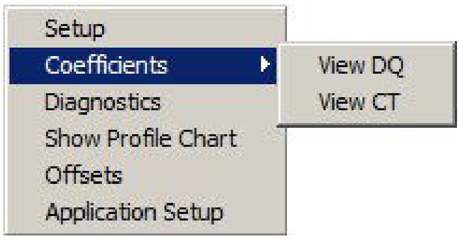
The `Local VOS` screen will display either the `Manual VOS` (default value of 1475m s^{-1}) or the `Auto VOS` which is calculated using measurements taken from the conductivity and temperature sensors. If the conductivity and temperature sensors are not installed (i.e. a SeaKing 701 unit) then the `Manual VOS` figure will be used. As with the `Mean Density` display the `Manual VOS` will also be displayed if no valid data is received from units fitted with the temperature and conductivity sensors.

5.6.3. Bathymetric Settings Bar

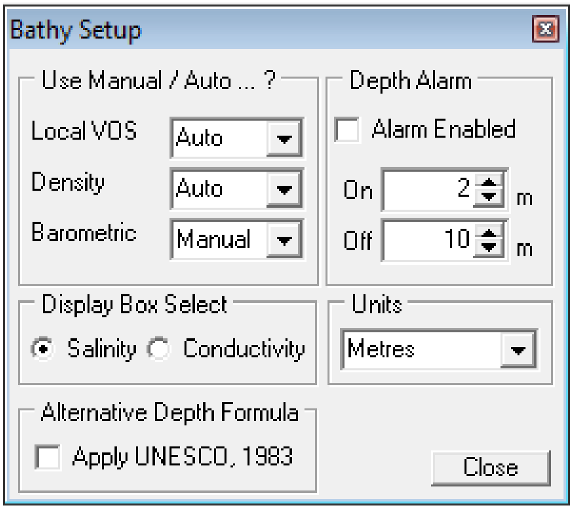
1. Application Tools (opens a menu to choose settings dialogs)
2. Application Indicator (green = "on", red = "off", flashing = "paused")
3. Zoom controls for vertical axis
4. `CYC` and `EXP` cycle and expand the current window (they are only visible in multi-window applications)
5. Profile saves or loads the settings profile
6. Changes the way the chart scrolls

5.6.4. Application Tools

The Application Tools menu can be accessed by clicking on the icon from the Bathymetric Settings Bar or by right-clicking on the main Bathymetric Application display.



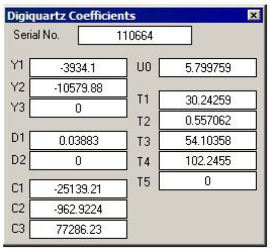
Setup

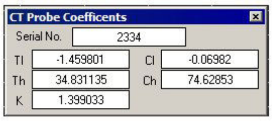


Local VOS	This value is applied in the display of acoustic sensor data. Select whether to use Auto to have the application calculate the Velocity of Sound calculated from the Bathymetric readings (for units fitted with the temperature and conductivity sensor) or select Manual which will apply the manually entered system value (select Settings menu and then Environment).
Density	This value is used in the depth calculation. When on automatic the system applies the Mean Density as calculated from the temperature and conductivity sensor (for units with those sensors fitted). In manual mode the application applies the manually entered system value (from the Environment dialog).
Barometric	If a barometer is fitted to the system the readings from this sensor can be used by selecting Auto otherwise a manually entered value should be used (entered in the Environment dialog which is under the Settings menu).
Depth Alarm	Enable the depth alarm to be warned whenever the Bathymetric unit enters a certain depth zone. This can be used as a warning system to advise when the vehicle or vessel is in ascent and close to the surface where a collision may be possible. Set at what depths to switch on and off the alarm. When the alarm is activated the Bathymetric display will flash.
Display Box Select	Changes which box is displayed on the Bathymetric display sensor display area
Units	Choose between metres, feet, fathoms or yards

Apply UNESCO, 1983	Switches the Depth and Gravity calculations from the standard formula to the alternative ones described in Appendix C, *Alternative Bathymetric Calculations*. Enabling or disabling this option will immediately affect both the onscreen reported depth and the depth output from REMV4. This option can also be used on previously logged data as Seanet Pro logs the raw data from the sensors.

