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Bathyswath OEM Integration Manual

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Voids

Section	Notes
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List of modifications

Version	Date	Modifications	Pages	Writer	Checker
1.05	07/09/2020	TEM Transducer Connector pinout corrected 3.2.7		JSS	
1.04	16/03/20	New graphic chart	25	FBY	
1.03	07/11/19	Software integration updates		MFG	
1.02	19/06/19	Correcting transducer connection table in 3.2.7		MFG	
1.01	25/02/16	117kHz transducer updated		MFG	
1.00	25/09/15	Reviewed and updated		MFG	
0.02	10/08/15	Initial document	nn	MFG	N/A

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 File Formats, in "Bathyswath File Formats.pdf"
Ref 5 Bathyswath Parsed File Format, in "Bathyswath Parsed File Format.pdf"
Ref 6 Bathyswath swathRT manual, "ETD_2020_Bathyswath_swathRT manual.pdf"
Ref 7 Bathyswath Getting Started manual, in "Bathyswath Getting Started.pdf"
Ref 8 Bathyswath Online User Guide, installed with the Bathyswath software.

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 OEM systems into other vehicles and systems.

1.4 CONTEXT

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.

1.5 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, which runs on Windows 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.

1.6 ITEMS TO BE SUPPLIED BY THE CLIENT

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

- A housing to contain the Bathyswath electronics boards (TEM), to protect them from mechanical damage and keep them dry,
- A source of electrical power,
- A computer to run the Bathyswath software or other software (see section 2.4),
- A motion sensor, to measure the roll, pitch and heave of the platform,
- A position sensor, to measure the position of the platform,
- A heading sensor, to measure the pointing direction of the platform,
- 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.

1.7 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.

1.8 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 7],
- The Bathyswath File Formats document [Ref 4],
- The Bathyswath Online User Guide [Ref 8].

1.9 BATHYSWATH VERSIONS

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

1.10 SUMMARY OF SPECIFICATIONS

Item	Height (mm)	Width (mm)	Depth (mm)	Weight in air (kg)	Weight in water (kg)
Transducer Electronics Module	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, 10W to 20W, depending on sonar transmit pulse settings

Communications: Ethernet 100BaseT

1.11 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 BATHYSWATH OEM COMPONENTS

2.1 PARTS OF A BATHYSWATH OEM SYSTEM

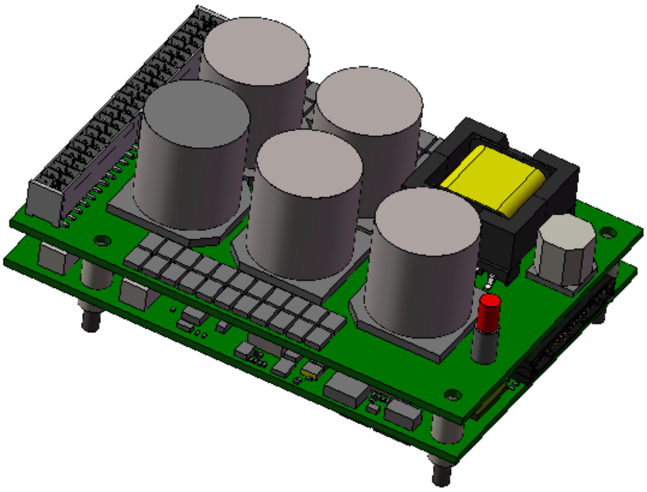
2.1.1 Standard OEM System

A Bathyswath OEM system includes:

A transducer electronics module (TEM)

Generates sonar transmit pulses, and amplifies and processes the echoes

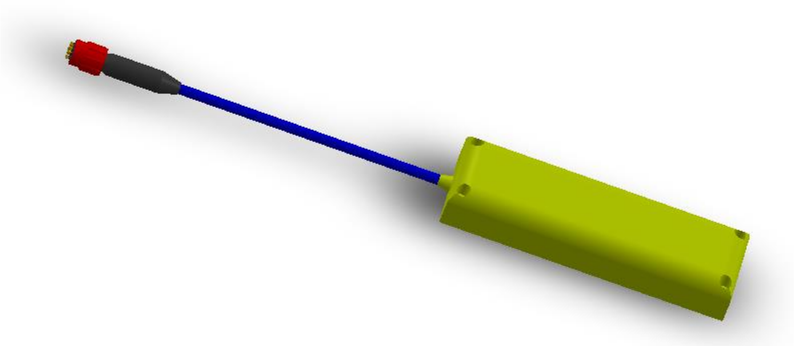
See section 2.2



One or more sonar transducers

Convert sonar signals to and from electrical signals

See section 2.3



Bathyswath software

Processes sonar data and interfaces TEM with users and external systems

See section 2.4

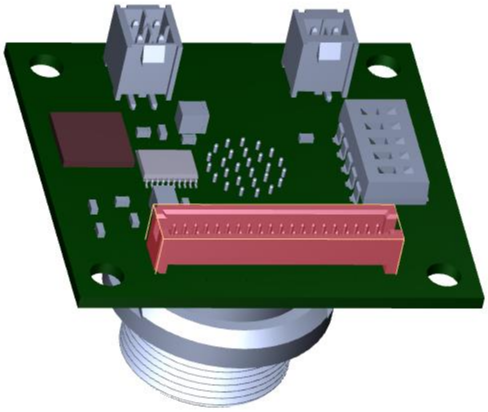
2.1.2 Optional Components

Additional optional components from ITER Systems include:

