www.iter-systems.com
support@iter-systems.com

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Bathyswath USV Integration Manual

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Voids

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	Section	**Notes**

List of modifications

1.05	07/10/20	Review and updates		MFG	
1.04	19/03/20	Technical review		MFG	
1.03	16/03/20	New Graphic Chart	27	FBY	
1.02	07/11	Referring software integration to OEM manual	27	MFG	
1.01	19/06/19	Correcting transducer connection table		MFG	
1.00	02/05/18	Initial document	nn	MFG	
Version	**Date**	**Modifications**	**Pages**	**Writer**	**Checker**

Table of contents

1 INTRODUCTION

1.1 REFERENCES

Ref 1 ETD_2002 Bathyswath Technical Information,
Ref 2 ITER Systems website, at http://iter-systems.com/
Ref 3 ITER Systems web page at https://www.iter-systems.com/history/
Ref 4 Bathyswath OEM Integration Manual,
"ETD_2006_Bathyswath_OEM_Integration_Manual.pdf"
Ref 5 Bathyswath File Formats, in "Bathyswath File Formats.pdf"
Ref 6 Bathyswath Parsed File Format, in "Bathyswath Parsed File Format.pdf"
Ref 7 Bathyswath swathRT manual, "ETD_2020_Bathyswath_swathRT manual.pdf"
Ref 8 Bathyswath Getting Started manual, in "Bathyswath Getting Started.pdf"
Ref 9 Bathyswath-Omega manual, "ETD_2027_Bathyswath Omega manual.pdf"
Ref 10 Bathyswath Online User Guide, installed with the Bathyswath software
Ref 11 ARC-Boat web page, at http://www.hrwallingford.com/expertise/arc-boat
Ref 12 EchoBoat web page, at
https://seafloorsystems.com/products/hydrographic/singlebeam-echosounders/product/echoboat-asv-autonomous-surface-vehicle

1.2 GLOSSARY & ACRONYMS

ACRONYMS	DEFINITION
AUV	Autonomous Underwater Vehicle
CW	Continuous Wave
DC	Direct current
DU	Deck Unit
FGPA	Field-Programmable Gate Array
GNSS	Global Navigation Satellite System
GPS	Global Positioning System: a GNSS, maintained by the USA
IO	Input - output
MRU	Motion Reference Unit
NMEA 0183	A standard computer interface for marine equipment, maintained by the US National Marine Electronics Association
OEM	Original Equipment Manufacturer
PC	Personal computer
PRF	Pulse (or Ping) Repetition Frequency
ROV	Remotely-operated underwater vehicle
TEM	Transducer Electronics Module
TIU	Transducer Interface Unit
USV	Unmanned Surface Vehicle (radio-controlled or autonomous boat)
UUV	Unmanned Underwater Vehicle: includes AUVs and ROVs

1.3 SCOPE

This document provides instructions for integrating Bathyswath systems into Unmanned Surface Vehicles (USVs).

2 BATHYSWATH

Bathyswath is a swath bathymetry sonar system. It measures the range and angle to sonar reflectors, such as the seabed, and also measures the strength of the sonar echo for each measurement. This information is typically used to make depth maps and sidescan images of the bottom of sea, rivers and lakes.

See Ref 1 and Ref 2 for more information on what Bathyswath is and what it can do.

2.1 BATHYSWATH IN USVS

Bathyswath is ideal for integrating into USVs, particularly small ones, because of its small size, low weight, and low power consumption. USVs are often used in very shallow water (less than 10m), where Bathyswath gives much wider swath widths than beam-forming swath bathymetry systems.

The Bathyswath software includes a rich set of functions and interfaces that support autonomous and remote operation.

The systems integrator has choices of Bathyswath configurations:

- Bathyswath-2-STD: the standard package, with the electronics mounted in a splash-proof Deck Unit.
- Bathyswath-2-Omega: a Bathyswath system packaged together with GNSS position sensor and attitude sensor modules, in a compact Deck Unit. See Ref 9.
- Bathyswath-2-OEM: a package of “bare” components, for integrators to include in their own systems. See Ref 4.

The STD package is simple to integrate, as it provides industry-standard connections (RJ45 for Ethernet, etc.), but the Deck Unit can be too large and heavy for some USVs. The Omega package is therefore a good choice for small USVs.

Bathyswath is provided with a choice of sonar transducers at different acoustic frequencies: 468kHz, 234kHz and 117kHz. These give increasing range (swath width), but are increasingly larger. The 468kHz transducers are best suited for most small USVs.

Like any swath bathymetry sonar system, Bathyswath also needs sensors for:

- Position,
- Motion,
- Sound velocity.

2.2 BATHYSWATH STD

Bathyswath-2-STD system is our standard version, it consists of:

- The Deck Unit (DU) in painted and anodized aluminium. It is IP66 and includes the sounder electronics for 1, 2 or 3 transducers.
- One, two or three transducers (117, 234 or 468 kHz choice).
- One, two or three cable extensions for the transducers (5, 10, 15 or 20m standard, more on request).
- A V-bracket (small V-bracket by default, it is only compatible with 234 and 468 kHz transducers; the big V-bracket is a necessary option for 117 kHz transducers or if you want to install, underwater between the transducers, a motion sensor and/or a sound velocity sensor).

2.3 BATHYSWATH OMEGA

Bathyswath Omega contains all the items needed for surveying in one compact housing:

- Bathyswath TEM electronics
- Dual GNSS system for position and heading
- INS motion system for roll, pitch and heave
- Raspberry Pi Linux computer with software for data acquisition and system control
- Power supply and interface board

A selection of GNSS and INS systems is available, to provide a range of price and data quality.

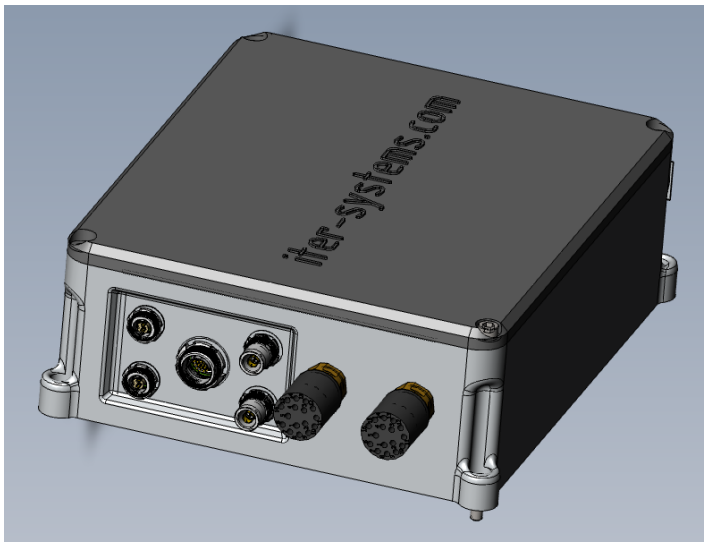


Figure 1 Bathyswath-2-Omega Housing

The external connections are:

- 2 x transducer connectors, same as Bathyswath-2-STD Deck Unit
- Spider Cable connector, same as Bathyswath-2-STD Deck Unit. Connects to power, Ethernet, PPS and sync
- 2 x GNSS antenna connectors
- 2 x auxiliary system connectors, for external sensors and RTK radio modems

2.4 BATHYSWATH OEM

Bathyswath OEM is a package of components that systems integrators can use to include Bathyswath in their own products. It is not intended for end-users. The components supplied in a Bathyswath OEM system are:

- A set of electronics boards: we call this the “Transducer Electronics Module”, or TEM,
- One or more sonar transducers,

- The Bathyswath software suite, with versions for Windows computers and Linux computers, and allows the system to be controlled, data collected from it, and the data to be processed to produce images, depth maps, and outputs to other software products.

Other components that are available from ITER Systems include:

- Mounting hardware for the sonar transducers,
- Extension cables, for extending the length of the sonar transducer connections,
- Interface boards, including power regulators, for the TEMs,
- Interface cables and test cables for the TEMs.

2.5 ITEMS TO BE SUPPLIED BY THE CLIENT

Clients who integrate a Bathyswath system will need to provide the following additional items:

- A source of electrical power,
- A computer to run the Bathyswath software or other software (see section 2.12),
- A motion sensor, to measure the roll, pitch and heave of the platform (included in Omega)
- A position sensor, to measure the position of the platform, (included in Omega)
- A heading sensor, to measure the pointing direction of the platform, (included in Omega)
- A sound velocity sensor, to measure the speed of sound in water, or some other way of measuring or estimating this,
- A mechanical mount for the sonar transducer(s),
- Electrical connections between all parts of the system, including from the sonar transducer(s) to the TEM.