Coefficients

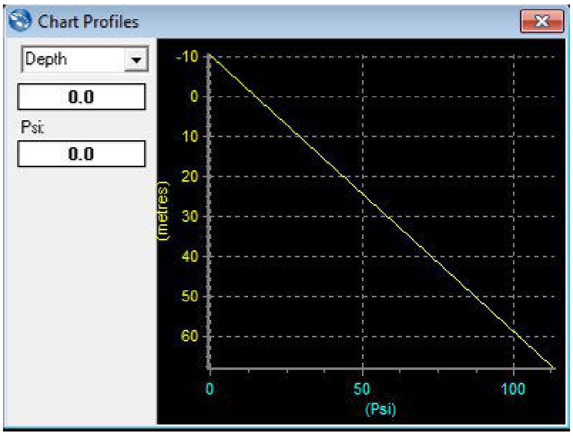




These dialog boxes display the coefficients in use by the built in sensors on the Bathymetric unit (for units without the temperature and conductivity sensors only the `View DQ` option will be available). These data are for information only and cannot be changed.

Show Profile Chart

This will display the pop-up from where the profile data can be displayed.

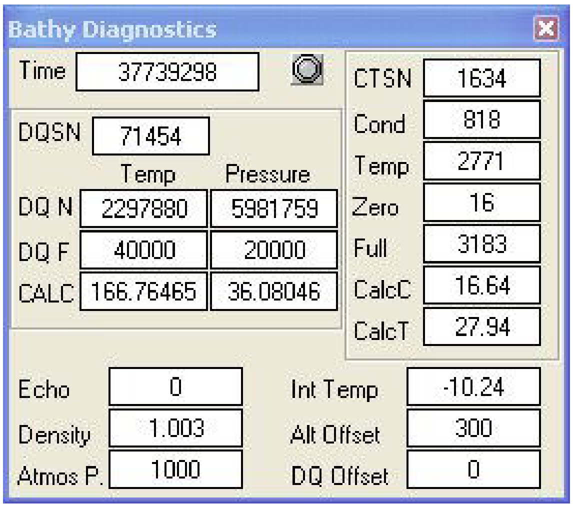


Click on the drop down list to select which Bathy data type (Vertical chart scale) to plot against `Psi` (Horizontal chart scale). Bathy data types that are selectable include; `Depth`, `Temperature`, `Salinity`, `V.O.S.`, `Local Density` and `Mean Density`

The profile chart will display the selected Bathy data over the range of the current loaded or updating profile.

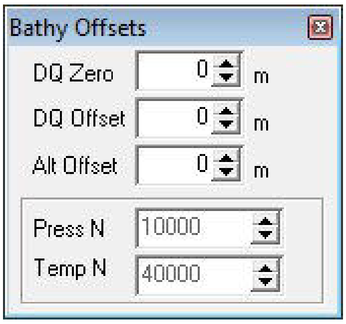
Diagnostics

Opens a dialog to display the raw data from the Bathy.



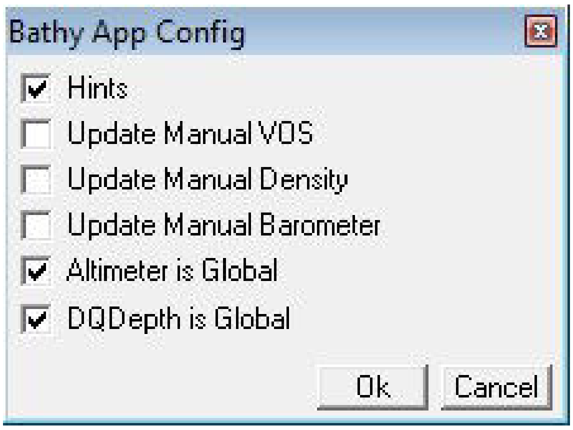
Offsets

After mounting the Bathy on the vehicle, enter the vertical offsets which is the vertical distance between the vehicle reference point and the Bathy Sensor (DQ Offset) and Altimeter (Alt Offset). Before diving, zero the depth by entering a DQ Zero value.



Application Setup

This opens the `Bathy App Config` dialog



Hints	Show the pop-up hints when cursor moves over certain control
Update Manual VOS	Update the Manual VOS with the current Local VOS calculation taken from CT readings
Update Manual Density	Update the Manual Density with the current Mean Density calculation taken from CT readings.
Update Manual Barometer	Update the Manual Barometer with the current Barometric reading (Barometer option required).
Altimeter is Global	This can be made Global to apply to other device connections
DQDepth is Global	This can be made global to apply to other device connections

5.6.5. Profiling Density and Velocity of Sound

This function provides a running mean update of density and velocity of sound (VOS) during Bathy descent and this data is logged to a look-up table.