Interface Board

Gives an external connection to the TEM

See section 4.1



Spider Cable

Connects to the Interface Board to give standard computer and power connections

See section 4.2

Transducer Extension Cable

Extends the connector tail on the sonar transducers

See section 4.3

Test Cable

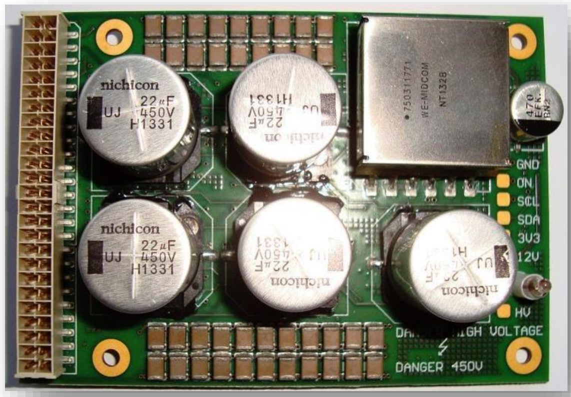
Provides connections to the TEM for testing and configuring

See section 4.4

2.2 TRANSDUCER ELECTRONICS MODULE

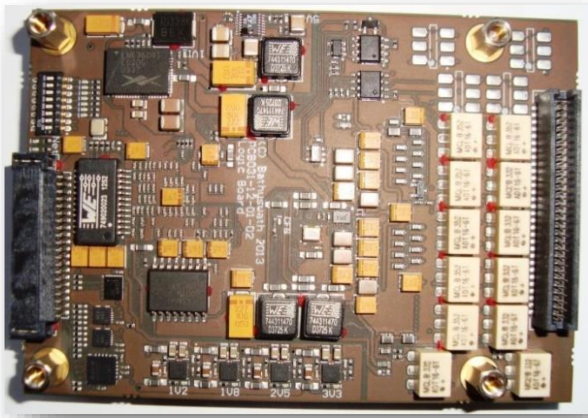
A Bathyswath-2 Transducer Electronics Module (TEM) consists of two circuit boards, which are stacked one above the other, and connected together using a connector on the top of one board and the bottom of the other.

Each TEM provides the interface to three sonar transducers, and operates at any sonar frequency from 100 kHz to 500 kHz.



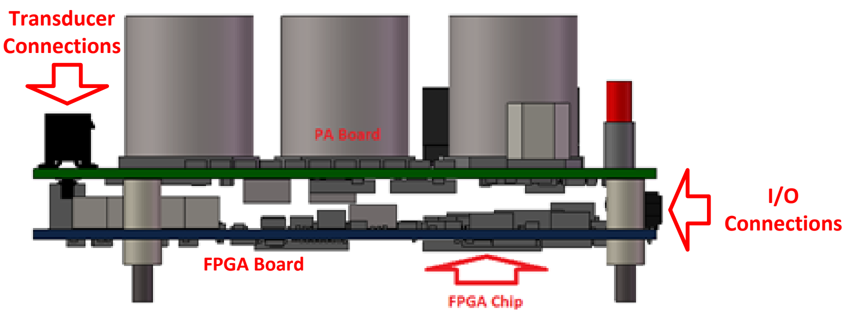
Power Amplifier (PA) board.

Interfaces to the transducers, and generates the transmit pulses.



FPGA board.

Amplifies the returned sonar signals, and digitises and digitally filters them. Communicates the results to the computer through an Ethernet interface.



Bathyswath-2 TEM, side view

Each board is 100x70mm, and the dimensions of the stack are:

Height (mm)	Width (mm)	Depth (mm)
36	100	70

Two connectors are provided:

- Transducer connections, on top of the PA (top) board: SAMTEC IPL1-1-02-L-D-K,
- Input-output connections (Ethernet, power, etc.), on the end of the FPGA (bottom) board: SAMTEC TFM-120-02-S-D.

Communications with external systems is through a 100BaseT Ethernet port.

TEMs require 12V DC power at about 10W.

2.3 SONAR TRANSDUCERS

2.3.1 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 AUV applications. However, it is larger than the standard 468kHz transducer.

2.3.2 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 (section 4.3).

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.

2.3.3 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.

2.3.4 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.

2.3.5 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.