OEM systems also need:

- A housing to contain the Bathyswath electronics boards (TEM), to protect them from mechanical damage and keep them dry
- Internal cables for the housing
- Cables to join this housing to the power supply and external systems

2.6 CONTACTING ITER SYSTEMS

ITER Systems designs, builds, sells and supports Bathyswath systems. See Ref 3 for a short history of the company and for contact details.

Some limited technical support is available as part of the OEM system sales price to clients who are integrating Bathyswath OEM systems. ITER Systems can also provide more extensive technical consultancy on request.

2.7 OTHER INFORMATION

Other information about Bathyswath systems can be found in:

- The Bathyswath website [Ref 2]
- The Bathyswath Technical Information document [Ref 1]
- The Bathyswath Getting Started manual [Ref 8]
- The Bathyswath File Formats document [Ref 4]

- The Bathyswath Online User Guide [Ref 10]

2.8 BATHYSWATH VERSIONS

This manual describes the Bathyswath-2 product version, first available in 2015.

2.9 SUMMARY OF SPECIFICATIONS

Item	Height (mm)	Width (mm)	Depth (mm)	Weight in air (kg)	Weight in water (kg)
Deck Unit (STD systems)	308.4	124	170	4.20	N/A
Transducer Electronics Module (OEM systems)	36	100	70	0.19	N/A
Transducer 117 kHz	220	550	70	9	1.4
Transducer 234 kHz	100	340	55	5	0.8
Transducer 468 kHz	60	230	40	1	0.1

Power: 12V (OEM), or 9-36V (STD) 10W to 20W, depending on sonar transmit pulse settings

Communications: Ethernet 100BaseT

2.10 PRECAUTIONS

Precautions should be taken while working on electronics boards:

1. ***The PA board (PCB033) has high voltage (up to 450 volts) on it, do not touch it with bare hands or tools when it is live; there is sufficient energy stored in the board to cause injury or death,***
2. Both TEM boards are fragile, handle with care,
3. The work-station should be clean,
4. Always use antistatic wrist strap and an anti-static work-station while working on the boards.
5. Fit a thermal pad to the FPGA chip and analogue processing chips on the underside of the FPGA board, and fit the FPGA board on a DU base plate. The thermal pad must be touching to the metal plate to maintain the temperature.
6. Use a fan to cool the boards while they are in use,
7. Do not turn on the power supply before all the connections are made,
8. Always turn off the power supply after the test,
9. Follow the guidelines.

2.11 SONAR TRANSDUCERS

2.11.1 Frequencies and Versions

Bathyswath sonar transducers are available in three frequencies: 117kHz, 234kHz and 468kHz. The higher-frequency transducers are smaller, give better image resolution, but reduced range to the bottom. The bandwidth of the transducers is sufficient to allow operation at any frequency between 100kHz and 500kHz, although the best performance is achieved at the nominal resonant frequencies.

The back surface of the transducers is flat; plates to match to the curved hull of a vehicle are available on request.

A buoyant version of the 468kHz transducer is available, which has its body made from closed-cell foam, so that the unit is slightly positively buoyant in seawater. This version is also shaped to reduce drag. It may be useful for some applications. However, it is larger than the standard 468kHz transducer.

2.11.2 Transducer Cables

Standard transducers are fitted with a 450mm-long cable tail, terminated in a Subconn MCIL16M connector. Other tail lengths are available on request, or the tail can be extended using a Bathyswath Transducer Extension cable

In the standard transducers, the tail leaves the connector at one end, making it easier to fit the transducer to a flat surface. It is usually best to have the cable leave the transducer from the rear, relative to the water flow, so these transducers are produced in pairs, one for the port side and one for the starboard side of the vehicle or mount.

These transducers can also be provided, on request, with the cable leaving the back face of the transducer, close to the end where the cable leaves the transducer on the standard version. Transducers can also be supplied without the wet-mate connector, so that integrators can fit their own connectors.

2.11.3 Transducer Interfaces

Bathyswath-2 transducers are fitted with pre-amplifiers on the receive staves and a matching transformer on the transmit stave, in order to maximise performance. The TEM provides power for the transducer pre-amplifiers.

2.11.4 Transducer Dimensions

Item	Height (mm)	Width (mm)	Depth (mm)	Weight in air (kg)	Weight in water (kg)
Transducer 117 kHz	220	550	70	8.6	1.3
Transducer 234 kHz	100	340	55	5	0.8
Transducer 468 kHz	60	230	40	1	0.1

Transducers are supplied with 1m short tail and a wet-mate connector.

2.11.5 Transducer Drawings

In the diagrams below, dimensions are in millimetres unless otherwise stated.

Transducer designs are subject to change; please contact ITER Systems for confirmation before designing your mechanical interface.