The displayed VOS at the surface will always be the measured value local to the sensor.

Text File Format

During descent calculations and measurements taken by the Bathy unit are stored in a look-up table at index intervals of 1psi. This is for the purpose of maintaining a running calculation of mean density and mean velocity of sound during deployment down to operating depth.

Note

The profile should be started at the very start of the dive.

If an index interval is missed, interpolation is applied to the preceding and the next index entries for mean density and mean velocity of sound data.

For example:

5psi 1472.2$m \cdot s^{-1}$
6psi no entry (therefore interpolated as 1472.4$m \cdot s^{-1}$)
7psi no entry (therefore interpolated as 1472.6$m \cdot s^{-1}$)
8psi 1472.8$m \cdot s^{-1}$

The look up table is a space-delimited text file (with file extension `.BP3`) that can be imported into a spreadsheet for further analysis or post-processing.

If measurements for mean density and velocity of sound are not available or unreliable for any reason, it is possible to load a saved profile from a previous dive (at the same geographical location) and this will be used during descent in place of real-time measurements from a CT probe.

Each column of the file is space delimited. The first column (containing the Index Number) has a fixed width of 14 characters and every other column thereafter has a fixed width of 20 characters.

The first line of the text file identifies the columns and also indicates the number of entries in the file as a number in the first column, for example a file with 2979 entries would have this as a first line:

```
BP3 2979  Loc Dens  Mean Dens  Pressure  Temp  Salinity  Loc VOS  Mean VOS  Depth
```

Operation of Profiles

At any point a new profile can be started by clicking on the `Profile` button. The sensor display area will indicate that a new profile has been started and is currently unsaved.

Note

The profile should really be started immediately before the dive and after the Bathy has been zeroed. If a profile is started when at depth the density and sound velocity entries up to that point will be filled in with the current measurements at the starting depth.

It is very important to remember to save and therefore close off a recorded profile. Depending on the length of the descent to the working depth, a profile can take several seconds to be saved to disk.

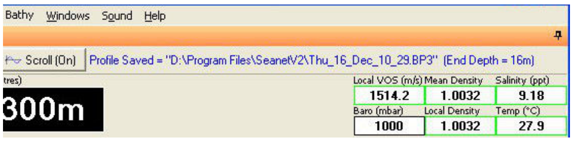
Note

Saving profiles should be performed while the Bathy is NOT in descent.

The update of the Bathy data may periodically be stalled during the save routine and this may result in areas where the interpolation has to be used to fill in the missed intervals within the recorded profile.

At any time it is possible to save the profile by clicking on `Profile` and selecting `Save`. The file will be named according to the current time and date, for example `Thu_16_Dec_10_29.BP3` is the designated file name for a file saved at 10:29 on the 16th of December.

When a Bathy profile has been saved to file the Sensor Display Area will indicate this by displaying the saved Bathy Profile filename. When Hints are enabled (from `Application Setup`) it is possible to move the mouse over the profile text to display a pop-up hint containing the full save name and also the end depth.



For the current dive the operator can opt to load all the profile data from a previous dive and apply this Bathy data as opposed to current readings. When a Profile has been loaded, its mean density table will be applied to current pressure readings in order to calculate depth. Also, local and mean VOS from the table will be used wherever applicable within the system. To load a profile click on the `Profile` button and select `Load`.

Appending to a Profile

Data will automatically be appended when diving to a greater depth than the last (maximum) depth entry stored in the loaded or saved profile. To save any appended data to the profile table it will be necessary to click `Profile` and then `Save` once again.

6. Care & Maintenance

Warning

In the unlikely event that the subsea housing has suffered water ingress at depth there may be internal pressurization. This could forcibly eject the end-cap when the lock ring is removed.

If wishing to dismantle the unit, for any reason, due care and attention should be taken to prevent damage or injury.

6.1. After using the Bathy

It is recommended that the unit be rinsed down with fresh water after each dive and especially if the unit is not going to be used for extended periods. Although the metal and plastic components are very resistant to corrosion, using fresh water is a simple way of minimising the chance of corrosion.