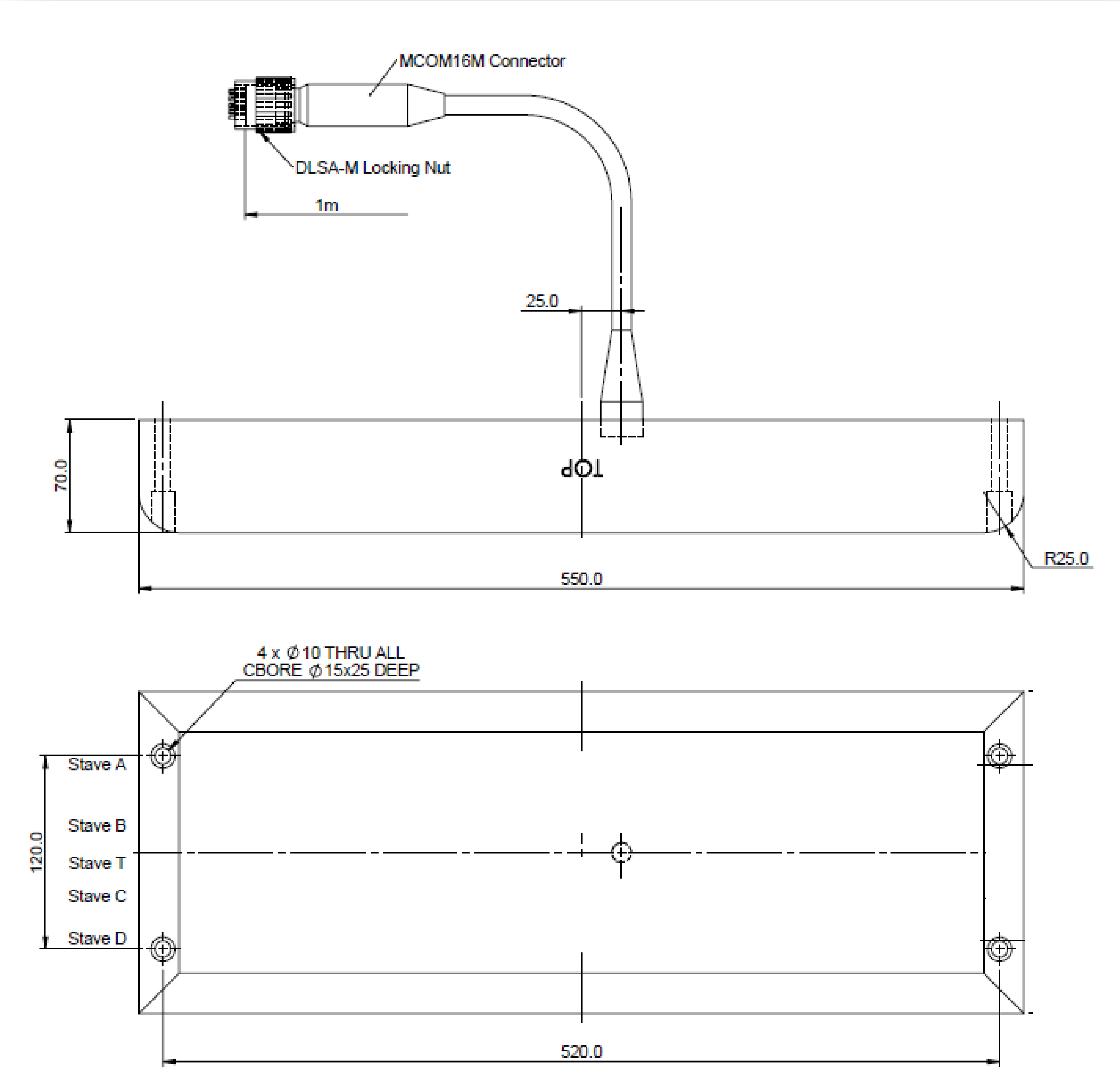


Figure 1 117kHz Transducer dimensions

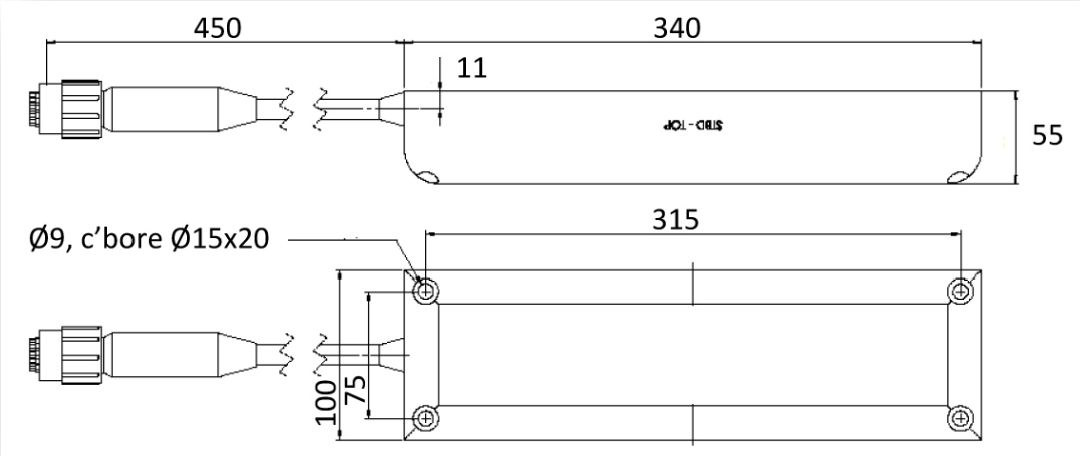


Figure 2 234kHz Transducer dimensions

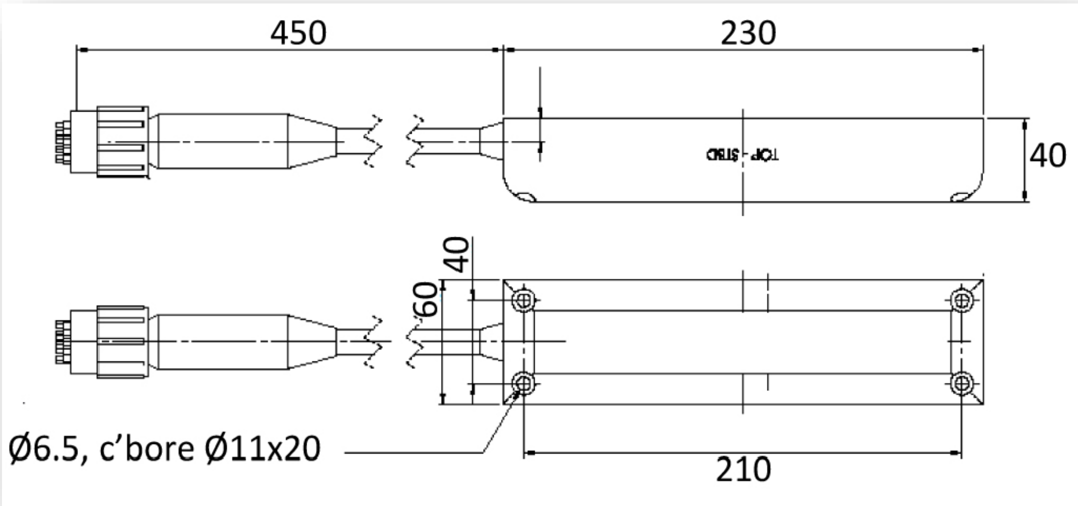


Figure 3 468kHz Transducer dimensions

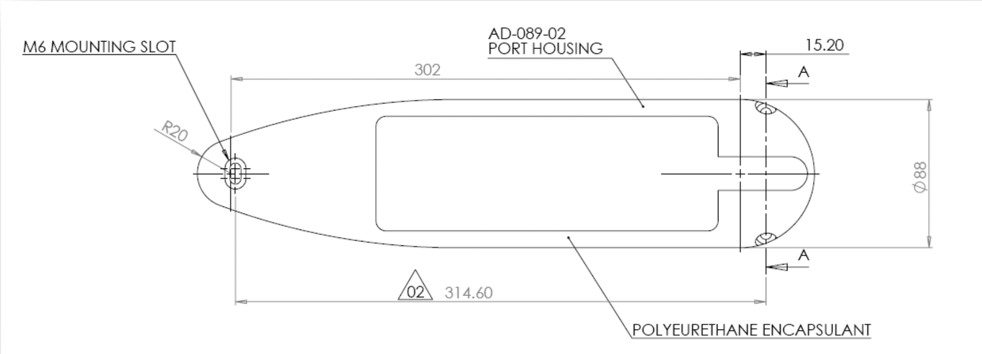


Figure 4 468kHz Buoyant Transducer dimensions

2.4 SOFTWARE

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

2.4.1 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 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.

2.4.2 Automation and Vehicle Interfaces