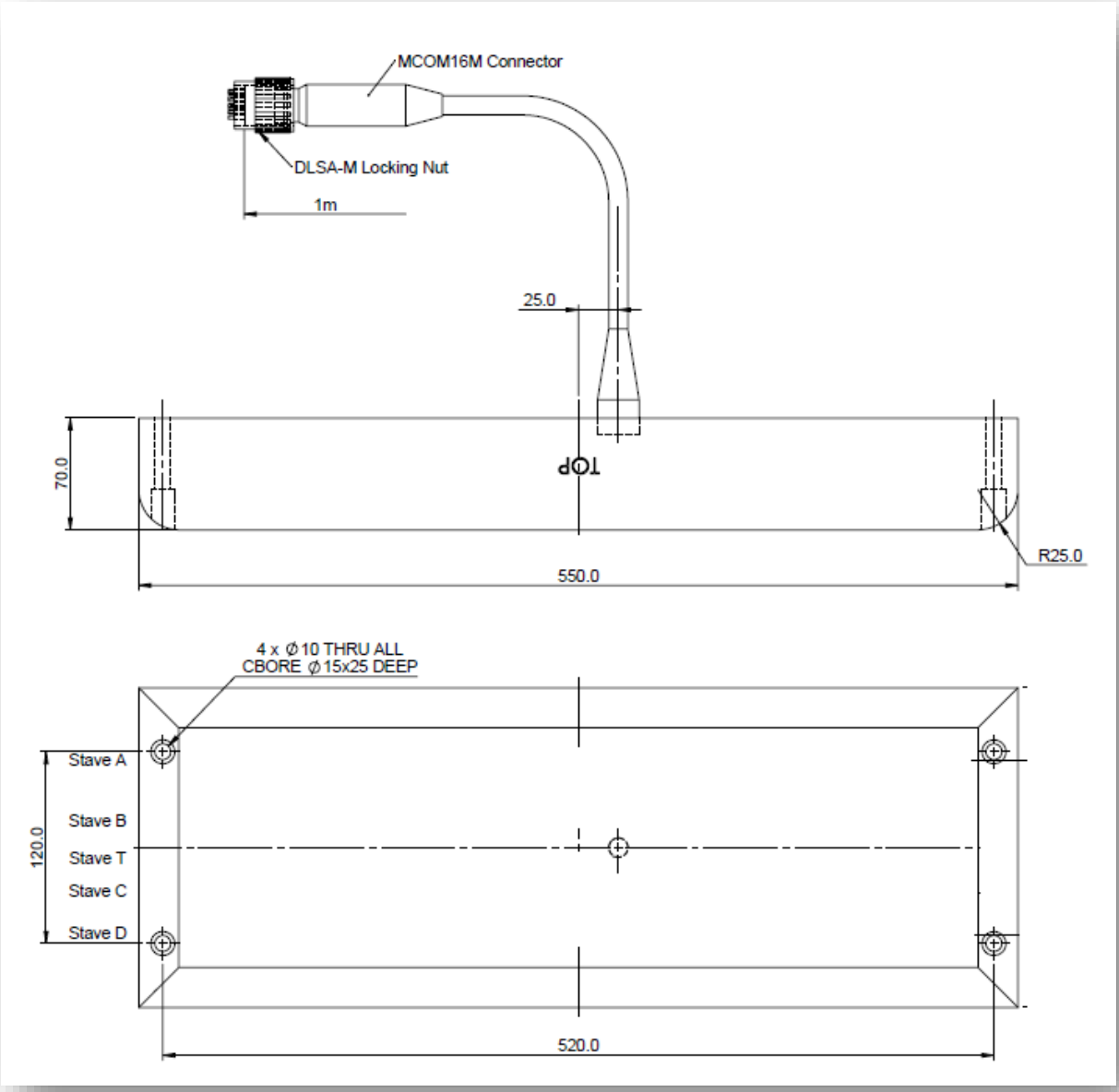


Figure 2 117kHz Transducer dimensions

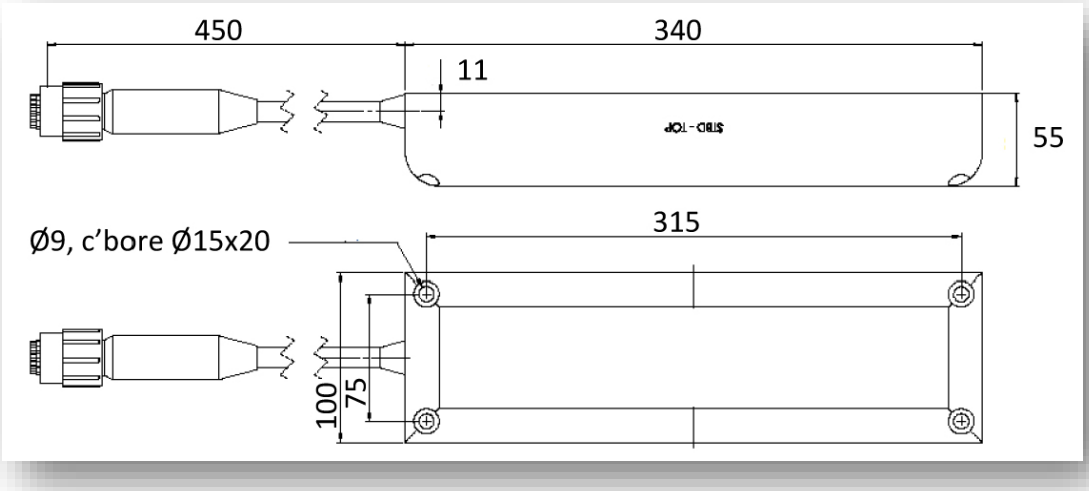


Figure 3 234kHz Transducer dimensions

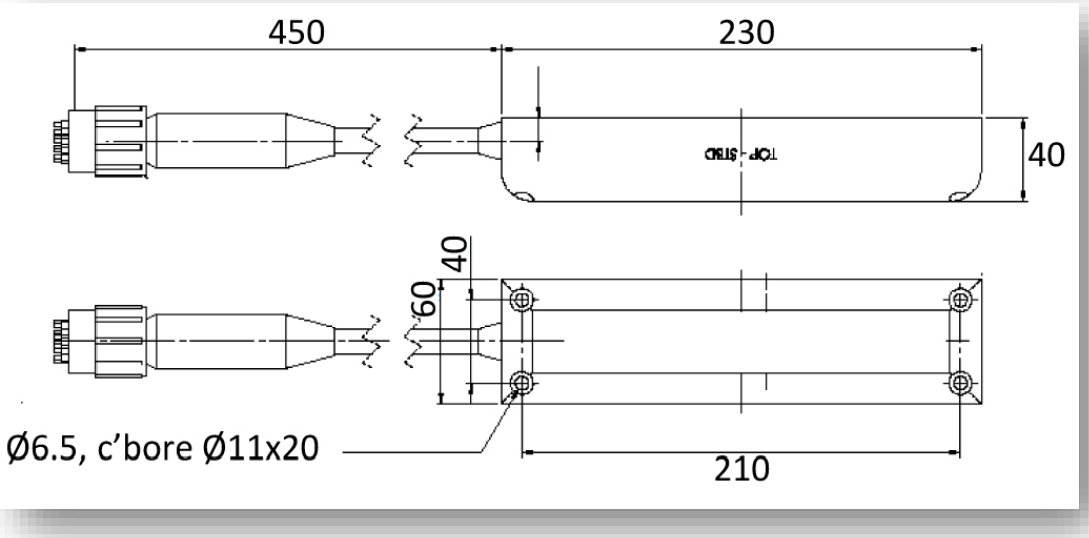


Figure 4 468kHz Transducer dimensions

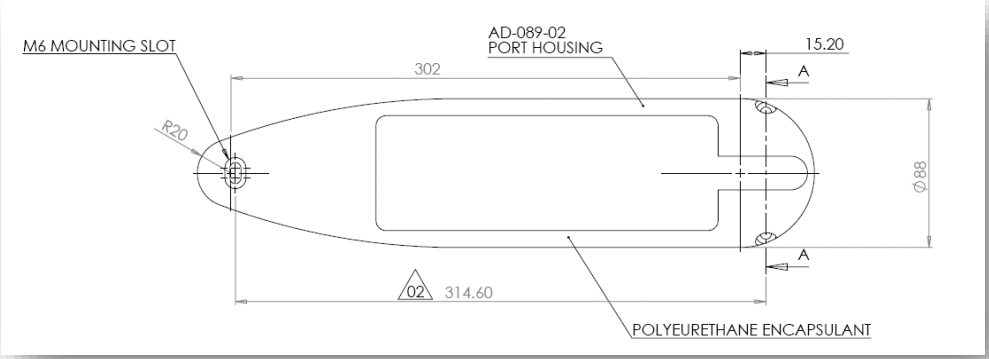


Figure 5 468kHz Buoyant Transducer dimensions

2.12 SOFTWARE

The Bathyswath software suite is described in detail in Ref 1.

2.12.1 Operating Systems

The Bathyswath software runs on Microsoft Windows. It runs on all Windows versions from NT onwards.

A separate real-time data collection program, swathRT, is available for operation on other operating systems, or where processing power is limited. This is available on Linux and Windows as standard, but can be compiled for other operating systems on request. See Ref 7.

2.12.2 Automation and Vehicle Interfaces

The most common way to integrate Bathyswath is to fit a single-board computer to the vehicle, running Linux or Windows, and with its own local data storage disk. The Bathyswath software connects to the vehicle's systems using Ethernet or a serial port, and to the Bathyswath TEM using Ethernet. The Bathyswath software responds to a set of command messages from the vehicle, starting and stopping the sonar, and writing data from the hardware to the local disk. The vehicle usually sends motion and position data to the Bathyswath system, for time-stamping and storing with the Bathyswath data for further processing. An alternative is to store the vehicle's motion and position data on the vehicle's systems, and to provide time-synchronisation messages that allow this data to be aligned with the Bathyswath sonar data in post-processing.

2.12.3 Configuration of swathRT (Linux and Windows)

A program called swathRT has been developed for operating Bathyswath on small, remote vehicles. It is available for Linux and Windows operating systems; other compilations are available on request.

See Ref 7 for details of swathRT.

2.12.4 Automation Configuration in Swath Processor (Windows)

The main program for collecting, storing, and processing Bathyswath data on Windows systems is called Swath Processor.

The Automation dialog Swath Processor, shown below, gives an indication of the options available.