The conductivity sensor should be cleaned to remove any build up of dirt, oil, mud or sediment. Excessive build up in the centre section of the senor may reduce sensitivity and result in a lowered conductivity measurement. These deposits on the conductivity sensor can be removed with a plastic bottle brush or similar.

Wherever possible avoid any prolonged exposure to extreme climatic and weathering conditions to reduce the wear and aging of components and connectors.

6.2. If storing the Bathy for extended periods

Make sure that the bathy is completely dry (if necessary leave to dry in air before stowing). Pack into storage container along with several pouches of silica gel.

6.3. SeaKing regular maintenance

General Guidelines

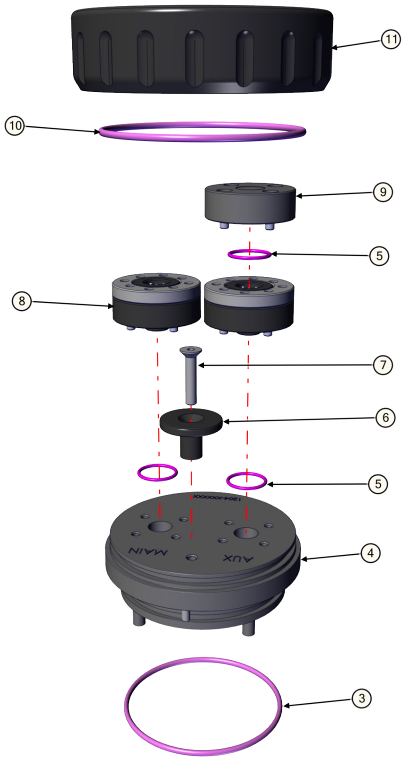
Caution

It is essential to have a regular maintenance schedule so that any defects arising from corrosion or erosion can be spotted early and corrected before they cause severe damage to the unit. It is recommended that the unit is annually serviced and can be returned to *Tritech International Ltd* for this purpose

Competent, trained, personnel can perform regular preventative maintenance on these units. Contact *Tritech International Ltd* for more details on the training courses available.

Servicable Items

The standard Tritech SeaKing unit has several user serviceable items, all located on the connector endcap.



Exploded view diagram	Item	Part Number	Description
	3	S01037	Body O-ring
	4	S01204 ASSY	Connector Endcap
	5	S00009	0161-16 O-ring
	6	S01252	Endcap puller
	7	S01299	M5x25 Endcap puller screw
	8	S00987	Waterblock
	9	S01182 ASSY	Pressurised blanking cap
	10	S01038	Retaining O-ring
	11	S01023	Retaining ring

Note

The part numbers expressed are subject to change.

Note

Alternative configurations may have additional serviceable items, if in doubt please contact *Tritech International Ltd* to establish the correct service routine.

The o-ring seals should be regularly inspected, cleaned and lubricates with the appropriate greasing compound. The body of the unit should also be inspected for any obvious signs of corrosion, especially in mating surfaces (such as the waterblock).

6.3.1. Disassembly of the SeaKing unit

Warning

In the unlikely event that the subsea housing has suffered water ingress at depth there may be internal pressurization. This could forcibly eject the end-cap when the lock ring is removed.

If wishing to dismantle the unit, for any reason, due care and attention should be taken to prevent damage or injury.

Important

The steps outlined here will expose sensitive electronic equipment and so appropriate steps should be taken to prevent any static discharge occurring which may harm the equipment.

Caution

Servicing of the SeaKing unit should only be carried out by competent personnel in a dry, clean environment with full ESD precautions.

Service tools required

- Clean absorbent wipes
- Silicon grease MS-111 lubricant (or equivalent)
- A M3 Allen Key or Hex driver
- A 5.5mm spanner, or nut spinner

Procedure

1. Rinse the unit and connector in fresh water and dry with absorbent wipes
2. Using the M3 Allen key, loosen each of the retaining screws of the Pressurised blanking cap (if present)
3. Using the M3 Allen key, loosen each of the retaining screws of the MAIN and AUX (if present) waterblocks. Each screw should be loosened by a quarter turn in order to prevent damage to the screw threads.
4. Remove the connector endcap locking ring
5. Using the endcap puller, pull the connector endcap off the unit
6. The electronics block will then slide out of the housing attached to the connector endcap.

Caution

Care should be taken when removing the electronics block. There will be fly leads from the top most PCB leading to other areas within the SeaKing. These leads may be damaged if too much force is used when extracting the electronics.