Previous versions of Bathyswath have been successfully integrated with a number of autonomous vehicles, including Hydroid REMUS100 and Gavia. The most common way to integrate Bathyswath is to fit a single-board computer to the vehicle, running 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.

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

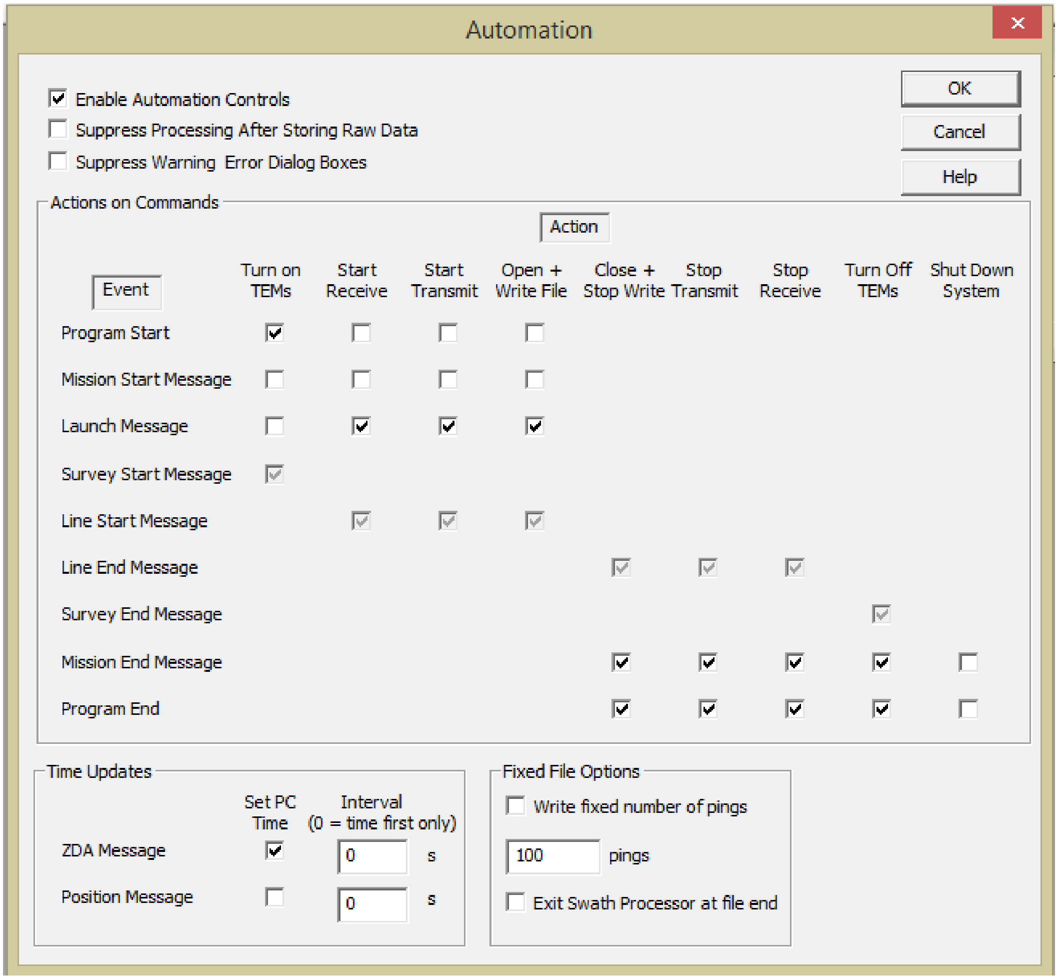


Figure 5 Swath Processor Automation dialog:
indicates the automation options in the Bathyswath software

See section 3.3 for the details of the software interfaces.