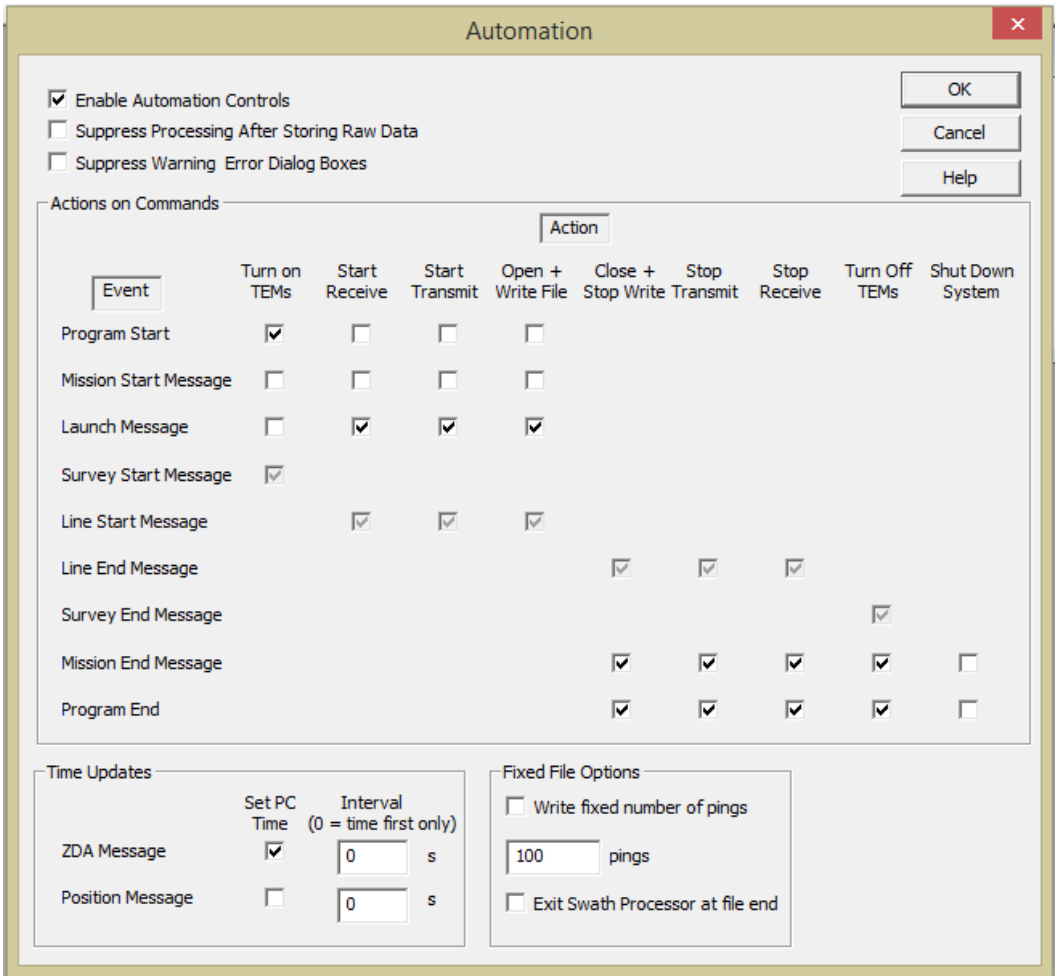


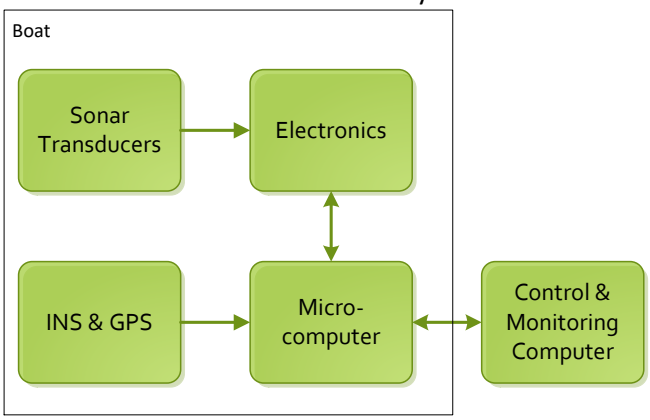
Figure 6 Swath Processor Automation dialog:
indicates the automation options in the Bathyswath software

See section 4.4 for the details of the software interfaces.

3 CONFIGURATION

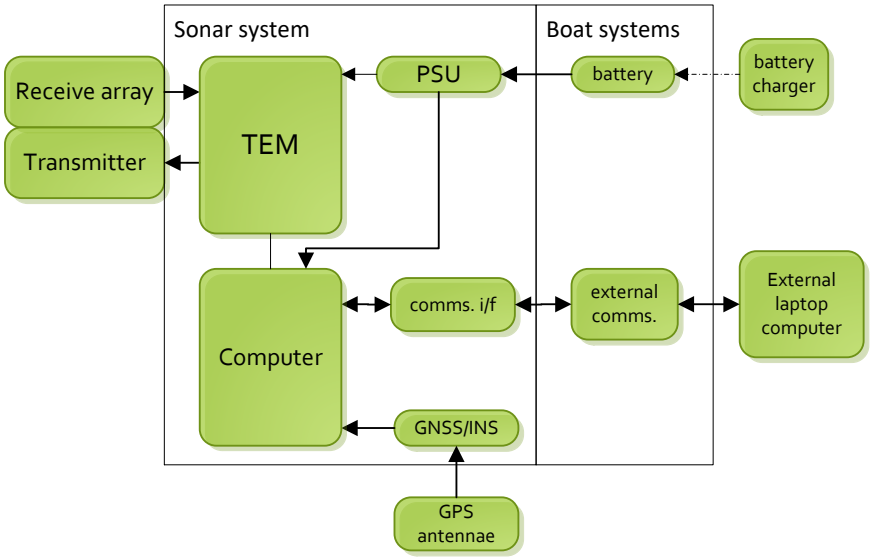
3.1.1 Block diagram

The main functional blocks of the system are:



3.1.2 Components

The hardware components that provide these functions are:

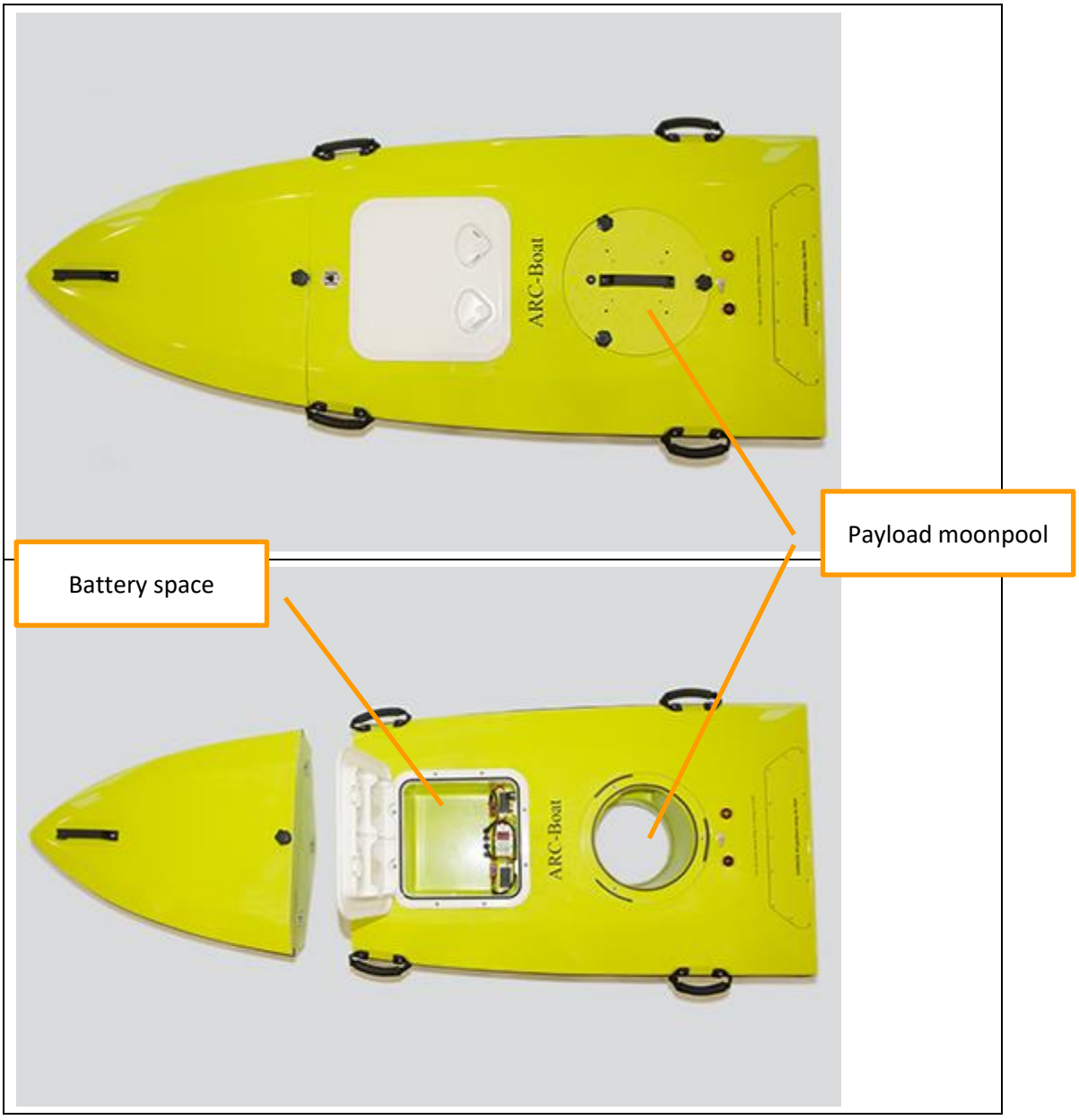


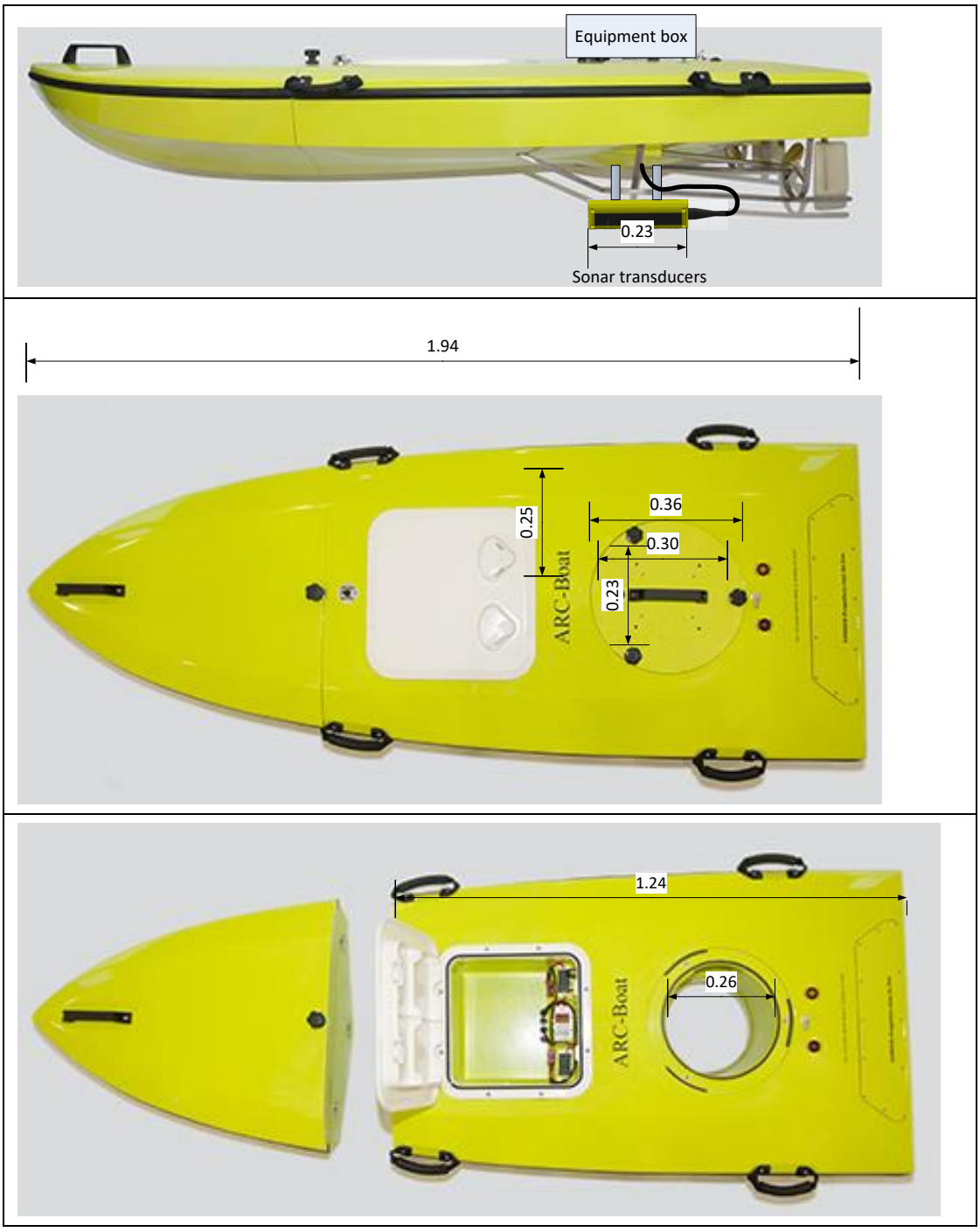
3.2 PHYSICAL LOCATION OF EQUIPMENT

Some USVs have a “payload moonpool”, where ADCPs and other equipment are fitted. A “sensor pod” can be fitted into this space, usually lowered in from the top and fixed in place with bolts.

This is the ideal place to fit the Bathyswath system. The transducers are fitted at the bottom of the pod.

The images below show Bathyswath fitted to ARC-Boat [Ref 11]. ARC-Boat uses Bathyswath-2-Omega.





Fitting the electronics to the top plate of the pod in this way helps to ensure that the transducers are mechanically tightly coupled with the INS, and makes it simpler to remove and replace the entire system in one go.

On Echo-Boat [Ref 12], there is space inside the hull to take the Deck Unit, so Bathyswath-2 STD is used.