7. On the top of the electronics block, use the 5.5mm spanner to carefully remove the four retaining nuts
8. In turn, remove each PCB and each set of four stand off posts underneath until only the PCB closest to the endcap remains – the COM PCB
9. Remove the last PCB and then unscrew the four guide posts from the connector endcap

Once fully disassembled, inspect the various o-ring seals and sealing surfaces for signs of damage and corrosion. Pitting and corrosion within an o-ring sealing area can cause a unit to lose integrity and lead to water ingress and significant damage.

Waterblock O-Ring	Endcap O-Ring
	

The highlighted areas on the images above are the critical sealing areas that should have no signs of corrosion. Corrosion in these areas will necessitate the replacement of the connector endcap.

6.3.2. Reassembly of the SeaKing unit

Important

The steps outlined here will expose sensitive electronic equipment and so appropriate steps should be taken to prevent any static discharge occurring which may harm the equipment.

Caution

Servicing of the SeaKing unit should only be carried out by competent personnel in a dry, clean environment with full ESD precautions.

Service tools required

- Clean absorbent wipes
- Silicon grease MS-111 lubricant (or equivalent)
- A M3 Allen Key or Hex driver
- A 5.5mm spanner, or nut spinner

Procedure

1. Carefully clean all parts and check for damage.
2. Inspect o-ring seals and replace if necessary.
3. Screw in the four guide posts onto the connector endcap
4. Fit the COM PCB and a set of four stand off posts
5. Refit each PCB and set of stand off posts
6. On the top most PCB, locate the four hexagonal pictures on the PCB

7. Using the 5.5mm spanner secure the retaining nuts at these locations
8. Carefully insert the electronics block back into the Body tube, ensuring that the dowel pin on the connector endcap lines up with the recess point on the Body tube
9. Fit the connector endcap locking ring
10. Using the M3 Allen key, fit the MAIN and AUX (if applicable) waterblocks. Each of the waterblock screws should be tightened, in turn, by a quarter turn until the waterblock is flush and level to the connector endcap
11. Using the M3 Allen Key, fit the Pressurised blanking cap (if applicable) either directly onto the AUX port, or on the AUX waterblock if it not to be used.
12. Visually inspect the unit to ensure that all surfaces have mated correctly

7. Troubleshooting

Continuous Status `Timeout 40` message

This indicates that there is no communication with the device flagged - in this case the node number of the Bathy device is 40. Check the power and communications links to the sonar head for continuity and for correct polarity and voltage. Ensure that the power supply can provide sufficient current to power all devices.

If a cable flood is suspected then the conductors will need to be insulation tested. The sonar heads and SCU will need to be disconnected.

Caution

This is especially critical if a cable insulation tester is used to check resistance between conductors. Permanent damage to the sensor heads and SCU may result if they are not properly disconnected.

Appendix A. ARCNET Termination

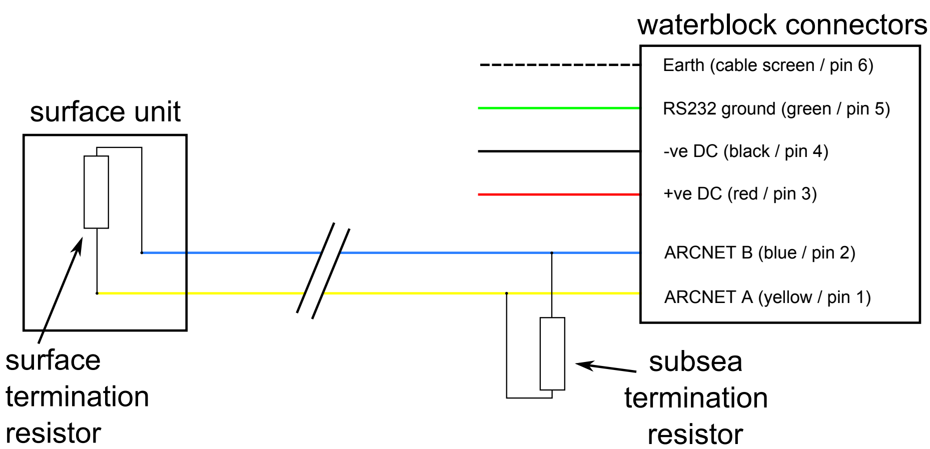
Depending on the cable length the ARCNET communication link requires a termination resistor to be installed at each end of the umbilical cable. Normally this is supplied fitted within the ARCNET cable DA-15 or within the SCU/SeaHub at the surface and is left for the user to fit at the sub-sea end in a convenient junction box or by use of a special waterblock.