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3 INTEGRATION

3.1 MECHANICAL INTEGRATION

3.1.1 TEM Mounting

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.

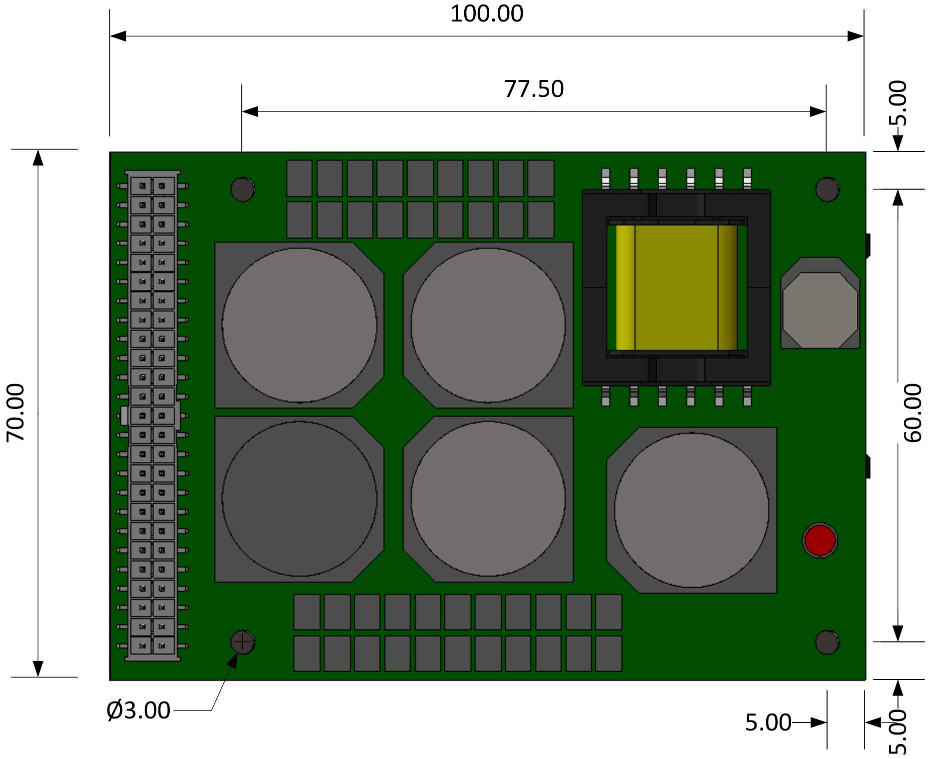


Figure 6 TEM Fixing Details
All dimensions in millimetres

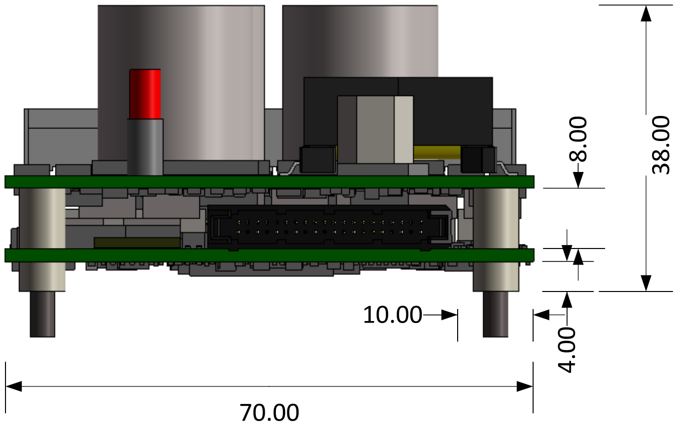


*Figure 7 TEM End View
Showing IO Connector*

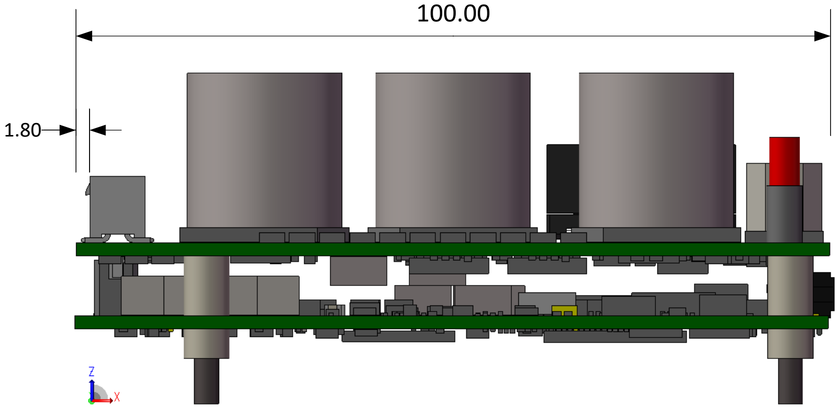


*Figure 8 TEM Side View
Showing location of transducer connector*

3.1.2 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.

3.1.3 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.**

3.1.4 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.

3.1.5 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).

3.2 ELECTRICAL INTEGRATION

3.2.1 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.