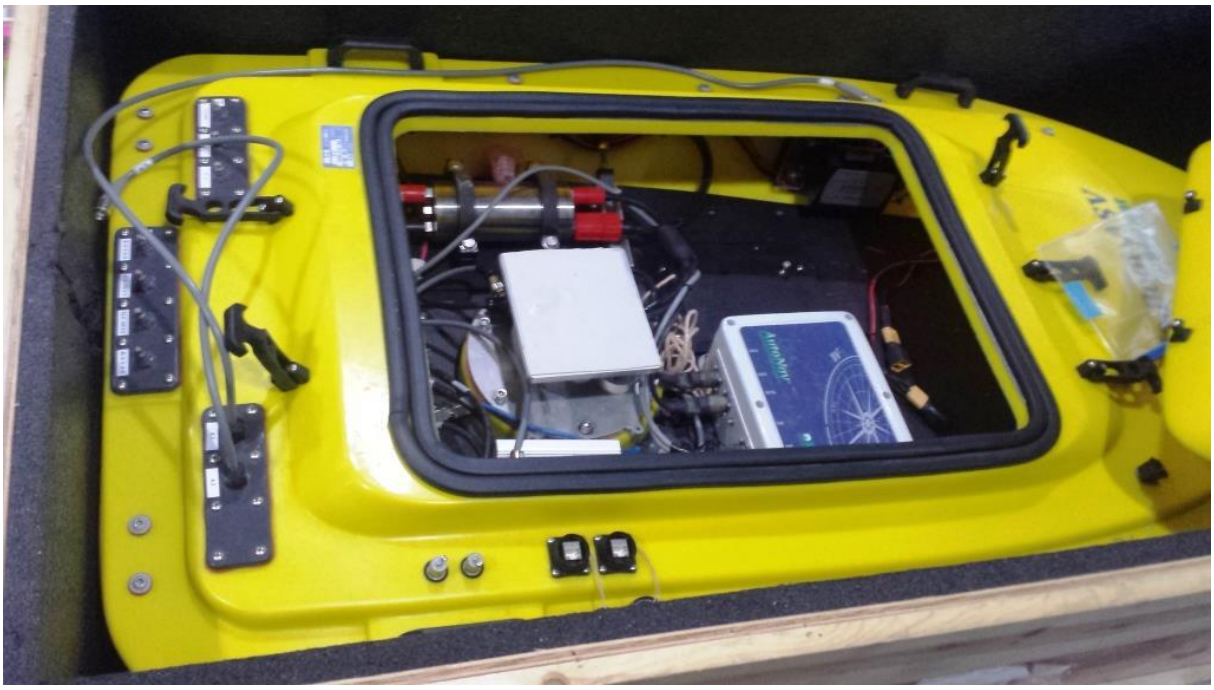


Figure 7 EchoBoat internal equipment space

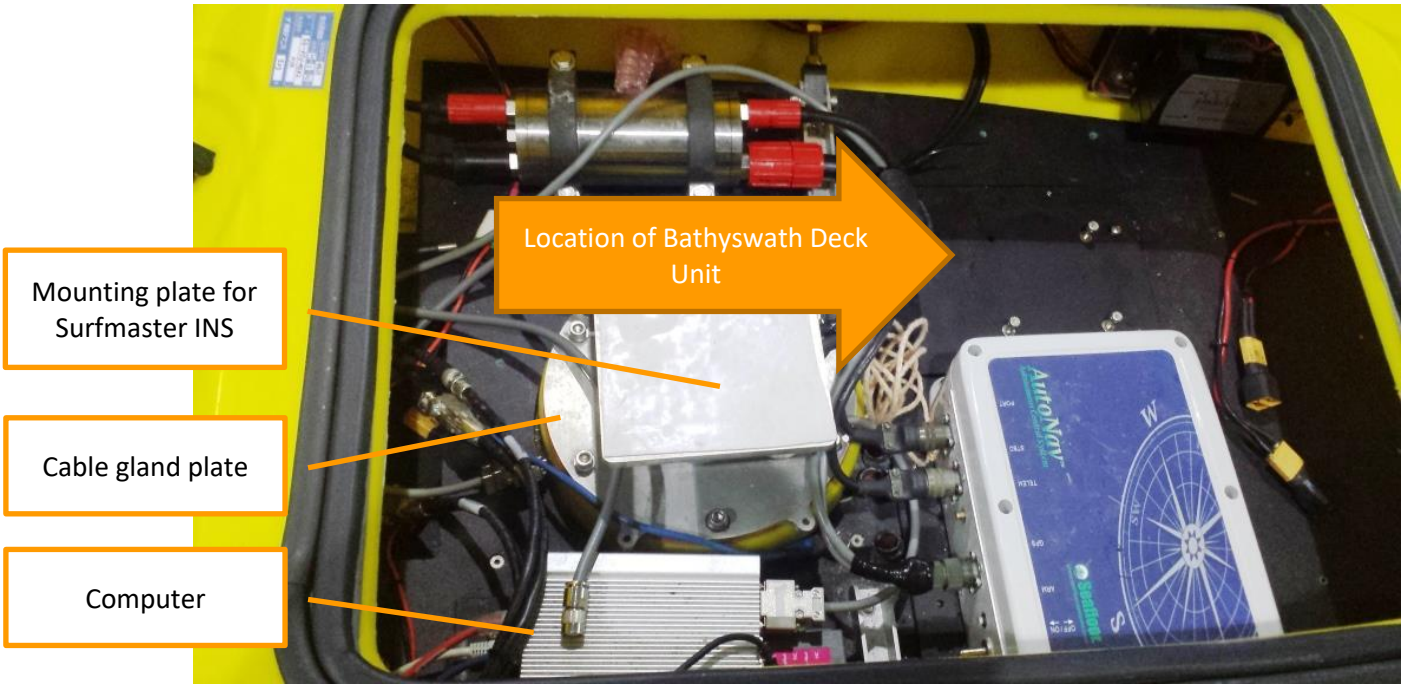


Figure 8 EchoBoat internal equipment space, showing location of equipment

3.3 POD

A "pod" can be used to fit the equipment to the boat. The sketch below shows a design for this pod.

Ideally, the pod should be designed so that the cable tails fitted to the Bathyswath-2 transducers are long enough to reach the Equipment Box; these cables are 0.525m long as standard. If not, then transducers can be supplied with longer cables, or transducer extension cabled provided.

If the sonar transducers are too large to fit through the moonpool tube, then the pod can be built so that the transducers can be added to the bottom of the pod after it has been fitted from the top.

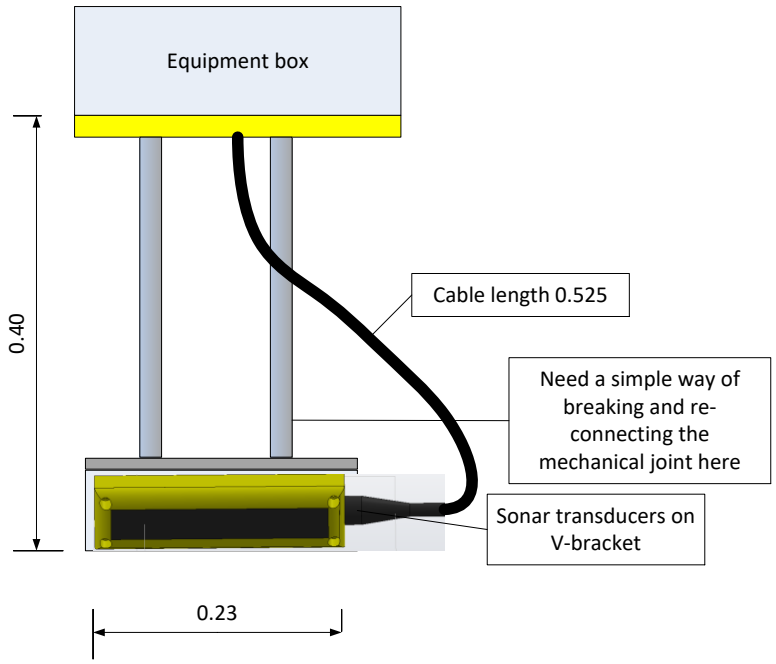


Figure 9 Bathyswath USV pod sketch

3.3.1 Transducer mount

The two transducers need to be mounted under the water, facing port and starboard, with a nominal declination from the horizontal of 30 degrees (i.e. the front face is at 30° to vertical).

A typical mounting bracket is shown below. This bracket can be purchased from ITER Systems if required.

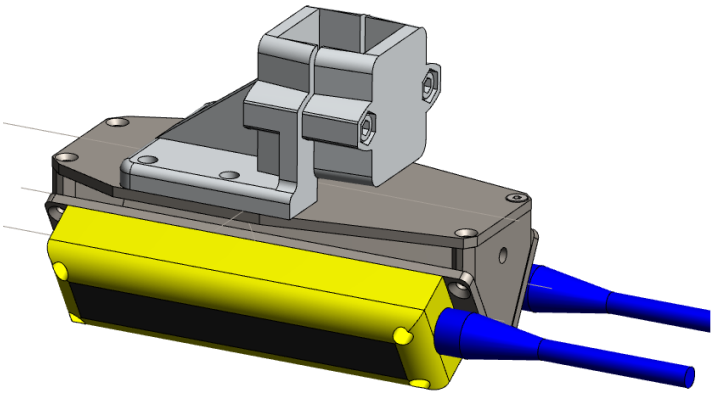


Figure 10 Bathyswath 468kHz transducer V-Bracket

3.4 INTERNAL CABLE LOOMS

If Bathyswath-2 OEM is used, the following internal cable looms are needed in the Equipment Box.

Item	Qty.	From	To	Supplier	Part #
TEM power, Ethernet & PPS	1	TEM	Power, PPS & RPi	ITS	ITS 60260-B-0005
TEM transducer loom	1	TEM	Transducer bulkhead connectors	ITS	ITS 60226-DU-2
Ekinox to RPi, Ethernet	1	Ekinox	RPi, via Ethernet-USB converter	ITS	
Ekinox to power	1	Ekinox	DC power	ITS	
Ekinox to bulkhead, TNC	2	Ekinox	Antenna connectors	ITS	RS 914-0330
TNC bulkhead connector	2	Int. TNC cable	Ext. TNC cable	ITS	RS 793-3629

Bathyswath-2 STD uses a Spider Cable: see below.

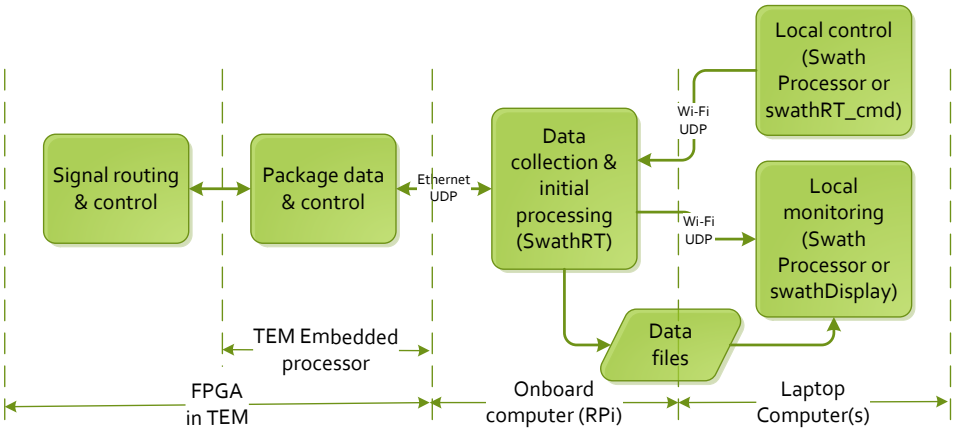
3.5 COMMUNICATIONS

The Bathyswath TEM connects to the computer by Ethernet, through a custom-built cable.

To save on internal cabling, the computer could connect to the boat's external Wi-Fi module using its own in-built Wi-Fi, and a Wi-Fi to Ethernet converter module, and the external Wi-Fi module connects to the laptop computer on the riverbank.

3.6 SOFTWARE

The main software components are:



The standard configuration for Bathyswath systems is to connect the TEM directly to Swath Processor, running on a Windows computer. That is possible for USVs: a small Windows computer can be fitted inside the equipment housing on the sonar pod. But if that is too expensive, large and power-hungry, then a small Linux micro-computer can be used. We have successfully used a Raspberry Pi, running Linux, for this. The Omega housing contains a Raspberry Pi. Swath Processor does not run on Linux, and in any case is a large and complex program, and the Raspberry Pi would not be powerful enough to run it. We therefore have a minimal version of the sonar interface, which runs on Linux, called swathRT. See Ref 7. The main functions of swathRT are:

- Receive commands from an external computer using UDP packets, and pass on the appropriate control packets to the TEM.
- Receive sonar data from the TEM and:
  - Store it to its on-board SD card (there is space for several day's survey on a large SD card),
  - Pass it on to external processes using UDP messages, for monitoring.
- Receive data from external motion systems, such as INS and GPS, and also store them and pass them on to external computers,
- Receive timing information, typically as NMEA ZDA messages, and use it to set the internal clock in the TEM.