The purpose of these terminations is to attenuate any electrical interference or "reflections" which may occur due to an impedance mis-match and the overall aim is to improve signal quality and negate any effects which might otherwise be felt by other sources of impedance such as from the cable itself.

The diagram below shows best practice to use when installing termination resistors on an ARCNET network of *Tritech International Ltd* sonar products.

Note

A special yellow waterblock is available from *Tritech International Ltd* which contains an in-line impedance of 39Ω which will enable quick and easy installation of the subsea termination resistor.



Cable length	Termination	Baud rate setting
Less than 100m	Single 39Ω subsea resistor	Normal baud rate
100-1200m	270Ω at surface and 39Ω subsea	Normal baud rate
1200-2500m	270Ω at surface and 39Ω subsea	Half baud rate

Note

If there is more than one sensor connected then the sub-sea resistor should be fitted at the junction box or splice of the cable.

Appendix B. Bathymetric Calculations

Depth Equation

$$Depth = \frac{g_n}{g}\left(\frac{0.70307(p - 0.01450377a)}{\rho}\right)$$

$Given:$
$p =$ absolute pressure in PSI
$a =$ surface atmospheric pressure in mbar
$\rho =$ mean density from CT probe (SK704) or fixed system density (SK701)
$0.01450377 =$ mbar to PSI conversion factor
$0.70307 =$ PSI to metres conversion for water of standard density
$g_n =$ standard gravity of 9.80665m s^{-2}
$g =$ local, latitude dependent gravity

Gravity Formula

$$g = 9.7803184(1 + 0.0053024\sin^2\theta - 0.0000059\sin^4\theta)$$

$Given:$
$\theta =$ local latitude in degrees

(International Association of Geodesy, Sp.Pub.Bull Geodesy 1970)

Salinity Equation

$$Salinity = S + S_D$$

$Given:$

$$S = 0.008 - 0.1692R_t^{\frac{1}{2}} + 25.3851R_t + 14.0941R_t^{\frac{2}{3}} - 7.0262R_t^2 + 2.7081R_t^{\frac{5}{2}}$$

$$S_D = (0.0005 - 0.0056R_t^{\frac{1}{2}} - 0.0066R_t - 0.0375R_t^{\frac{2}{3}} + 0.0636R_t^2 - 0.0144R_t^{\frac{5}{2}})F_t$$

$$F_t = \frac{T - 15}{1 + 0.0162(T - 15)}$$

$$R_t = \frac{R}{R_P \cdot r_t}$$

$$R_P = \frac{1 + P(2.06 \times 10^{-5} - 6.37 \times 10^{-10} + 3.989 \times 10^{-15}P^2)}{1 + 0.03426T + 4.464 \times 10^{-4} + (0.4215 - 0.003107TR)}$$

$$r_t = 0.6766097 + 0.0200564T + 1.104259T \times 10^{-42} - 6.9698 \times 10^{-7}T^3 + 1.0031 \times 10^{-9}T^4$$

$$R = \frac{C}{42.914}, \text{(note: 42.914 is conductivity at S=35, T=15}^\circ\text{C, P=0)}$$

$$P = \frac{\text{absolute pressure measured by sensor - barometric pressure}}{10}$$

$$C = \text{measured conductivity (CT probe)}$$

$$T = \text{measured temperature (CT probe)}$$

(Unesco, 1981)

Density Equation

$$Density = \frac{p_o}{1000\left(1-\frac{P}{k}\right)}$$

$Given:$

$k = gs^{1.5} + fs + e + P(js^{1.5} + is + h) + P^2(ns + m)$

$p_o = ds^2 + cs^{1.5} + bs + a$

$n = 9.1697 \times 10^{-10}T^2 + 2.0816 \times 10^{-8}T - 9.9348 \times 10^{-7}$

$m = 5.2787 \times 10^{-8}T^2 - 6.12293 \times 10^{-6}T + 8.50935 \times 10^{-5}$