3.2.2 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

3.2.3 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.

3.2.4 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 -”.

3.2.5 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.

3.2.6 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.

3.2.7 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
1	1	GND	26	GND
	2	TX -	27	TX +
	3	GND	28	Overall Screen
	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	Overall Screen
	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 -
3	17	GND	42	GND
	18	TX -	43	TX +
	19	GND	44	Overall Screen
	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

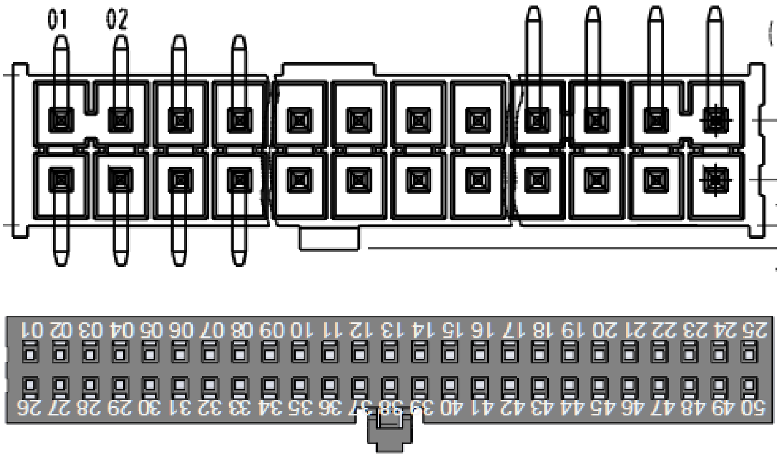
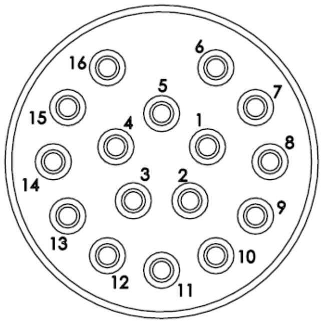


Figure 9 TEM Transducer Connector numbering

3.2.8 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 (3.2.7):

- Pre-amp power 0V,
- TXDR Test GND,
- Rx screens,
- Overall Screen (or connect this to the chassis screen of the system housing).

3.3 SOFTWARE INTEGRATION

3.3.1 General

There are two ways to integrate Bathyswath into a software system:

1. Use the Bathyswath Swath Processor program on a computer running Windows
2. Use the Bathyswath swathRT program on a computer running Linux or Windows; other operating systems can be supported on request.

On remote vehicles, the computer is likely to be a stand-alone embedded computer board.

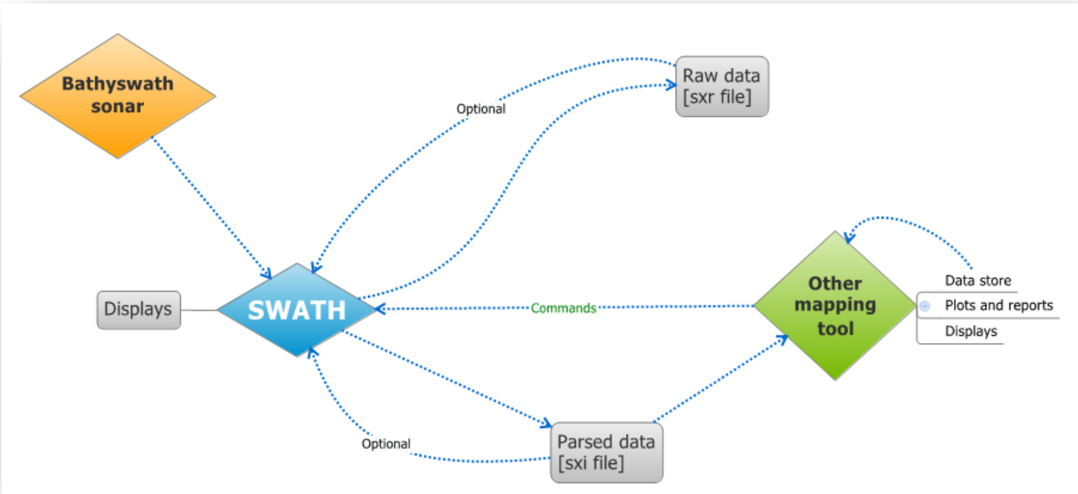
3.3.2 Bathyswath Swath Processor

Swath Processor is the main software application in the Bathyswath software suite. It provides real-time control and acquisition for Bathyswath sonar systems, and also acts as the first-pass post-processing tool.

Swath Processor has a rich set of interface formats that can be used to connect with external systems, via serial ports, TCP or UDP. The latter two can be used to share information between processes running on the same computer, or between computers using Ethernet links.

The Bathyswath software is described in Ref 1, and the external interface formats are described in Ref 4.

The relationship of Swath Processor ("Swath") with the other components is shown below.



The connection to the Bathyswath-2 TEM is through a DLL library.

Connection with other software, including the control and acquisition software of remote vehicles ("Other mapping tools" in the diagram above), includes:

- Commands in: serial port or UDP,
- Auxiliary data in (motion, position, etc.): serial port or UDP,
- Data out: TCP.

For use on autonomous vehicles, full data processing and displays can be disabled in the software, in order to minimise the use of computer resources.

Raw data files and processed data files can be created and stored on the computer disk in real-time, and/or raw data in range-angle format can be sent to external software systems over a TCP link, using the Bathyswath Parsed Data format [Ref 5].