In simple systems, the external computer runs an application (swathRT_cmd) that allows the user to send commands to swathRT, using UDP messages. Another simple application (swathDisplay) allows the sonar data to be viewed. However, in this case, it would be better to use the main Swath Processor Windows application for both command and data viewing.

4 INTEGRATION

4.1 MECHANICAL INTEGRATION

4.1.1 Deck Unit (STD systems)

STD systems have the electronics mounted in a Deck Unit.

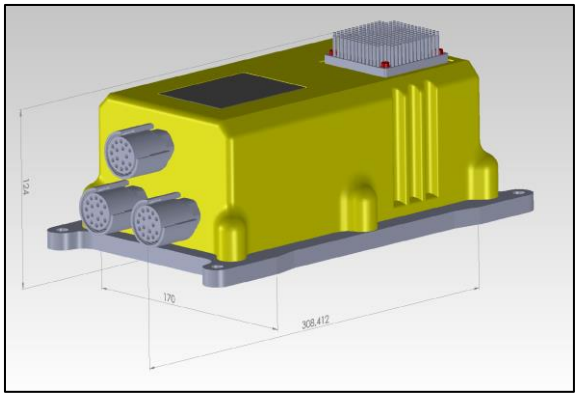


Figure 11 Bathyswath-2-STD Deck Unit

Housing	Length (mm)	Width (mm)	Depth (mm)	Weight in air (g)
Deck Unit	308.4	124	170	4200

The Deck Unit is fixed down with four fixing holes on its bottom plate.

4.1.2 Deck Unit (Omega systems)

The Omega housing is 270 x 221 x 92 mm. It is fixed down with four fixing holes on its bottom plate.

4.1.3 TEM Mounting (OEM systems)

The Transducer Electronics Module (TEM) is fixed to a base-plate in the system housing using four tapped stand-offs, which are supplied with the OEM system. These stand-offs are selected to give the correct height from the boards to the base-plate and between the two boards.

The TEM fixing holes are 3mm diameter, and the stand-offs supplied are M2.5.

The locations of the fixings are shown below.

The TEM, including stand-offs, weighs 190g.

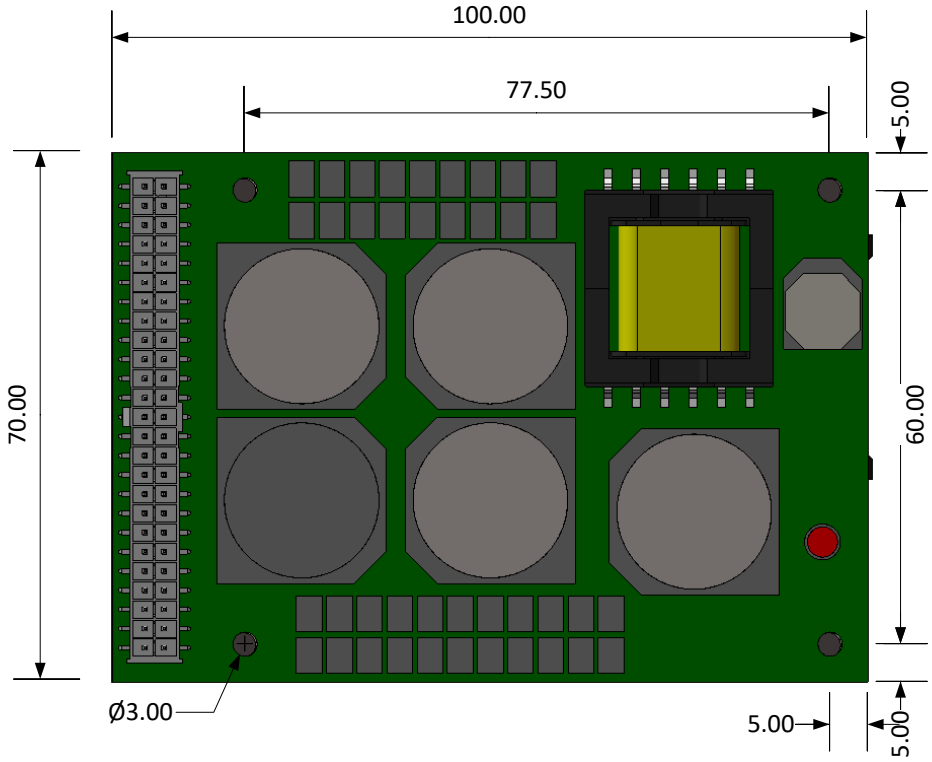


Figure 12 TEM Fixing Details
All dimensions in millimetres

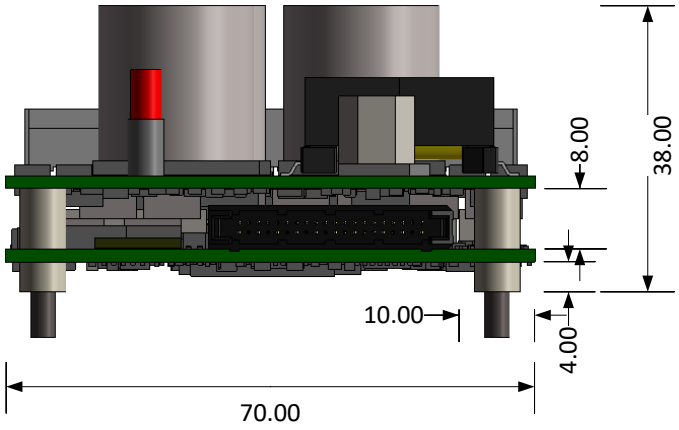


Figure 13 TEM End View
Showing IO Connector

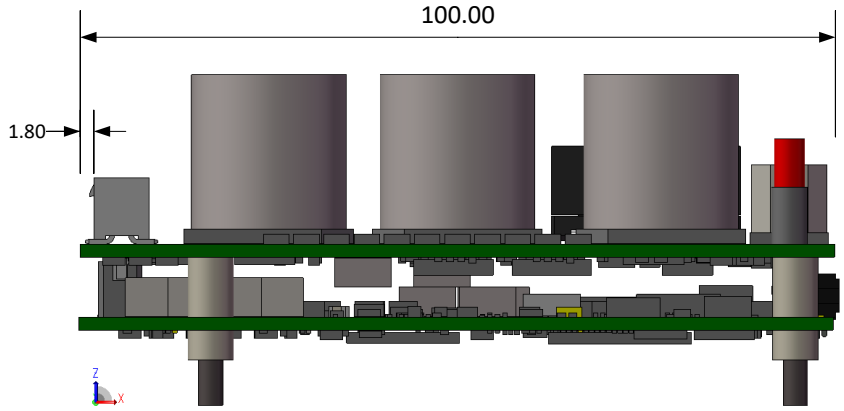


Figure 14 TEM Side View
Showing location of transducer connector

4.1.4 Cooling TEM

Ideally, fit the TEMs to a thermally-conductive base-plate. Use thermal pads to provide a cooling path from the FPGA and sonar interface ICs (the three large chips on the bottom of the board). Fit a fan to circulate air inside the housing that holds the TEM.

The TEM uses 10W power, so generates roughly the same as heat inside the housing. Most system housings are easily capable of dissipating this amount of heat energy in air or in water, but without a fan and/or thermal pads, parts of the TEMs can become too hot. The TEMs are provided with temperature sensors, and their readings are reported to the user through the Bathyswath Swath Processor software, and recorded with the raw sonar data files. The Bathyswath software has the option to disable TEM operation if the temperature exceeds a user-set limit.

4.1.5 Safety

The top board of the TEM stack has 450V stored in large capacitors to generate the sonar transmit pulse. **This could cause serious injury to people if it is accidentally touched. The TEM must be housed in a way that ensures that users cannot touch it when in use.**

4.1.6 Fixing Transducers

The sonar transducers are provided with four counter-sunk fixing holes. They are typically fixed to a backing plate using four marine-grade stainless steel socket-head screws, washers and locking nuts.

For swath bathymetry use, the transducers are generally mounted with the main axis horizontal, and pointing at 30° down from horizontal.

4.1.7 Tools

No special tools are required to install and maintain a Bathyswath OEM system. All fixings are metric, except where otherwise stated (the Subconn wet-mate connectors are sized in inches).