$j = 1.91075 \times 10^{-4}$

$i = -1.6078 \times 10^{-6}T^2 - 1.0981 \times 10^{-5} + 2.2838 \times 10^{-3}$

$h = -5.77905 \times 10^{-7}T^3 + 1.16092 \times 10^{-4}T^2 + 1.43713 \times 10^{-3}T + 3.239908$

$f = -6.67 \times 10^{-5}T^3 + 1.09987 \times 10^{-2}T^2 - 0.603459T + 54.6746$

$e = -5.155288 \times 10^{-5}T^4 + 1.360477 \times 10^{-2}T^3 - 2.327105T^2 + 148.4206T + 19652.21$

$d = 4.8314 \times 10^{-4}$

$c = -1.6546 \times 10^{-6}T^2 + 1.0227 \times 10^{-4}T - 5.72466 \times 10^{-3}$

$b = 5.3875 \times 10^{-9}T^4 - 8.2467 \times 10^{-7}T^3 + 7.6438 \times 10^{-5}T^2 - 4.0899 \times 10^{-3}T + 0.824493$

$$a = 6.536332 \times 10^{-9}T^5 - 1.120083 \times 10^{-6}T^4 + 1.001685 \times 10^{-4}T^3 - 9.09529 \times 10^{-3}T^2 + 6.793952 \times 10^{-2}T + 999.842594$$

$s = \text{calculated salinity}$

$P = \text{measured absolute pressure - barometric pressure}$

$T = \text{measured temperature (CT probe)}$

(Journal of Geographical Research, 1985)

Velocity of Sound Equation

$$Velocity\ of\ Sound = Ds^2 + Bs^{1.5} + As + C$$

$Given:$

$$D = D_{00} + PD_{10}$$

$$B = B_{00} + TB_{01} + P(B_{10} + TB_{11})$$

$$\begin{aligned} A = &(A_{32}T^2 + A_{31}T + A_{30})P^3 \\ . &+ (A_{23}T^3 + A_{22}T^2 + A_{21}T + A_{20})P^2 \\ . &+ (A_{14}T^4 + A_{13}T^3 + A_{12}T^2 + A_{11}T + A_{10})P \\ . &+ A_{04}T^4 + A_{03}T^3 + A_{02}T^2 + A_{01}T + A_{00} \end{aligned}$$

$$\begin{aligned} C = &(C_{32}T^2 + C_{31}T + C_{30})P^3 \\ . &+ (C_{24}T^4 + C_{23}T^3 + C_{22}T^2 + C_{21}T + C_{20})P^2 \\ . &+ (C_{14}T^4 + C_{13}T^3 + C_{12}T^2 + C_{11}T + C_{10})P \\ . &+ C_{04}T^4 + C_{03}T^3 + C_{02}T^2 + C_{01}T + C_{00} \end{aligned}$$

s = calculated salinity

P = measured absolute pressure - barometric pressure

T = measured temperature (CT probe)

$A_{00} = 1.389$
$A_{01} = -0.01262$
$A_{02} = 7.164 \times 10^{-5}$
$A_{03} = 2.006 \times 10^{-6}$
$A_{04} = -3.21 \times 10^{-8}$

$A_{10} = 9.4742 \times 10^{-5}$
$A_{11} = -1.258 \times 10^{-5}$
$A_{12} = -6.4885 \times 10^{-8}$
$A_{13} = 1.0507 \times 10^{-8}$
$A_{14} = -2.0122 \times 10^{-10}$

$A_{20} = -3.9064 \times 10^{-7}$
$A_{21} = 9.1041 \times 10^{-9}$
$A_{22} = -1.6002 \times 10^{-10}$
$A_{23} = 7.988 \times 10^{-12}$

$A_{30} = 1.1 \times 10^{-10}$
$A_{31} = 6.649 \times 10^{-12}$
$A_{32} = -3.389 \times 10^{-13}$

$B_{00} = -1.922 \times 10^{-2}$
$B_{01} = -4.42 \times 10^{-5}$
$B_{10} = 7.3637 \times 10^{-5}$
$B_{11} = 1.7945 \times 10^{-7}$

$C_{00} = 1402.88$
$C_{01} = 5.03711$
$C_{02} = -5.80852 \times 10^{-2}$
$C_{03} = 3.342 \times 10^{-4}$
$C_{04} = -1.478 \times 10^{-6}$
$C_{05} = 3.1464 \times 10^{-9}$