3.3.2.1 Swath Processor Input Commands

Several different formats of command messages can be used from external software packages to control the Bathyswath system through Swath Processor. These are described in detail in Ref 4. Select the one that fits best with your application. The available command formats are listed below.

3.3.2.2 "$PMISS" Commands

These commands are used by the control systems of autonomous vehicles to signal a change in mission state. The user can configure Swath Processor to act on mission state messages as required.

These messages are encoded using the "NMEA0183" format, headed with the string "$PMISS. These have a leading '$' character, followed by an identifying string ("PMISS", and terminating with a star ('*') and two-digit hexadecimal checksum (signified by "CK" in the table below).

Some actions may require external hardware, for example to control relays.

Message	Typically Sent	Possible Bathyswath Actions
$PMISS,MISSION_START	At power-up, when vehicle starts to receive status messages from Bathyswath	Turn on TEMs, Start receive, Start transmit, Open & write to file.
$PMISS,SURVEY_START	When the vehicle reaches the survey area	Turn on electronics (TEMs)
$PMISS,LINE_START	At the start of each survey line	Start a new data file, named according to time
$PMISS,LINE_END	At the end of each survey line	Close the data file
$PMISS,SURVEY_END	When the vehicle finishes the survey, and wants to start a transit without shutting down Bathyswath completely	Turn off the sonar electronics
$PMISS,MISSION_END	When vehicle has finished with Bathyswath altogether	User settable, similar to MISSION_START. Could be used to shut down the single board computer operating system, thus reducing power further.

3.3.2.3 $SWPCT Control Messages

These messages provide finer control of the Bathyswath system than is possible with the Mission State Messages; see above. They also use the "NMEA0183" message structure.

Message	Function
$SWPCT,TEM,ON,*CK\r\n	Apply power to the sonar electronics (TEMs)
$SWPCT,TEM,OFF,*CK\r\n	Remove power from the sonar electronics (TEMs)
$SWPCT,SNR,ON,*CK\r\n	Sonar control: start pinging
$SWPCT,SNR,OFF,*CK\r\n	Sonar control: stop pinging
$SWPCT,SNR,PWR, *power*,*CK\r\n	Sonar control: set power to specified number, 0 to 100. e.g. $SWPCT,SNR,PWR, 8,CK\r\n"
$SWPCT,SNR,RNG, *range*,*CK\r\n	Sonar control: set ping range in metres
$SWPCT,SNR,PLS, *range*,*CK\r\n	Sonar control: set pulse length in cycles, 2 to 250. e.g. $SWPCT,SNR, RNG, 100,CK\r\n"
$SWPCT,SNR,PRF, *pingrate*,*CK\r\n	Sonar control: set ping repetition frequency in Hz, 1 to 30.
$SWPCT,SNR,SMP,*samples per ping*,*CK\r\n	Sonar control: set the number of samples per ping, 512 to 8192.
$SWPCT,FILE,ON,*CK\r\n	Start writing to raw file
$SWPCT,FILE,OFF,*CK\r\n	Stop writing to raw file
$SWPCT,FILE,CLOSE,*CK\r\n	Close raw file
$SWPCT,FILE,PAUSE,*CK\r\n	Pause writing to raw file
$SWPCT,FILE,OPEN,*filename*,*CK\r\n	Create a new raw file, with name given by "filename".
$SWPCT,SESSION,LOAD,*filename*,*CK\r\n	Load a session file with the specified name
$SWPCT,SESSION,SAVE,*filename*,*CK\r\n	Save the session file with the specified name
$SWPCT,TTMODE,MASTER,*CK\r\n	Set the Transmit Trigger mode to "Master"
$SWPCT,TTMODE,SLAVE,*CK\r\n	Set the Transmit Trigger mode to "Slave"
$SWPCT,TTMODE,NULL,*CK\r\n	Set the Transmit Trigger mode to "Null"

3.3.2.4 CMS_CMD Data Blocks

Bathyswath data files and data interfaces use a common block-orientated format; see Ref 4. The "CMS_CMD" block allows an external process to set the state of Bathyswath and the processing and acquisition software.

3.3.2.5 '>' System Commands

As an alternative to the $SWPCT messages, simple ASCII strings can be used; these all start with the '>' character.

Message	Function
>SNR ON	Sonar control: start pinging
>SNR OFF	Sonar control: stop pinging
>SNR PWR *power*	Sonar control: set power to specified number, 1 to 10. E.g. ">SNR PWR 8"
>SNR RNG *range*	Sonar control: set ping range in metres
>SNR PLS *pulselength*	Sonar control: set pulse length in cycles, 2 to 250. E.g. ">SNR PLS 100"
>SNR PRF *pingrate*	Sonar control: set ping repetition frequency in Hz, 1 to 30. E.g. ">SNR PRF 20"
>SNR SMP *samples per ping*	Sonar control: set the number of samples per ping, 512 to 8192. E.g. ">SNR SMP 4096"
>FILE ON	Start writing to raw file
>FILE OFF	Stop writing to raw file
>FILE CLOSE	Close raw file
>FILE PAUSE	Pause writing to raw file
>FILE OPEN *filename*	Create a new raw file, with name given by "filename". E.g. ">FILE OPEN line3".
>SESSION LOAD *filename*	Load a session file with the specified name
>SESSION SAVE *filename*	Save the session file with the specified name

3.3.3 swathRT

As an alternative to running Swath Processor on a Windows Embedded computer, a Linux application, "swathRT" can be used. swathRT is used to control the Bathyswath system on a range of operating systems, including Linux and Windows. It is useful on non-Windows systems and where a more "lightweight" application is needed than the full Swath Processor program. See the swathRT manual [Ref 6].