4.2 ELECTRICAL INTEGRATION: STD SYSTEMS

4.2.1 Summary of Electrical Connections

The Deck Unit is connected using a Spider Cable. The Spider Cable connects the Fisher waterproof connector on the Deck Unit, or the Wet-Mate connector on the Subsea Unit to standard connector types, e.g. RJ45 for Ethernet, BNC for PPS, barrel connector for power, etc.

Figure 15 Bathyswath Spider Cable

The Spider Cable provides the following electrical connections:

- DC power in, on a “barrel connector”, as used for laptop computer power supplies,
- Ethernet communications, on an RJ45 connector,
- PPS timing signal input, on a BNC coax connector,
- Transmit synchronisation pulses in and out, on a Fischer multi-pin connector.

4.2.2 Power

The TEM accepts a 9 to 36 V DC input power supply.

Power consumption in normal use is between 10W and 20W, depending on the settings of the transmit pulse.

The power capacitors on the PA card charge up through a limiting resistor; this has been chosen to allow full power after 2 seconds, giving an “inrush” current with a peak power of 20W.

4.2.3 Ethernet

The TEMs support 100BaseT (100 Mbit/s) Ethernet communications, on four wires. An additional four wires are provided for 1000BaseT communications, but the current generation of TEM boards does not support 1000BaseT.

4.2.4 PPS

PPS timing signals are used in the TEM firmware to maintain the TEM’s internal clock, which is then used to time-stamp the sonar data packets that are sent to the software. PPS signals are typically provided by GPS positioning systems.

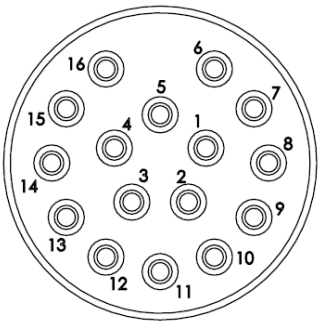
4.2.5 Transmit Synchronisation

The TEM can synchronise its sonar transmit pulses to external input pulses, or output pulses with it transmits.

4.2.6 Transducer Connector

Each transducer is fitted with a Subconn MCOM16M (16-way male) wet-mate connector.

Pin	Function
15	Stave A +
14	Stave A -
13	Stave B +
12	Stave B -
10	Stave C +
9	Stave C -
8	Stave D +
7	Stave D -
6	TX +
16	TX -
3	Pre-amp power +
1	Pre-amp power 0V
2	TXDR Test
5	TXDR Test Gnd
4	Rx screens
11	Overall Screen



Subconn MCOM16-M
Male front view
(mating face)

Connect the following to GND pins in the TEM Transducer Connector:

- Pre-amp power 0V,
- TXDR Test Gnd,
- Rx screens.

Overall Screen (or connect this to the chassis screen of the system housing).

4.3 ELECTRICAL INTEGRATION: OEM SYSTEMS

4.3.1 Summary of Electrical Connections

A Bathyswath OEM system uses the following electrical connections:

- TEM IO Connector: this is the horizontal connector on the bottom of the two TEM boards, providing:
  - DC power in
  - Ethernet communications
  - PPS timing signal input
  - Transmit synchronisation pulses in and out
  - General-purpose IO connections (for future use)

- TEM Transducer Connector: this is the vertical connector on the top of the two TEM boards, providing:
  - Three transducer connections, each with:
    - One transmit channel out
    - Four receive channels in
    - Pre-amplifier power supply
    - Transducer test connection
- Transducer connector: each connector is fitted with an underwater connector that interfaces with one of the TEM Transducer Connector channels.

4.3.2 TEM IO Connector

The IO connector is a Samtec TFM-120-02-S-DH, which mates with a Samtec SFSD series cable assembly.

Pin	Use	Pin	Use
1	Ground: All ground pins should be connected.	21	Used for initial programming, no not connect.
2	Ethernet pair 1 +	22	Used for initial programming, no not connect.
3	Ground	23	3.3V Logic input, GPI1
4	Ethernet pair 1 -	24	3.3V Logic input, GPI2
5	Ground	25	3.3V Logic output, GPO1
6	Ethernet pair 2 +	26	3.3V Logic output, GPO2
7	Ground	27	Ground
8	Ethernet pair 2 -	28	3.3V Output, 120mA max, from internal regulator.
9	Ground	29	RS485/422 Output 1 +
10	1000 Base T Pair 3+ (not used)	30	RS485/422 Input1 +
11	Ground	31	RS485/422 Output 1 -
12	1000 Base T Pair 3- (not used)	32	RS485/422 Input1 -
13	Ground	33	RS485/422 Output 2 +
14	1000 Base T Pair 4+ (not used)	34	RS485/422 Input2 +
15	Ground	35	RS485/422 Output 2 -
16	1000 Base T Pair 4- (not used)	36	RS485/422 Input2 -
17	Power input (9 – 18V) connect both DC Power in pins.	37	RS232 Output 2
18	Power input (9 – 18V)	38	RS232 Input 2
19	Used for initial programming, no not connect.	39	RS232 Output 1
20	Used for initial programming, no not connect.	40	RS232 Input 1

4.3.3 Power

The TEM accepts a nominal 12 V DC input power supply, 10V to 14V.

Power consumption in normal use is between 10W and 20W, depending on the settings of the transmit pulse.

The power capacitors on the PA card charge up through a limiting resistor; this has been chosen to allow full power after 2 seconds, giving an “inrush” current with a peak power of 20W.

4.3.4 Ethernet

The TEMs support 100BaseT (100 Mbit/s) Ethernet communications, on four wires. An additional four wires are provided for 1000BaseT communications, but the current generation of TEM boards does not support 1000BaseT.

Ethernet connections should be made through CAT5 cables. Short wire runs should at least be twisted in pairs: “pair 1 +” with “pair 1 -” and “pair 2 +” with “pair 2 -”.

4.3.5 PPS

PPS timing signals are used in the TEM firmware to maintain the TEM’s internal clock, which is then used to time-stamp the sonar data packets that are sent to the software. PPS signals are typically provided by GPS positioning systems.

PPS signals can be used on any of GPI1, GPI2, or the input lines of RS485-1 or RS485-2, selectable by a command sent to the FPGA from software. The default is GPI1.

4.3.6 Transmit Synchronisation

The TEM can synchronise its sonar transmit pulses to external input pulses, or output pulses with it transmits. These pulses can be sent and received on any of the GPI/GPO or RS485 lines, under software control. The default is to use the input side of RS485-1 for input synchronisation and the output side of RS485-1 for output synchronisation.

4.3.7 TEM Transducer Connector

All three transducers are connected via a single 50-way Samtec connector (IPL1-125-02-L-D-K). The mating connector is Samtec IPD1-25-D.

Tdxr Channel	Pin	Tdxr Signal	Pin	Tdxr Signal
3	1	GND	26	GND
	2	TX +	27	TX -
	3	GND	28	GND
	4	TDCR Power	29	TDCR Test
	5	Stave A +	30	Stave A -
	6	Stave B +	31	Stave B -
	7	Stave C +	32	Stave C -
	8	Stave D +	33	Stave D -
2	9	GND	34	GND
	10	TX +	35	TX -
	11	GND	36	GND
	12	TDCR Power	37	TDCR Test
	13	Stave A +	38	Stave A -
	14	Stave B +	39	Stave B -
	15	Stave C +	40	Stave C -
	16	Stave D +	41	Stave D -
1	17	GND	42	GND
	18	TX +	43	TX -
	19	GND	44	GND
	20	TDCR Power	45	TDCR Test
	21	Stave A +	46	Stave A -
	22	Stave B +	47	Stave B -
	23	Stave C +	48	Stave C -
	24	Stave D +	49	Stave D -
	25	GND	50	GND

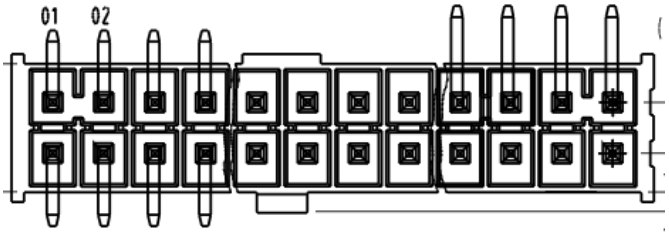


Figure 16 TEM Transducer Connector numbering

4.3.8 Transducer Connector

See section 4.2.6.

4.4 SOFTWARE INTEGRATION

See the Software Integration section of the Bathyswath OEM integration manual [Ref 4] for details if installing and configuring software for Bathyswath.