$C_{10} = 0.153563$
$C_{11} = 6.8982 \times 10^{-4}$
$C_{12} = -8.1788 \times 10^{-6}$
$C_{13} = 1.3621 \times 10^{-7}$
$C_{14} = -6.1185 \times 10^{-10}$

$C_{20} = 3.126 \times 10^{-5}$
$C_{21} = -1.7107 \times 10^{-6}$

$C_{22} = 2.5974 \times 10^{-8}$
$C_{23} = -2.5335 \times 10^{-10}$
$C_{24} = 1.0405 \times 10^{-12}$

$C_{30} = -9.7729 \times 10^{-9}$
$C_{31} = 3.8504 \times 10^{-10}$
$C_{32} = -2.3643 \times 10^{-12}$

$D_{00} = 1.727 \times 10^{-3}$
$D_{10} = -7.9836 \times 10^{-6}$

(Chen & Millero, 1977)

Appendix C. Alternative Bathymetric Calculations

These alternative formulas can be used by Seanet Pro depending on the settings within the Setup section of the Application Tools menu - see Section 5.6.4, “Application Tools” for more details.

Depth Equation

$$\text{Depth(m)} = (P_{DQZ} - P_{BARO}) \cdot 6894.757 / (g_{avg} \cdot \rho)$$

Given:
P_{DQZ} = Measured pressure from Digiquartz (in dbar)
P_{BARO} = Measured pressure from Barometer (in dbar)
g_{avg} = Average gravitational acceleration (in $m \cdot s^{-2}$)
ρ = Mean density (measured or fixed in $kg \cdot m^{-3}$)

(Saunders 1981; Harris 2000)

Gravity Formulae

$$g = 9.780318(1 + 0.0052788\sin^2\theta + 0.0000236\sin^4\theta)$$

Given:
θ = local latitude in degrees

(UNESCO, 1983)

$$g_{avg} = g(\theta) + \tfrac{1}{2}(2.226e^{-6})P_{db}$$

Given:
$g(\theta)$ = Gravity at latitude
P_{db} = Measured pressure in decibars

(Paroscientific, Schaad 2003)

Glossary

AIF	Originally "Acoustic Interface" but also used to refer to "ARCNET Interface" in which case it can refer to either the interface port on a SeaHub or SCU or to the expansion card available for installation into a computer.
ARCNET	Attached Resource Computer NETwork - a network protocol similar to Ethernet but with the advantage of working over much longer ranges.
Bathy	Alternate name for the *Tritech International Ltd* SeaKing 700 Series Integrated Oceanographic Sensor Suite which outputs data about the conditions of the seawater and water column which may have an affect on the sonar (temperature, depth, etc.,)
CT probe	Conductivity-Temperature probe usually as part of the SeaKing 700 series sensor suite.
DA-15	A 15 pin D shaped connector used mainly for the ARCNET connection on the SCU and SeaHub.
DC	Direct Current
Ethernet	A family of computer networking technologies for local area networks (LANs).
Gemini	Unless specified this can refer to any of the multibeam sonars in the Gemini range by *Tritech International Ltd* such as the Gemini Imager (720id), Narrow Beam Imager or Gemini Profiler (620pd).
Gemini Hub	A rack mountable device capable of driving 2 Gemini sonars and multiple serial sensors and outputting the data to a PC network.
PA500	An altimeter sold by *Tritech International Ltd*
PSU	Power Supply Unit
ROV	Remotely Operated Vehicle
RS232	Traditional name for a series of standards for serial binary data control signals.
RS485	A standard for defining the electrical characteristics of drivers and receivers for use in a balanced digital multipoint system (also known as EIA-485).
RX	Receive (data)
SCU	Surface Control Unit - a specially manufactured computer which is rack mountable and capable of processing the data from the sonar equipment running either Windows XP Embedded or Windows 7 and Seanet Pro or Gemini software.
SeaHub	An alternative to using a Seanet SCU, this device connects to a laptop or PC via USB interface, essentially this takes the signal from the sonar (in RS232, RS485 or ARCNET) and converts it into a signal suitable for the USB port of the computer.
SeaKing	A specific sonar produced by *Tritech International Ltd* but also refers to the family of sonar equipment manufactured by *Tritech International*

	Ltd comprising of the SeaKing, SeaKing DST scanning and profiling sonars and the Hammerhead survey sonar.
Seanet Pro	The software supplied by *Tritech International Ltd* which is capable of running all the sonar devices.
TX	Transmit (data)