It accepts a simple sub-set of commands over UDP, and stores the sonar data to disk for later processing with Swath Processor.

Auxiliary data (position and motion) can be input to swathRT and stored to the data files along with the sonar data.

3.3.4 Auxiliary Data Inputs

Auxiliary data includes motion (roll, pitch and heave), heading, and position. Swath Processor needs this information to convert the raw range-and-angle sonar data into depth data on a map. However, if such processing isn't needed in real time, then it might not be necessary to send auxiliary data to Swath Processor in real time, provided that all data is accurately time-stamped. Typical scenarios include:

- **Manned survey, using Swath Processor for all processing**:
  - Auxiliary data is needed in real time,
  - Auxiliary data can be sent with its own time-stamps, or time-stamped with computer time when it arrives in the Swath software.
- **Manned survey, using Swath Processor to interface to the Bathyswath hardware and another software package for processing and survey control**:
  - Auxiliary data is input to the other software package in real time, and does not need to be sent to the Bathyswath software,
  - Swath Processor sends range-angle data to the other software package for storage and processing.
- **Autonomous survey vehicle, auxiliary data stored in Bathyswath system**

  - Auxiliary data is sent from the vehicle systems to Swath Processor in real time; Swath Processor stores it together with the sonar data in the raw data files,
  - All data is time-stamped when it arrives in Swath Processor, so that it is well aligned when it is post-processed after recovering the vehicle.
- **Autonomous survey vehicle, auxiliary data stored in vehicle system**
  - Auxiliary data is not sent from the vehicle systems to Swath Processor in real time; Swath Processor stores only the sonar data in the raw data files,
  - The auxiliary data and sonar data must be time-stamped using closely synchronised clocks, so that it is well aligned when it is post-processed after recovering the vehicle: mechanisms such as PPS are needed for this.
- **Remotely-controlled unmanned surface vehicle (USV)**
  - System is configured as per the "Manned Survey" configuration, except that all acquisition, control and data storage takes place on an embedded computer on the vehicle.
  - The operation of the system is observed and controlled using a Remote Terminal connection, over a wireless link, into the vehicle's embedded computer from the operator's computer.
  - These vehicles do not often have their own sophisticated control system, so auxiliary data is typically sent directly to Swath Processor for storage.
- **Remotely-operated vehicle (ROV)**
  - System is configured as per the "Manned Survey" configuration,
  - The TEM is mounted in a housing in the ROV, and interfaced to a computer at the surface through an Ethernet link in the ROV's umbilical cable,
  - Alternatively, a single-board computer is also mounted in the ROV housing, and does some pre-processing of data before storing it locally or sending it up the umbilical cable: this can reduce the data rates up the umbilical,
  - Vehicle motion is either sent up the umbilical cable for integration in the surface computer, or input to an embedded computer in the ROV housing.

Swath processor can read the "native" data formats used by most attitude and position sensors.

3.3.5 Sonar Data Outputs: Parsed Data Format

Bathyswath Swath Processor and swathRT output sonar data and, if required, motion and position data, using the Bathyswath Parsed Data format [Ref 5]. This is a simple block-orientated format. It is read by several third-party software packages, including Hypack, QINSy and SonarWiz. It can also be read into other copies of Swath Processor. Parsed Data can be output in real time over a TCP link, linking software applications on the same computer or on different computers over an Ethernet network. It can also be saved to files, which are given the extension ".sxi", so that this format is sometimes also called "SXI".

The Bathyswath Parsed Data format is open and free to use by anyone.

4 OPTIONAL COMPONENTS

4.1 INTERFACE BOARD

The Interface Board, part number 60274_DU, can be used to connect the TEM IO connector to the outside world through a waterproof Fischer connector. A standard Samtec ribbon cable is used to connect the Interface Board to the TEM.

The Fischer connector used is part DBPE-105-Z-102-130.

The Interface Board includes a power regulator, which extends the voltage range of the system to 9V to 36V DC (the TEM has a voltage range of 10V to 14V).

4.2 SPIDER CABLE

The Spider Cable, part number 60204-DU, is used to connect the Fischer connector on the Interface Board to standard industrial connectors, including:

Signal	Connector
Ethernet	RJ45 male connector
Power in	2.5mm jack (as used in PC power supply units)
PPS in	BNC connector
Transmit synch in and out	Fischer S-102-A-056-130c connector

The cable is supplied with a nominal length of 1.5 metres.

4.3 TRANSDUCER EXTENSION CABLE

This cable is used to extend the 450mm cable tail of the Bathyswath transducers. It is fitted with Subconn wet-mate 16-way connectors, one male and one female, with the same pin-out as the transducers (see 3.2.8). These cables can be supplied to order with lengths as required; typically 20 metres, but no more than 30 metres.

It has part number 60263-LLL, where LLL refers to the cable length in metres.

4.4 TEST CABLE

The Bathyswath-2 Test Cable, part number 60262, is used to test and configure the Bathyswath-2 TEMs. It has a Samtec connector at one end, which mates with the IO connector on the TEM, and on the other has standard connectors:

Signal	Connector
Ethernet	RJ45 male connector
Power in	“banana” plugs
JTAG (to program the device)	10 way connector, which connects to standard “USB Blaster” programmers